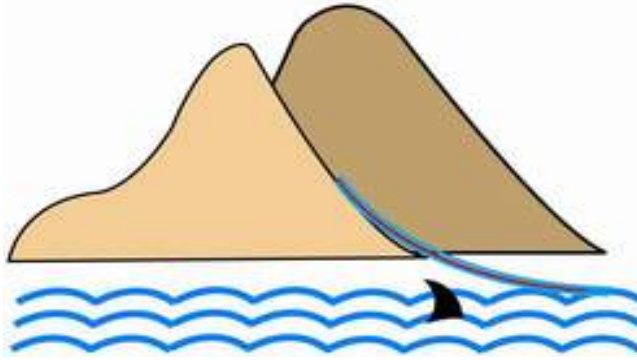




REPUBLIC OF YEMEN
Ministry of Water and Environment (MWE)
Environment Protection Authority (EPA)

YEMEN'S NATIONAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES (NPA)



EPA



DECEMBER 2003

FORWARD

With the advent of the industrial era, the threats to marine environment due to land-based human activities, whether in coastal areas or further inland, have considerably increased. Such threats are often ranked as major threats to the health, productivity and biodiversity of this environment.

Land-based activities, including the discharge of municipal, industrial and agricultural wastes as well as run-off and atmospheric fall-out, often carry the largest pollution load into the oceans (some 80%). Coastal and marine contamination usually has adverse impacts on the most productive areas of the marine environment, such as estuaries and near-shore coastal waters. Physical alterations of the coastal zones also threaten the marine environment either through destruction of habitats that are of vital importance to maintain ecosystem health or through indirect impact on such ecosystem due to construction works. Clearly then, and given that land-based activities could cause such adverse impacts on Yemen's marine environment, the need for an action-oriented program is obvious.

In response to international call to preserve the marine environment from land-based activities and the call of the GPA, Yemen's NPA has been developed. The NPA is not an end in itself but a useful strategic tool providing for a multifaceted, integral policy framework and a comprehensive, constantly updated, information base.

The initial development of Yemen' NPA (GP/3010-01-22) responds directly to the need identified by the Regional Programs through consultations held with over 70 Governments during seven regional workshops from 1996 to 1999, to share experience and promote the implementation of the GPA, both at the regional and national levels. Yemen's Environment Protection Agency (EPA) has the overall responsibility in the implementation of the NPA. The pertinent activities accomplished during the initial development of NPA, including this document and the Clearing-House Mechanism, are much appreciated.

The NPA would assist the Yemen in meeting its obligation in a comprehensive way under the Jeddah Convention and its associated Protocol on Land-based Activities (which is under drafting) as well as other relevant global legal instruments (e.g. the Convention on Biological Diversity, POPs Convention, MARPOL, etc). Moreover, NPA should help build national capacity to manage and quickly respond to national problems arising from land-based activities, including those which are of transboundary nature.

More importantly, Yemen's NPA must be developed further, essentially through developing certain pilot projects on-the-ground. Relevant key ministries will also be involved in the management and support of such proposed NPA projects. The approval of the NPA initiative places an obligation on these ministries, together with their parties working under their umbrella, to coordinate with the leading agency (EPA) in the implementation of such projects and to reflect it in their existing and future planned policies and plans.

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PREFACE

The Yemen's NPA is a result of a response to the international action calling to preserve the marine environment from land-based activities. The Republic of Yemen has developed its activities, under the umbrella of the Global Program of Action for the Protection of the Marine Environment from Land-Based Activities (GPA), led by the Yemeni Environment Protection Authority (EPA). The NPA aims to preserve the marine environment from land-based activities affecting the Yemeni marine environment at the national, provincial and local levels.

Development of the NPA is based on the methodologies recommended by the GPA. Thematically, contamination and physical alterations & destruction of habitats (PADH), identified as key problems in the NPA initiative, assessed and prioritized in relation to their pollutant sources categories. Geographically, each source category of the problems is assessed and prioritized both at the national level and provincial levels. In the context of the NPA each category is assessed at the level of Red Sea, western Gulf of Aden and eastern Gulf of Aden & Arabian Sea regions of Yemen. The NPA aims to preserve the coastal and marine environment from such activities at the national, in-country regional and local levels.

On the basis of the priorities established, management objectives are set for priority problems, with respects to source categories along with areas affected. To achieve these management objectives strategies and measures are selected to promote the sustainable use of marine and coastal resources, and to protect or remediate affected areas. Recognizing that priorities will change over time, strategies and action will be reviewed periodically to ensure they remain effective and are linked to management objectives.

The NPA is envisioned as an integrated management and policy framework. Land-based impacts and threats to the marine and coastal environment are complex and demand long-term, cross-sectoral, multi-disciplinary, and broadly participatory responses. It is therefore not an end in itself but be a useful strategic tool that can assist the Yemeni government, industry and local communities in the progressive prioritization, over an extended period of time, of their sustainable development needs and goals, and in the mobilization of both political and financial support. It provides for a multifaceted, integral policy framework and a comprehensive, constantly updated, information base.

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EXECUTIVE SUMMARY

Development of Yemen's NPA is an action-oriented program aiming to protect the marine environment from land-based activities at national, provincial and local levels. It is expected to be more widely participatory and consultative initiative. The immediately recommended immediate next step is the development of the Program Support Document for the NPA.

Yemen is one of 108 countries that committed to preserving the marine environment from land-based activities. Responding to this commitment it has developed a National Program of Action for the Protection of the Marine Environment from Land-Based Activities (NPA), under the umbrella of the Global Program of Action for the Protection of the Marine Environment from Land-Based Activities (GPA), led by the Yemeni Environment Protection Authority (EPA). Yemen's NPA aims to preserve the marine environment from such activities at the national, provincial and local levels.

The overall goals under the Yemen's NPA initiative are:

- ✓ To contribute to food security and poverty alleviation;
- ✓ To contribute to improvement of public health conditions;
- ✓ To maintain coastal and marine environment and ecosystem health, including biological diversity; and
- ✓ To contribute to generating of economic and social benefits, including cultural values.

In general, the NPA follows the principle guidelines and methodologies recommended by the GPA in the development of a NPA. It follows this process that consists of the following subsequent six steps:

- Identification and assessment of problems
- Establishment of Priority Problems
- Setting management objectives for Priority Problems .
- Identification, evaluation and are selection of strategies and measures
- Evaluation of the effectiveness of strategies and measures
- Program support elements

Thematically, contamination and PADH are identified as key problems identified in the Yemen's NPA initiative, assessed and prioritized in relation to their sources categories. The categories, identified in the NPA initiative, are: (not listed neither in order of significance nor priority)

Contamination

- Sewage
- Persistent Organic Pollutants (POPs)
- Heavy Metals
- Oils (Hydrocarbons)
- Nutrients
- Sediments Mobilization/Contaminated Sediments
- Litter

PADH

- Shoreline Alteration
- Coastal Wetlands and Intertidal Zones Alteration
- Coral Reef Degradation

Geographically, each source category of each key problem is assessed and prioritized both at the national level and provincial levels. In the context of the Yemen's NPA each category is assessed at the level of Red Sea, Western Gulf of Aden and Eastern Gulf of Aden & Arabian Sea regions of Yemen.

Establishing the key problems involves:

- ◆ Ranking the source categories of each key problem, identified in the NPA initiative, on the basis of relative severity of impacts and ICZM approaches, as well as relevant existing programs and strategies. Availability of information/data and national legislation are also taken into account in such a rank.
- ◆ Valuing the socio-economic impacts of environmental damages

On the basis of the priorities established, management objectives are set for Priority Problems, with respects to source categories along with areas affected. To achieve these management objectives strategies and measures are selected to promote the sustainable use of marine and coastal resources, and to protect or remediate affected areas. Recognizing that priorities will change over time, strategies and action will be reviewed periodically to ensure they remain effective and are linked to management objectives.

Support elements specific to the Yemen's NPA will be required at both the national and in-country regional levels. They are intended to ensure that the necessary administrative and management structure, including legal and financial mechanisms, a contingency plan and public participation, are in plan to support the national program over the long term.

Key 5-Year Objectives for the Yemen's NPA are to:

- Achieve a measurable reduction of pollutant loads in specific coastal locations
- Mainstream the NPA objectives in national and local policies and actions
- Expansion of the NPA coverage to address issues in relevant remote areas

To put the 5-Year objectives of the NPA into practice there is a need for the creation of a Program Support Document (PSD) to include components and pilot projects in more detail. Contribution of the Yemeni government in the development of the NPA for the next five years will be clarified in the PSD. It is immediately recommended to propose such a PSD Project in collaboration with the UNEP/GPA Coordination Office, to be implemented within three months.

CHAPTER 1 INTRODUCTION

This chapter contains an overview on the Yemen's NPA initiative and its objectives, showing guiding principles and approach of this initiative.

Yemen is one of 108 countries that committed to preserving the marine environment from land-based activities. It has developed a NPA initiative, under the umbrella of the GPA initiative that was adopted in 1995, for this purpose. The Yemen's NPA initiative generally aims to protecting the Yemen's marine environment from such activities. It follows the guiding principles and approach suggested by the GPA.

1.1 Overview

Internationally, there began a preparatory process to prepare a Global Program of Action on land-based activities In 1992, in accordance with the provision of paragraph 17.26 Chapter 27, of Agenda 21, under the United Nation Environment Program (UNEP). At the Washington Intergovernmental Meeting, held in 1995, the Global Program of Action for the Protection of the Marine Environment from Land-Based Activities (GPA) was adopted with commitments declared by 180 governments and the European to contribute to the development of the GPA. At this meeting the UNEP has been tasked as a Secretariat for the GPA, and included among its functions the promotion and facilitation of its implementation at the national, and regional level in coordination with interested regional and national agencies. The UNEP has established a UNEP/GPA Coordination Office at Hague, The Netherlands, for this purpose. This Office held its First Intergovernmental Review Meeting in November 2000 at Montreal, Canada.

Regionally, the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA), like other respective regional organizations, committed to develop the GPA at the regional level. In 1997 Yemen was involved in the assessment of the land-based activities on the marine environment of Red Sea and Gulf Aden coast, along with other countries located along this region.

Nationally, Yemen, with other selected countries, has started developing a Program to preserve the marine environment at the national level. This Program has been put into practice as a pilot project, namely, Pilot Development of Yemen's NPA for the Protection of the Marine Environment from Land-Based Activities-GP/3010-02-22, signed by the Ministry of Tourism and Environment (MTE) (it is now called Ministry of Water and Environment (MWE)) in October 2001. The Environment Protection Authority (EPA), MWE, has the overall responsibility in the implementation of the NPA.

1.2 Basis of NPA

The NPA initiative essentially focuses on the protection of the coastal and marine environment on the basis of the ecological sustainable development. The sustainable use of its resources is linked to public health, food security and economic and social benefits, including cultural values and traditional livelihoods. These elements are considered as decisive elements in the alleviation of poverty. Many countries, including Yemen, depend on sources of income from the sea, such as fishing and tourism. These sources would be

directly affected by degradation of the coastal and marine environment unless they take place on a sustainable manner.

Healthy coastal and marine systems provide renewable food supplies, tourism opportunities and many more benefits that are not well considered and/or abused in many coastal areas, including in many coastal rural areas of Yemen. Activities from industrial and agricultural production to daily domestic routines all generate impacts that cumulatively affect health of these critical ecosystems, and ultimately the surrounding people. The activities depend on such ecosystems for their subsistence and economic development. Public health should be considered from a degraded marine environment caused by contaminated seafood.

Like many developing countries, the food security in Yemen is threatened. The loss of marine living resources, which are vital for the adequate provision of food and for alleviating poverty, would contribute to the food insecurity in the country.

The subsistence economy of most coastal populations in Yemen, including villages, is based on marine living resources. These resources would be threatened by such degradation unless relevant effectively protective measures are put into practice. Such degradation leads to have adverse effects on the maritime culture, traditional lifestyles, and aesthetic values in the country.

1.3 Objectives

Generally, the Yemen's National Program of Action for the protection of the Marine Environment from land-based Activities (NPA) aims to protect the marine environment through co-operative solutions. Essentially, it aims to documenting a program with costed targeted projects – based on the methodologies suggested by the GPA- at the in-country regional and national levels. The fundamental purpose for implementing a national program of action (NPA) is to ensure the health and sustainable use of coastal and marine resources by responding in a strategic and feasible marine using targeted and adequate resource management, to both sustained and short-term processes caused by human activities on land.

Objective of the Yemen's NPA are as follows:

- To implement actions to address specific causes of environmental degradation or threats from land-based activities.
- To design an applicable flexible mechanism for identifying and addressing Priority Problems through partnerships and consensus amongst stakeholders, including coastal and watershed NGOs.
- To strengthen the public sector's ability to effectively respond to these causes and to ensure the sustainability of the actions and projects undertaken.
- To mobilise resources and partners, including international and national organizations and the private sector, for implementation of specific projects at the national and in-country regional levels.
- To raise awareness and understanding of the value, benefits and vulnerability of strategic coastal and marine environments

1.4 Guiding Principles and Approach

The main principles that are listed below would be considered when developing the Yemen's NPA. They are suggested as fundamental principles for achieving sustainable development in coastal and marine environments and are not listed in any order or priority. However, more principles may be added.

- The environmental economic, social and cultural values of coastal and marine resources will be identified and the effects of land-based activities on those values will be determined as far as possible.
- Assessments of the impact of land-based activities at local, regional, and global scales would be taken into account long-term impacts.
- Cumulative impacts should be taken into account when assessing the impact of land-based activities and determining cooperative action.
- If there is a risk of serious or irreversible damage to marine environments as a result of land-based activities, those activities should be permitted only if the damage can adequately mitigated using cost-effective measures, even in the absence of full scientific certainty concerning concerning the possible damage.
- The Yemeni Government would give due consideration to positive and negative impacts of domestic legislation and policies, including, amongst others, feasible measures, such as taxation and subsidies, on land-based activities that contribute to the degradation of coastal and marine environments.
- Effective and high-quality public consultation and participation are encouraged in both developing and implementing the Yemen's NPA. Interests and knowledge of the local communities, namely watershed and coastal communities, will also be recognized and incorporated into management arrangements. They should be encouraged to share responsibility for protecting coastal and marine environments from land-based activities.
- The desirability of maintaining more natural and sites of ecological, cultural, archaeological, historic and scientific significance will be taken into account when developing and implementing national actions.
- Consequences arising from the highly dynamic nature of coastal environments will recognised when devising national actions. Natural physical and biological processes in the coastal zone would be safeguarded. Developments, particularly coastal land filling, would be avoided in locations and sites where natural processes may threaten public safety.
- The biological diversity of coastal and marine ecosystems should be maintained for future generations. Where environmental qualities have been degraded, remedial actions will be initiated to restore these qualities.

Due to the wide range of land-based activities, which when combined have a deleterious impact on invaluable marine ecosystems, sustainable development and protection of marine ecosystems pose challenges that demand multidisciplinary and cross-sectoral approaches. The

future development and implementation of the Yemen's NPA initiative will use sustainable, pragmatic and integrated environmental management approaches and processes, such as integrated coastal area management, harmonized, as appropriate, with river basin management and land-use plans. New approaches are emphasized to brainstorm and adopt, e.g. an integrated coastal zone-river basin management approach, where applicable.

CHAPTER 2 METHODOLOGICAL FRAMEWORK

This chapter contains the methodological framework of the Yemen's NPA, including logic process used, stakeholder participation and project development.

Yemen's NPA generally follows the process recommended by the GPA in developing NPAs. Participation of relevant stakeholders, including NGOs and the private sector, is encouraged as a major activity for the development of the Yemen's NPA initiative. Pilot projects should be developed to enhance this initiative.

2.1 A Logical Process for NPA Development

The GPA recommends a process in the preparation of NPAs. Yemen's NPA follows this process that consists of: the following subsequent six steps:

- Identification and assessment of problems
- Establishment of Priority Problems
- Setting management objectives for Priority Problems
- Identification, evaluation and selection of strategies and measures
- Evaluation of the effectiveness of strategies and measures
- Program support elements

Each step of the above process is discussed in the following sections.

2.1.1 Problems Identification, Assessment and Prioritization

Thematically, contamination and PADH-as key problems identified in the Yemen's NPA initiative- are assessed and prioritized in relation to their source categories. Geographically, each source category of each key problem is assessed and prioritized both at the national level and in-country regional levels.

A. Identification and assessment of problems

Marine contamination and physical alterations and destruction of habitats (PADH) are the key problems relating to the Yemen's NPA initiative. The NPA reviews the key pertinent existing national plans and programs, that are, National Environment Action Plan (NEAP) of 1995 and Environment and Sustainable Development Investment Program (ESDIP) for the period of 2003-2208. On the basis of: urgency, irreversibility, effects on human health and economic productivity, number of people, and loss of amenities and effects on the poor, untreated wastewater, liquid and solid waste, degradation of natural habitats, marine pollution, mismanagement of fishery resources, dumping of ship waste and degradation of cultural and historic heritage are identified as relevant problems in the NEAP. The ESDIP also follows the similar criteria used in the NEAP in identifying the key environmental issues that are: water depletion and pollution; wastes; land degradation; habitat and biodiversity destruction; and climate change/energy.

However, the problems, identified both in the NEAP and ESDIP, are very general and identified based on criteria differed from that of the GPA. Importantly, Yemen's NPA, like

other NPAs, follows the process recommend by the GPA in identifying coastal and marine problems caused by land-based activities. This process combines the following five elements:

- Nature and severity of problems
- Contaminants
- Physical alterations and destruction of habitats (PADH)
- Sources of degradation
- Areas of concern

In the development of the NPA inadequacy and lack of data and information have made it difficult to precisely identify pertinent problems based on the respective process (combination of the five elements), most particularly criteria related to nature and severity of such problems. These criteria are: food security and poverty alleviation; public health; coastal and marine resources and ecosystem health, including biological diversity and economic and social benefits. Nevertheless, the NPA initially identify the following issues are the two key problems pertaining to the GPA initiative and relating to the NEAP and ESDIP.

- Contamination
- Physical Alterations and Destruction of Habitats (PADH)

The above problems identified in the Yemen's NPA initiative are assessed in relation to their sources categories, taking into account the five elements in the assessment of each category both at the national level and in-country regional levels.

Source categories of the contamination, discussed in the context of the NPA and identified in the GPA, are: (not listed neither in order of significance nor priority)

- Sewage
- Persistent Organic Pollutants (POPs)
- Heavy Metals
- Oils (Hydrocarbons)
- Nutrients
- Sediment Mobilization/Contaminated Sediments
- Litter

Source categories of the PADH, identified in the Yemen's NPA, are: (not listed neither in order of significance nor priority)

- Shoreline Alteration
- Coastal Wetlands and Intertidal Zones Alteration
- Coral Reef Degradation

In the context of the NPA each source category of each key problem is assessed both at the national level and in-country regional levels. Each category is assessed at the level of the following coastal regions:

- Red Sea (all coastal areas, islands and wadis located within the geographical scope of Haja, Al Hudaydah and Taiz governorates)

- Western Gulf of Aden (all coastal areas, islands and wadis located within the geographical scope of Lahj, Aden and Abyan governorates)
- Eastern Gulf of Aden and Arabian Sea (all coastal areas, islands and wadis located within the geographical scope of Shabwa, Hadramout and Al Mahra governorates)

B. Establishment of priority problems

Prioritization of each problem is set at the national level and at the level of each relevant Yemeni coastal region. Establishing the key problems involves:

- ◆ Ranking the source categories of each key problem, identified in the NPA initiative, on the basis of relative severity of impacts and ICZM approaches, as well as relevant existing programs and strategies. Availability of information/data and national legislation are also taken into account in such a rank.
- ◆ Valuing the socio-economic impacts of environmental damages

2.1.2. Objectives, Strategies and Measures of NPA

A. Setting goals and management objectives

On the basis of the priorities established, management objectives are set for Priority Problems in relation to their source categories.

B. Identification, evaluation and selection of strategies and measures

To achieve these management objectives, strategies and measures are selected

- ◆ to promote the sustainable use of marine and coastal resources, and
- ◆ to protect or remediate affected areas.

2.1.3 Ensuring Effectiveness and Support to NPA

A. Identification of criteria for evaluation of effectiveness

Recognizing that priorities will change over time, strategies and action will be reviewed periodically to ensure they remain effective and are linked to management objectives.

B. Development of program support elements

Support elements specific to the Yemen's NPA will be required at both the national and in-country regional levels. They are intended to ensure that the necessary administrative and management structure, including legal and financial mechanisms, contingency plans and public participation, are in plan to support the national program over the long term.

2.2 Encouraging Stakeholder Participation

The Yemen's NPA is expected to be more widely participatory and consultative in the future. The guiding objective is to ensure that a full range of stakeholders, including NGOs and the private sector, develop a sense of commitment to proposed measures and activities that comprise the national program of action.

The identification of a stakeholder:

- is an ongoing process that will be further developed refined over time.
- will be tailored to address different levels, i.e. national, sub- national, in-country regional and local ; and,
- requires an assessment of the needs and concerns of different stakeholder groups.

The following listed potential stakeholders would be encouraged to get involved in the activities of the NPA:

- Government representatives, parliamentarians, legislators and regulators;
- Local authorities and representatives of local and indigenous communities;
- Private sector representatives (industry, services and financial sectors) ;
- Potential investment partners, both domestic and international;
- Non-governmental organizations with relevant expertise;
- Experts from academia and scientific institutions (from scientific, technical and socio-economic backgrounds); and,
- Media, with a view to strengthening public awareness of the national program and generating support for it.
- Financial institutions both domestic and internal e.g. for microfinancing and entrepreneur financing

2.3 Development of Pilot Projects

Initial priorities can be organized around projects that are very visible or may have a big impact on a site or a cause of degradation, but that do not imply a large financial outlay. Pilot projects may be ongoing projects; reuse of treated municipal wastewater of Aden and Al-Hodiedah is an example. Ideally, a pilot project would activate the involvement of different stakeholder groups.

In order to stimulate support for the Yemen's NPA, a pilot project may be developed early on that has demonstration qualities, can become an incentive for future projects, and generate stakeholder commitment. It would serve to demonstrate that although assessments and evaluation are necessary, concrete actions are the real objective.

CHAPTER 3 NATIONAL PERSPECTIVE

This chapter contains a background on the Yemen's coastline, reviews the relevant national legal and institutional frameworks, and discusses the subsequent steps of the process used in the NPA at the national level.

Yemen is located in the southeastern part of the Arabian Peninsula. Red Sea, Gulf of Aden and Arabian Sea regions are the three main coastal regions located along its coastline. The country has developed a institutional and legal framework concerning the marine environment protection. Each of the following subsequent steps of the process used in the Yemen's NPA initiative is discussed at the national level:

- *Identification and Assessment of Problems*
- *Priority Problems*
- *Setting Goals and Integrated Management Objectives*
- *Strategies and Measures*
- *Criteria Evaluation*
- *Program Support Elements*

3.1 Background

The Republic of Yemen lies on the southwestern tip (part) of the Arabian Peninsula bordering Saudi Arabia to the north and Sultanate of Oman to the east. It occupies an area of nearly 555000 square kilometers - excluding Ar Ruba Al Khali Desert, located towards the north-eastern edge of the country. Aden (on the northwestern side of the Gulf of Aden) Al Hudaydah (on the southeastern side of the Red Sea) and Mukalla (on the northeastern side of the Gulf of Aden) are the main coastal cities (See Appendix 1) with areas larger than others in Yemen. Al Mukha (on the southeastern side of the Red Sea and closer to Bab el Mandab) and Nishton (on the Arabian Sea) are minor seaports in the country.

Yemen comprises many different topographic features: mountains, plateaus, coastal plains, desert, islands, etc. The coastal plains have a hot climate, with generally low to very low rainfall. Nevertheless, the plains contain important agricultural zones due to the numerous wadis (nonpermanent watercourses) (see Appendix 2). These wadis drain the adjoining mountainous and hilly hinterlands. They facilitate spate irrigation and provide recharge to the porous and permeable Quaternary sedimentary aquifers of the plains. Wadi run-offs often reach the coasts of Yemen, depending on the amount of the seasonal rainfalls and distance from upper catchments.

The coastline of Yemen is over 2100 kilometers long. It included three different coastal regions, i.e., Red Sea, Gulf of Aden and Arabian Sea. The Red Sea region is about one third long of this coastline, with the remainder bordering the Gulf of Aden region. The Red Sea and Gulf of Aden regions of Yemen represent a complex and unique tropical marine ecosystem with extraordinary biological diversity and a remarkably high degree of endemism. It is also an important shipping lane linking the world's major oceans. Western Gulf of Aden and Arabian Sea region is a highly productive fishery region due to the Upwelling phenomenon, supporting a feed web that ultimately sustains the fish community. The coastline is also an important shipping lane linking the world's major oceans. Recently, about 100 million tons of oil transit the Red Sea annually (PERSGA, 1995). Both the Red Sea and

the Gulf of Aden are designated “ special areas” under the international MARPOL convention.

There nine governorates, Haja, Al-Hudaydah, Taiz (Red Sea), Lahj, Aden, Abyan, Shabowa, Hadramout, and Al-Mahra (Gulf of Aden and Arabian regions) share the Yemen’s coast . However, not most areas, including main cities, found in these governorates locate along the coastline. According to the 1994 census, the total population of the coastal areas of Yemen was lees than 2 million distributed over nine governorates,

Over 115 islands lie in the seawater of Yemen with distinct climatic and natural characteristics. More than 112 of these islands lie in the Red Sea region of the country. Among those located in this region: Kamaran Is. is the biggest, and Mayoon Is., located at the Bab Mandab strait, has strategic importance. Generally, corals and coral habitats exist at the Yemeni islands, but with different diversity of communities and number. However, general speaking, Socotra is the largest Yemeni Island (nearly 3000 square kilometers) in the Arabian Sea and has a more exuberant flora and fauna, including corals, than any other region in the Arabia.

3.2 Legal Framework

In this section the national laws and the international conventions ratified that relate to the NPA initiative are discussed separately.

Yemen has developed a number of national instruments exist at various governmental levels. They are directly or indirectly concerned with the marine environment protection. It is party to international conventions, agreements and treaties that have implications on the marine environment.

3.2.1 National Laws

Since 1990 the Yemeni Government has established a number of national laws and regulations that concern and relate to the coastal and marine environment under responsibility of several agencies. The relevant national regulations and laws are listed below.

- Presidential Resolution No. 275 of 2000 (Master Plan of Socotra Archipelago)
- Law No.4 of 2000 (Duties of Local Governments)
- Law No.39 of 1999 (Cleaning and Improvement of Cities)
- Law No.25 of 1999 (Regulating and Handling of Pesticides)
- Law No.1 of 1995 (Common Benefit)
- Law No.20 of 1995 (Urban Planning Procedures)
- Law No.21 of 1995 (Land and Real State)
- Law No. 26 of 1995 (Environment Protection)
- Prime Ministerial Decree No. 4 of 1996 (Establishment of Protected Areas in Socotra)
- Law No.15 of 1994 (Ship Registration, Documentation, Monitoring)
- Prime Ministerial Decree No.23 of 1994(Validations and Penalties)
- Law No.4 of 1993 (Free Zone Law)
- Law No.11 of 1993 (Protection of the Marine Environment from Pollution)
- Law No.37 of 1991(Territorial Waters and the Exclusive Economic Zones)
- Law No.42 of 1991(Fisheries Law)

Each of the above laws is discussed below.

Presidential Resolution No. 275 of 2000: is concerned with the master plan of Socotra Archipelago (Socotra Is., Samha, Darsa Is., Abdulkoori Is. and others islands and its pinnacles that form part of it) as marine protected area of multi-use type. The Article of the Decree states that the Law aims at protecting the biodiversity of Suqutra group of islands, and striking a balance between the developmental requirement of the people and the available natural resources, in such a way that it does not affect the act of protecting nature, which in itself is of national and international importance. The Article No. (14) of the Resolution also subjects all ministries, public and private establishments to study the impact of the environment on all projects and activities in accordance with Law No. 26 of 1995 (Environment Protection Law).

