# PAKISTAN'S NATIONAL PROGRAMME OF ACTION UNDER THE GLOBAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND BASED ACTIVITIES


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## EXECUTIVE SUMMARY

This report attempts to describe Pakistan's (NAP) National Action Plan for the protection of Marine Environment from Land based activities. Pakistan's NAP is prepared under the umbrella of Global Plan of Action (GPA) for the protection of Marine Environment in the South Asian Seas Region which adopted by the Inter-Governmental Conference held at Washington D.C. in 1995. A plan for the implementation of GPA was prepared during 1996 by UNEP in cooperation with the experts of UN agencies, intergovernmental and non-governmental organizations and adopted by the UN General Assembly at its 51st Session in December 1996. It was agreed during a regional workshop (Sri Lanka 20-23 October 1997) to implement GPA in a phased, step-by-step approach involving both national and regional actions in the South Asian Seas Region through SACEP. As a primary component, the member countries of SACEP are to prepare National Action Plans (NAP) for implementing the GPA at the national level. Accordingly, a National Action Plan (NAP) of Pakistan has been prepared by a team of local experts identified by the Ministry of Environment, local government and rural development, Government of Pakistan. The NAP is prepared in accordance with the Terms of Reference and guidelines provided by the SACEP. Draft NAP was submitted in December 1999 and after incorporating suggestions from SACEP Secretariat the draft is now finalized as Pakistan's National Action Plan.

Pakistan has a coastline of about 990 km long with adjacent coastal zone of 240,000 square km in the Northern Arabian Sea. There are rich living and non living resources in the coastal zone of Pakistan. The living resources include mangrove forests along Sindh and Balochistan Coast with Indus Delta harbouring 6th largest mangrove forest of the world. The coastal and marine areas of Pakistan produce about 596,980 metric tons of marine fish and 25,000 metric tons of shrimp while it exports about 131,000 metric tons of fish worth Rs. 7.272 billions. The commercially important marine fisheries resources of Pakistan are composed of about 350 different species. Associated with Pakistan's coastal ecosystems is a complex array of natural resources which provide economic goods and services. These goods and services are both marketed, e.g. fish, shellfish and non-marketed, e.g. mangroves, for their medicinal uses, and their functions as nursery areas for juvenile fish and buffers against storm surges. These goods and services have an extremely important long-term strategic value for coastal development. The population in the coastal towns and settlements is mostly dependent on the subsistence catch of marine fish and shrimp for their food. The rapidly growing population is putting increasing societal demands on its coastal and marine resources and producing a stress on the coastal and marine ecosystems. The pressures from economic development from land based activities leading to depletion of coastal resources, degradation of water quality and increasing resource use conflicts have emphasized the urgent need for management, protection, conservation and sustainable development of Pakistan’s coastal and marine resources.

The coastal areas of Pakistan with an arid climate and negligible coastal agriculture have very low level of food security. The household food access and national self-reliance in Pakistan is also vulnerable to climate change impacts. The environmental degradation

through land based activities and pollution are affecting the primary production as well as secondary and tertiary production levels in the sea and thereby affecting the environmental pollution and the production of fish, shrimps, lobsters, crabs and clams, mussels, etc. The present levels of pollution and environmental degradation in the area has threatened the production of fish, shrimp and other living marine resources to a certain degree. There has been a decrease in the fish catch in general and shrimp catch in particular over the last two decades leading to increased poverty and poor socio-economy in the coastal areas. This situation is threatening the food security in the area that is caused mostly by land based activities including disposal of sewage and industrial effluents, non implementation of conservation and fisheries management, reduction in the Indus River discharge and pollution by contaminants discharged through the industrial effluents and untreated sewage. The low level of food security in the coastal areas is therefore linked with the un-interrupted supply of marine fish, shrimp, etc., which calls for the efficient management, protection and conservation of marine resources in the area. The coastal development policies must therefore undertake an accurate and holistic valuation of the coastal ecosystems, threats to their maintenance, protection, conservation and their sustainable development. In pursuance of these objectives the Ministry of Environment, Local government and Rural Development, Government of Pakistan has prepared a National Action Plan for the protection of its marine environment through land-based activities.

Pakistan's National Action Plan (NAP) focuses on the nature and severity of problems in coastal areas in relation to food security, public health, coastal and marine resources and ecosystem health, economic and social benefits and uses of coastal areas. It takes into account the various types of contaminants including sewage, heavy metals, oils, etc., and physical alteration including habitat modification and destruction in areas of concern. It also describes the various sources of degradation and pollution including point and non-point sources and erosion of the coastal areas as well as atmospheric deposition through air pollution. It describes in details the areas of concern affected and vulnerable and their current status of degradation. The main aspects of NAP are establishment of priorities based on Integrated Coastal Zone Management with reference to Source Categories and to the areas affected. The priorities also take into account an evaluation of the costs, benefits and feasibility of options for actions to protect coastal environment and its resources applying the Integrated Coastal Zone Management. Protection and management of mangrove forests and fisheries resources, reduced Indus River discharge, sanitation and arranging drinking water supply, food, fuel / fire wood and fodder for domestic animals are the main issues of the coastal population in rural areas. The urban and industrial areas along coast have problems of pollution through improper solid waste management, disposal of untreated sewage and untreated industrial wastes, inadequate water supply and sewerage system, poor drainage and air pollution. In addition there are conflicts in the use of space and coastal resources and environment which require integrated management approach.

The NAP has set-out specific management objectives on the basis of priorities established both with respect to source categories and areas affected. Some of these include the following main objectives:

- To protect and maintain critical stocks of coastal resources from harmful affects of industrial and urban contaminants such as heavy metal contaminants (Cr, Hg, Cd, Pb, Cu, Zn, Co), untreated sewage, persistent organic pollutants (plastic, polyethylene, pesticides, insecticides) and the oil (hydrocarbons);

- To improve sanitation through adopting appropriate sewerage system, sewage treatment and disposal practices in the coastal towns and cities;

- To adopt environmentally safe and efficient solid waste management in the coastal towns and cities with special emphasis on Karachi City;

- To improve, maintain and enhance critical environmental quality;

- To protect coastal resources, coastal structures (i.e. ports, harbours, seawater intakes of coastal power plants & industries, etc.), beaches and amenities from accidental oil spills;

- To maintain the amenity value of coastal zone (aesthetic appeal, control of development size, scale and location, etc.,);

- To preserve critical coastal resources such as Indus Delta Mangrove forest and associated ecosystem, estuarine and brackish fauna and flora;

- To rehabilitate degraded habitats (i.e. mangrove cleared areas, estuaries, backwaters, watersheds) and preserve critical habitats such as nursery, breeding and feeding grounds (i.e. estuaries, deltas, backwaters, coastal wetlands, coastal watersheds / dhands, etc.,) near-shore coastal areas and coral reefs;

- To control / reduce toxic contaminants and persistent organic contaminants levels in the industrial effluents to conform to the National Environmental Quality Standards;

- To improve air quality by reducing contaminants such as Lead, oxides of Carbon, Nitrogen, Sulfur and CFCs (chloro fluoro carbons) in the emissions from vehicles and industries and emissions from pesticides / insecticide sprays on agriculture crops;

- To minimize the impacts of physical alteration and habitat modification for existing and future socio-economic projects by appropriate regulatory measures;

- To control / minimize coastal erosion of the coastal areas for resource protection and coastal communities;

- To install a mechanism for continuous monitoring and evaluation of coastal and marine resources and the impact of contaminants on the coastal ecosystem;

- To facilitate implementation of regulatory controls through regulatory and economic instruments including polluters-pay principle and incentives;

In order to achieve the management objectives the NAP has identified , evaluated and selected strategies and measures: 1) to promote sustainable use of coastal and marine resources; 2) to reduce degradation of marine environment; 3) prevent, reduce degradation of affected areas including environmental quality criteria, land-use planning, rehabilitation of degraded habitats. The incentives to induce action to comply with measure include economic and regulatory incentives on "polluter pays" principle and internalization of environmental costs, technical assistance / training of personnel, education and public awareness. The criteria for evaluating the effectiveness of strategies and measures suggested in the NAP as well as the programme support elements for its effective implementation are also summarized in the plan.

# PAKISTAN'S NATIONAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES

**(UNDER THE GLOBAL PROGRAMME OF ACTION)**

## INTRODUCTION

This report attempts to describe Pakistan's (NAP) National Action Plan for the protection of Marine Environment from Land based activities. Pakistan's NAP is prepared under the umbrella of Global Plan of Action (GPA) for the protection of Marine Environment in the South Asian Seas Region by UNEP and SACEP. The National Plan of Action takes into account the current status of coastal resources and focuses on their protection from land -based activities and their sustainable development at the national and regional levels. Pakistan has a coastline of about 990 km long with adjacent coastal zone of about 240,000 square km along the Northern Arabian Sea (Figure-1). There are rich living and non living resources in the coastal zone of Pakistan. The living resources include mangrove forests along Sindh and Balochistan Coast with Indus Delta harbouring 6$^{th}$ largest mangrove forest of the world. The coastal and marine areas of Pakistan produce about 596,980 metric tons of marine fish and 25,000 metric tons of shrimp while it exports about 131,000 metric tons of fish worth Rupees 7.272 billions. The rapidly growing population of the country (130 million) is putting increasing societal demands on its coastal and marine resources and producing a stress on the coastal and marine ecosystems. The pressures from economic development from land based activities leading to depletion of coastal resources, degradation of water quality and increasing resource use conflicts have emphasized the urgent need for management, protection, conservation and sustainable development of Pakistan's coastal and marine resources. Recognizing the long-term strategic value of these coastal and marine resources it is necessary to identify and assess the problems and issues in the coastal zone of Pakistan Associated with Pakistan's coastal ecosystems is a complex array of natural resources which provide economic goods and services. These goods and services are both marketed, e.g. fish, shellfish and non-marketed, e.g. mangroves, for their medicinal uses, and their functions as nursery areas for juvenile fish and buffers against storm surges. These goods and services have an extremely important long-term strategic value. The coastal development policies must therefore undertake an accurate and holistic valuation of the coastal ecosystems, threats to their maintenance, protection, conservation and their sustainable development.

The Global Programme of Action (GPA) for the Protection of Marine Environment from Land-based Activities in the South Asian Seas Region was adopted by an Intergovernmental conference held in Washington, DC 23 October to 3 November, 1995. The UNEP was designated as Secretariat of the Global Action Programme. The UNEP prepared an outline of a plan for implementing the GPA during 1996 in cooperation with the experts of UN agencies, intergovernmental and non-governmental organizations. The plan was revised in the light of comments and suggestions received from consultations with agencies, governments and non-government organizations. The plan was presented to the 4th Session of Commission on Sustainable Development (April-May, 1996) for consideration within the context of its review of Chapter 17 (Oceans & Seas) of Agenda

21, as a basis for the preparation of a draft resolution by Governments on Institutional Arrangements for the implementation of GPA, adopted by UN General Assembly at its 51st Session in December, 1996. The outcome of a technical meeting on the Global Programme of Action clearing-house, convened by UNEP (Geneva, 26-27 September, 1998) have also been incorporated in the plan. Other elements of GPA include clearing house mechanism and technical coordination office. A workshop on Implementation of the Global Programme of Action was held in Sri Lanka, Colombo, 20-23 October, 1997. It was agreed in the workshop that: (1) GPA is to be implemented in a phased, step-by-step approach in the SACEP Region involving both national and regional actions; (2) as a primary component, the member countries of SACEP are to prepare National Action Plans (NAPs) for implementation of the GPA in accordance with the Terms of Reference for implementation of the GPA at the national level; (3) a regional workshop will then be convened to develop a Draft Regional Action Plan and to review progress; (4) the regional components in support of implementation of the GPA, including capacity building, public awareness and training be developed and implemented simultaneously with the development of a Draft Regional Action Plan; (5) concerted efforts will be made to identify and secure the support of UN and donor agencies and organizations regarding needed technical and financial resources for the preparation of NAPs and implementation of GPA at the national and regional levels.

In pursuance of the policy and guidelines, provided by the workshop in Sri Lanka (20-23 October, 1997) the SACEP Secretariat requested their focal point in Pakistan during 1999 to prepare National Programme of Action for the Protection of Marine and Coastal Environment of Pakistan. Accordingly, the Ministry of Environment, Local Government and Rural Development, Government of Pakistan nominated a team of experts to prepare a Draft NAP and submit the same to SACEP Secretariat through them. The present report is thus the outcome of the effort of the local experts who prepared the NAP in accordance with the Terms of Reference and guidelines provided to them by the Ministry of Environment, Local Government & Rural Development, Islamabad, Government of Pakistan. The Draft NAP was submitted in December, 1999 and after incorporating suggestions from SACEP Secretariat the NAP is finalized in March 2000.

## A. IDENTIFICATION AND ASSESSMENT OF PROBLEMS

### a) Identification of the nature and severity of problems in relation to:

### (i) Food security and poverty alleviation;

Pakistan has a low level food security and has yet to achieve self sufficiency in the production of its staple food i.e. wheat, other cereals and pulses. The annual production of cereal crops have not kept up to the food requirements of the country. The coastal areas of Pakistan with an arid climate and negligible coastal agriculture have very low level of food security. The household food access and national self-reliance in Pakistan is also vulnerable to climate change impacts (Downing, 1992). The population in the coastal towns and settlements is mostly dependent on the subsistence catch of marine fish and shrimp for their food. They also consume wheat and rice from upcountry, products from mangrove forests and wild life. The seafood from the coastal and marine areas mostly

consists of wild catch of marine fish, shrimp and other edible marine organisms. However, the people in the coastal urban areas and cities along the coast have different dietary preferences and are only partially dependent on the food from the sea. They use marine fish and shrimp as a supplement source of animal protein. The per capita consumption of fish for Pakistan excluding coastal population is less than 2.0 kg per year. Most of the wild catch of fish and shrimp is exported to earn foreign exchange which in turn is used for the imports of necessary items including food and food products.

The environmental degradation through land based activities and pollution are affecting the primary production as well as secondary and tertiary production levels in the sea and thereby affecting the environmental pollution and the production of fish, shrimps, lobsters, crabs and clams, mussels, etc. The present levels of pollution and environmental degradation in the area has threatened the production of fish, shrimp and other living marine resources to a certain degree. There has been a decrease in the fish catch in general and shrimp catch in particular over the last two decades leading to increased poverty and poor socio-economy in the coastal areas. This situation is threatening the food security in the area that is caused mostly by over-fishing, non implementation of fisheries management, reduction in the Indus River discharge and pollution by contaminants discharged through the industrial effluents and untreated sewage. The low level of food security in the coastal areas is therefore linked with the un-interrupted supply of marine fish, shrimp, etc., which calls for the efficient management, protection and conservation of marine resources in the area. The coastal and marine areas of Pakistan produce about 596,980 metric tons of marine fish and 25,000 metric tons of shrimp while it exports about 131,000 metric tons of fish worth Rupees 7.272 billions (MFD Statistics 1998).

The per capita GNP in Pakistan at present is below 400 US $ as announced in the recent annual fiscal report by State Bank of Pakistan (DAWN December 15, 1999). The per capita income in the coastal areas is also estimated to be less than 400 US $. The poverty in the coastal population particularly in rural areas is mostly due to decrease in wild catch per unit effort, reduction in fisheries production, increase in salinity of coastal agricultural lands, sea encroachment, reduction in the availability of freshwater for agriculture and for human consumption. The reduction in productivity of the coastal waters due to addition of contaminants in the industrial effluents and untreated / raw sewage, reduction of river discharge, increased salinity of coastal lands, erosion and the degradation of coastal environment have further accelerated the levels of poverty and have retarded the very limited efforts of poverty alleviation in these coastal areas by the Government and the local NGOs.

The efforts of the provincial governments for poverty alleviation remain ineffective due to lack of necessary funds, lack of political will / interests of the tribal / feudal system and vested interests. NGOs working in the coastal areas are only a few that too have a very limited agenda and program to work for poverty alleviation. Most of these limited programmes and the projects concerning poverty alleviation and the development are determined by the donor imperative and priorities of the provincial governments / NGOs and do not necessarily reflect the spirit of national development priorities and the

socio-economic needs and demands of the local people. In such a situation the desired results and outputs are not achieved and the poverty status of the target communities and coastal population remains largely unchanged. The main reasons for not getting the desired results of the limited efforts for poverty alleviation include lack of political will of the tribal / feudal system of local administration, lack of education and awareness, poor management of resources with disregard to conservation, lack of basic civic facilities including sanitation, water supply, roads and communication facilities, hold of mole holders and the lack of community participation in the plans and projects for socio-economic uplift.

Sanitation and arranging drinking water supply, fuel/fire wood and fodder for domestic animals are the main issues of the coastal population. Fishing is the main stay of steady income source of the communities in the coastal settlements, villages and coastal towns. A number of people are also employed in the associated fishing industry such as net making / net mending, collection of fire wood, fodder for the domestic animals, construction of small huts, fish drying, fish salting, construction of small wooden crafts, tea shops, hutment hotels, etc. Apart from the traditional fishing based income, new sources of income are being generated through smuggling of goods across the border. Education facilities in the coastal areas are generally inadequate. The literacy rate is very ,low. The literacy rate is approximately 6% in coastal Balochistan while 10-15% in coastal Sindh excluding Karachi. There are inadequate service facilities that have hampered development of coastal areas of Pakistan excluding Karachi Coast. The existing status of the various services and facilities is summarized in Table - 1.

**Table - 1. Status of Civic facilities and Services at the coastal areas of Pakistan excluding Karachi.**

| S.No. | Services | Status of Services | |
|---|---|---|---|
| | | **Balochistan Coast** | **Sindh Coast** |
| 1 | Road communication network | Very poor | Poor |
| 2 | Electricity | Non except Gwadur, Pasni | Non Except, Ibrahim Hyderi, Rehri, Keti Bundar |
| 3 | Drinking water Supply (Piped water) | Non except Pasni, Gwadur; Partial at Damb | Non except Ibrahim Hyderi, Rheri; Partial: Keti Bunder |
| 4 | Water for agriculture:<br>1)Freshwater from Rivers<br>2)Brackish-water | 1) Not available, Very little at Pasni; Rivers seasonal;<br>2) Not available | 1) Not available, seawater intrusion;<br>2) Saline / Brackish water at Keti Bundar, Shah Bundar & south of Badin |
| 5 | Sanitation | No facilities, poor and inadequate where available | No facilities, poor & inadequate where available |
| 6 | Health Care facilities | Very limited | Very limited |
| 7 | Education facilities | Poor, very limited | Poor, very limited |
| 8 | Fish Harbours / Jetties | Non except at Gwadur, Pasni, Ormara (in progress), | Non except at Karachi, Korangi; Ibrahim Hyderi |
| 9 | Fish processing, storage, | Poor, Inadequate except Pasni, Gwadur | Non except Ibrahim Hyderi, Korangi; Poor, Inadequate |
| 10 | Sources of Fuel / Firewood for cooking | Fire wood from coastal forests, mangrove forests, trees, bushes | Fire wood from Mangrove forests, coastal bushes, trees |
| 11 | Animal husbandry etc. Fodder for livestock | Poor, very Limited; Coastal vegetation, Mangrove leaves | Poor; Coastal vegetation, Mangrove forest, limited natural grass |

### (ii) Public health

There are a number of environmental issues in the coastal zone of Pakistan which have a direct bearing on public health in the coastal areas. The poor sanitation, poor drinking water supply and disposal of untreated sewage and domestic wastes and untreated disposal of industrial effluent causing contamination, pollution and public health risks.

Water Supply:

Scarcity of fresh water is a major constraint on the development of the economy of the coastal area. There is an acute shortage of water on the Balochistan coast. The local population depends on sweet water supply from shallow wells, 10-15 feet deep dug in the foot hills at one or two locations in the sand dunes. During dry seasons, the water in the wells turn brackish, causing much human suffering. During the dry season there is hardly any surface flow in the rivers. The availability of water in the river bed may well be attributed to stagnant water of seepage flow. Ground water occurs in the reservoirs under water table conditions. The quality of ground water in the coastal areas of Balochistan has deteriorated due to seawater encroachment. No rivers are to be found with a large and permanent flow of water along Balochistan Coast. For the greater part of the year the beds contain merely a shallow stream which frequently disappears in the pebbly bottom. After heavy rains the rivers become raging torrents. The largest river in the coast Balochistan area is Hingol. In Makran, the Dasht River flows south. An earth filled dam 1,524 meters long has been proposed on Dasht River at Merani when completed it would be the highest dam in the province with a water storage capacity of 600 million cubic meters of water to irrigate about 14,000 ha of land and generate some electricity.

The drinking water supply along Sindh Coast is from surface waters as well as from wells. The coastal villages around Karachi get their water supply from Karachi water supply system. The coastal settlements and villages located near Indus River or irrigation canals get their supply of drinking water from them. The other coastal villages get their drinking water supply from shallow and deep wells and often settle for slightly saline water. The water from the shallow wells is mostly contaminated. The coastal settlements located in the remote creek areas get their supply of freshwater / saline water from the nearby sources through water tanks using donkey/ camel carts and boats.

The water supply to Karachi is mostly from Indus River and Hub River supply about 20 % while Dumloti Wells also supply 1-2 % of the total water supply to the city. The total gross unconstrained demand for Karachi in 1996/97 was estimated at 595 MGD (Ahmad, 1999). Actual water supplies of 404 MGD are considerably less than this and represent a shortfall of about 200 MGD against the current demand. Even after the commissioning of new World Bank funded project of 100 MGD costing over US$ 300 million, the gap will persist. This has led to extensive water rationing (enforced through rotational supply) and contributed to low pressures throughout the system (Ahmad, 1999). It is estimated that at present, approximately 52 percent of water supply is being distributed to domestic consumers and 13 percent to non-domestic mainly industrial, commercial and agricultural consumers. The remaining 35 percent of water supply accounts for losses in

the system. Service coverage for piped water is estimated to be not more than 75% while for sewerage service it is only about 40% (Ahmad, 1999). As only 25% sewage is treated most of sewage is disposed into the city's watercourses without treatment (Ahmad, 1999; ESCAP, 1995, Rizvi, et al 1997, 1999). Physical losses of water can be substantially reduced. Revenue collection from retail customers is less than 40% of the potential, although collection rates are about 85% from bulk customers, which currently are the major source of revenue for KWSB. Major operational improvements and investments are needed to improve service levels for a population expanding at around 5% per annum and likely to double over the next 20 years. The Government believes that in order to simultaneously achieve the primary objectives of improving the level of service and reducing the government subsidy, engagement of private sector participation in KWSB is essential.

Sanitation:

There are very limited facilities for the coastal towns and villages of Pakistan with respect to sanitation. For the most part the coastal areas of Pakistan are sparsely inhabited except for Karachi City and a few smaller coastal towns. The majority of the coastal settlements do not have any sanitation facilities. In most of the coastal settlements there is no system of excreta or waste water disposal and use open spaces or semi enclosed spaces near the sea, creeks as toilets. Pit latrine system is difficult to introduce as in most coastal villages along Sindh Coast where subsoil water table as high as 2–4 feet. The coastal towns do not have any sewerage system and hence use the local ground depressions, storm water drains or adjacent seasonal rivers and creeks for disposal of untreated liquid domestic and urban wastes (sewage). This type of sewage disposal is practiced in Jiwani, Gwadar, Pasni, Ormara, Hub and Gadani on Balochistan coast. Similar arrangements are in place at coastal towns of Sindh such as Mirpur Sakro, Shah Bandar, Jati and Badin. However, at Keti-Bunder, due to low ground levels the disposal of waste waters to the adjacent creek is difficult during high tides. In addition to the storm water drains the coastal towns of Jati and Badin also use manmade drains leading to the creek through LBOD.

Suspected unhygienic conditions at landing sites and in the fish harbours have drastically reduced fish and shrimp exports from Pakistan to European Union countries. The European Union had imposed a ban on Pakistan sea food in June last because of poor hygienic conditions. Certain recommendations to improve the working conditions were made. The development work has now been completed at a cost of Rs 6.3 million with the result that the average price of Pakistani seafood products has increased in Europe from 80 cents to two dollar per kg after lifting of import ban, further the European Union had raised the status of Pakistan from C to B category exporters (DAWN 16 September, 1998).

Sewerage :

The coastal towns other than Karachi do not have any sewerage system and hence use the storm water drains adjacent to rivers and creeks for disposal of untreated liquid domestic

and urban wastes (sewage). This type of sewage disposal is practiced in the coastal towns of Sindh such as Gharo, Mirpur Sakro, Keti Bandar, Shah Bandar, Jati and Badin. In addition to the storm water drains the coastal towns of Jati and Badin also use manmade drains leading to the creek through LBOD. This type of sewage disposal is also practiced in Jiwani, Gwadar, Pasni, Ormara, Hub and Gadani on Balochistan coast.

Karachi is not only the largest port in the region but also the industrial hub of the country and the main source of pollution in the coastal waters of Sindh. It is estimated that about 262 million gallons per day (MGD) of sewage is generated in Karachi and adjacent areas from domestic and industrial sources. Of these 111 MGD is generated from municipal and the remaining from industrial sources ( Rizvi, et al, 1997). The industrial waste waters and sewage are discharged in to the tow seasonal rivers: Lyari River and Malir River of Karachi. These rivers act as main open sewers for the liquid waste disposal from the city. The Lyari and Malir Rivers are thus contributing about 59% and 25% of the total pollution load of the Karachi City respectively, while 15% of the pollution load is directly discharged into the adjacent open sea coast or to the Gizri, Korangi and Gharo Creeks.

Karachi water supply and sewerage infrastructure is a mixture of both old and some recent investments, it is generally inadequate to meet the current urban needs since its development has not kept pace with the city's growth. In addition, much of the existing infrastructure is poorly maintained and therefore does not operate efficiently. With some success, notable efforts have been made by the Government of Sindh, with the support of multilateral lending agencies, to improve the technical and commercial position of KWSB. Despite this, water and sewerage services in Karachi remain limited, and given the commercial prominence of Karachi in Pakistan, compare poorly in many respects with major cities in South and East Asia.

Solid Waste Management:

There is no regular arrangement for the disposal of solid waste, garbage and refuse in the coastal villages, and small coastal towns along Sindh and Balochistan Coasts. Solid waste collects wherever the wind carries. Most of it finds its way to the beaches through wind and land run-off and is often found littered on seashore adjacent to the coastal villages, towns, as inorganic materials. More than half of the coastal population of 180,000 lives in the coastal fishing towns of Ormara, Pasni, Gwadar and Jiwani. These towns have an inadequate system of garbage collection and refuse from the markets and residential areas. The refuse collected at 1-2 sites within the town and then is finally disposed off to a site located at some distance from the main town. No further treatment of solid waste is done except sun treatment and its further spread and final disposal is at the mercy of winds and land run-off. Most of the small sized coastal settlements and coastal villages along Sindh Coast are located close to seashore, creeks, surface drains or rivers and dispose off their solid wastes, garbage and refuse directly to the natural waters. The organic material is decomposed by the microbes while the inorganic materials are carried away by the running waters or tides. Solid waste collects wherever the wind and water carries it. Most of it finds its way to the beaches through wind and land run-off and is

often found littered on adjacent seashore as inorganic materials.

