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REGIONAL SEAS

Overview on Land-based Sources and Activities Affecting the Marine Environment in the South Asian Seas

UNEP Regional Seas Reports and Studies No. ?

Submitted to:

South Asia Co-operative Environment Programme

Prepared by:

Integrated Coastal and Marine Area Management Project Directorate
Department of Ocean Development
Chennai

UNITED NATIONS ENVIRONMENT PROGRAMME

2001

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Contents

Abbreviations

NRB National Report of Bangladesh
NRP National Report of Pakistan
NRS National Report of Srilanka
NRN National Report of Nepal

Regional Overview of Environmental Problems

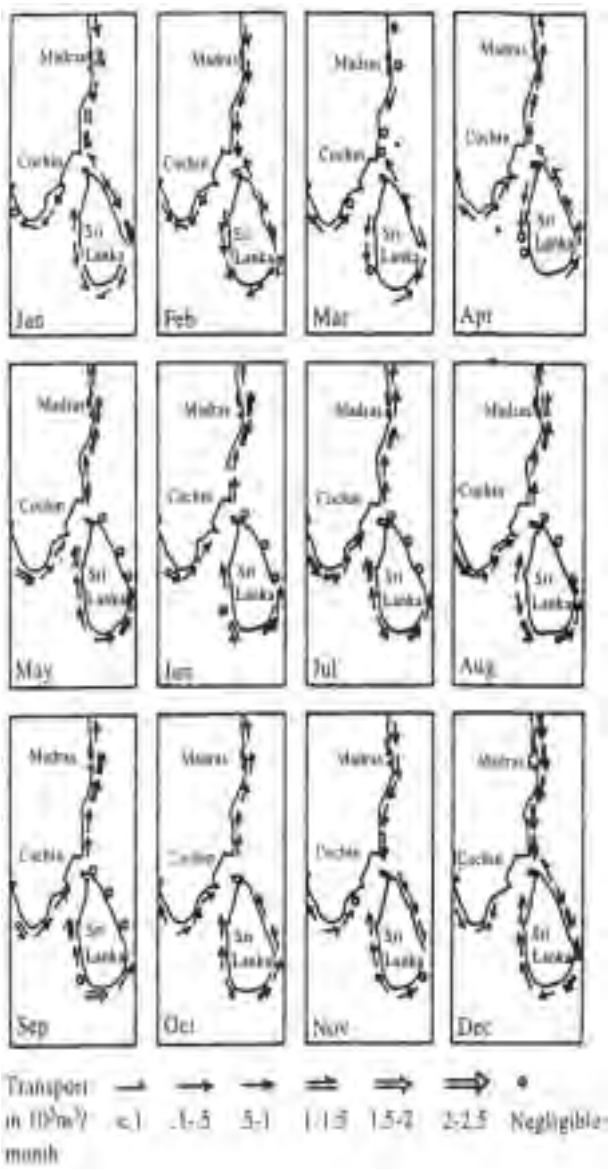
The South Asian countries bordering, the Arabian Sea and the Bay of Bengal have some of the largest and biologically rich marine ecosystems like Gulf of Mannar, Atolls of Maldives and Mangroves of Sundarbans. Presence of perennial rivers like Brahmaputra, Ganges, Godavari, Indus, Kelani, Magna, etc. have contributed to large network of backwaters, estuaries, salt marshes and mangroves. The Sunderbans is one of the largest mangrove formations in the world. The mangrove area of Sunderban in Bangladesh is reported to be 571,508 hectares and the Indian side of Sunderban form an area of 418,888 hectares (NRB and NRR 1999). Atolls of Maldives and a few areas of beaches of Sri Lanka, east coast of India, Pakistan and Bangladesh form habitat for endangered marine turtles like green and olive ridley turtles. Some of the largest coastal lagoons of the world like Chilka lake (India) and Puttalam lagoon (Sri Lanka) are located in the South Asian Seas region. The region has one of the world's finest coral ecosystem with the atolls constituting the entire country of Maldives. The Lakshadweep and Nicobar group of islands of India and a few regions of Sri Lanka have fringing reefs.

1.0. OCEANOGRAPHIC CHARACTERISTICS OF SOUTH ASIAN SEAS

1.1. Circulation

The environmental characteristics of South Asia Region have been described in UNEP Regional Seas Report and Studies No.82 (1987). The seas bordering South Asian countries, namely, Bangladesh, India, Maldives, Pakistan and Sri Lanka cover the Northern part of the Indian Ocean with the Bay of Bengal and the Arabian Sea as their Northern limits and South of Equator as their southern limit. The countries have bays, gulfs and straights. The geo-morphological nature of the South Asian continent greatly influence the oceanography of the area.

