

A STUDY ON COASTAL WATER POLLUTION OF BANGLADESH IN THE BAY OF BENGAL



A Dissertation for the Degree of Master in Disaster Management

By
Mohammed Mizanur Rahman
Student ID: 05268007

Fall 2006

**Postgraduate Programs in Disaster Management (PPDM)
BRAC University, Dhaka, Bangladesh**

ABSTRACT

The natural disasters have been regularly taking toll on the people and the resources of Bangladesh. Natural disaster causes inexpressible damage to lives, properties, livestock, life support systems and infrastructures. The coast of Bangladesh is known as a zone of multiple vulnerabilities as well as opportunities. It is prone to severe natural disasters such as cyclones, storm surges, floods, erosion, soil salinity etc. In combination with other natural hazards various forms of man made pollution made the coastal dwellers very vulnerable and ultimately slowed down their socio-economic development. This study will seek to analyze the vulnerabilities and risk of coastal water and suggest adopting appropriate measures for mitigation and management of coastal environmental pollution to the extent of generating environmental awareness among people.

The coastal region gets polluted as the pollutants are carried through different rivers and canals to the sea. Water channels are used for dumping industrial wastes that ultimately end up in the sea. There is no facility for waste treatment in densely populated urban areas. As a result, water pollution is increasing. About three thousand ships including oil tankers come to our ports every year. There are several thousand mechanized trawlers and boats that spill oil. Sea is also polluted by oil spill because of accidents in ships. The authority fails to check pollution as they have no receiving or collecting vessels to face the emergency situation during oil spillage. Even our Port Authority has no laboratory to measure the extent of the pollution. Foreign and local ships find the Chittagong Port and its outer anchorage a safe dumping area for their waste, taking advantage of poor laws and their lax implementation due to logistic support. The authority fails to take action against the ships as they flee very quickly after dumping waste in the sea. Besides, ship-breaking industry is located in Chittagong. Incidents like dumping of wastes into the sea by foreign vessels are also happening. A number of industries namely fertilizers, cement, pulp and paper, food processing, pharmaceuticals, metal, textile, chemical, petroleum and lubricant plants, etc, discharge heavy metals into the coastal water. The use of antibiotics and other chemicals used in shrimp fields is causing pollution in the water, which may harm other aquatic lives. Plastic bottles and other plastic products are most common forms of litter in the coastal water. The rapid and unplanned increase in shrimp culture is also becoming a concern. Shrimp culture in Cox's Bazar uses 620 tons of urea annually. It also generates 15 tons of waste daily, which comes into sea.

The government has already signed a number of international treaties and conventions to check environmental degradation. Integrated Coastal Zone Management (ICZM) activities in Bangladesh were initiated first in the year 1999; thereafter on 17 January 2005 the Coastal Zone Policy has been approved by the Government. This ICZM policy would be followed by its implementing strategy. The proper implementation of this strategy would lead the Coastal Zone Management in a sustainable way. Under the objectives of the Integrated Coastal Zone Management Project (ICZM project), Priority Investment Programs (PIP) are being developed as the operational arms of this strategy. It is possible to address the pollution in the coast through development of partnerships. Pollution in the coast may not be arrested in short term approaches, like experiences from other countries showed that it is a matter of time. Long term vision would be considered in designing the PIP, where the pollution issues to be addressed and its severity would be minimized. Priority actions may include in district development plan as a basis to start a long term investment program to limit the pollution level in the coast.

ACKNOWLEDGEMENT

This study carried out under the direct guidance of Dr. S I Khan, visiting Professor, Department of Architecture, BRAC University. The researcher wishes to express his indebtedness and gratitude to him for his continuous guidance, helpful criticism, invaluable suggestions and unfailing encouragement throughout the course out of this study.

The author sincerely thanks Dr. Fuad H. Mallick, Professor & Chairperson of Architecture Department, BRAC University for providing with all office facilities.

The author also expresses his gratitude to Mr. Terry JEGGLLE, a Senior Officer of ISDR for his valuable and helpful suggestions.

The researcher expresses his indebtedness to Oxfam GB, Bangladesh for granting him a scholarship to undergo the programme.

The author acknowledges the cooperation of all students of the same course and help of the staff of the Department of Architecture, BRAC University.

TABLE OF CONTENTS

Contents	Page No
Abstract	i
Acknowledgement	ii
Table of Contents	iii-viii
Acronyms	ix-x
List of Tables	xi
List of Figures	xii
List of Maps	xiii
Map of Study Area	xiv
 Chapter 1	 Background of the Study
1.1	Background 1-1
 Chapter 2	 Introduction
2.1	Pollution in General 2-3
2.2	Water Pollution 2-3
 Chapter 3	 Scope and Objectives
3.1	Scope 3-1
3.2	Aim of the Study 3-1
3.3	Statement of the Problem 3-1
3.4	Limitation of the Study 3-1
 Chapter 4	 Methodology and Approach
4.1	Framework of the Study 4-1
4.2	Literature Review 4-1
4.3	Collection of Area Maps 4-2
4.4	Selection of Study Area 4-2
4.5	Questionnaire Survey of the Household of the Study Area 4-2
4.6	Questionnaire Survey of the Officials of the Study Area 4-2
4.7	Formulation of Recommendations and their Implementation Plan 4-2
4.8	Justification of the Study 4-3

Chapter 5	Conceptual Framework	
5.1	Concept of Marine Pollution	5-2
5.2	Types of Pollutants	5-3
5.2.1	Pathogenic Pollutants	5-3
5.2.2	Aesthetic Pollutants	5-4
5.2.3	Ecomorphic Pollutants	5-4
5.3	Types of Marine Pollution	5-5
5.3.1	Points Sources	5-5
5.3.2	Non-Points Sources	5-6
5.4	Sources of Marine Pollution	5-6
Chapter 6	Study Area	
6.1	Study Area and Delimitation of Marine Boundary of Bangladesh	6-1
6.2	Pollution and Sediment Flux in Coastal Water of Bangladesh	6-1
6.3	Topography of Bay of Bengal Coastal Area	6-2
6.3.1	Climatic Condition of the Area	6-2
6.4	Demographical Characteristics	6-3
6.5	Biological Characteristics	6-3
6.6	Harmful Algal Blooms	6-3
6.7	The Marine Habitat	6-4
6.8	Marine pollution of Bangladesh Coastal Area	6-4
6.9	Site Maps	6-5
Chapter 7	Pollution Management Approach - Conventions for Pollution Control	
7.1	International Conventions	7-1
7.1.1	Global Water Pollution and International awareness	7-1
7.1.2	The IMCO Conventions	7-2
7.1.3	International Law: The United Nations Convention on the Law of the Sea	7-3
7.1.4	International Maritime Organisation (IMO)	7-4
7.1.5	Ocean Dumping Convention	7-5
7.1.6	Regional Seas Programme of UNEP	7-5
7.1.7	Global Program of Action	7-6
7.1.8	Agenda 21	7-6

7.1.9	The Dirty Dozen	7-6
7.1.10	Different Conventions	7-10
7.2	Bangladesh Conventions - National Legal Approaches for Bangladesh	7-10
7.2.1	Marine Protected Areas: Territorial Water and Maritime Zones Act, 1974	7-10
7.2.2	National Environmental Policy (1992)	7-11
7.2.3	National Water Policy	7-12
7.2.4	The Coastal Zone Policy 2005	7-13
7.3	Minamata (Japan): Environmental Contamination with Methyl Mercury - A Case study	7-14
Chapter 8	Data Collection and Analysis	
8.1	Industrialisation in Bangladesh	8-1
8.1.1	Industrial Hotspots	8-2
8.1.2	Major Polluting Paper Mill Industries	8-4
8.1.3	Major Polluting Fertilizer Factory	8-5
8.1.4	Textile	8-7
	8.1.4.1 Entry, Exposure and Effect in the Environment	8-7
8.1.5	Oil	8-8
	8.1.5.1 Transportation and Production of Oil and Gas	8-10
	8.1.5.2 Oil Spill	8-10
	8.1.5.3 Oil Spill Impact	8-12
	8.1.5.4 Degradation of Oil	8-13
8.1.6	Metals and Radioactivity	8-13
8.1.7	Radioactivity	8-14
8.1.8	Waste Heat	8-15
8.1.9	Asbestos Laden Ship Breaking	8-15
8.2	Urban Areas Pollutants: Domestic pollution	8-17
8.2.1	Sewage and other Marine Pollutants	8-19
8.2.2	Solid Wastes	8-20
8.2.3	Garbage	8-20
8.3	Agriculture and Forestry Pollutants	8-20
8.3.1	Pesticides and Other Persistent Organic Chemicals	8-21

8.3.2	Anti Fouling Paints	8-22
8.3.3	Aquaculture	8-23
8.4	Environmental & Economic Impacts of Shrimp Farming in Bangladesh	8-24
8.5	Vessel and other Major Marine Pollutants	8-25
8.6	Offshore Oil and Gas Exploitation	8-26
Chapter 9	Findings	
9.1	Urea Fertilizer Plants	9-1
9.2	Degraded Waters	9-2
9.3	Excess Nutrients	9-2
9.4	Other Contaminants	9-2
9.4.1	Sediment Contamination	9-3
9.4.2	Compromised Resources	9-3
9.4.2.1	Fishery Declines	9-3
9.4.2.2	Coastal Habitat Loss	9-4
9.4.2.3	Invasive Species	9-4
9.5	Health Impacts of Water Pollution	9-4
9.6	Marine Bacteria and Viruses	9-5
9.7	Different Level of Pollution at Different Season	9-5
9.8	Limiting vessel pollution	9-6
9.8.1	Waste Stream Discharges	9-6
9.8.2	Waste Pump out Facilities	9-7
9.8.3	Air Emissions from Large Commercial Vessels	9-7
9.8.4	Oil Releases	9-8
9.9	Improving Awareness of Ocean Activities	9-8
9.10	Effects of Marine Pollution	9-9
9.11	Trace Metal Pollution	9-9
9.12	Biochemical Oxygen Demand (BOD)	9-10
9.13	Dying of huge Sea Fish by Bay Pollution	9-11
9.14	Impact on Human Life	9-11
9.15	Disease and Death by Polluted Coastal Water	9-12
9.16	Coastal Habitat Loss	9-12
9.17	Natural Hazards	9-13

9.18	Economic Aspects	9-14
9.19	Pollution threatens Chittagong Port	9-14
9.20	Threats and Problems to Sundarbans	9-15
	9.20.1 Sundarbans and its Bio-diversity	9-15
	9.20.2 Threats to the biodiversity of Sundarbans	9-16
	9.20.3 Various Threats to the Environment and Human Life	9-17
9.21	Status of Pollution in Our Coastal Zone	9-19
Chapter 10	Problems and Potentials	
10.1	Problems and Issues	10-1
	10.1.1 Preventing the Spread of Invasive Species	10-1
	10.1.2 Identifying Major Pathways for Introduction of Non-Native Species	10-2
	10.1.3 Ballast Water	10-2
10.2	Reducing Marine Debris	10-2
	10.2.1 Assessing the Sources and Consequences of Marine Debris	10-3
	10.2.2 Addressing Marine Debris: Nationally Existing Programs	10-4
	10.2.3 Interagency Coordination	10-5
	10.2.3.1 Education and Outreach	10-6
	10.2.3.2 Working with Communities	10-6
	10.2.3.3 Working with Industry	10-6
10.3	Initiatives of Diferent Organisations	10-7
	10.3.1 Government	10-7
	10.3.2 Non- Government	10-8
	10.3.3 Regional / International Inventiveness	10-8
	10.3.3.1 Multi-Stakeholder Partnership	10-9
	10.3.4 Other National and International Inventiveness	10-10
	10.3.4.1 National Obligations	10-10
	10.3.4.2 International Obligations	10-10
10.4	Offshore Energy, Minerals and Emerging Uses	10-11
10.5	Exploration, Inspiration and Education	10-11
10.6	Global Water Quality	10-12
Chapter 11	Recommendations	
11.1	Addressing Coastal Water Pollution	11-1

11.1.1	Working for Next Generations	11-1
11.2	National Water Quality Monitoring Network	11-2
11.3	Creating Disincentives to Pollution	11-2
11.4	Pollution Prevention	11-2
11.4.1	Introducing Green Tax for Pollution	11-3
11.5	Strengthening Vessel Safety, Security and Environmental Compliance	11-4
11.5.1	A Culture of Compliance and Safety	11-4
11.6	Prevention: the First Line of Defense	11-5
11.6.1	Ballast Water Management	11-5
11.6.2	Controlling Other Pathways	11-5
11.7	Control and Prevention of Marine Pollution	11-6
11.7.1	Dredging	11-6
11.7.2	Combating Oil Pollution	11-7
11.7.3	Combating Industrial Pollution	11-8
11.7.4	Combating Municipal Water Pollution	11-9
11.7.5	Waste Water Treatment	11-10
11.7.6	Agricultural Source Treatment	11-10
11.8	Recycling Facility at the Chittagong Port	11-11
11.9	Education and Training for Pollution Control	11-11
11.10	Awareness Raising for Various Groups	11-12
11.10.1	Imagining a Brighter Future	11-12
11.11	Implementation of Integrated Coastal Zone Management	11-14
11.12	Implementation of Recommendations	11-14
11.12.1	Enabling Conditions	11-15
Chapter 12	Conclusion	
12.1	Conclusion	12-1
Bibliography		
Appendices		

ACRONYMS

<u>Abbreviation</u>	<u>Meaning</u>
ADB	Asian Development Bank
BADC	Bangladesh Agricultural Development Corporation
BCAS	Bangladesh Centre for Advanced Studies
BELA	Bangladesh Environmental Lawyers Association
BEMP	Bangladesh Environmental Management Project
BOD	Biological Oxygen Demand
BOT	Build, Operate and Transfer
BWDB	Bangladesh Water Development Board
BWFMS	Bangladesh Water and Flood Management Strategy
CARDMA	Coastal Area Resource Development & Management Association
CDS	Coastal Development Strategy
CEP	Coastal Embankment Project
COD	Chemical Oxygen Demand
CUFL	Chittagong Urea Fertilizer Limited
DFID	Department for International Development
DOE	Department of the Environment
ECNEC	Executive Committee of the National Economic Council
EEZ	Exclusive Economic Zone
EIA	Environmental impact assessment
EIP	Early Implementation Project
EPADC	East Pakistan Agricultural Development Corporation
EPWAPDA	East Pakistan Water and Power Development Authority
FD	Forest Department
FEJB	Forum of Environmental Journalists of Bangladesh
GoN	Government of the Netherlands
GoB	Government of Bangladesh
GPA	Global Program of Action
GPA	Guidelines for Project Assessment
GPP	Guidelines for People's Participation
GPWM	Guidelines for Participatory Water Management
HACCP	Hazard Analysis Critical Control Point
HYV	High Yielding Variety
ICZM	Integrated Coastal Zone Management
IMO	International Maritime Organization
IUCN	The World Conservation Union
KNM	Khulna Newsprint Mill
KPM	Karnafuli Paper Mills
LGED	Local Government Engineering Department
MARPOL	Marine Pollution conventions
MoEF	Ministry of Environment and Forest
MoWR	Ministry of Water Resources
MPO	Master Plan Organisation
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NEDA	Netherlands Environment and Development Agency

NGO	Non-governmental Organisation
NMIDP	National Minor Irrigation Development Project
NWCo	National Water Code
NWMP	National Water Management Plan
NWP	National Water Plan
NWPo	National Water Policy
NWRC	National Water Resources Council
PAHs	Polycyclic Aromatic Hydrocarbons
PIP	Priority Investment Program
POPs	Persistent organic Pollutants
SIDA	Swedish International Development Agency
SMRC	Saarc Metrological Research Centre
SPARRSO	Space Research & Remote Sensing Organization
TBTs	Tributelines
TSS	Total Suspended Solids
TMEs	Tertile Mills Effluents
TSPC	Triple Super Phosphate Complex
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Program
WARPO	Water Resources Planning Organisation
WB	World Bank
WMCA	Water Management Cooperative Association
WUO	Water User Organisation

List of Tables**Page No**

Table 8.1: The top seven polluters	8-3
Table 8.2: Waste and pollution from pulp and paper mills	8-5
Table 8.3: Wastewater characteristics of selected fertilizer factories, 1994	8-6
Table 8.4: Waste generated from fertilizer factories	8-6
Table 8.5: World wide annual inputs of oil to the marine environment	8-9

List of Figures	Page No
Fig 5.1: Activity Flow Chart	5-1
Fig 5.2: Pollutants in Karnaphuli and Pasur River	5-8
Fig 10.1: Source of Marine Debris	10-4

List of Maps**Page No**

Map 1: Coastal Area of our Bay of Bengal	2-2
Map 2: Chart- Bangladesh Coast of Bay of Bengal	6-5

Chapter 1

BACKGROUND OF THE STUDY

‘Communities will always face natural hazards, but today’s disasters are often generated by, or at least exacerbated by, human activities. At the most dramatic level, human activities are changing the natural balance of the earth, interfering as never before with the atmosphere, the oceans, the polar ice caps, the forest cover and the natural pillars that make our world a liveable home. But we are also putting ourselves in harm’s way in less visible ways. Destitution and demographic pressure have led more people than ever before to live in flood plains or in areas prone to landslides. Poor land-use planning, environmental mismanagement and a lack of regulatory mechanisms both increase the risk and exacerbate the effects of disasters.’ - Kofi Annan

1.1 Background

There was time, not so long ago, when the world was blissfully unaware of the environment and the damage that could be caused by its abuse. During the last quarter of this century, there has been increasing awareness among the people that nature’s gift to mankind cannot be taken for granted. Today there is complete consciousness of the enormous damage that has been caused to the environment by its continuous misuse for thousands of years. Not surprisingly, a greater part of this awareness has come from the developed world, which has been in the forefront of the ruthless race for development since the industrial revolution. This has brought about considerable degradation of the earth’s environment in its wake. It must be however admitted that, alarmed at the rapid degradation of their surrounding, the developed nations have also been at the forefront of remedial measures to rescue and protect the environment. A large number of laws have been passed to ensure a cleaner and greener environment. The results though slow to come have been encouraging. Scientists report that the hole in the ozone layer is filling up, rivers are getting cleaner and once again thriving with fish and birds.

Unfortunately, the picture is not so encouraging on the seas. For years, the oceans, which cover more than 70 per cent of the Earth and which are a critical element in maintaining the environment, have been the final receptacle of many wastes. The

world economy runs on fossil fuels, mainly oil and countries with limited petroleum resources have little recourse but to import. Tankers and pipelines permit the oil-based economy to function and in the process, oceans, coastal areas and inland waterways have become vulnerable to damage from operational and accidental pollution. It is not just oil alone that has been the source of marine pollution. For years the oceans have been abused without mercy. The waste dumped into the sea include dredge spoils, industrial wastes, sewage sludge, construction and demolition debris, solid wastes, explosives, chemical and radioactive wastes. Pollution at sea affects marine life through toxicity, which kills some plants and animals and reproductive failure in others; it also causes oxygen depletion, ecological disturbance and economic losses in fishing and recreational industries.

A number of measures have been taken by the world community to reduce the pollution of the seas. Improved technology and various innovations have resulted in cleaner and greener ships. New methods have emerged for combating large accidental oil spills. Many countries have set up contingency plans and disaster management organisations. New marine safety laws have been introduced and their implementation has been tightened world over. There is however no one perfect or all encompassing measure. Corrective measures and actions must embrace technical, economic, environmental and political means.