It is estimated that about 8,000 tons of domestic solid wastes is generated per day in Karachi City with a population of about 13 million. However. There is a regular solid waste management system for Karachi City. The soild wastes such as garbage, refuse from domestic sources is collected by special garbage collection vehicles and is then composted for use in the landfills. There is no arrangement for the disposal of hazardous solid wastes (SCOPE, 1992) except for the hazardous wastes from hospitals. There are a number garbage / refuse collection sites within the city. The solid wastes from the collection sites is then taken away by vehicles (ordinary vehicles and specially designed garbage vehicles) to either the composting center or to the two designated dumping / landfill sites for refuse located in outskirts of the city (Deh Jam Chakro landfill site near Surjani Town and Deh Gond Pass landfill site near Hub Chowki). At present there is no incinerator for the disposal of solid waste (except for Hospital wastes), however there are plans to acquire appropriate capacity of incinerator for this purpose. The solid waste at the landfill / dumping site is mostly used for land-filling, partially recycled for recyclable materials through open auctions and partially burnt in the open and also gets sun treatment. A fraction of the solid wastes is also being recycled on regular basis by the help of a few NGOs for re-use. However, the arrangements for the garbage collection, composting and recycling are not adequate to handle the entire waste generated by the city. It is estimated that about 30-40 % of the solid waste remains out of the collection and disposal system and about 20 % is deposited in the open sewers and storm water drains in the city while 20 % remains at the mercy of winds and land run-off for its final disposal. The Karachi Metropolitan Corporation (KMC) has recently installed two Incinerator plants (each capacity: 1,000 kg/hour for a maximum of 10 hours per 24 hours) for the disposal of Hospital wastes and are planned to cover the entire hospitals of Karachi in two phases. During the first phase the incinerator facility is available to five hospitals of KMC, one Sindh Government Hospital, Korangi and two private hospitals which generate a solid wastes of about 1250 kg to 1700 kg per day (Biosphere – 1999).

Health Services:

In general, there are very limited facilities for primary health care in the coastal areas. There are no health care facilities in most of the coastal settlements and small villages. However, in some coastal villages and coastal towns there are very limited facilities for primary health care in the form of BHU (Basic Health Unit) or RHC (Rural Health Center). On the average there is one doctor per 10,000 to 20,000 persons, one paramedic for every 10,000 to 15,000 and one RHC bed for every 12,000 to 15,000 persons. The situation is better in coastal towns and there is about one Hospital bed for every 3,000 to 5,000 persons. The infant mortality is high (112/1000) and maternal mortality rates are 400-700/100,000. The main problems of health sector are low population of single rural dwelling, dispersed villages, scarcity of trained health personnel particularly amongst rural females and inadequate numbers of doctors and paramedics in coastal towns. The health problems include Malnutrition in children and females, diarrhea diseases, parasitic and infectious diseases and vaccine preventable diseases (ESCAP, 1996).

### (iii) Coastal and marine resources and ecosystem health, including biological diversity;

Living Resources:

Major commercial fishing grounds for fish and shellfish along the coast of Pakistan extend from the Sindh coast stretching from Hub River to the Indian border and Makran coast west of Karachi along the Balochistan coast to the Iranian border. Pakistan is a net exporter of shrimps, lobsters, crabs, molluscs, fish and fishing products. A total of 83,138 m. tons were exported which fetched Rupees 7.27 billion. The total landing for small pelagics, large pelagics, demersal fish and shellfish in 1998 accounted for 433,456 m. tons (Table 2). The commercially important marine fisheries resources of Pakistan are composed of about 350 different species. Some 240 are demersal fish, 50 are small pelagics, 10 are medium sized pelagics and 18 are large pelagics fish in addition, there are 15 species of shrimps, 12 of squid/cuttlefish/octopus and 5 species of lobsters. In addition, biomass of mesopelagic fish in Pakistani offshore waters is estimated to be about 1 million tons, however, technology for its harvesting and utilization has yet to be developed on a viable scale. Considering, the present fish production from Pakistani waters is about 0.5 million metric tons, it is expected that fish production can be increased substantially by taking appropriate conservation measures for renewed sustainable development. Traditional fishing methods are used for catching fish. Gillnetting is the most important gear. For catching shrimp, stern trawling method is used, whereas for catching small pelagics (*Sardinella sp.* and *Thyssa sp.*) encircling net is used in addition to handline, longline, cast net and beach seines are also used in shallow coastal waters along the coast line.

**TABLE - 2. PROVINCE-WISE NOMINAL CATCH OF FINFISH AND SHELFISH**

Quantity in Metric tons

| **AREA** | **1997** | **1998** |
|---|---|---|
| PAKISTAN | 589,731 | 596,980 |
| MARINE | 422,201 | 433,456 |
| FIN-FISH | 387,647 | 394,265 |
| SINDH | 252,739 | 257,973 |
| BALOCHISTAN | 129,025 | 129,465 |
| EEZ | 5,883 | 6,827 |
| SHELL-FISH | 34,554 | 39,191 |
| SINDH | 33,028 | 37,675 |
| BALOCHISTAN | 1,381 | 1,334 |
| EEZ | 145 | 182 |
| INLAND | 167,530 | 163,524 |
| FRESHWATER FISH | 167,530 | 163,524 |
| SINDH | 102,508 | 106,611 |
| PUNJAB | 61,098 | 53,924 |
| N.W.F.P. | 743 | 840 |
| NORTHERN AREA | 110 | 83 |
| DAMS | 3,071 | 2,066 |

SOURCE: Marine Fisheries Department, Government of Pakistan.

Mangrove forest along occur along the Sindh deltaic region and on Balochistan coast. The Indus Delta harbours the largest single strand of *Avicennia marina* mangrove forest on 617,470 hectare under mangrove cover (Vistro, 1999). It is a diverse ecosystem and produce a variety of products for the lively-hood of coastal communities. Along Balochistan coast mangroves occur in only three sites viz a viz Miani Hor, Kalmat Hor and Gwater Bay, all spots are equidistant from each other. The area of mangrove cover in these three areas are 7750, 5400 and 5000 acres respectively (Mirza et al 1988). The reported mangrove species from the Balochistan coast are *Avicennia marina* from Kalmat Hor, *A. marina, Rhizophora mucronata* and *Ceriops tagal* from Miani Hor. The three species show a clear vertical zonation with A. marina occurring near the water front followed stepwise by *R. mucronata* and *Ceriops tagal* toward the land (Saifullah 1991). The mangroves support a variety of invertebrate fauna dominated by crustaceans and provide food and habitat to a large number of larval and juvenile fish and shrimps.

There are five species of marine turtles which breed and nests on the sandy beaches all along Sindh and Balochistan coast. Two of the species are among the endangered species. The entire coastline of Sindh and Balochistan from Ras Jaddi in the north, and the enclosed bay, support appreciable numbers of migratory birds and is likely to rank as a provincially (or perhaps nationally) important wetland zone, mainly by virtue of the diversity of coastal habitats available within a relatively restricted area.

Ecosystem Health:

Unplanned commercial exploitation of certain target species by foreign investors off Balochistan coast and within the EEZ of Pakistan may create an ecological imbalance i.e. removal of large pelagic species by way of over exploitation of tunas, Spanish Mackerels etc. from the system. This over exploitation of pelagic fish will result in an upsurge of small pelagic fish (sardines, anchovy, scads etc.) of less commercial value. Tuna and tuna like fish feed on small pelagic fish. Removal of the predator (Tuna) by over fishing will increase the population of small pelagic species thereby creating an ecological imbalance. As per Pakistan Environmental Protection Ordinance 1997, it is suggested that Environment Impact Assessment (EIA) be conducted prior to initiation of any projects. There is also a need to re-evaluate and monitor resources on a regular and systematic basis.

*Natural and human induced stresses.* Human activities usually have a negative impact on the coastal zones for example, discharge of industrial of industrial and domestic wastes, oil spills, coastal developments disregarding the environmental concerns, damming of rivers, dwindling estuaries and freshwater starved mangrove forests, over exploitation of coastal forests and over-fishing has caused marked declines in most of the world's greatest fisheries. Over-fishing or removal of predators from the system can create an ecological imbalance. Human pressures on the mangrove forests and coastal fisheries are the most important economic activity for the coastal communities along the Pakistan coast (with the exception of Karachi, and Hub Coasts). There is increasing evidence that human can and do cause profound impact on the short-term processes of the biological sector of the oceans. Marine habitats are destroyed or severely impacted by oil pollution,

dumping, sewage out-falls.

Interest also continues in exploration and exploitation of coastal mineral resources on the sea bed, and interest is emerging in commercial exploitation of genetic resources. Continued unplanned industrialization of coastal zones have contributed to the deterioration of coastal environment quality and loss of coastal amenities.

*Reduction of fish export*: Suspected unhygienic conditions at landing sites and in the fish harbours have drastically reduced fish and shrimp exports from Pakistan to European Union countries. The European Union had imposed a ban on Pakistan sea food in June last because of poor hygienic conditions. Certain recommendations to improve the working conditions were made. The development work has now been completed at a cost of Rs 6.3 million with the result that the average price of Pakistani seafood products has increased in Europe from 80 cents to two dollar per kg after lifting of import ban, further the European Union had raised the status of Pakistan from C to B category exporters (DAWN 16 September, 1998).

*Habitat loss:* Changing condition in coastal and terrestrial environments associated with degradation of environmental quality and the health of coastal ecosystems threaten the survival of certain species and communities. The coastal domain is dramatically affected by changes in sea level, ground water level, salinity, wave pattern, current regimes, sediment budgets, storm events and erosion patterns. Physical changes themselves result in a wide variety of biological changes at the population, community and ecosystem level, which in turn affect the suitability of the coastal zone and its resource for use by human population. Amongst the coastal ecological systems, corals, sea grass communities, mangrove ecosystems etc. are most vulnerable to severe changes. Mangroves are economically significant, since they serve as an important natural breeding/nursery grounds for commercially important penaeid shrimps and fish larvae. In the absence of an alternative resource mangrove also serve the underprivileged inhabitants of coastal communities as a valuable source of timber, charcoal and fodder for domestic animals. The mangroves support a variety of invertebrate fauna dominated by crustaceans and provide food and habitat to a large number of larval and juvenile fish and shrimps. Some fishes are permanent inhabitants of the mangrove ecosystem. The Balochistan mangroves in recent year have been categorized as critical habitats for a large number of invertebrate such as crustaceans, gastropods, bivalves, polycheate worms.

*Indiscriminate, unplanned development*: Coastal towns are devoid of any national planning schemes, with the result that unplanned development can cause serious environmental problems. There are often conflicts between stakeholders in the area, generally there is also a lack of planning in providing essential services such as water, sanitation, electricity, roads, health, education. There are very limited sub-national development plans for the coastal towns and cities of Pakistan with respect to sewage disposal. For the most part the coastal areas of Pakistan are sparsely inhabited except for Karachi City and a few smaller coastal towns. The main industrial activity along the coast is concentrated mostly along the coast of Karachi in Sindh and extend to the adjacent coasts of Hub and Gadani in southern Balochistan.

The coastal towns other than Karachi do not have any sewerage system and hence use the storm water drains adjacent to rivers and creeks for disposal of untreated liquid domestic and urban wastes (sewage). This type of sewage disposal is practiced in Jiwani, Gwadar, Pasni, Ormara, Hub and Gadani on Balochistan coast. Similar arrangements are in place at coastal towns of Sindh such as Mirpur Sakro, Keti Bandar, Shah Bandar, Jati and Badin. In addition to the storm water drains the coastal towns of Jati and Badin also use manmade drains leading to the creek through LBOD. The plans for sewage disposal and existing system of sewerage in Karachi are described below:

*Marine Pollution*: There are a number of environmental issues in the coastal zone of Pakistan and amongst these the disposal of domestic wastes and industrial effluent causing marine pollution problems along the urban centers are the most significant. The pollution problems have arisen due mainly to the indiscriminate discharge of effluent from industrial and agricultural sources and disposal of untreated liquid and solid wastes generated from domestic sources into the coastal environment. In addition, the coastal development activities involving man made alterations of the coastal environment have also accelerated the impacts of pollution leading to the deterioration of coastal environmental quality, depletion of coastal resources, public health risks and loss of bio-diversity.

Karachi City with an estimated population of about 13 million and the biggest trade & economic center of Pakistan with more than 6,000 small and large industrial units is a major source of industrial and urban pollution. The other coastal areas having industrial pollution problems are Hub Coast through Hub Industrial Estate and Gadani Coast through industries based in Gadani area. The heavy metals, persistent organic pollutants, air pollution and oil oil pollution are more significant. There is very little information available on the impacts of persistent organic pollutants in the coastal areas of Pakistan although their presence is noticeable particularly in solid wastes disposal.

The heavy metals in the coastal waters of Karachi are being accumulated in the sediments and marine organisms particularly those resident in the polluted areas. The accumulation of eight heavy metals (As, Cd, Co, Cr, Cu, Hg, Ni, Pb, and Zn) in the resident fauna from polluted coastal areas of Karachi. The heavy metals are being accumulated in considerably higher concentrations in marine organisms comprising of resident fauna of the polluted localities. The accumulation of five heavy metals (Cu, Co, Mn, Zn, and Fe) in the resident fauna from Gharo, Bakran and Korangi Creeks in considerably higher concentrations has been reported in marine organisms comprising of resident fauna of fishes including edible fishes, shrimps, some benthic organisms (bivalves and barnacles) from these areas. The concentrations of iron and zinc were found higher than the corresponding values for Mn, Cu and Co.

Oil pollution appears to be of some concern along the Pakistan coast. Sources of oil pollution include effluent discharges from two oil refineries, mechanized fishing boats and the cleaning of bilges and tank washing by the large number of merchant vessels as well as oil tankers that pass through the EEZ of Pakistan yearly (2500 oil tankers carry 33 million tons of crude oil, IOC/ICZM report, 1994). As a consequence, tar balls (residues

of weathered oil at sea) are commonly found on beaches. The recent case of oil spill (4 June, 1998) from R.V. Yashica abandoned about 304 km south-west of Karachi (approximately 112 km south of Pasni). The disabled ship was carrying 1500 tons of furnace oil. It has been reported that the movement of offshore oil slick under the influence of wind, waves, currents etc., is likely to end up on the coast of Pakistan (Pathmarajah, 1982).

Biological Diversity:

Several natural and man-made threats to bio-diversity were reported. Changes in physical factors such as high temperature, high salinity, upwelling of deoxygenated layers, erosion of the beaches due to negative sediment load from the river have caused considerable stress to the animal community. Disappearance of certain species of bivalve Mollusk including oysters and clams from the Sindh coast is specially mentioned. Several invertebrate species were reported to have disappeared from the inter-tidal zone due to pollution and due to ecological ineptitude and exploitation.

*Natural coastal vegetation*: The natural vegetation of coastal region is composed of *xeromorphic* type able to survive the arid climate. The vegetation not only suffers from extreme droughts but also from wind erosion and aridity. Bleaching of stem is common during extended dry spells. Many species in dry season are devoid of leaves. In coastal areas, salt spray (aerosol) coupled with sand particles clogg the respiratory mechanism of plants, affecting growth. *Prosopis juliflora* is the most significant widespread species distributed in all types of habitats. It has recently invaded the coastal area and has now formed population of various sizes. *Indigofera oblongifolia* and *Hycium depressum* is also widespread and grows well in sandy plains and dunes forming large bushes. Among the Acacia's, *Acacia nilotica* is the most common species and is distributed in low alluvial depressions, plains and foothills associated with relatively less austere moisture regime.

*Mangroves*: Mangroves along the Pakistan's 990 km coastline occur mostly along along Indus deltaic region along Sindh Coast and a few areas along Balochistan Coast. The mangrove forests of Indus Delta, Sindh consisting mostly of the mangrove (*Avicinia marina*) spread over 617,470 hectares (Vistro, 1999), representing the sixth largest mangrove block worldwide. The mangroves at the inter-tidal areas south of Shah Samando Creek has sparse mangrove vegetation in some areas while dense mangrove vegetation in other areas towards sea along the Sir Creek.

Mangroves along Balochistan Coast occur only three sites viz a viz Miani Hor, Kalmat Hor and Gwater Bay, all spots are equidistant from each other. The area of mangrove cover in these three areas are 7750, 5400 and 5000 acres respectively (Mirza et al 1988). The reported mangrove species from the Balochistan coast are *Avicennia marina* from Kalmat Hor, *A. marina, Rhizophora mucronata* and *Ceriops tagal* from Miani Hor. The three species show a clear vertical zonation with *A. marina* occurring near the water front followed stepwise by *R. mucronata* and *Certops tagal* toward the land (Kogo, 1979, Saifullah 1991).

A reforestation programme was developed under the auspices of IUCN/WWF to replant some of the indigenous species of mangroves (*A.marina* and *R. mucronata*) working closely with coastal communities to develop packages for encouraging local management and sustainable use of mangrove.

*Water birds and marine turtles*: The entire coastline of Sindh and Balochistan from Ras Jaddi in the north, and the enclosed bay, support appreciable numbers of migratory birds and is likely to rank as a provincially (or perhaps nationally) important wetland zone, mainly by virtue of the diversity of coastal habitats available within a relatively restricted area. The zone in question extends for about 13 km north and east from Ras Jaddi and comprises firstly, the rocky foreshore platform, about 2 km in length, bearing numerous pools with abundant marine invertebrates. This is followed by sandy beach, locally with shallow bays, lagoons and channels, extending for around eight kilometers to the vicinity of Pasni. This stretch is termed Pasni Hor. North and east of Pasni there is a vast mudflats, around the mouth of the Shadi Kaur.

*Water Birds*: Pelicans have been observed in a bay off Pasni Hor, probably *Dalmatian P. crispus*. Here also are large numbers of Dunlin *Calidris alpina*, sanderling *C. alba* and Kentish plover *Charadrius alexandrinus* with slightly lower numbers of Curlew *Numenium arquata*, greater san plover *Charadrius leschenaultii*, Greenshank *Tringa nebularia*. Bar-tailed Godwit Limosa lapponica, Oystercatcher Haematopus ostralegus. There are also several Grey Heron *Ardea cinerea* and Ergets, including *Ergetta intermedia*. A greater variety of wild life and Birds have been reported from Sindh Coast and Indus Delta ( Ahmed, 1999).

A similar range of species is found on the predominantly rocky foreshore close to Ras Jadi, but with Oyster-catchers in greatest numbers, along with hundreds of large gulls (mainly *Larus argentatus)*, Cormorants, several terns including large crested tern (*Sterna bergil*), Lesser Crested Tern (*S. Bengalensis*), Little Tern (*S. Albifrons*) and other terns and also some large raptors. Again, a similar range of species is found on the mudflat area to the north-east, with Curlews in large numbers. The bay area holds a few hundred gulls, numerous terns and some great Crested Grebe *Podiceps cristatus.* Numerous other birds are found including duck and grebes (Ahmad et al 1992).

The Indus Delta and coast of Balochistan are preferred sites for a number of resident and migratory birds. The Pelican numbers typically build up to 100 or so by February-March when they leave the area for their breeding grounds. Some pelicans are taken for food and for rendering into fat (either by boiling or by leaving the bird hanging in the sun to putrefy and collecting the exudate). Greater Flamingo *Phoenicopterus ruber* and a small party of crab plover *Dromas ardeola* have also been observed. The later is of particular interest as a local and sporadic winter visitor to the subcontinent (from coral island breeding sites in the western Indian Ocean and the Gulf). Peregrine falcon *Falco peregrinus* has also been seen hunting in the vicinity of Ras Jaddi.

No other site on the Balochistan coast has such a wide range of habitats - including cliffed river valley, estuarine mudflats, sandy shore-width lagoons, rocky shore, sheltered

marine bay, and rocky coastal cliffs within such a well-defined and relatively small area. Accordingly, the Pasni area should be rated as one of the natural areas on the Balochistan coast most deserving of conservation attention. In this location a species-rich and numerically important shore-bird fauna is present during the winter months. For further review on avifauna of the Balochistan coast, please refer to Ahmed et al. 1992, Zoological Survey Department.

*Turtle Nesting Habitat*: Although most of the Pakistan coast is lined with sand beaches, the total length that is well-suited to turtle nesting is somewhat limited. Long stretches of beach are backed by high near-vertical cliffs and are only a few yards wide at high water, these are likely to be too narrow to allow successful nesting. Some beaches are similarly narrow, and are backed by sandy plains or dune systems where nesting might be possible, but are separated there from by a short but very steep ridge which would make access difficult. Long stretches of beach appear mostly with silt and only a small depth of sand covering the underlying mud substrate which can often be seen washing into the sea; such areas are likely to have an insufficient depth of sand to permit best excavation and suitable conditions for egg incubation.

Literature sources report marine turtle nesting at Sandspit / Hawkesbay Sindh coast and Jiwani, Haft Talar (Astola Island) and the Sonmiani area. Unpublished reports from 1975 suggest that mass nesting occurs at Ormara. A preliminary survey on 19-22 January, 1987, of beaches near the four main towns on the Makran coast (Groombridge et al, 1987) confirmed that large numbers of marine turtles, seemingly all *Chelonia mydas*, still nest on parts of the Balochistan coast. Many nests were seen on the beach at the foot of the "Lighthouse Cliff" at Jiwani. Extensive nesting was recorded on the beach at the foot of the Kamgar Hills on the eastern side of Ormara West Bay, with sparse nests also along the northern margin of the same bay. Sparse nesting has also been recorded at Gwadar and at Pasni, between the Shadi Kaur and Ras Jaddi bay Balochistan coast.

### (iv) Economic and social benefits and uses, including cultural values;

Economics and uses of the coastal areas:

The potential use and benefit to clean coastal and marine environment of Pakistan are briefly summarized below. The following sectors of economy make use of the coastal and marine environment in Pakistan.

> Ports & Shipping; Fisheries and forestry; Communication & roads; Coastal agri-culture; Boat building, ship building; Ship breaking industry; Oil and gas mineral exploration; Salt industries and mineral industries; Disposal of sewage and industrial effluents by Municipalities & coastal industries; Coastal tourism; Storm protection and flood control measures; Pollution control management; Coastal power plants and Energy sector.

A description of the various economic uses of the coastal areas with reference to their impacts and social benefits to coastal population is given in Table-3.

**TABLE -3. ECONOMIC USES, IMPACTS & SOCIAL BENEFITS OF COASTAL AREAS IN PAKISTAN.**

| S.No. | SECTOR OF COASTAL ECONOMY | MAIN USAGE | MAIN IMPACTS | SOCIAL BENEFITS OF CLEAN COASTAL ENVIRONMENT |
|---|---|---|---|---|
| 1 | Fisheries:<br>1) Coastal & Marine Fisheries;<br>2) Brackish water Fisheries<br>3) Aqua-culture | Main-stay of Coastal Economy; Commercial Fishing for Fish, Shrimp, Lobsters, Crabs, etc.;<br>Artisanal Fisheries;<br>Mari-culture not exploited so-far. | Over fishing,<br>Disposal of wastes generate Organic Pollution, Eu-trophication in Coastal areas | Provide the main economic activity to coastal population;<br>Provide Subsistence, sustenance and support to coastal communities for food, living and jobs;<br>Produce Fish Catch worth over Rs 6 billion /year;<br>Fetch Foreign Exchange of over Rs 2 Billion / year |
| 2 | Forestry:<br>1) Coastal vegetation<br>2) Coastal Mangrove Forests | Increase and sustain productivity of coastal waters;<br>Provide Nursery, feeding and breeding grounds to a variety of fish, shell fish;<br>Provide Fire wood, fuel wood, Fodder and food products to coastal communities;<br>Provide Coastal Defense;<br>Reduce Soil erosion;<br>Clean air and water pollution. | Stop soil erosion;<br>Clean air and water;<br>Increase productivity;<br>Provide roosting for birds, refuge for wild life & fisheries<br>Provide food products and fire wood for coastal communities | Provide sustenance and support to coastal communities for food and shelter;<br>Help maintaining a good level of bio-diversity and nitches for coastal fauna and flora;<br><br>Support maintaining fisheries production at a certain level despite increase in fishing pressures;<br>Provide Clean coastal environment for coastal communities |
| 3 | Coastal Agriculture | Provide food, fodder and sustenance for coastal communities | Produce organic wastes, Residues of un-utilised fertilizers, insecticides & pesticides lead to coastal pollution | Provide food and sustenance to coastal communities and their cattle;<br>Provide some additional economic activity for the coastal population. |
| 4 | Ports and Harbours, Shipping | Provide sites for land-sea communication; Enhance trade through export, import of required commodities;<br>Provide landing facilities for fish catch and shell - fish , etc. | Dredging and maintenance dredging causes pollution problems; Shipping, navigation by mechanised crafts produce oily wastes and accidental oil spills leads to oil pollution; organic wastes, leaching of organotin compounds from anti-fouling paints and of heavy metals in to the coastal environment. | Strengthen Economy through promoting Trade activities under bulk Exports & Imports;<br>Promote hygienic conditions at the fish landing jetties, harbours;<br>Promote speedy marketing of fish and fisheries products |
| 5 | Communications Coastal Roads, water ways (rivers & creeks | Ensure speedy transportation of required commodities between cities and to the ports / harbours; Enhance trade of required commo-dities; Provide speedy access to modern facilities between the rural and urban centers | Environmental impacts include disturbance to wild life, coastal fauna and flora, impact on cultural heritage and local traditions | Promote development, strengthen economy and enhance socio-economy of the adjacent areas |
| 6 | Coastal Tourism | At present it is insignificant but has the potential to develop as an industry | Disturb the coastal fauna, flora and wild life. Also negatively impact the local culture and traditions. Social and moral values change. | Promote development, improve coastal economy, improve living standards and promote development of infra-structure. |
| 7 | Energy Sector | Provide basic needs for | Promote Air Pollution and acid | Provide Essential Energy / |

| | | | | |
|---|---|---|---|---|
| | (Coastal Power Plants) | modern day living, essential for development, Promote Economy | rains. Negative Impacts include Entrapment, Entrainment and Thermal shock to microscopic plants and animals as well as larger fish, etc.; Leaching of heavy metals and the Release of Anti-fouling chemicals including Chlorine to coastal waters leads to pollution | Power requirement for the urban and industrial development and serves as backbone of economic development. |
| 8 | Coastal Industries: (Chemicals, metals, Tanneries, Oil Refineries, etc.) | Provide products for business, trade and exports; Provide business opportunities, jobs and economic development | Disturb coastal ecosystems and wild life,; Improper management of solid waste and industrial wastes leads to severe pollution of coastal environment, public health risks and depletion of coastal resources. | Promote industrial development, job opportunities, business and trade including exports / imports; Proper treatment and disposal of sewage and industrial wastes help maintain clean environment. |
| 9 | Coastal Minerals Industries<br>1) Extraction of Minerals<br>2) Sea Salt (Coastal Salt Pan Industry) | Promote use of coastal lands for economic development, | Extraction of beach sand and minerals disturb local hydrologic regime; Production sea salt from polluted waters leads to public health risks | Promote coastal development and encourage use of local resources for coastal communities |
| 10 | Construction Material (Extraction of Coastal Sand & Gravel) | Promote use of coastal materials for economic development, | Extraction of gravel disturb local hydrologic regime and weaken coastal protection works and coastal defense. | Promote coastal development and encourage use of local resources for coastal communities |
| 11 | Boat Building / Ship Building | Promote Transportation through sea and water-ways; Essential for Trade and Fishing activities | Disposal of waste products leads to pollution; Mechanised boats and ships promote oil pollution | Promote shipping and exports; Promote fishing industry and local / foreign trade; Provide job opportunities; Help maintain traditional boat building skills. |
| 12 | Ship Breaking Industry | Provide scrap steel and other scrap metals for foundries; and scrap wooden products, etc., for a variety of re-use for local industry | The waste products and waste / un-used fuels, oily products, anti-fouling paints, and heavy metal leaching leads to heavy metal and oil pollution | Promote coastal area development, infra-structure; Promote development of foundries and allied industries; Provide job opportunities to local people. |
| 13 | Coastal Urban Developments:<br>1) Coastal urban Development and Housing<br>2) Beaches and Coastal Recreation<br>3) Disposal of Sewage and Solid waste management | Provide developed sites for residential use and setting up industrial usage; Provide recreation and business opportunities;<br><br>Provide safe drinking water, sanitation and clean environment | Disturb coastal ecosystems and wild life,; Increase pressures on coastal resource use; Improper management promotes poor sanitation, pollution of coastal environment, public health risks and depletion of coastal resources | Provide residential areas with modern day living facilities; Promote industrial development, job opportunities, business and trade including exports /imports; Help maintain good sanitation, safe drinking water supply, proper treatment and disposal of sewage and industrial wastes and proper solid waste management. |
| 14 | Oil & Gas Exploration | Provide good business prospects in Oil & Gas sector and its development for the benefit of coastal population from indigenous coastal resources. | Disturb coastal ecosystems and wild life; Improper manage-ment of exploratory activities and improper management & disposal of waste products leads to pollution of coastal environment and negatively affects coastal fauna & flora. | Disturb coastal ecosystems and wild life,; Improper management of wastes produced leads to damage coastal fauna, flora and negative impacts |
| 15 | Coastal Defense / Storm | Provide protection to coastal | Man made protection works | Provide protection to coastal |

| | | | | |
|---|---|---|---|---|
| | Protection:<br>1) Natural Coastal Defense<br>(Coastal vegetation & Mangrove forests)<br>2) Man made Defense<br>i) Coastal protection works<br>ii) Flood Control | area and coastal resources from Storms, cyclones;<br>Act as buffers and provide protection to coastal areas from flooding after heavy rains and land run-off | obstruct natural flow of water and hinder water exchange;<br>The man made structures limit and disturb the progression and natural growth and spread of coastal communities and disturb natural ecological balance. | structures, ports and harbours, coastal out-falls from the ravages of storms, cyclones and thus protect life and property;<br>Natural coastal defense also promote sustenance of coastal living resources and provide food, fodder, fuel / fore wood to the sustain coastal communities. |
| 16 | Water Drainage:<br>1) Saline Agriculture<br>2) Storm water Drainage for Urban & Land Run-Off | 1) Efficient Agriculture Drainage to the sea helps in fighting water logging and soil salinity problems in coastal and upland agriculture areas.<br>2) Provide natural and man made drainage facility to coastal areas;<br>Help maintaining good sanitation in the coastal areas / towns / cities. | Agriculture drain waters cause coastal pollution by residues of pesticides, insecticides and fertilizers;<br><br>Land-run-off brings a variety of pollutants from land based industries urban developments and human settlements | Efficient Agriculture Drainage rehabilitate agriculture lands under water logging salinity and thus help increasing agriculture production;<br>Improved Sanitation through efficient Storm water Drainage; Mitigate flooding of low lying lands and help maintaining clean environmental conditions in coastal areas for coastal communities. |