Figure 1. Coastal currents around South India and Sri Lanka



Monsoons are the characteristic features of the South Asia. Annually, two monsoons occur, namely, South-west (May - September) and North-east (October - December). The South-west monsoon current flows eastward along the west coast of India and reaches upto 3 knots of South of Sri Lanka. The funnel shaped continent at its tip in India and Sri Lanka makes the current to flow clock-wise, both in the Arabian Sea and in the Bay of Bengal (**Fig.1)** The Somali current prevailing along the East African coast is influenced by the stronger wind and causes this current to flow towards northerly direction in the Arabian Sea, resulting in a cold, nutrient-rich upwelling along the Somali coast. The South-west monsoon, which is active over the Arabian Sea region of India and Pakistan, brings heavy rains, especially in the South-west and Central part of the West Coast of India with an average annual rainfall of 3000 - 3500 mm. During the period of south-west monsoon, strong upwelling currents are noticed particularly along the south-west coast of India. The north-west monsoon is stronger in the Bay of Bengal and weaker in the Arabian Sea. Annually, it brings at least 2 - 3 cyclones with an intensity of wind reaching upto 100 knots with a surge of nearly 10 m.

The littoral drift is prominent in the western part of Bay of Bengal with a drift from south to north during March - November and north to south during December - February. The upwelling, monsoonal currents, cyclones and littoral drifts influence the physical aspects of coastline of south Asia significantly.

1.2. Salinity

The salinity of coastal waters is influenced by the monsoon, especially along the Bay of Bengal, where traces of low salinity is detectable in the river mouth, however, it is insignificant in the offshore areas. In the Arabian Sea, evaporation exceeds precipitation and excess of evaporation over precipitation is maximum (100 - 150 cm) in the Arabian Coast and gradually decreases towards south-east part of the Arabian Sea. The high salinity water noted in the Persian Gulf enters into the Arabian Sea and is detectable upto a depth of 300 m. However, beyond 63^{o}E longitude, it loses its characteristics in the southern Arabian Sea. The Bay of Bengal, where the precipitation exceeds evaporation, due to heavy discharge of fresh water from the rivers especially during the monsoon months exhibit lower levels of salinity. This is prominent in the northern part of the Bay of Bengal.

1.3. Tides and Waves

Both diurnal and semi- diurnal tides have been observed in the South Asia Seas Region. High tidal ranges from 3 -8 m and 6 - 12 m observed in the north-western part of India. The tidal amplitude decreases gradually towards South and, along the east coast of Sri Lanka, the mean spring tide is about 1 m.

2.0. COASTAL FISHERY RESOURCES

The fishery of South Asian Seas comprises mostly of fishes, shrimp, squids and crabs. The coastal waters are rich in fisheries and provide livelihood to a large number of fishermen and personnel employed in the allied industries.

In Bangladesh, demersal fishing potential of offshore areas is estimated to be 20,000 tonnes. Fish ranks next to rice as a staple food constituting 80% of the daily per capita annual production. It provides employment to about 10 million people. The fish landing as of 1981 was 13000 tonnes. Large number of people are engaged in the estuaries and mangrove area fishing. The annual yield from Sunderban mangrove areas alone is 7160 tonnes. At present 19% of the total fishing is from coastal and marine areas, 64% from rivers, 15% from small fresh water bodies and 1% from large fresh water bodies and 1% from brackishwater ponds. It has been recorded that the Bay of Bengal part of Bangladesh has 475 species of fish and 10 species of prawns (NRB, 1999).

In India, the estimated fishery potential at 0-50 m is 2.25 million tonnes and beyond 50 m depth it is 1.4 million tonnes. The current yield is 2.95 million tonnes at an estimated value of US$1250 million. The

resources upto a depth of 50 m are being fully exploited. Out of available potential of 1.4 million tonnes in the offshore region, it is estimated that only 1.13 million tonnes is of commercial value. About 86% of this potential is estimated to be of low commercial value. Over the years, commercial fisheries, primarily exploit high priced shrimp, lobsters and certain finfishes found in coastal areas upto 50 m depth. The coastal fishermen with an estimated population of 22 million consume fish as staple food next to rice and vegetables.(CSD, 1995)

In Pakistan, 0.4 million metric tonnes of fishery resources were exploited during the year 1998. The fishery resource of the mesopelagic waters is estimated to be 1 million tonnes. The technology for harvesting is yet to be developed. Still the traditional methods of fishing is common. The primary gear used is gill net. (NRP, 1999).

The estimated fishery production in the coastal waters of Sri Lanka is 153000 tonnes. Of this about 3250 tonnes were exploited during the year 1997. The estuaries and lagoons present throughout the coastline also support fishery. In 1997 export of prawns generated foreign exchange to the tune of Rs.2.2 billion equivalent to 51% of total exports (NRS, 1999).'