Law No. 4 of 2000: is concerned with Local Governments. The Article No. (19) of the Law states a number of duties and obligations, which are performed by the Local Council of each Governorate. Some such duties and obligations are listed below:

- Discussion and approval of architectural and environmental plans and submitting them to concerned central authorities for approvals.
- Supervision and monitor of the process of executing marine policies and protection of underground water basins against depletion and pollution.
- Revitalization of tourism and investments on tourism.
- Monitor of proper utilization of fish wealth, marine life and taking all the necessary steps to protect them within the limitation of the laws.

The Article No. (61) of the Law states that the Local Council of the district should take charge of the supervision of environmental policies and legislation, and to take all necessary steps to preserve the environment and the natural protected areas, and protecting them against pollution and attack.

Law No. 39 of 1999: is concerned with the general cleaning and improvement of cities. It, in accordance with the Article No. (3), aims at protecting the environment and public health, and disposing of wastes by using proper methods, or treating them, or recycling them by using up-to-date techniques. The Law, in accordance with the Article No. (5), prohibits dropping, placing, or leaving behind wastes on seacoast, agricultural land, stormwater courses and valleys. The Law also prohibits placing them in a hole in the ground and then covering them with earth, burning them, or placing them in places not designated for them. The Law also, in accordance with the Article No. (10), prohibits the manufacture and import of plastic bags that do not breakdown and disintegrate with time. It states that subject matters must be coordinated with other concerned authorities so as to take advantage of other legislation on the environment.

Law No. 25 of 1999: is concerned with regulating and handling of pesticides. The Article No. (3) of the Law states the objective of the Law that briefly deals with the handling of herbicides, and procedures for registry, monitoring and inspecting herbicides in an effort to avoid the danger posed by them and their toxic effects on the health of humans, animals and the environment. The Article No.(28) subjects all sections of the armed forces, security, exercises and duty, supply & commerce, seaports & airports to implement the Law.

Prime Ministerial Decree No. 4 of 1996: established parts of Socotra as a protected area and developed a High Committee for Development of Socotra headed by the Deputy Prime Minister and Minister of Planning and Development.

Law No. 26 of 1995: aims at fulfilling the international commitments with respect to protecting the environment and combating pollution. It places the responsibility of protecting the environment and its natural resources, combating pollution, and protecting terrestrial and marine wildlife on formal government authorities, public and private institutions, and the individuals.

The Law consists of five parts, 18 chapters and 92 articles. Part Four of the Law deals with Marine Pollution, and its Article (64) mostly and generally pertains to the Yemen's NPA. In accordance with this Article it is not be permissible to pollute the marine environment from land resources as from river estuaries and pipelines and sanitary discharge outlets and from industrial establishments, constructions and furnaces. If such pollution occurs it must be controlled and mitigated in accordance with the internationally accepted standards and criteria.

The Law also consists of other many articles-under other its parts- deal with contamination, and PADH, either directly or indirectly. In accordance with the Article (54), for instance, it shall be absolutely prohibited for any public or private party or any natural or juridical person to import, enter, dump, bury or store toxic, radioactive and hazardous wastes or the disposal of it by any means in the Yemeni environment.

In accordance with Article (35) of the Law it is not permissible for any competent body to give permission or issue a license to establish or operate or amend projects or establishments that affect and damage the environment or contribute its deterioration or causing its pollution or participate in occurring such effects or harming human health or other living marine organisms, only in accordance to the standards or criteria or specifications or conditions are determined and specified by the EPA.

In accordance with the Article (36) of the Law it is not permissible to issue licenses for projects and establishments which are by its nature a sources an environmental pollution or that is potentially causing environmental impacts and damage out of its activities, unless an environmental impact assessment referred to this law is undertaken.

Law No. 21 of 1995: aims at identifying land and real state belonging to the Government, drawing plans and marking them, maintaining and protecting them, setting up proper procedures for dealing with them so as to make use of them, capitalize on them and develop their resources. In its Article No. (38) the Law prohibits the hiring or the granting of permission to establish tourist or development projects on islands or coasts except after ascertaining that these projects would not cause any adverse effects on the environment or aesthetic values.

Law No. 20 of 1995: aims to deal with procedures for urban planning in all parts of the Republic. In accordance with the Article (3) of the Law, the Law aims at best usage of land, organizing its usage for various purposes, protection of agricultural land and sites for natural resources from infringement by construction and building works, protection of the environment from pollution, protection of valleys, water courses, flash flood courses, underground water and the coastline.

Law No. 1 of 1995: is concerned with repossession for common benefit. Its Article No. (1) allows ministries, corporations, authorities, and public establishments, when necessity arises, to repossess land for the common benefit against fair compensation for the sake of executing projects for the common benefit. The Article No. (2) states that the “necessary projects” are those of common benefit and which have no other alternative, such as sewerage system, location of sites of mineral resources, oil, gas, airports, seaports, dams, and irrigation and potable water projects.

Prime Ministerial Decree No. 23 of 1994: is concerned with violations of plans and construction works in main cities and towns, and the corresponding penalties. The Decree states a number of violations. Building in wadis beds and on wetlands are examples of these violations.

Law No. 15 of 1994: deals with the legal provisions of ships: registration, documents, monitoring and supervision. It also deals with those provisions that are related to marine accidents/incidents. Amongst the most important subjects this Law deals with is the ‘ship documents’, the most important of which are the certificates which safeguards against pollution, a register for dispensing oils. Also among the most important documents of fishing boats are the documents that deal with permission to fish. The Law prohibits any foreign ship from leaving Yemeni ports, or which is passing through or mooring in territorial waters, unless it satisfies all safety requirements as per provisions of international agreements valid in the Republic of Yemen with respect to safeguarding life in sea and in cargo ships, and protecting the marine environment against pollution.

Law No. 11 of 1993: was established for the protection of sea from pollution. The Law is mainly concerned with pollution by oil and pollution from passing ships. The law determines procedures for prosecuting, penalizing and requesting compensation from ships that violate the law. It gives the Public Corporation for Maritime Affairs the legislative power to deal with oil pollution at sea. In its article No. 35, the law prohibits any form of discharge of pollutants of any kind and from any source into the sea without prior treatment.

The Law prohibits shops, industrial and tourist complexes, facilities and public places to discharge, disposed of any polluting material, wastes or untreated liquids, which may cause pollution of the beaches of the Republic of Yemen, either done intentionally or unintentionally, directly or indirectly. The Law considers discharge as a punishable crime; as each discharge for any single day is considered as a separate single crime. The Law does not grant permission to build on seacoast or near it, which may result in discharge that contravenes the provisions of the Law, unless sewage and wastes treatment units are provided.

The Law defines Pollution of the Marine Environment as “Injection by man into the marine environment either directly or indirectly of matter or energy, thus causing, as a direct result, or could cause harmful after-effect, such as causing harm to marine life or man’s health, or disruption to marine activities, such as fishing and the lawful exploitation of seas and oceans, and the degradation of the quality of seawater to the extent of reducing its usage as a recreational site and for other purposes.”

“Discharge” is defined as “Drop, causing to leak, inject, pump, pour, empty, drown, pile-up, or throw away, either directly or indirectly, any environmental pollutant into the atmosphere, land or any area that is free from pollutants.” The Law defines polluting substances as “oils,

oily compounds, or any substance that is dangerous or harmful such as sewage and wastes, so that if added to water renders that water bad and spoiled, and causes its quality to degrade to the extent if used it could constitute a danger to man, animal, fish, or plants that are useful to man”.

Law No. 4 of 1993: is concerned with the Free Zone. Its Article No. (3) states that Free Zone areas shall be established in the Republic of Yemen by a Decree of the Prime Minister. In the Article No. (10) the Law prohibits entry of dangerous wastes and the carrying out of any work or activity, which is in violation with instructions pertaining to the protection of the environment. In the Article No. (10) the Law prohibits any activities or practices carried out in contradiction with special directives regarding the protection of the environment.

Law No. 42 of 1991: is the main legal framework for organization, exploitation and protection of fishing and aquatic resources. It deals with the protection of fisheries resources and regulation of fishing activities. The law prohibits the use of destructive fishing methods such as poisons, chemicals, etc. It also indicates means of limiting and/or dealing with pollution.

The law was amended in 1997 according to the *Presidential Resolution No. 43 of 1997*. In this amendment the Law also prohibits the plucking and cutting of seaweed and sea grasses or coral reefs except in exceptional cases and after securing prior permission from the responsible Ministry. Moreover, the Law prohibits factories, laboratories, and places which produce and handle chemicals and petrochemicals from discharging waste containing toxic substance, or any other substances that cause death or harm to marine life, unless treatment units are constructed to extract such substances and other harmful stuff before discharge.

Law No. 37 of 1991: defines the territorial waters and the exclusive economic zones of 200 nautical miles, the boundaries of the islands. It also regulates free passage in the Strait of Bab al-Mandab. It emphasizes on the prohibition of dumping any wastes into these zones. The Law states that “the passage of a ship or submarine or a submerged ship will be considered as a non-land passage if such a ship or a submarine or a submerged ship has, while in territorial waters committed an act that caused intentional pollution that is harmful to human health, marine life and marine environment.” It also states that the Republic enjoys a number of rights in the economic area and the continental shelf inclusive of the bottom and what lies underneath, and the vertical column of water. Such rights include full sovereignty over the marine environment, its maintenance, protection, prevention, monitoring, and fighting marine pollution.

To conclude, like most developing countries, Yemen has recent laws and regulations dealing with land-based pollution. This is attributed to the relative lack of awareness of the proper level or amount of importance that should be given to environment protection in general and to land-based pollution in particular.

As noted, Yemen gives great and “special” importance to laws and regulations, which deal with the environment in general, and more particularly to those concerning land-based pollution. However, the country faces a number of obstacles to implement its legislation. These obstacles include:

- Overlapping and contradicting aspects in authority that was granted to them through other laws and regulations that spelled out their duties and obligations;

- Weakness of institutional framework of concerned authorities causing them incapable to performing their duties and obligations assigned that have been stated in other standing laws and regulation;
- Extreme inadequacy in resources; and
- Scattering of pertinent issues over many different laws

Therefore, there is a need for harmonization of national legislation. A study should be carrying out to put laws and regulations dealing with land-based pollution into a single legal framework. Gathering together all related legal texts in a single manual or guide would simplify the task of national and foreign researchers in the field of land-based pollution in Yemen.

3.2.2 International Agreements

Yemen ratified most international conventions, agreements and treaties, which have implications on the marine environment, including living marine resources. Treaties or conventions that were signed by the ex-YAR and the ex-PDRY are still in force according to the unification decree. Most international conventions were ratified in the 1990s. In 1996 alone, four conventions relevant to environment, including the Biodiversity Convention, were ratified.

Yemen ratified the following conventions:

- Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment (Jeddah Convention 1982, updated 1994). Yemen is a party to this regional Convention under the umbrella of the Arab League.
- Protocol Concerning Regional Cooperation in Combating Pollution by Oil and other Harmful Substances in Cases of Emergency (1992, updated 1994). Yemen cooperates with Djibouti and Somalia in combating oil spills. Oil pollution control equipment for the Gulf of Aden area (Yemen, Somalia and Djibouti) has been stored at the Marine Emergency Mutual Aid Center (MEMAC) in Djibouti. Yemen and Djibouti are currently negotiating a bilateral agreement regarding the use of such facilities.
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1996)
- Convention on Biological Diversity (signed 1992, ratified 1996)
- Montreal Protocol on Substances that Deplete the Ozone Layer (1996)
- United Nations Convention on the Law of the Sea, signed in 1992, ratified in 1987, and entry into force in 1994, but updated in 1995)
- United Nations Framework Convention on Climate Change (signed 1992, ratified 1996)
- Vienna Convention on the Protection of the Ozone Layer (1996)
- Stockholm Convention on Persistent Organic Pollutants (POPs) (2001)
- Ramsar Convention on Wetlands (2001)
- Convention on Conservation of Migratory Species (2002)
- Convention on Desertification (1996)

3.3 Institutional Framework

Listed below are the authorities operating under the umbrella of different Ministries. These authorities concern with issues related to the marine environment conservation.

- ❑ Environment Protection Authority (EPA)
- ❑ Tourism Development Authority (TDA)
- ❑ Maritime Affairs Authority (MAA)
- ❑ Maritime Training Centre (MTC)
- ❑ General Corporation for Development and Promotion of Yemeni Islands (GCDPI)
- ❑ Marine Science and Resources Research Center (MSRRC)
- ❑ Coast Guard Authority (CGA)
- ❑ High Council for Urban Planning (HCUP)
- ❑ Faculty of Oceanography and Environment, Al-Hudyadah University
- ❑ Faculty of Environment and Marine Biology, Hadramout University
- ❑ Department of Earth and Environmental Science, University of Sana'a
- ❑ Environmental Research and Studies Division, University of Aden

Activities and duties of each authority are discussed below under the pertinent Ministry.

Ministry of Water and Environment (MTE)

The MWE (former Ministry of Tourism and Environment (MTE)) is a newly established governmental agency (2003). The following authority operates under the umbrella of it, which has the overall responsibility in the implementation of the NPA.

- **Environment Protection Authority (EPA):** has been established after establishment of the MTE in 2001. It follows the Environment Protection Council (EPC) that was established in 1991, but as the EPC had a coordinating role, the newly established EPA has a clear mandate to implement the environment legislation and to execute relevant programs and projects and as decided in its mandate. Currently, the EPA has:
 - Four directorates (Natural Resources, Control and Monitoring, Planning and Environment Data, and Administration & Financial Affairs)
 - Two departments: one for Legal Affairs, and the another for Awareness Raising, Non-Government Organizations (NGOs) & Information
 - Five Units (Climate Change, Ozone, Hazardous Waste, Women and Environment, Poverty Alleviation and Local Environmental Issues)

About 40 national employers now work for the EPA in environmental issues and most them have B.S. degrees in oceanography and marine environment. It has a branch in Aden and a department in Socotra Is. The branch has a POPs Unit.

Ministry of Fish Wealth (MFW)

The MFW regulates fishing, issues licenses, and supervises processing and marketing of fish and fisheries products for local consumption and export. Imports and/or manufacturing of fishing gear and other relevant equipment must be in accordance with specifications of the MFW. It is responsible for the management and development of Yemen's fish resources.

The MFW, through the department of monitoring and surveillance, is responsible for the enforcement of laws and regulations concerning marine resources. It has directorate offices in the capitals of governorates having coastal towns. The following agency is the most important party having activities relating to the NPA initiative and operating under the umbrella of the MFW.

- **Marine Science and Resources Research Center (MSRRC):** its head office is located in Aden. The MSRRC is the advisory body for the MFW. It advises the Ministry on fish stock assessment and management, fish landings, fishing seasons etc. It usually receives assistance from UNESCO and the Islamic Development Bank. It consists of three departments: Fisheries, Oceanography and Benthos. It has also a newly established small pollution control center at al-Buraiqa (Little Aden), an experimental mariculture station. The center has received some technical assistance from the Fisheries Development Project and has collaborated with this Project to execute a coastal habitat survey of the Gulf of Aden.

Most recently two branches have been officially established in Al Hudaydah and Mukalla that have less structure and staff. The MSRRC of Al Hudaydah was operated as UNDP/GEF Project for Protection of Marine Ecosystems of the Red Sea of Yemen before the establishment, and gained some diving gears and some equipment.

Ministry of Culture and Tourism

- **Tourism Development Authority :** is responsible for tourism activities throughout the country including eco-tourism. Permission for building tourist villages along the coast or Yemeni islands is issued by the GTA. In 1995, the GTA issued a set of regulations and guidelines for tourists while snorkeling or/and diving.

Ministry of Transportation

The MT (former Ministry of Transport and Marine Affairs). The following bodies operate under the umbrella of it.

- **Maritime Affairs Authority (MAA):** is the main governmental body concerned with maritime safety and marine pollution control. It also plays an important role in developing a legislative framework to protect the marine environment. The authority enjoys the right to monitor and inspect all Yemeni and foreign ships.
- **Maritime Training Centre:** has been established in Aden since 1989. It conducts training courses in port operations and maritime transport, maritime safety and pollution control. It offers courses on MARPOL Convention and oil spill response.

Ministry of Local Administration

- **General Cooperation for Development and Promotion of Yemeni Islands (GCDPI):** aims at the development of the Yemeni islands economically, educationally and socially, and the participation with other parties in encouraging investment in tourism on local and international levels.

Ministry of Interior

- **Coast Guard Authority:** has been officially established in 2002 to protecting the security and sovereignty of the Republic of Yemen, and its economic interests in the territorial waters and the net economic areas, guarding the coastline, islands, seaports and harbors. Main duties of this newly established authority include:
 - Combating pollution;
 - Apprehending illegal fishing practices and any violation of national laws and international agreements;
 - Monitoring of vessels, ships and aeroplanes;
 - Observing of changes in the natural marine variables and their possible effects on marine resources; and then reporting to concerned authorities

The CGA also aims at helping concerned authorities to fulfill their duties and obligations.

High Council for Urban Planning(HCUP)

The HCUP has been established in 199. It assumes a number of responsibilities; some of these responsibilities include:

- Safeguarding and protecting the environment from pollution; and
- protecting valleys, water courses, underground water and coastlines”.

The HCUP has an authority to approve standard skeletal drawings based on environmental, economic, and architectural studies. Environmental studies include the natural characteristics of the site as far as topography of the land surface is concerned, and the geological and hydrological characteristics, along with the nature of the natural surroundings and its effect on the liveliness of people and the unique characteristics of the site under planning. They must concern with the surrounding land usage showing such usage as residential, shopping, industrial, tourist, and historical, archaeological, agricultural, water and sewerage system.

Ministry of Higher Education (MHE)

The MHE was established in the late 1970s. It has pertinent institutions that are mainly responsibility for teaching, research and advising the Yemeni Government on coastal and marine issues. Generally they have a capacity for, and are, carrying out research and training in the fields of coastal surveys, pollution, to some degree. The following sections describe each institution briefly

- **Faculty of Oceanography and Environment, Al-Hodaydah University:** has been established since 1996 based in Al Hodaydah, with two departments, namely Oceanography and Environmental Science, but the latter has not been operated yet due to lack of relevant specialized people. It has less than ten Yemeni staff members specialized in various science issues; almost all of them are currently B.Sc. holders.
- **Faculty of Environment and Marine Biology, Hadramout University :** has been established since 1996 based in Fowa District, Mukalla City, with two departments, namely Environmental Science and Marine Biology. It has less than ten Yemeni staff

members specialized in various marine science issues; almost all of them are currently B.Sc. holders.

- **Environmental Research and Studies Division, University of Aden:** is based in Khor-Makasar District. It conducts research and some training relating to the marine ecology and pollution. It organizes some relevant conferences, such as In 1996, the first international symposium on Socotra Island that was held in 1996, and the second one will be held in December 2003.
- **Department of Earth and Environment Science, University of Sana'a:** has about 15 Yemeni staff members specialized in various marine sciences including marine geology and biology. It has a division that concern with the marine environment that offers a master's degree.

3.4 Identification and Assessment of Problems

Yemen's NPA follows the process recommend by the GPA in identifying coastal and marine problems caused by land-based activities. This process combines the following five elements:

- *Nature and severity of problems*
- *Contaminants*
- *Physical alterations and destruction of habitats*
- *Sources of degradation*
- *Areas of concern*

3.4.1 Nature and Severity

At present, it is not easy to assess the nature and severity of problems affecting the Yemeni marine environment in relation to the combination of the elements recommended by the GPA, i.e., food security and poverty alleviation, public health, coastal and marine resources, ecosystem quality, and socio-economic benefits. Severity of pollutant source categories, identified by the GPA, in relation to coastal and marine resources is reported in literature, but is not adequate.

Effects of some of contaminants on living coastal and marine resources are documented. The available studies reveal that some fish and molluscs were contaminated with certain POPs (organochlorine pesticides and PCBs) and heavy metals at several coastal areas of Yemen. Their impacts on the people living close to the effected area is still unknown, but they appear to be not significant because their concentration levels were low comparing with that were reported elsewhere in the world. Even so existence of such contaminants have caused concern for Yemeni scientists.

The Red Sea and Gulf of Aden regions, which are designed as “Special Areas” under the MARPOL Convention, are sensitive to oil pollution. Most companies operating oil terminal have a contingency plan in the case of a spill or an incident, but they have no adequate facilities to control a major spill; the 2002 major accidental spill of the oil tanker “*Lumberge*”, which occurred about 5 kilometers off Mukalla Seashore, eastern Gulf of Aden, is an example. It had effects on fishermen living close to the spilled area in terms of income. Some corals of the Red Sea region would have sever effects if such a major occurs.



Despite lack of relevant data on sewage, litter, nutrients and contaminated sediments it is likely that some of these categories have impacts on the Yemeni marine environment. Untreated municipal wastewater pouring into the seawater possible have effects on the marine ecosystem health and may pose problems to the public health in some coastal villages. The catastrophic die-off of fish taking place in and around coastal waters of Hadramout followed with impacts on human health. Ill cases to death resulted from eating affected fish were recorded and many residents refrained from eating fish hunted from the area. The sediments washed with wadi run-offs appears to have effects on fringing coral reefs in the Red Sea much more than other coastal regions of Yemen. The coastline of Yemen, particularly, beaches of villages, is noticeably accumulative with litter, reducing its aesthetic values. Accordingly, litter is the most source category threatening the Yemeni marine environment in terms of socio-economic benefits.

Generally, most coastal and marine habitats in Yemen suffer from human activities. Locals harvest mangroves and overexploit coral communities. Other marine species, e.g. sea turtles and birds, are also subject to activities, either indirectly through degradation of their habitats or directly through their unwise harvest. However, size of such activity is not well known. No adequate data are available to show the extent of such effects in relation to elements of coastal and marine resources, marine ecosystem and socio-economic benefits.

In short, the lack of data on effects of the source categories of the key problems have made difficult to assess them in relation to the combination of the elements recommended by the GPA. However, the Yemeni coastal areas are unlikely to have similar extent of effects of each category.

3.4.2 Contaminants

The contaminants – as pollutant source categories- identified by the GPA- are sewage, POPs, radioactive substances, heavy metals, oils (hydrocarbons), sediment mobilization/contaminated sediments, and litter. Each of this contaminant at the national level in the following sections.

Sewage

Sewage-related problems all over the world have a great deal in common. Consequently, domestic wastewater discharges are considered one of the most significant threats to coastal environment worldwide, particularly developing countries. Indeed, sewage is considered one of the common problems that Yemen is suffering from, but its matters vary in country regionally and locally. Domestic wastewater improperly discharged into its coastal and environments may pose a variety of concerns.

In the coastal regions of Yemen there are three sewage treatment plants only, constructed as oxidation ponds, with different capacities. Two of these plants exist in Aden and the third in Al Hudaydah. All other coastal areas discharge, either directly or indirectly, municipal sewage into the coastal waters. No sewerage systems are available to serve most people of the coastal areas of Yemen, particularly rural areas. The people dig traditional dug septic holes instead. Some shore-dwellers discharge their raw sewage immediately into the surrounding seawater. Generally, these are associated with pathogens that may result in human health problems through exposure via bathing waters or through contaminated shellfish, suspended solids, significant nutrient inputs, biochemical oxygen demand (BOD).

Expected effects of sewage on coastal and marine environment in Yemen appear to be very localized. Currently, there is no direct evidence of cumulative effects on this environment.

POPs

Persistent Organic Pollutants (POPs) are organic compounds that, to a varying degree, resist photolytic, biological and chemical degradation. They are often halogenated and characterized by low water solubility and high lipid solubility, leading to their bioaccumulation in fatty tissues. They are also semi-volatile, enabling them to move long distances in the atmosphere before deposition occurs.

Pops include many of the first generation organochlorine insecticides such as dieldrin, DDT, toxaphene and chlordane and several industrial chemical products or byproducts including polychlorinated biphenyls (PCBs), dibenzo-p-dioxins (dioxins) and dibenzo-p-furans (furans). Some of these compounds such as PCBs, may persist in the environment for periods of years and may be amplified by factors of up to 70,000 fold.

Some POPs existed in the marine environment of Yemen. The available study conducted by DouAul and Al-Shwafi, 2000), reveals that the fish (*Salo salo*) and the mollusks (*Trivela ponderosa*) collected from the Red Sea and Gulf of Aden regions were contaminated with certain and PCPs residues. Compounds of DDT were found in these organisms in both regions, but their concentrations were relatively lower than those reported previously in the Arabian Sea. Deldrine residues were present in the molluscs collected from the Gulf of Aden region. PCBs were also found in some samples of the fish collected from in both regions. Only the higher molluscs weight of PCBs was evident in the molluscs collected from the Gulf of Aden. To data PCBs are not manufactured in Yemen, so their presence can thus only be from industrial usage and the possible dumping of products containing PCBs.

Shoreline sediments collected from both the Red Sea and Gulf of Aden region were not contaminated with those residues or other POPs. Sandy nature of the sediments and its very low content of organic matter mainly explain this observation.

The Yemeni government have banned use of most of persistent organochlorine pesticides particularly DDT, since 1990 according to the pesticides manual for the Republic of Yemen, issued in 1990 by the Minister of Agriculture and Water Resources (It is now known as Ministry of Agriculture and Irrigation). These chemicals are: aldrin, chlordane, dieldrin, endrin, heptachlor, mirex, toxaphene and DDT. However, it is believed that smuggling of such pesticides has taken place.

Radioactive Substances

Radioactive substances enter the marine and coastal environment as a result of variety of human activities and practices (e.g. energy production). Other activities, such as the transport of radioactive material, pose risk of such release. Radioactive materials can present hazards to human health and to the environment. Radiation can alter essential cellular components and genetic material (DNA), causing a range of problems including cancer. Suspected radioactive contamination of foodstuffs can also have negative effects on marketing of such foodstuffs.

In Yemen, there are no sources of radioactive substances. Contamination of the marine environment with radioactive substances in the country has not been documented. Accordingly, these substances are not considered a problem to this environment at present.

Heavy Metals

Heavy metals are metals having high molecular weights, such as lead, cadmium, mercury, etc. These metals and their compounds, both inorganic and organic, are released to the environment as a result of a variety of human activities. Excessive levels of these metals in the marine environment can effect marine biota and pose risk to human consumers of seafood.

One of the principal metals of interest in used engine oil is lead, which originates from the decomposition of tetraethyle-lead. This is a gasoline additive that is used as an octane booster and is still in use in a number of countries. Lead is highly harmful, especially to the nervous system (Royal Society of Canada, 1986). The FAO/ WHO recommendation for lead intake for adults is 7µg per Kg of body weight per day.

In Yemen, in general, there is no industry dealing with products containing heavy metals in amounts that may cause harm to the environment or the human health. However, some of products containing certain heavy metals, such as batteries containing cadmium and nickel or lead with other products, are used. These products could explain the existence of heavy metals in the coastal environment of Yemen.

The contamination of the marine environment with the heavy metals is more likely attributed to the geochemical nature of beach deposits rather than anthropogenic input. Lead, Nickel, Crom and Cadmium (nonessential) were found in mussels (e.g. Hebba *et al.*, 2001). The concentrations of these metals in tissues of some species partially caused concern for national marine scientists, though they were not significant.

Oils (Hydrocarbons)

Many oils (hydrocarbons) are liquid and gaseous hydrocarbons of geological origin. They may be toxic to aquatic or marine life when ingested or absorbed through skins or gills. They interfere with respiratory systems, foul fur and feathers, smother aquatic communities, habitats and bathing beaches and taint seafood and contaminate water supplies. Impacts from land-derived oils will be regional for the more volatile fractions, and local (occasionally regional) for more refractory components.

Some major petroleum service installations locate along the coastline of Yemen. They are found in the following coastal areas.

Ras Isa: is located in the southern part of the Red Sea, close to the Kamaran Island. At this area there is an oil pipeline derived from inland (Marib) and extends 10km offshore, to be stored in *Safir* (a 100,000 tonne fixed supertanker converted for storage). In 2001 the annual oil export through this port was 7.63 million tons with 94 tankers call, carrying between 70000 and 140000 tons.

Aden: has a port with an oil refinery and an oil import/ export terminal. This terminal handles around 9.8 million tons per year.

Ash Shihr: has an oil terminal, located 55 nautical miles east off Mukalla, eastern Gulf of Aden region. In 1997, about 100 ships called, carrying 100,000 tons on average. The annual production has likely been increased since then.