The completion of national sub-national development plans, projects within the sectors mentioned above are expected to provide economic benefits mentioned below:

- Sustainable development of coastal and marine resources;
- Integration of multiple objectives of economic development, environmental protection;
- conservation of resources and societal demands for coastal resources;
- Conservation and sustainable development of fisheries and aquaculture;
- Protection of beaches;
- Improvements of water quality;
- Reduction of health risk;
- Improvement in the sewerage system and quality of life;
- Reuse and recycling of waste .waters and sewerage;
- Achieving a healthy and clean environment along with the sustainable development of coastal resource usage.

In view of the upcoming new developments along the coast of Pakistan in near future the following issues have been identified for adoption of measures for environmental protection and marine pollution controls as part of the coastal zone management to minimize the conflicts in the use of space and coastal environment.

* Development of new housing, recreation and industrial complexes in the coastal zone along Karachi, Hub, Gadani and Keti Bandar versus pollution control, beach protection, ecological balance, creek environment and maintenance of aesthetic and recreational value;

* Operation and Development of new ports, harbours and power plants and industries in the coastal zone versus mangrove forest, creek environment, dredging and oil pollution;

* Development of shrimp farming and other mari-culture practices in the coastal

areas versus growth and maintenance of mangrove forest in Indus Delta;

* Operation and development of new sea salt pan industry along Sindh and Balochistan coast versus disposal of industrial effluent, growth of mangrove forest and mari-culture;

* Development of desalination plants along the Karachi coast versus coastal environment.

The conflict resolution identified above is planned to be addressed through preparation and implementation of four integrated coastal zone management for Pakistan Coast (Rizvi, 1997). It is envisaged that there the overall coastal zone management plan should consist of four integrated management plans, one each for (i) Karachi, (ii) Sindh Zone, (iii) Hub-Gadani coastal area and for the (iv) rest of Balochistan coast. The Coastal Development Authority (CDA) would act as a lead agency to integrate management planning and monitoring implementation of integrated management along Sindh Coast. The Ministry of forestry , fisheries and coastal development, Government of Balochistan would act a lead agency for the integrated coastal zone management along Balochistan Coast.

The various sectors of coastal economy have been subject to ever expanding anthropogenic influences. Some of the major activities reported from the region, such as, reclamation of wetlands, dredging of the navigational channels, discharge of industrial effluent and urban waste, uses of insecticides, destruction of mangrove forests for various uses, trash fishing, indiscriminate killing of wild life, and the damming of the Indus river in the northern parts have been reported to be the main factors causing the destruction of coastal areas, especially the Indus delta.

The coastal community which rely heavily on coastal resources such as mangrove, fish and shrimps and, in this context, to the community development programme in Rehri, which is being implemented with the technical advice under the IUCN programme covering three aspects including income generation, environmental awareness and community organizations.

Cultural Values:

There are a number of cultural and archaeological sites located in the coastal areas of Pakistan. Most of these sites are not getting due attention of the concerned government departments and national agencies for their protection and conservation. These sites are listed in Table – 4.

**Table - 4. Cultural Heritage in the Coastal Areas of Pakistan**

| Cultural Heritage | Sites | Identified | Conserved |
|---|---|---|---|
| I. Historical / Archaeological Sites | | | |
| - Kodiro Fort / Ratto Fort | Indus Delta (Machak Island, Phitti Creek) | Local institutions | Nil |
| - Juna Fort | Indus Delta (Off Port Qasim) | Local institutions | Nil |
| - Bhimbore | Thatta, Indus Delta | Local institutions | Partial |
| - Alexandar Route | Balochistan coast & Sind Coast Balochistan Coast | Archaeological Dept. | Nil |
| - Mud Volcanoes | Sindh Coast (Karachi) | Local institutions | Nil |
| - Historical Monuments | | Local institutions KDA | Partial |
| II. Religious /Cultural Sites | Balochistan Coast | | |
| - Chandragupt (Mud Volcanoes) | Balochistan Coast Near | Local Institutions | Nil |
| - Hingloc (Hindu temple) | Hingol River | Local Institutions | Nil |

Source: Modified from Pakistan's National Conservation Strategy.

The cultural system in practice in the coastal areas guarantees the supremacy of feudal classes. The people in coastal regions belong to various clans and tribes with traditionally had hereditary productivities i.e. jats were pastrol people, breeders of camels; Memon & Shidies were merchants and traders; Khas Khelis were agriculturists and Dablas were fishermen. The artisans (potters, barbers and carpenters) serve the clan communities and in exchange are maintained by them. All economic relationship between clans was one of barter. Only tribal chiefs and Waderas (tribal elders) handle cash transactions. At present 90% of the population is involved in fishing and fisheries related activities, 8% in agriculture and 2% in service sector. There are four types of income generating activities in the fisheries sector. Over 70% of the people engaged in fishing are Khalasis. They act as labourers / helpers and get 1/16 of the value of fish catch as their share in fishing trips per head. The owner gets the rest of the catch but is also responsible for repairs of boats, engine and fishing net (SACEP 1998). The mole-holders have the upper hand in the local fisheries industry. They purchase the fish from the owner of fishing boats at reduced prices and often give them loan to maintain their boats, nets and engines whereas in return mole-holders get the right to purchase the fish catch at the rates fixed by them which are much below the market price.

### (b) Contaminants:

#### (i) Sewage

There are a number of environmental issues in the coastal zone of Karachi and amongst these the disposal of domestic wastes and industrial effluent causing marine pollution problems are the most significant. The pollution problems have arisen due mainly to the indiscriminate discharge of effluent from industrial and agricultural sources and disposal of untreated liquid and solid wastes generated from domestic sources into the coastal environment. In addition, the coastal development activities involving man made alterations of the coastal environment have also accelerated the impacts of pollution leading to the deterioration of coastal environmental quality, depletion of coastal resources, public health risks and loss of bio-diversity.

Karachi being the largest populated city of Pakistan (population is about 13 million) generates more them 200 millions gallons / day of domestic wastes, which is discharged through the sewerage system, nallah, and streams in to Lyari River, Boat Basin draining to the Karachi Harbour, and in to Malir River draining to Gizri Creek. There are several nullahs and storm water drains which discharge directly to the adjacent coastal waters along west coast and to the Korangi Creek, Gharo Creek along the east coast. All the liquid wastes finally enters in to the coastal waters of Karachi.

The sewage from Karachi coast contain number of contaminants which are harmful for the marine organisms and produce harmful Algal and Toxic Planktonic Blooms. As the sewage is rich in suspended and dissolved organic matter and also brings huge quantities of micro nutrients such as nitrates phosphates and silicates therefore it induces high productivity in short period often leading to Eutrophication. The contaminants in sewage usually include compound of heavy metals and other biodegradable compounds. It also brings to the coastal waters a variety of pathogenic micro organisms which may contain bacteria and viruses of infectious and communicable diseases. The typical composition sewage from Karachi city is given below:

Composition of sewage from Karachi

| | | |
|---|---|---|
| Total Dissolved Solids (TDS) | 32.68% | |
| Calcium bicarbonates | | 14.00% |
| Chlorides | | 13.20% |
| Sulphates | | 13.10% |
| Calcium Carbonates | | 13.18% |
| Magnesium oxides | | 5.21% |
| Organic Matter (Dissolved) | | 4.11% |
| Suspended Solids | | 2.97% |
| Iron Oxides | | 0.40% |
| Phosphates | | 0.20% |
| Total Nitrogen | | 0.20% |
| Ammonide Nitrogen | | 0.19% |
| Arsenic Oxides | | 0.12% |
| Aluminum Oxides | | 0.118% |
| Albumonide Nitrogen | | 0.004% |

### (ii) Persistent organic pollutants;

The organo-chlorine compounds such as pesticides, insecticides, PCBs and plastic waste materials are amongst prominent persistent pollutants along the coast of Pakistan. The use of chlorinated pesticides and insecticides has been considerably reduced compared with their use about 3-decades ago. However, these are still being used by the agriculture sector particularly for the cotton cash crop. The residues from these compounds reach the coastal waters through agriculture drainage, rivers, and run-off. There has been no effort made for the determination of their contents in the coastal environment of Pakistan except some preliminary efforts. Six chlorinated compounds (r-BHC, aldrin, heptachlor epoxide. P,p'-DDT, DDT metabolites, P,p'-DDT were identified in concentrations varying from traces to 125 ng/g in the tissues of oyster *Crassostrea glomerata* and *C. rivularis* from six locations along Pakistan Coast (Siddiqui and Khan 1988). IUCN

(1987) reported also reported concentrations of some PCBs in the sediments from coastal areas of Karachi during a baseline survey. The preliminary survey values, however, did not show an appreciable concentrations of PCBs in the sediments.

The plastic pollution has become very prominent on the beaches because of the indiscriminate use and uncontrolled disposal of polyethylene shopping bags which litter the common beaches of Karachi. The other important form of plastic pollution is the presence of plastic pellets (polyethylene and polystyrene balls) of of plastic products. These balls are common in beach sands along the high water mark. However, no study has yet been made on the plastic pollution in the marine environment of Pakistan (Rizvi et al 1999).

**(iii) Radioactive substances;**

There are only a few sources of Radioactive Pollution along the coast of Pakistan. These include the nuclear power station at Karachi, and a few clinical and Research Laboratories which use radio-tracers for clinical and research objectives. Amongst these KANUPP (Karachi Nuclear Power Plant) is the only significant source of Radio active Pollution because of nature and volume of radio-active effluent it discharges into the environment. It also has an elaborate arrangement for radio-active waste disposal which is also shared by the other users of radio active products at Karachi coast. At present no study has been made to monitor radio-activity from artificial sources in the coastal environment along Karachi Coast.

The Karachi Nuclear Power Plant (KANUPP) is located on the coastline about 18 km west of Karachi. It is heavy water moderated and cooled, natural uranium fuelled, horizontal pressure-tube reactor with a generating capacity of 137 MW electricity. It is in operation since 1972. The philosophy of waste management in practice at KANUPP is to either concentrate and store or dilute and disperse into the environment. The discharge of radioactive gases from a 60 m high stack consists of tritium, tritium oxide, noble gases (Ar14, Kr88, Xe138 and daughter products), iodine and radio-active particulates. The stack effluent is filtered with pre-filters, absolute filters, and charcoal filter. The plant is equipped with vault cooling system which eliminates the production of large quantities of Argon 14 (Siddiqui and Mirza, 1979).

The low radioactivity level combustible solid waste is burnt in the open pit. The low level and intermediate level non-combustible radio-active solid waste and all other combustible and non combustible radio-active solid wastes are stored in one of the concrete lined trenches 9 meters long, 3 meters wide and 3 meters deep, reinforced with 10 cm of concrete all around. when the trenches are full to within 30 cm from top, they are filled with sand and soil and covered with concrete to contain the waste for an indefinite period of time (Siddiqui and Mirza, 1979). The radio-active liquid wastes are collected from the reactor building, after some treatment, is thrown into the adjacent sea through the out-fall of seawater cooling system. The discharge of effluent from dispersal tank to the cooling water outfall is controlled to permit sufficient dilution to bring the level of radioactivity to less than 4 x 10-7 (Ci / ml - permissible limit) before entering into the sea. The Gross

radioactivity of the liquid effluent ranges between 150 to 1165 mCi with 1085 mCi of Tritium before discharge to sea (Siddiqui and Mirza, 1979).

**(iv) Heavy metals;**

The heavy metal pollution in the coastal waters of Karachi is evident from the fact that these are being accumulated in the sediments and marine organisms particularly those resident in the polluted areas. The accumulation of eight heavy metals (As, Cd, Co, Cr, Cu, Hg, Ni, Pb and Zn) in the resident fauna from polluted coastal areas of Karachi. The heavy metals are being accumulated in considerably higher concentrations in marine organisms comprising of resident fauna of the polluted localities. The accumulation of five heavy metals (Cu, Co, Mn, Zn, and Fe) in the resident fauna from Gharo, Bakran and Korangi Creeks in considerably higher concentrations has been reported in marine organisms comprising of resident fauna of fishes including edible fishes, shrimps, some benthic organisms (bivalves and barnacles) from these areas. The concentrations of iron and zinc were found higher than the corresponding values for Mn, Cu and Co (Rizvi et al 1999). The coast of Balochistan is relatively less polluted. The only significant land-based industry along the Balochistan coast is the Hub Industrial Estate and ship breaking industry at Gadani. A part of the organic waste is generated by the sparse population of the coast reaches the adjacent sea. A fraction of the solid waste and considerable amount of wastes generated by the small fishery industry, however ends up in the coastal waters.

The pollutants in the effluent discharged through various industries could be categorized as follows:

- Dissolved organic substances including biodegradable and persistent toxic materials,
- Dissolved inorganic toxic metals,
- Insoluble organic substances,
- Insoluble inorganic substances.

As these industrial effluents originate from a variety of large and small industries, they contain a number of organic and inorganic pollutants. A variety of toxic substances are part of the pollutants being discharged untreated into the coastal waters. Some of the major pollutants from these sources are heavy metals, organo-metallic compounds, poly-hydroxy phenols, metal oxides and sulphide, high BOD organic wastes, acidic and alkaline de-oxidizing agents, PCBs, pesticides and insecticides, crude oils, lead compounds, toxic hydrocarbons, and chrome salts from the tanneries.

The heavy metals are being accumulated in the sediments and marine organisms. The accumulation of eight heavy metals (As, Cd, Co, Cr, Cu, Hg, Ni, Pb, and Zn) in the fauna of coastal waters of Karachi is especially in higher concentrations in marine organisms comprising of resident fauna of the polluted localities.

HITE is situated in the west of Karachi near the border between the province of Sindh and Balochistan. It represents the most recent and fast developing industrial area. Major group of industries in HITE area include textile, chemicals, industrial gases, automobile,

food and beverages, poultry farms, metallurgical and engineering, glass and cement industries. The effluent discharged from these sources are untreated and find their way into the Hub River and finally into the Arabian sea.

**(v) Oils (hydrocarbons);**

Major sources of oil pollution along Pakistan coast are oil refineries and shipping traffic, mechanised fishing fleet and oil terminals at Karachi Harbour, Port Qasim, and occasional oil spills. The two oil refineries; the National Refineries Ltd (NRL) and Pakistan Refineries Ltd (PRL); both located near Korangi Creek, Karachi discharge their oily waste waters in to the Korangi creek area. The volume of the effluent discharged from NRL is about 350,000 to 400,000 Million gallons /day (Ahmed, 1979). An equal amount is estimated for the effluent discharged by PRL on per day basis. The available data on the analyses of the final effluent from Sewage Treatment Plant No.1 and 2 show that 39.1 mg/l (or 3,558 kg/day) of Grease in the discharged sewage is contributing to the oily wastes of Karachi Harbour while 80 mg/l (or 7,280 kg/day) is discharged to Gizri Creek from domestic sources.

The quantitative estimate of oil pollution in Karachi coast and adjacent creeks is lacking. IUCN (1987) have reported some values conducted during their short term pollution survey programme. The survey found oil concentrations in seawater for the Karachi coastal waters ranging between 0.9 to 12.5 (g/l with highest value from Gizri Creek Mouth indicating influence of Refinery Effluent. Similarly, the oil residue concentrations for the sediments from coastal areas ranged between 0.7 to 208 (g/l with highest values reported from Karachi Harbour (167 (g/l) and near ship anchorage area offshore (208 (g/l, IUCN, 1987) indicating the influence of oily wastes from oil tanker traffic, shipping and , oil terminals in Karachi Harbour and oily wastes from Karachi City.

Visual observations, however, indicated considerable amount of oil and tar ball resulting from shipping traffic in the Karachi Harbour, parts of Korangi Creek (Moazzam and Rizvi, 1979) and in the Port Qasim. Most affected areas include Chinna Creek, Backwaters of Mauripur and Sandspit within Karachi Port Trust area and Boat Basin area associated with Karachi Harbour and parts of Gizri Creek due mainly to lack of adequate flushing of the waters in those areas. This has resulted in virtual loss of the habitats within the oil polluted parts of coastal area for most of the marine benthic species.

Some oil pollution along Balochistan coast is observed mostly along Gadani and Sonmiani coastal waters. The coastal waters of Jiwani to Ormara also experience occasional oil slicks from the oil tanker traffic to the Persian Gulf which some times throw their bilges and deballast in the Gulf of Oman. consequently, the oil and oily waste reach the coast of Balochistan by drifting on the water surface. The tar balls are common along the beaches of Gwadar and occasionally on other beaches along Balochistan coast, however, their number and frequency of occurrence is much less than that at Gwadar. Presumably, it is nearness of Gwadar to the oil tanker traffic to the Persian Gulf which might be contributing to some level of oil pollution in the eastern part of Balochistan Coast.

Oil pollution appears to be of concern all along the Balochistan coast. Oil slicks and oil sheen occurs more frequently off the coast of Pasni and Gwadar. The oil slicks are generally more frequent along the ship traffic routes all along the coast but mostly within 50 miles from the coastline. The source of this oil pollution appears to be tank washing and ballast cleaning by oil tankers, oily bilges from ship and routine ship operations. Tar balls have been reported frequently in the offshore water, and on the Makran coastal beaches extending from Gadani beaches on the east to Jiwani coast on the west. The density of the tar balls varies from place to place. Nevertheless, their densities are higher on the western part of Balochistan coast than on the eastern parts except Gadani Beach.

**(vi) Nutrients;**

A large quantity of nutrients are supplied to the coastal areas by Indus River, Hub River and seasonal rivers such as Malir River, Lyari River, Winder River, Porali River, Hingol River, Shadi Khor and Dasht River. There has been a drastic reduction in the load of nutrients brought by Indus River for the last fifty years. This reduction in Indus discharge has a negative impact on the Indus estuary and the productivity of the mangrove forest and fisheries. Nutrients from the urban wastes and land run-off also reach the coastal waters, however the sewage from the urban wastes bring a sizable amount of nutrients from Karachi City.

The Karachi Harbour, Gizri Creek, and Korangi Creek receive large quantities of nutrients as part of the liquid waste and garbage being disposed of in these creeks. Gharo Creek also receives high nutrient loadings. Nutrients are essential for maintaining good water quality. Higher concentrations of nutrients, however, result in overproduction and utilization of dissolved oxygen in the seawater. This leads to anoxic conditions and eutrophication. Anoxic conditions prevail in about 40 per cent of the bottom areas of Karachi Harbour and about 60 per cent of the Gizri Creek areas (Rizvi et el 1999). Eutrophication is conspicuous in the middle and lower parts of Gizri Creek. Phytoplankton blooms are common in Korangi/Gizri Creeks, and in coastal waters adjacent to Clifton beach, (*Asterionella japonica* bloom), and dinoflagellates bloom in the waters of Sandspit Beach, and Hawkesbay.

**(vii) Litter;**

The litter waste generated by the coastal areas can be grouped into two main classes i.e. urban solid wastes and rural solid wastes. The urban solid wastes are mostly from Karachi city. The typical composition of solid waste from Karachi is given below:

| | |
|---|---|
| Paper | 3.6% |
| Plastics | 2.1% |
| Rags | 7.1% |
| Metal | 0.2% |
| Glass pieces | 2.5% |
| Fine pieces | 18.2% |
| Compostable matter | 52% |
| Moisture | 43.1% |

The contaminants and the solid wastes are from the plastics, chemicals, and hazardous wastes and non-biodegradable compounds. In addition it is also a source of contamination of infectious and communicable diseases. The wastes from rural areas composed of paper, plastics and biodegradable materials with a small percentage of non-biodegradable matter.

**(c) Physical alteration, including habitat modification and destruction in areas of concern;**

Habitat Modifications in the Indus Delta caused due to damming the Indus River:

The Indus River has been dammed upstream at several places for the purposes of providing water for agriculture and power generation. Downstream Indus in the Indus deltaic region, very little freshwater is available to the coastal vegetation and the mangroves. According to an estimate there is need a minimum of 15 (10 to 20) Million acre feet (MAF) of water to support the growth of mangrove vegetation and the mangrove system as a whole. The requirement of about 10 MAF water is met during the Southwest Monsoon period (June to August). During the dry periods, the coastal Indus Deltaic region has higher water salinity (approx. 30-33 ppt). There is also a shift in the diversity of faunal and floral assemblages from estuarine to the hyper-saline types. The common example is that of a migratory fish (Palla: *Hilsa ilisha*) that was once an abundant fish migrating upstream, prior to damming of the Indus.

Similarly, reduced freshwater from Indus has also increased seawater intrusion inland making the coastal land too saline for traditional agricultural crops i.e. red rice that was once grown at Keti Bundar can no longer be supported by higher salt contents in the soil.

Development of ports, harbours, marinas including power plants and coastal installations:

There has been considerable physical alteration of the coastal and marine environment due to the construction of ports and harbours and other coastal installations. The dredging activities for the navigational channels of Port Qasim and Karachi Port have changed the hydraulic regime, water circulation and water exchange patterns in the affected areas within the port and in the adjacent coastal area under their influence. The power plants and the steel mill along the coast have also changed the coastal environment around them. In addition to the physical change and circulation of water these power plants and coastal industry also use large quantity of seawater for cooling and discharge the same back to the sea. This not only contributes the heavy pollution from the leaching of heavy metals, and discharge of antirust and anti fouling chemicals, it also raises the temperature of the adjacent body of the coastal water by 3–7 degree C. The entrapment and entrainment of plankton in large quantities in the cooling system exposed to thermal shocks produce the negative impacts on the recruitment of marine organisms and chlorophyll production. It is estimated that about 20 million cubic meter of water per day is sucked in the power plants which appears to be a major concern for the environmental conservation.

Land Reclamation by dredging and filling by the dredge spoils*:*

Land reclamation seaward has been restricted to coastal urban cities. The Karachi Metropolitan has acquired approximately 4000 ha of unplanned reclamation for urban housing scheme along the coast of Clifton. An additional 3000 acres of land reclamation are planned by a housing society. Much of the land filled sediment is obtained by dredging nearby sediments from the coastal area. The damaged material from the coast alters the near shore bathymetry that in turn disturbs the hydraulic regime resulting in increased rates of coastal sediment erosion or accretion through energy waves during Southwest Monsoon pound coastal defenses/seawall, that results in the seawater spillover on the land side affecting the coastal private and public properties. Contaminants get re-suspension during the activities of lifting sand and silt and its deposition at other sites. In addition it also smothers the benthic marine organisms.

Construction of Tidal Link Drain, LBOD in the Indus Delta:

The coastal wetland including dhands (natural land depressions with water), mud flats and adjacent area in the south eastern part of Indus Delta have been long been used as a natural drainage passage for the run-off from the land, flood waters, agriculture waste waters and seepage from agriculture lands. The final drainage reaches Rann of Kutch which has been acting as a natural drainage basin. Dhands of the Indus Delta have long been used as a natural drainage passage for the run-off from the land, flood waters from lower Sindh area to Rann of Kutch through Shakoor Dhand, Sanhro Dhand, Mehro Dhand and Cholri Dhands. The area has also been used as a natural drainage basin for the drain waters from agriculture waste waters and seepage from agriculture lands. These dhands receive water from Kotri Command area drains and from the land run-off from the lower Sindh area. The size and water volumes in these dhands vary according to the season and availability of drainage water and temperatures of air and humidity. The area receives drain the water from lower Sindh area through Shakoor Dhand, Sanhro Dhand, Mehro Dhand and Cholri Dhands. The size and water volumes in these dhands vary according to the season and availability of drainage water and temperatures of air and humidity (Rizvi, et al, 1998).