3.0. COASTAL ECOSYSTEMS

3.1. Mangroves

In Bangladesh, coastal zone is extensively covered with dense mangrove forest. The ancient travel documents of 19th century describes presence of mangrove forest all over the coast especially in the central and west region (NRB, 1999). The Ganges, Brahmaputra and Magna Delta has provided largest mangrove forest of the world covering an area of 571,508 hectares of which in 70000 hectares consist of tidal channels and rivers (NRB, 1999). The area termed as Sunderbans represent 12.5% of the forest cover of the country. Mangrove forest also occur in the central part of the delta. Mangrove ecosystem support coastal fisheries and other economic activities of the local population. In India, the mangrove formations are found in the Gangetic West Bengal termed as Sunderbans (418,888 hectares), Andaman & Nicobar islands (15000 hectares) in the deltaic region of Krishna, Cauvery and Mahanadhi rivers and in the Gulf of Kachchh. The west coast contains patchy mangroves (CSD 1995). Mangroves form one of the natural defence against the cyclones along the east coast. In Pakistan, along the 990 km coastline, mangrove formations are found in the Indus delta and in Baluchistan covering an area of 18,150 acres (NRP, 1999). In Sri Lanka, Mangroves serve as a narrow inter-tidal belt in estuaries and lagoons. The total coverage of Mangroves in the country was 8687 sq.km in 1993 (NRS, 1999). Most extensive coverage of mangroves occur in the Puttalam district followed by Triconomallee and Batticoaloa.

3.2. Coral Reefs

In Bangaldesh, coral reef formation has been reported from St.Martin islands which is about 6 miles off from the main land of Bangladesh and is situated closely to Myanmar (NRB,1999). In India, the coral formations are in Lakshadweep Islands which is a group of islands of coral origin, Andaman & Nicobar group of islands, 19 islands of Gulf of Mannar and a few areas of Palk Bay and in the southern part of Gulf of Kachchh (CSD 1995). 342 species of corals belonging to 76 genera have been reported from the seas surrounding India. The Maldives, being an island country formed out of corals, has about 15 atolls. In Pakistan, very few patchy corals present mostly in the coastal and offshore areas of Balochistan (NRP, 1999). In Sri Lanka, coral reef are formed as fringing reefs and they are centred around the entire coast. The major ones are in Arippu, Point Pedro, Foul Point, Thennady Bay etc. Coral coverage is more in the northern and eastern part of the country compared to the west and southern part (NRS, 1999). (NRS, 1999)

3.3. Sea grasses

Sea grass ecosystem in India is present in the Gulf of Mannar, Lakshadweep and Andaman & Nicobar and

Gulf of Kachchh. Abundance is estimated to be 700 to 800 metric tonnes. 14 species of seagrasses have been reported (CSD 1995). In Sri Lanka, seagrass beds are abundant along the open coast as well as within estuaries and lagoons. Large bed covers are reported from the Dutch Bay to Jaffna lagoon. At Mannar, the seagrass beds extend to the northwest, towards islands in India (NRS, 1999).

3.4. Coastal Lagoons

In India, coastal lagoons like Chilka, Pulicat, Vembanad lake etc are the prominent coastal lagoons which support both urban and rural population to meet their livelihoods. While the Vembanad lake is surrounded by urban settlements, part of Chilka lake are encircled by rural settlements with very less industries in these areas (CSD 1995). In Pakistan, the south eastern parts of Sind province has a belt of low lying areas measuring 4000 sq.km area. There are shallow/brackishwater lagoons adjacent to the mudflats between Indus delta and Rann of Kachchh (NRP, 1999). In Sri Lanka, the coastal lagoons are prominent along the west coast. Puttalam, Jaffna, Kudaimanu, Batticolaoa and Negamboo lagoons support the wide variety of fishing activities benefitting the local population (NRS, 1999). The settlements are mostly semi-urban to rural in nature with very few industries in these areas. However, usage of lagoons as harbours and disposal of sewage is also seen.

3.5. Estuaries

In Bangladesh, estuarine formations are in the Ganges-Brahmapura-Magna river system which result in Sunderban mangroves. The Karnaphuzhi estuary is one of the major estuarine systems of the country with human settlements all along the estuary (NRB, 1999). In India, the estuaries are prominent all along the east and west coast and the major ones are Hooghly, Mahanadhi, Godavari, Mandovi, Zuari, Tapi, Cochin backwaters and Narmada. Urban, semi-urban settlements and industrial developments are found on the banks of most of these estuaries. The mega city of Calcutta is located along the bank of Hooghly. There are number of small estuaries which are fed by monsoonal fresh water flow. In Pakistan, estuarine formations are mostly in the Indus delta and human settlements and developments are also found along the estuaries. In Sri Lanka, prominent estuaries are also formed as lagoons, the example being Negomboo estuary, Kelani estuary and Valaichchenal estuary(NRS, 1995). Urban and semi-urban settlements are found around these estuaries.