Chapter 2

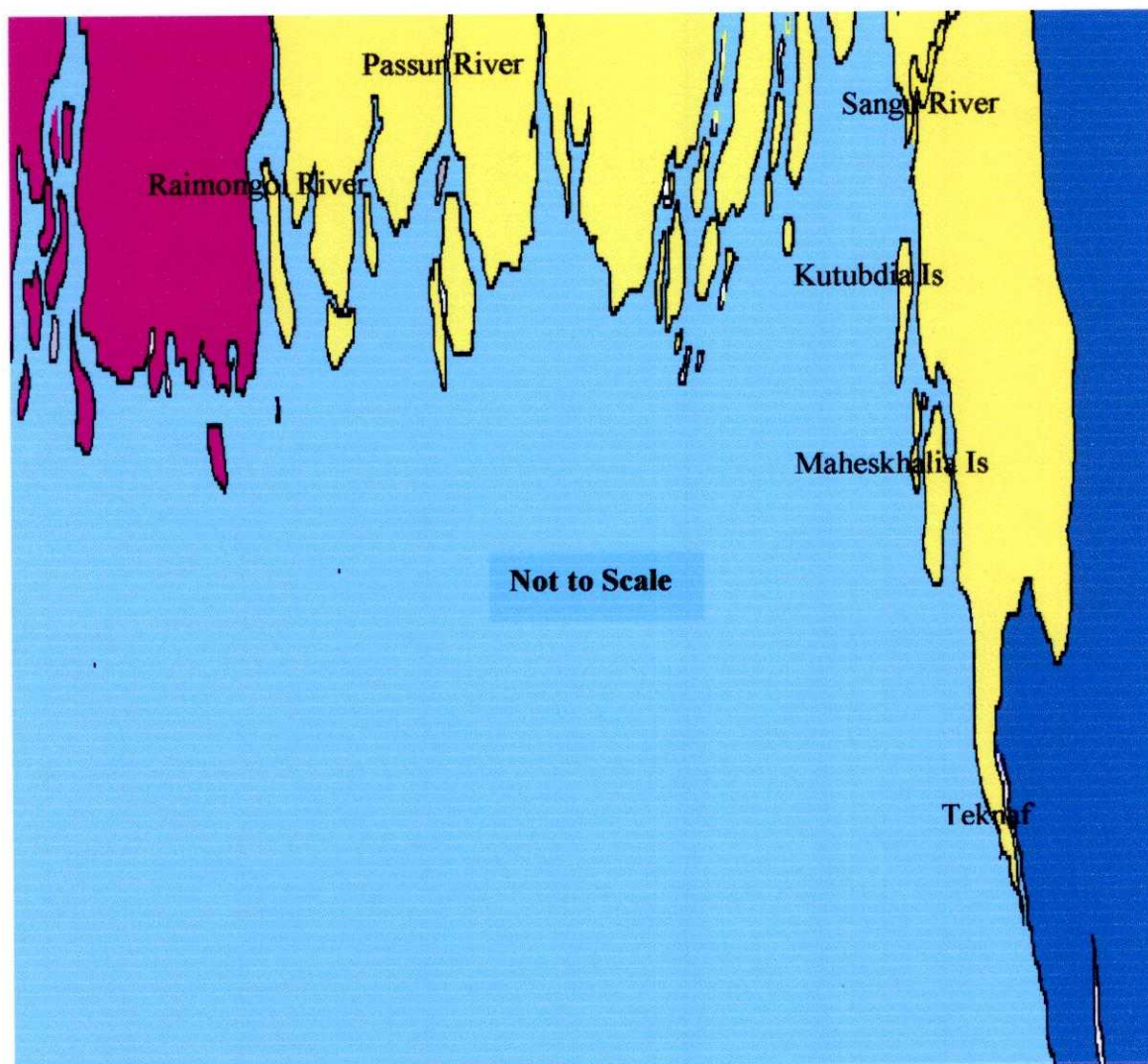
INTRODUCTION

The coast is a widely used term encompassing numerous geographic sub-regions within the broad area where the land meets the sea. Some of these terms are defined in law, agreed to by conventional usage. Bangladesh is the largest delta in the world. Three major rivers- the Padma (down flow of the Ganges) flowing from the west, the Jamuna (down flow of the Brahmaputra) flowing from the north and the Meghna flowing from the north-east form this huge delta. The Bay of Bengal is in the south of this country. The coastal length along the Bay of Bengal is about 710 km, which extends from the mouth of Naaf river in the southeast to the mouth of Raimangal river along the Indo-Bangladesh border in the west. The coast of Bangladesh is known as a zone of multiple vulnerabilities as well as opportunities. It is prone to severe natural disasters such as cyclones, storm surges, floods, erosion, soil salinity etc. In combination with other natural hazards water logging, high arsenic contents of ground water, various forms of man made pollution, made the coastal dwellers very vulnerable and ultimately slowed down their social and economic development. The population of the coastal districts is about 30 millions, which is about 25% of the total population of Bangladesh. The extent of human impact on the coastal zone is directly related to the population density not only in the coastal zone itself but also in the inland areas of the country.

Some initiatives have been taken to see the pollution status in the coastal zone in a scattered way and also very little initiative has been taken to control its severity. Integrated Coastal Zone Management (ICZM) activities in Bangladesh were initiated in the year 1999, the Coastal Zone Policy has been approved by the government on 17th January 2005. The policy has eight objectives to address the vulnerabilities and opportunities of the coastal areas, where environmental friendly industrial activities and other sustainable use of natural resources have been addressed very carefully and lawfully. The proper implementation of this strategy would lead the coastal zone management in a sustainable way that is why the strong political will and enforcement of the existing Environmental Conservation rules, 1997 is necessary. The Coastal zone pollution is addressed in the draft Coastal Development Strategy (CDS) as a cross cutting issue. To minimize, control this level of pollution, some immediate measures to be initiated. Under the objectives of the Integrated Coastal Management

Project (ICZM project), Priority Investment Programs (PIP) are being developed as the operational arms of this strategy. The Priority Investment Programs are the multi sectoral and multi agency programs, where the concern departments or agencies in coordination with other government or non-government agencies can develop and implement the investment programs. It is possible to address the pollution in the coast through development of partnerships and define projects or programs. Pollution in the coast may not be arrested in short-term approaches, like experiences from other countries showed that it is a matter of time. Long-term vision would be considered in designing the PIP, where the pollution issues to be addressed and its severity would be minimized.

Map 1: Coastal Area of our Bay of Bengal



2.1 Pollution

Contamination of the environment, by man-made substances or energy that have adverse effects on living or non-living matter is known as pollution. This contamination of air, water or soil materials interferes with human health, the quality of life or the natural functioning of ecosystems. In simple terms, pollution can be seen as the wrong substance in the wrong place in the wrong quantities at the wrong time, affecting the natural environment. 'Hot spots' generally termed as the abundance or sufficiently presence of a particular category. In this study highly Polluted areas/localities are termed as 'Pollution hotspots'.

2.2 Water Pollution

Pollution is defined as 'to make foul or unclean; dirty'. Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. When it is unfit for its intended use, water is considered polluted. Pollution is a phenomenon that arises out of interaction with environment or presence in the environment leading to degradation or adversely affecting the integrity of the environment. As the population of the universe is increasing, the human activities are also increasing due to full-fill the demand of the rapid population. We know that industries are needed for higher production. But it cannot be denied that the pollutant gases evolving from the chemical industries are really threatening not only for the new generation but also for the whole universe. After industrial revolution, human activities have certainly changed our way of life by many ways. Agricultural practices require intensive cultivation of land including multiple cropping, drainage of wetlands, irrigation of arid lands, felling of forest for more land, application of HYV seeds, fertilizers, herbicides and insecticides. Production of huge quantity of consumer product requires vast amounts of raw materials and produce pollutants and hazardous waste by-products. Extraction of minerals and other raw materials at the expense of environment is causing pollution.

When toxic substances enter lakes, streams, rivers, ocean and other water bodies, they get dissolved or lie suspended in water or get deposited on the bed. This results in the pollution of water whereby the quality of the water deteriorates, affecting aquatic

ecosystems. Water pollution has many sources. The most polluting of them are the city sewage and industrial waste discharged into the rivers. Presently, only about 10% of the waste water generated is treated. The rest is discharged as it is into our water bodies. Due to this, pollutants enter groundwater, rivers and other water bodies. Such water, which ultimately ends up in our households, is often highly contaminated and carries disease causing microbes. Agricultural run-off or the water from the fields that drains into rivers, is another major water pollutant as it contains fertilizers and pesticides.

Domestic sewage refers to waste water that is discarded from households. Also referred to as sanitary sewage, such water contains a wide variety of dissolved and suspended impurities. It amounts to a very small fraction of the sewage by weight. But it is large by volume and contains impurities such as organic materials and plant nutrients that tend to rot. The main organic materials are food and vegetable waste, plant nutrient come from chemical soaps, washing powders, etc. Domestic sewage is also very likely to contain disease causing microbes. Thus, disposal of domestic waste water is a significant technical problem. Today, many people dump their garbage into streams, lakes, rivers and seas, thus making water bodies the final resting place of cans, bottles, plastics and other household products. The various substances that we use for keeping our houses clean add to water pollution as they contain harmful chemicals. In the past, people mostly used soaps made from animal and vegetable fat for all types of washing. But most of today's cleaning products are synthetic detergents and come from the petrochemical industry. Most detergents and washing powders contain phosphates, which are used to soften the water among other things. These and other chemicals contained in washing powders affect the health of all forms of life in the water.

Chapter 3

SCOPE AND OBJECTIVES

3.1 Scope

The study is limited to discussing the various sources of our coastal marine pollution and the impact of marine pollution on the environment. The various techniques and methods available to combat and contain major oil spills are also discussed. Our capabilities and inadequacies with respect to marine pollution control are finally discussed.

3.2 Aim of the Study

- To evaluate vulnerability and risk of marine environmental hazard of coastal area of Bay of Bengal.
- To explore loss profile due to polluted coastal water.
- Suggest a pollution abatement plan and its management using available organizations.

3.3 Statement of the Problem

This dissertation will seek to identify and study the various sources of marine hazards and their protection/prevention and suggest measures to combat marine hazards affecting our coastal areas.

3.4 Limitation of the Study

The following limitations have been identified during the study:

- a. Whole coastal area has been selected for the study and it was really difficult to conduct the study in limited time and limited resources.
- b. There was shortage of manpower and it was difficult for individual to carryout the field survey.
- c. Some information is collected on the assumption basis which may not be perfect.

- d. The study is made for the whole coastal area on the basis of data collected from Chittagong outer anchorage, Mongla Port (Pasur river mouth) and Coxes Bazaar beach area. There may be confusion to get the overall picture of whole coastal area.

Chapter 4

METHODOLOGY AND APPROACHES OF THE STUDY

Methodology describes the procedures to be followed to operationalize the research design for collection and analysis of the information data in conformation with research. In order to obtain the objectives a series of activities are performed. Literature review, data collection and observation, analysis and proposals are the main phases of methodology. Data acquired by BN hydrographic department will be incorporated. A short survey in the sample area of coastal belt will be carried out.

4.1 Framework of the Study

The clear understanding is essential for properly interpreting, analyzing and new information generation of any subject or problem. The dissertation is limited to discussing the various sources of marine pollution, quality of sea water and the impact of marine pollution considering human component in magnitude of damage, humanitarian impact, economic impact, environmental impact etc. Our capabilities and inadequacies with respect to marine pollution control are discussed and it will focus on present state of awareness/preparedness of people. The various techniques and methods available to combat and contain major oil spills are also discussed. Questionnaire survey is used to collect data for analysis in the project. The questionnaires are sent to the coastal people. Interview was made with some experts, academicians and officials of Ministry of Shipping and Ports, Geological Survey of Bangladesh, Bangladesh University of Engineering and Technology (BUET) and Bangladesh Navy Hydrographic Directorate. Thereafter, suggestion of a pollution abatement plan and its management is discussed with some recommendations.

4.2 Literatures Review

In order to get the required data literatures review of previously published articles, reports, books, magazines, etc on the state of coastal water pollution were consulted. In the absence of adequate books and publications on the subject in Bangladesh internet was an important source of information to determine the extent of the work done so far related to the topic.

4.3 Collection of Area Maps

The charts of the three focal points (Chittagong Outer Anchorage, Mongla Fairway and Cox's Bazar Anchorage) were collected from Bangladesh Navy hydrographic department before the reconnaissance survey was conducted.

4.4 Selection of Study Area

The main study site was the Bay of Bengal. The focal points were the Outer Anchorage area of Chittagong, Cox's Bazar area and Mongla Fairway area.

4.5 Questionnaire Survey of the Household of the Study Area

Questionnaires were used as research methodology in the study. The questionnaires were sent to the coastal people. There was an overview of using a questionnaire as research method, its advantages and disadvantages, the aim of pre-testing, study into detail and describe the design of the questionnaire.

4.6 Questionnaire Survey of the Official of the study area

In this study, the opinion of the officials is very important because they will be directly responsible for development of the areas. For the questionnaire survey, the officials and stuffs were requested to those section of the questionnaire that the respective personnel are appointed to perform the tasks. Questionnaire was used to collect information regarding the present pollution condition of the coastal area of the Bay of Bengal, the pollution control measures at institution level and policy formulation and implementation by concerned organizations.

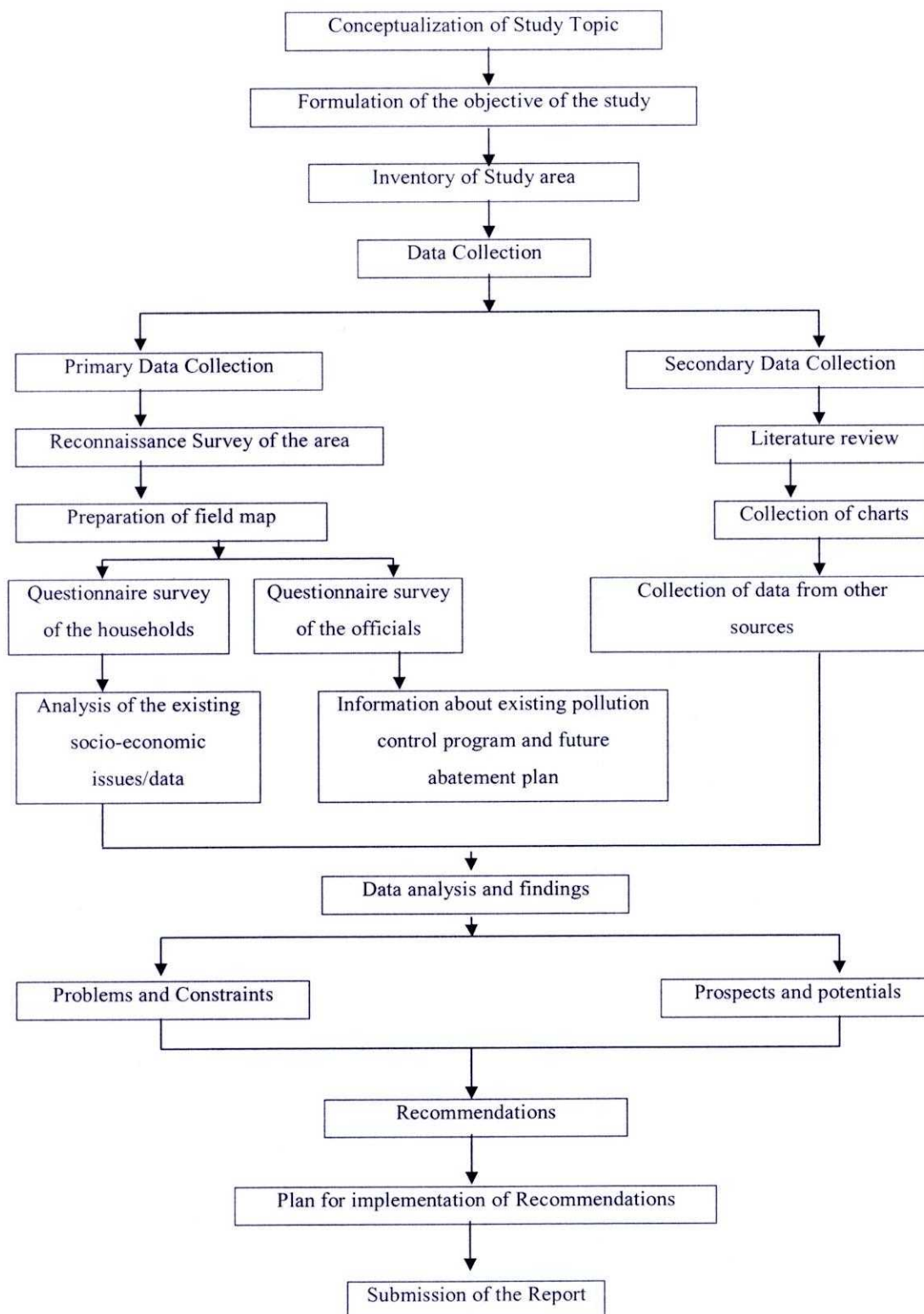
4.7 Formulation of Recommendations and their Implementation Plan

In the final stage of the study, some possible means are provided to control the pollution of the Bay of Bengal and reduce the impact of pollution. Finally implementation plan for achieving the recommendations are proposed for polluted situation.

4.8 **Justification of the Study**

The world's oceans occupy a central place in growing international concern about the health of the environment. Heightened public attention to the environment along with the internationalization of environmental issues carries implications as well for the sea services. A report by the UN multinational Group of Experts on Scientific Aspects of Marine Pollution (GESAMP) titled 'The State of the Environment' concluded that the open ocean areas of the world are still in good shape and largely free of marine pollution. Growing marine pollution problems exist in a number of the world's coastal waters, specially those associated with population centre, industrial activity and river inputs. In an economy driven world, tourism is fast becoming the mainstay of economy. Recreational uses of the seas, especially the coastal seas have become boosting factors for the tourism industry. This has created a powerful interest in the marine environmental quality. Extensive attention is being paid to problems of human health risks from waste water pathogens and some progress has been made towards international coordination and standard setting. A prominent source of ocean pollution comes from oil spills. A single spill from one of the leviathans that are roaming the ocean highways could substantially add to the amount of oil pollutants being added to the ocean each day.

Figure 5.1 Activity Flow Chart



5.1 Concept of Marine Pollution

The most widely accepted definition is the one devised by GESAMP. This states that marine pollution is the 'introduction by man, either directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activity including fishing, impairment of quality for use of sea water and reduction of amenities.' According to the definition of United Nation Convention on law of the Sea, 'Pollution in the marine environment' means the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or likely to results in such deleterious effects:

- a. As harm to living resources and marine activities, including fishing and other legitimate uses of the sea.
- b. Impairment of quality for use of seawater and reductions of amenities.

Implicit in the definition is the concept that there is a distinction between contamination, in which concentrations of a substance are elevated above natural levels without measurable effect and pollution, in which concentrations are elevated to the point where harmful effects may be observed. The key question is, therefore, at what stage is the ability of the oceans to absorb the pollutants without harm exceeded? The answer is clearly related to factors such as toxicity of the waste to the organisms, the quantity discharged and the nature of the receiving environment. In practical terms the procedure for determining which, if any, wastes may be discharged to the sea are determined by individual countries. Some have taken the view that no waste should be discharged at all and waste must be dealt with on land regardless of environmental effects and costs. Other countries derive some estimate of environmental capacity and license discharges to remain substantially below it. Marine disposal then becomes one option in a general waste management strategy.

In both cases, two unavoidable features have to be recognised. The first is that however much we try to minimize it, waste is inevitably created as a side product of

human activities. There will always come a point at which the effort (in resource or energy terms) required to clean up waste creates greater problem than the waste itself. The second point is that waste has to be dealt with and that it is incumbent on every member of the society to ensure that all wastes are disposed off in ways that cause the minimum environmental impact. It is therefore vital that rational arguments and not unreasoning prejudice should prevail in the formulation of waste management strategies.