Bir Ali: The Rudum Terminal is 80 nautical miles west off Mukalla. Annual production is anticipated to be 500,000 tons, with about 11 tankers call annually. This terminal has not yet been operated.

Balhaf: is 70 nautical miles west of Mukalla. It is due to be developed as a natural gas liquefaction plant and a loading terminal for the production of the major gas fields in the Marib region. The anticipated annual production is 5 millions tons.

Mukalla: is the most major coastal city in the eastern Gulf of Aden and Arabian Sea regions. A new oil refinery has been developed to be installed in this city.

The coastal regions of Yemen are subject to oil contamination. It was estimated that, in 1995, about 4.9 million tons of crude oil was discharged and 4.2 million tons of refined products loaded for carrying by sea via the Aden oil refinery. The range of oil concentrations in shoreline sediments collected from the Red Sea, Gulf of Aden and Arabian Sea regions of Yemen were 0.565- 1.767, 3.000- 9000 μ g/g and 5.000- 21.000 μ g/g respectively (SAP, 2001). They were lower than the reported elsewhere, thus not causing significant effects. By contrast, the major crude oil spill of *Lumberge*, i.e., about 17,000 tons, occurred close to the Ash Shihr terminal, is most likely to have effects on the marine environment and impacts on the fishermen living close to the accidental area in terms of income reduction.

Nutrients

The increase in nutrients such as nitrate, nitrite, phosphate could lead to eutrophication that can be resulted from augmentation of nutrients input to coastal and marine areas. Mobilization of nutrients enhance productivity in the marine environment. On the other hand, they could lead to declined species diversity, to increased algal growth, reduced dissolved oxygen associated with fish mortality, and, it is suspected, to the increased prevalence of frequency of toxic algal blooms.

Not all coastal regions of Yemen are similarly affected by eutrophication. In the Red Sea coast region, it occurs occasionally at Bab Al-Mandab strait. In the western Gulf of Aden region it has not been documented, so it is not considered a priority problem/issue. In contrast, some national specialists consider that the sever fish mortality event, occurred in February 2002, in the western Gulf of Aden and Arabian Sea region resulted from this phenomenon. However, this is still to be ascertained.

Sediment Mobilization/Contaminated Sediments

Natural sedimentation and siltation are important in the development and maintenance of numerous coastal habitats. Some habitats require sediment input. Sediment can be repositories for some contaminants that can accumulate over time.

Occasionally, heavy rainwater from Yemeni wadis reach the sea with sediments in large quantities. These sediments can affect the coral reefs by increasing turbidity, which decreases amount of light leading to coral mortality. Some elevated concentrations of contaminants



(heavy metals, POPs and polycyclic aromatic hydrocarbons) are associated with major seaport as a result of shipping and land-based activities. Dredging and inter-tidal disposal of contaminated sediments can lead to increased dispersion of these contaminants. Generally speaking, problems resulted from these sediments will continue until land-based sources are better controlled.

Litter

Litter or marine debris is any persistent, manufactured or processed solid materials that is discarded, disposed of or abandoned in the marine and coastal environment. Lost and discarded material, whether originating from land or from ships, is now recognized as a major form of marine pollution. Litter in the marine environment can also damage coastal habitats and in some situations interferes with biological production in coastal areas.

Most coastal areas, particularly villages, of Yemen are substantially impacted by high litter accumulations. Most of the litter include plastic products, including food bags, oil and water bottles. There are a number of wrecked vehicles lying abandoned along the beachside of certain coastal cities, including Aden. The garbage accumulates on some reefs and around the towns (coastal environment) by coastal communities. It is one of the common problems in Yemen. Beaches of almost all coastal villages accumulate with litter more substantially than that of main coastal cities.

In short, the litter accumulation is a common problem at each beach of most coastal regions of Yemen, and would continue unless effective actions are taken to reduce or mitigate effects associated with such an accumulation. This problem could reduce the aesthetic values of coastal areas, posing a threat to tourism.

3.4.3 Physical Alterations and Destruction of Habitats (PADH)

Habitats could refer to coastal zones, such as beaches and mud flats, as well as to spawning areas and fishing grounds in shallow waters. Intertidal and subtidal alteration of fish habitat in the coast of Yemen are mainly linked to shoreline construction activities, the use of certain fish harvesting gears. Unwise harvesting of marine organisms from intertidal zones can lead to altering or losing habitats for other organisms and decreasing biodiversity, thus threatening their life. The shoreline alteration, coastal wetlands & intertidal zones alteration and coral reef degradation are the source categories of the PADH, identified in the context of the Yemen's NPA. They are separately discussed at the national level in the following sections.

Shoreline Alteration

The increase in populations and economic activities in coastal areas is leading to an expansion of constructions and alterations to shorelines. The impacts are therefore related more to ecosystem integrity than to human health or the economy, although the fishing industry can experience losses.

The major land-based activities altering features of Yemeni shorelines are unplanned developments, including industrial constructions. Aden has been subject to the such developments much more than any other Yemeni coastal area. Rarely, the agriculture-localized impacts can cause alterations to the shorelines.

Coastal Wetlands and Intertidal Zones Alteration

Human activities in terrestrial or wetlands habitats have severe implication due to land use changes, overuses and misuses. These impacts are evident for the loss of habitats, for wetland characterization changes and for natural resources degradation. It is well known that wetlands are highly productive habitats. They play an essential role in critical life stages of fish, amphibians, reptiles, birds and mammals.

Yemen has a variety of wetlands, including mangroves and sabkhas. According to the Al-Saghier 2001, there are 20 wetlands scattering along the coastlines of the Red Sea and Western Gulf of Aden with different systems. They represent a majority stop over for thousands of sea birds migrating to and from Eurasia and Africa. The wetlands, including mangroves, have been subject to several land-based activities, partially anthropogenic. The characteristics and status of wetlands of the Eastern Gulf of Aden and Arabian Sea are still entirely unknown.

The alteration in Yemeni intertidal zones are usually attributed to shoreline construction works, the use of certain fish harvesting gears, harvesting of marine organisms as well as litter accumulations. These activities can cause alterations to, or losses of, habitats for other species, thus decreased biodiversity.

Corals Reef Degradation

Characteristic and diversity of corals and coral reefs vary from region to region and from area to area as well. In the Red Sea region, only about 25% of coastlines support these reefs, but the best-developed reefs occur at the islands of this region. True coral reefs developed on biogenic calcium carbonate are most widely developed in the region, framing the mainland coast and offshore islands. In contrast, coral reefs of the Gulf of Aden region are much lower than that of the Red Sea region. Only 5% of the coastline of the Gulf of Aden supports these reefs, and most of them occur west of Al-Mukalla with exception of Socatra Archipelago where extensive coral growth exist.

Activities threatening the coral reefs in Yemen vary from region to region. However, coral reefs and habitats in the Red Sea region appear to have been affected from human activities, including over-exploitation, much more those in the Gulf of Aden region.

3.4.4 Sources of Degradation

Sources of degradation of the Yemeni marine environment vary from region to region and also from area to area. These variations depend on the size of activities, availability of service facilities as well as geographic and natural characteristics of areas. Table 3.1 shows the point and non-point sources of this degradation at the national level.

Sources of degradation can be divided into three sources: point and non-point sources and atmospheric deposition, as described in the UNEP/GPA and UNEP/NPA Handbooks in a broad description. Garbage burning sites (landfills) and vehicles emissions could be sources contributing to the degradation of the Yemeni marine environment through transferring certain POPs and heavy metals to the sea during supporting winds or sandstorms, but the amount probably be not large to cause significant effects. In contrast, land filling-as a point

source-, and agricultural run-off –as a non-point sources-, for instance, has played a role in the degradation of certain coastal marine environments in Yemen.

Table 3.1: Sources of degradation of the Yemeni coastal and marine environment in relation to the source categories of the problems identified in the NPA initiative

Source Categories	Sources of Degradation	
	Point Sources	Non-Point Sources
Sewage	Sewerage systems (slaughter houses, hospitals ,car washing and oil supply/exchange stations, and industrial facilities) Fish canning factories Ea-side power plants Shore dwellings	Wadi run-off /floods Septic holes Underground Seepage
POPs		Agriculture run-off Accumulations of litter on shores
Heavy metals	Factories using batteries Textile factories Wrecked vessels/ships	Wadi run-off
Oils (hydrocarbons)	Aden oil refinery Safir/Ras Isa terminal Al Shehr oil terminal Seaports Sea-side power plants	Debalasting passing ships Wadi run-offs Oil supply/exchange stations Car washing stations
*Nutrients	Sewerage system Industrial facilities (e.g. fish canning)	Wadi run-off and floods
Sediments	Harbour dredging Construction/Building debris	Dam works Terrace/ soil and shore erosion works
Litter	Coast waste tips Sea-side wrecked vehicles Onshore drifted ships/vessels Local fishermen and foreign trawlers Passing ships	Wadi run-off (garage tips) Watershed individuals Fish landing areas
Shoreline alteration	Coastal land reclamation/filling Harbour dredging	
Coastal Wetlands and intertidal zones alteration	Coastal land filling Mangrove clearing and grazing	Harvesting of target intertidal organisms Wadi run-off
Coral reef degradation	Coral collection (for decoration and constructions) Coastal land reclamation/filling Anchoring	Reef fish aquarium trade Over-exploitation of reef communities (e.g. edible fish and sea cucumbers)

- This category was not well documented as a result of human consequences, but their above sources are generally believed to increase it in somewhere in the seawater of Yemen (with no evidence).

Some sources contributing to degradation of living marine resources in Yemen are not clear. For example, the major source causing the severe fish mortality, occurred in most coastal waters of the Eastern Gulf of Aden, was a conflict issue. Yemeni oceanographers have controversial opinions on the cause: some consider it as a result of the Tropical Upwelling, and others point out it is as a result of the eutrophication.

However, in general, there other sources contributing to the degradation must be considered in terms of public awareness, institutional facilities, and jurisdiction. These sources generally include:

- Inadequacy of
 - municipal services and public awareness in most coastal cities
 - polluting industry control
 - local capacity dealing with pollutant source categories
 - onboard treatment
 - navigation aids
 - technology
- Poor of
 - national legislation dealing with some polluting source categories
 - coastal planning and management
 - water and reef communities exploitation regulations
- Lack of
 - solid disposal
 - municipal services and public awareness in coastal villages
 - fishing surveillance and enforcement of relevant existing regulations
 - stock assessment
 - relevant regular research and studies
 - monitoring programs for coastal and marine habitats health
 - port reception facilities
 - adequate waste disposal regulation
 - waste management systems
 - enforcement of marine ecological assessment

3.4.5 Areas of Concern

There are a number of important coastal areas and sites scattering along the coastline of Yemen (See Table 3.2). Their Importance and significance vary from each other. However, The following (Al Luhaya, Ras Isa/Kambaran Island, Groups of Hannish and Zugar Islands, Aden Coastal Wetlands, Khor Umaira, Socotra Archipelago, Belhaf and Bir Ali, and Hawf) are the key coastal areas of concern. Important and significant of each area is discussed below.

Al Luhayah

Al Luhaya is a coastal village of about 30000 hectares located on the Red Sea region and is about 90 kilometers south off Midi Coast near the Saudi border. It is characterized by the largest and well- developed mangrove forest, extensive sand bars and mudflats, several

seagrass meadows and some coastal vegetation. In addition, the village is a very important area for migratory waterfowl, providing ideal habitats for at least three globally threatened animal species including green turtles (*Chelonia mydas*), dugongs (*Dugon dugon*) and white-eyed gulls (*Larus leucophthalmus*). Some mangroves were cleared for aquaculture and road construction proposes. Further clearing or adverse activities may severely lead to their deterioration.

Ras Isa/ Kamaran Island

The area of Ras Isa/Kamaran Island is located north of Al Hudaydah in the Red Sea region of Yemen. Cora reefs along with diverse associated marine fauna exist in the vicinity of this area. The two mangrove species found in Yemen, namely, *Avacina marina* and *Rhizophora mucronata*, are widespread on the Kmaran Is. An oil terminal (Ras Isa oil terminal) and a 100,000 ton supertanker converted for oil storage (*Safir*) are situated in the vicinity of the area as well. Therefore, occurrence of a major oil spill in the seawater of the area would severely affect the nearby habitats, particularly corals. Fishery for aquarium business is another major source threatening these corals. The Ras Isa/ Kamaran Island was proposed as a marine protected area in the Strategic Action Plan, led by the Regional Organization for the Conservation of the Red Sea and Gulf of Aden (PERSGA). However, it has not been established yet.

Groups of Hannish and Zugar Islands

Groups of Hannish and Zugar Islands lie in the center southern Red Sea region of Yemen. Coral and coral populations in the seawater of these groups are believed to be of a great of biogeographical importance to the region. These groups may receive coral recruits from the southern Red Sea, located between the Gulf of Aden region (with its connection to the Indian Ocean fauna) and the northern Red Sea region. The groups are volcanic islands with some pinnacles that are vital steeping stones for coral propagules traveling between these regions. Reversals of prevailing seasonal currents may provide a mixed supply of coral propagules from two different regions of marine fauna, depending on the relevant spawning periodicity.

Northern. Bab Al Mandab and Perim Island

The Northern part of Bab Al Mandab and Perim/Mayun Is. has extensive seagrass beds and mangrove stands and is an important waterway washing nutrients for organisms of the Red Sea. The area is suggested as a protected area in the SAP.

Aden Coastal Wetlands

Aden is renowned with coastal wetlands that include:

- A marshland of an area of 50 ha fed partially by run-off of treated municipal wastewaters of the Haswah plant located nearby;
- Four large lagoons at the western part of the Aden peninsula
- An artificial lagoon sited at the Haswah sewage treatment plant; and
- Wide intertidal zones.

The Aden coastal wetlands are considered the most important sites for migratory sea birds in Yemen, which meet the criteria of the international Ramsar sites and Bonn Conventions. Over

10000 waterfowls, including three globally threatened and 12 regionally important species visit these wetlands. Lesser Flamingo (*Phoenicopterus minor*), with 9200 birds counted-based on the last census in 1996, the largest concentration anywhere in the Middle East. Among the most important species found in the area are. Other important species include great spotted eagles (*Aquil clanga*), imperial eagle (*Aquila heliaca*), and crab plover (*Dromas ardeola*). Activities of the Free Zone Authority are not allowed in these wetlands according to an agreement made with the EPA.

Khor Umairah

Khor Umairah is a semi-enclosed lagoon, isolated from the shore by a permanent sand spit running from the east, of fine mud and sand with rocks in the central part of the lagoon. Mixed seagrass and coral reef habitat exist in this lagoon that supports feeding of marine turtles.

Socotra Archipelago

The archipelago, located in the Arabian Sea of Yemen, occupies some 3625 square kilometers and is home to diverse terrestrial plant and animal life with a high degree of endemism. Socotra is the largest Is. in Yemen and main island in the archipelago, the others being Abd al-Khuri, Samha and Darsa. There are also smaller rock islets, Kal-faraon and Sabouniya. They are all fringed by diverse and largely pristine marine habitats and biota, including well-developed coral communities. The archipelago is a protected area of a multiple-use type, officially issued according to the Presidential Resolution No. of 2002. It has received international, regional and national funding and logistical support through the GEF-Socotra Biodiversity project.

Balhaf-Burum Area

Balhaf-Burum Area is a coastal area located in the Eastern Gulf of Aden and Arabian Sea region, stretching and grouping of high aspect islands with extensive fringing coral reefs and rich fishing sites. Besides, they are an important site for nesting of important seabirds and threatened marine turtles. Yemen Several sites of conservation importance are located in this area. The three islands of Baraqa, Sikha and Hallaniyah lying less than 10 kilometers off Bir Ali Shore on the Gulf of Aden coast, all important sites for breeding of the endemic Socotra Cormorant (*Phalacrocorax nigrogularis*) and Sooty Gull (*Larus hemprichii*). Karif Shoran, located in the sites, is a site with a unique habitat because of a volcanic crater lagoon along with a mangrove forest that is the only site exist in the Eastern Gulf of Aden and Arabian Sea region of Yemen-with exception of Socotra Island. The area is *de facto* coastal protected area, and protective measures currently take place through the CZM project, led by the EPA.

Hawf

Hawf is a coastal district located within Al-Mahra governorate in the Arabian Sea region. The coastline of this district is about 18 kilometers long with a relief of 1.8 kilometers in its limestone mountains. The area is rich in coastal vegetation and dominated by *Anogesissus dhofarica*, *Dodonaea angustifolia* and *Jatropha ghorfarica*. Socio-economically, the area is characterized by an attractive sandy beach and considered a tourist site. It is important for grazing managed by locals.

Table 3.2: Coastal and marine sites of ecological importance in Yemen
(Developed after the NBSAPY Draft of 1999)

Region	Habitats		Wetlands		Vegetation		Turtle nesting sites	Rocky/ Algal sites
	Corals and coral reefs	Seagrass meadows	Mangrove forests	Sabakhas	Palm groves	Tees and Halophytes		
Red Sea	Tikfash Is. Ukbaan Is. Hunaish- Archipelago Humar Is. Ras Isa Abu Zahr Dhubab Yakhtul Al-Mukha	Jubana Urj ArRuaya Dhubab Habl Mawshij Nukhayla	Midi Luhayah Ar Ruays Urj Salif Kamaran Habi Dhubab N. Bab El- Mandab	Midi Luhayah Salif Urj Gholaifqah Habl Mawshij Dhubab	Jubana Mujalis Urj Gholaifqah Faaza AbuZahr		Zuqar Is Hunaish Is. Haronia Ar Ruays Khawkha Dhubab	
Western Gulf of Aden	Perim Is. Khor Umaira Aden Shuqra	Khor- Umaira			Al Bander	Bander .	Ras Imran Aden	
Eastern Gulf of Aden and Arabian Sea	Balhaf Sukha Is. Borum Socotra Is. Samha Is. Darsa Is. Abdekuri Is. Ras Fartak	Socotra Is.	Kor Shuran Socotra Is. Ras Shuab		Shehair Seyhut	Ahwar Ras Qawa Ras Imran Socotra Is	Nushaima Al Qarn Sharma Jithmun Ar Raida Seyhut Khalfut Socotra Is.	Ras Qawa Shuqra Borum Fowa Shubair AlQarn Al Hami Khalfut Ras Dharbat Ali Socota Is.

3.5 Priority Problems

Based on the setting the priority concern of each source category of contamination is nationally ranked from low to high.

3.5.1 Relative Importance of Impact

The key problems identified in the context of the Yemen's NPA initiative are the importance of impact to establish priorities in relation to their resource categories (Table 3.3 shows the priority rank of each source categories).

Table 3.3 Ranking of priority source categories.

Source Categories	<i>At In-Country Regional Levels</i>			At the National Level
	Red Sea	Western Gulf of Aden	Eastern Gulf of Aden and Arabian Sea	
<i>Sewage</i>	Medium-High	Low-Medium	Medium	Medium-High
POPs	Medium	Medium	Medium	Medium
Heavy Metals	Low	Medium	Low-Medium	Medium
Oils(Hydrocarbons)	High	Medium-High	Medium-High	Medium-High
Sediments	Medium	Low	Low-Medium	Low
Nutrients	Low	-	Medium	Medium
Litter	High	Medium-High	High	High
<i>Shoreline Alteration</i>	Low-Medium	High	Low	Medium
Wetlands and Intertidal Zones Alteration	High	Medium	Low-Medium	Medium
Coral Reef Degradation	High	Medium	Low	Medium

Establishment of the priority problems (contamination and PADH) are separately discussed in the following sections.

A. Contamination

Ranking each priority source category of contamination is discussed below.

Sewage

Sewage is considered one of the major problems that the Yemeni marine environment is suffering from. However, variation of sewage matters is recognized in local conditions. Untreated sewage-related effects are greatly considered globally. They pose risks to human health. Accordingly, this issue is given a medium-high priority.

POPs

Most of organochlorine pesticides (pesticides business) have been used in Yemen, although they have been banned for over a decade. The country still uses capacitors containing PCBs for electrical purposes. Organochlorine pesticides and PCBs were found in certain marine living organisms. POPs are in need of a medium priority concern even there is no effective research dealing with the extent of their effects.

Heavy Metals

In Yemen, general speaking, there is no industry dealing with products containing heavy metals, which may cause adverse effects on the environment or the human health. However, some of imported products containing certain heavy metals, such as batteries that contain cadmium and nickel or lead with other products, are used. These products could explain the existence of heavy metals in the coastal environment of Yemen. At the national level, a medium priority assigned for this pollutant source category.

Oils (Hydrocarbons)

To date Yemen has no adequate facilities to cleaning up oil spills although the Red Sea and Gulf of Aden region are considered "Special Areas". They are sensitive to such a spill. The marine environment of these regions are often subject to incidental oil spills and leaks, and to other activities caused by point land-based sources that include discharge of untreated sewage and pouring of waste car lubricants either on beaches or on wadi beds. Liquid wastes of most oil change and car washing stations flow to the sewerage systems. Existence of tar balls on Yemeni shorelines is a common problem. Deballasting passing ships are considered the major source of contamination of this problem. Although there are no data revealing the impact of the largest oil spills (the October 2002 accident caused by *Lumburge* oil tanker), it has caused significant effects on the affected marine environment, following with income reduction of fishermen living close to the affected area. Accordingly, oil contamination is considered a medium-high priority concern.

Nutrients

In Yemen the agriculture and sewage could be point sources of nutrients contamination through the use of substances increasing nutrients in the sea. Importantly, most coastal regions of it are not affected by the eutrophication. Therefore a low priority is assigned for this category.

Sediment Mobilization/Contaminated Sediments

Yemeni coastal watershed areas share floods-related problems, through wadi run-off, during rainfall seasons. These floods usually wash harmful substances and materials along with sediments to eventually reach the sea. Sediments can also enter the sea through activities of harbour dredging and reclamations which vary from area to area. At the national level, a medium priority is given for this category

Litter

The accumulation of litter on the seashores of Yemen is considered a high priority to protect the coastal and marine environment from such an accumulation. Such an accumulation on the beaches and shores has reduced aesthetic values and is reflected in reduced aesthetic values. This, in turn, poses impacts on socio-economic benefits. The litter includes several types of waste, such as plastic materials. Garbage is usually found with litter. These wastes vary from region to region, but almost all coastal areas, particularly villages, face this problem, and even in some main coastal cities.

B. Physical Alterations and Destruction of Habitats (PADH)***Shoreline Alternation***

Practices of coastal land filling have been increased in some coastal areas of Yemen where shoreline construction works have taken place without encountering with marine ecological assessments. Impacts of such practices appear to be localized, considered one of the major and complicated issues at certain coastal cities, particularly Aden, leading to alterations in shoreline features. At the national level, however, the shoreline alteration is assigned as a medium priority concern.

Coastal Wetlands and Intertidal Zones Alteration

Several wetlands, including mangroves that are nursery habitats for commercial fish, are scattered on the coastlines of the in-country coastal regions. Importantly, many migratory sea birds, including threatened species, regularly visit most these wetlands that are considered critical habitats. These wetlands and intertidal zones are subject to adverse effects, including unwise use. Most of them are still at risk, and the status of others is still unknown. A medium priority is an appropriate rank assigned for this category at the national level.

Coral Reef Degradation

Coral reefs are important habitats that should be fully protected from direct human activities, oil pollution and other adverse effects. Many such habitats are still under assault and could be subject to severe degradation unless protective measures are taken. Unfortunately, no such measures are taken to mitigate or avoid further activities degrading these reefs in the Red Sea region, causing high concern. On the national level, however, this category is considered a medium priority concern because other important reefs are enhanced with these measures.

3.5.2 Options for Actions

The priority actions related to the source categories of the key problems under the National Environmental Action Plan (NEAP) are as follows:

- ◇ Closure/replacement of waste disposal site;
- ◇ Privatization of treatment, storage and disposal of hazardous waste;
- ◇ Privatization of solid waste collection and recycling;
- ◇ Regulation of hospital waste treatment, disposal, and implementation of pilot projects; and
- ◇ Preparation of coastal zone management plan

3.6 Integrated Management Objectives

The GPA recommends that objectives set forth in terms of:

- Overall goals and targets;
- Specific targets for the geographical areas affected; and
- Specific targets for industrial, agricultural, urban and other sectors

This section presents the overall goals under the NPA initiative and then provides them along with management objectives for the Priority Problems identified in the previous section.

3.6.1 Overall Goals

The overall goals under the NPA initiative are as follow:

- ✓ To contribute to food security and poverty alleviation;
- ✓ To contribute to improvement of public health conditions;
- ✓ To maintain coastal and marine environment and ecosystem health, including biological diversity; and
- ✓ To contribute to generating of economic and social benefits, including cultural values

3.6.2 Contamination

The specific objectives for each source category of contamination are provided below.

Sewage

The overall goal is to contribute to a safer coastal and marine environment and presentation of marine habitats contamination. The specific management objective is to develop an effective system for wastewater collection, treatment, reuse, and disposal in the main urban areas, through motivation of the private sector.

POPs

The overall goal is to reduce/virtually eliminate organochlloring pesticides inputs. The specific management objective is to encourage environmentally sound and economically rational pest management practices.

Heavy Metals

The overall goal is to reduce inputs where they are likely cause pollution. The specific management objective is to control industrial and hospital waste disposal.

Oils (Hydrocarbons)

The overall goal is to prevent or alleviate the effects of oils (hydrocarbons) on the coastal environment. The specific management is to prevent spills of oil into the coastal and marine environment.

Nutrients

The overall goal is to reduce inputs where they are likely pollution. The specific management objectives is to improve the sustainable management of agricultural land through reduction of inputs use.

Sediment Mobilization/Contaminated Sediments

The overall goal is to reduce sediment contamination at sources. The specific management objective is to improve the management of coastal watershed through investment in wadi training and protection.

Litter

The overall goal is to reduce the incidence of litter found in the marine environment. The specific management objective is to develop an effective system for solid waste collection, recycling and disposal through motivation of the private sector.

3.6.3 Physical Alterations and Destruction of Habitats (PADH)

The primary objective for the PADH is to avoid/ or mitigate significant alterations and destruction of coastal and marine habitats. The specific management objectives for each source category of the PADH at the national level are identified below.

Shoreline Alteration

The management objective is to protect the coastal areas and water from unsustainable use.

Coastal Wetlands and Interidal Zones Alteration

The management objective is to identify critical unknown habitats and prevent overuses and misuses on those already known.

Coral Reef Degradation

The management objective is to protect and/or rehabilitate of coral reefs, where possible, especially in the Red Sea region.

3.7 Strategies and Measures

Strategies and measures are set to achieve the management objectives established for Priority Problems . These strategies are a combination of the following elements:

- *Specific measures*
- *Requirements and incentives*
- *Institutional arrangement*
- *Data collection*
- *Monitoring system*
- *Cost recovery and source of finance*

3.7.1 Selected Strategies

The GPA recommends that strategies and programs to achieve the integrated objectives should include a combination of:

- i) Specific measures to promote the sustainable use of marine and coastal resources and to protect or remediate affected areas;
- ii) Requirements and incentives to induce action to comply with measures such as
 - . economic instruments and incentives
 - . regulatory measures
 - . technical assistance/cooperation
 - . education and public awareness
- iii) Identification of institutional arrangement to undertake management tasks associated with strategies and measures
- iv) Identification of short-term and long-term data collection and research needs
- v) Development of a monitoring and environmental-quality reporting system
- vi) Identification of sources of finance and mechanisms available to cover the costs of administrating and managing the strategies and programs.

The proposed strategies and measures for the key problems, identified in the NPA, are separately identified in the following sections.

3.7.2 Contamination

In this section a comprehensive set of strategies and actions is presented for each source category of contamination. It is designated to attain each of the management objectives specified earlier. The strategies and measures address the six specific source categories of contamination that are given a medium to high priority at the national level.