4.0. ENVIRONMENTAL PROBLEMS IN THE COASTAL MARINE REGIONS OF SOUTH ASIA

Large cities like Karachi, Mumbai, Chennai, Calcutta, Dhaka and Colombo are located along/near the coastal areas of the South Asia. Besides fast developing cities like Goa, Mangalore, Cochin, Visakhapatnam, Male, Chittagong are also located along the coastline. The total estimated population living along the coastline areas (10 – 40 km from coastal line) of the South Asian region is as follows:

S.No.	Country	Population in Million	Length of Coastline
1	Bangladesh	30.00	
2	India	184.00	
3	Maldives	0.20	
4	Pakistan *	13.00	
5	Sri Lanka	6.12	
	Total	**233.32**	
	** Data available for Karachi only*		

It may be noted that the population density varies from country to country, more towards higher density. The presence of large population is due to developmental activities attracting the coastal areas, due to obvious reasons of using the sea as a place for waste disposal/ dumping. Such combinations of increasing population and rapid industrial growth, combined with inadequate efforts in the management of wastes, have led to moderate to serious threat to the quality of coastal and marine environment. The waste from the industries and the domestic sources reach the adjoining coastal environment through rivers and creeks.

Figure 2. Water ways of Chennai carrying sewerage and industrial effluents into the sea

4.1. Solid Wastes

Considering the large size of population living along the coastal areas, the estimated solid waste generated by the population is about 11650 tonnes per day (estimated average of 0.5 kg per person per day) The solid waste generally arises from domestic and industrial sources. The composition of the solid waste for most of the urban in the region is almost the same as given in the National Report of Pakistan, for Karachi (NRP, 1999).

Paper	3.6%
Plastic	2.1%
Rags	7.1%
Metal	0.2%
Glass piece	2.5%
Fine piece	18.2%
Composed matter	52.0%
Moisture	43.1%

The domestic waste also includes waste from the hospitals which pose a serious threat of infection and communicable diseases. The waste from the rural areas mostly composed of paper, plastics and bio-degradable matter. The solid waste generated is only partially collected and the rest are dumped in a haphazard manner in the open areas (CSD 1995, NRB, NRP &NRS, 1999). The collected wastes are dumped in open areas outside the city/town limits and incinerated in the open air. Even though the quality of emissions are to be checked, most often it is believed that it contains certain toxic compounds as well as harmful bacteria, as the wastes also contain hospital wastes, plastics and composed matter.

4.2. Sewage

Estimates indicate that an average of 50 litres of water is used by an individual in a day, out of which 30 litres results in waste, giving an approx. figure of the total waste water generated as 7000 Million Litres Day (MLD) in the coastal areas of all the South Asian countries.

Domestic waste carried through municipal sewerages are either released in the rivers, creeks or directly into the coastal areas with or without treatment (Fig.3). Except in few urban areas, the sewage collection facilities are far inadequate compared to the volume generated and most of the sewage from the coastal towns and villages is disposed in open drains which gets connected with the tidal creeks or other aquatic system. Out of the estimated 7000 MLD sewage generated, it is reported that treatment is made to a limited extent and such a facility in Mumbai (300 mld out of 2000 mld) Karachi (47 mld out of 757 mld).

Figure 3. Disposal of untreated sewage on the beach at Chennai, India

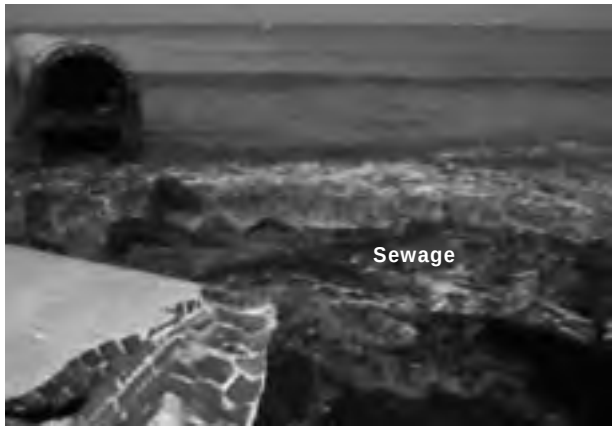


Figure 4. Release of wastewater from small industries into creeks

It is also found that in the South Asian Seas region, the municipal sewerage system whether closed or open are also being used for disposal of untreated waste from small and medium scale industries (Fig.4)

A review of National reports submitted by the countries in the region indicate that the constituents of sewage remains more or less the same and typical municipal waste water characteristics is given in the table below:

Characteristics of a Typical Domestic Sewage mixed with Effluents From Small and Medium Scale Industries (E.g. Mumbai)