5.2 Types of Pollutants

Pollution can be classified on the basis of the type of pollutant, such as pesticides and other persistent toxic organic compounds, heavy metals, radioactivity, human and animal effluent and toxic gases. The most familiar forms of pollution result from the chemical properties of the substances concerned, but the physical properties may also be important, for example ionizing radiation, noise pollution and excessive heat. Microorganisms (wildlife and soils), radionuclides (underlying rock), nitrates and nitrites (nitrogen compounds in the soil), heavy metals (underground rocks containing arsenic, cadmium, chromium, lead and selenium) and fluoride are some naturally occurring pollutants. Similarly there are some man made pollutants such as bacteria and nitrates (human and animal wastes-septic tanks and large farms), heavy metals (mining construction, older fruit orchards), fertilizers and pesticides (anywhere crops or lawns are maintained), industrial products and wastes (local factories, industrial plants, gas stations, dry cleaners, leaking underground storage tanks, landfills and waste dumps), household wastes (cleaning solvents, used motor oil, paint, paint thinner), lead and copper (household plumbing materials), water treatment chemicals (wastewater treatment plants) due to human activities.

5.2.1 Pathogenic Pollutants

The pathogenic pollutants create either acute or chronic problem. Acute effects are those which occur in a relatively short period of time, while chronic effects may take time to be recognized, but are more dangerous. Some pathogenic pollutants will have chronic effects on the organism other than death such as deformity in growth, damage to particular organs, genetic damage to individuals etc.

5.2.2 Aesthetic Pollutants

These pollutants receive more attention of the scientists because they are visible and much more bothersome. Some of the visible effects of aesthetic pollution are as follows:

- a. Solid waste material piled up in shallow waters.
- b. Building activities on the coastline.
- c. Oil wells and oil rigs off shore visible from the coastline.
- d. Spoil areas resulting from dredging operations.
- e. Effluents that cause change in colour of the sea or increase the amount of suspended sediments.

5.2.3 Ecomorphic Pollutants

These pollutants produce a change in the physical characteristics of the environment in such a way that there may be drastic changes in the structure and composition of the biosphere. Some of the ecomorphic pollutants are:

- a. **Sediments.** As it settles down to the bottom, it will tend to bury the organisms living on the bottom. Sediments also tend to fill in marshy areas, killing the marsh grass and completely changing the habitat. When the sediment is in suspension, it also has an effect on the eco-system due the change in the transparency. By making the water more opaque, light will not be able to penetrate thereby affecting the growth of the bio-planktons and zoo-planktons.
- b. **Oil.** It has a toxic as well as physical effect on the marine environment. The results of oil coating the feathers of a bird are a well-known physical effect. Though the oil does not poison, it simply makes it impossible for the bird to fly, consequently resulting in the death of the bird. A film of oil on the surface of the water will also decrease the amount of sunlight entering

the water and will hence limit the exchange of oxygen from the atmosphere. Oil slicks therefore tend to have an impact on the meteorology of a place.

c. **Nitrogen Compounds and Fertilizers.** The nutrients washed into the sea have a non-toxic effect on marine waters. They lead to excess growth of aquatic plants which is likely to have an adverse effect on the biocycle. Once these plants begin to grow at a very rapid rate, they may tend to cover the entire surface of water, thereby preventing any light from penetrating into the deeper layers of the sea leading to anoxic condition.

d. **Waste heat.** Waste heat received from electrical power plant and other industrial sources will increase the water temperature and may result in damage to the marine organisms. Marine animals can even be killed by thermal shock or they can suffer lingering effects unable to adapt to the change in the surroundings.

5.3 Types of Marine Pollution

Water pollution arises from the discharge of industrial, agricultural and human wastes into freshwaters, estuaries and seas. This may result in the poisoning of aquatic organisms or the depletion of oxygen owing to excessive growth of micro organisms (anthropogenic eutrophication), which makes less of the water habitable for fish. Metal pollution and toxic organic compounds are of concern for human and environmental health as a result of discharges to water, air and the terrestrial environment. Two types of water pollutants exist; point source and nonpoint source.

5.3.1 Point Sources

Point sources of pollution occur when harmful substances are emitted directly into a body of water. This pollution can be termed as point source as the amount of pollutant can be measured at a point of time. An oil spill best illustrates a point source water pollution and sewage discharge point, municipal waste dumping sites, litters from beaches, mining, aquaculture and other industries are example of other point sources.

5.3.2 Nonpoint Sources

A nonpoint source delivers pollutants indirectly through environmental changes and it is very difficult to quantify such as solid wastes from other sources, such as septic fields and pit, over water latrines, land fills, erosion, agricultural run off, shipping, atmospheric deposition, sedimentation, dredging etc. Another example of this type of water pollution is when fertilizer from a field is carried into a stream by rain, in the form of run-off which in turn affects aquatic life. The technology exists for point sources of pollution to be monitored and regulated, although political factors may complicate matters. Nonpoint sources are much more difficult to control. Pollution arising from nonpoint sources accounts for a majority of the contaminants in streams and lakes.

5.4 Sources of Marine Pollution

Many causes of pollution including sewage and fertilizers contain nutrients such as nitrates and phosphates. In excess levels, nutrients over stimulate the growth of aquatic plants and algae. Excessive growth of these types of organisms consequently use up dissolved oxygen as they decompose and block light to deeper waters. This, in turn, proves very harmful to aquatic organisms as it affects the respiration ability of fish and other invertebrates that reside in water. Pollution is also caused when silt and other suspended solids, such as soil, wash off plowed fields, construction and logging sites, urban areas and eroded river banks when it rains. Under natural conditions, lakes, rivers and other water bodies undergo eutrophication, an aging process that slowly fills in the water body with sediment and organic matter. When these sediments enter various bodies of water, fish respiration becomes impaired, plant productivity and water depth become reduced and aquatic organisms and their environments become suffocated.

Pollution in the form of organic material enters waterways in many different forms as sewage, as leaves and grass clippings or as runoff from livestock feedlots and pastures. When natural bacteria and protozoan in the water break down this organic material, they begin to use up the oxygen dissolved in the water. Many types of fish and bottom dwelling animals cannot survive when levels of dissolved oxygen drop

below two to five parts per million. When this occurs, it kills aquatic organisms in large numbers which leads to disruptions in the food chain. Pathogens are another type of pollution that proves very harmful. They can cause many illnesses that range from typhoid and dysentery to minor respiratory and skin diseases. Pathogens include such organisms as bacteria, viruses and protozoan. These pollutants enter waterways through untreated sewage, storm drains, septic tanks, runoff from farms and particularly boats that dump sewage. Though microscopic, these pollutants have a tremendous effect evidenced by their ability to cause sickness.

Three last forms of water pollution exist in the forms of petroleum, radioactive substances and heat. Petroleum often pollutes water bodies in the form of oil, resulting from oil spills. Oil Pollution is an example of this type of water pollution. These large-scale accidental discharges of petroleum are an important cause of pollution along shore lines. Besides the supertankers, off-shore drilling operations contribute a large share of pollution. One estimate is that one ton of oil is spilled for every million tons of oil transported. This is equal to about 0.0001 per cent. Radioactive substances are produced in the form of waste from nuclear power plants and from the industrial, medical and scientific use of radioactive materials. Specific forms of waste are uranium and thorium mining and refining. The last form of water pollution is heat. Heat is a pollutant because increased temperatures result in the deaths of many aquatic organisms. These decreases in temperatures are caused when a discharge of cooling water by factories, vessels and power plants occurs.

The pollution of marine environment is largely caused by pollutants arising from land-based sources, transportation of cargo by sea routes and exploration of off shore oil and gas. The origins of different inputs can be roughly grouped in terms of the four area of human activity as follows:

- a. Industry – Industrial processes, products and wastes.
- b. Urban Areas – Energy production, transport and wastes.
- c. Agriculture and forestry.
- d. Transportation of oil and cargo and exploration of off shore oil and gas production.

Figure 5.2 Pollutants in Karnaphuli and Pasur River



Photo 5.1: Ships and Lighters are berthed alongside jetty of Chittagong Port which are discharging huge amount of pollutants including bilge in Karnaphuli river



Photo 5.2: Sunderban Mangrove forest produces lot of debries

Chapter 6

STUDY AREA

6.1 Study Area and Delimitation of Maritime Boundary of Bangladesh

Bay of Bengal a northern extended arm of the Indian ocean, is located between latitudes 5°N and 22°N and longitudes 80°E and 100°E. It is bounded in the west by the east coasts of Sri Lanka and India, on the north by the deltaic region of the Ganges-Brahmaputra-Meghna river system and on the east by the Myanmar peninsula extended up to the Andaman-Nicobar ridges. The southern boundary of the Bay is approximately along the line drawn from Dondra Head in the south of Sri Lanka to the north tip of Sumatra. The Bay occupies an area of about 2.2 million sq km and the average depth is 2,600 metre with a maximum depth of 5,258 metre. Bangladesh is situated at the head of the Bay of Bengal.

The width of the continental shelf off the coast of Bangladesh varies considerably. It is less than 100 km off the south coast between Hiron Point and the Swatch of no Ground and more than 250 km off the coast of Cox's Bazar. Sediments are fine seaward and westward with the thickest accumulation of mud near the submarine canyon, the Swatch of no Ground. The shallow part (less than 20m) of the continental shelf off the coast of Chittagong and Teknaf is covered by sand and the intertidal areas show well-developed sandy beaches. The shallower part of southern continental shelf off the coast of the Sundarbans, Patuakhali and Noakhali is covered by silt and clay; and extensive muddy tidal flats are developed along the shoreline. Some of the shoals and sand ridges present on this part of the continental shelf show an elongation pattern pointed towards the Swatch of no Ground.

6.2 Pollution and Sediment Flux in Coastal Water of Bangladesh

Pollutants washed down from lands and/or dumped directly threaten the marine water of Bangladesh. The large number of rivers and waterways that criss-cross the entire country drain surface runoff and sediment loads from watershed that spread over the upstream districts and finally emptied into the Bay of Bengal, play a vital role in carrying pollutants from different sources. Most of the pollutants are in the form of sediments,

municipal and industrial wastes, agro-chemical residues and pollutant discharge from ships and boats.

The pollution loads from oil spills, industrial wastes, municipal wastes from coastal cities and agricultural wastes were observed. Dissolved inorganic and organic carbon and associated sediment flux through the major river system into the Bay of Bengal was also observed. It is found that the pollution loads are on the increase in the coastal zone and remedial measures are urgently necessary for minimizing degradation of coastal ecosystem.

6.3 Topography of Bay of Bengal Coastal Area

Fresh water from the rivers largely influences the coastal northern part of the Bay. The rivers of Bangladesh discharge the vast amount of 1,222 million cubic meters of fresh water (excluding evaporation, deep percolation losses and evapotranspiration) into the Bay. The temperature, salinity and density of the water of the southern part of the Bay of Bengal is almost the same as in the open part of the Bay. In the coastal region of the Bay of Bengal where a significant influence of river water is present, the temperature and salinity are seen to be different from the open part of the Bay. The waves and ripples entering from the southern part of the Bay provide the energy for mixing the water and consequently bring uniformity in its chemical and physical properties. Tidal action is also very great in the shallow coastal zones.

6.3.1 Climatic Condition of the Area

The mean annual temperature of the surface water of Bay of Bengal is about 28°C. The maximum temperature is observed in May (30°C) and the minimum (25°C) in January-February. But the annual variation in temperature is not great, about 2°C in the south and 5°C in the north. Salinity the surface salinity in the open part of the Bay oscillates from 32‰ to 34.5‰ (parts per thousand, i.e., grams per kilogram of sea water) and in the coastal region varies from 10‰ to 25‰. But at the river mouths, the surface salinity decreases to 5‰ or even less. The coastal water is significantly diluted throughout the year, although the river water is greatly reduced during winter. Along the coast of the Ganges-Brahmaputra Delta, salinity decreases to 1‰ during summer and increases up to

15% to 20% in winter. Salinity gradually increases from the coast towards the open part of the Bay.

6.4 Demographical Characteristics

Tides the semi diurnal type of tides, i.e, two high and two low tides during the period of 24 hours and 52 minutes. The highest tide is seen where the influence of bottom relief and the configuration of the coast are prominent, i.e, in shallow water and in the Bay and estuary. The average height of tidal waves in the deltaic coast of the Ganges it is 4.71 meter. In the Bay of Bengal tidal currents specially develop in the mouths of the rivers, like the Meghna. Color and water transparency the colour of the water in the open part of the Bay is dark blue which gradually changes to light blue to greenish towards the coast. Transparency is great, 40-50 meter in some places. This region is characterised as a rule by high transparency of water. Regions of low transparency and turbid water are available in the limited area of the pre-deltaic part of the rivers Ganges and Brahmaputra.

6.5 Biological Characteristics

Biological characteristics of the occurrence of marine species both plants and animals has largely been controlled by the physico-chemical properties of our coastal water. Water discharges from the surrounding river catchments carry huge influx of sediments full of nutrients to the Bay of Bengal, particularly along the near shore region. This has turned the Bay into a fertile marine fishing ground of the region. The near-shore up-welling zone not only has a high yield of nutrients, but also is a high primary production area for the phytoplankton and related zooplankton zones.

6.6 Harmful Algal Blooms

The term harmful algal bloom (HAB) is used to describe destructive concentrations of particular algal species in sea waters. These blooms are sometimes called red tides because the high algal density can make the sea surface appear red, but the surface may also be green, yellow or brown, depending on the type of algae present. For reasons not yet clearly understood, harmful algal blooms are occurring more frequently within our coastal waters. The consequences are particularly destructive when the algae contain

toxins. In the last two decades, reports of gastrointestinal and neurological diseases associated with algal blooms and waterborne bacteria and viruses have increased. Though seafood poisonings are probably underreported, they also seem to be rising in incidence and geographic scope. Harmful algal blooms cost our nation a huge due to fisheries closures, loss of tourism and recreation and increased health care and monitoring expenses.

6.7 The Marine Habitat

Wetlands, estuaries, sea grass, coral reefs and other coastal habitats are vital to the health of marine and estuarine ecosystems. They protect the shoreline, maintain and improve water quality and supply habitat and food for migratory and resident animals. An estimated 95 per cent of commercial fish and 85 per cent of sport fish spend a portion of their lives in coastal wetlands. Coral reefs cover only about one-fifth of 1 per cent of sea area and yet provide home to one-third of all marine fish species and tens of thousands of other species. Coral reef fisheries yield 6 million metric tons of seafood annually, including one-quarter of fish production in developing countries. In addition to their immense ecological and direct economic benefits, healthy marine habitats offer highly valuable recreation and tourism opportunities and enhance the worth of coastal real estate.

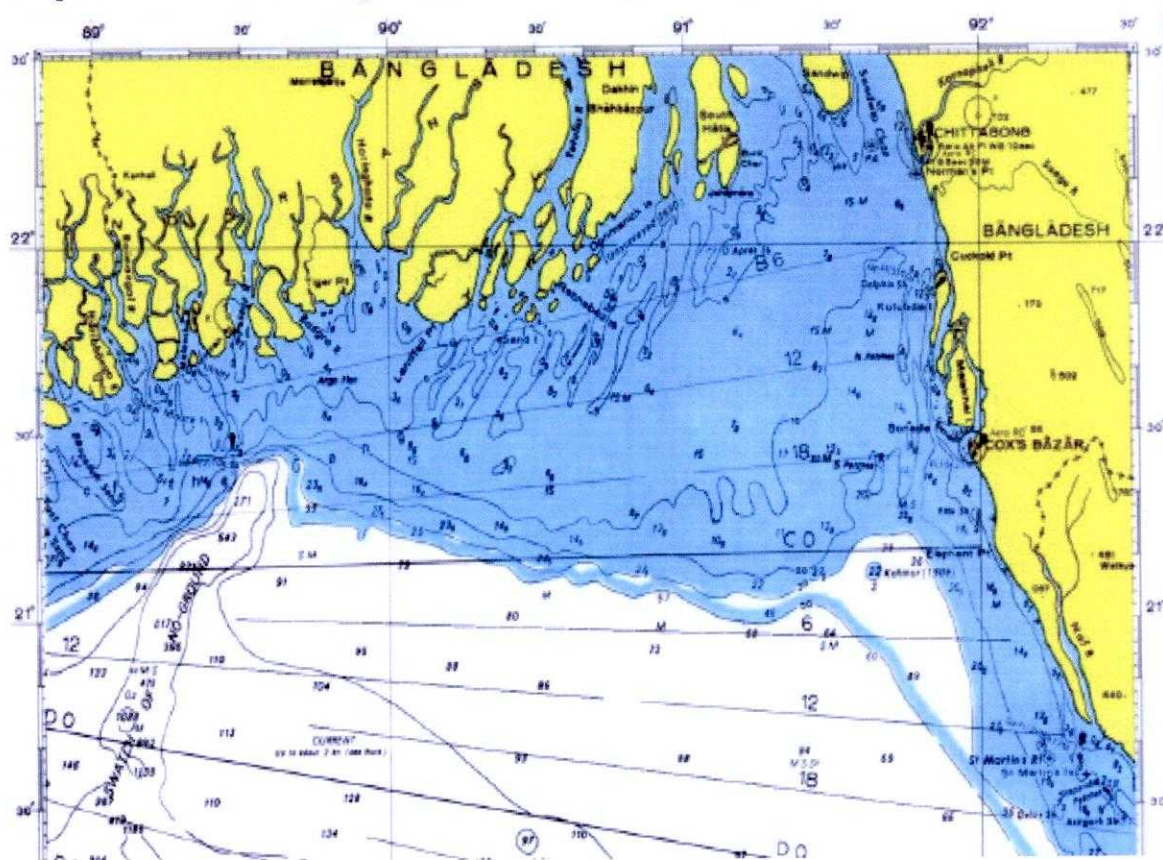
6.8 Marine pollution of Bangladesh Coastal Area

Bangladesh is a maritime nation. The sea coasts of Bangladesh extend over 700 kms in the Bay of Bengal. The area of EEZ is approximately 40,000 sq mls. Borne by water of rivers and canals, the industrial waste of factories founded beside rivers and canals, chemical fertilizers used in agriculture and the waste from the sewerage of towns and cities end up in the Bay of Bengal. Dry docks to facilitate repair and maintenance of vessels and oil exploration with offshore drilling unit also pollute the sea. The oil discharged from the above mentioned sources and the waste of different other sources destroy the marine life, fish, aquatic plants and other aquatic organisms living in the sea. They harm the agricultural and forest resources and the recreational spots along the 700 km long coastal land of Bangladesh. They also pose serious health hazards for people living in the coastal areas.

As per international convention, ocean going vessels are required to keep their waste oil, oil mixed bilge and other trash on board and remove/dispose or transfer them whole at berth. But till now for want of reception facilities in Bangladesh ports no infrastructure has developed either to recycle these wastes or dump them underground. Currently, as many as 2500 registered vessels including the tankers and hundreds of unregistered small mechanised boats ply in the inland waters. In addition to these approximately 1300 cargo ships and boats ply in the coastal waters. Burnt oil, oil mixed bilge and other wastes are dumped into sea and rivers from these ships. The coastline of the Bay of Bengal extending from Faujderhuth to Kumira is being used for ship breaking. Oil from broken ships or other oil related wastes may pollute the sea in these areas. Future remedies in real term in Bangladesh there are no authority to monitor marine pollution caused by vessels and coastal industrial ventures and no body knows the exact extent of the pollution that has taken place in the Bay waters so far over the years.

6.9 Site Maps

Map 2: Chart- Bangladesh Coast of Bay of Bengal



Source: Admiralty Chart

Chapter 7 POLLUTION MANAGEMENT APPROACH - CONVENTIONS FOR POLLUTION CONTROL

We depend on Coastal and marine environments for sustenance, health and economic development. They need to be protected as much as possible from pollution and degradation coming from the land. With respect to institutional framework, different countries adopt different strategies on the institution charged with the enforcement and regulatory functions of protection of the environment. Study shows there is no specialized organization dealing specifically with marine pollution. In some countries there are many agencies/bodies that deal with environmental issues related to coastal pollution. The resultant effect of this arrangement is that most of the time; there is no or little coordination between the activities of the various bodies and agencies responsible for management of environmental issues.

7.1 International Conventions

There are positive developments and successes in the East Asian region itself. Technical and human resources and financial assistance are available within the wider east Asian region but cooperation and co-ordination of efforts internationally are needed to bring about improvements in the management of land-based and other forms of pollution in the marine and related environments. SACEP is a significant regional cooperation for the implementation of a regional project resulting from the SAARC meeting held in Male, Maldives in October 1997. The Male declaration enunciated a need for a regional environmental action plan and adopted a common position on climate change.