The alignment of the Tidal Link Drain of LBOD, constructed in 1995, passes through Pateji and Cholri Dhands and have blocked the existing natural flow of excess water / drainage from Cholri Dhand to Rann of Kutch. This situation has increased the influence of seawater in Dhands and hence increase their water salinity. A marked increase in seawater influence in the Tidal Link Drain and in KPOD may also hinder the smooth drainage of agriculture saline water from LBOD to the Arabian Sea. In order to provide an alternative drainage to excess water from these Dhands a man made structure - Cholri Weir (600 m long) has been constructed. The Cholri Weir is designed to allow excess water from dhands to the Arabian Sea via Tidal Link Drain for drainage. However, there is a risk of increasing the influence of seawater in Dhand areas through seawater flooding during High Tides through the Tidal Link Drain (Rizvi, et al, 1999b). The Dhands have a different rates of water exchanges between them through wind induced, thermo-haline circulation which is also influenced by the input of discharges from drains and run-off.

They also exhibit marked seasonal variations in their size of water filled areas: they shrink in dry season and expand during the wet season (Rizvi, et al, 1998).

There have been some morphological changes since the commissioning of the Tidal Link drain of the LBOD in 1995. These changes include changes in the shapes and courses of creeks. Some new creeks have developed and some older creeks have been reduced or disappeared. Similarly, a new creek is seen developing towards the Tidal link Drain. It seems that drain waters from the Tidal Link Drain would create a zone of slightly less saline waters in the Sir Creek area while the area of Rann of Kutch adjacent to Tidal Link Drain would become more saline. This slight change would further promote respective depositional and erosion tendencies in affected areas.

**(d) Sources of degradation**:

**(i) Point sources (coastal and upstream), such as:**

**a. Waste-water treatment facilities:**

Sewage Treatment Facilities*:*

There are very limited facilities for the coastal towns and cities of Pakistan with respect to sewage treatment and its disposal. For the most part the coastal areas of Pakistan are sparsely inhabited except for Karachi City and a few smaller coastal towns. The main industrial activity along the coast is concentrated mostly along the coast of Karachi in Sindh and extend to the adjacent coasts of Hub and Gadani in southern Balochistan.

The coastal towns other than Karachi do not have any sewerage system and hence use the storm water drains adjacent to rivers and creeks for disposal of untreated liquid domestic and urban wastes (sewage). This type of sewage disposal is practiced in Jiwani, Gwadar, Pasni, Ormara, Hub and Gadani on Balochistan coast. Similar arrangements are in place at coastal towns of Sindh such as Mirpur Sakro, Keti Bandar, Shah Bandar, Jati and Badin. In addition to the storm water drains the coastal towns of Jati and Badin also use manmade drains leading to the creek through LBOD. The plans for sewage disposal and existing system of sewerage in Karachi are described below:

Karachi being the largest populated city of Pakistan (population is about 13 million) generates more than 200 millions gallons / day of domestic wastes, which is discharged through the sewerage system, nallah, and streams in to Lyari River, Boat Basin draining to the Karachi Harbour, and in to Malir River draining to Gizri Creek. There are several nullahs and storm water drains which discharge directly to the adjacent coastal waters along west coast and to the Korangi Creek, Gharo Creek along the east coast. All the liquid wastes finally enters in to the coastal waters of Karachi (Rizvi, 1993; Ahmad,1999).

The domestic waste waters / sewage are discharged into the two seasonal rivers: Lyari River and Malir River, which act as main open sewers for the liquid waste disposal from the city. The Lyari and Malir Rivers are thus contributing about 59% and 25% of the total

pollution load of the Karachi City respectively, while 15% of the pollution load is directly discharged into the adjacent open sea coast or to the Gizri, Korangi and Gharo Creeks (Rizvi et al, 1997; SACEP, 1998; KWSB, 1999).

The Lyari River discharges highly contaminated mixture of sewage from north and west of Karachi city and industrial waste waters from SITE and Industrial area of North Karachi and F.B. Area. In addition, Several nullahs and streams carrying domestic sewage and industrial effluent also discharge directly to Karachi Harbour backwaters, Chinna Creek (Boat Basin), Gizri Creek, and open sea coast at Clifton. The Chinna Creek receives two big sewers and seven smaller sewers carrying raw sewage and untreated urban wastes. The Chinna Creek - an enclosed water body, is connected to the Manora Channel, Karachi Harbour. The open coastline between Manora Channel and mouth of Korangi Creek receives untreated domestic waste from 3-5 small sewers from Defense Housing area and Clifton.

The effluent from south and south-east of Karachi City such as Landhi and Korangi Industrial area find their way to the Malir River through sewerage system Sewage Treatment Plant No.2 (20 MGD Capacity), and storm drains leading to Gizri Creek and Korangi Creeks. The Malir River carrying the sewage and industrial waste drains into Gizri Creek and Korangi Creek. In addition there are several nullahs and streams which carry un-treated domestic and urban sources which discharge directly to Gizri Creek, Korangi Creek and Gharo Creek.

The city has an inadequate capacity (about 20% only) for the sewage treatment being generated in Karachi. There is no sewage treatment facility in any other coastal town in Pakistan. The sewage treatment capacities of the two existing sewage treatment plants in Karachi are up to 40 millions gallons / day (20 million gallons / day each). Therefore, more them 80% of the sewage is flowing to the Karachi coastal waters untreated (Rizvi, 1993). The data is showing high BOD values and high amount of suspended solids.

The Lyari River exports major load of pollution into the Karachi Harbour from SITE area into the upper reaches of the Harbour, the harbour also receives oil, inorganic, and organic pollutants from various sources including heavy shipping traffic, fishing trawlers, fishing boats, coastal installations including Karachi Shipyard and Engineering Works, chemical and pharmaceutical industries located at West wharf, Mauripur, Sher-shah and Baba & Bhit Islands. Likewise the Chinna Creek, backwaters of Karachi Harbour and the adjacent Boat Basin area receives bulk of the untreated domestic and oil pollutants.

The other coastal areas having industrial pollution problems are Hub Coast through Hub Industrial Estate and Gadani Coast through industries based in Gadani area. The rest of the coastal areas of Pakistan are mostly free of industrial pollution (Rizvi et al, 1997).

Karachi water supply and sewerage infrastructure is a mixture of both old and some recent investments, it is generally inadequate to meet the current urban needs since its development has not kept pace with the city's growth. In addition, much of the existing infrastructure is poorly maintained and therefore does not operate efficiently. With some

success, notable efforts have been made by the Government of Sindh, with the support of multilateral lending agencies, to improve the technical and commercial position of KWSB. Despite this, water and sewerage services in Karachi remain limited, and given the commercial prominence of Karachi in Pakistan, compare poorly in many respects with major cities in South and East Asia.

Industrial waste water Treatment:

Karachi City, has an estimated 6,000 small and large industrial units. The other coastal areas having industrial pollution problems are Hub Coast through Hub Industrial Estate and Gadani Coast through industries based in Gadani area. The rest of the coastal area of Pakistan is mostly free of pollution.

The industrial waste waters and sewage are discharged in to the tow seasonal rivers: Lyari River and Malir River, which act as main open sewers for the liquid waste disposal from the city. The Lyari and Malir Rivers are thus contributing about 59% and 25% of the total pollution load of the Karachi City respectively, while 15% of the pollution load is directly discharged into the adjacent open sea coast or to the Gizri, Korangi and Gharo Creeks (Rizvi et al, 1997; ESCAP, 1996; KWSB, 1999).

**b. Industrial facilities;**

The pollution problems have arisen due mainly to the indiscriminate discharge of effluent from industrial and agricultural sources and disposal of untreated liquid and solid wastes generated from domestic sources into the coastal environment. In addition, the coastal development activities involving man made alterations of the coastal environment have also accelerated the impacts of pollution leading to the deterioration of coastal environmental quality, depletion of coastal resources, public health risks and loss of biodiversity. The main industrial activity along the coast is concentrated mostly along the coast of Karachi in Sindh and extend to the adjacent coasts of Hub and Gadani in southern Balochistan.

Sources of Industrial Pollution*:*

Karachi has about 8000 small and large industrial units. This can be grouped in to different industrial zones . These include Sindh Industrial Trading Estate (SITE) in the North, Landhi Industrial Trading Estate (LITE) in the East; Korangi Industrial Area (KIA) in the South; and the Hub Trading Estate (HITE) between Karachi and Gadani in the west, along Balochistan Coast close to Karachi. Steel mill complex in the East and south-east constitute a separate industrial entity in the region. The socio-economic activities of these industrial zones are summarized as follows.

*(a) Sindh Industrial Trading Estates (SITE):* SITE situated north of Karachi, represents the largest industrial area of Karachi which has about 5000 registered industrial units and several thousands cottage industries that are not registered (Rizvi et al, 1999). Major industries causing pollution in the area include textile, chemical, detergent, iron and steel, sulphur refining, paints and dyes, pharmaceutical, plastic, metallurgical and engineering,

vegetable oils, food and beverage, automobile, cement, oil and lubricant industries and a number of tanneries. Effluent discharged from these industries find their way through nallah and streams into Lyari River and eventually via Karachi Harbour to the sea. Almost all the effluent discharged into the public sewer or in the natural environment from the industries located within SITE are untreated.

*(b) Landhi Industrial Trading Estate (LITE) and Korangi Industrial Area (KIA):* LITE and KIA are located along the southeast of Karachi Harbour with the following major group of industries, textile, metallurgical, auto-engineering works, machine tool factory, power plants, oil refineries, tanneries, chemicals and Sindh Alkalis, pharmaceutical, food and beverages, tanneries, cotton industry, poultry farms, cattle yards, slaughter house and a large number of cottage industries. The industrial wastes from these sources contain large amount of toxic and nontoxic materials which ultimately reaches sea, without any treatment, through nullah and streams draining into the Malir River and Gizri Creek as well as through storm water drains.

*(c) Steel Mill Complex and Port Qasim Area:* Pakistan Steel Mill Complex located in proximity to Port Qasim has developed an elaborate treatment plant for waste generated. The waste material is also discharged into the waste seawater cooling waters. However, the major source of pollution from Steel Mill include the waste from iron ore treatment, PCBs, about 200 Million gallons/day of heated seawater, heavy metals such as Fe, Cu, Zn, Co, etc. leaching in to the adjacent Bakran Creek (Rizvi, et al, 1988).

Port Qasim is located at the Gharo creek about 23.5 km landward from the mouth of Phitti Creek on the open sea coast. The area is mostly occupied by port operations, shipping traffic, steel industries and power plants. The port activities at iron ore and coal terminal, ballast water discharged from ships and other land based activities including organic matter and nutrients from spilt iron and fertilizer generate pollution, mostly untreated, which is discharged into the Gharo Creek.

*(d) Karachi Harbour and West Wharf Area:* Lyari River transports the major pollution load to the Karachi Harbour. However, the harbour also directly receives oil, inorganic, and organic pollutants from various sources including heavy shipping traffic, fishing industry , power plant, fishing trawlers and mechanised boats, coastal installations including Karachi Shipyard and Engineering Works, chemical and pharmaceutical industries located at West wharf and Mauripur area.

The ship breaking industry at Gadani has been a prominent source of pollution because of the booming business of ship-breaking along the coast of Gadani particularly during 1970s. The business has reduced considerably since then and now only a few ships are handled /per month. This industry has been the biggest source of heavy metal pollution in the area. In addition, waste oils, bilge oils, and other waste products are also discharged directly into the inter-tidal area on the beach at the sea front.

Out of six major industrial complexes in Karachi, three are situated within city (SITE, North, West Wharf Area, Industries in the North of Karachi), and three (KIA, LITE and

the Steel Mill) are situated in proximity to the Indus Delta creeks. The KIA is principally located adjacent to the Korangi creek and part of Kadiro creek, whereas LITE is situated close to Kadiro and part of Gharo creeks and Port Qasim. The Steel Mill Complex is located on the Gharo Creek. Thus, the entire Korangi / Phitti , Kadiro and Gharo Creeks form an inter-related system of creeks, receiving bulk of the domestic and industrial wastes from the major sources of pollution in the South-east of Karachi (Rizvi, et al, 1999). In contrast to this, the effluent being discharged from HITE (situated west of Karachi) through Hub River directly to the Arabian Sea; and from SITE (situated in North and North-west within Karachi) the effluents are discharged to the Sea through Karachi Harbour via Lyari River; the effluents from KIA and LITE are discharged to the sea through Gizri Creek, Korangi Creek, Kadiro Creek and Gharo Creek / Phitti Creek.

In addition to the domestic and industrial waste disposal there are some other equally important sources of pollution in the coastal waters. These include maintenance dredging of the navigational channels of the ports and harbours and land reclamation practices along the coast that also carry out dredging of the near-shore areas for providing landfill material. Dredging loosens and re-suspends the settled fraction of silt and sand to produce very high load of suspended solids in the coastal area under the influence of mixing processes. Dredging also disturbs the hydrogen sulfide-laden upper layers of sediments forcibly mixing and dissolving hydrogen sulfide toxic substances in seawater.

**c. Power plants;**

A number of industries discharge their heated effluent in to the adjacent coastal environment which is source of thermal pollution. Amongst these the power plants and the steel mills are prominent. All coastal power plants along the coast of Pakistan draw in their cooling systems a large quantity of sea water directly from the adjacent sea and discharge their heated effluent into the adjacent coastal waters.

There are five coastal power plants in Karachi: i)Karachi Nuclear Power Plant at Paradise Point; ii)Thermal Power Stations of KESC (Karachi Electric Supply Corporation) located at West Wharf, iii) KESC Power Station at Ibrahim Hyderi (Korangi Creek), iv) KESC Power plants at Bin Qasim (Gharo Creek) and v) Power Plant at Pakistan Steel Mills. These sources discharge large quantities of heated water into the adjacent coastal environment each day. It is estimated that the three power plants, Pakistan Steel Mills, and Sindh Alkalies together discharge about 1,354 million m3 per year of heated effluent / waste waters with an average Delta T of 9.62 degree C from their cooling system in the Korangi Gharo Creek system (IUCN, 1987a). The temperatures of the heated effluent on the Karachi Coast, on the average, are about 3 to10 degree C higher than the ambient temperatures. Pakistan Steel is discharging a huge quantity (960 million m2/day) of cooling water with Temperature of about (3 to 7 degree C DeltaT) along with its other waste waters / effluent into the adjacent Bakran & Gharo Creek (Rizvi, et al, 1986,1988).

The considerably large quantities of the heated effluent are a source of fatal thermal shock to marine organisms, eggs and larvae of a number of marine Organisms and small zooplankton phyto-plankton and thereby affecting the ecosystem. The continuous discharge of heated effluent may raise the temperatures of the seawater of the area upto 7

degree C above the ambient in the vicinity of the discharge point and upto a few degrees (0.5 – 3 degree C) in the heated plume area adjacent to the out-fall of the power plants (Moazzam and Rizvi, 1980).

**d. Construction works (e.g., dams, coastal structures, harbour works and urban expansion);**

Impact of dams on Indus Deltaic Resource (Management, Fisheries, Marine Fauna and Flora, Estuarine Ecosystem):

Reduced flow of water downstream and silt from Indus River has an impact on the Indus Estuary and on Indus Delta Mangrove Ecosystem that is dependent on the annual supply of water and silt load. Most important cause of environmental degradation of Indus Delta is the reduction in volume of Indus discharge due to construction of dams and barrages up-country. Main impacts of reduced discharge include the following:

- Reduced estuarine conditions due to reduced flow of water & silt from Indus River;
- Increased Seawater intrusion in Indus Delta and salt water intrusion in adjacent lands;
- Meandering and erosion of creeks;
- Disappearance of estuarine fauna and flora from the major parts of Indus Delta;
- The mangrove cover in Indus Delta has reduced from estimated 43.3% to 23.8% during a span of 22 years from 1966 to 1998;
- Freshwater discharge reduced from 150 MAF before 1947 to 35 MAF in 1992 and to 10 MAF during 1992-98. Similarly, silt deposition decreased from 400 million tons to 100 million tons in 1992 and to 35 million tons during 1992-98.

The estimated and actual supply of freshwater flow and silt and mangrove cover changes in Indus Delta are given below:

| **Factors 1947-98** | **Estimated Before 1947** | **Actual 1977-1992** | **Estimated 1992-98** | **Difference 1947-1998** |
|---|---|---|---|---|
| Fresh water flow | 150 MAF | 35 MAF | 10 MAF | (-) 140 |
| Silt deposition | 400 million tons | 100 m. tons | 35 m. tons | (-) 365 |
| Mangrove cover (% of Tidal Delta area) | 43.3% | 23.8% | 18 - 22 % | (-) 23.3 |

Modified from Keerio & Bhatti, 1999, Irrigation Department's report & satellite imagery; Qureshi, 1999.

Accordingly the average water flows in Indus River below Kotri has been 35 MAF of which about 10 MAF reaches the mangrove forest. The reduction of freshwater flow, silt and nutrient availability result in low productivity, salt water intrusion and changes in the geomorphology of the Indus Delta.

**e. Habitat modification (e.g., dredging, filling of wetlands or clearing of mangrove areas);**

Dredging activities are being undertaken along the Sindh and Balochistan coast for land reclamation, maintenance dredging of navigational channel of ports and harbours and for planned ports along the Balochistan coast at Gwadar. The impact of dredging and habitat modification would be on the benthic fauna and flora, resuspension of settled pollutants

on the sea bottom together with high sediment suspension that includes high turbidity, which in turn reduces light penetration thereby reducing primary (phytoplankton) products. Suspended five sediments also clog gills of filter feeds and pelagic fish caused mortality. Sessile benthic organisms and interstitial benthic fauna also become smothered by disturbed sediments.

Degradation of mangrove habitats through overexploitation by coastal inhabitants for fuel/firewood and fodder has resulted in a reduced faunal assemblages such as barnacles, tunicates, etc. Thereby reducing biodiversity. Qureshi (1993) reported 16,000 camel and 11,000 cattle head graze on mangrove. Accordingly, the total exploitation of mangrove in the Indus Delta is 18,000 tons/year (Meynell, 1993).

**(ii) Non-point (diffuse) sources (coastal and upstream), such as**:

**a. Urban run-off;**

The urban run-off from the coast of Pakistan is significant only in case of Karachi coast. However, the run-off from the city is limited due to low average rainfall (280 mm/year). The run-off from the other parts of Sindh coast are also negligible. However, the run-off is restricted during the rainy season (July-Sept) when this reaches the coastline and brings along a number of pollutants from the up-country.

Most of the coastline of Balochistan is un-inhabited. The entire population of the coastal area of Balochistan is less than 0.4 million spread over a number of fishing settlements/ villages and a few small towns. The prominent towns are Jiwani, Gwadar, Pasni, Ormara, Damb and Gadani. There is no sewerage system and the storm water drains are used for drainage. Drinking water is scarce. There are small units of power plant each at Pasni, Ormara, Gwadar and Jiwani which operate only intermittently to supply powers for few hours a day.

As most part of the coast of Balochistan province is un-inhabited hence it is not polluted by domestic waste / Sewage. The few small coastal towns and several very small fishing villages along Balochistan Coast dispose off their domestic wastes in to the near by nullah or storm water drains or in the adjacent seasonal rivers. Because of the disposal of very limited and smaller quantities of domestic wastes their quick dispersal the pollution problems are un-noticeable.

**b. Agricultural run-off**;

The agriculture run off in the coastal areas is mostly from the agriculture lands around Indus Delta. The run-off is limited due to low rainfall. However, during the rainy season the floods bring a lot of nutrients and sediments from agriculture lands to the coastal area. It also brings considerable quantities of the residues of pesticides, insecticides and fertilizers.

**c. Erosion as a result of physical modification of coastal features;**

*(i) Coastal erosion:* The coastal erosion is prominent along most of the sandy beaches

which are almost flat and having a low beach angle (slope) and are eroded by south-west monsoon waves. These include a number of sandy beaches along Sindh and Balochistan Coasts. Some of these are located along Manora, Sandspit, Hawkesbay, Paradise Point beaches along Karachi Coast and Gwadar, Pasni, Gadani beaches along Balochistan Coast. The sandy narrow neck of the Isthmus joining the headland and mainland at Gwadar is subjected to erosion and overtopping of waves across east and west bay in stormy south-west monsoon season. Pasni shoreline at and south of Ras Jaddi has erosion tendency between it and Jabl-e-Zarin. This tendency has now been altered due to construction of a fish harbour. Protection measures have been taken through stone pitching at Gadani. Proper engineering works such as groynes, should be constructed to protect beaches from excessive erosion.

The mean sea level (MSL) along the coast at Pasni is about 1.4 m from the chart datum. The MSL is slowly but gradually rising at a rate of about 1.1 mm/year. Sea level rise has been observed all over the world due to climate change/global warming. Although a small sea level rise may be compensated by tectonic uplift rate of the Balochistan coastline estimated at 1-2 mm/year at Ormara. However low lying areas at Gwadar, Gadani may have an impact, the headland at Gwadar may be cut off. This may adversely affect the deep sea harbour being planned there. At Gadani the people can migrate further inland as the sea gradually advances to higher ground. The other possible impact of sea level rise would be on the coastal industry. Even a modest rise in the sea level will threaten storm barriers and salinize fresh water reservoirs along the coastal belt.

*(ii) Flash Floods:* Frequent flash flooding as a result of torrential rains in Balochistan / Makran division during the SW monsoon period cause heavy losses to both human and their property. At least 250 persons including women and children in 107 villages were swept away and 25,000 people were rendered homeless, by flash flood in March, 1998 (Dawn, 5 March, 98). The most affected areas are Turbat where several villages including Jutani Jo, Spin Bazar, Aliabad, Tezang, Rekni Beet, Aabenar, Marriabad and Absar were badly effected by the flash floods. Ground lines between Turbat and the rest of the country were severely damaged and most of the telecommunication system in the area was also badly affected. The only refuge people could find to save themselves were tree tops and high grounds (hills etc.). Flash floods also washed away the top fertile soil. It also disabled the irrigation system, affecting agricultural land near Dasht, Nihing and Kech Rivers.

### (iii) Atmospheric deposition caused by:

#### a. Transportation (e.g., vehicle emissions);

The total number of all types of motorized vehicles on the road in the megacity of Karachi is estimated to be 930,000 (Ghauri et al 1999). This figure is 30% of the overall vehicular transportation in the country. Lead (Pb) has long been recognised as a neurotoxin. The main sources of human exposure to lead is leaded gasoline. Vehicular traffic is the largest source of environmental lead-pollution in most urban areas up to 10% of lead in gasoline is released with auto-exhausts and it is estimated that half of the lead emitted from vehicle settles out of the air within 100m of the roadway, leaving the finer

particles to disappear throughout the atmosphere (US EPA Report 1983). The automobile lead concentration emitted into the atmosphere is between 2 to 7(g/m3 with maximum value of 16 (g/m3 in areas of heavy traffic in Karachi (Ghauri et al 1999). Besides posing an immediate risk to health through inhalation, vehicular lead-emission also accumulate in the soil and enter the food web contributing to exposure through ingestion for longer period of time. High blood lead levels have been detected in urban cities where gasoline with high lead contents is widely used. Other vehicular emission identified were carbon mono-oxide (9-10 ppm), CO2 (370 ppm), NO3 compounds derived from the combustion of petrol / diesel were 0.3 – 0.5 ppm.

**b. Power plants and industrial facilities;**

Several large and small plants/industrial units are located in the coastal city of Karachi. The atmospheric pollution survey was carried out by Ghauri et al 1994 of SUPARCO (Table 5). They have concluded that from an air pollution stand point the internal combustion engine has been blamed from most of the pollutant in urban areas. Man-made emission mostly from combustion of fossil fuel contains SO2. Coal combustion accounts for approximately almost all sulfur emission around Pakistan Steel Mills, where according to an estimate 13,600,00 ton of coal is imported to produce coke. This coal contains about 2-3% of SO by with. Airborne SO4 and Selenium (Se) has been observed in the steel manufacturing plant (Pipri)) and Nooriabad. Total Suspended Particulate (TSP) measured by SUPARCO shows a range between 230-260 (grams / m3 per day. Other atmospheric particles identified were Na, Al, Mn, Fe, Br, Sb, Pb, V and Ni (Table 6). Since industrial emission are likely to increase over the coming decades, it is anticipated that as a spin off episodes of fog over the industrialized zones will increase in the future under persistent dry conditions.

**Table-5 EXPECTED AIR POLLUTION LOADS FROM INDUSTRIAL AND MUNICIPAL SOURCES**
**(Source: Ghauri et al, 1994; SUPARCO)**

| Industry | Products ($10^3$ units p.a.) | Particulates (Kg/unit t.p.a.) | | $SO_2$ (Kg/unit t.p.a.) | | $NO_2$ (Kg/unit t.p.a.) | | CO (Kg/unit t.p.a.) | |
|---|---|---|---|---|---|---|---|---|---|
| Food | 2488 | 2.5 | 5971.2 | | | | | | |
| Textiles (fiber processing) | 33 | 14 | 462 | | | | | | |
| Paper mail | 1.5 | 10 | 15 | | | | | | |
| Industrial chemicals | 46 | 10.4 | 478.4 | 5 | 8 | | | 128.5 | 154.67 |
| (Sodium carbonate, rubber, Polyester fiber, printing ink) | | | | | | | | | |
| Polyethane | 0.116 | | | | | | | | |
| Resin | 4.5 | 17 | 76.5 | | | | | 120 | 13.92 |
| Ultramarine bleu | 1.625 | 100 | 162 | 5 | 8 | | | 3.5 | 15.75 |
| Refineries | 4500 | 3000 | | | | | | 1.54 | 94578 |
| Product Desulphurisation | | | | | | | | | |
| Crude storage | 160 | 2.3 | 368 | | | | | 0.8 | 128 |
| Product storage | | | | | | | | | |
| Glass and ceramics | 40.6 | 131 | 5318.6 | | | | | | |
| Metals | | | | | | | | | |
| Steel mill fugitives | | | | | | | | | |
| Metallurgical | | | | | | | | | |
| Coke oven | 515 | 1.75 | 901 | 2.01 | 1035 | 0.02 | 10.3 | 2.1 | 1081 |
| Sinter plant | 756 | 0.05 | 37 | | | | | | |
| Blast furnace | 183 | 4.1 | 750 | | | | | | |
| Steel converter | 179 | 25.5 | 4564 | | | | | | |
| Billet mill | 175 | 8.5 | 1487 | | | | | | |
| Battery manufacture | 0.057 | 65 | 3.7 | 43 | 2.45 | | | | |
| Waste disposal | 358 | 8 | 2864 | 0.5 | 179 | 3 | 1074 | 13 | 5370 |
| Open burning of municipal Waste | | | | | | | | | |
| Total | | | 23458.4 | | 1232.45 | | 1084.3 | | 16221.3 |

t.p.a. = tons per annum ;
p.a. = per annum.