Sewage

- i) Specific Measures
 - Build new waste water treatment plants with best practice technologies
 - Closure/replacement of waste water disposal site
 - Maintain existing sewerage systems.

ii) Requirements and Incentives

- Impose equitable fees for sewage discharged and give incentives to the private sector
- Maintain sewerage systems and waste water treatment plants
- Issue standards for treated waste water use and developed public awareness on the use of treated wastewater
- Orientation of the technical assistance and cooperation to support sewage disposal facilities

iii) Institutional Arrangement

- Develop a national policy for sewage disposal in urban coastal centers

iv) Data Collection

- Collect more information on existing sewerage systems and necessary future expansion
- Conduct research studies on the effect of municipal sewage on the human health and coastal environment

v) Monitoring and Environmental Quality Reporting System

- Issue a law and a by-law for testing and inspection of water treatment and disposal
- Provide training programs
- Involve the public in a pertinent environmental monitoring system

vi) Cost Recovery and Source of Finance

- Supplement the existing charging system for sewage services to contribute to the financial viability of services

POPs

i) Specific Measures

- Use of the integrated pest management (IPM)

ii) Requirements and Incentives

- Reorientation of agricultural and environmental policies to introduce appropriate economic incentives including taxes and special levies on pesticides use to account for negative externalities and short-term subsidies to account for positive externalities in the use of the IPM.
- Development of a regulatory framework to ensure appropriate and safe production/import, distribution, and use of pesticides
- Development of a system that increases the awareness of policy makers, consumers, and producers of hazards of pesticide use

iii) Institutional Arrangements

- Implementation of the polluter pays principle that include imposition of import licensing fees and sales tax
- Support for alternative practices through research and extension to encourage the adoption of environment-friendly technologies
- Banning unsafe pesticides through banning their import and sales
- Public investments in education and communication media to provide unbiased information on the benefits and risks of pesticide use
- Pesticide registration and storage disposal inspection
- Financing and rewarding research that facilitates adoption of IPM

iv) Data Collection and Research Need

Pest Management

- Pest problems and pest management practices
- Externalities of pesticide use
- Cost and benefit analysis of alternative pest management methods

Policies Influencing Pest Management

- Macro-economic and sector policies
- Regulatory and environmental policies
- Research, extension and training systems

v) Monitoring and Environmental-Quality Reporting System

- Quality control and risk assessment of new and existing pesticides
- certification and inspection of pesticides storage and disposal

vi) Cost Recovery and Source of Finance

- The revenue generated from fees, taxes and penalties
- Governmental subsidies

Heavy Metals

i) Specific Measures

- Control industrial and hospital waste treatment and disposal;
- Manage the geochemical nature of beach disposal sites by water flow

ii) Requirements and Incentives

- Build treatment facilities for solid wastes containing heavy metals
- Impose fees for hospital and industrial waste disposal and penalties on violators
- Regulate industrial and hospital waste disposal and prohibit the disposal of hazardous wastes into sewerage systems



iii) Institutional Arrangement

- Implementation of polluter pays principles
- Establish coastal watershed management approaches

iv) Data Collection and Research Needs

- Conduct research on hazardous waste water management

v) Monitoring and Environmental quality Reporting System

- Establish coastal watershed management and monitoring approaches

vi) Cost Recovery and Financing

- Revenue from fees and penalties
- Governmental subsidies
- Donor assistance

Oils (Hydrocarbons)

i) Specific Measures

- Provide management of recycling and re-use of waste oil

ii) Requirements and Incentives

- Build waste oil treatment facilities
- Impose fees on the oil waste disposal
- Encourage the private sector to invest in recycling project
- Execute awareness programs on the oil waste disposal

iii) Institutional Arrangement

- Implementation of polluter pays principles that include penalties on violators

iv) Data Collection and Research Needs

- Collect data on the amount of used oil

v) Monitoring and Environmental Quality Reporting System

- Conduct research and studies on waste oil management and impacts
- Promote the regional contingency plan on the navigation risk in the Red Sea-Gulf of Aden region

vi) Cost Recovery and Financing

- Revenue from fees and penalties



- Government subsidies
- PERSGA and NGOs contributions

Nutrients

i) Specific Measures

- Established land use planning based on participatory approaches

ii) Requirements and Incentives

- Focus on research dealing with production management and fertilizers
- Expand agricultural extension services

iii) Institutional Arrangement

- Reorientation of agricultural research and extension systems to incorporate the land use planning approach

Sediment Mobilization /Contaminated Sediments

i) Specific Measures

- Use the coastal watershed management

ii) Requirements and Incentives

- Develop wadi training and protection programs
- Invest in stabling economically sustainable forests

iii) Institutional Arrangement

- Introduce sediments control technical and systems to municipalities

Litter

i) Specific Measures

- Use the solid waste management approach

ii) Requirements and Incentives

- Improve existing landfills and develop new landfills
- Impose fees for the collection of garbage
- Encourage the private sector to invest in recycling projects

iii) Institutional Arrangement

- Inform agencies concerned on waste disposal procedures



3.7.3 Physical Alterations and Destruction of Habitats (PADH)

In this section a comprehensive set of strategies and actions is presented for each source category of the PADH. It is designated to attain each of the management objectives specified earlier. The strategies and measures address the three specific source categories of the PADH that are given a medium to high priority at the national level.

Shoreline Alteration

i) Specific Measures

- Introduce principles of the integrated coastal zone management (ICZM)

ii) Requirements and Incentives

- Defining areas to be protected and policies for zoning and development of economic activities in the coast
- Preparation of a draft on guidelines, rules and regulations for control of activities on the coast

iii) Institutional Arrangement

- Build and develop national institutional capacities for the physical planning and monitoring of coastal zone developments

iv) Data Collection and Research Needs

- In-country regionally environmental assessments
- Regulatory need assessments

v) Monitoring

- Establish an integrated GIS system for physical planning and monitoring of coastal zone developments

vi) Cost Recovery and Financing

- Establish a mechanism for recurrent funding to support CZM activities
- NGO- type activities in support for CZM initiatives

Coastal Wetlands and Intertidal Zones Alternation

i) Specific Measures

- Use the integrated coastal zone management (ICZM) approach

ii) Requirements and Incentives

- Guidelines, rules and regulations for controlling the use of the habitats
- Mechanisms for public and private partnership

Coral Reef Degradationi) Specific Measures

- Initiate the implementation of actions to protect and or rehabilitate of corals

ii) Requirements and Incentives

- Mechanisms for recurrent funding to support rehabilitation and protection of coral reefs
- Public/private partnership

3.8 Criteria for Evaluation of Effectiveness

Effectiveness of strategies and measures proposed for each key problem identified the NPA initiative is evaluated in relation to the following selected criteria:

- Environmental Effectiveness
- Economic Efficiency
- Equity
- Flexibility in Administration
- Public Sector Costs and Revenue

3.8.1 Selected Criteria

Development of specific criteria and mechanisms for evaluating the effectiveness of proposed strategies and measures, which are required to achieve management objectives for the pertinent problems, include the following:

(a) Environmental Effectiveness

The measurable attainment of the management objectives, depending on the problems involved, reducing contamination or physical alternative of the resources. Another point to consider is whether there are incentives to reduce contamination/PADH alternative below the minimum requirements.

(b) Economic Efficiency

A comparison between the microeconomic and macro-economic costs of various strategies and measures for a given environmental impacts.

(c) Equity

The ability to implement the strategies and measures vis-à-vis the polluters and the population generally, where different burdens or benefits accrue to individual groups.

(d) Flexibility in Administration

This is concerned with the modalities of introduction or implementation, their adaptation to existing institutional structures and the statutory permissibility of the strategies and measures,

e.g. need for information, demand for trained staff, responsibilities of institutions, possibilities for decentralization and self-help potential.

(e) Public Sector Costs and Revenue

A rising out of the introduction and implementation of the strategies and measures (e.g. costs of supervision, general administration, services and infrastructure). Directly imputable revenue e.g. from charges, levies or taxes, should be offset.

3.8.2 Contamination

In the case of contamination-related problems, the following general criteria for evaluating effectiveness can be used:

- Nature and level of hazard of the pollutant (s) including long term impact and state of disposal
- Ability to monitor contamination and attribute them to polluters;
- Availability of corresponding environmental technologies, and alternative processes
- Estimated costs of prevention and their variation by source categories of contamination;
- Number, type, size and regional distribution of polluters;

In each source category of contamination, the potential strategies and measures must be evaluated and compared with each other. Where the use of the individual strategy and measure depends on the existence of others, the package as a whole should be evaluated.

3.8.3 Physical Alterations and Destruction of Habitats (PADH)

The specific source categories of the PADH share a common criterion for evaluating effectiveness. The following general criteria can be used for such a category.

- Productive capacity of habitats that are either lost or degraded, compared with production capacity that is restored or created in coastal and marine habitats
- Legal formulation of the relevant property right in coastal areas and water and their enforcement
- Ability to monitor destruction and attribute them to polluter;
- Estimated costs of presentation and or rehabilitation and their variation by the source of the alternation
- Number, type size and regional distribution of polluters

3.9 Program Support Elements

The principle support elements for the implementation of NPA include:

- Institutional support for national integrated coastal management change policy formulation and coordination
- Integrated coastal area and river-basin management program as a multi-sectoral system for managing the use of coastal and marine resources
- Monitoring (reports on implementation and effectiveness)

3.9.1 Institutional Support

The political commitment and management needs in terms of policy and institutional change are a complex in that they are sectoral boundaries and need to cover both macro- and micro-level initiatives. Careful sequencing and targeting of specific measures are also needed to minimize the economic costs associated with policy shift.

At the initial stages of the NPA, the key institutional support elements are as follow:

i National Integrated Coastal Area Management Policy (NICAMP)

Establishment of a national NICAMP framework provides a useful first step in implementing an ICZM program at the national level. However, other policies and institutional framework are necessary to implement the program related to a multi-sectoral agencies. The following institutional support elements are proposed.

ii Working Groups

The establishment of an ICZM task force or working group should be considered in the development of the Yemen's NPA in the next phase.

iii Lead Agency

Special public sector sponsored initiatives and measures on ICARM should be established only for a set period of time that is only until appropriate pricing, regulatory and other incentives are established and relevant institutions are operating effectively to monitor, regulate and provide a flow of relevant information and incentives.

iv Broad Consultation Process

A broad consultation process using workshops and seminars can be used to help re-define re-define targets and priorities and to define appropriate institutional roles and responsibilities for different elements of NICAMP implementation, thus helping to bring the various public, private and NGO ICZM stakeholders together within a concerted and open program. This process also acts to raise awareness and understanding about various environmental issues and help create a broad constituency in favor of ICZM and the mobilization of public funds to support implementation.

ii Training/Capacity Building

This is the most common and least explicit of the institutional recommendations in the NPA. It is best if this recommendation can be related to specific environmental problems and targeted at functions performed by specific government officials at various levels. At the national level the training/capacity building should be to carry out policy regulator and coordination measures while at the regional/local to undertake the specific measures of management program.

iii Economic and Regulatory Measures

Targeting and implementing economic and regulatory measures require certain preconditions:

a Availability of Supportive Infrastructure

It will be least costly to implement and enforce such measures when a supportive infrastructure and program is already established, such as watershed management program an coastal zone management pan-Aden mode).

b Relationship Between Polluters and Community Affected

Support for such measures will also be greater when there is a close relationship between the polluters and local community affected such as the fishery industries in the eastern Gulf of Aden and Arabian region, where they consider to part of both polluters and communities affected.

3.9.2 Monitoring and Evaluation

Monitoring provides the information necessary for measuring progress in the NPA and the adequacy of the policy instruments selected. Therefore, there is a need for open and transparent reporting actions include:

- Providing annual report on progress in implementing the NPA
- Developing additional indicators for monitoring;
- Promoting regular consultations with the relevant stakeholders; and
- Providing periodic reports land-based activities and their effects on the marine environment

CHAPTER 4 RED SEA REGION

This chapter provides a background on the coastline of the Red Sea region of Yemen and discusses the subsequent steps of the process used at the level of this region.

The Red Sea region of Yemen is over 2100 kilometers long. It is characterized by abundant reefs, coastal wetlands, including mangroves and sabakah, and palm groves. Each of the following subsequent steps of the process used in the Yemen's NPA initiative is discussed at the level of the Red Sea region of Yemen.

- *Identification and Assessment of Problems*
- *Priority Problems*
- *Setting Goals and Management Objectives*
- *Strategies and Measures*

4.1 Introduction

In this document the Red Sea coast region of Yemen includes the coastal cities and villages and islands lie from Bab Al Mandab to the border with Saudi Arabia (see Appendix1) . This region, with a coastline of approximately 730 kilometers long (DouAbul *et. al.* 1999), varies in its natural characteristics, including exposures and habitats. “North of As Salif, the coastline is sheltered from strong wave action due to the many shelf islands close inshore. In contrast much of the coast south of As Salif is exposed, but some large sand spits, such as Ras Al Katib, provide sheltered bays or lagoons” (DouAbul & Haddad, 1999, p. 12). Coral reefs, mangroves, seagrass, palm groves and sabakha are the major coastal and marine habitats that exist in the Yemeni Red Sea region. Scattering of the reefs, mangroves, seagrass are more widespread along the region than any other region in Yemen.

More than 115 islands lie in the Red Sea coast region of Yemen. Most of these islands occur in the northern part of the region, and most of them are inshore islands. These inshore islands rang from due west of As Salif to the border with Saudi Arabia. Kamaran Island is the biggest inshore island and inhabited with the largest people (about 5000) among other inhabited islands of the region, i.e., Fasht Is., Zuqar Is., Hanish Is. and Miyon Is. The Hannish and Zuqar groups are the two biggest offshore islands found in the southern part of the region, and Perim/Miyon is a large island occupying a central location of Bab Al Mandab.

Tihama, a semi desert plain, is an inland area from the coast of the region, with about 50 kilometers wide. The eastern edge of this area rises into the mountain of western Yemen with height to 3.8 kilometers. Many wadis drain the mountains. Some wadis are dry for many years. Much of surface waters of other wadis drain into the Tihama. However, they reach the sea only during heavy rainfalls with a large amount of sediments.

Human settlements are scattered along the mainland coastline of the region. The estimated total population of the coastal areas for 2002 was nearly 0.8 million -based on the accumulate growth rate (3.5%) since the 1994 census. Al Hudaydah, Al Makhah and Al Khawkhah are the main coastal cities, where 530,000, 50,000 and 34,000 people live (estimated populations of the 2002). The first two cities have port facilities, and the third is considered an important venue for recreational activities, including tourism, because of its tropical location and attractive beach features.

Limited industrial installations and activities exist in the coastal areas of the mainland of the region. These installations include two power stations using cooling water for boiling and seaports. The Ra Isa oil terminal, with a supertanker converted for storage (*Safir*), is another major industrial installation. Generally, apart from these installations, the region is not renowned with major industries or activities threatening the coastal and marine environment in the region. However, occurrence of a major oil spill would severely affect living marine resources in the region. In addition, there other adverse activities, particularly human activities, affect the environment and its living resources in the Red Sea region.

4.2 Identification and Assessment of Problems

As explained in Section 2.1.1, contamination and PADH are identified as key problems related to the NPA initiative. This section assesses each problem in relation to their sources categories at the level of the Red Sea region.

4.2.1 Contamination

Assessment of each source categories of contamination identified in the Yemen's NPA (sewage, POPs, heavy metals, oils(hydrocarbons), sediments, nutrients, litter) is essentially based on food security and poverty alleviation, public health, coastal and marine resources and ecosystem health, including biological diversity, and eco-social benefits. Severity of such categories varies from category to category. Assessment of such a category is discussed separately in this section at the national the level of the Red Sea region.

Sewage

Sewage, principally untreated municipal wastewater is one of the most prevalent problems facing inshore coastal waters in the Yemeni Red Sea region. Other coastal areas have no sewerage systems. Most of the people living in these areas use traditionally dug septic holes instead, and others discharge their raw municipal sewage immediately into the sea.

Al Hudaydah is the largest coastal city in the region, and is one of the major port in Yemen, with the estimated population of 530,000 in 2002- based on the accumulate annual growth estimated at rate of 3.5% , since the 1994 census. It is the only coastal city having a sewerage system of treatment plants in the region. Its municipal sewage is discharged into a series of eleven oxidation ponds which serves nearly 35% of the residential population, with about 18000 cubic meters daily discharged. It contains several types of industrial liquid effluent and animal waste. About 70% of the municipal sewage is used for agriculture purposes, including windbreaks. The remainder (30 %) is discharged through a small open channel north of the city into the seawater close to khawr Al Kathib. Thus, effects of the municipal sewage of Al Hudaydah on the marine environment are unlikely to be significant.

Other point land-based sources of sewage in the Red Sea coast region of Yemen are the power plants. There are two oil burning power plants located along the mainland coastline of the region: one is situated in Ras Al Kathib, ~ 20 kilometers north off Al Hudaydah, and the other in Al Makhah with an area of 530 meters X 580 meters for each. Both plants use seawater for cooling. The volumes of water used are modest (7500 cubic meters per hour).

Seawater warming, associated with power station cooling system, has been responsible for the death of coral reefs in many places. In most cases a 4-5 C° increase over ambient temperature



was enough to cause coral reef mortality. However, visual surveys around Ras Al Kathib station showed no overt ecological effects from the warm water discharge. Measurements (see Table 4.1) in the discharge water channel and in areas just offshore of the outfall showed water temperatures only a few degrees above ambient levels within 50m of the cooling water outfall (Brodie and Turak 1999).

Table 4.1: Physico-chemical characters of the seawater at the outfall of wastewater discharged from the power stations in the Red Sea region of Yemen

Parameters	Average value
Temperature	35 C°
Conductivity	52000 (us)
Salinity	42270 ppm
T.D.S	40000 ppm
pH	8.4
Iron	100 ppb
Copper	10 ppb
Carbonate	30 ppm
Bicarbonate	120 ppm
Chlorine	0.1 ppm
Calcium Hardness	600 ppm
Magnesium	1900 ppm
Sulphate	3240 ppm
Chloride	20860 ppm

POPs

Like other inland areas adjacent to the coastal regions of Yemen and neighboring countries, organochlorine pesticides have been used in inland areas adjacent to the Red Sea region for some decades. In March 1995 samples of certain fish, mussels (*Trivela ponderosa*) and surface sediments were collected from several coastal locations in this region (see DouAbul and Al Shwafi, 2000). These samples were sent to two independent international laboratories, i.e. Geochemical & Environment Research Group, Texas A&M University and Environment Research Institute, City of Amsterdam, for calibration purposes and to establish the levels of pesticides and PCBs. For the Red Sea region of Yemen the result of this study showed that:

- most organochlorine residues in the marine environment of the region were either below the detection limits or in very low concentrations;
- DDT occurred in almost all fish samples examined. This suggested that there was continuing contribution of DDT from land-based sources, namely agriculture, to the Red Sea though this contaminant has been officially banned in Yemen. So it was concluded that its residues must be originated from a more remote source or more likely, from continuing illegal use. However, comparably, DDT concentrations in those fish were relatively lower than those reported previously in the Arabian Sea;
- traces of some PCB compounds were also found in some samples of fishes from the region; and

- shoreline sediments collected from the region were devoided of organochlorine pesticides and PCBs residues. This observation was mainly attributed to the sandy nature of the sediments and its very low content of organic matter.

As discussed above, the agricultural run-off reaching the sea through wadis is likely to be the most major source of the POPs contamination in the living marine organisms. However, its effects on the inshore habitats and the people living at the coastal watershed areas of the Red Sea region are still unknown.

Heavy Metals

Recently, several studies have been carried out describing the concentration and distribution of heavy metals along the Yemeni Red Sea region. They have focused on the existence of heavy metals in fish, mussels and shoreline sediments. In general, data revealed that the levels of cadmium (Cd), cobalt (Co), chrome (Cr), copper (Cu), ferrous (Fe), manganese (Mn), nickel (Ni), lead (Pb), and zinc (Zn) in the region were generally within the range of levels reported for other regions in the world (Al Mudaffar *et.al.*, 1994, Hebba and Al-Mudafar, 2000). However, the concentrations of Cd, Cr, Mn, Ni, Pb and Zn in some fish collected from As Salif and Al Hudaydah sites were higher than those in other sites in the region. It is largely believed that human activities attribute to such high concentrations. which was mainly due to human activities in both sites. Concentrations of some metals, including Zn, Cu, Mn and Fe, in both shrimps and sea snails collected were higher more that in other fish collected from the same sites.

Another study, conducted by DouAbul & Hebba (1999), revealed that the concentration of heavy elements in fish, molluscs and shoreline sediments in the region were rather low concentrations. Additionally, the shrimps (*P. semiculatus*) collected showed a lower concentration (5.93 ppm) of Cu, compared with that (29- 171 ppm) showed by Karbe *et.al* (1981). However, in most recent studies (e.g. Hebba, *et al.*, 2002), the mean concentrations of some heavy elements in dissolved particulates and sediments, collected from several loacation in the region, were slightly higher than those found in other parts of the world.

Contamination of the respective region with heavy metals is possibly attributed to several sources. Ship traffic, municipal wastewaters, sandstorms, vehicle exhausts and coastal development activities might contribute to the contamination of the marine organisms and coastal waters with such metals. Atmospheric transportation and activities of upper catchments reaching the sea through wadis run-off are the possible sources contributing to the contamination of the sediments with heavy metals. Existence of Cu in the coastal waters may be due to cooling corrosion from the electricity power plant located at Ras Al Kathib. The significance of such a contributor is not well understood, however.

Oils (Hydrocarbons)

Recentely 100 million tons of oil transit the Red Sea region annually (PERSGA, 1999). It is navigationally complex from its narrow mouth at Bab al Mandab and along its entire reef lined length. Its narrow width greatly increases the likelihood of collisions between vessels. The Red Sea is designated “special areas” under the international MARPOL convention.

In the Yemeni Red Sea region there is a terminal oil extended to Ras Isa, located on the As Salif pennisula north of Al Hudaydah. The terminal comprisees *Safir* (the 409,000 tonne

supertanker converted for storage), sited at the southern end of the Marib-Ras Isa oil pipeline that extends 10 kilometers off the shore. The receiving oil (at the rate of 165,000 barreles/day) is stored in *Safir* through this pipeline. A tandem mooring is used to loading oil from the *Safir* to export tankers, but in strong wave conditions loading occurs via floating hose at a distance of 100m. Crude oil tankers are usually less than 100,000 tonnes, and about 80 of these tankers use this facility annually. Table 4.2 shows the amount of export and import oil in 2001.

Table 4.2: Shipping activities of the ports in the Red Sea region of Yemen in 2001.

Ports	Ships	Boats	Oil Tankers	Export Oil	Import Oil	Export Cargo	Import Cargo	Total / ton
Al Hudaydah	674	-	251	-	1774786	87159	2895619	4757564
Al Makhah	29	84	76	-	367914	53972	123319	545205
As Salif	13	346	-	-	-	11943	24355	36298
Ras Isa	-	-	94	7630977	-	-	-	7630977
Grand Total	716	430	421	7630977	2142700	153074	3043293	12970044

Oil contamination in the coastal water of the region has occurred. The seawater in near Yemen's border with Saudi Arabia was frequently contaminated with hydrocarbons (e.g. DouAbul and Al Shwafi 1998), with a higher concentration detected in the open waters (785 µg/l, Brodie and Turak, 1999) compared with other parts in the region. However, its effect would not be potential as much as that of a major oil spill if it occurs.

To date no major oil spill has been made in the Red Sea coast of Yemen. However, the area in the vicinity of the *Safir* would have severely affected if a large oil spill occurs, due to prevalent weather conditions. The prevailing southerly winds and currents would drive the oil north into the area around Kamaran Island and inshore coastal areas, where extensive coral reefs, mangroves, and sabakah communities and valuable finfish and shrimp fishing grounds exist.

Repeatedly it has been reported that the shoreline of the region is contaminated with tar balls. They are patchily scattered along it. They have been detected in many beaches of coastal areas, including Ras Isa, Makhah, Khwakha, Ras Al Katib, for many years, especially in 1998, in large quantity. The tar balls were also detected at Perim and Murk Islands in the same year (Brodie and Turak, 1999). Existence of these balls may result from activities of the oil facilities and services. Deballasting appears to be the major non-point source of the chronic oil pollution in the coastal waters of the region.

Other sources contributing to the oil contamination are the two sea-side electrical power plants, namely, Ras Kathib and Al Makhah. These plants receive fuel oil through underwater pipelines from a single mooring close to the shore, with no less than 3 million tons in 2001 (see Table 4.2). It was reported that some oil spills from coupling/uncoupling operations and from underwater pipe leaks were made. According to the Public Electricity Corporation, frequent incidental oil spills occur when oil tankers face strong winds during these operations. These incidents are common and there is no adequate facilities to control such leaks or spills.

Sediment Mobilization / Contaminated Sediments

There are several land-based activities that are sources of existence of sediments in the marine environment of the Yemeni Red Sea region. Contaminated sediments most likely enter the sea through wadi run-offs during seasonal rainfalls.

There no less than eight wadis exist in the geographical scope of the region. These include Wadi Mawr, Wadi Haradh, , Wadi Surdud, Wadi Siham, Wadi Rima, Wadi Zabid, Wad Rasyan, Wadi Mawza'a. Rainfalls in Yemen occur seasonally, so occasionally heavy rainwaters from wadis reach the sea with a large amount of sediments. The estimated total annual sediments yield of all these wadis is 52,260,000 tons, based on the sediments yield factors, i.e., surface geology, soil, climate, runoffs, topography, ground covers, land use, and uplands and channels erosion (see Al-Subari, 2001 for more details). Changes in land interiors and in highlands led to sever degradation of the higher Wadi system and slopes e.g. negligence of terrace system that is advancing in deterioration, which eventually led to higher silt deposition in lower Wadis and coastal areas. An example is Al-Luhyyah port in which sedimentation blocked half century ago.

Sediments associated with wadi run-off can affect fringing reefs of the region, by increasing turbidity that decreases amount of light leading to coral mortality, particularly in the northern part. However, not all surface water of the wadis reach the sea and some are dry for many years. Wadi Mawr and Wadi Siham could be the more possible sources washing more contaminated sediments to the sea than others, with freshwater of 23 and 68.99 cubic meters per year respectively in 1998. The former has the more total annual sediment yield than any other wadi adjacent to the region. Installation of more dams in the region since 1998 in the vicinity of wadis appears to have reduced the quantity of sediments entering the sea through the wadi runoff.

Coastal waters of the region are also subject to sediment contamination resulting from other land-based activities. The seawater of some coastal areas, including Al Hudaydah, is subject to seasonal sandstorms. Other activities have taken place to deepen shipping channels and harbours in Al Hudaydah. Dredging can lead to increase dispersion of contaminated sediments.

However, in general, no data are available to reveal whether there are significant effects on the marine environment of the region caused by sediments. Quality and quantity of the sediments entering the seas thorough the above sources is still unclear. There is a need for evaluation of the risk of the wadi fluxes and possible changes in the resent times to inshore habitats, including coral reefs.

Nutrients

General speaking, the southern part of the Red Sea region is affected by the inflow of rich intermediate water from the Gulf of Aden during late summer. This may increase nutrient concentrations by up to 25 % above the level of the central Red Sea which in turn stimulate primary production by 300% (Turak and Brodie, 1999).

Available data showed that the highest concentrations of nutrient salts were always in a station close to Bab Al Mandab Strait, whereas the lowest were in Midi, located iin the norther part of the Yemeni Red Sea region, thus reflecting the influences of Gulf of Aden. Seasonal

variations were evident with maximum concentration in July corresponding to the up-welling phenomenon in the Arabian Sea. In 1995, a severe fish mortality event occurred in the vicinity of Bab Al Mandab Strait. It was highly considered that eutrophication was the source caused this event.

A few eutrophication events are believed to occur in other parts of the Red Sea coast of Yemen on small scales. However, they are not well documented, and are still to be ascertained.

Litter

The Red Sea coastline of Yemen is subject to litter contamination resulted mainly from land-based activities. Specifically, beaches and shorelines of almost all rural areas of this region, including As Salif and Dubbab, are substantially impacted by high litter accumulation. While quantitative surveys have not yet carried out, qualitative inspection indicates that the litter has accumulative with mixture of ship and local urban materials. The most visible types of such materials are plastic bags and bottles, glass bottles, aluminum cans, papers, rags, woods and plastic sheets used to wrap *khat* (stimulant leafs chewed by almost all adult Yemenis as a daily habit) causing notably socio-economic impact through reduction of amenities. For example, in Dhubab medical wastes are disposed of into the sea behind the hospital, and in As Salif the beach accumulate very noticeably with plastic bags of different types and shapes. However, in the main coastal areas, i.e., Al Hudaydah, Al Makhah and Al Khwkhah, this impact is not recognized as much as that in coastal villages of the region. .