7.1.1 Global Water Pollution and International Awareness

With over 70 percent of the planet covered by oceans, people have long acted as if these very bodies of water could serve as a limitless dumping ground for wastes. Raw sewage, garbage and oil spills have begun to overwhelm the diluting capabilities of the oceans and most coastal waters are now polluted. Beaches around the world are closed regularly, often because of high amounts of bacteria from sewage disposal and marine wildlife is beginning to suffer. Perhaps the biggest reason for developing a worldwide effort to

monitor and restrict global pollution is the fact that most forms of pollution do not respect national boundaries. The first major international conference on environmental issues was held in Stockholm, Sweden, in 1972 and was sponsored by the United Nations (UN). This meeting, at which the United States took a leading role, was controversial because many developing countries were fearful that a focus on environmental protection was a means for the developed world to keep the undeveloped world in an economically subservient position. The most important outcome of the conference was the creation of the United Nations Environmental Program (UNEP). UNEP was designed to be the environmental conscience of the United Nations and in an attempt to allay fears of the developing world; it became the first UN agency to be headquartered in a developing country, with offices in Nairobi, Kenya. In addition to attempting to achieve scientific consensus about major environmental issues, a major focus for UNEP has been the study of ways to encourage sustainable development increasing standards of living without destroying the environment. At the time of UNEP's creation in 1972, only 11 countries had environmental agencies. Ten years later that number had grown to 106, of which 70 were in developing countries.

The techniques for establishing marine pollution control regimes have varied. For example the regime for vessel-source pollution has largely been built up within the 'International Maritime Consultative Organisation' (IMCO) with its headquarters in London. Also within the United Nations' framework, the 'United Nations Environment Programme' (UNEP) established in Nairobi by the Stockholm Environment Convention, has accepted a special role in promoting regional agreements. In other cases, ad hoc diplomatic conferences have been used to negotiate specific conventions such as the 'London Dumping Convention' and the 'Paris Convention on Land-based Pollution'.

7.1.2 The IMCO Conventions

The approach to the international control of marine pollution from all sources has long been strongly influenced by the customary doctrine of freedom of navigation on the high seas which was codified in the Geneva Convention on high seas. This convention specifically referred to other freedoms (fishing, submarine cables and pipelines) but the

states consequently assumed that they were free to use the seas for the disposal of wastes from a variety of sources and for testing weapons.

IMCO was established in 1958, as an inter-governmental organisation for the purposes of developing rules and practices concerning the technical aspects of international shipping and encouraging the adoption of the highest practical standards for maritime safety and efficient navigation. There are now at least thirty IMCO conventions and protocols. In 1973, IMCO adopted an International Convention for the Prevention of Pollution from Ships (MARPOL), which now covers all forms of pollution from ships (except ocean dumping of wastes). The convention includes provisions relating to pollution by oil, harmful substances carried in freight containers, sewage and garbage. Under the enforcement provisions, of the 1973 convention, the flag state retains the primary responsibility in case of oil discharge. The Torrey Canyon disaster in 1967 enabled the International Convention in 1969 to empower coastal states to take action in defined circumstances against vessels on the high seas, which have become maritime casualties.

7.1.3 International Law: The United Nations Convention on the Law of the Sea

The United Nations Convention on the Law of the Sea (UNCLOS) incorporates in its part XII the first comprehensive statement of international law for the ocean environment. The United Nations Convention on the Law of the Sea (UNCLOS, 1982) provides specifically for marine scientific research, protection of the marine environment and the promotion of research centres (Part XII - Protection and Preservation of the Marine Environment: Articles 192-196). One interesting issue is the relationship between the establishment of MPAs and the restriction of activities within their boundaries, on the one hand, and the freedom of navigation under UNCLOS. Some type of restriction on navigation would seem in practice to be the most effective way of preventing damage due to dumping, as the no-dumping rule is extremely difficult to enforce except where the culprits are caught red-handed which is of course infrequent. Still UNCLOS does reflect and is consistent with the full corpus of international law affecting the oceans.

To control pollution from land-based sources followings according to UNCLOS, 1982 may be adopted:

1. States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from land-based sources, including rivers, estuaries, pipelines and outfall structures, taking into account internationally agreed rules, standards and recommended practices and procedures.
2. States shall take other measures as may be necessary to prevent, reduce and control such pollution.
3. States shall endeavour to harmonize their policies in this connection at the appropriate regional level.
4. States, acting especially through competent international organizations or diplomatic conference, shall endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control pollution of the marine environment from land-based sources, taking into account characteristic regional features, the economic capacity of developing states and their need for economic development. Such rules, standards and recommended practices and procedures shall be re-examined from time to time as necessary.
5. Laws, Regulations, measures, rules, standards and recommended practices and procedures referred to in paragraphs 1, 2 and 4 shall include those designed to minimize, to the fullest extent possible, the release of toxic, harmful or noxious substances, especially those which are persistent, into the marine environment.

7.1.4 International Maritime Organisation (IMO)

It is a London based specialised agency of the UN dealing with shipping safety and the prevention of marine pollution. The 1990 UN report on the state of the marine environment indicate that about 12% of marine pollution results from maritime transport and a further 10% from dumping by ships of land generated wastes. The UN report estimates that the measures taken in the IMO have prevented as much as 10 million tons

of oil being discharged into the sea each year from tank cleaning and ballasting operations. The IMO is already playing a significant part in worldwide effort. The use on ships of certain gases that damage the ozone layers has been banned and the organisation is looking at ways of reducing still further the pollution of the atmosphere resulting from shipping operations. Incineration at sea - a controversial way of disposing of harmful substances-could be ended within a few years. Further improvements have been made by the MARPOL conventions. IMO has initiated a global programme for the protection of the marine environment to ensure the measures developed over the years are successfully implemented.

7.1.5 Ocean Dumping Convention

Dumping at sea of toxic wastes generated on land, especially radioactive wastes and redundant nerve gases, some of which have reappeared or were accidentally discovered by fishermen, led to such international protest that in 1972 both a regional and an international convention to prevent it were adopted. The Oslo Convention adopted by 12 states of the North Atlantic area preceded the London Dumping Convention for which it was a model, though there are differences. Dumping is also controlled under the more comprehensive Helsinki Convention for the Baltic sea and the Barcelona Convention for the Mediterranean.

7.1.6 Regional Seas Programme of UNEP

UNEP has played a significant role formulating regional seas programme. In 1981, the governments of Indonesia, the Philippines, Singapore and Thailand adopted the Action Plan for the Protection and Development of the Marine and Coastal Areas of the East Asian Seas Region (EAS Action Plan). But due to financial problems the programme is in doldrums. The mid-70s saw the development of the Mediterranean Action Plan under the direction of the UNEP. This was the first of the ten regional programmes promoted by 120 coastal states. An eleventh programme, focusing on South Asia is under development and a regional oil spill contingency plan for the five countries of the South Asian regional seas was drafted.

7.1.7 Global Program of Action

The first intergovernmental review meeting of the Global Program of Action for the Protection of the Marine Environment from Land-based Activities (GPA) in November 2001, in Montreal, Canada, reiterated national governments concerns about the state of the world's coastal and marine environments and made firm their commitments in ensuring that through the implementation of the GPA, improved governance of coastal and marine environments can be attained.

7.1.8 Agenda 21

Agenda 21, is a non-legally binding set of guiding principles for national governments and International organizations on the future directions of environment and development programs. Agenda 21 devotes one of its forty chapters, chapter 17, specifically to the "protection of Oceans and seas" is entitled; "Integrated management and sustainable development of coastal and marine areas, including exclusive economic Zones". Section 17.5 "objectives" states "Coastal states commit themselves to integrated management and sustainable management of coastal areas under their national jurisdiction". Section 17.6 states "Each coastal state should consider establishing, or where necessary strengthening coordinating mechanisms for integrated management and sustainable development of coastal and marine areas and their resources, at both local and national levels.

7.1.9 The Dirty Dozen

A 'dirty dozen' issue areas covering the range of ocean environmental issues were taken up at the 1992 UN conference in Brazil. The dozen areas are as follows:

- a. **Environmental Security.** This concept draws a connection between environmental protection and a broadened notion of national security. It raises questions about an effective mix of unilateral and multilateral measures and about the forms of mutually acceptable international security mechanisms among nations pursuing their own goals. A connection with traditional defence interests is the potential for international conflict over issues of resource use and environment management.

b. **Land-based Marine Pollution.** Although marine pollution is commonly associated with sea based sources such as ocean dumping, marine transportation and off-shore hydrocarbon production, a UN expert group estimates that in fact nearly 70% originates from land-based sources through run-offs, discharges and atmospheric emissions. This presents a basic puzzle for control efforts. To get at marine pollution requires taking on all pollution. The problem grows further roughly in step with population and economic growth. Many groups now advocate a global convention on land-based pollution. This risks undermining an already shaky international law by adopting either very strong provisions virtually doomed to failure in economically strapped developing countries like Bangladesh or very weak provisions with little practical effect.

c. **Coastal Zone Management.** One approach to control land-based marine pollution and to resolve conflicts between the environment and coastal development is Coastal Zone Management (CZM). The idea is to replace isolated regulation of individual resources or activities with a comprehensive regional planning and management processes. For practical purposes, coastal zones are usually defined by jurisdictional boundaries. On a global basis, the UN has identified this approach as a policy priority for developing countries. In the US the Coastal Zone Management Act of 1972 has been reauthorized to make federal activities of the coastal states consistent with the coastal management plans of those states, as long as the state plans conform to national guidelines. It affirms explicitly that, all federal activities whether inside or outside the coastal zone, must conform to the state CZM plans, if they affect natural resources, land uses and water resources in the coastal zone.

d. **Living Resources Conservation.** Management authorities are seeking ways to reconcile multi species relationships and to achieve integrated management of large marine ecosystems that may require multilateral, regional cooperation. Contentious issues include driftnet fishing on high seas, wasteful by-catch and destruction of non-targeted species. These include large number of dolphins, whales, birds and sea turtles. Many are threatened species protected by international law. The growing emphasis on the conservation of biological diversity has resulted in the creation of marine reserves worldwide. The International Maritime Organisation has devoted much of its attention to

identifying special areas and particularly sensitive sea areas, with a view to internationally agreed protective measures.

e. **Hazardous Materials Transportation and Disposal.** A basic conflict between coastal state protection and traditional navigational freedoms has the context for the evolution of international rules and guidelines for the seaborne transportation of hazardous materials. In general, international agreements provide for primary enforcement by the vessel's flag state. Any enforcement by coastal countries is subject to specified safeguards and usually must defer to flag state enforcement. Also all laws and regulations adopted by coastal states to control pollution from vessels transiting their maritime jurisdiction must conform to generally accepted rules and standards. Still a number of coastal countries continue to assert navigational restrictions that exceed the generally accepted international norms. The central issue therefore is how to restrain such unilateral restrictions and stabilize coastal controls on a consistent basis.

f. **Nuclear Contamination.** This is an area at which the public fears and scientific evidence are at odds. Human activity have added only negligibly to the ocean's natural background radioactivity, primarily by explosions of nuclear weapons, effluents from nuclear facilities and ocean dumping of solid nuclear wastes. Scientific evidence indicates that present and future risk to individuals from past dumping is extremely small. The best methods for long term disposal of the large and growing backlog of radioactive wastes are as yet unperfected and ocean disposal options such as deep seabed emplacements of high level wastes are still favoured by some scientists.

g. **Open-Ocean Environment.** Though pollution levels are not alarmingly high in the oceans, there are reports that lead, chlorinated hydrocarbons and artificial radionuclides are present everywhere in the oceans and given the low levels of contamination, their effects, if any will be observed or predicted only when there is an adequate baseline of reliable data and a better knowledge of the deep seas that control them. Driftnet fishing on the high seas is also considered as an insult to the open-ocean environment.

h. **Damage Assessment.** Fair compensation of victims is a basic tenet of environmental security, but it depends on proper assessment of environmental

damages. The Exxon Valdez spill and Iraq's intentional release of Kuwaiti oil into the Persian Gulf during the Gulf War underscore the issue. A basic problem is accounting for long-term effects and especially hard for low-level, chronic effects. A closely related problem is one of distinguishing human causes from natural fluctuations. A closer integration of scientific and economic research is needed to improve damage assessment.

i. **Global Warming and Sea Level Rise.** The presumption is that global warming, driven by the build up of greenhouse gases from human activities, will increase the volume of water in the oceans (through a combination of thermal expansion and melting ice) and lead to sea level rises throughout the world. The expected physical impacts of sea level rise include, inundation of low coastal lands, relocation or destruction of coastal wetlands, shoreline erosion and beach loss, increased exposure to storm surge and flooding, and increased salinity of rivers etc. Evidence of acceleration in the rise of the sea level is much more moderate than earlier alarms. On balance it appears that humankind are getting better at understanding and addressing the problem of sea level rise faster than it is getting worse.

j. **Marine Scientific Research and Technology.** Improved scientific information and expanded technological capabilities are crucial for ocean environmental management. Understanding global ocean circulation patterns and of air-sea interactions is key to improved prediction of climate change, for example.

k. **Problematic Policy Principles.** Four principles among those emerging as doctrine in international environmental affairs warrant careful scrutiny and critical re-examination. They are command and control in environmental affairs, uniform standards, polluter pays for the costs of pollution and the precautionary principle to avoid environmental risk in the face of scientific uncertainty.

It is now widely recognised that marine pollution is in many respects an international problem and that its control requires international cooperative effort. Because of the ecological inter-relationships of the marine environment, a major problem now is to find means of coordinating the activities of all the new bodies concerned with the regulation of pollution from a variety of sources.

7.1.10 Different Conventions

In addition, the government of Bangladesh has signed several international conventions that have implications for environmental aspects of water resources planning. The major conventions are:

- Agenda 21
- The 1992 Rio convention on climate Change and Biological Diversity
- The 1971 Ramsar Convention on Wetlands,
- The 1973 Convention on International Trade on Endangered species of Wild Fauna and Flora (CITES)
- The 1954 International Convention for Prevention of Pollution of the sea by Oil. Under this, permitted discharge amounts and locations from the ships are specified.

7.2 Bangladesh Conventions - National Legal Approaches for Bangladesh

In Bangladesh the organization dealing with general environmental matters also has the function of regulating marine/coastal pollution. But due to lack of co-ordination among agencies and also lack of sufficient resources, the pollution in the coastal areas are now a days, becoming a great concern for the Environmentalists. Department of Environment under Ministry of Environment and Forest play the main roll over the environmental issues in our country.

7.2.1 Marine Protected Areas: Territorial Water and Maritime Zones Act, 1974

Legislation in the South and Southeast Asia region relating to marine parks and reserves continues the tradition of dealing with them in the context of fisheries and environmental legislation. In Bangladesh conservation, use and exploitation of marine resources are provided for under the Territorial Water and Maritime Zones Act, 1974. According to provisions in this Act, conservation zones may be established to protect marine resources from indiscriminate exploitation, depletion or destruction. At present, there is no legal provision for the management of coastal zones.

7.2.2 National Environmental Policy (1992)

The Bangladeshi Government completed the development of its National Environmental Policy in 1992 and has since gone on to establish acts by which the policy can be administered. The 1992 Environment policy contains four broad policies for coastal and marine management:

- Ensure the conservation and environmentally sound development of coastal and marine ecosystem and resources.
- Prevent all local and external activities that lead to pollution in the coastal and marine areas.
- Strengthen necessary research in order to preserve and develop coastal and marine environment and resources.
- Restrict coastal and marine fisheries within sustainable limits.

The 1992 Environment policy included the Environmental Conservation Act of Feb 1995. The law was enacted for conservation, improvement of quality standards, and control and mitigation of pollution of the environment. The Act covers a wide range of areas that relate to water resources management in Bangladesh. Key sections under the Act include those that deal with water pollution and fisheries. The Act states that if discharge of any environmental pollutant occurs, or is likely to occur, in excess of the prescribed limit laid down by the Rules, either through accident or other unforeseen events, the person responsible at the place where the discharge occurs is bound to control and mitigate the environmental pollution caused. However, despite such unequivocal statements within the Act, the discharge of untreated industrial waste, including heavy metals, is common and little, if anything, is done to enforce existing policy provisions.

As a response to the National Environment Policy, 1992, the following environmental legislation has been set as the framework for environmental management of the country:

- The 1995 Environmental Conservation Act
- The Environmental Conservation Rules of 1997
- The 1997 EIA Guidelines for Industries
- The 1999 Environmental Court Act

7.2.3 National Water Policy

The National Water Policy (NWP) 1999, with over 50 clauses of relevant with environment is intended to guide both public and private actions to ensure optimal development and management of water that will benefit both individuals and society at large. It attaches special importance to the conjunctive use of ground and surface water. Directions are provided on such issues as river basin wide planning, water rights and allocation, public and private involvement, public investment, water supply and sanitation, fisheries, navigation, agriculture, industry and environment. Compliance with the policy will ensure that the development and management of the nation's water resources include protection, restoration, preservation of natural habitats and their dependent bio-diversity and water quality with specific provisions for wetlands, mangrove and other forest resources including endangered species. The policy also prescribes water resources management practices that avoid or at least minimize environmental degradation. The national water policy sets following main objectives:

- To address the related issues
- To ensure availability
- To accelerate development
- To bring necessary institutionalisation
- To develop state of knowledge and capability

Some specific provisions are as follows:

- Protection restoration and enhancement of the water resources
- Protection of water quality, including strengthening of regulation concerning agrochemicals and industrial effluent monitoring
- Facilitation of portable water and sanitation
- Provisions for fish and fisheries
- Participation of local communities is a requirement for water sector development activities, as a subject to an environmental assessment procedure and for the planning and management process.

7.2.4 The Coastal Zone Policy 2005

The Coastal Zone Policy (CZP) 2005 with its eight development objectives forms a comprehensive frame work for ensuring the environmental friendly activities in the coastal areas along with its sustainable development. Development objectives are:

- Economic growth
- Meeting basic needs and creating livelihood opportunities for coastal communities
- Reduction of vulnerabilities and enhancement of coping capacities
- Sustainable management of coastal resources
- Equitable distribution of resources and economic benefits across social strata
- Empowerment of the coastal communities
- Women's advancement and promotion of gender equity
- Preservation and enhancement of critical ecosystem.

The Government considers the following three reasons for the Coastal Zone Policy:

- The coastal zone is lagging behind in socio-economic development in many aspects
- This is both a cause and a consequence of peoples vulnerability to many disasters and to the deteriorating environment
- Coastal zone has potential to contribute much to national development.

The Coastal Zone Policy (CZP) builds on the relevant segments on coastal issues and explicates them in a manner that provides the direction for realizing the objectives of the policy. The policy also prescribes provisions to control the pollution in the coast to minimize the environmental degradation. Provisions are as follows:

- Zoning regulations will be established for location of new industries in consideration of fresh and safe water availability and effluent discharge possibilities
- All industrial units will be required to install built in safeguards against pollution within a given timeframe and will help them in obtaining financial

support from international bodies to carry out the adjustments. Units failing to comply with the pollution standards will be required to pay 'green tax' for cleanup of the environment polluted by them

- Sewage treatment plants will be set up for the major cities like Chittagong, Khulna and Barisal and gradually in other urban centers
- Steps will be taken to handle the issue of discharge of bilge water from ships and oil spill according to international conventions to which Bangladesh is a signatory.

A review of the desirability of supporting ship breaking as an industry will be done and, in the event of its continuation, environmental standards will be prescribed under which it has to conduct its activities. The policy also has provisions for conserving the critical ecosystems in the coast.