**TABLE - 6. MEAN CONCENTRATIONS IN SIZE-FRACTIONED SAMPLES COLLECTED DURING 1987**

| Specie | SPARCENT (SPR) | | Sonmiani | | Pakistan Steel | | S.I.T.E. (SITE) | |
|---|---|---|---|---|---|---|---|---|
| | Total Conc. | Conc. (comp<2$\mu$) | Total Conc. | Conc. (comp<2$\mu$) | Total conc. | Conc. (comp<2$\mu$) | Total conc. | Conc. (comp<2$\mu$) |
| Na | 990.00 | 426.00 | 4,593.00 | 211.00 | 1,315.00 | 611.00 | 1,279.00 | 609.00 |
| Al | 2,314.00 | 1,122.00 | 894.00 | 268.00 | 2,979.00 | 60.00 | 4,611.00 | 2,537.00 |
| Mn | 55.60 | 31.50 | 16.20 | 6.00 | 630.00 | 367.00 | 94.00 | 62.70 |
| Fe | 1,734.00 | 788.00 | 759.00 | 295.00 | 12,650.00 | 5,600.00 | 2,506.00 | 1,267.00 |
| Br | 32.10 | 25.90 | 8.30 | 5.70 | 28.20 | 22.40 | 20.60 | 17.30 |
| Sb | 9.34 | 8.85 | - | - | 1.35 | 1.10 | 6.46 | 5.84 |
| Pb | 593.00 | 568.00 | 3.30 | 2.10 | 85.10 | 75.00 | 255.00 | 228.00 |
| V | 7.80 | 4.50 | - | - | 21.40 | 15.30 | 5.80 | 3.80 |
| Ni | 6.20 | 4.00 | 3.40 | 2.10 | 10.60 | 7.30 | 8.50 | 5.40 |

Concentration in ng/$m^3$

Source: Ghauri et al, 1994, SUPARCO.

**c. Incinerators;**

The coastal city of Karachi having a population of 13 million people generates a total of 600 tones of solid hazardous wastes per day. This includes waste from industrial units and hospitals (ESCAP 1995). The National Environmental Quality Standards (NEQS) are now in place (1998) on control and regularity mechanism and emissions.These regulations are not enforced effectively resulting in an atmospheric pollutants by different kinds of hazardous particles Burning of solid and liquid hazardous waste is another major source of air pollution The emphasis world over is on high temperature incineration to ensure complete destruction of hazardous waste. The Karachi Metropolitan Corporation (KMC) has recently installed two Incinerator plants (each capacity: 1,000 kg/hour for a maximum of 10 hours per 24 hours) for the disposal of Hospital wastes and are planned to cover the entire hospitals of Karachi in two phases. During the first phase the incinerator facility is available to five hospitals of KMC, one Sindh Government Hospital, Korangi and two private hospitals which generate a solid wastes of about 1250 kg to 1700 kg per day (Biosphere – 1999). The Karachi Metropolitan Corporation (KMC) has plans to install more incinerators to cope with the situation depending upon the availability of funds. Currently, the hazardous city waste is burnt in open land-filled areas that produce toxic fumes in the urban cities. From public health point of view it is essential to conduct a scientific studies to evaluate the chemical composition of particulate as aerosols in relation to episodes of epidemiological diseases.

**d. Agricultural operations;**

There is very little agriculture activity in the coastal areas. However, areas adjacent to the Sindh coast produce large quantities of rice and other agriculture produce. Some of the agriculture crops produce methane (a green house gas), Carbon Dioxide and a fraction of the pesticides and insecticides sprayed on them also find their way into the atmosphere. Thus there is a little contribution of coastal agriculture in the air pollution.

## (e) Areas of concern (what areas are affected or vulnerable):

Changing condition in coastal, terrestrial environments, Indus Deltaic and Hub Deltaic region associated with degradation of environmental quality and the health of coastal ecosystems threaten the survival of certain species and communities. The coastal domain is dramatically affected by changes in sea level, ground water level, salinity, wave pattern, current regimes, sediment budgets, storm events and erosion patterns. Physical changes themselves result in a wide variety of biological changes at the population, community and ecosystem level, which in turn affect the suitability of the coastal zone and its resource for use by human population.

### (i) Critical habitats, including coral reefs, wetlands, seagrass beds, coastal lagoons and mangrove forests;

Amongst the coastal ecological systems along the coast of Pakistan the most vulnerable to land based human activities include coastal waters of Karachi, Hub and Gadani, Mangrove forest, Estuaries, coastal wetlands, Coastal lagoon, Near-shore coastal areas

and very limited sea grass beds along Indus Estuary. There only a few coral beds off Cape Monze and at parts of Balochistan Coast, are most vulnerable to changes in water quality.

(a) Polluted Coastal areas:

*(i) Coastal waters of Karachi including Backwaters:* Coastal waters of Karachi particularly backwaters and near-shore waters along South-coast are most vulnerable to the impacts of land-based human activities. Backwaters play an important role in supporting coastal productivity and fisheries. The backwaters serve as sheltered habitats for a variety of coastal and marine organisms which use them as nursery and feeding grounds. These include mussels oysters and other filter feeders and many commercial species of shrimp and fish. The backwaters also serve as wave protected / sheltered habitats for adult shrimp and small pelagic fish during south-west monsoon. Backwaters also receive land run-off and sediments and hence provide basic ingredients for high primary productivity of the coastal waters. Backwater have large assimilative capacity to provide natural treatment to clean polluted waters and act as a buffers between polluted waters /contaminants and the adjacent clean coastal waters.

The backwater habitats of interest to the land-base activities from Karachi include Boat Basin / Chinna Creek, Lyari Backwaters, Sandspit Backwaters, Baba and Bhit Islands, Shamspir Island, Korangi Creek / Malir River Estuary and associated Backwaters. These are most vulnerable to the land based human activities including disposal of industrial and domestic wastes from Karachi. The open coastal waters along South-east, Karachi receive polluted waters from Karachi Harbour as well as from Korangi Creek and from several open sewers in the south of Karachi. The backwaters of Karachi and adjacent areas along open coast in the south receive about 262 to 300 MGD of raw sewage and untreated industrial waste waters from sewerage system and the drains discharging directly to the sea. As such these untreated waste waters and raw sewage constitute the major sources to produce severe pollution stresses. Most of these backwaters have considerable land area which acts as natural oxidation ponds and provide land treatment to the raw sewage and industrial wastes to some extent. The existing higher ambient temperatures (20 to 45 degrees C) and the natural treatment (oxidation ponds / land treatment) do provide some degree of treatment to the urban wastes. However, the present loading of these backwaters with municipal and industrial wastes has exhausted their assimilative capacities for quite some time and the additional loading is causing visible pollution impacts through poor aesthetic quality, anoxic conditions at the bottom, poor water quality and low productivity of coastal waters, poor health of coastal / marine organisms, reduced coastal fishery and on the health of the coastal communities.

*(ii) Coastal waters of Hub and Gadani:* The coastal areas of Hub and Gadani Coast are vulnerable to the industrial effluents emanating from the industries located in Hub coastal town and at Gadani. Hub industrial effluents are discharged mostly through Hub River to the coast while Ship breaking industries dispose their wastes directly to the adjacent coastal waters. The coastal area affected is part of Sonmiani Bay considered to be highly productive in terms of its production as observed through wild catch of fish and shrimp

from this area. The famous Jumbo Shrimp breed and grow in Sonmiani Bay and its adjacent Sonmiani Coastal Lagoon .

(b) Mangrove Forests:

The mangroves support a variety of invertebrate fauna dominated by crustaceans and provide food and habitat to a large number of larval and juvenile fish and shrimps. The mangroves in recent year have been categorized as critical habitats for a large number of invertebrate such as crustaceans, gastropods, bivalves, polycheate worms. Some fishes are permanent inhabitants of the mangrove ecosystem. Mangroves are economically significant, since they serve as an important natural breeding / nursery and feeding grounds for commercially important penaeid shrimps and fish larvae. In the absence of an alternative resource mangrove also serve the underprivileged inhabitants of coastal communities as a valuable source of timber, charcoal and fodder for domestic animals.

*Mangrove Forest along Sindh Coast:* The mangrove forests consisting mostly of the mangrove (*Avicinia marina)* occur in the Indus Delta along Sindh Coast on 617,470 hectares (Vistro, 1999), representing the sixth largest mangrove block worldwide. The Mangal at the inter-tidal areas south of Shah Samando Creek has sparse mangrove vegetation in some areas while dense mangrove vegetation in other areas towards sea along the Sir Creek. The dominant species is *Avicennia marina*. The tidal inundation is frequent with sediments below a few cm (i.e. 4-10 cm) are dark and anaerobic.

The climate of Indus Delta (Sindh Coast) is arid, high humudity, irregular and scanty rainfall (150-225 mm), monsoonal winds (12-13 km.hour), high temperatures in summer (35-45C) and solar radiation of 180-200 kcal cm-2 / year (Qureshi, 1990). Therefore, the mangrove forest of Indus Delta is dependent mostly on the Indus River Discharge for its survival and growth. The Indus Delta mangrove forest use to receive about 150 MAF of Indus River Discharge per year. The discharge has decreased considerably from 58.54 MAF (Million Acre Feet) during 1966-67 to 15.9 MAF during 1998. Mangrove cover in the Indus Delta has, therefore, reduced from 43.3 % in 1966 to 23.8 % in 1998 due mainly to the reduced supply of Indus Discharge in to mangrove forests after the construction of barrages and dams on Indus River upcountry (Keerio and Bhatti, 1999). The average Indus River Discharge below Kotri during 1966 to 1988 have been 34.8 MAF of which 20 MAF actually reached mangroves in the Indus Delta upcountry (Keerio and Bhatti, 1999).

The sea encroachment due to reduction of Indus Discharge as well as gradual increase in sealevel rise (1.1 mm / year , Source: NIO, Karachi) and associated increased coastal erosion are major factors for degradation of Indus Delta Mangrove forest. The other degradation factors include fodder harvesting for cattles (about 19.5 million kg of grasses and 67 million kg of leaves through browsing by about 6,000 camels, 32,000 buffaloes, 8,000 goats, sheep & cows) and wood harvesting (18,000 tons / year) by the coastal population of about 135,000 (Hoekstra, 1998) and there are 20,654 families in 162 coastal villages in Indus Delta (Shah, 1998). The discharge of industrial effluents particularly oily wastes is significant for the deterioration of water quality of the

mangrove forest areas close to Karachi. However, the discharge of sewage and organic wastes in to the coastal water bodies harbouring mangroves is beneficial for the growth of mangroves. The discharge from LBOD supplies low saline (10-20 ppt) water into the Inter-tidal environment with hyper-saline conditions (water salinity 35-50 ppt) (Rizvi, et al 1998, 1999b) which promote growth of mangroves. However, the mangrove cover has almost been absent in the coast area along Shah Samando Creek prior to the discharges from LBOD.

*Mangrove Forests along Balochistan Coast*: The mangrove forests along Balochistan Coast occur at three sites: Miani Hor, Kor Kalmat and Gwatar Bay, Jiwani. The area of mangrove cover in areas along Balochistan Coast are 7750 acre for Miani Hor, 5400 acres at Khor Kalamat and 5000 acres at Gwatar Bay, Jiwani (Mirza et al 1988). Mangrove cover in the Balochistan is reported to have decreased, threatening the survival of the natural resources and there by the livelihood of a large number of fisherman. Reference was made to the indiscriminate exploitation and its deterioration, which was attributed to changes in the environmental conditions in the coastal areas such as hyper-salinity, decreased alluvial flow, pollution, soil erosion, dredging and felling of mangroves. The average consumption of mangrove wood per head was estimated to be 7 Kg per day, with the estimated total consumption per year in the order of 20,000 tons. The impact of mangrove loss and its effect on associated marine community was discussed to evolve a management strategy to address the problem. A reforestation programme was developed under the auspices of IUCN / WWF to replant some of the indigenous species of mangrove such as *Rhizophora mucronata* as well as the most common *Avicinia marina*, working very closely with coastal communities to develop packages for encouraging local management and sustainable use of mangrove.

(c) Coastal wetlands:

In the South-eastern parts of Sindh province of Pakistan there is a belt of low lying lands between the agriculture lands and the inter-tidal delta of Indus River. The low lying areas cover more than 400 sq km area. The very low angle of beach slope has produced a very large inter-tidal mud flats extending about 30 to 40 km distance between low and high water marks. In addition there is a large and very prominent salt marsh called Rann of Kutch which is formed by the discharge of natural drainage for flood waters and waters from land run-off as well as from the discharge from Indus River before changing its last course. The area has very low rainfall (25 to 35 cm/year) with surrounding deserts, fluent discharge and monsoon wind pattern. The arid climate together with a moderate to high tidal range along the coast, produces inter-distributary evaporates and barren halite encrusted mud-flats in the adjacent Rann of Kutch. The substantial storm tides from southwest monsoon winds in summer inundate vast area of both the Indus Deltaic plains with salt water. Coastal wetlands in this part of Indus Delta are in the form of depressions or low lying lands called dhands. These are shallow and brackish / saltwater lakes located adjacent to coastal mud flats in the coastal areas south and south east of Badin. Most of these mud flats are without mangrove forest except the mud flats on the islands situated seaward.

The economy of the coastal area of Thatta and Badin relies on the resources and bounty of coastal wetlands, mangrove forests and on estuaries. When these natural resources are imperiled. So are the livelihoods of the coastal communities who live and work along the coast. As our population grows, the demands imposed on natural resources increase and protecting these resources for all natural, economic and aesthetic values becomes even more important. Some wetlands have already been lost but the remaining wetlands need good and effective conservation efforts to protect them.

(d) Coastal Lagoons:

There are two tidal lagoons namely Miani Hor at Sonmian Bay and Khor Kalmat located along Balochistan coast. The Miani Hor is a large lagoon and has a narrow and shallow connection with the open sea which restricts the water exchange. Two seasonal rivers fall into this lagoon and help in maintaining a good growth of mangrove forest and also support good fisheries particularly white jumbo prawns. Khor Kalmat is also a very important tidal lagoon which supports mangroves forest And also a variety of marine organisms which are endemic to Balochistan coast. The marine organisms at this lagoon enjoy a relatively clean environment except for some oil pollution from the open sea.

(e) Coral reef (coral beds):

There is a limited coral reef off Cape Monze, between Churna Island and Karachi coastline along Sindh Coast. Some part of the this coral reef is still surviving although most part is dead. The dead corals are commonly witnessed along the shores opposite to the coral bed. Very little information is available about this coral bed and its associated species. Occasional under water surveys have revealed that there are a few types of corals still surviving and appear to be most vulnerable to the changes in water quality. There is a huge power plant at Hub River Delta near the open coast opposite to the location of coral beds. It is posing a threat to the fragile ecosystem of coral reef and may lead to its total destruction in near future.

Parts of Balochistan coastal and offshore areas contain coral beds with associated communities although not widespread, they appear in patches at Astola Island and Gwadar, where a vast fossilized coral reef is present. Soft coral such as seafan (*Gorgonina* sp), brain coral is also present at west bank south of Astola Island. A variety of coelentrates and bryozoan colonies are also found in most parts of the Balochistan coast. Gwadar area is being excavated for construction material for various development projects and it is feared that the unique features of the Makran coast will be destroyed if the present scale of excavation continued.

**(ii) Habitats of endangered species;**

The impact of land based activities including pollution sources and environmental degradation processes have rendered a number of habitats unsuitable for the survival and growth of various sensitive species of coastal fauna and flora along polluted parts of Pakistan Coast. These include most parts of degraded Indus Delta, polluted beaches of

Karachi and Gadani Coasts.

There are several groups of marine species which have potential resources value or have special conservation interest are threatened by habitat loss and over exploitation. Vulnerable among these are five species of marine turtles, destruction of mangrove ecosystem, loss of fisheries and some species of marine invertebrates such as brachiopod (*Ligula sp*.), the lug worm (*Arenicola cristata*) and the lancelet (*Amphioxus sp*.)

The Green Turtles (*Chelonia mydas*) and Olive Ridley (*Lepidochley olivacea*) are two endangered species found along the Pakistan coast. Sandy stretches from Karachi (Sindh Coast) to Gadani and upto Jiwani (Balochistan Coast) are favorite nesting habitats of the marine turtles. Marine turtles spend, almost their entire life cycle out at sea, where they prey upon slow drifting marine organisms such as jelly fish or they scavenge on dead benthic animals. Adult and mature turtles mate in the open ocean. Female turtles need to come ashore to lay eggs this is accomplished by constructing a sand pit in the soft sediment close to the high water mark Mortality of turtles also occur due to the degradation of their natural marine environment due to pollution. One of the major threats to the turtle population in the Gadani area is the coastal and offshore oil pollution, organic and inorganic pollutants and possibly increased human activity as a result of industrialization in the coastal areas. This prompted the Sindh Wildlife Management to promulgate an ordinance in 1972, which declared marine turtles as protected species along the Pakistan coast ( 990 km). Both the green turtles and the Olive Ridley have been declared as endangered species by the International Union for Conservation of Nature and Natural Resources (IUCN). The Sindh Wildlife Management and the World Wildlife Fund for Nature (WWF) have initiated a protection and research program to conserve the turtles, their eggs and hatching at their habitats.

The impact of land based pollution sources and dredging activities have rendered a number of habitats unsuitable for the survival and growth of various sensitive species of coastal fauna and flora along Karachi Coast. The habitats of the Brachiopod *Lingula sp.* at the beaches of Korangi Creek and the lug worm *Arenicola sp*. at Clifton-Kemari beach tract (Moazzam and Rizvi, 1979), Baba and Bhit Islands, Manora Channel, Karachi Harbour have become unsuitable (Ahmed, 1999). The Manora Channel lagoon has become unsuitable for dolphins and they are not seen there any more because of increased levels of pollution. Similarly, the Indus Delta Creeks near Karachi have become unsuitable for the finless porpoise (*Neophocaena phocaenoides*) due to increased human activities (IUCN, 1993).

**Table-7. Threatened habitats for endangered species and species at risks along the coast of Pakistan.**

| S.No. | **Threatened Habitats** | **Fauna / Flora /Species at Risk of Disappearance** | **Endangered Species** |
|---|---|---|---|
| 1 | Karachi Open Coast: 1: Sandy beaches: Sandspit, Hawkesbay, Paradise Point; | Five species of Turtles, Star fishes and other echinoderms; | Turtles:(*Chelonia mydas, Lepodochelys olivacea)* |
| | Karachi Open Coast: 2: Clifton-Kaemari Coast | Due to eutrophication, oil pollution and sedimentation processes at this part of the coastline many fragile species have disapeared from this habitat:<br>1) lug worm *Arenicola cristata;*<br>2) Star fishes; | Lug worm *Arenicola cristata;* |
| 2 | Boat Basin area / Chinna Creek, Karachi | All bottom resident fauna except some Mollusks, mangrove and some epi-benthic seasonal seaweeds because of anoxic conditions at the bottom soils. | The entire Boat Basin area is unsuitable for a variety of marine and estuarine fauna. |
| 3 | Backwaters of Karachi Harbour | Most of the bottom resident fauna except some Mollusks, mangroves and some epi-benthic seasonal seaweeds because of anoxic conditions at the bottom soils. The following species / groups have disappeared:<br>1) lug worm *Arenicola sp; 2)* Sessile epi-benthic fauna and 3) Filter feeders | A considerable area (< 40 %) has become unsuitable for a variety of marine and<br>Estuarine benthic fauna |
| 4 | Indus Estuarine Areas | - Estuarine Fauna / Flora has gradually disappeared form most part of Indus Delta. The number of species reduced. The following are on the verge of disappearance:<br>- Oyster (*Crassostrea rivularis, Crassostrea species*);<br>- Bivalve (*Atrina sp;* Window pan oyster (Anomia sp.), *Pinna sp)* | Indus Blind Dolphin,<br>Indus Dolphin *(Sausa Plumbea)* |
| 5 | Gizri Creek | Upper and most of middle part of Gizri Creek with all bottom resident fauna except some Mollusks, some mangroves and some epi-benthic seasonal seaweeds because of anoxic conditions at the bottom soils. | A considerable area (< 50 %) has become unsuitable for a variety of marine and<br>Estuarine benthic fauna. |
| 6 | Korangi Creek | Parts of Korangi Creek Beach near Ibrahim Hyderi has developed anoxic layers below a thin layer of silt at the bottom. Most of the benthic fauna has disappeared form polluted parts of Korangi Creek. The number of species reduced. The following have disappered or / are on the verge of disappearance:<br>- Brachiopod *Lingula sp.;*<br>- lug worm *Arenicola sp*<br>- Oyster (*Crassostrea rivularis, Crassostrea species*);<br>- Bivalve (*Atrina sp;* Window pan oyster (Anomia sp.), *Pinna sp)* | Brachiopod *Lingula sp*. |

### (iii) Ecosystem components, including spawning areas, nursery areas, feeding grounds and adult areas;

Ecosystem components:

The coastal ecosystems along Pakistan Coast could be broadly classified into about three types of environments: Near-shore coastal environment; Delta environment and Creek environment. There are several ecosystems within these coastal environments: Near-shore coastal ecosystems, Estuarine Ecosystems, Mangrove Ecosystems, Hyper-saline

Ecosystem, Coastal water-sheds (dhands) and salt Marshes. Various components of these ecosystem are inter-linked and interact with reference to their functions as breeding, spawning, feeding grounds and adult areas for a variety of marine and coastal species.

*(i) Spawning, Breeding and Nursery grounds:* The spawning areas, nursery areas, feeding grounds for a number of marine organisms under the components of the ecosystem are listed below:

*Sindh Coast:*

- Indus Delta (feeding and breeding grounds for: estuarine fauna and flora, Palla Fish (*Ilisha tenulosa, Illisha filigera,),* mud skippers, commercial fishes such as mullets, shrimps, etc.,); Mangrove forests (*Avicennia marina*, wild life, birds, shrimps, small pelagic;
- Indus Estuary (Estuarine fauna, shrimp, fishes, Indus Dolphin, Indus blind dolphin);
- Keti Bunder area & Richal Creek (Nursery grounds for shrimp, fish & estuarine fauna);
- Brackish water dhands (Nursery & feeding grounds for brackish water / estuarine fauna);
- Off Karachi Coast (Nursery grounds for small pelagic fish, shrimps;
- Gizri Creek, Korangi Creek (Feeding grounds for mullets, small pelagic fish);
- Karchi Harbour (Nursery grounds for shrimps, small pelagic fish);

*Balochistan Coast:*

- Hub River Delta (Nursery & feeding grounds for brackish water / estuarine fauna);
- Sonmiani Lagoon (Nursery grounds for shrimps, fish & feeding grounds for marine invertebrates, Nursery for mangrove *Rhizophora mucronata, Avicenia marina*);
- Kalmat Khor (Nursery grounds for shrimps, fish & feeding grounds for marine invertebrates, Nursery for mangrove *Rhizophora mucronata, Avicenia marina*);
- Dasht River Delta, Gwatar Bay (Nursery grounds for shrimps, fish & feeding grounds for marine invertebrates, Nursery for mangrove *Avicenia marina*);
- Off Cape Monze (very limited coral reef, mussels, other filter feeders);
- Sonmiani Bay (spawning / breeding grounds for shrimps, fishes and marine invertebrates; feeding grounds for fish, shrimp and small and large pelagic fish;
- Shadi Khor (Nursery grounds for shrimps, small pelagic fish);

*ii) Feeding grounds for adults, and nursery grounds:* The feeding grounds for adults and nursery grounds for a variety of marine species including a number of commercial species of shrimps and fishes are listed below:

*Sindh Coast:*

- The Indus River Estuary (including limited sea grass beds along Indus River Discharge area, Keti Bunder, Hajamro Creek, Khobar Creek);
- Indus Delta Mangrove forest;
- Indus Deltaic creeks;
- Dhands along Southeast coast Indus Delta (feeding / nursery grounds for brackish water / estuarine fauna);
- Intertidal areas of Southeast Indus Delta;
- Coastal area off Indus Delta (including Khori Great Banks);
- Coastal area off- Korangi and Phitti Creek;
- Coastal area off Karachi Coast;

*Balochistan Coast:*

- Hub River Estuary and associated Hub River Delta;
- Sonmiani Lagoon and associated mangrove forest;
- Sonminai Bay area (Nursery grounds for shrimps, fish & feeding grounds for marine

invertebrates);
- Kalmat Khor and associated mangrove forest;
- Shadi Khor, Pasni;
- Dasht River Delta and asssociated mangrove forest;
- Gwatar Bay, Jiwani.

A small estuary of Shadi Kaur at Pasni and the entire shoreline from Ras Jaddi and the coastal area of the Astola Island constitute a wetland zone which supports as feeding ground to a wide variety of fish, shellfish, shrimps, other crustaceans and Mollusk and migratory birds. Any ecological disturbances as a result of man activities will hamper recruitment of these shrimps into fishable stock thereby resulting in reduced catches in the subsequent months.

*(iii) Biologically productive area:* The ecosystems along the coast of Pakistan are highly biological productive especially during the post southwest monsoon. Upwelling, cold and warm water fronts are biologically productive areas along the coast of Pakistan particularly in the Pasni offshore area. Productivity of chlorophyll, phyto-plankton and zoo-plankton is high. Disruption in the food linkage will disrupt the energy flow from the lower trophic level to the other. Due care must be exercised not to disturb the ecological imbalance through human impact. The overall Productivity of the mangrove areas has been reported to be high (365-780 gC/m2/year), compared to coastal waters (50-200 gC/m2/Year) which accounts for greater potential for fisheries yield in the former area. Apart from over exploitation of fishery resources, the loss of fisheries was attributed towards high salinity regimes which often extends into the distant parts of creeks on account of reduced freshwater flow into the estuarine system. Other factors which have been reported to have affected fisheries include increase pollution and destruction of mangrove forest which endangers the potential nursery grounds and in particular the shrimp fisheries which account for significant contribution in foreign exchange.

*(iv) Routes of highly migratory species:* Tuna and tuna like fishes are high migratory, they are pelagic fish. There migratory pattern begins from North of the Equator (Indian Ocean) following the west coast of Africa, Pakistan (Balochistan coast), India and eventually end up in Sri Lanka. Care must be taken not to impede the migratory route of these shoaling tuna (also known as the beef of the sea).

*(v) Critical areas for significant pelagic fish species:* Local fishing communities are dependent on coastal fisheries for their livelihood. Mullets are a favourite coastal fish on which the local fisherman thrive. Lobsters, shrimps and commercially important crabs are also of significant from export point of view. The shallow rocky areas of Balochistan are important grounds for lobsters and the blue crabs.

(vi) *Nesting habitants of migratory birds and turtles:* The endangered green turtles have their favourite nesting sites along the Sindh and Balochistan coast. On the Sandspit beach is a turtle sanctuary managed by the Sindh Wildlife Board, but it must be continued to be protected. The migratory birds find a sanctuary in the wetland of Pasni and Astola Island. The birds migrate from Siberia in the north to escape the harsh winter.

### (iv) Shorelines;

The shorelines along the coast of Pakistan which are most vulnerable to land-based activities are listed below:

- Karachi south and south-east shoreline;
- Deltaic creeks;
- Bundal Island;
- Budo Island;
- Khobar Creek Mouth;
- Hajamro Creek Mouth;
- Ormara headland.