Coastal urban communities in the region have limited forms of garbage collection and disposal. These municipal services are much less in rural coastal areas than those in coastal cities of the region. Therefore, apart from the main coastal areas, litter, including garbage, is expected to accumulate more substantially, thus affecting the adjacent coastal areas as long as the litter is not cleaned and services are not developed.

4.2.2 Physical Alterations and Destruction of Habitats (PADH)

Assessment of each source categories of PADH identified in the Yemen's NPA (shoreline alteration, coastal wetlands and Intertidal zones alteration; and coral reef degradation) is essentially based on food security and poverty alleviation, public health, coastal and marine resources and ecosystem health, including biological diversity, and eco-social benefits. Severity of such categories varies from category to category. Assessment of such a category is separately discussed in this section at the level of the Red Sea region.

Shoreline Alteration

In the Yemeni Red Sea coast region most loss or degradation of shoreline habitats is resulted from many small scale activities of individuals, of small industries or of local utilities. These activities may appear benign in most urban areas where land filling and construction practices take place. With the exception of Al Hudaydah, there is no many urban developments along the Red Sea of Yemen. The net consequence over many years, however, is a cumulative loss of some critical habitats. Historically, shoreline of the region has altered for many years due to the following activities.

Urbanization and urban planning: was a serious threat, in certain coastal areas, to the sustainability of important shoreline habitats in the region. This is attributed to the reason that important shoreline habitats attracted human activities and settlements in the past for agriculture, fisheries and seaport activities (examples are Al Hudaydah, Al Luhyah, Al Makhah, Al Khawkhah and Midi). Poor urban planning caused most of their shore habitats to be dumped and converted to land for housing, especially in Al Luhyah, Al Hudaydah, Al Khawkhah and the south part of Midi. Indirect impacts from urbanization continue to contribute to losses in riparian zones. The earth materials produced (sediment) had progressively moved by rain floods and finally reach the sea and spread of impervious surface areas causing degradation of hydrology and water quality.

Since mid-seventies, the Yemeni Government through the creation of rural cooperatives and related subsidies, a massive movement towards road building to link rural areas with central cities in each Governorate all over Yemen. The fast road building created a system of roads in the western escarpment with huge earth rebels deposited on slopes and watercourses. The earth materials produced had progressively moved by rain floods and finally reach the coastal areas. The road developments did not encounter with any regulatory measure reducing the impact of sedimentation and erosion control. With progressive time and rainwater washing out road sedimentation reached wadi beds and clay has been carried to the sea, which led to negatively alter the characteristics of most of shoreline habitats of the region and wadi mouths. Furthermore, sedimentation and clay depositions appear to have affected the marine ecosystem and threatened coral reefs along the region.

Industrial constructions: Recently limited industrial activities have taken place around Al Hudaydah, Al Makhah, Ras Isa and As Salif. Constructions of jetties, bridges, piers, shore residence, the oil supertanker/platform (*Safir*) and other artificial structures have often involved some loss of natural habitats.

More recently other two major local constructions have taken place: one is a recreational construction, i.e., Al Hudaydah cornice, and the other is a private industrial construction, i.e. shrimp aquaculture. This cornice was redeveloped in 1999 to be extended to 150,000 square meters (10,000m X 15m) along the beach of Al Hudaydah City, including the seawalls of igneous rocks along Al Katheib road. The shrimp mariculture development, which is 1,500,000 square meters (3,000 meters X 500 meters) located in Al Luhyah, is not yet operated. However, this industrial construction eliminated the adjacent mangroves, thus affecting wetland biodiversity, and sea grasses meadows. Coral reefs may have been affected by works of this construction that led to increase turbidity in the seawater close to the construction area. Unfortunately, no environment impact assessment was enforced before constructing this project that is expected to implement in the near future.

Coastal Wetlands and Intertidal Zones Alteration

Major wadi run-offs reaching the Red Sea coast region of Yemen have created important wetlands. These wetlands include many estuaries, lagoons of fresh and brackish water, sabakah, mostly inhabited with mangroves. The combination of annual high precipitation of up to 1200 mm and the altitude of the western mountains reaching up to 3666 meters above Sea level with floods reaching the Red Sea at several major wadis have created these important wetlands. The size of these wetlands correlate with the size of upper wadi catchments. There are also several wetlands at the ends of small wadis and their tributaries.



According to the most recent study, conducted by Al Saghier (2002), there 19 mainland coastal wetlands are scattered along the coastline of the respective region. The largest one of these wetlands, namely, a mangrove type, is found in Al-Luhyyah Coast. However, there are other mangroves areas located on the islands of the region. Mangrove patches on these islands ranged from one hectare on Al Murk Is. to over 500 hectare on Kamaran Is.(Brodie and Turak 1999).

The wetlands, particularly mangroves, face many threats as a result of land-based activities. The significant and severity of these threats vary from wetland to wetland. Severely, mangroves, particularly in the northern part of the region, are harvested on unwise manner. The people living near to the shoreline harvest these habitats for material to construct houses and traps for target maraory birds. Some fishermen cutt mangroves of shelf islands for firewoods. Significantly, they are subject to grazing by camels in some coastal areas, including Al Hudaydah and Al Luhayah. The extent of such activities causing destruction to mangroves is still well unknown.

Other activities include floods-carried solid and oil wastes, road developments and seaport works. These activities, however, are not siginificantly contribute to the wetlands alteration and degradation compared with the other activities-explained above.

Interidal zones of the region are also subject to a few activities. Certain gastropods of the zones are harvested for homemade perfume purposes. Dry feet of these organisms are used in the preparation of the perfume to make it nicer smell. They have been soled locally. However, since 1998 the feet have also been exported to Saudi Arabia. According to the Ministry of Fish Wealth Office in Al Hudaydah, 325 kg and 150 kg of the dry feet were sent to it in 1999 and 2001 respectively. However, it is believed that much more than these quuantities are smuggled. Although they are no data or research revealing the impact of this harvesting on the gastropods, unsuitable uses of them may take place (since the price has become tempting).

Coral Reef Degradation

Coral growth of the Red Sea coast region of Yemen is found both as coral reefs and coral communities on a variety of substrates. Two types of coral reefs development are found: 1) fringing reefs of the southern Red Sea coast and some offshore islands and 2) semi-submerged patch reefs west of Al Hudaydah and south of Ras Isa Peninsula. Most coral growth and coral communities along the northern coast and near shore islands occur on relic Pleistocene or Holocene reef formations.

The respective region does not have classical fringing reefs. About 25% of the mainland coastline supports coral reefs (Al Agwan, 2001; Nicolas & De Vantier, 2000; Turak & Brodie 1999). Corals and coral reefs are widespread along the region's mainland coast south of Khawkhah (Turak & Brodie, 1999). In general, the coral reef health in the southern part of the region was better than in the northern part, with exception of that off certain shore islands, Az Zubayer Group and At Tair in the north.

Reef habitats of the region have been subject to direct and indirect adverse activities, including land-based activities. Historically, many buildings in the coastal villages are built from coral blocks. Corals have been widely used in construction of houses and mosques for many years (these activities probably no longer take place). They are also in use for road constructions adjacent to some coastal villages. Such activities have devastating impacts on reefs. Moreover,

corals are targeted for decoration business. Other activities include boat anchoring and overexploitation of reef communities.

More recently, specific reef fish, including butterflies, are exported for aquarium businesses. Since 1996 these fish have exported to several countries via companies based in Al Hudaydah. The sustainability of this industry with regard to the available stocks has not been assessed. Collection of these fish is usually associated with devastating materials and/or activities to reef health, but they, to some degree, are not evident. Sea cumpers are also harvested to export abroad. This type of business has been rapidly raised without encountering with a stock assessment for these reef organisms. This, in turn, may threaten their population.

Coral bleaching is another source contributing to coral reef degradation. Observed widespread dead coral appear to have been associated with recent bleaching events, including 1998. While Yemen corals may be adapted to high water temperature, small rises above the normal range may be sufficient to bleach and kill coral. Continuing sea surface temperature rises, as predicted under the most reasonable global climate change predictions, are likely to have serious effects on Yemen coral reefs and may even cause ecosystem shifts to algal reef dominance (Brodie and Turak 1999). However, currently, the details of the local and regional extent of these effects are entirely unknown.

Although reefs of the region are suffered from several activities, including anthropogenic, they are not yet protected. There are some proposed marine protected areas, but they are not yet established.

Coral reefs of the Yemeni Red Sea region should be managed effectively. Reef habitats and communities in the northern part of the Red Sea coast region of Yemen are under assault due to the several activities. Permanent or long-term damage to coral populations on the islands located on the southern part of the region would have severe impact to biogeographical consequences, due to gene flow between the Gulf of Aden and the rest of the Red Sea. Coral reefs and populations in this part are likely to be of a great biogeographical importance to the region. Accordingly, from two different views, the entire coral reefs should be conserved.

4.3 Priority Problems

Contamination and PADH- as key problems identified in the NPA initiative- are prioritized in relation to their source categories, ranked from low to high. This section separately discusses the prioritization of such a problem along with its source categories at the level of the Yemeni Red Sea region.

4.3.1 Contamination

Ranking priority of each source category of contamination varies from category to category. A low priority is assigned for heavy metals and nutrients; the others (sewage, POPs, oils (hydrocarbons), sediments and litter) are considered a higher rank at the level of the Red Sea region. The priority rank of such a source category is discussed below.

Sewage

A sewerage system of treatment plants exists in Al Hudaydah City only. The other coastal areas lack such a system, and even a system of sewer pipes. The people living in these areas

use traditionally dug septic holes instead and some discharge their raw municipal sewage immediately into the sea. A medium-high priority is an appropriate rank assigned for this pollutant source category.

POPs

POPs could cause serious environmental and public health problems. Certain POPs, including DDT, were found in marine organisms of the region. However, their concentrations were either low or under detection. Even so POPs are in need of a medium priority concern. No research has been conducted on the extent of their effects on the people living at the coastal watershed areas where receive agricultural run-offs, which appear to be the major resource of POPs contamination in the coastal environment, during heavy rainfalls. Also, the risk of POPs on coastal habitats facing wadis mouth should be evaluated.

Heavy Metals

Heavy metals were found in some fish, molluscs and shoreline sediments collected from certain coastal areas in the region. However, concentrations of the metals were lower than that in other parts of the world. Thus, a low priority is given to this category.

Oils (Hydrocarbons)

The valuable and intensive habitats, including habitat reefs, in the vicinity of the 400,000 ton supertanker converted for storage (*Safir*), are in a sensitive position to major spills. This issue has been considered a high priority because if such a spill occurs they will have been severely affected. No adequate facilities are available to control either this spill or those occur at the power stations using oil fuel for boiling in the region. In addition, the marine environment of the region have been subject to deballasting activities caused by passing ships. Scattering of tar balls along the shoreline supports it.

Nutrients

A low priority is assigned for this category because not all coastal areas of the Red sea region of Yemen were subject to eutrophication. This phenomenon was documented at Bab Al Mandab only. Therefore severity of nutrients is unlikely to be significant on a large scale.

Sediment Mobilization/Contaminated Sediments

Sediments entering the Red Sea region through wadi run-off appear to have affected valuable inshore habitats. Contaminated sediments were found in the coastal environment of the region. However, lack of research dealing with the assessment of sources of this contamination has made it difficult to further assess its severity. There is a need for such research, ranking this category as a medium priority concern.

Litter

The litter accumulation on beaches of almost all coastal villages in the Red Sea region are common. Coastal communities living adjacent to these villages have mainly caused this accumulation that has reduced amenities of their shores. No relevant adequate municipal

services are available to control such an accumulation. Accordingly, a high priority concern is given to this category.

4.3.2 Physical Alterations and Destruction of Habitats (PADH)

Ranking priority of each source category of PADH varies from category to category. The shoreline alteration is considered a lower priority either than coastal wetlands and intertidal alteration or coral reef degradation. The priority rank of such a source category is discussed below.

Shoreline Alteration

The increase in population growth and economic activities in coastal area leads to an expansion of several constructions, thus altering seawater quality and substrates. The unplanned settlement around main cities, including Al Hudaydah, is a common problem. It may eventually result in loss of certain critical habitats such as mangroves, to the south and the north of Al Hudaaydah city, and fringing coral reefs. Coastal constructions, however, in the region are not potential to inshore habitats on a large scale. Most recently, activities of construction works, including land filling, have increasingly taken place in a certain watershed coastal area (Al Luhayah). They have significant impacts on its inshore habitats. On a large scale, activities of construction works altering shorelines of the region is being ranked as a low-medium propriety concern, but protection of inshore habitats from these activities should be highly considered at Al Luhayah.

Coastal Wetlands and Intertidal Zones Alteration

Many wetlands have been identified most recently, but the risk of each factor affecting them is still well unknown. Mangroves are subject to harvesting by locals and to grazing by camels. Certain organisms living within intertidal zones are also subject to harvesting for business purposes. Unfortunately, no regulatory measures have been enforced to avoid or mitigate such activities. This category is in need of a high priority concern.

Coral Reef Degradation

Coral reefs of the Red Sea region are more widespread than any other in-country coastal region. Since these reefs are not yet managed-despite of being exposed to several impacts-their conservation should not be ranked less than a high priority. Many reefs in the region are considered critical and important habitats, and they should be protected from major impacts.

4.4 Goals and Management Objectives

This section provides the management objectives set to protect the Yemeni marine environment from the key problems (contamination and PADH) in relation to their source categories that are given medium priorities and higher ranks at the level of the Red Sea region.

4.4.1 Contamination

Sewage

The overall goal is to prevent discoloration of the water and pollution in shellfish harvesting and recreational areas. The specific management objective is to improve municipal and industrial waste water disposal practices.

POPs

The overall goal is to prevent the effect of POPs on human health and coastal environment. The specific management objective is to control agricultural run-off.

Oils (Hydrocarbons)

The overall goal is to prevent fish and shellfish contamination. The management objective is to control major oil spills into the marine environment.

Sediments Mobilization/Contaminated Sediments

The overall goal is to prevent the physical impact of sediments on habitats. The specific management objective is to control discharge of these sediments into coastal environment.

Litter

The overall goal is to prevent litter/plastic accumulation on beaches. The specific is to obtain public cooperation with solid waste management (collection and disposal).

4.4.2 Physical Alterations and Destruction of Habitats (PADH)***Shoreline Alternation***

The overall goals is to prevent coastal zone degradation. The specific management objectives is to control coastal development activities.

Coastal Wetlands and Intertidal Zones Alternation

The overall goal is to prevent/minimize loss of wetlands. The specific management objective is to regulate land use.

Coral Reef Degradation

The overall goal is to control reefs degradation. The specific management objective is to protect these habitats from major negative impacts.

4.5 Strategies and Measures

This section provides the strategies and measures established to protect the Yemeni marine environment from the key problems (contamination and PADH) in relation to their source categories that are given medium and high priority concerns at the level of the Red Sea region.

4.5.1 Contamination

Sewage

- Expanded oxidation ponds
- Water pollution regulation (municipal and industrial);
- Identify an acceptable location for the submerged, where the effluent will not degrade significant water areas or contaminate shellfish beds and beaches

POPs

- Coastal watershed management
- Evaluate the risk of POPs on the people living in the coastal watershed areas and on coastal habitats

Oils (Hydrocarbons)

- Shipping/oil facilities and regulations
- Strengthening of surveillance services on illegal oil spills on the coastal zone

Sediment Mobilization/ Contaminated Sediments

- Comprehensive assessment of this pollutant source categories

Litter

- Solid waste management
- Expanded coverage to low-income rural areas via community based approaches
- Create contestable markets to encourage private sector entry
- Public education to obtain cooperation

4.5.2 Physical Alterations and Destruction of Habitats (PADH)

Shoreline Alternation

- Planning regulation and enforcement
- Special areas designation (seashores)
- Tourism-type activity in support of environmental initiative

Coastal Wetlands and Intertidal Zones Alteration

- Appropriate incentives (prices and taxes)
- NGO-type activity in support of environmental initiative

Coral Reef Degradation

- Pollution control regulation enforcement
- Development of regulation measures relate to harvest of living marine resources
- Coastal and marine protected areas

CHAPTER 5 WESTERN GULF OF ADEN REGION

This chapter provides background on the coastline of the western Gulf of Aden region of Yemen and discusses the pertinent subsequent process steps at the level of this region.

In this document the western Gulf of Aden region of Yemen includes the coastal areas and islands located within the governorates of Lahj, Aden and Abyan. The coastline of this region is 540 kilometers long. Important sites for threatened soaring sea birds, including migratory species, mainly characterize this region. Each of the following subsequent steps of the process used in the Yemen's NPA initiative is discussed at the level of the western Gulf of Aden region of Yemen.

- *Identification and Assessment of Problems*
- *Priority Problems*
- *Setting Goals and Management Objectives*
- *Strategies and Measures*

5.1 Introduction

In this document the western Gulf of Aden region includes the coastal cities and village and islands located within the geographical scope of the governorates of Lahj, Aden and Abyan (see Appendix 1). The coastline length of this region is about 540 kilometers. The residential population of the coastal areas was 2650 and 4628 in Lahij and Abyan respectively (1994 census), which is expected to grow to 3868 and 6758 people respectively in 2005-based on the accumulative annual growth rate, estimated at 3.5%, since the 1999 census. In contrast, the population dynamic has significantly changed in Aden where the residential population has grown much more than that of the other governorates, since it has been declared a “Free Zone” in 1991. This led to grow its population since then to 563,000 people in 1995, due to considerable migration of population to it from several inland areas in the country.

Aden is an increasingly important venue for recreational and commercial activities. It is also an ecologically important stop for many migratory sea birds due to existence of a wetland system that provides feeding and nesting for these birds, including threatened species.

The population growth in the respective region, particularly Aden, may exacerbate severe coastal-use conflicts in terms of land and water space and coastal and marine resources utilization. Indeed, coastal natural resources in Aden have subject to negative activities of the industrial development. The coastal and marine environment in the region is subject to other activities such as discharge of untreated sewage and activities of oil export & refining processes. Some of these sources play a role in the degradation of some coastal habitats in Aden.

There are three major wadies reaching seawater of the region. They are Hassan, Bana and Tuban. Beds of Wadi Bana and Wadi Hassan are found within the geographical scope of Abyan. The upper catchment of Wadi Bana is a very long way from this scope, whereas the upper catchment of Wadi Hassan is situated in Abyan. These catchments flow to the Abyan shore about twice a year with freshwater of about 20 million cubic meters per year. In contrast, beds of Wadi Tuban are found within the geographical scopes of Lahj and Aden, but the upper catchment of this wadi has not flowed to the Lahj shore for nearly twenty years and rarely flow to the Aden shore.

Flash floods for Wadi Hassan and Wadi Abyan could contribute to coastal pollution in the respective region. These floods possibly include POPs and other harmful substances affecting the coastal environment. However, there is no evidence to confirm it. Additionally, the quality of the seasonal freshwater reaching the sea is not yet clear.

5.2 Identification and Assessment of Problems

As explained in Section 2.1.1, contamination and PADH are identified as key problems related to the NPA initiative. This section assesses each problem in relation to their sources categories at the level of the western Gulf of Aden region of Yemen.

5.2.1 Contamination

Assessment of each source categories of contamination identified in the Yemen's NPA (sewage, POPs, heavy metals, oils/hydrocarbons, sediments, nutrients, litter) is essentially based on food security and poverty alleviation, public health, coastal and marine resources and ecosystem health, including biological diversity, and eco-social benefits. Severity of such categories varies from category to category. Assessment of such a category is discussed separately in this section at the national the level of the western Gulf og Aden region.

Sewage

At present, not all coastal areas of the region have a sewerage system. No such a system is available to serve the residential people of the coastal areas of Lahj and Abyan, where 3489 and 6095 people live respectively (estimated 2002 census). Instead, traditionally dug septic holes are used. By contrast, there a sewerage system serves most homes of the districts of Aden, i.e. Al-Mansoorah, Dar Sa'ad, Al-Sheik Othman, Al-Bureika (Little Aden), Crater, Khormaksar, Mualla and Twahi. The estimated total population of Aden was 649805 in 2002, which is expected to grow to 720450 in 2005 (based on the accumulative annual growth, estimated at a rate of 3.5% per year, sine the 1994 census).

There are nine main outfalls in Aden. Eight outfalls are distributed within its five districts: one at Ma'alla, four at Twahi, one at Crater, one at Khormaksar and the last at Al Burika (Little Aden). Until 2001 all of these outfalls was discharging untreated sewage into the sea. In 2000, according to CMEC (2001), a high mean *Eschericia Coli* was found in the seawater close to the outfall of Ma'alla' (see Table 5.1),which was considered a sewage-contaminated site. The ninth outfall pours its contents into a treatment sewage plant of eight oxidation ponds at Al Haswah, situated 2 kilometers off the coast. The plant receives the municipal sewage of Al Mansoorah, Shiek Othman, Al Sha'ab City and DarSa'd. It serves most homes of these districts, with about 15000 cubic meters of sewage discharged daily. Very small proportion (<5%) of this sewage is reused for agricultural purposes, mainly windbreaks.

Some shore-dwellers of the region, including those in Aden, discharge immediately their raw municipal sewage into the sea. This sewage is unlikely to be large in amount, but it is likely to have more effects on human health than on the coastal environment. Here, it may require conducting studies on the extent of such effects.

Table 5.1: Bacterial count in the seawater close to outlets of municipal wastewater of some districts in Aden

Parameters	Guide values	Locations				
		Hukkat, (Sirah)	Ma'alla	Khormakhsar	Al Haswah,	Al Burika
Eschericia Coli /100mL	100	31	117	1	2	3
Coliform /100mL	500	64	95	0	3	6

(Adopted from CMEC, 2001)

General speaking, effects of sewage and municipal wastewater either on the coastal habitats or on living resources are still unclear. Samples of mussels, fish, or shellfish have not been taken for bacterial contamination analysis. Mortality of these resources related to sewage contamination has not been recorded. Also, no studies have been conducted dealing with effects of sewage on the wetlands of Aden.

There is a stream and desalination plant (SDP) in the region . It is another source for sewage-related problems. The SDP is situated in Al Haswah. The hourly discharge of seawater used is 20,000 cubic meters with water temperature of 44 °C. This water is discharged into an exposed beach, where flush is rapid. It may not cause significant effects on the quality of seawater and on living marine resources close to the plant. However, there no study supports it.

Some chemicals are used at the SDP. About 40 milliliters of chlorine is added hourly to the cooling water input to preventing fouling marine animals from settlement inside the pipelines that feed the cooler and the condenser with seawater. The percentage of this added chemical ranges from 0.1 to 1.0 with an extra high concentrated amount added every six hours.

Other chemicals are added with water to clean the boilers from trapped materials. These are sodium carbonate Na_2CO_3 , hydrochloric acid (HCL), ammonia solution (NH_4OH) sulfuric acid (H_2SO_4) and sodium hydroxide (NaOH) with annual use of 14 tons, 10360 liters, 800 kg, 217 liters and 7410 kg respectively (SDP Authority, personal communication.)

The waste of the chemicals used in the SDP is collected in separate ponds found inside the plant. Therefore, it is not discharged into the surrounding sweater.

The textile factory in Aden has no own sewage treatment plants. However, the factory discharges its wastewater into the public sewerage system to eventually reach the treatment plants of Al Haswah. The annual discharge is about 144,000 metric tones. The wastewater contains the chemicals used at the factory. They are NaOH, Cl_2 , H_2O_2 and H_2SO_4 with slight concentrations of 0.025 g/l, 0.008 g/l, 0,004 g/l and 0.0012 g/l respectively. The operation period of the factory is a two-day a week. Its productive capacity is small, with dyes used of 369.6 kilograms per year. In contrast, the Shukra Fish Canning Factory, situated at Shukra, Abyan, discharges its wastewater directly into the sea. The factory daily use less than 50 liters of water for boiling fish cans. Nevertheless, this factory is unlikely to cause sewage-related problems due to its small productive capacity.

Some people in Aden have been subject to sewage-related disturbance for some years because of the sewerage system damage. Sewers leakage in some cities was not uncommon. This

gave the Yemen government cause for concern, leading to propose another sewage treatment plant at Al Areesh. This plant, which is 600 meters X 1,200 meters in area with eight oxidation ponds, would serve the populations of Crater, Khormaksar, Mualla and Twahi. The total assumed receiving capacity of the Al Areesh treatment plant is 105,000 cubic meters per day at three stages of equal capacity. It is currently operating at its first stage. Reuse of the municipal sewage is proposed as well.

POPs

There are a few sources for POPs, by which they could reach the coast of the respective region. General speaking, use of agriculture pesticides could be a non-point source for POPs, particularly DDT, reaching seawater through the wadi run-off in the region during rainfalls. However, not every run-off reaches the sea.

No run-off for Wadi Al Kabir, which faces Haswah shore and is the only direct main route of pesticides come from Lahj agricultural lands to the sea, that is dry for nearly 20 years. Since then the adjacent marine environment has not been subjected to pesticides, including POPs, contamination through this wadi. In contrast, there are two wadis, that are, Wadi Bana and Wadi Hussan, whose run-off reach Abyan Coast (~ 65 kilometers east off Aden) about twice a year with freshwater of about 20 million cubic meters per year.

Effects of the wadi run-off on the coastal and marine environment are most probably not similar mainly due to characteristics of lands. In 2000, generally, the entire gross cultivable areas were about 38474 hectares in Abyan, but the planted areas were 30090 hectares. The land in the vicinity of Wadi Hussan is semi-arid, whereas Wadi Bana is semi-wet. So the latter is the most possible route of the pesticides, including POPs, reaching the western Gulf of Aden. Their effects could be not significant because the land where these pollutants are used is a long way from the sea. Available data revealed that inshore sediments collected from the region were contaminated with PCBs and DDT in 1998, but most concentration levels were non-detective (Al Shwafi, 2000). Other available data reveal that the seawater at Aden Harbour was not neither contaminated with chlorinated pesticides nor PCBs-with the exception of one site (12.47.58N: 44.58.90E, with less than 1 µg/l) (MEP, 1996). No more recent research dealing with the extent of effects of the POPs is available.

Atmospheric transportation could be a non point source, by which POPs, particularly dioxins and furans, might reach the sea, through smokes and ashes resulted from burning processes of the domestic garbage in a public landfill site. It is situated at Dar Sa'ad, east off Aden- Taiz Highway). It annually receives about 240,888 and 9,000 tones of garbage and industrial solid waste come from Aden and Lahj respectively. However, the site is a long way (about 5 kilometers off the coast) from the seashore. Thus, it most unlikely to have significant effects on the surrounding marine environment.

Heavy Metals

Heavy metals were found in shore sediments of the main coastal areas of the region (see Table 5.2). The concentration of iron (Fe) was much higher than any other heavy metal. It ranged from 644 to 936 µg/g dry weights in shore sediments collected in April 1996 from the shores of Little Aden and Ahour respectively (Sana'a University, 1996). However, these levels are not potential to cause significant effects on the coastal environment. They are within the range of acceptable levels. Sources of these metals were most likely natural origin.

Table 5.2: Mean concentrations of heavy metals in shore sediments sampled from mainland coastal areas in the Yemeni western Gulf of Aden region (concentrations in µg/g dry weight)

Stations	Cd	Co	Cr	Cu	Fe	Mn	Pb	Zn
<u>April 1996</u>								
Al Sugiah	0.56	13.5	ND	48.0	785	92.2	18.6	23.0
Khor Omira	0.42	16.8	11.7	5.0	851	116.4	ND	43.0
L. Aden	0.63	24.5	3.1	2.5	644	32.2	2.0	16.2
Shuqrah	0.56	27.8	ND	9.3	750	71.1	17.5	15.2
Ahour	ND	8.0	28.9	9.0	936	69.5	12.5	17.5
<u>August 1996</u>								
Al Sugiah	0.60	11.9	ND	56.8	888	77.9	22.2	12.5
Khor Omira	0.57	16.9	10.9	4.8	763	100.7	10.9	17.8
L. Aden	0.48	15.7	4.6	3.2	625	38.9	13.0	15.9
Shuqrah	0.61	8.9	11.7	10.8	644	91.0	12.7	17.5
Ahour	ND	11.3	22.2	10.9	902	66.9	16.8	22.9

*Mean of at least three determinations. ND=below the detection limit of 1 ppm
(Adopted from Sana'a University and MSSR, 1996)

Other available data showed presence of heavy metals in the seawater and some marine organisms of the region, but their concentrations were not potential as well. MEP(1996) revealed that concentrations of heavy metals in the seawater at Aden Harbour were generally below the detection limits-with the exception of copper (Co), tin (Tn), iron (Fe), and zinc (Zn). The study considered that the contamination with the first two metals was a result of anti-fouling paints used for shipping vessels. In contrast, the contamination with the last two metals was most likely to be resulted from the sewage effluent of Ma'alla, into which effluent of a paint manufacturing company pour. Szefer *et al.* (1997) revealed also that concentrations of some heavy metals (Cd, Pb, Zn, Cu, Mn and Fe) in mussels sampled from Crater Coast, Sira, Ra's Marbat and Fuqum, were within the detection limit as well- with the exception of Zn that showed an elevation, at the Fuqum site only.