7.3 Minamata (Japan): Environmental Contamination with Methyl Mercury - A Case study

In Minamata, Japan, inorganic mercury was used in the industrial production of acetaldehyde. It was discharged into the nearby bay as waste water and was ingested by organisms in the bottom sediments. Fish and other creatures in the sea were soon contaminated and eventually residents of this area who consumed the fish suffered from MeHg (methyl mercury) intoxication, later known as the Minamata disease. The disease was first detected in 1956 but the mercury emissions continued until 1968. But even after the emission of mercury stopped, the bottom sediment of the polluted water contained high levels of this mercury. Various measures were taken to deal with this disease. Environmental pollution control included cessation of the mercury process; industrial effluent control, environmental restoration of the bay and restrictions on the intake of fish from the bay. This apart research and investigative activities were promoted assiduously, and compensation and help was offered by the Japanese Government to all those affected by the disease. The Minamata disease proved a turning point, towards progress in environment protection measures. This experience clearly showed that health and environment considerations must be integrated into the process of economic and industrial development from an early stage.

The major sources of water pollution come from mainly industrial, municipal/urban areas and agricultural activities. Important marine pollutants, which do not fit into these categories, include solid wastes (industrial wastes and dredge spoil), garbage (particularly plastics and fishing nets) and waste heat.

8.1 Industrialisation in Bangladesh

With increasing industrialisation in the country, the volume of industrial waste released into the marine environment either directly or through the rivers is steadily on the increase. These industrial wastes contribute to enormous quantities of pollutants reaching the sea. The most important sectors of industry and processing industry from the marine pollution point of view are:

- a. Non-renewable local resource based industries and mining. This category includes industries based on mineral resources such as limestone, hard rock, gravel, glass, sand, various types of clays and heavy metals such as copper and zinc. Natural gas is harvested as an energy resource, which support the fertilizer factories and power stations. Other resources are coal, white clay and peat with coal harvesting still in the process of development. In this sector, major polluters are the cement and fertilizer cement factories.
- b. Agro and forest based industries. This category includes jute, pulp and paper, match, sugar, tobacco, tanneries/leather, salt, shrimp and food processing industries. From pollution point of view, sugar, pulp and paper and tanneries are the major contributors.
- c. Iron, steel and non-ferrous metals.
- d. Imported resource based and Chemical industries. This category includes textile, pharmaceuticals, plastic, petroleum/refineries and metal works. Most of these are considered as highly polluting such as petrochemicals, oil refineries, pesticide manufacturers etc.
- e. Engineering and surface treatment industries (metal products, electrical and mechanical engineering, shipbuilding, galvanizing etc.).

8.1.1 Industrial Hotspots

Most of the major polluting industries such as pulp and paper, sugar, fertilizer, pharmaceuticals, metal and chemical industries are mostly located on the banks of major rivers and lakes. Other than Dhaka the major industrial locations of the country are concentrated in two metropolitan areas:

a. Khulna (Shiromoni, Khalishpur and Rupsha). Some 300 industries are located in and around Khulna city, of which 290 are considered as major polluters, currently discharge huge amount of liquid waste into the river Bhairab. These include Khulna Newsprint Mill, a large number of jute mills including Crescent Jute Mills Company, many match factories, textile mills and Bangladesh Cable Shilpa Sangstha - all are causing severe water pollution of the Bhairab River. These pollutants may be contributing to the 'top dying' disease of the tress in the Sunderbans in addition to causing serious damage to both freshwater and marine ecosystems. By now the river water near the industries become poisonous or unusable for the local community, such as water of the Bhairab at Nowapara-Fultala point in Abhoinagar upazila has been contaminated causing death of fish.

b. Chittagong (Kalurghat, Patenga, Bhatiary, Nasirabad and Kaptai). The total number of industries is about 720 of which 370 are considered as major polluters. The polluting industries of Chittagong are 19 tanneries, 26 textile mills, 1 oil refinery, 1 TSP plant, 1 DDT plant, 2 chemical complexes, 5 fish processing units, 1 urea fertilizer factory, 1 asphalt bitumen plant, 1 paper mill (solid waste disposal hourly 1450 m³), 1 rayon mill complex, 2 cement factories, 2 pesticide manufacturing plants, 4 paint and dye manufacturing plants, several soap and detergent factories and a number of light industrial units directly discharge untreated toxic effluent into Karnaphuli river. From the survey of effluents from different industries, it has been found that the discharge is generally composed of organic and inorganic wastes. The organic wastes are the effluents from the tanneries, fish processing units, degradable wood chips, pulps and untreated municipal and sewage (about 40,000 kg BOD daily) etc. The inorganic waster are chemicals used by the industries such as various acids, bleaching powder, lissapol, hydrogen peroxide, alkali, salts, lime, dyes, pigments, aluminium-

sulphate and heavy metals etc. The DDT factory and fertilizer factory disposing of DDT, toxic chemicals and heavy metals to the Karnaphuli River and ultimately to the Bay of Bengal. Some survey show about 220 ppm of chromium, 0.3-2.9 of cadmium, 0.05-0.27 ppm of mercury, 0.5-21.8 ppm of lead entering river and sea water much higher than allowable limits and extremely alarmingly to aquatic flora and fauna and through food chains to human beings. Most of the industries are located on the banks of the Karnafuli River and the Kaptai Lake. Another group unique to Chittagong is the ship building/wrecking industry. This sub-sector contributes a lot of marine oil pollution. Ballast and bilge waters from oil tankers and ships anchored in the port should only be emptied at installations where the oil can be separated and recycled. This is obligatory in many countries but in Chittagong, ships directly discharge their waste oil-water mixtures into the Bay of Bengal. Industrial solid wastes in the coastal water in the Chittagong region are very high as most of them do not have any treatment plant that is required under the environment law. As a result, all the polluted discharges come directly to the sea through different canals and rivers. It is reported that some indigenous fish species like Ruhi, Katal and Mrigel are yet to release spawns this year at the Halda River, the main source of naturally bred fries in the country. This is unprecedented in recent history. The non-spawning might aggravate the gradual extinction of these species.

c. Barisal. There are about 8 large scale Industries including Pharmaceuticals, textiles and cement Factories. Small-scale industries are also there, which includes Jute mill, Electronics, cold stores, Biscuit, dairy farm etc.

Table 8.1: The top seven polluters

No	Industrial Sector	Rank by pollution type			Rank sum
		Water	Toxic Metal	Toxic Chemicals	
1.	Metal	3	1	8	12
2.	Fertilizers/pesticides	5	4	4	13
3.	Pulp and paper	1	12	2	15
4.	Industrial chemicals	6	6	5	17
5.	Food industry	4	9	6	19
6.	Cement/Clay	11	2	9	22
7.	Petroleum/refineries	10	13	10	33

Source: World Bank Report 1997

8.1.2 Major Polluting Paper Mill Industries

a. Khulna Newsprint Mill. Khulna Newsprint Mill (KNM), Khalishpur, Khulna is one of the oldest large-scale plants in Bangladesh, having been constructed with Canadian assistance in 1959. Its pre-environmentalist technology, semi-chemical pulping, is now losing ground internationally to cleaner technologies such as the thermomechanical process. No cleanup has been undertaken at KNM. It emits large volumes of airborne sulphur dioxide and effluents are dumped completely untreated into the Bhairab River. The wastewater has high Biological Oxygen Demand (BOD), suspended solids, oil and grease, and significant residual sodium sulphite and carbonate from the wood treatment process. While KNM is a substantial polluter and there are abundant employment options in the area, it has experienced no pressure for cleanup. This is apparently because KNM sits among several polluting installations on the riverbank and cannot be clearly identified by downstream communities.

b. Karnafuli Paper Mill (KPM). Karnafuli Paper Mill, the largest of all paper mills in Bangladesh, is situated in Chandraghona amidst hills and gardens, 30 miles away from Chittagong metropolitan City, on the bank of river Karnafuli. With a total manpower of about 3017, the industry produces about 30,000 MT of paper annually. KPM uses bamboo and tropical hardwood as raw materials. Caustic soda and sodium sulfate are used to produce brown paper. For bleaching, chlorine, caustic and calcium tylo are used to produce white paper. Some additives like china clay, dye and binding materials; starch rosin and alum are added to the prepared stock of pulp for improving strength and physical properties of the paper. The waste contains sulfite liquor, black liquor (containing Na_2CO_3 , Na_2S and NaOH) and hazardous chemicals like chromium, sulfur and acids. Washed chemicals are passed to the recovery section where 80% of the used chemicals are recovered and reused. The remaining 20% is discharged into the river untreated. The pH of the river water varies between 6.3 and 8.0 near the Kaptai Barrage and KPM sites. KPM sources suggested that the factory is old and does not have proper treatment facilities. Installation of treatment plants have been considered, but remain constrained by the availability of space and fund. People along the riverbank have stopped using river water. They complained that

chemical waste from 20 industrial plants on the riverbank along with wastewater used for post-harvest jute processing has been drained into the river.

Table 8.2: Waste and Pollution from Pulp and Paper Mills

Type of waste/pollution	Pollution characteristics
Suspended solids containing fine bark particles and silt, fibers and fiber particles and coating and filling materials	High content of suspended solids Clogging of water intake pipe downstream
Soluble organics include discards of wood sugars, carbohydrates and other compounds	Rapid growth of microorganisms Enhanced growth of slimes Contribution to high BOD
Soluble inorganics include sulphites, phenols, chloride and phosphate	Toxic effect on aquatic life Excessive growth of algae
Toxic substances include crude soap produced as a bi-product in the manufacture of kraft pulp	Toxic effect on aquatic life
Black and sulphite liquor	Lowering of dissolved oxygen content and consequent impact on aquatic life
Unpleasant appearance of dark effluents, foam and visible streaks of clay and titanium oxide	Aesthetic pollution
Lignino-cellulose deposited at the bottom of the river around the point of discharge	Creation of anaerobic condition and destruction of aquatic life
Mercury	Heavy metal pollution affecting both water quality and aquatic life

Source: World Bank Report, 1997

8.1.3 Major Polluting Fertilizer Factory

- a. Triple Super Phosphate Complex (TSPC). This plant located on the Karnafuli River close to the Bay of Bengal. However, the resemblance to CUF ends there. TSPC is the most pollution-intensive, dangerous plant and has been identified by the environmental division of the Bangladesh government as a major

problem. The wastewater is loaded with flouride and sulphur. Despite the use of a scrubber, there are heavy air emissions of sulphur di- and tri-oxide, flouride and nitrous oxide. In any case, the water from the scrubber is simply dumped into the river.

Table 8.3: Wastewater Characteristics of selected fertilizer factories, 1994

Parameter	TSP complex at Chittagong	Chittagong Urea Fertilizer Factory at Chittagong
pH	4.5	9.4
BOD5 (mg/l)	0	0
COD (mg/l)	20	200
SS (mg/l)	11910	4968
Phosphate (mg/l)	56	7
Nitrate (mg/l)	20	22
Kjeldahl-N (mg/l)	15	185
Chromium (mg/l)	0.075	0.022
Nickel (mg/l)	0.068	0.087

Source: World Bank Report, 1997

c. Chittagong Urea Fertilizer. Although the nearby CUF plant has had no difficulty with neighboring villages, TSPC is under extreme pressure. Local communities have not hesitated to protest, because there are many other potential employers in the-region. The implicit threat of violence is present and the plants own employees are quite concerned about the impact of its air emissions on their health. Although the plant managers are fully aware of the problems, little or no cleanup effort is visible to date. In part, this seems to be because the technical and human resource requirements for effective cleanup in such a facility are more demanding.

Table 8.4: Waste generated from fertilizer factories

Type of waste	Contents
Solid	- Contaminated sludge, process condensate - Urea dust - Waste catalyst and catalyst dust containing cobalt, zinc, nickel, chromium, copper and iron - Other solid scraps and waste dumped in scrap yards
Liquid	Wastewater with high ammonia content

	• Wastewater containing sulfates, phosphates, fluorides, urea, amines, methanol and hydrogen sulfide • Effluent from cooling towers, boiler blow downs, washing, spills and leakage, surface runoff and gypsum sludge in case of TSP complex
Gaseous	• Ammonia in purge gas • Flue gas containing CO₂, CO, CH₄, As, etc. • Formaldehyde vapor • Urea dust • SO_x in case of TSP

8.1.4 Textile

Textile mill effluents (TME) are complex mixtures of chemicals, varying in composition over time and from mill to mill. They can include high concentrations of suspended solids and metals, extreme pH and elevated temperatures. Given the many mills across the country, exposure is widespread. Studies indicate that effluents have harmful effects on a wide variety of aquatic organisms. An assessment is needed to evaluate the toxicity and biological impact of treated and untreated textile mill effluents on aquatic ecosystems. The assessment should include the examination of the fate and effects of dyes in aquatic environments downstream.

8.1.4.1 Entry, Exposure and Effect in the Environment

There are a number of Textile mills in the coastal zone of Bangladesh. As far as can be determined, most of these conduct wet processing operations, producing a liquid waste stream. Untreated TMEs have been characterized as having extreme pH, elevated temperatures, high concentrations of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), total suspended solids (TSS), oil, grease and metals. Secondary treatment of textile wastewaters reduces the pollutant concentrations in TMEs. All known releases of TMEs are ultimately to some form of water (rivers, lakes, estuaries, marine environments), whether they are discharged directly or through a wastewater treatment system. Because approximately 94% of wet processing textile mills are located in Chittagong, Barisal and Khulna, most discharges are predicted to be to the freshwater /marine water environments. TMEs are expected to partition mainly between the water

and sediments in the receiving environment, with little partitioning to the atmosphere. Besides fish, untreated textile mill effluents have been shown to be toxic to a wide range of aquatic toxicity including: freshwater mussels, crabs, frogs, freshwater alga as well as diatoms and bacteria. The problem in interpreting most of the aquatic toxicity data is that the type of mill or process whose effluent was tested for toxicity has not been well characterized. For that reason no general conclusion can be drawn on the toxic potential of specific effluents. The processes used in individual plants can also change throughout the year according to the outputs required and many mills employ batch processes resulting in effluents whose toxic potential would change dramatically within temporal scales of weeks to months. Another serious shortcoming of the existing knowledge, is that the receiving environments have not been characterized, making it difficult to estimate the extent of the impact that will occur with a given discharge. Finally, the chemical use patterns within the textile industry, particularly those associated with dyeing, are changing rapidly as technology evolves. Assessment and measurement endpoints will focus on aquatic environments and related wetland environments. Given the chemical complexity of TMEs, several assessment endpoints are required to ensure that a range of ecosystem components are considered in the assessment. Assessment endpoints for the ecological risk assessment of TMEs are the biodiversity of benthic macro invertebrates, population abundance of sensitive aquatic species which could include fish, algae, invertebrates, amphibians, piscivorous mammals and birds. Proposed measurement endpoints are community impacts derived from field studies of benthic macro invertebrates, acute and chronic aquatic toxicity tests of whole effluents and water samples from receiving environments, toxicity tests of sediments in receiving environments and embryo toxicity and other endocrine disruption-related endpoints of whole effluents.

8.1.5 Oil

Oil is not a single substance but a complex mixture of great many chemicals. Crude oil contains thousands of compounds and refined oils such as kerosene or gasoline consist of rather simpler mixtures. As a result of this complexity, many of the environmentally significant properties such as toxicity, solubility and viscosity vary considerably from oil to oil, making the task of predicting effects very difficult. The total global production of crude oil is about three billion tonnes per year and approximately half of this is

transported by sea. This means that on any given day there are approximately 8.25 million tonnes afloat around the oceans. For the most part, the shipping lanes lie well out to sea in deep water, where the risks of accidents are small. However, on leaving and approaching ports ships are obviously close to land and experience has shown that in these coastal zones the risks of serious incidents are greatest. The recent incident of the MV SHOURAV off chittagong outer anchorage is an example in point.

The most recent estimates indicate that the total amount of oil entering the oceans directly as a result of human activity is about 3 million tonnes per day. To this must be added another 250,000 tonnes deriving from natural seeps of oil is leaking from submarine oil-bearing strata. The table below gives a breakdown of the various sources of oil, which shows that despite the wide publicity given, tanker accidents are not the largest source of oil, although they are the most important in terms of the environmental damage they cause. Workers use special nets to clean up after an oil tanker spill. Tanker spills are an increasing environmental problem because once oil has spilled, it is virtually impossible to completely remove or contain it. Even small amounts spread rapidly across large areas of water. Because oil and water do not mix, the oil floats on the water and then washes up on broad expanses of shoreline. Attempts to chemically treat or sink the oil may further disrupt marine and beach ecosystems.

Table 8.5: World Wide Annual Inputs of Oil to the Marine Environment

<u>Source</u>	<u>Annual Input (million tones)</u>
Offshore production	0.05
Routine ship operations	1.05
Ship accidents	0.42
Atmosphere	0.3
Land-based sources	1.23
Ocean dumping	0.02
Natural sources	0.25
Total	3.32

8.1.5.1 Transportation and Production of Oil and Gas

Pollutants from these activities may reach the seas in various ways like shipping accidents at sea, accidents in oil rigs, discharges from ships, spills during loading and unloading operations in ports and treatment of boat hulls and ship hulls with organic paints. The common substances that may be released and dispersed this way are:

- a. Hydrocarbons- This includes oil products in various forms.
- b. Oils and chemicals from various drilling rigs and oil platforms.
- c. Chemicals carried by ships, which may be released as a result of accidents or due to careless handling in ports.
- d. Radioactive substances, as a result of accidents involving nuclear fuel carriers or dumping.

8.1.5.2 Oil Spills

Of the various types of pollution in the coastal zone, pollution with oil received most attention, not only because the incidents are numerous, but also since extent and effects are clearly visible. Oil pollution of coastal waters and lands come from tankers, freight and container vessels using the busy sea transportation routes of the southern Bay of Bengal (connecting Far East and Middle East/Europe; ESCAP, 1987), as well from shipping activities in and around the main ports of Bangladesh itself. Spills result from accidents and intended discharges; they circulate to coastal areas by the semidiurnal tidal current. Oil spills pollute coastal waters and ultimately intoxicate the soil. Oil spills from these sources are a major threat to the marine resources. Approximately 400,000 tons a year spilled into the Bay of Bengal of which 6000 tons is contributed by Bangladesh. Bangladesh annually imports around 1.20 million tons of crude oil and 0.5 million tons of refined oil. Major portion of this oil are transported to inland areas of Bangladesh through smaller tanker and also during lightening activities in the outer anchorage, a certain portion of the oil leaks into the sea. Examples of accidents at sea are numerous. There have been persistent reports of oil slicks in the territorial waters of Bangladesh and in the upper Bay of Bengal.

In several instances they caused large-scale oil pollution in the coastal wetlands. In 1990 a big oil spill from an unknown origin was detected along the sea face of the Jongra forest camp in the Chandpai Range of the Sundarban. In January 1992, a huge oil slick appeared on the Khulna coast. Oil spill due to ship wreckage occurred in August 1994, when a Panamian registered ship capsized near the Dhangmari Forest Station; oil from its fuel tank spread about 15 km downstream and affected a considerable part of the Sundarban and its resources. It caused instant mortality of grasses, seedlings of *Heritiera fomes* and *Excoecaria agallocha*; mortality of fish, shrimp and other aquatic animals has also been found. In addition to that severe accidental oil spillage due to extreme natural calamities, tank leakages and other causes is a constant danger for Bangladesh. This country was devastated by a cyclone in 1991, with maximum wind velocity of 235-240 kph and tidal surge of 6-10 meters height. As a result, eighteen vessels sank in the Chittagong port area and many other boats, trawlers, barges and ships in the rivers channels and off the coastal areas. In the year 1989 a greek-owned flag ship, has caused a huge oil slick along the Chittagong, Cox's Bazar coast. The vessel had developed a hole through, and losses 3000 tones of crude oil from the ship near kutubdia. Inland oil spills are mostly relatively small, but since their frequency of occurrence is high they have a substantial environmental impact. The Chittagong and Mongla ports are the main sources of oil pollution in the coastal zone; oil pollution is reported to be heavy in their vicinity. The Mongla situation is of special importance, since the port is not at sea, but about 80 km upstream of the Pasur River. The complete stretch from the Bay of Bengal towards Mongla port runs through the Sundarban. On an average, the port deals with 1,500-1,600 vessels and 12,000 to 13,000 cargoes annually. Moreover, numerous mechanized river crafts and fishing boats enter the Sundarban or pass through it regularly. Vessels operating through the Mongla Port use 2 million tons of oil annually as fuel. These vessels discharge waste oil and oil spillages, in addition to ballast water, sewage and waste. Apart from this oil refinery at port releases 50,000 mt of oil per year, of which a significant amount of oil runs to the coastal water. Chittagong port also deals with 1500 vessels every year in addition to it 40 oil tanker, 2500 registered vessels and hundreds of unregistered mechanized river crafts and fishing boats are using the river and the coast of Bay of Bengal regularly.