### (v) Coastal watersheds;

In the South-eastern parts of Sindh province of Pakistan there is a belt of low lying lands between the agriculture lands in the inter-tidal delta of Indus River. These are in the form of prominent depressions / low lying areas locally called Dhands and are located between the agricultural lands and the High Tidal zone which are filled with brackish / saline water. The low lying areas covered about 400 sq km area and consist of four major Dhands namely, Pateji Dhand, Cholri Dhand, Sanhro Dhand, Mehro Dhand and all are connected to Cholri Dhand through narrow open inter-connections: i.e. between Cholri and Pateji Dhands, Mehro and Sanhro Dhand and between Sanhro and Cholri Dhands. The Pateji Dhand is a land locked shallow basin connected to the western end of Runn of Kutch at an elevation of about 3.3 ft. average mean sea level. The Cholri Dhand is directly connected to Runn of Kutch through in the South-east for the drainage of excess waters from the Dhand areas. The average depths in these Dhands vary between 0.37 m to 1.8 m. The maximum water level in Dhand areas has been reported to be 1.698 m during 1983 and 2 m during 1995 (Rizvi et al, 1998).

The coastal watersheds constitute brackish water / salt water Dhands. These dhands receive discharge of low saline agriculture drains as well as land run-off from north through gravity flows. They also receive highly saline waters from Rann of Kutch from south-east and hyper-saline seawater from creeks in the south due mainly to the water overflows during high tides. The water was finally disposed off into Rann of Kutch but now have ben diverted to the Tidal Link for final disposal to the sea through Shah Samando Creek and Sir Creek. These dhands are filled to maximum during rainy season (July-September) while water volumes shrink to a much smaller size during dry seaon (November-January). The water salinity in these dhands vary from 2 ppt to 30 ppt in most areas with the exception of Pateji Dhand which exhibit higher water salinities (upto 55 ppt).

Dhands with brackish waters act as brackish / saline water lakes and support a diverse ecosystem, fisheries and as sanctuary for a variety of water fouls and migratory birds. Any significant change in the water quality of these dhands produces negative impacts and negatively affects the brackish water / estuarine ecosystem in the area. The construction of Tidal Link and discharge of agriculture drain waters through them has exposed them to all types of pollution and environmental stresses.

### (vi) Specially protected marine and coastal areas;

There are only a few protected areas along Pakistan coast. This includes one area each in Sindh and Balochistan as listed below:

- Indus Delta Mangrove forests (Sindh);
- Hingol Park (Balochistan).

### (vii) Small islands;

There are a number of small Islands around Pakistan coast. However all of them are uninhabited and do not have any economic activity on them. They do have significance in the coastal ecological balance by providing various niches and habitats to a variety of marine organisms. Besides, they also have the potential for recreation for future use. The fauna, flora and associated ecosystems on these small islands are directly or indirectly affected by land-base human activities. These Islands are listed below:

- Oyster rocks (Karachi coast);
- Khuddi Island (Indus delta);
- Bundal Island (Indus delta);
- Churna Island (Balochistan coast);
- Astola Island (off Pasni, Balochistan coast);
- Kayo Island (off Khalifa Point, Balochistan coast).

## B. ESTABLISHMENT OF PRIORITIES

### 1. Priorities for action:

**(a) The relative importance of impacts upon food security, public health, coastal and marine resources, ecosystem health, and socio-economic benefits, including cultural values, in relation to:**

**(i) Source-categories (contaminants, physical alteration, and other forms of degradation and the source or practice from which they emanate);**

The relative importance of impacts upon food security, public health, coastal and marine resources, ecosystem health and socio-economic benefit in relation to the source categories of contaminants and the sources/practices from which they emanate are summarized in Tables - 8 & 9. The priorities with the various source categories are given below.

- Amongst the contaminants the untreated industrial waste waters, untreated sewage, persistent organic pollutants and the oil (hydrocarbons) have the priority;

- Amongst the contaminants in untreated Industrial waste waters particularly the heavy metals (Cr, Hg, Cd, Pb, Cu, Zn, Co), non-biodegradable and persistent organic wastes such as plastics, polyethylene, pesticides and insecticides have a priority;

- The un-treated sewage and litter because of improper solid waste management (i.e.

collection and disposal of solid wastes) is important for the coastal towns and villages;

- The solid waste management, sanitation, collection and disposal of municipal waste waters have priority in the coastal towns and villages for public health and health of coastal resources;

- Amongst the point sources of environmental degradation dams, coastal structures, Industrial facilities, waste water treatment facilities, power plants and habitat modifications ( e.g. dredging, filling of wetlands and clearing of mangrove areas) are important for coastal areas of Pakistan;

- Amongst the Non-point (diffuse) sources of environmental degradation urban run-off, agriculture run-off and coastal erosion are more important for the coastal areas of Pakistan;

- Amongst the Atmospheric deposition caused by Transportation (e.g. vehicle emission), power plants and industrial facilities and Agriculture operations are more important. Amongst air pollutants the contaminants such as Lead, oxides of Carbon, Nitrogen, Sulphur and CFC (chloro-fluoro carbons) and pesticides / insecticide sprays on agriculture crops are more significant;

- Appropriate regulatory measures to minimize the impacts of physical alteration and habitat modification for existing and future socio-economic projects is priority;

- The provision of appropriate drainage facilities also a priority area to minimize the impact of urban run-off;

- Minimizing coastal erosion is also a priority area for the coastal resource protection and for coastal communities;

- Contingency planning to check pollution by oil spill is also a priority for the protection of coastal amenities and coastal resources Pakistan;

- Priority for contingency planning and continuous need for monitoring and evaluation of coastal and marine resources and the impact of contaminants on the coastal ecosystem.

**(ii) The area affected (including its uses and the importance of its ecological characteristics);**

The source categories and their impacts on coastal and marine ecosystem degradation are given in Tables - 8 & 9. The coastal production in various sectors is interwoven with the changes/modifications in other sectors of socio-economy in a complex manner. The inputs from various land based activities into coastal areas are reflected in an appropriate response by the coastal ecosystem, its production rates and have impact on socio-economic conditions of the coastal communities. The areas affected by the various socio-economic activities and the details of the impacts are summarized in Table-8. The areas affected include the following:

*(i) Affected Areas:*

The following areas are affected by the land-based human activities along Pakistan Coast:

- *Coastal waters of Karachi including backwaters:*
  - Boat Basin / Chinna Creek area;
  - Karachi harbour;
  - Gizri Creek;
  - Korangi creek ;
  - Gharo Creek;
  - Seaview & Clifton Beach.
  - Off Cape-Monze / Churna Island (coral beds)
- *Indus Delta Mangrove Forest;*
- *Indus Estuary;*
- *Coastal water dhands;*
- *Coastal areas of Hub:*
  - Hub River Delta;
  - Gadani coast;
- *Gwadar coast:*
  - East Bay coastal area
- *Ormara coast*:
  - Coastal area adjacent to new port
- *Pasni coast:*
  - Shadi Khor area.

*(ii) Priority areas for Action:*

The following affected areas along Pakistan Coast have priority for action:

- Amongst polluted coastal areas: Karachi coastal areas (Backwaters of Karachi Harbour, Boat Basin, Sandspit Backwaters and Deltaic areas of Malir and Lyari Rivers, Gizri Creek, Korangi Creek, Gharo Creek and Clifton-Seaview Beach); Hub River Delta, Gadani and Hub Coast;

- Amongst the critical habitats the Indus Delta Mangrove Forests, wetlands along Sindh Coast and a small coral reef along Karachi Coast are important;

- Amongst the habitats of endangered species the breeding and nesting grounds of turtles (Green turtles) on sandy beaches along Karachi and Hub / Gadani Coasts;

- Amongst the coastal watersheds the dhands located in south-east of Badin and North of Shah Samando Creek;

**TABLE - 8. RELATIVE IMPACTS OF ENVIRONMENTAL DEGRADATION ON OASTAL AND MARINE RESOURCES AND SOCIO ECONOMY OF THE COASTAL AREAS OF PAKISTAN**

| | **Sources of Degradation** | **Food Security** | **Public Health** | **Resources in the Coastal belt** | **Near-shore marine Resource** | **Socio-economy** | **Cultural values** |
|---|---|---|---|---|---|---|---|
| I | Contaminants | | | | | | |
| | Sewage | M-H | H | M | M-L | H | H |
| | Solid waste | M | H | M-H | M | H | H |
| | Persistent organic pollutant | M | H-M | M-H | M-H | M | M |
| | Heavy metals | M-H | H-M | M-H | M-H | M-H | M |
| | Oil Pollution | M-H | M | H-M | H | H | M |
| II | Physical alteration | M-H | L-M | M-H | M-H | H | M |
| | Habitat modification | H-M | L-M | M-H | H | H | M |
| | Destruction in of areas of concern | H-M | L-M | H | H | H | H |
| III | Point Sources (Coastal & upstream) | M-H | H | M-H | H-M | M | M |
| | Waste water Treatment | M-H | H | M-H | H-M | M | M |
| | Industrial facilities (SITE, LITE, KIA, HITE) | M-H | H | H | H-M | H | H |
| | Coastal installations | | | | | | |
| | Power Plants | M | M-H | M-H | H-M | H | M-H |
| | Coastal Industry | M | M-H | M-H | H-M | H | M-H |
| | Coastal mining for sand & gravel | L | L | M-H | M-H | M | L |
| IV | Non Point Sources | | | | | | |
| | Coastal Erosion | M | H | M | M | H | H |
| | Urban Run-off / Floods | M | M-H | MH | MH | M | M |
| | Agriculture Run-off | M | M | M | M | M | M |
| | Land & fills and Hazardous wastes | M-H | M-H | M-H | M-H | M | H |
| V | Atmosphere deposition | | | | | | |
| | Transport emission | M | H | M | L | M-L | M |
| | Power Plant & Industries emission | M-H | H | H | M | M-L | H |
| | Agriculture operation emissions | L | M | M | L | M-L | L |

LEGENDS: L = Low Impact; H = High Impact; M = Moderate Impact.

**TABLE - 9. IMPACTS OF SOCIO ECONOMIC ACTIVITIES AND THE RELATIVE IMPORTANCE ON THE VARIOUS SECTORS**

| SECTOR | ACTIVITY | EFFECT ON MARINE ENVIROMENT | |
|---|---|---|---|
| | | COASTAL COMMUNITY | COASTAL |
| **Ecosystem health** | Effluent dump and pollution | Loss of Income, Reduction of Amenities | Degradation of Water Quality, Eutrophication; Toxic Algal bloom , Fish Kills; Reduced biodiversity ; Low Fish productivity |
| **Food Security**<br><br>**Agriculture** | Pesticide & Fertilizers | Public Health, Increase in poverty, Migration of Community | Danger to Fisheries / Mangroves / Biodiversity; Pollutants in Food Chain |
| | Dams & Barrages | Displacement of Public Resources | Increase in Salinity, Decrease in Sediment Flow, Reduced River Discharge |
| **Coastal Forestry** | Deforestation & Over Cutting | Loss of Fuel/Fodder | Increase in Siltation and Flooding, Reduced $CO_2$ uptake, Loss of Fish Productivity; Low Diversity |
| **Coastal and Marine Resources** | Over Fishing Increase Pollution Load | Reduced Productivity, Loss of Income, Loss of Fish Stock | Low Productivity, Habitat Loss, Habitat Destruction; Eutrification; Loss of Biological Diversity; Ecological Imbalance. |
| **Socio Economic Benefit** | Poor Living Standard, Low GNP, Reduced Export | Loss in Income Fisheries, Poor Health, Poor Sanitation, Loss in Coastal Tourism. | Poor Nutrition, Low Fish Stock, Degradation of Coastal; Environmental Quality; Depletion of Living Resources |
| **Public Health** | Untreated Discharge of Effluents, Dumping of Solid Waste. | Poor Health, Increased Diseases, Infant Mortality | Pathogenic Pollution; Beach Contamination; Trace metal pollutants in Living Resources |
| **Cultural Values** | Loss of Traditional Values | Migration to Cities | Loss of Artisanal Fishery; Loss in Fishery Tradition |

**(b) The costs, benefits and feasibility of options for action, including the long-term cost of no action.**

Marine resource of Pakistan have an immense potential in contributing towards national growth and progress. The economic valuation of the living and non-living resources and the cost / benefits of the economic values of coastal and marine areas of Pakistan with and without integrated development scenarios is given in Table-10. Estimated cost of any remedial measures, whether within or outside the coastal zone , outweighs any loss of potential of wealth in the coastal zone and their non quantifiable contribution to the maintenance of the health of coastal ecosystems and coastal environment. The scenarios in Table-10 were adopted and modified from a Report of the Government of Pakistan on Sectoral Report on Coastal Warming and Rise in Sea Level (GOP 1995). The figures are good estimates and are calculated on the basis of an assessment of the present market value of the coastal resources, the projected cost of the development for the next 15 years and the projected cost of the protection and conservation of the coastal resources. It is very difficult to evaluate the ecological cost and contribution of the coastal communities of marine organism in the coastal ecosystem. Their production and ability to clean the environment is calculated and assessed to be their value. Therefore these cost estimates and valuation of coastal resources are based on a complex process. It has been worked through the present and projected cost estimates and a valuation process based on the current trends and future projected development scenarios. The values given in Table-8 are subject to vary by (±) 10-15% and could serve as a base for calculating management cost for the various development scenarios for long term planning.

The present value of various coastal resources will continue to decline if unchecked due to continued coastal degradation particularly from land based activities. If sustainable development plans are adopted under integrated coastal area management the resources will not only appreciate in value but will also have minimized risks and degradation rates. It is estimated that over a development scenario of 15 years (Table-10) through appropriate protection and conservation measures, it will be possible to recover loses to Pakistan's coastal resources and to keep the safe custody of coastal resources for the future generations. These options outweigh the costs involved in the restoration and maintenance of the coastal resources and in the uplift of socio economic conditions of the coastal communities. The benefits are immense in the investment for the improvement of environment compared with the projected economic damages and environmental loses under the scenario of business as usual.

## 2. Establishing Priorities for action:

**1) Elements of Action Plan:**

Given the demonstrated competence of the local expertise in this area, with the encouragement of the local and federal governments, a successful programme of action can be initiated comprising of the following elements:

**Table-10 EVALUATION OF THE COST & BENEFITS OF THE ECONOMIC VALUES OF COASTAL & MARINE AREAS OF PAKISTAN WITH & WITHOUT INTREGRATED DEVELOPMENT SCENARIOS**

| Parameters of Coastal Economy | Present Value Rs. (in Billion) | Cost of No Action | | Cost of Protection & Conservation | |
|---|---|---|---|---|---|
| | | No Development | 15 Years Development | No Development | 15 Years Development |
| **Coastal & Marine areas** | | | | | |
| • Ports & Harbours, Structures | 100 | 50 | 25 | 50 | 200 |
| • Recreational Potential | 5 | 5 | 25 | 5 | 2 |
| • Land damages due to Salt Water Intrusion and Sea Level Rise | 5 | 5 | 50 | 1 | 2 |
| • Coastal Development and use at present level | 75 | 20 | 30 | 15 | 10 |
| • Sustainable Development through ICZM | 15 | 20 | 30 | 5 | 7 |
| **Economic Values of Areas of Concern** | | | | | |
| • Fisheries Sector | 10 | 10 | 20 | 20 | 40 |
| • Forestry Sector | 5 | 5 | 10 | 15 | 30 |
| • Ecological benefits including biodiversity | 5 | 5 | 5 | 15 | 25 |
| • Environmental Values | 25 | 25 | 10 | 30 | 35 |
| • Cultural & Historical Sites | 1 | 1 | 1 | 3 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| **Pollution Damages** | | | | | |
| • By Point Sources | 50 | 50 | 100 | 25 | 30 |
| • By Non – Point Sources | 50 | 50 | 75 | 20 | 28 |
| • By Atmosphere | 20 | 20 | 40 | 10 | 13 |
| **Physical alteration (damages)** | | | | | |
| • Habitat Modification | 20 | 25 | 40 | 12 | 15 |
| • Destruction in areas of concern | 25 | 25 | 60 | 10 | 10 |
| • Cyclones & Floods (damage) | 10 | 15 | 20 | 5 | 8 |

- Empowering local communities through community-based management - that resources and activities should be managed in a manner which ensures meaningful stakeholder participation at the community level in decision making;

- Strengthening coastal economics and dealing effectively with poverty – All levels of decision making consider the implications of proposed actions on local economics and take issues to the local level as a key part of the process;

- Recognizing the rights and interests of indigenous peoples – Establishing effective partnerships that recognize and incorporate indigenous tenure, traditional ecological knowledge and resource management practices; and

- Integrating traditional knowledge with conventional science – Establishing cooperative mechanisms and partnerships that enable the appropriate integration of science, policy, technology and traditional knowledge;

- Instituting freshwater conservation programmes in order to reduce the volume of waste water that is generated by a community;

- Reducing the contamination of sewage and sewage sludge through regulatory and voluntary methods;

- Engaging all sectors in remedial action planning;

- Using land-use planning and development planning to link up locations in coastal areas for industries that produce hazardous waste with waste water treatment infrastructure and to declare fragile landscapes along the coast to be natural reserves; and

- Foster local & provincial plans of the national governments to establish marine management and protection zones.

**2) Community Participation:**

To ensure the effective involvement of local authorities and communities in the integrated management process, the principle of subsidiary should be followed. This is similar to empowerment and implies providing all partners in the coastal zone with the knowledge, skills, information and other resources. Of importance at the international level, would be continued efforts to reform international donor and financing institutions to invest their resources to support joint local authority and community action. Public information and education efforts by the government agencies is considered integral to important aspect the partnership between the people and their government.

**3) Implement Integrated Management:**

Implement Integrated Coastal Zone Management (ICZM) as a "top down" management process in which the governments are responsible for development of comprehensive legislation and national policies including the design and implementation of institutional reforms, public participation in management issues. The desired public involvement includes joint planning, referred to as " multi-stakeholder processes" which allows a still exchange of information and thus assists decision making.

**4) Responsibilities of the Government:**

The responsibilities of local, provincial and national government should be linked, according to the laws and rules of governmental organization. The central government is responsible for the overall plan, including the weighted interests of the various sections, coordinating and harmonizing these interests and taking the final decisions. The various sectoral departments like water management, environment, economics and finance, contribute to the ICZM plan for providing the sectoral aspects. The provincial government should take actions for ICZM according to their jurisdiction: analyzing problems, generating solutions and discussing ICZM matters with the central government. The local level participates in the ICZM process by implementing the necessary measures and by presenting their suggestions, interests and implications of the measures on the ICZM at the local level. A clear definition of tasks and responsibilities have to be worked out in consideration of the present situation in Pakistan. The incorporation of the three levels in the ICZM provides the general support for ICZM and for the implementation of the management actions.

**5) Relevant Data and Information:**

In order to generate multi-sector data and information required for coastal zone management, there is a need for a multi-purpose numerical modeling system. An adequate knowledge of oceanographic conditions e.g. current speeds, circulation patterns, water stratification, mixing rate, wave climate and wave refraction patterns, distribution of salinity, temperature, dissolved oxygen and nutrients is essential for coastal zone management. A multi-purpose numerical modeling system is indispensable for a good evaluation of the distribution of pollutants and other substances into the channels, creeks and in the coastal zone. Models can be beneficial to the determination of the flow circulation, residual flows, effects of storm surges on the distribution of matter; the wave effects in navigation channels, the rate of littoral sediment transport; the water quality e.g. BOD-DO, oxygen depletion and bacterial decay balances, organic nitrogen-, ammonia-, nitrate and nitrite balances; eutrophication e.g. phytoplankton, benthic algae, zooplankton, oxygen balances and mineralization estimates; heavy metals distribution patterns and waste discharge and concentration studies. At present there is a great need for a training program for the set up and elaboration of such a modeling system.

**6) Identification of Key Issues in Coastal Zone:**

The key issues identified for coastal zone management in Pakistan (IOC/ICZM, 1994) of coastal areas excluding Karachi are given below:

- *Coastal Resource Protection*:
  - *Coastal Resource Protection / Conservation*: Protect mangrove forest, regulate multiple use of mangroves; Introduce product substitution particularly alternatives to mangrove use for fuel, fodder, etc.;
  - *Reduce Environmental Degradation*: mangrove: loss and degradation; other values and uses;

- *Indus River Discharge / Freshwater Supply*: Ensure adequate Indus Discharge / freshwater supply to Indus Delta to maintain estuarine conditions and ecological balance;
- *Coastal / Marine Pollution:* Reduce / control coastal / marine pollution;
- *Public awareness*: Launch public awareness & environmental education; development of a model fishing village;
- *Community Participation*: Involvement of users and scientific community;
- *Sea-level Rise*: Protect coastal structures, ports, harbours, coastal industries at risk and Archaeological Resources in delta under threat;

- *Poor socio-economy / living conditions of Coastal Communities*:
  - Improve socio-economy of Coastal communities:
  - *Poor Sanitation*: Improve sanitation through facilities of sewerage disposal & solid waste management and public health services;
  - *Drinking Water Supply:* Arrange adequate quantity of drinking water supply to coastal areas;
  - *Poverty Alleviation*: Improving socio-economic conditions and alleviation of poverty;
  - *Poor Road Access and Communications*: Improving road access and communication facilities;
- *Integrated Coastal Zone / Coastal Area Management*:
  - *Coordination / Collaboration*: Creation of an inter-ministerial committee to ensure integrated management;
  - Creation of an issue advisory body within the provincial governments for the coastal development;
  - *Implement Environmental Legislation:* Improve and enforce environmental legislation;
  - Empowering a lead agency in the province to collaborate and coordinate for integrated coastal zone management;
  - *Community participation*: Promote participatory approach to encourage participation of local communities for sustainable development of coastal resources;
  - *Data / Information needs*: undertake resource / issue assessment and mapping and collect multi-sectoral data / information for resource management;

**7) Legitimate action for Pollution Control:**

it is essential that the existing legislation should be harmonized and enforced. The legitimate system and administrative set up for pollution control can be upgraded by exercising the responsibilities of the various agencies and actors:

(i) responsibility of the central government: the Government (Ministry of Pollution and Environmental Control) is responsible for formulating and implementing fundamental and comprehensive policies with regard to pollution and environmental control and should exercise regular checks with appreciation and fines;

(ii) responsibility of the local government: the local government through its designated Ministry is responsible for formulating and implementing policies with regard to pollution and environmental control corresponding to national policies and other policies in accordance with the natural and social conditions and with their jurisdiction;

(iii) responsibilities of corporations: the corporations are responsible for taking the necessary measures to prevent environmental pollution and ensure proper disposal of wastes. The are responsible for the reduction of environmental loads in the course of their business activities in accordance to the policies of the Government;

(iv) responsibility of citizens: citizens shall make efforts to reduce the environmental loads, associated with their daily lives.

**8) Harmonization of legislation:**

*A*ddresses the harmonization of the existing legislation. Adapt the Forest Act so that it includes not only the Sindh Coast but also the Karachi area including the Port Qasim Authority to arrive at a uniform legislation along the Karachi coast. There is also confusion on the management of the fisheries potential resources between Provincial and Federal Fishery Departments.

**9) Enforcement of the legislation:**

Enforce the harmonized existing legislation. The enforcement of the legislation can best be implemented by the local authorities (District management), Environmental Protection Agencies (EPAs), Maritime Security Agency (MSA), Pakistan Coast Guards, Port Authorities (KPT, PQA, etc.,), Customs, Department of forestry, wild life, Department of fisheries, and Coastal Development Authorities. Some these agencies are already performing this duty. A closer interaction is required amongst these agencies for better results. Besides interaction and coordination each agency should have a specific area of operation e.g. the KPT may be responsible for enforcing the legislation within the harbor; the Coast Guard for the coastal area; the MSA up to the maritime boundary of the EEZ and Customs within the parts. Research Institutes may be engaged in delivering background environmental information and techniques.

**10) Extension of the Coastal Development Authority:**

The Coastal Development Authority has been created recently and is responsible for the overall development, improvement, quantification and coordination of the coastal areas of Thatta and Badin Districts. It is recognized that CDA may be extended to the Karachi District East (Karachi Coast) in order to have a central body for the coordination of the whole area as mentioned above.

**11) Implement / Establish environmental impact assessment:**

Environmental impact assessments should be applied in letter and spirit for all major activities producing wastes and pollutants. Especially the distribution and extension of the waste should be evaluated and monitored.

**12) Enforce Mitigation / Rehabilitation measures***:*

For the projects / industries already in place there should be an assessment of the environmental damages done so far with emphasis on reducing environmental degradation, rehabilitation and mitigation measures within a reasonable time frame (i.e. a relaxation period of 1-2 years) under the existing relevant legislation.

## C. SETTING MANAGEMENT OBJECTIVES FOR PRIORITY PROBLEMS

### 1. Specific Management objectives with respect to:

**1) Source Categories:**

- To protect and maintain critical stocks of coastal resources from harmful affects of industrial and urban contaminants such as heavy metal contaminants (Cr, Hg, Cd, Pb, Cu, Zn, Co), untreated sewage, persistent organic pollutants (plastic, polyethylene pesticides, insecticides) and the oil (hydrocarbons):

    - Heavy metals contaminant, plastics and other industrial wastes:

    - Ensure treatment of industrial wastes by enforcement of existing and appropriate new environmental legislation;

    - Control / reduce toxic contaminants and persistent organic contaminants levels in the industrial effluents to conform to the National Environmental Quality Standards;

    - Provide incentives to help treatment of industrial wastes and their environmentally safe disposal;

    - Adopt concept of community industrial waste treatment plants where applicable for the existing industrial units and particularly for the development planning for new industrial setups;

    - Adopt "Polluter pays" principle for industrial waste treatment and its environmentally safe disposal;

    - Ensure incineration of industrial solid wastes particularly for hazardous industrial wastes and plastic / polyethylene wastes;

    - Discouraging the use of plastics and polyethylene products which are known for their environmental hazards and public health risks and clogging of sewers;

    - Stop / ban disposal of polyethylene / plastic bags in the public places and public sewers;

    - Improve air quality by reducing contaminants such as Lead, oxides of Carbon, Nitrogen, Sulfur and CFCs (chloro fluoro carbons) in the emissions from vehicles and industries and emissions from pesticides / insecticide sprays on agriculture crops;

    - Oil Pollution:
    - Ensure use of low lead oils products: furnace oil, petrol, diesel, etc.;
    - Stop / control oil spillage particularly during the handling and transportation of oils;

    - Enforce strict environmental controls at oil refineries and oil terminals and bunkering points to check oil spillage;

- Prepare to combat oil pollution during oil spill emergencies through provision of oil spill combating equipment and implements and appropriate and effective Contingency planning;

- Protect coastal resources, coastal structures (i.e. ports, harbours, seawater intakes of coastal power plants & industries, etc.), beaches and amenities from accidental oil spills;

- Pesticides / Insecticides:

- Stop use of banned pesticides and insecticides in the country;

- Reduce usage of pesticides / insecticides and adopt biological controls and other environmentally safe practices to achieve pest control;

- Sewage Treatment:

- Ensure sewage treatment: At least primary treatment for all sewage must be carried out before discharging it to the coastal waters;

- Promote recycling of primary treated sewage for gardens, green belts in public places and for limited agriculture use. Primary treated sewage can be safely discharged to the coastal waters through long marine out-falls;

- Carry out secondary treatment of sewage if long marine-out-falls are not feasible. Carry out sewage treatment in phases to adjust to the availability of funds;

- Promote community sewage treatment plants for new residential coastal towns and large residential projects;

- Foster development of safe solid waste disposal practices such as composting, incineration and waste recycling;

- Improve sanitation through adopting appropriate sewerage system, sewage treatment and disposal practices in the coastal towns and cities;

- Adopt environmentally safe and efficient solid waste management in the coastal towns and cities with special emphasis on Karachi City;

- To improve, maintain and enhance critical environmental quality;

- To maintain the amenity value of coastal zone (aesthetic appeal, control of development size, scale and location, etc.,);

- To preserve critical coastal resources such as Indus Delta Mangrove forest and associated ecosystem, estuarine and brackish fauna and flora;

- To rehabilitate degraded habitats (i.e. mangrove cleared areas, estuaries, backwaters, watersheds) and preserve critical habitats such as nursery, breeding and feeding grounds (i.e. estuaries, deltas, backwaters, coastal wetlands, coastal watersheds / dhands, etc.,) near-shore coastal areas and coral reefs;

- To control / minimize coastal erosion of the coastal areas for resource protection and coastal communities;

- To minimize the impacts of physical alteration and habitat modification for existing and future socio-economic projects by appropriate regulatory measures.