Parameter	mg/l
Dissolved Solids	1450
Suspended Solids	245
BOD	258
Sulphate	75
Nitrogen	35
Phosphorus	6
Chloride	587
Manganese	507
Iron	2.5
Cobalt	0.030
Nickel	0.081
Copper	0.110
Zinc	0.251
Lead	0.011

The major sources of sewage contamination in the South Asian Seas countries are as follows:

In Bangladesh, the domestic sewage from Chittagong city is dumped in Karnapuzhi river and the BOD load is estimated to be 3500 kg BOD per day. It has been projected that by the year 2000, 5070 kg BOD per day is expected to be released into the river, from Chittagong and surrounding areas. When combined with industrial waste, BOD load in the river reaches 40000 kg BOD per day and along with other sources, the total BOD is estimated to be 45500 kg BOD per day. As a result of heavy load of BOD, the resultant BOD level in the river is 3 ppm and at times the dissolved oxygen also drops to 0.1 ppm. No treatment of sewage is reported (NRB,1999).

In India, the source of sewage pollution is disposal of municipal waste through rivers, creeks, and the shore disposal is either through pipelines or creeks. The volume of waste water generated in major cities and large towns is estimated to be 4300 MLD out of which 3860 MLD is collected through sewerage systems. The remaining load is disposed into the open drains and canals. In case of small towns, the waste water generated is estimated to be 330 MLD out of which 200 is collected through sewerage system and remaining are disposed into open drains which finally reaches adjoining rivers/creeks/backwaters. As a result of the disposal of raw sewage into the rivers, very high levels of BOD values are observed in several freshwater zones of the estuaries and at times even at the mouth of estuaries. In most of the estuaries, due to sand bar formation at the mouth, the wastewater remains within the estuary during the dry season (7-9 months). Monsoonal flow in the river removes the sand bar and the waste is carried towards sea by the run off. Sewage is disposed in raw condition and a low volume of 390 MLD out of 1800 MLD generated alone is treated. During such occasions, high concentration of pathogenic bacteria and marginal decrease of dissolved oxygen, prevail in the coastal water for a short period of time. In general, except in the sea off Mumbai, the quality of seawater along the Indian coast is fairly good.

In Pakistan, most of the sewage is generated along the coast of Karachi and the adjacent coast of Hub and Gadani in the southern Baluchistan. 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 local domestic and urban waste. In Karachi where 200 Million Gallons per Day(MGD) of sewage is generated, it is discharged through sewerage system and canals. This sewerage system drains into Lyari river which reaches Karachi harbour. The sewage discharged into the Malir river reaches Gizri creek. Besides, several canals and stormwater drains also carry the sewage directly to the coastal waters. Out of the sewage generated, only 20% is treated and the remaining 80% is disposed untreated. In Sri Lanka, properly planned sewerage systems are not yet been developed except for the Colombo municipal area. In Colombo only 60% of the households are connected with sewage collection systems and the remaining is disposed the waste in open areas and in streams and canals. Sewage collected from the Colombo city are disposed through 2 ocean outfalls located in Wellawatta and Modar. The squatter settlements along the southwest coast leads to fecal pollution and solid waste on beaches and nearshore areas.

The above situation of sewage generation, disposal and treatment clearly indicates that in most of the countries, the sewage collection facilities are far inadequate compared to the quantity generated and the treatment facilities are almost negligible.

4.3. Industrial Waste

South Asia is one of the fast developing industrial region with several industrial sites and power plants located along the coastal areas. The industrial cities like Chittagong, Karachi, Mumbai, Cochin, Chennai, Calcutta and Colombo are located on/near the coast. The country wise details of the nature are industrial pollution is given below:

In Bangladesh, industrial zones are mostly located along the Chittagong area and the waste from the industries are released at several points in the Karnapuzhi river. The majority of the industries include textile, paper and leather. The tanning industries dump the waste in the surrounding areas, which finally find their way through open drains to Karnapuzhi river. The waste contains BOD value of 600-1200 ppm for vegetable tanning waste and 800-1200 ppm for chromium tannium waste.. The other waste include sulphur and mercury. A prominent DDT industry located in the area also releases the waste into the river. No treatment of waste is done before disposal.

In India, a variety of industries such as Chemicals, Fertilisers, Pharmaceuticals, Textiles, Soda Ash, Petro-chemicals, Dyes, Engineering, Automobile, Plastics and Metallurgical etc are located in and around industrial zones of Tapi, Hazira, Mumbai, Mangalore, Alapuzha, Cochin, Calicut, Tuicorin, Pondicherry, Cuddalore, Chennai, Visakhapatnam, Paradip and Calcutta. The estimated waste water that are generated by industries is $0.7 \times 10^3 m$ (as of 1994) and they are disposed through creeks, rivers and directly into the sea (Fig.5). This does not include the waste that are generated by innumerable small and medium scale industries which are located within or outside the city/town limits. Wastes from such industries are mostly drained into municipal sewers or in creeks. It has been found that the waste load from industrial estates containing a group of industries have a BOD load of 500 to 1050 and COD of 800-1200. The loads of suspended solids are also found to be high. Due to disposal of raw waste from these industries, the concentration of heavy metal in sediments at river mouths in few areas and in the creeks of Mumbai have reached at alarming rates. The disposal of industrial waste particularly from the large industries is through ocean outfalls and they are located from 500 mts to 2 km into the sea. While most of the major industries treat their wastes, large number of small and medium scale industries do not treat the wastes before disposal. Establishment of Central Effluent Treatment Plants by a group of small and medium scale industries is also prevailing in a few areas in Gujarat, Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh and West Bengal (CSD 1995).