Once spilled, oil spreads very rapidly, with lighter fractions moving most quickly. From the moment of release the composition of oil begins to change as the lighter, more

volatile components tend to evaporate or dissolve, leading to a steady increase in the proportion of the heavier, tarry residues. The action of the winds and waves tends to mix oil with water leading to the formation of oil-in-water emulsions. These emulsions are very stable and may persist for long periods. The relatively toxic components that dissolve may have adverse effects on the animals in the underlying water. These effects are normally fairly minor in extent because mobile creatures such as fish can avoid contaminated waters, although less mobile phytoplankton and zooplankton may be affected over limited areas. Oil has entered the oceans from natural seeps over geological time, so it is not a totally alien substance as some synthetic pollutants are. This means that a considerable variety of bacteria have evolved which are capable of at least feeding on some of the components of tar/oil, so that eventually all but the most resistant fractions (such as tars and asphaltenes) are degraded.

8.1.5.3 Oil Spill Impact

Oil pollution has serious damaging impact on mangrove ecosystem, their coastal and marine resources. Oil spills cause action and mortality to mangrove trees and damage to nursery ground of marine fish and crustaceans in swamps. The pneumatophores (breathing roots) of the trees covered by thick tar of oil resulting in defoliation and it is anticipated that with the increase in port activities consequent increase of accidental oil spills, the mangrove of Bangladesh and its ecosystem may be irreversibly damaged. A study were done to project the possible damage which may occur as a result of oil spill in and around the passur river which runs through the Sundarban mangrove forest and the only route for ships to reach Mongla port from the Bay of Bengal. Natural water is a solution of dissolved chemical substances. The excessive presence of these materials, beyond threshold limits, makes it harmful to living organisms and its beneficial uses. Petroleum is such a toxic organic matter, harmful to any living system. The objective of water quality management is to control the discharge of pollutants so that the water quality is not degraded to the unacceptable level below or above the natural background and controlling of discharge is a quantitative exercise. In view of the above, and the environmental sustainability issues, it is necessary to monitor the changes in water quality status associated with oil spills and to develop strategic plan for the protection of water environment and the aqua cultures from the harmful effects of oil spills and to sustain the productivity of the natural environment.

If the Oil spill occurs in the Akram Point in the late winter during high tide, Gewa belt will be highly damaged and damage to Sundari will be less. Oil spills also deposit on the sand bar and mud flat. To project the amount of damage of oil spill, a mathematical model in relation to tide, season and the place of occurrence of oil spills in the river Passur will bring the information to a sharper focus. The impact on other coastal belt is also getting dangerous in consideration with the bio-diversity of the coastal water. Industrial effluents, oil spills and ship breaking Industries all together makes the situation complicated for the existence of the biotic fauna and floral composition. Namely the Karnafuli river, Halda river, Bhairab river, Bakkhali river and number of canals and the Bay on the south east becoming polluted, even beyond the level of subsistence.

8.1.5.4 Degradation of Oil

Degradation rates of oil are highly temperature dependent, being much greater under warm conditions. It follows that a major oil spill in cold conditions (such as the Exxon Valdez in Alaska in 1989) are likely to be much more long lived than had the spill been in Gulf of Mexico. With the general trend toward oil explorations moving to more and more remote regions, including polar seas, the risks of long lasting damage from a large oil spill are increasing as times goes on. The most serious effects of oil pollution are also the most obvious. Gross fouling of beaches, plants and animals can have devastating effects. Seabirds are particularly vulnerable because oil coats their feathers, causing loss of both thermal insulation and buoyancy. Few seriously affected birds can survive. Sea mammals are also vulnerable to oil spills, which irritates their sensitive membranes although it is not often directly fatal. Fouling of breeding beaches could have very serious effects on breeding success. The effects of even the most dramatic oil spills are generally localised; gross pollution from them disappears relatively rapidly, though some subtle effects may last for decades, with enormous economic costs.

8.1.6 Metals and Radioactivity

All natural metals occur in seawater in greater or lesser amounts. Some, such as iron, copper, cobalt and zinc are essential in small quantities for the healthy growth of marine organisms. Arsenic, cadmium chromium, nickel, lead and mercury are the most common

heavy metal pollutants, where mercury and cadmium are of greatest concern. Mercury, lead and cadmium have no known biological role. All metals are toxic if present in excess. Mercury is an important industrial chemical used in the manufacture of small batteries. Most coastal waters adjacent to industrialized areas can be expected to have elevated levels of mercury, which needs to be monitored regularly. Living organisms, including marine species, concentrate heavy metals in their tissues, becoming highly contaminated in the process. The major sources for these metals are the industrial effluents and oil spills. Tin, in the form of organotin, has been recently recognized as a serious marine pollutant. The use of organotin compounds in anti fouling paints on boats has resulted in comparatively high concentrations of these chemicals in some enclosed waters. Although very effective as anti fouling agents, they affect marine organisms like deformation of oyster shells. Many countries have banned the use of organotin anti foulants.

8.1.7 Radioactivity

The oceans contain appreciable amounts of radioactive material derived from natural sources in the atmosphere and the earth. Added to this is a mixture of artificial radioactive substances derived from atomic weapons testing, other military activities and peaceful uses of nuclear energy. Since the Test Ban Treaty of 1963, which proscribed atmospheric and underwater test by signatory nations, the amount of radioactivity reaching the oceans from this source has considerably reduced. Sources which are now more important include waste discharges from nuclear fuel reprocessing plants, nuclear reactors, low-level radioactive waste dumped at sea, accidental discharges from the loss of nuclear powered submarines (about five to-date). The amount of radioactive material added, as a result of human activities is small compared to the relatively high natural levels of radioactivity of the oceans. It is therefore not thought to be a threat to the health of the marine environment in general. The principal concern with respect to the marine environment is the significance of any routes by which this artificial radioactivity can come back to land and result in excessive exposure to humans.

8.1.8 Waste Heat

Waste heat is a pollution hazard to waters only where the ambient temperatures are already high. In many tropical waters marine organisms live close to the upper limit of their temperature tolerance range. If the waste heat discharged from a factory or power plant raises the temperature further, mortalities of marine organisms may occur.

8.1.9 Asbestos Laden Ship Breaking

The ship scrapping, the most polluting industry in the country started in 1971 and ballooned since 1980 with a huge involvement of resources. Currently 1.5 million tons of scrapped iron is produced by scrapping the ships per year. The coast line extending from Faujdarhat to Kumira at Sitakunda stretched over 30 km. About 50 ship-breaking units are operative near Chittagong. In the course of dismantling old ships, Ship breaking yards in Bangladesh dismantle up to 80 ships, mostly oil tankers, a year, a variety of poisonous chemicals is released to the environment. They include polycyclic aromatic hydrocarbons (PAHs), heavy metal ions, PCBs and TBTs (from paints) and even radioactive elements. Poisonous gas is leaked out while breaking platform of large oil tankers. Operating on beaches at Sitakundu, they indirectly employ some 300,000 people.

In Jan 2006, Greenpeace warned the ship breakers of Bangladesh about the move by a Bangladeshi scrap merchant to buy the huge asbestos-laden ship SS Norway. Thereafter, all the government authorities including Chittagong Port, Bangladesh Navy and the environment department were intimated not to allow the ship into Bangladesh waters. Launched in 1960 as the SS France, the 11-storey ocean liner is on a watchlist of 50 vessels which it fears will not be decontaminated before being scrapped, saying the French workers who built the ship claim it contains 1,250 tonnes of material that contains asbestos. Asbestos, a mineral fibre which can be easily inhaled, is known to cause cancer and asbestosis, a fatal lung scarring. It was commonly used in insulation and in construction as a fire retardant.

The bottom sludge of residual heavy oil in the oil chambers of tankers and other lubricants and engine oils from condemned tankers/ships, constitute a considerable

amount of oil and chemicals spilled during washing and dismantling operations. Birds and trees are dieing. People of adjoining areas are suffering from health hazards. Workers work under primitive and hazardous conditions without cleaning the poisonous and dangerous wastes beforehand.

Ship-breakers release waste water and waste oil at ship breaking yards near major port cities and dump broken pieces of various articles around such yards. In Bangladesh, the ship breakers just use a softer public approach to answer the critics and please the people involved and the observers. The government has not adopted concrete measures to ensure the respect of domestic legislation and its international obligations on working conditions at the yards, including union rights. There is still no systematic inspection of the whole yard before a certificate of compliance is issued by the Department of Environment. The government of Bangladesh launched a programme on ship breaking in November 2003 entitled 'Safe and Environment Friendly Ship Recycling Project', supported by UNDP and ILO. This three-year programme aims at regulating ship breaking in the country and includes the establishment of an office in Chittagong and safety training for the workers. However, Greenpeace and FIDH learned that ILO teams working with the governments might not be able to really change the situation because of limited access to the yards and due to collaboration with a highly corrupted government that directly suffers under the pressures made by the powerful shipyard owners.

Recently, students of the Marine Science Department of Chittagong University conducted a survey on water pollution at the coast of Sitakunda, where most of the ships are scrapped. The results of the survey indicated heavy pollution loads by high concentrations of chemicals: 0.5 to 2.7 ppm of mercury, 0.5 to 21.8 ppm of lead, 220 ppm of chromium, 0.3 to 2.9 ppm cadmium, 2.6 to 5.6 ppm of iron, 5.2 to 23.2 ppm of calcium and 6.5 to 10.57 ppm of magnesium. The Bangladesh water quality standards for some of these chemicals are 0.05 ppm for lead, 0.05 pp for chromium, 0.005 ppm for cadmium, 1 ppm for iron, and 75 ppm for calcium.



Photo 8.2: Ship Breaking Yards in Sitakunda dismantle up to 80 ships each year, mostly oil tankers, a variety of poisonous chemicals is released to the environment.

8.2 Urban Areas Pollutants: Domestic Pollution

Increasing amount of solid waste is generated in the coastal region coupled with deficient collection system & inadequate disposal practices. Additionally disposal of solid wastes originating from ships and other sources are impacting the coastal areas. The land based solid waste pollution has its origin in inadequate disposal practices such as using rivers & streams and mangrove swamps as dumpsites. Poorly managed land fills in coastal areas can also become sources of debris, specially in the rainy season, when run off may wash wastes out to sea. The discharge of sewage can cause public health problems either from contact with polluted waters or from consumption of contaminated fish or shellfish. The discharge of untreated sewage effluents also produces long-term adverse impacts on the ecology of critical coastal ecosystems in localized areas due to the contribution of nutrients and other pollutants. Pollution due to inadequate sewage disposal causes nutrient enrichment around population centers, and high nutrient levels and even eutrophication near treatment facilities and sewage outfalls. Increased nutrient concentrations promote increased algal and bacterial growth, degradation of sea grass and coral reef ecosystems, decreased fisheries production, along with risks to human health.

The highest levels of domestic sewage are found in the coastal areas, particularly Khulna, Chittagong, Barisal, Patuakhali and Noakhali. Increasing amount of solid waste is generated in the coastal region coupled with deficit collection system and inadequate disposal practices. Khulna is experiencing huge problems in the dealing with solid waste generated in the city every day. A fast growing population, coupled with industrial activities and uncontrolled urbanization, has lead to rapidly increasing quantities of waste being generated.

Chittagong City Corporation area alone produces 1200 tons of solid waste annually. Most of these are dumped in two places. Halisahar is one such dumping ground for 25% of the total waste, which is very close to the sea and is connected by a canal. At Roufabad the other 75% of the waste is collected on 6.5 hector of land. For Domestic solid waste management, Cox's bazaar pourashava collected 75% waste, which are 15 tons/day and dumping near the Bakkhali river. Waste disposal and sanitation system in Barisal city is also inadequate The municipal waste generation is nearly 70 ton/day of which 40-50 tons are dumped in a municipal designed open space and the rest part goes nearby canals, ditches or in small water bodies. Only 20-30% of people have sewage facilities. Considering the above situation it is clear that poorly treated or untreated sewage/solid wastes are being discharged in coastal waters. Disposal of untreated sewage into the aquatic system is responsible more importantly for the degradation of the environmental condition in the long run and also for the loss both aquatic and terrestrial biodiversity including flora and fauna. This issue could be pointed out as the adverse impact of domestic pollution. In addition to that shipping and commercial fisheries, using rivers, streams, mangrove swamps as dumpsites and poorly managed land fills contributes further. It is estimated that ship generated solid waste may account for 80% of solid waste being disposed in the coast.

The most important activities in urban areas with regard to marine pollution are the sewage treatment plants treating sewage from households, industrial plants and hospitals and the dredging of port entrances and the dredging/dumping for land reclamation purposes. Sewage is a product of municipal drainage system containing domestic waste with or without the addition of wastes from the industries and fresh water run-off. Sewage is thus heterogeneous in nature and its composition is highly variable. It largely contains dissolved and suspended solids, numerous micro-organisms like bacteria and

viruses which are pathogenic. The disposal of untreated and partially treated domestic sewage into the coastal waters either directly or through the rivers and drainage system is one of the sources causing heavy pollution.

8.2.1 Sewage and other Marine Pollutants

Raw sewage should be harmless because more 99% of it is pure water. Unfortunately it is the remaining fraction of a per cent that causes all the problems. Dissolved in the water are a variety of inorganic (nutrients and trace materials) and organic (biodegradable and persistent) materials. Together with these there is the suspended solids consisting of human excrement, inorganic grit and other organic and inorganic materials. There are also large quantities of pathogenic organisms. In some systems domestic wastes may be combined with industrial wastes, which create additional problems.

The most important feature of raw sewage from a disposal point of view is its oxygen demand. The oxygen demand is the amount of oxygen that will be consumed by the bacteria as they feed on and degrade the waste. If the amount of oxygen required is similar to or greater than that available, serious problems may arise. It may give rise to a situation wherein all oxygen may be consumed, leading to anoxic conditions, which are extremely toxic to aquatic animals. Many coastal areas around the world suffer from the problems of excessive oxygen demanding wastes. The various forms of sewage treatment that are available are all designed to reduce the oxygen demand of the effluent. In doing so they produce more highly mineralized waste water and sludge. The mineral elements present in the waste water are not necessarily benign. A proportion of them is nutrients such as nitrates and phosphates, which, if discharged in an inappropriate way, can stimulate excessive algal growth with a consequent high oxygen demand. This problem called eutrophication, has recently created a lot of problems in the Scandinavian and Mediterranean coasts where large quantities of rotting organic matter has serious consequences for tourists.

One clear link between sewage disposal and environmental problems is related to the consumption of contaminated seafood. Fish are capable of accumulating a variety of pathogenic organisms from sewage contaminated water. If consumed by humans these can have ill effects ranging from stomach upsets to serious diseases.

8.2.2 Solid Wastes

Solid wastes from industry include products from extraction of alumina from bauxite and acid iron waste from production of titanium oxide. Although iron is not considered to be a marine toxin, when discharged in large quantities into the sea, it forms a fine precipitate, which readily drifts and may adhere to living organisms, clogging feeding or respiratory systems. Dredge spoil in enormous quantities is moved around the ocean floor in the process of dredging harbours and channels. This does not involve the introduction of anything new in the environment, but it can be an important mechanism by which contaminants are moved to coastal waters and it is this aspect of dredge spoil disposal which is probably of greatest concern.

8.2.3 Garbage

The disposal of persistent garbage at sea is prohibited by international convention. Nevertheless large quantities of plastics find their way into the marine environment, where they are generally found as small particles, which may be consumed by marine animals. Long lasting plastics, glass objects are the most wide spread form of litter in the coastal water, but wood, metal, rubber and fabrics are also common. Drift wood often abundant on beaches near logging operations. These types of litters are common in the beaches, from the tourist and ships. Turtles, fish, birds and other animals are often victim to plastic litters when they ingest. World wide an estimated 100 000 marine mammals and turtles are now killed annually by plastic litter.

8.3 Agriculture and Forestry Pollutants

The largest single class of non-industrial polluters is farms. Agricultural pollutants include commercial fertilizers, animal wastes, pesticides, insecticides and sediments. In many cases, the agricultural component of these pollutants has been far greater than any other single source. The main substances added to the marine environment by modern agriculture are nitrogenous and phosphoric compounds and organic compounds in chemical pesticides like DDT. Accumulation of agro-chemicals in surface water and groundwater is still limited, as their use, apart from urea, is still relatively low in

Bangladesh. But in recent years the use of pesticides and fertilizers by farmers, largely unaware of the potential negative effects, is growing fast, posing a big challenge to health, environment and the declining economy of the country. Croplands are the major source of coastal sediments; sediments resulting from soil erosion are already regarded as the main source of water pollution. In general, fish are suitable indicators of surface water health and the ongoing decrease in fish quantity, accompanied with an increase in fish diseases in Bangladesh might well reflect that the tolerable range of environmental degradation is reached. Continued economic growth and development has drastically changed the traditional land use patterns of the region. Agricultural development has been rapid, and, in addition, coastal areas have seen increased population growth together with changes in adjacent land use, increasing the pressures on the marine and coastal areas.

8.3.1 Pesticides and other Persistent Organic Chemicals

Historically, the chemicals that have provoked the greatest concern in terms of their effects on the marine environment are the chlorinated hydrocarbons. These chemicals include such well-known substances as the pesticide DDT and the polychlorinated biphenyls (PCBs). It is apprehended by scientists that fish mortalities in the open water of Bangladesh have occurred due to uncontrolled use of pesticides. Pesticides like aldrin, dieldrin, endrin and heptachlor are extensively used in Bangladesh. Dieldrin is about 40 to 50 times more toxic than DDT. A few drops of aldrin or endrin can kill all the fish in pond and these compounds persist in the soils for a long period. Although many hundreds of different chemicals come under the heading of chlorinated hydrocarbons, many of them share a number of important properties. In particular, they are generally fairly toxic, are persistent in the environment and are bio-accumulated. Because of these characteristics, very low concentrations in seawater can lead to much concentration in fish, marine mammals and fish-eating birds. Disposal of waste chlorinated hydrocarbons is proving to be difficult. At present, the best technology available is incineration at high temperature. There are considerable economic and environmental advantages in carrying this out at sea, where the waste acid produced is readily absorbed by the sea.

Persistent organic pollutants (POPs) are fat soluble toxic chemicals that do not easily degrade, persists for many years in the environment, concentrate up to food chain and

accumulate in animal tissues. To meet the agricultural production target for an increased population in a land scarce region, pesticides (insecticides, herbicides, fungicides, etc.) are extensively used. Pesticides reach the coastal and marine environment via rivers and by atmospheric transport. Pesticides in the marine environment may affect living organisms, and, through contamination of seafood, may become a public health problem. It has been estimated that 90% of the pesticides that are applied do not reach the targeted species. Pesticides are highly toxic and tend to accumulate in the coastal and marine biota, making pesticide contamination a serious concern. The negative effects of pesticides in the marine and coastal environments include changes in reef community structure, such as decreases in live coral cover and increases in algae and sponges and damage to sea grass beds and other aquatic vegetation from herbicides. Marine organisms may be affected either directly, as the pesticide moves through the food chain and accumulate in the biota, or by loss or alteration of their habitat. This, in turn, will lead to decreased fisheries production. Pesticides may cause fish kills in areas of poor water circulation, and ground water and drinking water supplies may become contaminated. Areas under particular threat are those with little water exchange and circulation, where pesticide residues don't get flushed out quickly.