- To install a mechanism for continuous monitoring and evaluation of coastal and marine resources and the impact of contaminants on the coastal ecosystem;

- To facilitate implementation of regulatory controls through regulatory and economic instruments including polluters-pay principle and incentives;

- To improve existing environmental legislation to cover all aspects of pollution control management;

**2) Areas affected:**

*(i) Indus Delta Mangrove Forest and Indus Estuary:*

- To manage the mangrove forests on sustainable basis, so that their economic, social, and ecological benefits are optimized;
- To ensure that the required quantity of river discharge (freshwater & sediments) reaches mangrove forests to sustain their growth and survival;
- To ensure that ecological functions of mangroves are not hampered;
- To lessen the impact of adjacent developments on mangroves;
- To minimize non-sustainable and conversional uses of mangroves;
- To preserve the mangrove ecosystem to sustain marine fishery stocks;
- To provide livelihood means and employment to coastal communities;
- To restore degraded mangrove forest areas through natural, or artificial regeneration;
- To establish construction setback limits from mangroves for different types of development along the mangrove forest.

*(ii) Polluted parts of Karachi and Hub and Gadani Coast:*

- To improve and expand the sewage treatment facilities, sewerage and drainage system at coastal towns and in Karachi (i.e. the existing plans of Karachi Water and Sewerage Board and long marine out-fall options);
- To improve and Enforce National Environmental Quality Standards (NEQS) for effluent discharge from various industries;
- To implement the principal "Polluter Pays" to control pollution;
- To improve and Enforce Existing laws and regulations to control pollution to prevent pollution of rivers, estuaries, backwaters, watersheds and Coastal areas;
- To promote community sewage treatment plants in coastal towns;
- To promote community Industrial waste treatment plants for various categories of industries in the coastal areas and adjacent upstream industries;
- To protect rivers (i.e. Lyari / Malir / Hub River), their estuaries and backwaters from discharge of sewage and industrial wastes;

*(iii) Coastal areas of Gwadar, Pasni and Ormara:*

- To introduce appropriate sewage treatment facilities, sewerage and drainage system;
- To enforce National Environmental Quality Standards (NEQS) for effluent discharge from existing and future industries;
- To implement the principal "Polluter Pays" to control pollution;
- To promote community sewage treatment plants in coastal towns;

## 2. Coastal Resource Management objectives:

- Collection and updating of relevant data / information, and development of coastal environmental indicators to guide planning and monitoring of coastal zone for the protection from land-based human activities;
- Regulation of land-based activities of the various identified sources of environmental degradation in the affected areas of the coastal zone;
- Establishment of environmental objectives for the areas affected by environmental degradation and pollution including conservation requirements, ecosystem protection and restoration, discharge limits, water quality for receiving waters and waters flowing into the coastal zone;
- Control and reduction of inputs from polluting and hazardous substances (from industrial, municipal and agricultural sources) under various source categories identified into the coastal zone;

## 3. Integrated Management objectives:

- Development of a comprehensive planning and management system for Coastal Zone of Pakistan;
- Establishment of an overall policy for the sustainable development of the coastal areas;
- Formulation of sectoral development policies and plans that are compatible with the objectives of overall policy;
- Preparation of guidelines and policies for managing coastal ecosystems and resources;
- Formulation of a General Coastal Resource Management Plan for each sector and issue, i.e. coastal forests, mangrove forests, aqua-culture, sand mining, coastal erosion, water quality, tourism, river deltas, estuaries, backwaters, and marine protected areas;
- Formulation area specific plans that use zonation to designate areas where compatible activities can be integrated and non-compatible ones can be segregated;
- Integration of sectoral plans into national and regional development plans;
- Coordination of development initiatives on the national, provincial, district and local levels.
- Formulate compatible development strategies that incorporate erosion prevention planning;
- Strengthening of Existing local, provincial and Federal institutions for integrated management (i.e. Coastal Development Authority, Government

of Sindh to work as lead agency for management of coastal zone of Sindh):

- Creation of an inter-ministerial committee to ensure integrated management through inter agency Coordination / Collaboration;
- Creation of an issue advisory body within the provincial governments for the coastal development;
- Improve and enforce environmental legislation;
- Empowering a lead agency in the province to collaborate and coordinate for integrated coastal zone management;
- Promote participatory approach to encourage participation of local communities for sustainable development of coastal resources;
- Undertake resource / issue assessment and mapping and collect multi-sectoral data / information for resource management;

**4) Management through Existing Regulatory Environmental Legislation:**

Management and other solutions adopted to deal with the problems are in the form of environmental legislation and programs made by the government of Pakistan. Some of the objectives of the environmental protection, and conservation are built in the legislation prepared so far. There are many areas of concern which still require appropriate environmental legislation for ICZM. The need for the new environmental legislation cannot be over-emphasized. However, there is a dire need for the implementation of environmental legislation in letter and sprit to achieve the specific targets of time table for areas affected. A high powered Marine Pollution Control Board has been setup during 1995. Lately, two Environmental Tribunals have been setup in Karachi and Lahore by the Government of Pakistan to check environmental pollution and help enforce existing environmental legislation. The environmental legislation and other measures taken so far listed below:

Pakistan Environmental Protection Ordinance;
Pakistan Environmental Protection Act approved by Parliament expected to be notified by the end of 1997;
Establishment of Environmental Protection Agencies at Federal and Provincial Levels;
Development of Environmental Impact assessment procedures and guidelines;
Partial strengthening of EPA's;
Public awareness;
National Environmental Quality Standards, 1994;
Establishment of Marine Pollution Control Board, 1995;
Establishment of Environmental Tribunals, 1999.

## D. IDENTIFICATION, EVALUATION AND SELECTION OF STRATEGIES AND MEASURES

### (a) Specific measures, including, as appropriate:

#### (i) Measures to promote sustainable use of coastal and marine resources and to prevent/reduce degradation of the marine environment

The core issues and root causes of environmental problems in the coastal zone of Pakistan could be broadly grouped into two types: those arising primarily from a combination of poverty and population growth, leading to over exploitation of coastal and marine resources; and the other emanating from the increasing industrialization and urbanization leading to pollution of water, air and land. The identification and selection of management strategies and measures to be adopted should directly or indirectly address these core issues. The environmental management strategies, measures and programmes to cope with the situation are mentioned below:

1. Develop Integrated Coastal Zone Management Plans for the following areas:
   - Karachi coast
   - Indus Delta (Sindh coast)
   - Hub coast (Balochistan coast) including Sonmiani Bay and Miani Lagoon
   - Ormara to Jiwani coast including Khor Kalmat (Balochistan coast);

2. Constitute a high level Steering Inter-ministerial committees both at national and provincial levels to coordinate the integrated coastal area management plans;
3. Prepare a Resource Audit of the coastal towns and villages;
4. Establish a protected area system for the coastal resources of Sindh and Balochistan coast;
5. A biodiversity profile of the coastal areas be prepared;
6. Habitat Maps and Ecosystem Maps should be prepared and maintained by regularly updating;
7. Launch a comprehensive education and awareness programme for coastal population;
8. Develop an effective legal framework for implementation of Marine Pollution Conventions and Biodiversity Convention;
9. Introduce incinerators for the treatment of solid wastes in urban coastal areas particularly for Karachi City;
10. Provide alternate sources/substitutes for fuel and fodder for coastal communities (such as natural gas for cooking and agriculture produce for fodder);
11. Enhance capacity of sewage treatment to cope with the quantity of sewage generated in Karachi including long marine out-fall options;
12. Restore degraded ecosystem by declaring them protected areas and marine parks;
13. Develop/arrange primary treatment facilities for sewage in all coastal towns;
14. The NEQS should be enforced in letter and spirit;
15. Community based industrial waste treatment plants should be promoted;
16. Improve and expand sewerage system and storm water drainage in Karachi. Extend sewerage coverage to all parts of Karachi;

17. All industrial wastes should be treated before discharging into the public sewer or coastal environments.
18. Formulate and enforce appropriate national and provincial industrial/municipal waste discharge standards and water quality standards for the receiving water bodies along Pakistan coast;
19. The existing arrangement for the collection of solid waste, garbage and litter be improved and extended to cover all parts of coastal cities and towns by the respective local authorities;
20. All hazardous and toxic solid wastes should be treated and burned in the incinerators;
21. Encourage introduction of cleaner technologies for all sector of economy particularly for industry and energy sectors;
22. A well coordinated national programme of monitoring marine ecosystems and bio-diversity designated protected areas, should be initiated. Biological resources are renewable and even increase with proper management. The highly diverse natural ecosystems which support the biological diversity also maintain hydrological cycles, regulate local climate, build soils, recycle the essential nutrients, absorb and breakdown pollutants. Many plants and animal species are now under threat of becoming extinct due to habitat degradation. The loss of biological diversity is likely to have a profound impact on development and provision of raw material for human communities. Further, the loss of each additional gene, species or habitat reduces the available options. The following strategies are recommended for research and development:

    - Foster development and conservation of biological diversity under wetlands and mangrove areas;
    - Protect nursery grounds of fish and shrimps so that recruitment into fishable stock is maintained;
    - Promote research to conserve mangroves and associated ecosystems;
    - Foster R&D need for regular monitoring programme for fishery stock assessment;
    - Experimental fishing or exploration of new resources should be encouraged;
    - Develop sea farming in regions where agriculture is not possible;
    - Coastal and offshore biodiversity be monitored on a regular basis.

23. Development should be linked with increasing awareness, education, basic modern technologies for skilled education. Vocational training centers should be established for the local community so that new skills can be learned. To maintain law and order and to check smuggling in some of the coastal towns the law enforcement agencies must be strengthened.

24. The existing literacy figures and educational facilities are not adequate, the education department should not only accelerate but also revise their policy for improving and enhancing education facilities in the area. Female literacy rate is disappointingly very low and need immediate action.

**(ii) Measures to modify contaminants or other forms of degradation after generation, such as waste recovery, recycling and waste treatment:**

Waste recovery is carried out using a number of different refuge vehicle types, depending upon needs such as narrow streets in cities and on available financial and management resources. The choice of waste collection vehicles is also dependent upon their case of use for loading and unloading of waste into the fruits.

Karachi Metropolitan Corporation (KMC) in Pakistan has a public fleet of 100 new and 250 old garbage vehicles. At resent, the KMC fleet collects around 35 percent of the 600 tons of garbage generated daily (ESCAP, 1996). KMC has also launched the ADB funded solid waste management programme. This programme which was conceived in 1988, is being implemented in both short and long term phases under the Karachi special development programme. The KMC had already begun execution of its short-term plan, starting with the construction of approach roads to the two new landfill sites, 650 ha in Deh Gondpass and 610 ha in Deh Jam Chakro – both sites are to be used as new land fills with the addition of more vehicles in KMC, it is expected that the new fleet of vehicles would be collecting nearly 45 to 50% of the Karachi's waste. Further, many people, including groups of children, scavengers for waste papers, plastic, glass bottles, cardboard, cans etc. That are sold to garbage dealers for recycling. Herds of animals (mostly cow, sheep etc.) are also allowed to forage for edible material at the localised garbage disposal sites. Waste dumping at sea is frequently adopted as a solution, causing significant health and pollution problems, as well as a threat to marine life.

The current method of treatment of urban solid waste in coastal cities of Pakistan is through open dumping and basic landfill operations. Biodegradable waste mostly fish by-products, rotten fruits and vegetables) are also used to convert into manure. Further, special emphasis is also given to area having high domesticated animals to promote the use of fecal material/excreta/cow dung for the production of bio-gas and fertiliser by microbes and earthworms. Organic fraction in the waste is used by locals as compost, that is used in gardens, houses and parks to improve the condition the soil. Both the local government and the NGOs should prepare programmes for recycling of solid wastes and sewage. The existing efforts in this direction are insignificant and should be enhanced by providing incentives.

The following measures should be taken to ensure adequate waste treatment and recycling of sewage from the urban centers of the coast particularly the Karachi City.

- Upgrade programmes for primary treatment of sewage to cover the entire quantity of sewage generated in the urban area;
- Implement existing NEQS in letter and spirit to ensure treatment of industrial effluent at source of its generation;
- Promote community based industrial waste treatment plant for various categories of industries located in a manageable area.
- Encourage projects and programmes that facilitate recycling of primary treated sewage through public / private partnerships.
- Primary treated sewage should be recycled to meet the demands for

industrial water as well as for horticulture and agriculture usage within the urban area and its adjacent suburbs.

- Surplus primary treated sewage be discharged into the adjacent rivers and storm water drains i.e. Malir River & Lyari River in case of Karachi City.

**(iii) Measures to prevent, reduce or ameliorate degradation of affected areas, such as Environmental quality criteria, with biological, physical and/or chemical criteria for measuring progress:**

**a. Environmental Criteria**

There are many criteria to assess the quality of the environment and some relevant criteria are given below:

- Physical parameters such as colour, turbidity, light penetration and visible physical alterations of habitats should be used to detect and measure environmental quality and perturbations;
- Chemical parameters such as BOD, DOC, DO, H2S concentration should be used to check the water quality of the affected area and be an essential part of the monitoring programs.
- Biological assays in the laboratory and ecological surveys of the affected coastal areas should be undertaken to observe / measure / monitor the adverse effects of environmental degradation on the coastal areas using indicators of inhibition of chlorophyll production, presence of algal mats etc.;
- Presence of Planktonic blooms in the coastal areas should be used to assess the health of the ecosystem and as an indicator of organic pollution.

*Stress indicators*: The "animal biomarkers as stress indicators" are used to monitor biological `effects caused by anthropogenic elements which affect various physiological / biochemical / metabolic processes whereby organisms might not be able to maintain homeostasis. Altered metabolic rate if not compensated by adaptive mechanisms of the organism may affect its survival and or reproduction. Many physiological and biochemical bioassay or biomarkers have been developed over the last decades which can be used as indicators of exposure, effects and/or stress. These assays or biomarkers represent a xenobiotically-induced variation in cellular or biochemical components or processes, structure and functions in a biological system of an organism. Reference was made to the two types of biomarkers, namely, the biomarkers for general pollution and the other more specific biomarkers that affect the nervous system, damage the genetic material and other functions in the organisms (Hameedi, 1997)

*Reduce auto emission:*

- Initiate and implement programmes under the existing environmental legislation to combat automobile emission in the urban and industrial areas;
- Karachi, Mass Transit Schemes should be encouraged.

*Public health:*

- Incinerator be installed to treat hazardous solid waste, material instead of using the same for land fill the spread of disease can be controlled and public sanitation and health can be improved;
- Stop the discharge of untreated sewage and industrial waste into the coastal areas;
- Treatment plants should be mandatory for all sitting and for planned coastal industry to

improve coastal ecosystem.

*Poverty alleviation:*

- Provide livelihood means and employment to coastal communities;
- Aqua culture must be encouraged in coastal areas to augment Fish / Shrimp production to alleviate poverty;
- Mangrove ecosystem should be termed as protected areas; coastal tourism should be encouraged to generate income on a sustainable basis;
- Foster R&D project to improve environmental condition in coastal and off-shore areas;
- Teach environmental education aspects in the educational curriculum.

**b. Land-use planning requirements, including criteria for siting of major facilities;**

The industry is central to economy of modern society and indispensable to growth. The industry extracts material from natural resource base and inserts both product and pollution in the environment. The following criteria and programme are suggested:

- EIA for every project should be mandatory with emphasis on mitigation measures;
- It is proposed that industry and environment should go hand in hand to meet the growing demands of the coastal communities;
- The land use planning process should give due emphasis to environmental concern;
- New industry should not be sited on agriculture lands;
- New industries should be sited away from the urban centers;
- Foster both scientific and local knowledge in assessing land use, planning; restoration efforts and impacts of development action;
- Prepare a risk analysis of seismic activity along major faults and subduction zone for use in land planning;
- Promote appropriate use of communal and state land in the coastal area;
- Siting of industry should be away from fragile ecosystem/protected area;
- There should be a setback limit of 500 meters for site selection of any development project along the coastline;
- Sea level rise and storm surges heights should be given due consideration in the designing of coastal development projects.

**c. Rehabilitation of degraded habitats;**

*1) Degraded Habitats:*

The following degraded habitats have been identified which require rehabilitation measures:

I. Degraded habitats (due to upstream sources)
   - i) Indus River Delta
   - ii) Hub River Delta

II. Degraded habitats (due to pollution)
   - a. Karachi Coastal Area
     - i) Karachi Harbour area
     - ii) Boat Basin area
     - iii) Gizri Creek
     - iv) Korangi Creek (partially degraded)
   - b. Hub River Delta

### *2) Rehabilitation of Degraded habitats*

The degraded habitats along the Pakistan coast are mostly located along Sindh coast with the exception of Hub River Delta along Balochistan coast. Along Sindh coast the following degraded habitats have been identified for rehabilitation amongst the several others which are only partially degraded. The rehabilitation measures for the Indus Delta and its mangrove forests and the rehabilitation programmes for the polluted habitats along the coast are briefly mentioned below:

#### i) Indus Delta and Mangrove Forest

- Declare the degraded habitats within Indus delta as protected areas;
- Restoration of water balance and the allotted 10 MAF below Kotri Barrage water by Indus Water Accord be maintained throughout the year;
- Afforestation of mangrove by indigenous species in the affected areas;
- Implement an effective conservation and management of restoration plans in Indus delta;
- Reduce fishing pressure within Delta by implementation of existing legislation with respect to fishing gear, mesh sizes, closed season and closed fishing areas;
- Introduce community participation and integrated approach for management and conservation measures;
- Encourage use of alternate sources of energy and fuel to ease pressure on mangrove forests from local communities;
- Foster R&D Programmes that focus on rehabilitation of habitats and ecosystems in Indus delta;
- Create public awareness and promote education in local communities particularly for the following:
  - Conservation of resource consciousness;
  - Rehabilitation of mangrove forests;
  - On alternate use of fuel and fodder;
- Manage the mangrove forests on sustainable basis, so that their economic, social, and ecological benefits are optimized;
- Ensure that the required quantity of river discharge (freshwater & sediments) reaches mangrove forests to sustain their growth and survival;
- Lessen the impact of adjacent developments on mangroves through administrative measures;
- Minimize non-sustainable and conversional uses of mangroves;
- Preserve the mangrove ecosystem to sustain marine fishery stocks;
- Restore degraded mangrove forest areas through natural, or artificial regeneration;
- Ensure that ecological functions of mangroves are not hampered;
- Establish construction setback limits from mangroves for different types of development as recommended below:
  - Industrial development 1,000 meters
  - Housing estates and residential areas 500 meters
  - Aqua-culture development 100 meters
  - Tourism development 100 meters

#### ii) Hub River Delta

The rehabilitation of the degraded parts of Hub River Delta require the restoration of water balance, implementation of NEQS to maintain water quality, maintenance of estuarine salinity and restoration plans for oyster beds and bird sanctuary to restore their resource levels prior to the start of degradation.

iii) Polluted Habitat/Areas

- Stop discharge of untreated sewage;
- Stop discharge of untreated industrial wastes;
- Replenish the polluted bottom sediments in Boat Basin, Karachi Harbour and parts of Korangi Creek;
- Ensure unrestricted flushing of polluted areas with fresh seawater from the sea;
- Encourage afforestation of mangroves.

## (b) Requirements and incentives to induce action to comply with measures, such as:

### (i) Economic instruments and incentives, taking into account the "polluter pays" principle and the internalization of environmental costs;

Pakistan has introduced some economic instruments and incentives for the betterment of environmental condition. The incentives provided to the industry include free import of waste treatment equipment by the industry. All equipment for pollution combating is exempted from duties and sales tax etc. Further economic incentives should also be announced, the installation of treatment works must also be encouraged through a "Carrot and Stick Policy". The Carrot being economic incentive such as tax exemption and accelerated depreciation of the cost of equipment and the stick being the requirement to pay a discharge fee. Suitable amendments in the Pakistan Environment Ordinance would need to be made to enable this policy.

The inventory of coastal economic must be conducted in case of damage to the ecosystem by oil spillage. The total cost of damage would need to be assessed and would include both direct and indirect costs to be paid by the polluter for the restoration and rehabilitation of the resources and ecosystems over a time period of at least ten years.

The principle of subsidiary should be followed. This is similar to empowerment and implies providing all partners in the coastal zone with the knowledge, skills, information and other resources. Of importance at the international level, would be continued efforts to reform international donor and financing institutions to invest their resources to support joint local authority and community action.

### (ii) Regulatory measures:

The important role of environmental assessment (EA) in integrated coastal zone management is recognised. As a formalized process the purpose of EIA is an attempt to identify and predict the impacts of policies, legislative proposals, programmes, projects and operational procedure on the biogeo-physical environment resources and human health, and thus interprets and imparts information that could be used in management. As both the concept of ICZM and the EA process are directly linked to the sustainable development, the adoption of the principles of latter is considered as prerequisites to any management planning process. The recently established environmental courts would be help in helping in appropriate and just implementation of the environmental legislation

which regulate the pollution control management and in keeping the environmental quality within the desired levels. The various environmental legislations and ordinances which are in place are given below.

*Pakistan's Constitutional Provisions relating to Environment:*

Pakistan is a federation comprising the (a) four provinces of Balochistan, North West Frontier, the Punjab and Sindh, (b) the Islamabad Capital Territory, and (c) the Federally Administered Tribal Areas (Article 1 of the Constitution). As a result there are various sources of legislation; the Federal Parliament makes federal laws and Provincial laws are enacted by the respective provinces.

The Constitution of Pakistan, 1973, provides that the Federal Parliament and the Provincial Assemblies are all competent to legislate in environmental matters. However, in the event of any inconsistency between the Federal and the Provincial Laws, the Constitution provides that the Federal law shall prevail.

Chapter 1 of Part V of the Constitution provides for the distribution of legislative powers. The relevant Articles 141, 142 and 143 are reproduced below for case of reference:

141. Extent of Federal and Provincial Laws. Subject to the Constitution, Parliament may make laws (including laws having extra territorial operation) for the whole or any part of Pakistan, the Province or any part thereof.

142. Subject-matter of Federal and Provincial laws, - Subject to the Constitution.

(a) Parliament shall have exclusive power to make laws with respect to any matter in the Federal Legislative List;

(b) Parliament, and a Provincial Assembly also, shall have power to make laws with respect to any matter in the Concurrent Legislative List;

(c) A Provincial Assembly shall, and Parliament shall not, have power to make laws with respect to any matter not enumerated in either the Federal Legislative List or the Concurrent Legislative List; and

(d) Parliament shall have exclusive power to make laws with respect to matters not enumerated in either of the lists for such areas in the Federation as are not included in any Province.

143. Inconsistency between Federal and Provincial laws, - if any provision of an Act of a Provincial Assembly is repugnant to any provision of an act of Parliament which Parliament is competent to enact, or to any provision of any existing law with respect to any of the matters enumerated in the Concurrent Legislative List, then the Act of the Parliament; whether passed before or after the Act of the Provincial Assembly, or, as the case may be, the existing law, shall prevail and;

the Act of the Provincial Assembly shall; to the extent of the repugnancy, be void.

The enabling provisions of the Constitution notwithstanding, the law makers, both at the federal and provincial levels, have not yet introduced any specific legislation in respect of Pakistan's coastal management.

*Pakistan Environmental Protection Ordinance:*

The Pakistan Environmental Protection Ordinance ("the Environment Ordinance") was promulgated in 1983 and followed by its amendment and adoption in 1997 covering protection, conservation, rehabilitation and improvement of the environment, for prevention and control of pollution and promotion of sustainable development. It is today the principal statement of Pakistan's national commitment in this area. Pakistan's periodic Five Year Plans had, over recent years, been acknowledging the importance of environmental planning but it was through the Environment Ordinance that Pakistan for the first time in 1983 translated its environmental concerns into a legislative commitment with the resultant prospects of the rights of the public in this respect.

The Environment Ordinance extends to the whole of Pakistan and its territorial waters, Exclusive Economic Zone. It sets up a high-powered Pakistan Environmental Protection Council (section 3) and a Pakistan Environmental Protection Agency (section 5) with wide-ranging powers for both respectively (sections 4, 6 and 7). Section 8 provides for the requirement of an Environmental Impact Statement in certain conditions to be "prescribed by regulations". Section 9 provides that the Agency shall assist local councils and other local authorities or government agencies and persons in implementing "schemes for the proper disposal of waters". Penalties of imprisonment up to two years or with fines up to Rs. 100,000 or both are provided in section 12. But the Ordinance is at best a modest attempt to meet Pakistan's growing environmental degradation. It does not specially cover important areas such as water, air, marine and noise pollution specific geographical areas or ecological systems like coastal areas but the Pakistan ordinance short-listed all these only to the need to regulate development and industrial actively through the requirement of an Environmental Impact Statement (section 8).

*Environmental Impact Assessment (EIA)*

The Environment Ordinance has made the Environmental Impact Assessment (EIA) the focal point of its entire environmental effort. The requirement in respect of an Environmental Impact Statement (EIS) is the only substantive provision of the ordinance. This is provided in Section 8(2) to (5) as follows:

(2) Every proponent of a project, the construction or completion of which is likely to adversely affect the environment shall file with the Agency, at the time of planning the project, a detailed environmental impact statement including information on:

(a) The impact on the environment of the proposed industrial activity;

(b) The treatment works of the proposed project;

(c) The unavoidable adverse environmental effects of the proposed project;

(d) The steps proposed to be taken by the project proponent to minimise adverse environmental effects.

(3) The agency may prescribe guidelines for the preparation of environmental impact statements, and where such guidelines have been prescribed, the proponents of projects shall prepare environmental impact statements according to the said guidelines.

(4) The agency may itself or through the appropriate government agency review the environmental impact statement and, where it deems appropriate, it may also involve public participation in the assessment of the environmental impact statement.

(5) After the review under Sub-Section (4), the Agency may either approve the environmental impact assessment or recommend to the Federal Government that the project be modified or rejected in the interest of environmental objectives.

The above provisions of the Ordinance are, however, not directly implementable. They are left to a future determination. This is provided in Section 8(1):

(1) The provisions of this section shall apply to such -

(a) persons or class of persons, or
(b) industrial activity or class of industrial activity, or
(c) category, type or volume of discharges of air pollutants or wastes;
(d) area or class of areas, or
(e) classes of public waters as may be prescribed by regulations.