Atmospheric transportation is the non-point sources by which heavy metals, particularly lead (Pb), may reach the sea. Winds could carry lead released from vehicle exhausts to the sea. However, effects of heavy metals resulted from his source are still entirely unknown.

Oils (Hydrocarbons)

Oil/hydrocarbon facilities are common at Aden. These facilities include an oil refinery, and refinery harbour at Little Aden (Al Burika district), bunkering berths at the harbour and the ship fuel supply pipeline from the refinery to the south of the harbour. In 2002 the total volume of feedstock of crude oil processed was about 3,500,000 tons (Aden Refinery Authority, personal com.). It counts half of the total capacity of the oil refinery.

Deliveries of fuel oil by the bunker berths to ships have been declined considerably since the 1970s. They were declined from 600,000 tones/year in the mid-1970s until 1988, to 450,000 tons/year by 1990, and to 200,000 tons by 1991. In 1996 the bunker supply of the Aden harbour was around 40,000 tons (Facy, 1996). However, it has increased up to 100,106 tons in 2001. Table 5.3 shows the amount of wastewater discharged together with treatment types of the refinery.

Table 5.3: Discharge and treatment types of the Aden oil refinery

Type of discharge	Cooling water	Process water	Ballast water
Flow of discharge	40 million tons/yr	40 thousand tons/yr	10 thousand tons/yr
Type of treatment	Gravity separation	Gravity separation	Gravity separation
Hydrocarbons concentration at the exit of the treatment system	Nile	25 mg/L	25 mg/L
Quantity of hydrocarbons discharged	Nile	1.0 tons /yr	0.25 tons /yr

(Source: Aden Refinery Authority)

Oily water resulting from the refining process is separated, and its effluent is discharged into the seawater south to the refinery. This effluent is contaminated with hydrocarbons (Table 5.3 shows the quantities and concentration of these hydrocarbons). However, the quantities of the hydrocarbons discharged are below the normally allowed values for refineries on different parts of the world (Haidra, 1990). They could result in oil contamination on a small scale (at the discharge site) only.

A series of oil accidents and incidents has occurred in the western Gulf of Aden of Yemen. In general, incidental oil leaks are not uncommon. In 1986 oils leaked into the sea due to failure of bunkering operation during loading oil from tankers to storage tanks, and due to leaks resulted from the pipes carrying supply to the bunkering berths (MEP & MSRRC, 1995). In 1995 a bunker barge sank at Tawahi district, Aden, causing considerable localized oil pollution (Facey, 1996).

According to the Public Corporation for Maritime Affairs (PCMA) two major oil spills occurred in Aden coast, one in 1999 and the other in 2001. In 1999 a container ship spilled about eight tons of ship fuel into the seawater adjacent to the container terminal. This spill was partially cleaned by the PCMA using dispersing chemicals. The effect extent of this spill on the marine environment was unclear due to lack of relevant research.

In May 2002 three tons of crude oil was spilled to the sea due to equipment failure occurred during loading from an oil ship tanker to the refinery of the harbour. A portion of this spill was broken up by dispersing agents used by the oil pollution control boat of the PCMA (Zuqar Boat). Another portion of the oil spill was washed by currents to the adjacent shore and some were remain on the sea surface. No harm to marine animals was detected in the area affected, but the rocks near to the harbour were covered with the oil spilled.

There other incidental oil spills occurred in the seawater of Aden. However, no relevant records exist to show the total number of oil spill and their quantities.

Hydrocarbons existed in mussels and shore sediments collected from shore of some main coastal areas in the region. In 1996 a study revealed comparable levels of petroleum hydrocarbons in Aden Gulf region with those reported for other parts of the world. Clear frequency of hydrocarbon concentrations determined in different sites along the coast of the

region. Almost all concentrations of hydrocarbons were higher in August 1998 than those in April 1996 (see Table 5.4). The southwestern monsoon that occurs from June to September could explain this variation. During this monsoon currents can wash ballast and oily water from the offshore to the inshore of the region. Existence of tar balls along the region shores, especially Abyan shore, supports it. Accordingly, heavy traffics and oil facilities, especially oil tankers, significantly contribute to the contamination of the shoreline with hydrocarbons in the region.

Table 5.4: Mean concentrations of petroleum hydrocarbons in shore sediments and mussels sampled from mainland coastal areas in the Yemeni western Gulf of Aden region

Stations	Petroleum hydrocarbon concentrations ng/g dry weight (Marib light crude oil equivalent)			
	April 1996		August 1996	
	Mussels	Bulk Sediments	Mussels	Bulk Sediments
Al Sugiah	8800	500	20000	520
Khor Omira	17600	720	26000	600
L. Aden	20800	840	13000	900
Shugrah	-	440	-	400
Ahour	-	600	-	500

(Adopted from University of Sana'a and MSSR (1996))

Local fishing is another source contributing to hydrocarbon contamination in the region. Local fishers usually dump gas oil into the sea. However, the amount of this dump is very small, compared with those leaks and spills caused by the oil facilities at Aden.

Nutrients

Sewage might play a majority role for enrichment of nutrients in the region. However, there is no evidence of this enrichment that lead to "eutrophication". A field survey showed a low increase in concentrations of ammonia, nitrite and phosphate near to the sewage outlet of Ma'alla (MEP, 1996). These concentrations, however, were not potential to cause eutrophication.

The wadi run-off reaching the sea could be a non-point source for the nutrient contamination. Most poor farmers use phosphate-contained fertilizers for their agricultural lands. A portion of these fertilizers is likely to wash with the run-off to the sea during rainfalls. However, in general, the quantity and quality of the fertilizers reaching the sea are not yet known.

To date no eutrophication event has been documented in the respective region. This might be due to the rapid exchange of seawater, the extensive seawater mixing and the flushing rates in the areas of sewage outlets, or the sources causing the nutrients contamination/enrichment are not efficient in quality and quantity to cause such a phenomenon. Consequently, the nutrient contamination in the western Gulf of Aden region is not considered a priority issue at present.

Sediment Mobilization/Contaminated Sediments

Sediments reaching the sea could contain several contaminants. Sediments contaminated with oil are obvious at the small inlet at Cltix Square, Al Mansourah District, between the main causeway and Caltix, Aden. Sediments at some areas close to the sewage outlets, particularly around the harbour and at bender Al Tawahi, appear to have contaminated with harmful substances. Wadi beds could receive dredged soils contaminated with pesticides from the

upper catchment in the areas where the pesticides are heavily used. These dredged soils flow to the sea during rainfalls. The quantity of the pesticide residues, however, is greatly fallen due to the long distance from the areas of pesticides used to the sea. As such their effect on the marine environment would not be significant. In general, however, no data are available to show the quality of the sediments reaching the sea and their effects on the coastal and marine living resources.

Coastal land-filling can be another source for the presence of sediments in the sea. Constructions have been practiced along the Aden shoreline for many years. Such activities lead to increase sediments in seawater, causing effects to the surrounding coastal habitats and to the quality of the water column through increasing turbidity.

Litter

In the region, particularly in the rural coastal areas, there is no widespread concern about the litter contamination. The level of biological impact associated with this type of contamination could be not as significant as that of the social impact. Many shore residents are not comfortable with the accumulation of litter on their beaches. Such an accumulation may cause infections, mainly in rural areas. Most visible material are plastic products, such as food bags, empty water bottles, and damaged tires. The litter is mixed with domestic garbage dropped individually on some beaches.

In Aden the litter is scattered around the Farsi Lagoon in Little Aden, at Aden lagoons, and on Abyan beach in KhorMasker. Many wrecked vehicles lay abandoned along the seaside of certain coastal districts of Aden as well.

Some sources of accumulations of litter on Abyan Beach are sea-based activities. In Abyan the beach has become a dumping site for construction debris, waste road asphalt of Abyan-Aden highway and other waste materials, extending about 8.5 kilometers long. In Aden the beach is similarly accumulated with litter, but with less construction debris. No public awareness program pertaining to this issue has effectively been done.

In general, shore clean-up services are not common at the region, particularly in rural coastal areas. The public awareness program this issue is not sufficient.

5.2.2 Physical Alterations and Destruction of Habitats (PADH)

Assessment of each source categories of PADH identified in the Yemen's NPA (shoreline alteration, coastal wetlands and Intertidal zones alteration, coral reef degradation) is essentially based on food security and poverty alleviation, public health, coastal and marine resources and ecosystem health, including biological diversity, and eco-social benefits. Severity of such categories varies from category to category. Assessment of such a category is separately discussed in this section at the level of the western Gulf of Aden region.

Shoreline alteration

Shoreline alteration-caused activities have occurred at the shoreline of Aden for many years. Shore reclamation, for commercial ports, housing, recreational, tourism, commercial and industrial facilities, are point sources for this alteration. Historically, the shoreline of Aden

has had a series of gradual process of coastal reclamation, associated with land-filling, since early 1900 (Facey, 1996). It can be summarized as follows :

- ❖ 1908-1910: Initial reclamation at Tawahi;
- ❖ 1952-1954: 4.6 million cubic meters of spoil used for reclamation at Little Aden;
- ❖ 1954-1958: Reclamation at Ma'alla Slave Island, Tawahi and the North Shore;
- ❖ 1984: Reclamation of fishing harbor quay area;
- ❖ 1989-1992: Reclamation of the Ma'alla Terminal;
- ❖ 1998: Reclamation of the Container Terminal;
- ❖ 1962 to date: Gradual reclamation of the intertidal area between the Causeway and the mainland at Khormasker (it also covers Abyan Beach, the subtidal areas at Sierrah).

The most recent reclamation extended to cover some wetlands at Labor Island, to the intertidal zone between the cause way and the main land at Khormakhser, including the Victory Park opposite to Aden Hotel. It has covered an area of about 20 hectares so far.

Almost all the area located north of Aden Hotel and the shoreline of Sierrah almost have been reclaimed. Extensive construction, including reclamation, was made to build up a big trading and tourist center at the shore of Sierrah. Hukkat Bay was already altered and no access to the sea through this bay. In AL Buirika, Al-Ghadir shores (Beach), has altered by building up the MSRRC and chalets. The remaining areas, similar to those at Gold Moher, and the small islands are proposed to become private tourist lands.

Coastal development activities, associated with land-filling, in Aden have rapidly been increased. They cause direct loss of habitats for birds and could lead to decreased coastal ecosystem integrity at Aden.

Coastal Wetlands and Intertidal Zones Alteration

There are a number of wetlands in Aden-excluding mangroves. They have several wetland systems that are in close proximity to each other. They include Aden lagoons, an intertidal flat along the harbour site, marshes and Abyan beach (Al Saghier and Porter, 1996). The open sewage canal outlet of the Al Haswah sewage treatment plant has made the marches as artificial wetlands. Diversity of avian fauna enriches these wetlands. The wetland systems, including marshes, provide feeding and nesting habitat for three globally threatened species and twelve species with regionally important populations (Al Saghier and Porter, 1996). Wetlands of Aden, included in a *Directory of wetlands in the Middle East* (Scott, 1995), are identified as important bird areas in the Middle East (Evans, 1994) and represent a majority stop over for thousands of wading birds and waterfowl migrating to and from Eurasia and Africa (Al Saghier and Porter, 1996).

The wetlands have gradually been affected by land-based activities, mainly land-filling. Activities of coastal developments threaten the wetlands of Aden. They are still at risk due to development pressures, such as reclamation for providing space for housing, for tourist facilities, for trading and industrial facilities and for port constructions (terminals). Specifically, the significant effect on the wetlands is likely to occur with the future development acceleration of Aden free zone. A long maintenance failure caused the supply pipeline of the pumping fuel, from the oil refinery to the storage tanks, situated south of the harbour, to leak into a wetland at the Caltix round-Crater main road (main Cause way), Aden, for some years. This leakage led to oil contamination accumulated at this wetland.

However, the EPA in Aden was becoming increasingly concerned about the regular leaks of the pipeline into the wetlands, causing the pumping to stop. A supply tanker is instead.

Coral Reef Degradation

Less well known about coral reefs in the region more than any another part of the world. No detailed information has yet been provided on the benthic life-forms of coral communities- with the exception of the most recent study conducted by Kemp & Benzoni in early 1998 at Ras Imran, Aden - and factors threatening reefs of the region.

General speaking, coral reefs in the region are not well developed. They grow on hard substrates at Sierrah, Crater headlands, Ras-Fuqum, Ras-Omeran, near to Al Burika Bridge (the intertidal mudflat), and Farci Lagoon, in Qawah coast (Watt, 1996, Bawazir. & Abu Fatooh, 2001) and also in the coast of Khor Omerah at Lahij and Shuqrah at Abyan (CEMP, 1985, MEP & MSRRC, 1995, MSRRC, 1996). Kemp & Benzoni (2000) revealed that extensive stony corals at Ras Imran grew directly on non-biogenic substrates, with no biogenic rock accretion.

Several activities have affected coral habitats. Boat anchoring, fishing nets laid on reefs for catch, trapping practices, especially when they got lost and settle on reefs, and use of corals for decoration and souvenirs have contributed to the coral reef degradation. The coastal land-filling is considered the significant factor threatening the coral reefs at Aden. Land-filling practices were well obvious at the harbour, at Sierrah, at Al Tawahi as well as at Al Burika, where coral reefs were devastated.

No specific studies have been done concerning coral bleaching in the western Gulf of Aden region of Yemen. The most recent study on corals of this region (Kemp (Kemp & Benzoni, 2000), conducted in early 1998, did not show any damage of corals resulting from the bleaching during the study. However, they pointed out that corals in Socatra archipelago were severely bleached by May 1998, and in the other study areas, that are, Mukalla and Bir Ali, corals appear to have suffered similarly to those of Socatra. High levels of coral mortality followed this bleaching. It is most probable that corals of the western Gulf of Aden coast were subject to the bleaching event of 1998, with considerable mortality. However, local and regional levels of this mortality and bleaching impacts remain vague.

5.3 Priority Problems

Contamination and PADH- as key problems identified in the NPA initiative- are prioritized in relation to their source categories, ranked from low to high. This section separately discusses the prioritization of such a problem along with its source categories at the level of the western Gulf of Aden region of Yemen.

5.3.1 Contamination

Ranking priority of each source category of contamination varies from category to category. A low priority problem is assigned for sediments, whereas the others (sewage, POPs, oils hydrocarbons and litter) are considered higher priority problems at the level of the western Gulf of Aden region of Yemen. Contamination with nutrients is not currently given a priority problems. The priority rank of such a source category is discussed below.

Sewage

There are two wastewater treatment plants in Aden governorate: one services almost all people of the four districts (Al Mansoor, Dar Sa'ad, Al Sheikh Othman and Al Bureika) and the other would serve almost all people of the other four districts (Crater, Khormaksar, Ma'alla and Tawahi). Hence, the municipal waste water is no longer considered a major problem threatening the marine environment of this governorate, which is one of the main coastal governorates in the region and entire Yemen, and could be similar to other coastal areas of the region. Importantly, no other major coastal areas located along the coastline of the region. Accordingly, a low-medium priority is an appropriate rank given for this category.

POPs

Several compounds of POPs residues existed in certain living marine resources. The higher molecular weight of PCBs was found in the mussels (*Trivela ponderosa*) collected from coastal areas of the region, compared with that collected from the Red Sea region of Yemen. Although these organisms have not been eaten locally existence of PCBs in the marine environment has caused concern. Therefore, POPs are considered a medium priority problem.

Heavy Metals

The available data showed that shore sediments sampled from certain locations in the region were contaminated with heavy metals, but did not show whether they have affected living marine resources. So, it would be difficult to well assess this category, leading to rank it is as a medium priority problem at present.

Oils (Hydrocarbons)

A medium-high priority has been ranked for this category. Occurrence of major spills in the western Gulf of Aden region might have a severe impact on living marine resources, including commercial fish, following with reduction in socio-economic benefits. Although the region have facilities for controlling oil spills, including Zugar Boat, they are more unlikely to control such a major spill. Besides, debalasting passing ships are not tracked.

Nutrients

Events of nutrient enrichment in the marine environment (eutrophication) have not been documented in the Yemeni western Gulf of Aden region. To date this category is not a priority problem in this region.

Sediment Mobilization /Contaminated Sediments

In Aden direct inputs of sediments into seawater of the region have been associated with reclamation activities. In the entire region sediments washing from inland through wadies are likely to affect the coastal sites close to the wadi mouths, but these areas-apart from Aden-appears to be not critical habitats. At the in-country regional level, the category is assigned as a low priority problem because no many wadis are found in the region and the surface water of the existing wadis rarely reach the sea. However, at a local level, sediments mobilization-related problems should be highly considered at Aden.

Litter

The coastline of the western Gulf of Aden, particularly Aden and Abyan, is substantially impacted by different types of litter. The most visible litter are wrecked vehicles and tires lying on certain beaches, plastic products, and empty cans and bottles. Some beaches accumulate with household waste tipped individually and/or construction waste and deposits with other manufactured products, including expired drugs. This has reduced aesthetic benefits of the beaches, and possibly has adverse impacts on the marine environment and human health. The input of the litter is a medium-high priority problem in the region.

5.3.2 Physical Alterations and Destruction of Habitats (PADH)

Ranking priority of each source category of PADH varies from category to category. A low priority is assigned for coral reef degradation, whereas the others (shoreline and coastal wetlands & intertidal zones alterations) are considered higher priority problems at the level of the western Gulf of Aden region. The priority rank of such a source category is discussed below.

Shoreline Alternation

Historically, landfilling practices have been significantly increased in Aden. More significantly, these practices have been rapidly increased since 1990 without conducting ecologically marine assessments, and some were illegal, leading to altering the shoreline features. This issue is considered one of the main and complicated issues in the region. There is a need for a high priority concern for activities altering the shoreline values.

Coastal Wetlands ad Intertidals Zones Alternation

In Aden there are two inshore areas that are sensitive to urban activities. They as are regularly visited by flying migratory seabirds. For this reason there was an agreement with the Free Zone Authority to keep these two areas out of activities of free zone areas. This means no construction is allowed on these two areas. However, their sensitivity has given this category a medium priority concern.

Coral Reef Degradation

Although the western Gulf of Aden region has a lower diversity of coral reefs, compared to those in the Red Sea region, there is a need for further research to understand their status more clearly. Degradation of coral reefs in the region is a medium priority problem at present. These reefs are possibly sensitive to oil pollution and/or other human activities, particularly tourism.

5.4 Goals and Management Objectives

This section provides the management objectives set to protect the Yemeni marine environment from the key problems (contamination and PADH) in relation to their source categories that are given medium and high priority concerns at the western Gulf of Aden region.

5.4.1 Contamination

POPs

The overall goal is to prevent the atmospheric transport of these pollutants particularly dioxins and furans as a result of the burning process of public garbage at the open incineration sites. The management objective is to well assess POPs in the region.

Heavy Metals

The overall goal is to prevent the negative impacts of heavy metals on the marine resources. The management objectives is to evaluate whether these metals have affected marine resources in the coastal areas.

Oils (Hydrocarbons)

The overall is to prevent coastal resources contamination. The management objective is to control major oil spills into the marine environment.

Litter

The overall goal is to prevent the accumulation of litter on beaches. The management objective is to obtain public cooperation with litter collection and disposal programs.

5.4.2 Physical Alterations and Destruction of Habitats (PADH)

Shoreline Alternation

The overall goal is to prevent further shoreline alternation. The management objective is to control coastal development activities.

Coastal Wetlands and Intertidal Zones Alternation

The overall goal is to prevent loss of wetlands. The management objective is to minter human activities.

Coral Reef Degradation

The overall goal is to prevent degradation of coral reefs in the region. The management objective is to assess the present status of these habitats.

5.5 Strategies and Measures

This section provides strategies and measures established to protect the Yemeni marine environment from the key problems (contamination and PADH) in relation to their source categories that are given medium and high priority concerns at the level of the western Gulf of Aden region.

5.5.1 Contamination

POPs

- Impact assessment on the coastal areas

Heavy Metals

- Impact assessment on coastal resources

Oils (Hydrocarbons)

- Shipping/Oil facilities
- Oil spills regulations and control
- Coastal zone management

Litter

- Provide solid waste management services
- Encourage the private sector entry into solid waste management services
- Public education to obtain cooperation
- Tourism-type activities in support of solid waste management

5.5.2 Physical Alterations and Destruction of Habitats (PADH)

Shoreline Alternation

- Coastal zone management, regulations and enforcement
- Tourism-type activities in support of environment initiatives

Coastal Wetlands and Intertidal Zones Alternation

- NGO-type activities in support of environment initiative
- Establishment of a GIS system for physical planning and monitoring programs

Coral Reef Degradation

- Regional environmental assessment that will identify the cumulative impacts of coastal development on these habitats

CHAPTER 6 EASTERN GULF OF ADEN AND ARABIAN SEA REGION

This chapter provides a background on the coastline of the eastern Gulf of Aden and Arabian Sea region of Yemen and discusses the pertinent subsequent process steps at the level of this region.

In this document the eastern Gulf of Aden and Arabian Sea region of Yemen includes the coastal areas and islands located within the governorates of Hadramout, Shabwa and Al Mahara. The coastline of this region is 850 kilometers long. Important sites for threatened turtles and existence of rare & endemic organisms (in Socotra Is.) mainly characterize this region. Each of the following subsequent steps of the process used in the Yemen's NPA initiative is discussed at the level of the eastern Gulf of Aden and Arabian Sea.

- *Identification and Assessment of Problems*
- *Priority Problems*
- *Setting Goals and Management Objectives*
- *Strategies and Measures*

6.1 Introduction

In this document the eastern Gulf of Aden and the Arabian Sea region includes the coastal cities and villages and islands, including Socotra Island, that are located within the geographical scope of the governorates of Hadramout, Shabwa and Al Mahara (see Appendix 1). The coastline of this region is about 850 kilometers long. The 1994 population of its coastal areas was 262018. It is expected to grow to 417669 in 2005.

Many people in the region depend on maritime activities and seafood products. The majority of the communities is engaged in fishery sector activities such as fish processing, canning, and trading. The region is relatively enriched with commercial living marine resources, so fishing industry is common at it. Specifically, Hadhramout is considered an industrial and commercial center for fishes. Accordingly, the food security at the region depends highly on maritime products. Consequently, any severe contamination, either caused by industrial or agricultural activities, would more likely to have direct or indirect negative impacts on the sea life, marine environment and territorial seawater of the region.

The region, particularly Hadhramout and Al Mahara coasts, is distinguished with its qualitative and quantitative biological wealth of marine organisms. Such wealth is influenced by the upwelling in summer. This phenomenon enriches the whole aquatic pole with the food chain and provides moderate aquatic temperature by mixing the proportionally cold bottom strata with the warm surface layers, thus facilitating appropriate physiological, chemical and nutritive environment for fishes and other marine organisms. In this regard, the region is characterized with diversity of fish species, including sardines, anchovies, pelagic carangids, groupers (Family of Serranidae), emperors (Family of Lethrinidae) and bottom catfish.

Extensive sandy substrates that are extended the dry sandy beaches to more than 100 meters deep also distinguish the coast of the region, but they are mostly restricted between the tide curve and 30 meters deep. They exist patchily in coasts of Shabwa and Hadhramout with depth ranging from 8 to 30 meters.

Seagrass meadows and sea weeds, including green and red-brown algae, exist in the region. They are considered important coastal habitats. Al Shaher and Ras Broum in Hadhramout are peculiar with intensity of such habitats.

6.2 Identification and Assessment of Problems

As explained in Section 2.1.1, contamination and PADH are identified as key problems related to the NPA initiative. This section assesses each problem in relation to their sources categories at the level of the eastern Gulf of Aden and Arabian Sea region of Yemen.

6.2.1 Contamination

Assessment of each source category of contamination identified in the Yemen's NPA (sewage, POPs, Heavy metals, oils/hydrocarbons, sediments, nutrients, litter) is essentially based on food security and poverty alleviation, public health, coastal and marine resources and ecosystem health, including biological diversity, and eco-social benefits. Severity of such categories varies from category to category. Assessment of such a category is discussed separately in this section at the level of the eastern Gulf of Aden and Arabian Sea region of Yemen.

Sewage

Based on the Official Population Census of 1994, the total population of the coastal areas in the region was approximately 224395 in 1994. In Socotra Island, the population was approximately 37623. No efficient sewerage systems are available to serve all this population. At present, no sewage treatment plants are constructed with these systems. Most of the municipal sewage of the cities and villages is discharged directly into the sea without any treatment. It contains different contaminants such as waste of hospitals, of slaughter houses and of car washing stations. Although there are no studies indicating the extent of effects of the municipal sewage, either on the marine environment or on public health, it may cause disturbance to some shore-dwellers in the region. It is also expected that it might cause problems on public health. The quantity and quality of sewage discharged of most of the coastal areas of the region are provided below for each area.

Al Mukalla

Al Mukalla is the largest coastal city in the region, located within the scope of Hadhramout Governorate. The 2002 population of this city was estimated at 132019 (based on the accumulative annual growth, estimated at rate of 1.04, since the 1994 census). A sewerage system exists in this city. It services 80% of the people, covering Al Ummal (Laborers) Zone, the old city of Mukalla and 50% of October Zone. The reminder (20%) use traditionally septic holes that are common in October and Ba-Abboud zones. The municipal sewage of Foua, a recently developed suburb sited 15 kilometers off Al Mukalla and distinguished with urban development, is collected and discharged through minor sewers. Digging traditional septic holes is also common in this area. Its 2002 population was estimated at 50,000.

The municipal sewage of Al Mukalla and its suburbs is discharged to the sea without treatment. Its sewerage system discharges daily about 3000? cubic meters of its effluent, through a sewer pipe of 1,250 meters long and 0.5 meter diameter, into the sea of 20 meters

deep. The municipal sewage contains organic and non-organic substances that come mostly from domestic use.

The municipal sewage is pumped from the septic holes, to be then pumped into nearby wadis beds. It ultimately flows to the sea, washed with the run-off during heavy rainfalls. The pumping sites are not far from human dwellings. They cause horrible smell and form plums becoming suitable areas for propagation of flies, of mosquitoes and of many other insects. Accordingly, problems associated with such plumes are likely to be more public concern than of ecological significance.

There many small industrial installations exist in a number of places in Hadramout. They include: Fish Canning Plants (three factories and the Fish Development Project); Petroleum Distributions; Al-Khair Industrial Complex in Al-Rayyan; Electricity Power Generation Stations in Khalaf and in Al-Rayyan; the Coastal Fishing Corporation; and Al Shahr Oil Terminal. Other installations are stations for distribution of oil by-products and for cleaning and lubrication of vehicles. The quantity and quality of sewage discharge of each installation is provided below.

Inland Electrical Power Plant of Al-Rayyan Suburb: produces 38.4 megawatts per hour. It has a network of sewer pipes discharging its sewage effluent into a nearby wadi.

Inland Electrical Power Plant of Khalaf Suburb: produces 13 megawatts of a closed cooling system, due located along the shoreline. The waste oil is discharged into two basins with capacity of 5 cubic meters. They are used to separate the oil that is transferred to special barrels in a place outside the plant, to be then soled to nearby limestone mills. Other waste fluids are immediately discharged into the sea through a seven-meters-long pipeline.