8.3.2 Anti Fouling Paints

Anti fouling paints for the underwater hulls of ships and boats are used so that they release a toxic material into the water in just the right amounts killing the organic growth on the hull. The older generation of such paints which used copper as toxin released enough amount of toxins not only affecting the fouling organisms but also harmful to other marine organisms at some distance away from the hull. One result of recent research has been the development of a new family of paints using acrylic resins as vehicles and tri-butyl tin fluoride (TBT) as the primary anti fouling ingredient. Marine vessels, since 1970s, are using TBT (tributyltin) painted on their hull to keep clean and smooth their hull from the fouling organisms, so that it can travel faster. Now TBT has been described as the most toxic substance ever deliberately introduced into the marine environment. It is less toxic in water, lasts longer and is more effective in not allowing bottom growth. Since the toxins get retained for a longer period of time, disposal of paint scrapings requires greater care. Thus the solution one problem presents yet another

problem, but these problems could be solved if some care is taken to ensure that additional health hazards do not get created.

8.3.3 Aquaculture

Shrimp farming reduces pressure on natural fisheries, it involves habitat conversion, damage to wild populations and the production of effluent. The contribution of coastal aquaculture, and particularly shrimp culture, to both the local and national economies is a major source of export earnings and employment in coastal areas - traditionally among the poorest in the country. In order to make shrimp and fish production more environmentally friendly and sustainable, the Government of Bangladesh has implemented a project with a WB credit of a US\$28 million and a US\$5 million Global Environment Facility grant for a major fisheries project in the country. The project seeks to address some of the environmental and social problems facing the rapidly-growing shrimp farming sub sector. For example, unplanned development of shrimp culture has had negative environmental impacts in terms of water quality, disease, mangrove deforestation and the degradation of agricultural land. In particular, the practice of alternating shrimp culture and rice farming has often been upset by more intensive use of land areas for shrimp. The unplanned seedling of ponds and the increasing use of antibiotics and other chemicals have led to severe pollution problems. Most of the problems are caused by smaller producers. Many shrimp farms are now established on wetlands and areas of former mangroves. Conversion of such areas for shrimp production should be strictly controlled in near future. There is an incidence of huge death of snails and marine turtles at Cox's Bazar sea beach, in April, 2004. According to the scientists it is due to the Mother shrimp catch, for the shrimp hatchery. It is estimated that there are about 60 shrimp hatchery in and around Cox's Bazar area. Every day about 50 trawlers catches mother shrimp from the bottom of the sea. During the catch from the bottom of the sea huge quantity of other fishes are caught and finally they die, and the habitat of the snails and clams have been destroyed. Finally the snails and clams come out of their habitat and died. Some times even marine turtles are also caught and died. The same incidences were seen in the previous year also.

8.4 Environmental and Economic Impacts of Shrimp Farming in Bangladesh

The coastal aquaculture in Bangladesh has expanded horizontally rather than vertically, land area either suitable or unsuitable for development of aquaculture has been flooded with saline water and the farming system is mostly traditional in nature. Shrimp farms are primarily located at the south-western part of the country in the districts of Khulna (19%), Satkhira (19%) and Bagerhat (29%); and in the south-eastern part of the country mainly in the Cox's Bazar district (31%). In addition there are about 422 ha in Keshabpur thana (Political unit) of Jessore district, 43 ha in Anowara and Banshkhali of Chittagong district. The average size of a shrimp farm in Bangladesh is 28 ha. Shrimp culture in Cox's Bazar uses 620 tons of urea annually. It also generates 15 tons of waste daily, which comes to the water. About 70 tons of municipal waste is produced daily and 20- 30 per cent of it directly comes to canals. Destruction of Mangroves like other south-east Asian countries rapid destruction of mangroves was done in Bangladesh for expansion of coastal aquaculture. In the south-eastern part of the coastal zone of this country majority of the shrimp farms were developed at the cost of valuable mangroves. Once the Chakaria Sundarban of this area was occupied by dense mangroves and had the status of a forest reserve with an area of 18 200 ha. Following introduction of shrimp farming most of the mangroves (more than 50%) were rapidly cleared out for preparation of shrimp ponds. This forest reserve used to occupy an area of about 8510 ha till 1977; leasing out of land in this mangrove area started from then on. Leaseholders are ruthlessly cleared the forest in their leased land.

Human activities for living and infrastructure development demanded more and more areas in the unleased portion too. The area is still retained by the Department of Forest, is also exploited for brackish water aquaculture by the local people through an undeclared cooperation with the officials of this department. Practically the whole area is in a process of decay. Mangroves support a very rich ecosystem providing a habitat of many commercially important finfishes, crustaceans and mollusks. Presence of acid sulphate soils in the mangrove areas is well known which poses a strong limitation on aquaculture development. Poor growth, soft shelling and mass mortality of shrimp are reported frequently by farmers due to presence of potential acid sulphate soils in the ponds of this region. Besides this, mangrove removal may cause coastal erosion, changes in patterns of sedimentation and shoreline configuration. Apart from ecological impacts, inhabitants in

the vicinity of Chakaria Sundarban used to earn their livelihood through collection of fuel wood, thatching materials, timber and various food stuff such as honey, fish etc. Consequently with removal of mangroves from this region people of this area have been deprived of these benefits. It is also true for Bangladesh that conversion of mangroves to shrimp ponds lead to a shift from a multi-use system to a single use, with net benefits shifting to fewer users.

8.5 Vessel and other Major Marine Pollutants

The used engine oil is discharged to the sea from the ships. The other major source of oil in the marine environment is the result of accidents that take place during shipping and transferring processes. The more the handling steps involved the more the accidents and associated losses. Comparative figures of oil lost in handling accidents and oil pumped from bilges are not available, though it is estimated that a large portion of the oil reaching the marine environment is the result of poor handling procedures. Better procedures are required, but perhaps even more than better procedures, stricter enforcement of accepted safe procedures would go long way in decreasing the amount of oil that enters the oceans each year.

Ballast is any material used to weight and/or balance an object. For thousands of years ships have carried solid ballast. Now a days ships use water as ballast. Ballast water can cause damage to the water bodies when it carries aquatic lives. There are thousands of species that may be carried in ballast. These include bacteria, small invertebrates, eggs, cysts and larvae of various species. This shipping practice is reducing the natural barriers of dispersal of species across the water bodies. As a result the whole ecosystem is being changed. The ballasting of tankers with sea water after they discharge their cargo is always followed by de-ballasting of the sea water into the sea before loading oil again. This results in sizable amounts of oil getting washed out into the sea. There are not very many effective schemes available for avoiding such discharge into the sea. Our coast is being used by thousands of vessels, dumping ballast water, which needs to be well addressed by the policy makers, to comply with MARPOL, by introducing the port reception facilities.

Further structural weaknesses of the tankers themselves occasionally result in damage to the vessels in rough seas resulting in oil spillage. Such incidents cannot be totally prevented and will continue to occur. But the moot point is that once oil gets spilled at sea under large wave conditions, which is usually the case when accidents occur, retrieving this oil is very difficult. The effects of such spills are usually felt in far off coasts. The only way to prevent oil from getting to the marine environment is to prevent the accident from occurring in the first place. Alternatively, once the accident takes place the oil must be prevented from escaping the ship.

8.6 Offshore Oil and Gas Exploitation

Offshore oil and gas exploitation can become sources of pollution, either in the form of accidental oil spills or from the release of 'produced water' from the oil-bearing strata with the oil and the gas at the time of production. The produced water is discharged into the marine environment together with waste drilling chemicals and mud, and may contain substances that exert high oxygen demand, together with toxic poly-aromatic hydrocarbons (PAHs), benzene, ethylbenzene and heavy metals, such as lead, copper, nickel and mercury. Pipeline breakage, well blowouts, platform fires overflows and equipment malfunctioning often causes the accidental oil spills from the offshore operations. In addition to the accidental oil spills, there is also a significant amount of natural seepage of petroleum hydrocarbons from submarine oil deposits, which contributes to marine pollution. Unlike the previously described sources of oil pollution, natural oil seepages are very difficult to estimate.

For the great mass of Bangladesh, the degree of concern about environmental issues seems most closely tied to the rising impact of water pollution. Despite its low level of economic development, Bangladesh is so densely populated that its environmental absorptive capacity is practically nil. Industrial facilities in such pollution intensive sectors as pulp, chemicals, fertilizer and cement nearly always discharge wastes into rivers which serve large downstream populations. In many cases, communities can clearly identify facilities whose discharges have caused fish kills, illness and damage to irrigated paddy crops.

9.1 Urea Fertilizer Plants

The five urea fertilizer plants currently operating in Bangladesh are all under the control of BCIC, a state own corporation. This study covers four plants, whose operating characteristics are quite similar. They are all located on rivers, into which they discharge their wastewater. All use natural gas as the basic feedstock; include both ammonia and urea facilities and operate on self generated electricity. Their common technology produces carbon dioxide by steam reforming and separates it with the Benfield process. Despite all these similarities, however, the facilities exhibit widely varying pollution intensity and investment in EOP treatment. As with most industrial development activities, along with the economic and energy-related benefits of oil and gas production are actual and perceived risks to the environment, coastal communities and competing users. Today, safety stipulations are more stringent, technologies are vastly improved, inspections are regular and frequent and oil spill response capabilities are in place. Nevertheless, there remain numerous environmental issues associated with the development and production of oil and gas. Foremost among these are:

- Physical disruption of and damage to bottom-dwelling marine communities.
- Discharge of contaminants and toxic pollutants present in drilling muds and cuttings and in produced waters.
- Emissions of pollutants from fixed facilities and vessels.

- Seismic exploration and production noise impacts on marine mammals and fish and other wildlife.
- Immediate and long-term ecological effects of large oil spills.
- Chronic, low-level impacts on natural and human environments.
- Cumulative impacts on the marine, coastal and human environments.

9.2 **Degraded Waters**

Despite some progress, our coastal ecosystems continue to show signs of degradation, thereby compromising human health, damaging the economy and harming marine life. In 2001, 23 percent of the nation's estuarine areas were impaired for swimming, fishing and supporting marine species. Meanwhile, pollution could jeopardize the safety of drinking water for millions of people living near the coast.

9.3 **Excess Nutrients**

The over supply of nitrogen, phosphorus and other nutrients in coastal ecosystems is one of our nation's most widespread pollution problems. Runoff from agricultural land, animal feeding operations and urban areas, along with discharges from wastewater treatment plants, storm sewers and leaky septic systems, adds nutrients to waters that eventually enter the sea. All told, our bay and estuaries show signs of nutrient over enrichment, including oxygen depletion, loss of sea grass beds and toxic algal blooms. All of these excess nutrients have not come from local sources. In addition, atmospheric deposition from agriculture, power plants, industrial facilities, motor vehicles and other often distant sources accounts for up to 40 percent of the nitrogen entering estuaries.

9.4 **Other Contaminants**

A smaller amount of oil enters our waterways from tanker and barge spills and from recreational boats and personal watercraft. Pollution from sewage treatment plants has been reduced as the result of tighter regulation during the past thirty years, but concerns remain about the release of untreated human pathogens, pharmaceuticals, toxic substances and chlorinated hydrocarbons.

9.4.1 Sediment Contamination

Some chemicals tend to bind to particles and thus accumulate in sediments, bottom dwelling and bottom-feeding organisms are especially at risk. As sediment-bound pollutants enter organisms and move up through the food web, larger animals and humans are also affected. Excess sediments can also cause harm by smothering stationary bottom-dwelling marine communities. The yearly sediment load in the region can be estimated at 109 tons per year, which is approximately 12% of the global sediment input from rivers. Most land in the region, especially on the small islands, is relatively near the ocean, making the coastal and marine environments especially vulnerable to sedimentation caused by human activities. Dredging is another contributor to the siltation of coastal waters. Dredge materials are generally contaminated sediments containing toxic heavy metals, organic pollutants etc. originating from domestic and industrial point discharges and non-point sources. Dredging of shallow coastal waters to keep open shipping lanes, while not producing pollution, causes serious re-suspension of sediments and resulting decrease of water clarity. Increased water turbidity decreases the productivity of coral reefs and sea grass beds, which rely on light for photosynthesis. In cases of high sediment load, physical smothering of coral reefs, sea grasses, and associated filter feeders and other benthic organisms is also possible.

9.4.2 Compromised Resources

Fishery declines, degraded coastal habitats and invasive species are compromising our ability to meet current and future demands for healthy, productive marine resources.

9.4.2.1 Fishery Declines

Declining fish populations are the result of over fishing, the unintentional removal of non-targeted species (known as bycatch), habitat loss, pollution, climate change and uneven management. The cumulative impact of these factors is serious. As fishing boats turn to smaller, less valuable and once discarded species, they are progressively “fishing down the food web,” thereby causing changes in the size, age structure, genetic makeup and reproductive status of fish populations. This seriously compromises the integrity of

marine ecosystems, the ecological services they provide, and the resources upon which country rely.

9.4.2.2 Coastal Habitat Loss

Pollution, subsidence, sea level rise, development and the building of structures that alter sediment flow all contribute to the problem. With the loss of the nation's wetlands, shorelines are becoming more vulnerable to erosion, saltwater is intruding into freshwater environments, flooding is on the rise, water quality is being degraded and wildlife habitat is being fragmented or lost. The nation is also losing miles of mangrove and kelp forests.

9.4.2.3 Invasive Species

Across the nation and throughout the world, invasive species of plants and animals are being intentionally and unintentionally introduced into new ecosystems, often resulting in significant ecological and economic impacts. We know that over many non-native species have become established in coastal marine habitats. Most non-native marine animals and plants are introduced through the discharge of ships' ballast water and holding tanks. Many different species of marine life are transported around the world every day and every hour some thousand gallons of ballast water arrive in our coastal waters carrying at least a portion of this immense fleet of foreign organisms. Further contributors to the spread of invasive species include the aquarium trade, fisheries-related activities, floating marine debris, boating, navigational buoys and drilling platforms. Strains on coastal environments caused by other factors may make them even more vulnerable to the spread of non-native species. Invasive species can also cause significant ecological damage by out-competing native species, altering local food webs and reducing the resources available for other organisms.

9.5 Health Impacts of Water Pollution

It is a well-known fact that clean water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth, yet it has been observed that millions of people worldwide are deprived of this. Freshwater resources all over the world are threatened not only by over exploitation

and poor management but also by ecological degradation. The main source of freshwater pollution can be attributed to discharge of untreated waste, dumping of industrial effluent and run-off from agricultural fields. Industrial growth, urbanization and the increasing use of synthetic organic substances have serious and adverse impacts on freshwater bodies. It is a generally accepted fact that the developed countries suffer from problems of chemical discharge into the water sources mainly groundwater, while developing countries face problems of agricultural run-off in water sources. Polluted water like chemicals in drinking water causes problem to health and leads to water-borne diseases which can be prevented by taking measures can be taken even at the household level.

9.6 Marine Bacteria and Viruses

Bacteria and viruses are present everywhere in the sea water; in fact, each milliliter of seawater contains on average 1 million bacteria and 10 million viruses. While only a small percentage of these organisms cause disease in humans, they pose a significant health risk. Humans become exposed to harmful bacteria and viruses primarily by eating contaminated seafood (especially raw seafood) and by direct intake of seawater. Many, if not most, occurrences of high concentrations of pathogens in the ocean are the direct result of land based human activities. Pollution and urban runoff lead to nutrient-rich coastal and sea waters that provide ideal conditions for the growth and reproduction of these micro organisms. With ever-increasing numbers of people living in coastal areas, along coastal watersheds, or inland along rivers that ultimately drain into the ocean, waste and pollution has increased to a level that creates negative environmental and human health related consequences.

9.7 Different Level of Pollution at Different Season

The Bay of Bengal is influenced by the wet southwest summer Monsoon and the colder, dryer continental northeast Monsoon during winter. The southwest Monsoon dominates from June through September with southwest maritime winds bringing strong rainfall to most of the area. The precipitation can reach as much as 25 millimeter per day in certain zones. Monsoon rains and coincident destructive cyclone storms recurrently cause great loss of life along the bay's northern coast. On the average, four to six Monsoon

depressions form in the Bay of Bengal during the southwestern Monsoon season which cause cyclone with tidal surge. Excessive sediment load of rivers also constitutes a water quality problem because water is rendered unsuitable for certain uses without treatment. During Monsoon sea level rises 2'-3' and sea water contains maximum sediments.

9.8 Limiting Vessel Pollution

The benefits from vessel activities are significant, but they also present risks to people and the environment that need to be effectively addressed. Limiting vessel pollution, improving vessel safety and addressing potential security threats associated with vessel operations depend on responsible owners and operators, conscientious crews, enforceable national and international standards and development of new technologies and management approaches. There is also a need for heightened awareness and better real-time information about the full array of offshore activities to ensure safety, security and environmental quality. Vessel owners and operators and government agencies responsible for oversight of vessel operations share responsibility for continued improvement in vessel safety, security and environmental compliance. Over the past few years, attention has been focused on better implementation, oversight and enforcement of existing requirements. The success of all these efforts will depend on a broad domestic and international framework with several components. A key component of the framework is a strong voluntary commitment on the part of vessel owners and operators to build a culture that incorporates safety, security and environmental protection as important and valued aspects of everyday vessel operations. Another important component is an international commitment to effective oversight and enforcement. Strengthening commitments to environmental protection, flag state oversight and port state control will help prevent and reduce the impacts of vessel pollution. However, effective reduction of vessel pollution will also require the development of new control measures. Of particular concern are vessel waste discharges containing pathogens and nutrients, air emissions and oil releases.

9.8.1 Waste Stream Discharges

Every day, vessels ranging from large cargo ships to small recreational boats discharge wastes into coastal waters. The waste streams from recreational vessels primarily contain

sewage, while cargo ships discharge both sewage and toxic substances. These wastes, if not properly disposed of and treated, can be a significant source of pathogens and nutrients with the potential to threaten human health and damage shellfish beds, coral reefs and other aquatic life. According to the U.S. Environmental Protection Agency (EPA), the amount of bacterial pollution in the discharge of untreated sewage from just one recreational boat is equivalent to the amount in the treated sewage of 10,000 people during a similar time period.

9.8.2 Waste Pump Out Facilities

Pump out facilities are essential for handling waste from boats equipped with holding tanks. CPA/MPA is responsible for determining whether adequate pump out facilities are available to recreational boaters before approving most country no-discharge zones. In addition to purchase and install sewage pump out stations and portable toilet waste dump stations waste pump out facilities provide environmental education to boaters. Authority may also award grants to marinas to construct these facilities. Despite these programs, the current shortfall in adequate pump out facilities makes it virtually impossible for boaters to comply with prohibitions against the discharge of untreated waste in some coastal areas.

9.8.3 Air Emissions from Large Commercial Vessels

Most commercial ships are powered by marine diesel engines that use fuels containing high concentrations of contaminants. These engines have high emissions on a per engine basis and contribute to high ozone and particulate matter levels in many coastal and port areas. A study of global impacts from large vessel air emissions indicates that approximately 80 percent of vessel air emissions occur within 200 miles of the coast and that a major part of these emissions are concentrated in a few areas in the Northern Hemisphere. International and domestic marine trade is predicted to more than double in the next twenty years, reinforcing the need to expeditiously develop and implement measures to abate vessel-generated air pollution.

9.8.4 Oil Releases

Vessels can release oil into marine environment in a variety of ways, including accidental spills of oil and fuel, release of oil during normal engine operations and intentional discharges. Two devastating spills off the coast of Europe involving older single-hull tankers the Erika in 1999 and the Prestige in 2002 clearly demonstrate the challenges presented as ship operators and government agencies work to prevent future spills.