Figure 5. Industrial wastes released through creeks into the sea

In Pakistan, most of the coastal industries are located around Karachi in the form of industrial sites like Sindh Industrial Trading Estate(SITE) and Landal Industrial Trading Estate. In SITE 5000 registered industrial units and several units that are not registered are functional. These industries include textiles, chemicals, iron, steel and dyes. The waste from these industries and other areas enter into the coastal environment through rivers, canals and streams. It has been estimated that the stream releases 200 MGD along with heavy metals such as iron, copper, zinc and cobalt etc into the neighbouring creek. It is reported that most of the waste are released as untreated (NRP, 1999).

There are 60,000 industries in Sri Lanka ranging from large scale industries to small, minor and quarrying and repair shops. 2 of the 3 Investment Treatment Zones and 2 primary industrial estates are located in the coastal area near Colombo. The export processing zones are provided with central wastewater treatment facilities. All effluents discharged from the industrial areas are collected through a network of sewerage connected to the central treatment facilities. The effluent from similar industries at Kokanal and Karpore industries are released in adjoining coastal waters. The wastewater contains high value of BOD. It has been estimated that the wastewater loads from industrial areas of Colombo city is about 10737 m^3/ day (NRS, 1999).

The above situation of non-treatment of waste from most of the industries with their effluents containing heavy metals, high BOD materials are released into the creeks, coastal waters etc. result in contamination of seawater especially the sediments with high amount of cadmium, mercury etc.

4.4. Agricultural Run-off

The South Asia is one of the major agricultural regions in the world. Besides for local consumption, a few varieties of rice, wheat, cereals, etc. are also exported, mostly from India and Pakistan. In recent years, in order to cope up with the increasing food demand, high yielding varieties of rice, wheat, cereals etc., are grown in the region, which need substantial quantity of fertilizers and insecticides. The run-off from agricultural fields containing large amount of nutrients in the form of nitrogen and phosphorous and residues of insecticides mostly belonging to organo-phosphorous and synthetic pyrethyroid groups reach the rivers and finally to the coastal waters.

In Bangladesh, the cropping area in the region is about 4.3 million acres. The major crops being rice, wheat, jute, cotton, vegetables, species etc. The yield per acre is about 0.7 t per year for wheat. The estimated per capita annual requirement is about 1.65 t. The agricultural lands along the coastal areas are mostly reclaimed from the low lying regions. India is basically a agricultural country with rice, wheat and cereals as prominent crops in the interior as well as coastal areas. The agricultural sector consumes about 70% of the water from the rivers and the underground sources. It has been reported that the average fertilizer consumption is about 75 kg per hectare. The insecticide consumption is about 13.3 kg per hectare. The insecticides are mostly of organo-phosphorous and synthetic pyrethyroid in nature. Even though DDT is banned for agricultural use, HCH is still being used as an insecticide in some of the agricultural fields (CSD 1995).

In Pakistan, agricultural activity is sparse in the coastal areas. However, areas adjoining to Sindhu coast, large quantity of rice and other agricultural products are being produced. The fertilizer and pesticides used reach the coastal waters through creeks and rivers, after they are drained into these water bodies (NRP, 1999).

In Sri Lanka, even though the agricultural activities are not widespread in the coastal areas, the use of fertilizers to the level of 77 kg per hectare and the pesticides to the level of 1.6 kg per hectare are being practiced. Since the agricultural fields are close to the rivers and the lagoons, the run-off from agricultural fields are drained into these rivers and lagoons.

4.5. Oil Pollution

The land based activities especially the automobile oriented activities, industrial use of oil in the form of machinery oil, furnace oil and processing of crude oil to petroleum products are the major source of oil pollution in the coastal water. The inland transport of crude oil from ports to refineries and disposal of oil sludges by tankers in the adjoining water bodies are the prominent sources of oil pollution from the land based activities.

In Bangladesh more than 50% of the oil pollution in the marine environment comes from urban and river run-up. The numerous river crafts and the steamers plying along the waterways and discharge of waste of oil wastes and bilge washes reach the ambient environment itself (NRB, 1999). Similar situation are also prominent in Hooghly in India and port waters in other countries.