Petroleum Products Distribution Installation of Khalaf Suburb: is a public sector affiliated to the Yemeni Petroleum Company. It receives between 9,000 and 10,000 tons of petroleum products per week. They are in the form of petrol, diesel, gas oil and kerosene for domestic use in the region. The installation maintains eight containers of different capacity ranging from 900 tons to 14,000 tons. They are washed once a year or every two years, depending on types of the products contained. The suspended solids and the water used for washing the containers are pumped into its own special basins for preliminary treatment in open trenches where precipitation of the waste takes place. Afterwards, the waste oil is separated from water and transferred to barrels to be sold to limestone-produced mills. The remaining water mixed with oil substances are discharged into the sea through a four- inches- diameter pipe at a maximum depth of 5 meters. The installations discharge its municipal sewage effluent (~ 400 cubic meters per month) into the sea without any treatment.

There is a laboratory in the installation. It is used for chemical and physical inspections of the petroleum products received. However, the laboratory is not used to testing the substances or fluids discharged, which daily reach about 0.2 cubic meters, at an average oil concentration up to 0.05 mg/l. On the other hand, there is a surveillance program over the installation carried out by the competent authorities with respect to the precipitation, but no monitoring programme is conducted regularly.

Fish Canning Factories: their liquid effluents are discharged into the sea without treatment. They mainly contain detergents and animal non-organic refuse resulting from the canning processes. They usually create a fertile pasturage for propagation of bacteria in the discharge

sites. General speaking, decomposition of the animal waste, with the washing substances, lead to increased nutrients enrichment. This may cause planktonic and bacterial blooms that could be harmful to fishes and/or to human health, or at least could be a suitable environment for propagation of the bacteria causing endemic diseases. However, no data are available to show whether the site is common with such diseases or blooms.

The canning factories are located adjacent to the shoreline, with the exception of one factory that is a few hundred meters off the coast and consequently has difficulty in discharging the liquid waste to the sea due to the pipe length. The factories use some plant oils in the canning processes. Some of these oils dropped from canning lines to the ground that is washed with water and detergents. This in turn, accounts, along with the municipal wastewater of the factories, a large amount of liquid effluent reaching 10 cubic meters per day. All this effluent is discharged to the sea immediately, after passing through filtration clasps (or what is called traps for sticking or solid substances), through pipelines, without any treatment.

The factories produce monthly about 7 tons of organic solid waste as a result of the canning processes. These wastes are dumped into the sea, either directly or through wadis run-off. About 90% of the wastes are the remaining parts of the fishes processed and 10 % are materials not suitable for cooking or crushing. The waste and the garbage of the factories are often collected to be thrown away, along with the garbage of the city, in the nearby wadi beds without any treatment process. They ultimately reach the coast during rainy seasons. Otherwise, they were directly disposed of into the sea (this is what takes place usually).

Public Corporation for Coastal Fishing: its daily productive capacity was 20 tons but currently produces about 20 tons per month. The liquid waste of the corporation is directly discharged to the sea without treatment, through a five- inch-diameter pipe and at depth of not more than two meters. The large solids are separated before the discharge. The liquid waste contains waste petroleum products resulting from maintenance of the machineries and equipment use, suspended solids, melted solids and detergents. The corporation utilize about 6 cubic meters of water per day. The cooling system to the equipment is of a closed type.

Al-Khayr Industrial Complex for Food Commodities and Plastic Items: includes two divisions: one for food commodities and the other for plastic products. The first division produces preserved food commodities, including potatoes and sorghum crush products. Its total productive capacity is 20 tons per month. The other division produces plastic items that are in the form of nylon bags of different sizes and colours. Its monthly productive capacity is 50 tons. The factory daily utilize about 10 cubic meters of water.

Petroleum Products Distribution (Pumping) and Car Washing Stations: are widely spread in Al Mukalla city and its suburbs. There are more than 15 petrol distribution stations and 8 stations for washing, for lubricating and forchanging engine oil of vehicles. These stations deal with oil substances for cleaning vehicle engines, which result in liquid wastes containing high percentage of different oil products. The daily average quantity of the petroleum products used is about 7,800 liters per station.

The vehicles washing stations serve around 10 vehicles as a daily average. They utilize 2,500 liters of water and use about 70 liters of burnt diesel products for this purpose. Liquid wastes of the stations are discharged to the nearby wadis, or in open boreholes close to the stations to be then collected and transport to a remote waste land. They often are pumped into the public sewerage system.

Al Shahr

Al Shahr is a coastal city located 55 kilometers east off Al Mukalla. The 2002 population of this city was estimated at 43244. Activities of fishery and fish processing are common in the city that lacks efficient services of a sewerage system, including collection, sewers and treatment plants). Its sewerage system services a small proportion of people. The sewage effluent is directly discharged to the sea through a number of sewer pipes of different diameters ranging from 10 to 30 meters. The use of traditionally dug septic holes is common in the city. They are continuously overflowed to the streets and to nearby wadis, thus leading to increased propagation of flies and mosquitoes and other insects. They are rarely pumped.

There is a company (Borum Fishes Company) dealing in fishes, sited very close to the shore. Its liquid effluent is continuously discharged into its own septic hole. It is never pumped from the hole, depending on groundwater seepage. The solid waste of the company is screened before the discharge. The oil waste resulting from maintenance of the equipment, machineries, electrical generators used is collected in special barrels to be then sold to limestone mills.

Al Hami

Al Hami is a rural coastal area, located 29 kilometers east off Al Shahr. The 2002 population of this area is estimated at 11585. A sewerage system is constructed in this area but lacks treatment plants. Its effluents are discharged to the sea every day through 12 fallout pipes of different diameters ranging from 10 to 30 meters with an average volume of 260 cubic meters. A small proportion of people still use traditionally dug septic holes for their sewage effluent.

There is no treatment plant for the municipal sewage of the Fourth Fishes Development Project that exist in Al Hami. The waters used to wash the fishes used and the ground are mostly brought from seawater. They are returned to the sea with an average quantity estimated at 450 cubic meters per day.

Al Ghaidha

Al Ghaidha is the most major coastal city located within the geographical scope of Al Mahara Governorate. The 2002 population of this city is estimated at 10928. No sewerage system is available to serve its people. Instead, the people dig their own septic holes into which their municipal sewage is discharged. The sewage effluent is pumped from these holes to be then pumped into flood-running beds sited 20 kilometers off the city. A sewerage system development has been designed for Al Ghiadha, but not yet executed.

There two major installations exist in Al Ghiadah City. These are the Electrical Power Plant of the city and the Public Corporation for Fishery. They are situated 6 kilometers off the city. Their sewage effluents are discharged to the sea without any treatment. The liquid effluent of the plant, which is in the form of waste oil and wastewater, is pumped into an open place outside the plant. Its liquid effluent, which is in the form of waste oil and wastewater, is pumped into an open place outside the plant. The corporation deals in fishes (lobsters, tuna, young sharks and emperors). Its sewage effluent is discharged into its own septic hole and its liquid and solid refuse (including damaged and non-marketable leftovers of fishes) are directly discharged to the sea. The same way takes place for the similar corporation exists in Heynouth Area that is located 35 kilometers off Al Ghaidha. Its all liquid and solid wastes find their way to the sea.



POPs

The total area of cultivatable land in Hadhramout Governorate is 6,891 hectares, out of which 4,307 hectares (62%) are cultivated. From 1990 to 1998 the total of chemical pesticides used in the cultivated land in some areas adjacent to Hadhramout Coast was 8,140 liters. The percentage of their use vary largely from area to area ranging from 4,410 liters (54%), 1,898 liters (23%) and 1,044 liters (13%) in the areas of Al Shahr, Ghail Bawazir and Maiffa'a respectively. The remainder (788 liters (10%)) is distributed within other areas.

The pesticides used in those areas contain a wide range of chemical compounds. Phosphoric pesticides is the highest percentage (40%) of these pesticide. The Pyrothroidic, carbonic and mylathion pesticides account 30%, 20% and 24% respectively of the total pesticides used. Hexachlorocyclohexane (HCH) was less than 0.5 per cent.

The hazard of the pesticides used in the region was focused on their residue concentrations in the soil. Generally, the study showed that their concentrations in all samples collected from, and in all stations studied in, Al Eis, Al Shehr District, was about 0.001 ng/g of dry soil (Qarbal, 1999). Despite their low concentrations, they are considered disturbing indicators with regard to environmental concerns. Negative impacts have been anticipated to affect surrounding terrestrial wildlife and humans. However, they are probably not significant because the cultivated land is a long way from the shoreline and the runoff rarely reach the sea at large amounts in the region.

Yemen still utilize amounts of some organochlorine pesticides, such as DDT, dieldrin, HCB, heptachlor and PCBs. Hence, they were generally found in marine organisms and shore sediments in the Gulf of Aden coast, but at very slight averages not exceeding 6 ng/g dry weight (0.3 – 5.7ng/g), which were under detection (DouAbul & Al-Shiwafi, 2000). However, the extent of effects of such pesticides/ insecticides on the marine environment, including marine organisms, is not yet known. No relevant studies have been conducted in the region.

Types of the pesticides used in Al Mahara Governorate are numerous. These include seven, lipacide, malithion, sumasydine, sumathione, malcreep super. Officials at the Governorate Office Ministry of Agriculture and Irrigation suggest that they are unlikely to have negative impact on seawater they are used at large amounts and the farms are a long way from the shore as well. However, many pesticides are believed to be increasingly smuggled into the region. They are available in the local market.

Heavy Metals

Effects of heavy metals resulting from contents of the industrial liquid waste are possibly not significant as that of natural activities, mainly erosion, in the region. The geochemical structure of many highland areas and volcanic mountains, located in the three governorates, contain some heavy metals that are washed to the sea through wadis during floods. Other sources include decomposition of solid waste containing such metals and fallout from wrecked vehicles laying abandoned along beaches. The rapid population growth and the increase in the industrial activities contribute to the increase in the heavy metals contamination in the region.

Some heavy metals were found in the shore sediments collected from different coastal areas in the region (See Table 6.2). In 1996 a study showed that the concentration levels of lead (Pb)

in the sediments vary from shore to shore. The highest concentration level was detected in Ahour that is located within the geographical scope of Shabwa Governorate. In contrast, levels of the other metals were very low, with the exception of chrome (Cr) and cadmium (Cd) (Sana'a University, 1996).

Table 6.1: Mean concentrations of heavy metals in shore sediments sampled from mainland coastal areas in the Yemeni eastern Gulf of Aden and Arabian Sea region.

Station	Cd	Co	Cr	Cu	Fe	Mn	Pb	Zn
<u>April 1996</u>								
Balhaf	ND	8.5	ND	1.1	770	80.8	19.5	26.5
Al Mukalla	0.56	13.5	11.7	12.5	684	50.1	17.5	12.5
Ras Qussir	ND	11.2	20.5	1.9	538	9.6	11.5	8.7
Sayhout	0.84	15.6	16.0	1.1	619	22.5	11.8	12.5
Haswien	0.56	18.0	3.1	1.7	457	1.5	14.5	8.5
Muhaifif	0.49	29.9	11.7	8.2	280	9.5	9.5	8.0
Hawf	0.28	18.0	20.3	1.4	68	22.5	9.8	8.6
<u>August 1996</u>								
Balhaf	ND	10.4	ND	2.1	810	90.9	ND	28.5
Al Mukalla	0.66	12.3	9.6	15.5	503	55.1	20.4	10.9
Ras Qussir	ND	10.9	21.2	3.9	760	39.6	10.9	10.9
Sayhout	0.27	14.7	4.5	2.7	509	78.5	11.1	5.6
Haswien	0.52	17.9	5.7	1.2	470	25.0	10.8	6.7
Muhaifif	0.43	25.4	12.2	6.7	190	65.2	9.0	8.9
Hawf	0.27	10.1	23.0	4.4	170	17.0	16.0	19.0

*Mean of at least three determinations. ND= Non-Detective (below the detection limit of 1 ppm)

Heavy metals were also found in tar balls scattering along the coastline of the region. The concentration of these metals varied from metal to metal. The lead was detected with high levels comparing with the other metals (Al-Kahali *et al.*, 2001). Its average concentration in the tar balls sampled from the shores of Shuqra, Ahour, Balhaf, Sayhout, Haswien, Al Muhaifif was around 5.35 ng/g. Concentrations of the others were 0.88, 2.54, 0.6, 0.94, 0.82, 3.14, 3.30 and 0.76 ng/g for cadmium, cobalt, manganese, chrome, ferrous, nickel, lead, zinc and vanadium respectively.

Despite the concentrations of these metals being low, they would possibly lead to accumulative pollution in the near future, more particularly when the other petroleum service installations are established..

Oils (Hydrocarbons)

The coastline of the region is frequently subject to oil contamination. The oil petroleum spills at Al Shahr Oil Terminal and Rakouna, debasting tankers and passing ships are major surceases contributing to this contamination. The other sources include the sewage effleUNET of oil supply stations, and other service installations that are mainly located at Mukalla port. Tar balls are obviously scattered along the shoreline with different weights ranging from 50 to 100 grams.

The extent of impact of the contamination sources on the marine environment is not well known in the region. In spite of the frequent petroleum leaks being observed over time, they are not documented due to difficulty in accessing to the studies conducted for such a leak.

In 1996, it was found that the sediments and the mussels (*Tirvella pondoersa*) collected from some shores in the region were contaminated with petroleum hydrocarbons. The available data indicated that the shores of Qusaye'r and Al Mukalla, located within Hadhramout Governorate, were very much polluted with these hydrocarbons. Their concentrations in the sediments collected from these shores were much higher than those collected from Sehyouit Shore, located within Al Mahra Govenarate (see Table 6.2). Petroleum hydrocarbons in *Tirvella spp* collected were not detected in every study area. The concentrations, however, were generally within the international acceptable limits.

Table 6.2: Mean concentrations of petroleum hydrocarbons in shore sediments and mussels sampled from mainland coastal areas in the Yemeni eastern Gulf of Aden and Arabian Sea region

Stations	Petroleum hydrocarbon concentrations ng /g dry weight (Marib light crude oil equivalent)			
	April 1996		August 1996	
	Mussels	Bulk sediments	Mussels	Bulk sediments
Balhaf	-	800	-	300
AL Mukalla	-	560	-	2100
Ras Qussair	22400	640	43000	500
Sayhout	-	120	-	1600
Haswien	-	400	-	1500
Muhaifif	-	680	-	700
Hawf	19200	400	22000	600

(Adopted from University of Sana'a, 1996)

Importantly, some coastal areas in the region, particularly Hadhramout, are in the course of developing other petroleum services. These include establishment of a Petroleum Refinery installation at Al Dhabba Suburb and a new port for exportation of petroleum products. It is important to consider their negative activities that may occur to have effects on the surrounding marine environment. Therefore, effective cooperation and co-management program among relevant stakeholders should take place to avoid or mitigate effects on the marine environment, which may occur in the future.

Sediment Mobilization/ Contaminated Sediments

The wadi Run-off is considered the major non-point source contributing to the sediments entering to the coast of the region. There about 14 wadis exist within the geographical scope of the region. They include three permanent shallow watercourse (Wadi Hajr & Al Maseela Wadi in Hadhramout and Wadi Mayfa'a in Shabwa). The average annual flow for Wadi Al-Maseela, Wadi Mayfa'a and Wadi Hajr is about 110, 100 and 470 million cubic meters respectively (Ministry of Agriculture and Irrigation, 1997). The other wadis flush seasonally into the sea during rainfalls. No research exist to deal with the quality of the run-off.

The mouths of wadi areas/Estuaries of the region are being assaulted by sedimentation. They accumulate with sediments drifted with wadi runoff from upstream. The sediments are likely to contain sludge particles of the sewage pumped into wadi beds and other contaminants come from poor agricultural practices. They appear to have affected the estuaries. However, no evidence exists to confirm it.

Nutrients

Several sources could contribute to contamination of the marine environment with nutrients in the region. The effluent sewage might lead to nutrient enrichment its coastal waters. It contains industrial liquid waste, including several types of detergents that are used in large quantity. Some of the municipal sewage pumping into wadi beds is washed to the sea as a result of heavy rainfalls that generally wash fertile soil containing nutrients. Soil of the mountains and the wadis exist in the region contain raw elements of the basic biological substances. The floods might also wash residues of pesticides and herbicides used in agriculture. However, in general, there are no studies done to show whether these sources causes nutrient enrichment in the surrounding marine environment.

The increase in nutrients usually cause "eutrophication". This phenomenon often occurs in the seawaters of Al Mukalla, Al Shahr and other coastal areas in the region. In 2001, it was believed to cause mortality of many commercial fishes in the region, particularly Mukalla Coast. It followed with disease cases among people consuming fishes from the area and leaded to deaths in some cases. This, in turn, incited society in general and the surrounding community in particular. Indeed, many residents in the region refrained from eating fish at that time.

Sources causing the event of the sever fish mortality are not clearly understood. The effluent detergents are believed to be the source of this event, but there are no data on their amounts. The inadequacy of chemical analysis for seawater has made it difficult to know its major sources. The event relatively occurred offshore. For this reason some marine scientists suggest that it was as a result of the natural phenomenon, namely "upwelling". Nonetheless, it was a controversial issue among relevant scientists. There is still doubt as to whether human activities contributed to the fish mortality-related event.

Litter

Most coastal areas locating in the governorates of the region, particularly Hadhramout, accumulate with litter along their shores and beaches. Through direct observation to some areas of Hadhramout Shore it was observed that there were large amounts and several types of litter together with rubbish scattering along their intertidal zones. The litter included empty bottles of plastic oil plants and glass soft drinks of different sizes. Other litter included unwanted fishing gears. Generally, there were over 25 types and more than 2,500 pieces of litter scattered along every one kilometer of the intertidal zones. It seems that no municipal services exist to collect the litter in these zones where cleanup campaigns were probably not conducted someday.

6.2.2 Physical Alterations and Destruction of Habitats(PADH)

Assessment of each source categories of PADH identified in the Yemen's NPA (shoreline alteration, coastal wetlands and intertidal zones alteration, and coral reef degradation) is essentially based on food security and poverty alleviation, public health, coastal and marine resources and ecosystem health, including biological diversity, and eco-social benefits. Severity of such categories varies from category to category. Assessment of such a category is separately discussed in this section at the level of the Gulf of Aden region.

Shoreline Alteration

At present, the factor threatening the coastal environment in the region, most particularly in Al Mukalla, is the change of the shoreline features through land reclamation practices. These practices has rapidly been increased in Al Mukalla sine May 1990 (the unification of Yemen). For example, a large coastal area, extended 400 meters toward the sea and 20 meters deep) was filled in to construct Al Mukall Cornice as a recreational development . Over 2 million cubic meters of sand, 180,000 metric tons of rocks and 42,000 tons of concrete are used to for this purpose. The development had altered the nature values of the coast burying an area with coastal habitats exceeding 4,000 square meters. From the nutritive and the commercial points of view, it eliminated a critical area. The area was relatively enriched with corals and important fishes, including crustacean and mollusks, such as turbot fishes, halibut, tarpon fish, sloth fish and date fish. It is also believed that it was a habitat for effective propagation of some of these organisms.

Other coastal installations are planned to be implemented in the future. These include the new exportation port for petroleum products in Al Dhabba area and Broum. The installations could have further alteration on the shoreline in the region.

Coastal Wetlands and Intertidal Zones Alteration

Apart from Socotra Archipelago and Bir Ali Coast, the eastern Gulf of Aden and Arabian Sea region lacks mangroves, but there are a number of estuaries. These areas are the hardest hit habitats. They are productive coastal areas at the mouth of wadis where freshwater and seawater meet.

Most wetlands in the region are subject to negative land-based activities. Some of its estuarine habitats are being assaulted by sewage and waste washed with wadi ru-off during heavy. Others became as dumping sites for surrounding shore-duelers to throw away their garbage. Some fishermen catch certain gastropods living in the intertidal zones. They extract their feet to be used in preparation of special home-made perfumes. Some of these feet are exported to the Sultanate of Oman for the same purpose. This type of catch happens in a few coastal areas with no further information.

There are other types of wetlands in the region. The shallow water that is continuously flowing in the three permanent wadis (Wadi Hajr, Wadi Al-Maseela, Wadi Mayfa'a) could be also considered wetlands. They are also subject to certain factors or problems affecting their ecology. Wadi Hajr could be free of any major problem with the exception of household waste dropped by watershed community. General speaking, many residents living close the watershed area throw away their garbage in the wadi beds.

Generally, no data are available to show the impact size of effects on the intertidal zones and wetlands. Additionally, there no studies shows the extent of importance and significance of these areas-with the exception of mangroves in Socotra and Bir Ali. However, unwise harvesting of the gastropods in wetland habitats might minimize the marine biodiversity in the region.

Coral Reef Degradation

Coral reefs are good indicator for marine pollution. They are sensitive habitats for acute biological and physical effects. They unfortunately cannot be recovered in a short time when they are severely affected and damaged. It takes a long time to recove, which might extend to a decade if the effects were not acute. Therefore, the protection of these habitats prior to being affected should be greatly considered. Sewerage

Coral reefs are scattered in a few certain coastal areas of the region, but Socotra Archipelago is the most intensive diversity with corals. Apart from this archipelago, corals grow in Belhaf Coast, located within the geographical scope of Shabwa Governonrate, with a number of live corals in comparison with other coastal areas in the region. Old and new developed coral reefs, mainly of massive types, are widespread in this coast. Corals also grow at Mukalla-Broum and Hallah. They exist with old reefs extending from 3 to over 30 meters deep and attaching on rocky substrates that are common at these coastal areas. Ras Shurma Site is considered one of the coastal sites that are enriched with coral habitats, rocky substrates, and sandy seashore extended from Qusaiyer and Seyhout in Hadhramout to Ras Fartak in Al Mahara. Coral reefs in Belhaf Coast are more extensive than those exist at Mukalla, Hallah, or Ras Shurma.

The coral reefs of the region are subject to bleaching events. The reefs at Socotra Archipelago were severely affected by the 1998 bleaching event followed with a high level of mortality of coral communities (Kemp, 2001). It is believed that coral communities at Bir Ali and Belhaf were also similarly affected by this event. However, no data exist to show the extent of effects the event.

The important coastal areas in the region have become as protected areas. Parts of Socotra Archipelago was officially declared as a protected area of multiple-use type, pursuant to the presidential resolution No.275 of 2000. The areas of Balhaf-Bir Ali and Ras Sharma-Jathmun are *de facto* protected areas, which are expected to be declared officially in the nea future. There national, regional and international efforts have been devoted for the conservation of the biodiversity in the region. They include preparation of relevant management plans. Consequently, the coral reef habitats in the region are relatively free of human activities, either in the present time or in the near future, as long as these efforts continue.

6.3 Priority Problems

Contamination and PADH- as key problems identified in the NPA initiative- are prioritized in relation to their source categories, ranked from low to high. This section separately discusses the prioritization of such a problem along with its source categories at the level of the eastern Gulf of Aden and Arabian Sea region of Yemen.

6.3.1 Contamination

Ranking priority of each source category of contamination varied from category to category. A low-medium priority is assigned for heavy metals and sediments, whereas the others (sewage, POPs, oils/hydrocarbons, nutrients and litter) are considered higher priority problems at the level of the eastern Gulf of Aden region. The priority rank of such a source category is discussed below.

Sewage

To date, no sewage treatment plants exist to serve the residential population of the eastern Gulf of Aden and Arabian Sea region. Not every coastal area has a sewerage system as well. The municipal sewage reaches the sea in different ways, regardless of underground seepage. Almost all the installations, including fish canning factories, discharge directly and/or indirectly their sewage effluent into the sea without treatment. However, the flush is rapid in the coastal water of the region. This could not cause significant effects on the coastal environment. Even so, sewage-related problems should not be assigned less than a medium priority concern in the region as long as no efficient sewerage exist.

POPs

General speaking, POPs cause poisonous accumulation, especially on marine organisms, and human health. Wadis are the most possible route of POPs contamination in the coastal environment of the region, through washing pesticides used in agriculture. Despite the DDT being banned it is still soled in many shops. At present, POPs contamination has been ranked as a medium priority because no research dealing with their effects has been conducted. Hence, it would be difficult to rank this category either lower or higher.

Heavy Metals

Existence of heavy metals in sediments collected from the region has not implied the risk of them on living coastal resources, although they appear to have significant effects on the marine environment of the region. There is a need for effective research dealing with effects of these metals on these resources, and dealing with extent of such an effect if occurs. A low-medium priority is an appropriate rank assigned to well assess this category.

Oils (Hydrocarbons)

Contamination of the coastal and marine environment with oil and hydrocarbons is considered a major non-point problem threatening the region's marine environment. Diversity of fishes enrich this environment, due to seasonal upwelling. A large oil spill is likely to have severe effects on this production, thus having adverse impact on fishermen income. The most major accidental oil spill of the *Limburge* oil tanker has more likely affected many living marine resources, including commercial fishes and marine ecosystem, following with impacts on income of fishermen living close to the accidental area.

An oil refinery will be installed in Al Mukalla in the near future. This oil service facility, in addition to existing and under-development oil facilities, would contribute to the increase in oil contamination and oil spills unless appropriate actions are taken to mitigate or avoid their effects. No adequate facilities are available to tracking such a spill and avoid further relevant impacts. Accordingly, a medium-high priority are assigned for this category.

Nutrients

The region faced a sever event following with a high level of fish mortality, particularly commercial fish, and impact on local socio-economic and public health. It is believed that this event was a result of nutrients enrichment associated with human consequences. This problem was a controversial issue. Resources causing the nutrients contamination should be

ascertained, ranking it as medium priority. Excessive nutrients-related problems and sources affecting this event in the region should be more clearly understood.

Sediments Mobilization/Contaminated Sediments

Flood drainage during rainfalls, sludge settlement in the vicinity of sewage outfall areas, and oil exporting ports are the main sources of sediments entering coastal waters of the region. Although no data exist to show whether these sediments have adverse effects they possibly contain harmful substances and appear to have effects on marine environment and/or human health. However, the risk of the sediments is still unclear, giving this categories a low-medium priority concern.

Litter

The contamination of litter has been considered a high priority problem at the level of the Eastern Gulf of Aden and Arabian Sea region. Beaches of many coastal areas, particularly villages, accumulate mainly with plastic waste. Most estuaries accumulate with garbage and rubbish washed with wadi run-off. No relevant measures are taken to avoid such effects caused by accumulations.

6.3.2 Physical Alterations and Destruction of Habitats (PADH)

Ranking priority of each source category of PADH varies from category to category. A low priority is assigned for coral reef degradation; whereas the others (shoreline and coastal wetlands & intertidal zones alterations) are considered a higher rank at the level of the eastern Gulf of Aden region. The priority rank of such a source category is discussed below.

Shoreline Alternation

Alteration of the shoreline of the region is very localized. The excessive of land reclamation taking place in Al Mukall (one of the major industrial area in Yemen) has led to a significant alternation of its shoreline. These activities have not been encountered with environmental assessment studies. They increased the risk to the marine ecosystem and inshore habitats. Other coastal areas have much lower contractions. At the level of the relevant region, the shoreline alteration is given a low priority problem, but it should be highly considered in Mukalla.

Coastal Wetlands and Intertidal Zones Alternation

Some wetlands in the region accumulate with garbage and sediments which appear to have adverse effects on its marine environment. In general, however, status of wetlands and intertidal zones of the region are not clearly understood. This would give this category a low-medium priority until their status is well understood.

Coral Reefs Degradation

There major national, regional and international concerns have been taken to protect important coral reef areas in the region. Protective measures, including management plans has taken place for these areas for this purpose. Degradation of important reefs is considered a low priority problem as long as these efforts continue. .

6.4 Goals and Management Objectives

This section provides the management objectives set to protect the Yemeni marine environment from the key problems (contamination and PADH) in relation to their source categories that are given medium and high priority concerns at the eastern Gulf of Aden and Arabian Sea region.

6.4.1 Contamination

Sewage

The overall goal is to control coastal and marine water pollutants. The management objective is to improve municipal and industrial sewage disposal practices.

POPs

The overall goal is to understand the extend of effects of POPs. The management objectives is to assess their effects on human health and marine organisms.

Sediment Mobilization/Contaminated Sediments

The overall goal is to prevent/minimize human health consequences and fish and shellfish contamination caused by contaminated sediments. The management objective is to assess their effects on human health and marine organisms.

Heavy Metals

The overall goal is to prevent/ minimize their risks on living coastal resources. The management objective is to control their effects on the marine environment.