In Pakistan, much of the industrial activity is financed by Governmental agencies such as the Industrial Development Bank of Pakistan (IDBP), the Agricultural Development Bank of Pakistan (ADBP), the Pakistan Industrial Credit and Investment Corporation (PICIC), and the National Development Finance Corporation (NDFC). These agencies require detailed feasibility studies of the project that they are requested to finance.

It is proposed that the following measures be considered for the existing pollutants:

(1) they should be required to pay a Discharge Fee for their effluent discharges.

(2) economic incentives such as duty free import of pollution abatement/treatment work, accelerated depreciation and tax write-offs should be given to those entrepreneurs who rectify an existing design.

(3) to induce the installation of treatment works progressively, the Discharge Fee should be increased, say doubled every three years. After a period, the Government should have the option to close down the plant if treatment works have not been installed by then.

*Establishment of Environmental Courts*:

Government of Pakistan during late 1999 has established two Environmental Courts in Karachi and Lahore. This was announced by the Director General of Pakistan Environmental Protection Agency, Islamabad on World Environment Day. The courts have become operational with immediate effect.

**(iii) Technical assistance/co-operation/ including training of personnel;**

*a) Assistance Required:*

- Financial assistance for adequate capacity building of Environmental Protection Agencies by providing Pollution Monitoring Equipment and Training.
- Funding for developing Data Base of Pollutants.
- Transfer of Technology and expertise to combat pollution levels from various sources.
- Strengthening of institutions already engaged for the protection of marine environment.

*b) Issues that are relevant for Regional Co-operation:*

- Development of national programmes of action for the protection of marine environment from land based activities.
- Development of coastal management plan for conservation of habitats, wetlands and mangroves at national level.
- Conducting a study on the status of marine environment and identification of sources categories in relevance to Regional Plan of Action.
- Establishment of Clearing House Mechanism.
- Establishing the institutional basis for co-ordination for implementation of regional plan of action.

**(iv) Education and public awareness;**

- Involve NGOs and CBOs to play a major role in promoting environmental education and exhaustive public awareness campaigns in the coastal areas.
- Initiate programmes to educate coastal communities on the conservation and management of coastal and marine resources at local and community levels.
- Enhance public awareness amongst print and electronic media as well as government functionaries on the significance of sustainable development through integrated coastal area management.
- Implement tailored public education programmes at the town / village levels to

encourage public participation and awareness amongst local communities for a cleaner environment and sustainable use of natural resources

**(c) Identification/designation of the institutional arrangement with the authority and resources to carry out management tasks associated with the strategies and programmes, including implementation of compliance provisions;**

Pakistan has a number of agencies and institutions that are responsible for specific activities relating to natural resources and jurisdictions under both the Federal and the Provincial government, local governments and international NGOs.

| Federal organizations: | Management Tasks: |
|---|---|
| National Institute of Oceanography | R&D on ocean resources |
| Centre of Excellence in Marine Biology | Education in R&D |
| Marine Fisheries Department | R&D and Management of Fisheries |
| Zoological Survey of Pakistan | Invertebrates fauna |
| Pakistan Environmental Protection Agency (PEPA) | Legislation, Conservation |
| Pakistan Council of Scientific & Industrial Research (PCSIR) | Research on living organisms |
| Karachi Port Trust (KPT) | Maintenance/conservation of port & harbour area |
| Karachi Development Authority (KDA) | Upkeep of beaches |
| Karachi Water & Sewerage Board (KWSB) | Sewage and water treatment |
| Maritime Security Agency (MSA) | Enforcement and implementation |
| Port Qasim Authority (PQA) | Protection of harbour/port |
| Pakistan Navy (Hydrography Department) | Hydrography and navigation |
| Board of Revenue (Mangrove Forest) | Conservation of mangrove forests |
| Ministry of Environment & Urban Affairs | Enforcing legislation and making new policies on environment |
| Pakistan Armed Forces/Paramilitary forces | Monitoring, enforcement, policing |
| Provincial departments: | |
| Sindh Fisheries Department | Policy, legislation, statistics |
| Balochistan Fisheries Department | Policy, legislation, statistics |
| Balochistan Environmental Protection Agency | Policy, legislation, conservation |
| Environmental Protection Council Balochistan | Policy, legislation, conservation |
| Pasni Fisheries Harbour Authority | Regulation and fishery management |
| University of Karachi: | |
| i. Marine Reference Collection Resource Centre ] | |
| ii. Institute of Marine Sciences ] | Education, training & research |
| iii. Department of Zoology ] | |
| iv. Department of Botany ] | |

| | |
|---|---|
| Coastal Development Authority (CDA) Sindh | Coastal development Sindh |
| Environmental Protection Agency Sindh. | Conservation of environment |
| Sindh Wildlife Department (Turtles) | Conservation of Turtles |
| Sindh and Balochistan Forests Departments | Management of forests (Mangroves) |
| Karachi Metropolitan Corporation | Waste management |

Local Government:

| | |
|---|---|
| City Councils of various districts. | Community participation |

NGOs:

| | |
|---|---|
| CBO (Community based organizations) | |
| IUCN | Advocacy and Awareness |
| WWF | |

**(d) Identification of short-term and long-term data-collection and research needs;**

Information and data: A wide range of interdisciplinary and inter-sectoral information required. These include information and data on coastal resources, wild life, forestry, fisheries, and environment including land, water and air. Therefore, there is need for data / information on physical environment, climate, geomorphology, hydrology, oceanography, biological environment, non-biological resources, impact of developments on the environment, demography, coastal development, industries, business and trade, cultural, NGOs, CBOs, recreational and socio-economic aspects.

There is a need for a multi-purpose numerical modeling system. An adequate knowledge of oceanographic conditions e.g. current speeds, circulation patterns, water stratification, mixing rate, wave climate and wave refraction patterns, distribution of salinity, temperature, dissolved oxygen and nutrients is essential for coastal zone management. . Some basic information on physical conditions could be derived from satellite imageries for which facilities do exist in Pakistan. A multi-purpose numerical modeling system is indispensable for a good evaluation of the distribution of pollutants and other substances into the channels, creeks and in the coastal zone. Models can be beneficial to the determination of the flow circulation, residual flows, effects of storm surges on the distribution of matter; the wave effects in navigation channels, the rate of littoral sediment transport; the water quality e.g. BOD-DO, oxygen depletion and bacterial decay balances, organic nitrogen-, ammonia-, nitrate and nitrite balances; eutrophication e.g. phytoplankton, benthic algae, zooplankton, oxygen balances and mineralization estimates; heavy metals distribution patterns and waste discharge and concentration studies. At present there is a great need for a training program for the set up and elaboration of such a modeling system.

GIS system: Geographic Information System (GIS) is being implemented by UNEP on a global scale. Planning was regarded as a fundamental step in any ICZM activity. The

need for information and data on the environment and the resources of the area to be managed was considered as prerequisites for any planning process. Wrong decisions without a proper planning could cause irreversible effects. Resource maps could be excellent tools for determining the scope and scale of management as well as thematic approach; they are cheap and could be used by a variety of professionals including planners, demographers, NGOs as well as for raising public awareness. Maps do not compete with other description material. Stressing the need for a national data center for CIS system, it was stated that Pakistan, having already acquired considerable know-how in marine environmental and resource studies, has reached the stage for GIS system to be introduced.

**(e) Development of a monitoring and environmental-quality reporting system to review and, if necessary, help adapt the strategies and programmes;**

The federal government institutions such as MSA, NIO, MFD, PEPA, Zoological Survey Department, SUPARCO, CEMB and Ministry of Communications (Ports & Shipping Wing) should prepare monitoring programmes for the areas/domain under their jurisdiction. The provincial EPAs should prepare reporting systems to check the incidences of violations of the Environment Protection Ordinances and the rules formulated under them. A high level ministerial committee should periodically review the monitoring and reporting strategies and adopt changes accordingly.

Environmental monitoring, together with pertinent research and assessment activities is considered as a key element of integrated coastal area management and an iterative and evolutionary process that strives to harmonize resource use strategies, socio-economic factors, and institutional arrangements in order to ensure sustainable benefits of the coastal zone. Monitoring programme should be comprehensive to include spatial distribution and long term trends in contaminant concentrations in the environment, biota and ecosystems and validation of models aimed at predicting consequences of different environmental management scenario and actions. It is proposed that future coastal environmental monitoring in Pakistan, or collectively in the north Arabian Sea region, follow a tiered approach in sampling intensity; a sparse network of permanent monitoring sites encompassing the whole region; and intensive, relatively short-term monitoring of specific areas that are most directly affected by and are at risk from coastal pollution and habitat losses. The programme must be tailored to address specific environmental and ecosystem management needs, based on the relative importance of different pollutant categories encompassing: conventional pollutants (suspended solids, oil and grease, fecal coliform bacteria); non-conventional and priority pollutants such as metals, organo-chlorines, and other xenobiotic substance. This strategy is considered particularly relevant to Pakistan where different physiographic segments of the coastline also have markedly different environmental issues such as the Indus Delta coast (reduced freshwater flow from Indus River affecting mangrove ecosystems, shrimp aquaculture sites and biological productivity), Karachi coast (massive and large uncontrolled pollution from municipal and industrial sources causing degraded habitats, diminished aesthetic values and risks to human health), Lasbella coast (nascent shellfish fishery, recreational use of beaches, and impending industrial development sites), and the

relatively pristine Makran coast (sea-level change, marine biodiversity, fisheries economy, and potential development of mineral resources).

**(f) Identification of sources of finance and mechanisms available to cover the costs of administering and managing the strategies and programmes;**

The following financial sources are identified for the implementation of strategies & programmes.

- World Bank assisted Project for Environmental Protection and Resources Conservation, which will continue till June 1999.

- Combined Effluent Treatment plant being established for treatment of Tannery effluent being funded by the Dutch Government.

- Funding of Asian Development Bank for treatment of Industrial waste water for one of the Industrial Estate.

- Partial funding of Netherlands Government for Federation of Pakistan Chambers of Commerce and Industry for adoption cleaner technology.

## E. CRITERIA FOR EVALUATING THE EFFECTIVENESS OF STRATEGIES AND MEASURES

Pakistan issued an Ordinance (1993) for environment protection paving the way for efficient and reliable environmental reporting by several agencies at the Federal and Provincial levels. An integrated environmental information system has been outlined. The monitoring measures include the use of inventories and satellite imageries for resource and environmental monitoring, feedback and control The major projects included: development of a system for environmental monitoring, including water pollution monitoring, air pollution monitoring using plants as bio-indicators, enforcement of control standard for industrial gaseous emissions and motor vehicle exhaust and noise.

In most developing countries like Pakistan environment is regarded as an unwanted stepchild of development. Economic performance is of central relevance for environment because it is essential for alleviation of poverty, which is one of the major factors for environmental deterioration. People in coastal areas tend to use the resources unsustainable by clearing trees for fuel and fodder for animals often find themselves in situation when the coastal ecosystem productivity diminishes and can no longer support their livelihood. These coastal communities migrate in large numbers to cities, increasing the pressure on the urban environment. Continued and unplanned industrialization of the Karachi has degraded by natural environment by destruction of habitats and by unabated pollution with the most serious problems affecting fresh water, and coastal ecosystems. Rapid urbanisation, coupled with increased ownership of motor vehicles, have contributed to air, water and land pollution and lowering the quality of life in the city where an increasing proportion (13 million) of the region's population live. The various strategies and approaches to achieve progress have now been free of cost. For rapid but sustainable growth, economic policies are needed that influence the pace of output growth, and are tied to policies for human resource development and for the protection of environmental resources. Experience in other parts of the world has shown that where natural resources are limited, but industrial development is rapid, market forces will encourage the development of newer technologies which are more resource conserving. It is the task of policy makers to make sure that economic instruments are in places to promote this change (ESCAP-1995).

In order to evaluate the effectiveness of various strategies and programmes the following measures and criteria are proposed.

### 1. Monitoring and assessment framework:

- A legal framework for the institutional arrangements to monitor the progress and implementation of NAP and issue regular progress reports;
- Coordination and collaboration of all relevant government agencies;
- Participation of all stakeholders;
- Timely feedback to take up corrective measures and actions
- Interest groups / stakeholders / NGOs / CBOs and Government agencies to monitor implementation in specific sectors;

## 2. Setting-up an Assessment System for NAP:

- Ministry of Environment, Local Government and Rural Development, Government of Pakistan will coordinate and provide a platform to organise a forum for rountables on NAP;
- Identification of Stakeholders involved in assessment process;
- Collection of necessary information and data required for assessment;
- Organise as assessment exercise and roundtable and determine issues and - indicators for assessment and progress monitoring;
- Collection of additional information and data on the issues and indicators identified in the assessment excerise.

## 3. Monitoring Implementation of NAP:

- *Setting-up Specific Indicators:*

  - The implementation mechanism for NAP has to be in place to monitor its implementation. The specific indicators to signal levels of progress on the implementation will have to be worked out separately on sub-project wise and on sectoral basis.
  - The regular monitoring with reference to the availability and release of funds for various sub-projects, physical progress. Resource allocation and utilization of funds and in achieving the objectives of the NAP in various sectors.

- *Environment / Ecosystem Monitoring:*

  - Land: (Land-use patterns, soil texture, water logging / salinity, land conversion and degradation);
  - Water: (Water Quality and levels of selected contaminants of estuaries, water sheds, inland and coastal waters; Diversity of Brackish water and marine ecosystems, water discharges to coastal water sheds, deltas, mangrove forests and estuaries);
  - Air: ( Local air quality, levels of contaminants in the emissions from automobiles and industries);
  - Species and population: (Changes in coastal vegetation, Mangrove species and area under mangrove forest, Status of birds, wild fauna and flora; population of domestic animals; changes in common and dominant wild catch species i.e. fish, shrimp, etc., from brackish / estuarine and coastal waters;
  - Resource use: (Status of agriculture, forestry and fisheries, etc., waste generation and disposal ; energy, materials, recycling, levels of contaminants in the resources);
  - Coastal Communities: (Health and population, wealth, knowledge and culture, community participation, community structure, trade and professions);

- *Operationalising the Monitoring Programme:*

  - *Government:*

    The existing government agencies such as Ministry of nvironment in the federal and EPAs in the provincial governments will perform their jobs to launch the NAP.

    Each Government agency / department involved in the NAP will have to play its active role in launching and implementing NAP. They will have to plan and monitor their own progress and provide feedback to its management and respective roundtables and to other

designated agencies for reflection and action for NAP.

- *Community participation:*
  The local communities, NGOs, CBOs and private sector will play an active role in launching and implementing NAP. They will have milestones and indicators to measure progress and would provide regular feedback to the management, roundtables and to designated bodies for discussion and course correction.

- *Review of NAP for making adjustments:*

*Periodic Review of Implementation of NAP to assess*:

- the objectives, indicators of progress and the levels of achievements;
- the progress on provision of legal, financial and human resource required to implement the NAP;
- to check the levels of required institutional support;
- to incorporate the experiences and feedback for successful implementation of NAP;
- to review the objectives and priorities within the overall objectives of GPA and national priorities;
- A team of relevant experts should help review the NAP to adjust to the changes, new demands and national priorities.

## 4. Institutional Arrangements for Monitoring and Assessment of NAP:

- *Governance:*
  A Steering Committee will oversee the implementation of NAP, oversee the monitoring and assessment process and provide high level advice. It will also determine the time table and timing of the Review of NAP as well as periodic assessment of the progress. The focal point at the Ministry of Environment, Local Government and Rural Development, Government of Pakistan will coordinate these activities.

- *Institutional set-up*:
  The Ministry of Environment, Local Government and Rural Development, Government of Pakistan will establish an independent monitoring and assessment body to monitor implementation of NAP.

# F. PROGRAMME SUPPORT ELEMENTS

## a) Organisational arrangements to co-ordinate among sectors and sectoral institutions;

Constitute a high level inter-ministerial steering committee to develop and coordinate the implementation of national plans for integrated coastal area management. This committee should be assisted by provincial high level steering committees who should look after coordination and implementation of provincial plans for coastal area management and sustainable development. These steering committees should be able to co-opt members as required for certain specific management tasks and should also appoint consultants to prepare short-term and long-term plans and strategies for the sustainable development of the coastal area keeping in view the participatory approach,

involvement of CBOs and NGOs and the local scientific and administrative agencies. The local experts, scientific institutions and CBOs should also be involved to prepare and implement appropriate strategies and plans for implementing and monitoring of coastal area management.

On the management planning of coastal zone in Sindh, a number of institutions were reported to be involved: they represent local, provincial and federal governments, ad hoc bodies, researching institutions, non-governmental organizations and private parties. More than 30 agencies were cited to have jurisdiction/concern in the area. A number of institutions are concerned with the management structure encompassing land sale/lease, quality development, law enforcement, tourism, promotion of development, education, maintenance and coordination.

For the sparsely populated Balochistan coast, extending from Lasbela near Karachi to Makran coast at the Iranian border, the existing socio-economic conditions were described with particular reference to the limited resources that are available in terms of agriculture crops, livestock, educational facilities, health and availability of essential support systems such as water and energy. Reference was made to the plans to attract investment from both public and private sectors to support development activities around Gawadar, a fish harbour, Pasni a fishing port, Ormara, Jewani and other coastal towns.

High priority is reported to have been given to develop accessibility to various coastal areas by constructing road network through out the coastal region. As part of water management in the coastal area the projected construction of dams on the Hingol River, at Mirani on Dasht River and Acra near Gwadar were briefly discussed.

**b) Financial mechanisms (including innovative approaches to provide continuing and predictable programme funding);**

Users of all the coastal and marine resources, particularly marine parks and protected areas, recreational facilities can generate necessary funds on continuing basis for their maintenance and for the implementation of the environmental programmes.

Small interest free loans should be made available to the local communities in the coastal areas to alleviate poverty with a view to generate financial resources using indigenous expertise by utilizing coastal resources that are renewable, on a sustainable basis.

**(c) Means of identifying and pursuing research and monitoring requirements in support of the programme;**

*a) Means for Research on Environment / Development Issues and Monitoring:*

The technical resources in the public sector organsiations involved in managing the coastal resource, their protection, conservation and the existing and new R & D organisation working on the coastal and marine resources provide the backbone in planning, initiating the issues and problem areas in coastal resource management,

protection and sustainable development. NGOs, CBOs, local coastal communities provide help in identifying the main socio-economic problems and problem areas for management and protection. The issues and problem areas so identified then serve as the basis for development of research and monitoring programmes and projects funded by the government and foreign donor agencies. The financial resources are must for the implementation of research and monitoring programmes.

A number of issues and problem areas relating to the protection of coastal and marine resources from land based activities have been identified by the existing means in the country. The future R & D and environmental monitoring programmes would have to take into account the current issues and issues projected for near future. These issues and problems include the following:

> Issues and problems in the implementation of ICZM tailored to the local requirements; Introduction of new industries and new products in the coastal zone to meet the objectives with defined policy for sustained development of coastal and marine resources. Issues relating to cost and benefit analysis for Environmental costs versus development projects particularly in the sensitive ecological areas; Industrial development versus strict environmental controls; Issue of rehabilitating Indus Delta Mangrove Forest and its ecosystem with reference to Indus River Discharge to Delta; Introduction of environmental friendly technologies; Acquiring larger fishing fleet capacity for deep sea and EEZ fisheries; Provision of good infrastructure and on-shore facilities to operate fishing industry for greater productivity. Improved institutional developmental infrastructure of provincial and federal governments for coastal resource management. Acquisition of modern aqua-culture technology; Incentives for better environmental controls and introducing environmental friendly technologies for modernization of existing industrial plants; Incentives should be provided for export of value-added products from coastal resources; Exploration for sustainable use of non-living resources such as mineral, ores, hydrocarbon, gas hydrates, renewable energy sources; Attracting investment in setting up industries and tourism in the coastal areas to boost the national economy.

*b) Supporting scientific management of mangroves and fishery resources*

There is a strong need to put mangrove areas within Indus Delta under the control of an appropriate organization. Similarly, there is a strong need to put mangrove areas at Gwadar Bay, Kalmat Hor under the control of one organization. There is also a need for survey and monitor of mangroves along the Balochistan coast. There are key areas for local artisanal fisheries. Miani Hor produces one of the world's best quality shrimps. The mangroves provide ideal condition for the growth of post larval shrimps of the family penaeidae. It is therefore necessary that these mangroves are conserved and put under scientific management.

There is substantial potential for development of non-conventional fisheries resources through mari-culture of invertebrates such as oysters, clams, mussels, mantis shrimps, crabs, lobsters etc. Special programmes for development of this industry should be formulated and implemented on a sustainable basis.

*c) Improving cooperation and coordination among agencies*

There is lack of cooperation and coordination among agencies, research institutions, government departments and NGOs. All these organizations work in isolation with very little coordination, this often results in overlapping and duplicating of efforts. An integrated approach is needed to pool in the existing resources and develop programmes that can contribute towards future economic development and contribute toward national economy.

*d) Revamping facilities for Coastal Resource Management*

*i) Fisheries:* The fishing boats, fish catch technology, fish harbour and jetties need revamping / up-gradation. Primitive techniques and fish handling procedures are the main cause of fish quality. Generally two steps are required, firstly maintenance of quality should be ensured through legal measures while the boats are at sea and secondly, the technology for handling and transport of fish at the port or landing areas should be substantially upgraded to ensure that the quality of fish does not fall below acceptable standards and that the otherwise valuable fish does not end up in fish meal plants.

*ii) Communication, roads and highways:* All weather metalled roads should be given priority and developed along the coast. These roads would open up the area for investment in fish and non-fish related industries. The cost of these roads can easily be recovered by toll taxes and octroi on fish and fishery products. An effective road network would integrate the least developed coastal areas into the main stream economic and industrial development and increase employment opportunities.

**(d) Contingency Planning;**

There is a need to prepare contingency plans in the following priority areas:

*I. Oil Spill Emergencies*

1) National contingency plan to meet oil spill emergencies in the coastal and adjacent offshore areas within the territorial limits of Pakistan.
2) All ports and harbours within the country should prepare contingency plans to combat oil pollution within the areas under their jurisdiction.

*II. Storm Surge / Cyclone Disasters*

1) Provincial governments, Coastal Development Authorities and District Level Coastal Administration should prepare storm surge / cyclone disaster contingency plans to deal with emergencies in the coastal areas during and after cyclone disasters.

*III. Emergencies due to mishandling / spills of hazardous chemicals, radioactive material, etc., during use or transportation.*

1) There is a need to prepare contingency plans to meet the emergent situation with reference to the mishandling / spills of hazardous chemicals to protect the coastal and marine areas. There should be separate plans for

the situation arising due to mishandling during transportation through coastal areas or their accidental spills during their use within the industry and laboratories in the coastal areas.

2) There is also a need to prepare contingency plans to meet the emergencies due to mishandling of radioactive substances or mishandling of hazardous radioactive chemicals with reference to the possible contamination of the marine environment.

**(e) Human resources development and education;**

2) *Capacity building and institutional strengthening involved in Management and R&D Coastal Resources*

There exists a need to strengthen the technical and professional capability at all levels that deal with coastal and marine resource management, development, R & D and enforcement of environmental legislation. There is also need for institutional capacity building related to existing structure and linkages - a continued substantial initial investment in modern equipment and physical structure is required on urgent basis..

*Revamping EPAs,CDA, Departments of Fisheries,and Forestry:* There exists a need to strengthen the technical and professional capability at all levels that deal with coastal marine resource development such as forestry, fisheries, EPAs, CDA. There is need for institutional capacity building related to existing structure and linkages - a continued substantial initial investment in modern equipment and physical structure is required on urgent basis.

Federal and provincial departments responsible for coastal development and marine fisheries need to be strengthened, these are inadequately staffed to undertake all the necessary activities relating to monitoring, law enforcement, planning and development. Facilities like a well equipped laboratories are lacking. These departments need to be adequately revamped and provided with requisite information, set up fishery data base, have proper equipment to discharge their legal responsibility, undertake research and development programme in sectors of improved marine resource management, fisheries techniques, fish handling, processing and improving the quality of fish and fishery products. This also includes development of fishing gears, aquaculture techniques, fish processing, sea ranching, fish quality inspectors and supervisors etc.

**(f) Public participation and awareness (e.g., based on integrated coastal area management principles);**

*1) Participatory community based approach for future management of coastal resources*

Although fishing is the predominant economic activity of almost all coastal communities they are not socially, politically and economically organised to upgrade this economic

activity. The community based organizations and the role of NGOs as well as of the local government is virtually absent. Small fishing communities have no infrastructure for landing and handling of their catch. Consequently there is substantial wastage and degradation of the quality of the catch. A study may be carried out to provide these communities with appropriate low cost and locally maintainable facilities. Government and concerned NGOs should endeavour to improve this situation. Participatory approach is also needed to improve the coastal sanitary conditions, alleviate poverty and to initiate community based socio-economic projects for the management of coastal resources.

*2) Promoting co-management and gender equality*

The Government of Pakistan should encourage females to contribute toward coastal development activities together with their male counterparts. Active participation of women in fish handling/processing, environmental education programme, aquaculture, health, research should be encouraged to promote gender equality and further improve the socio-economic condition of coastal communities. Gender discrimination should be discouraged in all sectors of development.

*3) Raising awareness among people, government and NGOs/CBOs*

Steps should be taken to create general awareness about fisheries, environment and pollution among the general public. Extension services need to be strengthened in Pakistan coastal areas. Extension services for fishing, processing, marketing and aqua-culture should be made available to the private sector. A study should be conducted to determine the requirement of trained manpower. Because there is no institution that conducts training and education in marine environment and fisheries, a training center be established in coastal fishing villages.

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**LIST OF ABBREVIATIONS**

| | |
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| ADB | Asian Development Bank |
| BOD | Biological Oxygen Demand |
| CBO | Community Based Organization |
| EEZ | Exclusive Economic Zone |
| EIA | Environmental Impact Assessment |
| ESCAP | Economic and Social Commission for Asia and the Pacific |
| GIS | Geographic Information System |
| GOP | Government of Pakistan |
| GPA | Global Programme of Action |
| HITE | Hub Industrial Trading Estates |
| ICZM | Integrated Coastal Zone Management |
| IUCN | International Union for the Conservation of Nature |
| KIA | Korangi Industrial Area |
| LBOD | Left Bank Outfall Drain (National Project) |
| LITE | Landhi Industrial Trading Estates |
| MAF | Million Acre Feet |
| MFD | Marine Fisheries Department |
| NEQS | National Environmental Quality Standards |
| NGO | Non Governmental Organization |
| NIO | National Institute of Oceanography |
| KESC | Karachi Electric Supply Corporation |
| KW&SB | Karachi Water & Sewerage Board |
| KPT | Karachi Port Trust |
| LBOD | Left Bank Out-fall Drain Project |
| PEPA | Pakistan Environmental Protection Agency |
| PQA | Port Qasim Authority |
| R&D | Research and Development |
| Rs | Pakistan Rupees |
| SITE | Sindh Industrial Trading Estates |
| SUPARCO | Space and Upper Atmospheric Research Commission |

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| UNEP | United Nation Environmental Programme |