Oil Pollution by Ships and Maritime Activities

South Asia, particularly, the seas bordering Pakistan, India, Sri Lanka and Maldives is being used as an international tanker route for transport of crude oil from the gulf countries to the Far-east. It has been estimated that nearly 3500 oil tankers originating from the Persian Gulf pass through south of Pakistan, west of India, between Maldives and Lakshadweep islands of India, southern peninsula of India, south of Sri Lanka and reach the Malacca strait after passing between Nicobar and Sumatra islands. About 500 million tonnes of crude oil is transported through this route.

The oil spills due to shipping occur mostly during the accidents and grounding of tankers. However, during the transfer of oil in ports as well as through Single Buoy Mooring Stations and bunkering also, oil enters into the coastal waters and the port areas.

4.6. Ship breaking operations

The ship breaking yards are operational in Pakistan, India and Bangladesh. In Bangladesh, ship breaking operations have been started on an industrial scale in the recent years. Nearly 50 ship breaking units are functional in the sea shore from Kulna to Fauzderhat in Chittagong and near Mogla port in Kulna. The lubricants, engine oils and debris form major pollutants during dismantling operations. The waste oil is not collected properly and disposed in the adjoining sea (NRB, 1999). In India, ship breaking operations are carried out on beaches of Alang in Gujarat, for a distance of about 10km along the coastline. On an average 5 ships are broken per day. Chronic oil pollution due to draining of waste oil into the sea during the breaking operations is evident (CSD 1995).

In Pakistan, ship breaking industries at Gadani is a major source of pollution to the adjoining coastal areas. Recently, the ship breaking operations are at low level and only a few ships are broken in a month (NRP, 1999).

5.0. SEDIMENT TRANSPORT

Sediments form an important source of nutrients for biological organisms in the aquatic environment. It is a major source of substratum for mud flats and mangrove areas. The perennial rivers like Indus, Ganges, Brahmaputra, Magna, Kamili, Kosi, Kelani, Negambu etc bring enormous sediment to the mouth of the rivers and also supply the sediment for beach formation. Loss of sand material occur due to erosion of coastal areas by natural phenomena like cyclones and streams. In the South Asia, due to increase of population and need for water for agriculture as well as for human consumption, man-made structures like dams have been built in all the major rivers which contain the silt carried by the rivers. Since the river water is extensively used for agriculture to sustain food production and to alleviate poverty, discharge of

fresh water to the coastal ecosystems have been considerably reduced. Since the sediment particles are transported along with the fresh water, depletion in supply of sediments to the coastal areas also takes place. Such a short supply of sediments has caused wide scale impact, like reduction in sediment supply for beach nourishment, compensation of substratum loss in mangrove areas due to human activities etc.

Further, the human activities in the upper reaches of the river particularly in the mountain regions, like deforestation, use of land for agriculture, has led to floods and erosion of mountain areas causing large scale transport of land debris, sand, stone etc. to the river. At many locations the river course get diverted and leading to diversion of sediments. Such a diversion also reduces natural supply of sediments to the coastal habitats.

6.0. PHYSICAL ALTERATION OF HABITATS

The upstream activities like regulation of river flow erosion of banks in the downstream, and coastal activities like unplanned coastal structures etc. cause variation in the geo-morphology of the coastal areas by way of accretion and erosion. This also results in reduction of areas of lagoon and other coastal habitats by way of increased sedimentation in the banks and reduced water inflow from sea as well as river. Excessive sediment transports, which are carried to the longer distance, too affect the coral reefs. To sustain the economic growth to cope up with the increasing population, the South Asian countries are now proceeding towards large-scale expansion of existing developmental activities and planning for major investments in coastal areas in the immediate future. For e.g. port activities like breakwater in southern India is posing a threat of erosion constructing in adjoining lagoon which may lead to alteration of lagoon to a bay in the coming future. All such developmental activities tend to aggravate the existing problem of habitat loss or their alteration with negative impact, like reduction of livelihood to local inhabitants.

In Bangladesh, diminishing of mangrove vegetation and mangrove areas, particularly in Sunderbans, which is a source of livelihood for 0.3 million people, is a major concern. It has been reported that, due to the combined effect of natural and human activities like conversion of mangrove areas to shrimp culture ponds, the mangrove areas have been decreasing. The economic losses are easily understood in terms of dependence of population on the resources of the mangroves, particularly the renewable resources like fisheries. Besides loss of mangroves due to the human intervention, it also leads to imbalance in fisheries production in the adjoining coastal waters, where the fishery resources are shared by India and Bangladesh in their respective jurisdictions. The loss of habitats significantly affect wild life population in the mangrove areas. The Royal Bengal Tiger is already endangered. It has been reported that the Javan Rhinoceros, Wild Buffalo, Swamp Deer, Hog Deer etc. have become extinct. These were available in 1920s. Further, the Muggu Crocodile species are vulnerable. In Chakaria Sunderbans, the deforestation caused large-scale erosion of Maheshkhali island. If these forests are cleared to provide area for shrimp and finfish culture farming, the Kuttubdia and Mehkul islands will be under pressure of erosion and hundreds of thousand people will be exposed directly to severe cyclones and tidal surges. The forest used to cover 7490 hectare as reserved and 10020 hectare as protected forests. But, since 1977, about 3321 hectare land has been released to private firms and individuals for fish production. The Charkaria Sunderbans also faces pressure from the salt manufacturers. The mangrove areas were converted as salt farms. Similar scenario is also reported from other parts of the Sunderbans mangrove areas.