Oils (Hydrocarbons)

The overall goal is to prevent/minimize coastal resources contamination with petroleum products. The management objective is to control major oil spills into the marine environment, including oil spills from shipping oil and industries.

Nutrients

The overall goal is to prevent/minimize damage of nutrients on human health and commercial fishes. The management objective is to identify the excessive nutrients-related problems and sources in order to improve their regulation/management.

Litter

The overall goal is to prevent litter accumulations on beaches of many coastal areas. The management objective is to improve collection through public cooperation.

6.4.2 Physical Alterations and Destruction of Habitats (PADH)

Shoreline Alternation

The overall goal is to prevent shoreline alteration. The management objectives is to improve planning control on coastal development activities.

Coastal Wetlands and Intertidal Zones Alternation

The overall goal is to minimize loss of wetlands. The management objectives is to introduce land taxation and enforcement.

6.5 Strategies and Measures

This section provides strategies and measures established to protect the Yemeni marine environment from the key problems (contamination and PADH) in relation to their source categories that are given medium and high priority concerns at the level of the eastern Gulf of Aden and Arabian Sea region.

6.5.1 Contamination

Sewage

- Assess impacts of untreated sewage on human health
- Develop sewage treatment plants with best practice technology
- Industrial and municipal water pollutants regulation
- Coastal zone management

POPs

- Conduct relevant research and studies
- Examine all sources of POPs in the marine environment
- Assess impacts of organochlorine pesticides on the marine environment and human health in the coastal watershed areas

Sediment Mobilization/Contaminated Sediments

- Assessment of sources and impacts of the sediments entering the sea

Heavy Metals

- Update relevant research and studies
- Develop solid waste management
- Coastal zone management

Oils (Hydrocarbons)

- Industrial and shipping/oil facilities regulations
- Monitoring and evaluation of various oil spills into the marine environment

Nutrients

- Controlling agricultural run-off
- Improvement/enforcement of related policies and regulations
- Generation of a steady supply of relevant information and technologies

Litter

- Develop solid waste management
- Expanding services to low-income rural areas
- Encourage of the private sector entry

6.5.2 Physical Alterations and Destruction of Habitats (PADH)

Shoreline Alternation

- Planning regulation and enforcement
- Pollution control regulation

Coastal Wetlands and Intertidal Zones Alternation

- Develop appropriate incentives (prices and taxes)
- NGO-type activity in support of environment initiatives

CHAPTER 7 AN INITIATIVE FOR ACTION

This chapter contains a 5-year objectives for the NPA and the concluding remarks.

A 5-year program (2004-2008) has been proposed to effectively develop activities and components of the Yemen's NPA initiative. It includes pilot projects with different purposes. It is immediately recommended to create a PSD.

7.1 5-Year Objectives

The key objectives for the Yemen's NPA in the period 2004-2008 are to:

- ✓ Achieve a measurable reduction of pollutant loads in specific coastal locations;
- ✓ Adopt and achieve pilot projects related to the Yemen's NPA
- ✓ Enhance capacity of most related local and national authorities for addressing Priority Problems related to the NPA in a more expeditious and effective manner;
- ✓ Adopt the use of alternative approaches in addressing specific land-based sources of pollution;
- ✓ Mainstream the NPA objectives in regional, national and local policies and actions; and
- ✓ Enhance public awareness of the NPA initiative

7.2. Proposal Projects

The overall objectives of the proposal project(s) are to:

- Demonstrate a commitment to action on the ground
- Generate awareness, support, and incentives for the continued development of the Yemen's NAP
- Encourage development of new partnerships with different stakeholders and partners; and
- Contribute to the development of a relevant model that can be replicated and updated

7.2.2 Pilot Projects

It is important to sustain and develop the activities and components of the Yemen's NPA, suggested as pilot projects. To demonstrate a commitment to action on the ground, pilot projects are proposed for this purpose as well. Programme support and on-the-ground action projects are separately shown in the following A and B sections.

A. Programme Support Projects

There is a need for the sustainability and development of the Yemen's NPA activities and components. Listed below are the concrete issues taken into account as pilot projects to be implemented by 2008.

- I. Integrated Coastal Area and River Basin Management (ICARM) Program
- II. Strategy Action Plan on Municipal Wastewater
- III. NPA Clearing-House Mechanism (CHM) Development
- IV. NPA Development

Each project is discussed below.

I. Integrated Coastal Area and River Basin Management (ICARM)

As the only national initiative addressing the linkages between freshwater and coastal and marine environments, it is a priority for the NPA to forge closer links between freshwater and coastal and marine communities. This is the role of the ICARM program that is a key program of working components of the GPA initiative. Basic principles of this ICARM Programme include:

- Respect for the integrity of river basin and coastal ecosystems also recognizing limits on the use of resources
- Multi-sectoral and multi-level integration in decision making linking broad scale management to local level interventions

Therefore, there is a need for adoption of the ICARM Program at the national level. Guidelines and approaches of the program will be mainstreamed with the GPA initiative.

II. Strategy Action Plan (SAP) on Municipal Wastewater

This project aims to directly address domestic wastewater discharge, one of the most significant threats to sustainable coastal and ocean management, by reducing pollution levels caused by the discharge of inadequately treated municipal wastewater at selected coastal area sites. Its main objectives is:

- To mainstream sustainable, innovative and alternative approaches and procedures to wastewater management.

The SAP on Municipal Wastewater is another key program of working component of the GPA Initiative. Hence, there is need to adoption the SPA, including guidelines and approaches, at the national level.

III. NPA Clearing-Mechanism (CHM) Development

The Clearing-House Mechanism (CHM) is one of the principle means by which users, including decision makers, at all levels can electronically access up-to-date, cutting-edge information relevant to their activities. It enables users rapid and often directs access to institutions and individual expertise for advice and assistance as well as information on appropriate technologies and best practice.

However, in general, the Yemen's NPA has been launched with an initial structure. Hence, it is in a need of development, suggested as a pilot project. This project aims to develop the structure and components of the CHM. Its objectives are to:

- Provide
 - information on appropriate technologies and best practice
 - more information and data related to the marine environment and the Yemen's NPA initiative
- Disseminate, where possible, full subtitles of bibliographies
- Design nodes (member sites) for specific source categories
- Link with other related national web sites

B. On-The-Ground Action Projects

Three pilot projects are proposed to demonstrate action on the ground. These projects are:

- I. Municipal Wastewater Treatment Plant
- II. Garbage Collection and Treatment
- III. Incinerator for Hospital Wastes

Each above pilot project is described below.

I. Municipal Wastewater Treatment Plant

Since sewage is one of the most significant threats to sustainable coastal and ocean management and almost all coastal villages of Yemen have no sewerage systems for their sewage. It is suggested constructing such a system with oxidation ponds in such a village. This sewerage system- as a pilot project- will be constructed in a coastal village where locals harvest mangroves for firewood and for materials for house constructions. The project aims to reduce:

- Untreated municipal wastewater on the marine environment
- Harvesting of mangroves caused by locals

Objectives of the projects are to

- Treat municipal wastewater
- Reuse of treated wastewater in agriculture purposes
- Encourage locals to use tree, planted from the treated wastewater, instead of mangroves, on a manner sustainable and equitably
- Harvesting of mangroves caused by locals

II. Garbage Cleanup and Recycle

As cleared, almost all shores of coastal villages accumulate with litter, including garbage washed from inland through wadi run-off. Watershed communities use wadi banks as a landfill for garbage. Protecting the marine environment from litter was given a high priority in each coastal region in the context of the Yemen's NPA. Hence, initial beach cleanup campaigns were conducted within the activities of the NPA in its first phase. However, there is a need for development of such a cleanup, suggested as a pilot project. This project aims to reduce the effects of litter on the marine environment.

Main objectives of the project are:

- To clean and recycle litter and garbage/litter accumulative on wadi beds and beaches
- To enhance awareness to both coastal and watershed communities on effects of litter and garbage accumulation on the marine environment
- To encourage relevant communities use recycled products
- To raise income of poor families living along a wadi bank

From each coastal region a coastal watershed area will be determined. Activities of this pilot project will be implemented in cooperation with NGOs involved in the cleanup activities.

III. Incinerator for Hospital Waste

This pilot project has been proposed by the NEAP. Therefore, an appropriately designed incinerator will be constructed for the hospital waste from hospitals through out coastal regions. Its precise location and capacity will be determined by feasibility and environmental studies to be undertaken during project implementation. Appropriate transport waste to the incinerator will also be determined. The project aims to reduce effects of hospital wastes on the marine environment.

7.2.2 Projects Support Elements

The proposal projects could comprise four major elements, namely:

- (i) Institutional development for EPA, MTE, and the principal municipalities through the appointment of international experts, training of staff, and provision of computers, and other modern equipment to help improve efficiency;
- (ii) Preparation of a coastal zone management program that would serve as tool for the protection of the country regional coasts from further degradation;
- (iii) Constancy support services for the design/protection of the implementation of proposal projects; and
- (iv) Formulation through an application of economic-based mechanism, packages of specific economic measures to deal with those activities which create the most pressing national/regional levels environmental problems

Main objectives of the elements are:

- To strengthen Environment Protection Authority (EPA) and the Ministry of tourism and Environment (MTE)
- To create instruments for the more orderly planning and development of the ICZM-Aden Model; and
- To increase the community private sector CBO's/NGO's in economic management of coastal resources

A. Salient Features and Implementation Level

A.1 National Level

I. Marine Environment Management Capacity-Building

This component aims to strengthen Environment Protection Authority (EPA) and the Ministry of Tourism and Environment (MTE). As both EPA and MTE are newly established institutions, their staff require training in the development and implementation of their responsibilities staff of the principal municipalities at the regional level will also require training in the development and implementation of their responsibilities with regards to coastal zone management.

The component would provide training aboard in coastal management of four technical staff from EPA/MTE and six from the three regions municipalities

Recruitment of the following three international experts is required in this component

- 1) Senior environmental engineer, with experience in coastal environment
- 2) Senior financial experts with experience in environment program financing; and
- 3) Senior planner with experience with planning coastal zoning and urban development

Upon the recommendation of the above experts, the component would finance the procurement of computers and other equipment.

II. Integrated Coastal Zone Management (ICZM) Program

This component aim at creating the instruments and building the institutional capacities for the physical planning and monitoring of the coastal zone development, in order to improve environmental conditions and prevent further degradation.

Its outputs would include:

- Preparing a comprehensive regional environmental assessment which will identify the cumulative pressures and impacts of the coastal zone development under different investment scenarios ;
- Establishing a integrated GIS system for physical planning and monitoring of the coastal zone development for use by EPA, Ministry of Tourism and Environment and the municipalities;
- Replicate ICZM Plan-Aden Model in other coastal areas to be approved and legally binding on all future development on such a coast ; and
- Initiating the implementation of emergency actions to protect and/or rehabilitate coastal resources.

The ICZM Program would include:

- (a) A strategy for allocation of coastal and marine resources, defining areas to be conserved and protected and policies for zoning and development of economic activities in the coast,
- (b) A regulatory need assessment and preparation of draft guideline, rules and regulation of control of activities on the coast; and
- (c) Mechanism for recurrent funding to support CZM activities and encourage public/private partnership

A.2 In-Country Regional and Local Levels

III. Community-Based Activities

The coastal zone management program would produce concrete plans for using economic-based mechanisms in the management of coastal resources. However, formulation, through an application of these mechanisms, packages of specific economic measures need to be developed to deal with those activities which create the most pressing environmental problems. Presented below are the packages of economic measures that it would be advisable to adopt in order to solve some of the main Priority Problems of land-based activities discussed in the context of the NPA.

a) Management of Protected Areas

With establishment of the system of protected areas proposed by coastal zone management plan, differential (foreign/nationals) fees will be charged for access to eco-tourist areas. Initially the schedule of fees will be based on the cost of operating those areas and subsequently (if justified by the demand) on the carrying capacity of each (that is, on the maximum volume of visitors its national will allow).

a) Taxation System for Haphazard Occupation of Coastal Areas

The zoning of coastal areas proposed by the coastal zone management plan will be complemented by a system of taxation on the use of coastal lands and of sale of use right. Taxes will apply to existing land uses in conflict with zoning regulation. Sale of use of rights will seek to increase the value of the scenic resources and the cost of its alternation, and to finance works for its improvement.

b) Taxation System for Industrial Wastes

A tax will be levied in industrial dumping of effluents, including shipping/oil facilities, and solid wastes, including hospital into watercourses. Based on the amount of contaminants discharge, its level will depend initially upon the existing density of contamination of the water and the plants location. Subsequently, it will be periodically adjusted on the basis of the results obtained.

c) Rate System for Garbage Collection and Treatment

A selective and differential rate system for garbage collection and treatment will be introduced to cover total cost of the services. The system will be experimental and its adoption graduated. Systems of deposit/refund will be adopted for non-biodegradable goods (tires, certain plastic, batteries, etc.) under this system, users of those goods will pay a deposit, which will be refunded only after the used good is returned to certain collection centers.

d) Consultancy Support Services

Full consultancy services will be provided for the implementation supervision of the project components including the implementation supervision of the package of specific economic measures of environmental management.

B. Estimated Costs**Technical Assistance (2004-2006)**

The table below shows an estimate of the cost of technical assistance, expressed in US \$(000)

	Unit	Quantity	Rate	Total
1. Three International Experts	m/m	72	10	720
2. Training	m/m	75	2	150
3. Assistance to EPA	m/m	24	10	240
4. Municipal Assistance	m/m	24	10	240
5. Short-term Experts	m/m	24	10	240
6. Equipment and Computers				200
7. Contingency				210
Total				2000

Integrated-Coastal Zone Management Program (2005-2007)

The table below shows an estimate of the cost of ICZM Program, expressed in US \$(000)

	Unit	Quantity	Unit Cost	Total
1. EA and ICZM	plan	2*	300	600
2. GIS	system	3	200	600
3. Emergency Action				1500
4. Contingency				300
Total				3000

Community-Based Activities (2006-2008)

The table below shows the cost estimate of community-based activities, expressed in US\$ (000)

	Unit	Quantity	Unit Cost	Total
1. Collaborative Management of Protected Areas	Agreement	3	100	300
2. Use of Coastal Lands	System of Taxation	3	100	300
3. Industrial Wastes Dumping	System of Taxation	3	100	300
4. Solid Waste Disposal	Rate System for Collection and Treatment	3	200	600
5. Consultancy Services	m/m	72	5	360
6. Contingency				140
Total				2000

* ICZM Model for Aden is prepared under the umbrella of the SAP-PERSGA

7.3 Concluding Remarks

There is a need for a Program Support Document (PSD) to:

- Include components of the Yemen's NPA initiative
- Show costs of ground action projects proposed
- Evaluate feasibility and viability of the projects proposed
- Provide selected projects with detailed information, including periods and sites
- Mobilize and endorse financial resources, including the private sector

The PSD should be completed in three months. An international consultant and national expert- along with the NPM- are required to create it. The cost of the PSD ranges from 50,000 to 100,000 US\$. The GPA/UNEP Coordination Office could appoint the consultant after conferring with the EPA. The proposal of the PSD Project is suggested to be prepared in cooperation with this Office.

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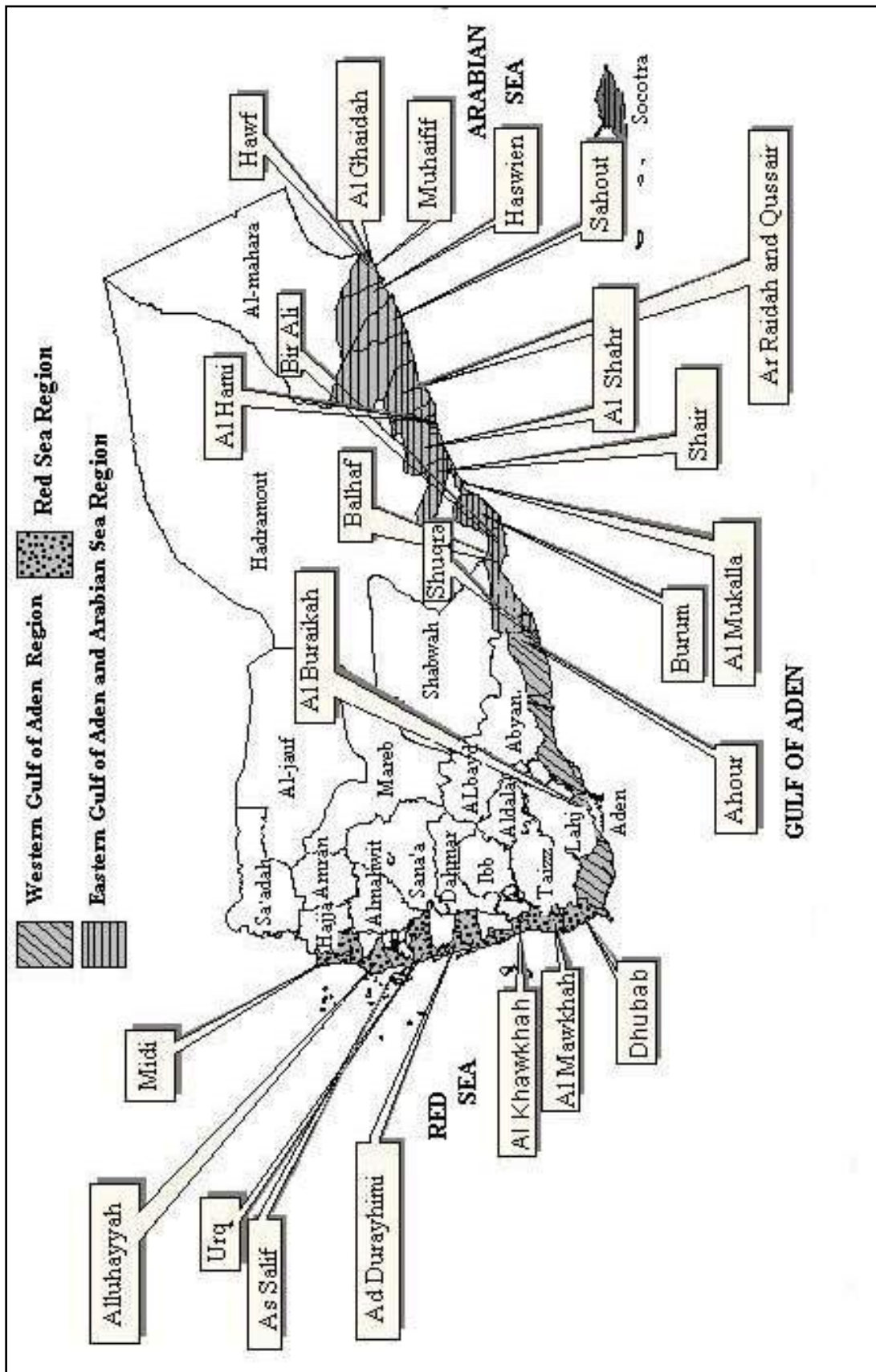


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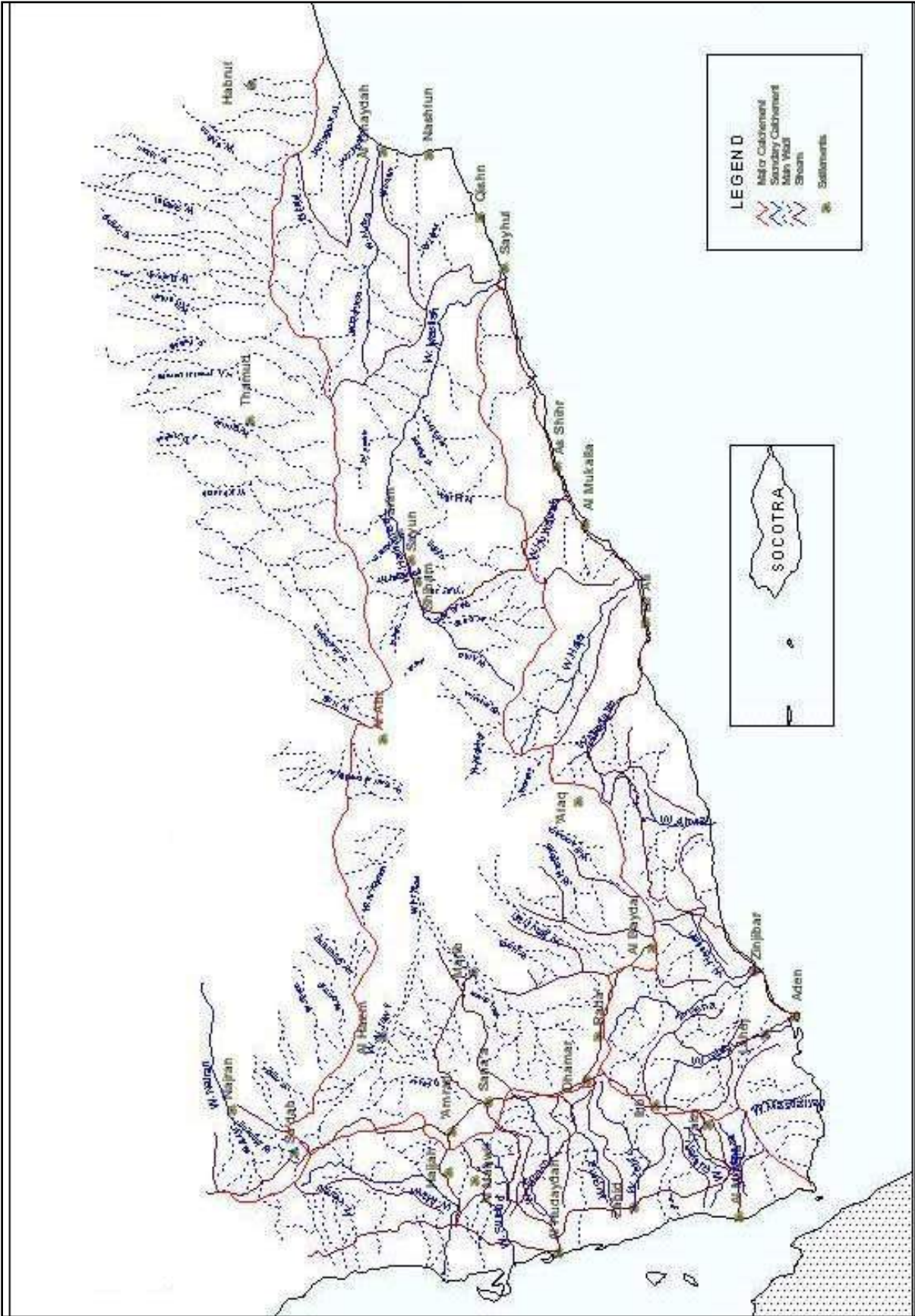
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APPENDICES

Appendix 1: A map showing the main coastal areas along with the Yemen's NPA regions



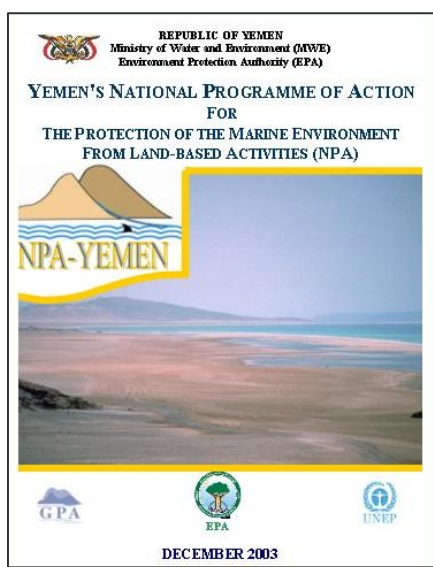
Appendix 2: A map showing drainage areas of Yemen



Appendix 3: List of Acronyms and Abbreviations

BOD	Biochemical Oxygen Demand
CHM	Clearing-House Mechanism
CBO	Community Based Organization
CGA	Coast Guard Authority
DDT	Dichloro-diphenyl-trichloroethane
EA	Environmental Assessment
EPA	Environment Protection Authority
FAO	Food and Agriculture Organization of the United Nations
GCDPI	General Corporation for Development and Promotion of Yemeni Islands
GPA	Global Program of Action(for the Protection of the Marine Environment from Land-Based Activities)
GIS	Geographic Information System
ICZM	Integrated Coastal Zone Management
ICARM	Integrated Coastal Area-River-Basin Management
MAA	Maritime Affairs Authority
MARPOL	The International Convention on the Prevention of Pollution from Ships
NBSAPY	National Biodiversity Strategy and Action Plan for Yemen
MSRRC	Marine Science and Resources Research Center
MTC	Maritime Training Centre
MWE	Ministry of Water and Environment
NEAP	National Environment Action Plan (for Yemen)
NGO	Non-Government Organization
NPA	National Program of Action (for the Protection of the Marine Environment from Land-Based Activities)
NPM	National Program Manager
PADH	Physical Alterations and Destruction of Habitats
PCB	Polychlorinated Biophenyl
PCMA	Public Corporation for Maritime Affairs
PERSGA	Regional Organization for the Conservation of the Red Sea and Gulf of Aden
POP	Persistent Organic Pollutant
PSD	Program Support Document (for the Yemen's NPA)
SAP	Strategic Action Plan (for the Regional Conservation of the Red Sea and Gulf of Aden)
TDA	Tourism Development Authority
UNEP	United Nations Environment Program
WHO	World Health Organization of the United Nations

Appendix 3: About this Document



The Yemeni Ministry of Water and Environment (former Ministry of Tourism and Environment) has commissioned the Environment Protection Authority to develop the Yemen's NPA, including this Document, in coordination with the UNEP/GPA Coordination Office and PERSGA, where appropriate, under a Development Pilot Project (GP/3010-02-22) since October 2001. The Yemen's NPA Team prepared this Document, after discussing priority problems with participants attended three on-day local workshops and a two-days national meeting/workshop. Ranking priority problems at the levels of Red Sea Region, western Gulf of Aden Region, and eastern Gulf of Aden and Arabian Sea Region was separately set at the workshops held in Al Hudaydah, Aden and Mukalla respectively. Setting such priorities, and strategy actions developed for the NPA, were agreed at the national meeting held in Sana'a, in participation of Mr. David Osborn (Program Officer of the GPA). The EPA would like to express their thanks to those people who contributed to the development of the NPA, including participants of the NPA workshops and Yemen's NPA Team.

Problems assessed by: Nabeel A Shawafi (at the national level); Murtada A. Alwan and Aref A. Hamoud (at the level of the Red Sea region), Gamal A. Al-Harrani (at the level of the Western Gulf of Aden region) Salem R. Bazar and Abdulatif A. Al-Munifi (at the level of the Eastern Gulf of Aden and Arabian Sea region)- with feedback provided by Hassan A. Hebba (at the level of the Red Sea region) and Gamal A. Allozy (at the level of the Western Gulf of Aden region).

Legal framework reviewed by: Jafar A. Shotah

Strategies and measures set by: Ghazy A. Al-Sakaf

Document revised and edited by: Zaher A. Al-Agwan

Appendix 5: Yemen's NPA-CHM

A Clearing-House Mechanism (CHM) can be generally defined as a referral system through which decision-makers are provided with access to current sources of information, practical experience, and scientific and technical expertise. The CHM is a recent approach created to deal with dissemination of information/data, management and up-to-date technology for, along with other information pertaining to, a certain issue on an internet (so-called web) on a regular basis and with a full access to the content of a CHM.

The Yemen's NPA has developed a CHM during its initial phase. This CHM has been launched since August 2003.



(The Homepage of Yemen's NPA-CHM)

The major components of this clearing-house structure are as follows:

- **Frequently Asked Questions (FAQs):** This component separately provides information-as FAQs- several issues, including the source categories of the problems
- **Bibliography:** provides national bibliographies related to the key problems defined in the Yemen's in two sections.
- **Photo Gallery:** shows a selected collection of some photos related to the key problems, taken at the workshops of the NPA.
- **Contacts:** In this component Yemen's NPA CHM users can make on-line contact with the CHM for queries and/or feedback and contacts with relevant qualified and skilled people, including the NPO Team.
- **NPA Library:** will provides documents prepared for the Yemen's NPA initiative.
- **Nodes:** This component will include member sites of the Yemen's NPA initiative.

Access to the Yemen's NPA-CHM is available at the following web address:

<http://www.yemen-npa.org>