In India, the changing river courses, fluctuation in sediment transport, priority for irrigation of agricultural fields and resulting in diversion of water, has caused siltation of (eg. Chilka) shifting of river months (Godavari), coastal lagoons and the mud flat areas (Gulf of Khambat). The changes of course of Hooghly river and dredging by port authorities to maintain the draft for shipping for Haldia and Calcutta Ports have threatened the existence of Niachara island in West

Bengal. Similarly, due to the decreasing of fresh water inflow and formation of sand bar at the mouth of Chila Lake, the lake area has been reducing to the extent of 5 - 10% per year. The present area is 1100 sq. km. Such reductions are also reported for Pulicat Lake and Ennore crek (Fig.6).

Figure 6. Dredging operations at Ennore Creek, Chennai to remove accreted sediments

The alteration of sediment budget in the coastal areas by the perennial and monsoonal rivers flowing to the beach areas, influence the shoreline changes and in turn has affected the habitat of endangered species like turtles. For example, the largest turtle breeding grounds along the coast of Gahirmata, which is close to Wheeler island, where annually about 1 million turtles nest are shifting the nesting to nearby areas. This is due to the alternation in the size of Wheeler island. Along the West Coast of India, sedimentation in the Gulf of Khambat and also to some extent in Gulf of Kutch has been reducing the water areas in the Gulf areas by 1 - 2% per year. Further, manmade activities like construction of ports in the Gulf of Kutch are also responsible for habitat loss. The decrease of mangrove areas even though not prominent in mangrove forest rich areas like Sunderbans and Pitchavaram, ingression and aquacultural activities, the reduction in the mangrove area at least by 2-5% are noticed particularly in the Coringa mangroves in the recent 5 years. The human intervention like conversion of seasonal wet lands as human settlement areas, which attract migratory birds, is also common along the coastal areas of the country. Uses of these areas as salt pans and also using the land for shore-based industries have led to the disappearance of some of the seasonal wetlands.(CSD, 1995)

In Pakistan, the habitat modification, due to the construction of dams at several places along the Indus river, led to decrease of water supply to mangrove and coastal areas. The mangroves need a minimum of 10 million acre ft. of water to support mangrove vegetation. Even though this water requirement is met during the south-west monsoon during the dry season, due to decrease of water flow, the salt water ingression from the sea area is prominent. As a result, species adapted to high salinity are very prominent. Similarly, the abundance of Hilsha in the upstream prior to damming of Indus river was evident. In case of mangroves, nearly 16000 camels and 11000 cattle graze the mangrove areas leading to exploitation of 16000 t of mangroves per year. The reduction in the mangrove areas is being compensated by several afforestation programmes (NRP, 1999).

In Sri Lanka, in the coastal area sediment extending upto 685 km from Kalpitiya to Yala National Park, about 175000 to 285000 sq.m of coastal area is lost every year due to erosion caused by natural and manmade activities. The impact of erosion is felt in the decreasing habitat area for intertidal animals. The conversion of area around the lagoons for shrimp culture has decreased the lagoon area affecting the abundance of bio-diversity. Mangroves are destroyed for expansion of human settlements and also for expansion of aquaculture. It is estimated that the current mangrove habitat will be reduced by the year 2001. The proliferation of slums and squatter settlements along the coastal areas have affected all the birds and beach fauna (NRS, 1999).

In Nepal, due to natural phenomena like Glacial Lake outburst, soil erosion due to tectonic activities of major mountain ranges and consequent downcoming of the river system, human activities such as deforestation, improper cultivation practices and development work, induces movement of soil and sediments to the downstream areas (NRN, 1999). It has been estimated that the soil loss ranges from 5000 kg per

hectare per year on level terraces to 20000 on sloping terraces. During peak river discharges, sedimentation results in abrupt river channel changes, causing huge losses in the arable land in low lying areas. Adoption of the traditional method of top down approach helped in retention of upland terraces due to mixed cropping etc. Due to vanishing of this approach, the density of vegetation in upland terraces is decreasing. Damming reduces to some extent silt load to down stream areas.

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