9.9 Improving Awareness of Ocean Activities

Vessel safety and environmental protection depend not only on appropriate operation of each vessel, but on the safe movement and management of all vessel traffic. Effective vessel traffic management takes place within the larger context of other coastal and ocean uses and requires accommodation between those uses and navigation. The rapidly increasing variety and number of offshore uses and the potential for conflicts between competing interests operating in the same area will increase the need for information concerning the nature and extent of offshore activities. In today's highly interdependent world, efforts to ensure national security, maintain environmental quality and manage the use of marine resources will require unprecedented awareness of activities, trends and anomalies in the maritime domain, including those that may require some intervention.

The Coast Guard, which has a leading role in developing increased maritime domain awareness, defines it as '...the effective understanding of anything in the marine environments that could adversely affect our security, safety, economy or environment.' For the Coast Guard, maritime domain awareness applies equally to fisheries enforcement, illegal human migration, marine safety, environmental protection and search and rescue efforts. While much of the recent effort to increase maritime domain awareness has grown out of concerns for national security, the information gained will benefit a variety of other national interests. For instance, the expanded use of the Automated Identification System not only tracks and identifies vessels for security purposes, but provides information to assist safe navigation and help reduce the risk of accidents that could adversely impact the marine environment. The information can also help identify areas of vessel congestion or potential conflicts with other uses, thus serving as a valuable management tool.

9.10 Effects of Marine Pollution

The impact of pollution on coastal environment and consequently on human health can be serious. Each and every type of pollutant has its own effect on the marine environment. Depending on the change they bring about they can be divided into three types as follows:

- a. **Pathogenic Pollutants.** Pathogenic pollutants cause diseases. This disease may be fatal if the pollutant is a lethal poison. As these pollutants cause disease, which can sometimes be fatal, pathogenic pollutants are more serious than the other two.
- b. **Aesthetic Pollutants.** Aesthetic pollutants a change in the environment displeasing the human sense organs i.e. eyes, ears and nose.
- c. **Ecomorphic Pollutants.** Ecomorphic pollutants cause a change in the physical characteristics of the environment, thereby changing the structure and composition of the biosphere.

9.11 Trace Metal Pollution

Trace metals from the three coastal regions of Bangladesh and also from the Ganges-Brahmaputra-Meghna (GBM) river system were analyzed. In the Central region the lower Ganges system shows relatively higher concentration of non-detrital fraction of heavy metals due to the presence of industrial and agricultural runoff in the drainage basin. In GBM estuary low concentration is found in water but higher concentration found in sediments. However, compared with other climatological latitudes most of the values found in the estuary are much lower. In the Eastern region, seasonal variation of heavy metals in the Moheshkhali Channel of the Bay of Bengal reveals the highest concentration of these metals during the monsoon period. However, the level of these metals was well below the permitted levels recommended for human consumption internationally.

16 species of Marine fish were also analyzed and the concentration found was well below the level for human consumption. Almost same level of trace metals concentration was

found in Karnafuly estuary and north eastern region of Bangladesh coast. In the Western region concentrations of Fe, Cu, Zn and Cd in surface waters and Cr, Cd, Pb, As, Cu, Mn and Fe in bottom sediments of Sundarban Mangrove Forest area were measured. Concentrations of Fe, Cu, Zn and Cd in water samples and concentration of Mn, Cu, Zn, Cd, and Pb in sediment exceeded the certified values. Comparing with the certified limits given by WHO, Pb, Zn and Cu exceeded the toxic level among the macrobenthos. The source of water pollution from the Ganges-Brahmaputra-Meghna estuary is from domestic sewage, land washout and river run-off. Results suggest that only the western region was comparatively polluted. Perhaps the mixing and dispersion effect in the central and eastern region by the combination of a strong river run-off during monsoon and semi-diurnal tide along the coast of the Bay of Bengal creates a dynamic regime which prevents from longer residence time in the near shore region. On the other hand, in the western region the ecosystem become a sump for pollutants because the normal structure and circulation of currents in the Bay of Bengal tend to prevent the mixing of these shallow waters with the rest of the ocean.

9.12 Biochemical Oxygen Demand (BOD)

The amount of organic material that can rot in the sewage is measured by the biochemical oxygen demand. BOD is the amount of oxygen required by micro-organisms to decompose the organic substances in sewage. Therefore, the more organic material there is in the sewage, the higher the BOD. It is among the most important parameters for the design and operation of sewage treatment plants. BOD levels of industrial sewage may be many times that of domestic sewage. Dissolved oxygen is an important factor that determines the quality of water in lakes and rivers. The higher the concentration of dissolved oxygen, the better the water quality is. When sewage enters a lake or stream, micro-organisms begin to decompose the organic materials. Oxygen is consumed as micro-organisms use it in their metabolism. This can quickly deplete the available oxygen in the water. When the dissolved oxygen levels drop too low, many aquatic species perish. In fact, if the oxygen level drops to zero, the water will become septic. When organic compounds decompose without oxygen, it gives rise to the undesirable odors usually associated with septic or putrid conditions.

9.13 Dying of huge Sea Fish by Bay Pollution

In September 2004, thousands of sea fishes found dead and floating at the outer anchorage of Chittagong Port apparently due to seawater pollution. During that period a huge number of dead fishes, mainly hilsha and other small marine fishes, were found floating on seawater. Sea fish that died on an epidemic scale at the outer anchorage of Chittagong Port were rotten, posing a threat of further pollution of bay waters. The laboratory test was conducted to ascertain the cause of the fish mortality. Later it was found that the fishes died of pollution from the port city's domestic wastes dumped into the sea and oil spilled out of the vessels calling at Chittagong Port. The epidemic broke out two days after the incident of oil spillage from an oil tanker of state owned Bangladesh Shipping Corporation (BSC) in the port channel. Immediately after the spillage that spread over 15 km area in the sea, Chittagong Port Authority (CPA) sued the oil tanker MT BANGLAR SOURAV. A probe body of CPA found that 180 metric tons of crude oil was not offloaded at the time of discharge of imported crude. The BSC officials claimed that a portion of the crude oil might have remained as residue inside the tanker after it carried about 15,000 MT of crude from mother vessels.

9.14 Impact on Human Life

Everything in the world has both positive and negative sides. But coastal water pollution has only bad impact on human life. Some of the noticeable impacts on human life are given below:

- Change of landscape
- Deforestation
- Water logging and salinity
- Migration of population
- Pollution of water bodies by the discharge of effluents from industries, mining operations, etc.
- Greenhouse gases and global warming
- Ozone depletion in stratosphere
- Smog and haze
- New kind of diseases and health hazards

- Radiation hazards
- Contamination of ground water by pollutants
- Lead in air from the motor vessels' exhaust (Using leaded gasoline)

Many of these impacts are tied to individual localities while some are global nature and some cross the territorial boundaries. Smog, haze, deforestation, desertification pollution of water bodies such as streams and lakes, ground-water, etc, are example of local specific impacts. Desertification, nuclear radiation, etc, are impacts that can cross the territorial boundaries. Green house gases, global warming, ozone depletion, etc, are examples of global impacts.

9.15 Disease and Death by Polluted Coastal Water

Following disease may occur to the coastal/affected people:

- Eye irritation
- Nose and throat irritation
- Irritation of the respiratory track
- Gases like hydrogen sulphide, ammonia and mercaptans cause odour nuisance even at low concentrations.
- A variety of particulates particularly pollens, initiate asthmatic attacks.
- Chronic pulmonary diseases like bronchitis and asthma, are aggravated by a high concentration of sulphur di-oxide, nitrogen oxides, particular matter and photo-chemical smog.
- Carcinogenic agents cause cancer
- Dust particles cause respiratory diseases. Diseases like silicosis, asbestosis etc results from specific dusts.
- Noise pollution creates hearing and mental problems in different ways.

9.16 Coastal Habitat Loss

Pollution, subsidence, sea level rise, development and the building of structures that alter sediment flow all contribute to the problem. With the loss of the our wetlands, shorelines are becoming more vulnerable to erosion, saltwater is intruding into freshwater environments, flooding is on the rise, water quality is being degraded and wildlife habitat

is being fragmented or lost. The nation is also losing huge mangrove forests. Recent observation suggests that direct human disturbances and environmental change are two major causes of harm to coral reefs, although a host of other factors also contribute. Coral reef declines are exacerbated by cumulative impacts, such as when over fishing, coral bleaching and disease decrease a reef's resilience.

Industrial units in different areas dump their wastes on open places and pour toxic chemicals in canals and rivers. City Corporations/Municipal authorities dump domestic wastes on poorly maintained landfills. Dumping of wastes and effluents in the Chittagong port area has turned quite serious. The crews of foreign ships are using the Chittagong port as a dumping station. It is so because too many ships come to Chittagong and stay at the anchorage for days together. They dispose of their wastes including waste oil in the port areas, beyond the knowledge of port officials. The ultimate aim of keeping the environment conducive to human habitation in such locations can be achieved, if authorities in the port areas and industrial belts adopt pollution control and reduction measures. The prevailing situation is quite problematic. The disposal of wastes from ships and industries has to be brought under control. Law enforcing agencies may undertake inspection of areas under threat and force owners of factories and ships to follow the existing laws.

9.17 Natural Hazards

As the nation's shores become more densely populated, people and property are increasingly vulnerable to costly natural hazards. Before 1970, no single coastal storm had caused insured losses greater than 1000 crore taka. Since then, at least five storms have resulted in such losses, including Cyclone of 1991. Coastal erosion, storm surges, tsunamis and sea level rise are serious threats to people living and working along the shore, particularly in low-lying areas. In some instances, our engineering capability has improved protection against natural hazards along the coast; in others, however, it has made us more vulnerable. The loss of wetlands and other shoreline vegetation increases susceptibility to erosion and flooding. The installation of sea walls, groins and other coastal armoring structures can alter patterns of sediment and current flow, eventually accelerating erosion, rather than preventing it.

9.18 Economic Aspects

Oil Pollution can affect coastal and marine fisheries both in quantity and quality. Quantitative damage reduces the longevity of fish stocks. Qualitative damage reduces the value as food. It is reported that Bangladesh has sustained a loss to the tune of over US\$ 100 million owing to 1,440,000 m³ of timber loss caused by the death of Sundary tree alone since 1976. The thin layer of oil on water surface hampers the nutrition and air-sea interaction of gases, affecting the location of planktonic food organisms. Fish can take up oil directly with food, resulting in the tainting of fish tissue. The poly aromatic hydrocarbons (PAH's) present in the crude oil are persistent and carcinogenic, have a tendency to be biologically accumulated in fish tissues and can pass in turn to organisms of higher tropic levels in the food chain. Fisherman also claimed sudden decline of fish catch in the affected are probably due to migration of fish from the fishing ground. There are reduced number (50-60%) of catch for at least 10 species of common fishes in comparison with the year 1993. At least two of them are not found at all.

The marine fisheries resources in the water area of the Bay covering an area of about 70,000 square km are highly potential and fishing ground in the Bay is considered as the best in tropical countries. According to an official report in 1995, permanent stock of marine fisheries in the Bay is about quarter million metric tons. Of them 9,000 metric tons are shrimp species, which is the most thrust sector for earning foreign currency. Around 1.5 million people depend on fishing in the Bay of Bengal. Cox's Bazar shrimp processing centers annually Export about 1000 tons of shrimp, have a great economic impact to national economy. Of them nearly 35 million are marine fishermen, who are to be found along the 710 km coast stretching from the river Naf, falls into the Bay in the South East of the country to Raimangal river along Indo-Bangladesh border in the West.

9.19 Pollution threatens Chittagong Port

Hundreds of ships visiting Bangladesh's main port in Chittagong are taking advantage of lax laws and logistic backups against dumping of pollutants into the sea with officials struggling to stop it with only a binocular and a camera. Foreign and local ships find the Chittagong Port and its outer anchorage a safe dumping area for their waste, taking advantage of poor laws and their lax implementation due to logistic support. Many ships

dump pollutants in the sea or pollute the air emitting black smoke. About 700 offending vessels were detected over the last three years and were fined but could not completely stop the oil spillage, dumping of other pollutants and emission of black smokes. Many foreign ships used to dump burnt oil in the outer anchorage of the port defying international regulations. Nearly taka 1.5 crore was realised as fine from 700 ships, of them 130 foreign in last two years. Fifty of them were detained on charges of dumping pollutants. The 117-year-old port handles more than 80 per cent of Bangladesh's foreign trade with an average of 1,600 ships using the facility annually. Despite repeated pleas to the CPA for creating necessary provisions for clearing garbage on shore and at sea yielded a little result.

Toxicities, illegal dumping of rotten rice, onion and other goods by foreign vessels, industrial and inland wastage, oil spilling in the Bay are the root causes of polluting the fin and shell-fish resources. There is indication that chemical ingredients used in dry fishes and pesticides residues seepage into seawater deteriorating the marine eco-system, which also ultimately will have adverse affect on zooplankton and phytoplankton. Seafood industries also counted for polluting the marine environment, wastage from sea food processing industries are dumped into the places, closed to the sea. Effluents from 50 per cent of the industrial units in export processing zone, Chittagong pour into the Bay as effluent treatment plants have not been established in those industries. It is found that the crews of the vessels even don't follow sewage treatment; moreover Chittagong city lacks sewer treatment plant which caused direct dumping of human excreta into the sea.

9.20 Threats and Problems to Sundarbans

The Sundarbans has supported a rich fishery for more than a century. However, the fishery yield of the Sundarbans is declining due to a lack of an enforced management system and numerous threats to the Sundarbans.

9.20.1 Sundarbans and its Bio-diversity

The Sundarbans wetland is the most diverse and rich natural forest resource in Bangladesh. It is located in the southwestern part of Bangladesh, at the great delta of the Ganges, Brahmaputra and Meghna rivers at the edge of the Bay of Bengal. The

Sundarbans covers an area of 6017 km², of which, water constitutes 1874 km², equivalent to 31.1 per cent of its total area. In addition, it includes a twenty kilometers-wide marine zone in the Bay of Bengal, which covers an area of 1603 km². The Sundarbans is a large part of the Bangladesh coastline of 480 km and supports a diverse biological resource of over 291 species of fisheries resources, 334 species of plants, 300 species of birds, 32 species of mammals, 35 species of reptiles and 8 species of amphibians. The Sundarbans wetland was declared a Ramsar site under the 1971 Convention on Wetlands in 1992, the first such site in Bangladesh. It was declared a World Heritage Site by UNESCO in 1997. The Sundarbans is a great social and natural asset and an important source of water, food, biodiversity and economic development for Bangladesh. For these important reasons, community development activities for users of these resources are in progress for the sustainability of the wetlands. Mangroves are considered important ecosystem components due to their exceptional productivity and their structural diversity. The mangrove wetlands offer refuge and nursery grounds for juvenile fish, crabs, shrimps and molluscs by providing food and shade.

The fisheries of the Sundarbans wetland have been arbitrarily separated into inshore and offshore fisheries based on the proximity to the Bay of Bengal. The inshore fishery area refers to the rivers, canals and creeks inside the Sundarbans. Fishing in this area is artisanal in nature and carried out by using 21,500 small and open non-mechanized boats ranging from five to ten meters in length. The offshore fishery area refers to the estuaries and the marine zone. The area has a depth of about five to fifteen meters and operates from October to February due to weather conditions. There are approximately 2500 motorized and non-motorized large boats ranging from ten to fifteen meters in length. Fishers and their associates gather for about five months in Dubla Island, an area inside the Sundarbans near the Bay of Bengal suitable for drying fish and are engaged in fishing and fish processing activities.

9.20.2 Threats to the biodiversity of Sundarbans

Fishers use Golpata (*Nypa fruiticans*) leaves, tree poles and posts for thatching boats and houses, cooking and fish drying racks, thus causing a large effect on biodiversity. The fishers also clear forestland and damage the forest in order to extend the fish drying yards. In the offshore fisheries, the set bag nets often have a by-catch of turtles.

According to the IUCN Red Book of Threatened Species of Bangladesh, four species of fish are endangered and five are vulnerable in the Sundarbans due to over fishing. The threat to biodiversity of the Sundarbans is particularly from the direct effects of fishing on non-target species such as the capture and death of larger vertebrates. Harvest control and market extension (as sharks and stingrays are used in other parts of the world), are necessary in this regard.

9.20.3 Various Threats to the Environment and Human Life

The Indian government's construction of a barrage on the river Ganges, upstream of Bangladesh in the 1970s, reduced the dry season fresh water discharge into the Sundarbans. As a result, it is estimated that saline water intrusion has increased by 2-3 ppt (part per thousand) in the Sundarbans, affecting the flora and fauna of the forest. In addition, the Sundarbans water receives large amounts of pollutants from urban areas, harbours, farmlands and ship traffic inside the Sundarbans en route to Mongla Port. It is reported that uncontrolled and indiscriminate fishing threatens the environment and fisheries all over the world. In the Sundarbans, it is evident that threats to biodiversity, fisheries resource and environment are the direct and indirect result of uncontrolled fishing and lack of integration among concerned departments leading to the degradation of ecosystem functions and loss of habitats. Pollution has long-term effects on coastal and marine populations that lead to a change in the biodiversity. The Sundarbans experiences pollution, although the effects have not been quantified.

Many studies show that respiratory and intestinal diseases and infections among bathers rise steadily in step with the amount of sewage pollution in the water. They demonstrate, too, that bathers are at risk even in lightly contaminated waters that meet the pollution standards laid down by various Environmental Protection Agency. A recent WHO report has estimated that one in every 20 bathers in 'acceptable waters' will become ill after venturing just once into the sea. The toll from consuming contaminated shellfish is even greater. Pathogenic bacteria can survive in the sea for days and weeks; viruses can survive in the water or in fish and shellfish for months. The particularly virulent infectious hepatitis virus which has caused many outbreaks of the disease associated with eating shellfish can remain viable in the sea for over a year. Shellfish, like oysters, mussels, clams and cockles, feed by filtering huge amounts of seawater and can

concentrate viruses and bacteria a hundredfold from the water in which they live. There is strong evidence that fresh shellfish on sale for food frequently contain enough viruses to make many of those who eat them ill. They are often eaten raw or after only a light steaming which is not enough to kill most of the viruses or bacteria.

New evidence of the dangers of sewage pollution is just one example of a general reappraisal of the relative importance of different pollutants of the sea. Some of those once thought to be the most damaging worldwide are now believed to be much less important, either because more is known about them or because they have been brought under control. The supposed effects of man-made radionuclides discharged into the sea still loom large in the minds of the general public and politicians. Although threats from accidental releases cannot be ruled out, radionuclides now probably worry scientists less than any other category of marine pollutants. Similarly, highly publicised and exaggerated concerns about the extent of contamination of the seas and their life by heavy metals cannot be justified; it is probably far less serious than pollution by nutrients and some persistent organic chemicals.

Until recently, most attention concentrated on pollutants which directly or indirectly poisoned sea life and those consuming it or were suspected of doing so. Evidence that concentrations of these substances now in the marine environment are causing such effects is mostly inconclusive. It is now well-established that some chemicals can harm the endocrine systems of a wide range of wildlife species, both on land and at sea and may give rise to strange 'genderbending' effects. Tributyl tin, for example - which has been widely used in anti-fouling coatings on ships and in fish farming - appears to have made female sea snails grow false penises and to have severely affected oyster fisheries in some areas. Its use has now been restricted in most developed countries, but it is still being traded in some markets. It is possible that other environmental contaminants could 'sneak up on us', causing further unexpected effects.

A group of researchers has found a connection between ocean temperatures and cholera outbreaks and plans to test the model worldwide for predicting the incidence of the deadly water-borne disease. Most cholera outbreaks start in coastal areas. Higher temperatures make the coastal waters 'bloom' with plankton that carries the deadly cholera bacteria. It is found that rising sea temperatures and ocean height near the coast of Bangladesh in the Bay of Bengal from 1992 to 1995 often preceded sudden growth of

plankton and the cholera outbreaks. Scientists have correlated years of hospital cholera records from Bangladesh with sea temperature and ocean height data that came from a variety of satellites and sea-surface observations. The satellites, including the U.S.-French TOPEX/Poseidon oceanography satellite, measured water temperature and ocean height, as well as colors that indicated plankton growth. Scientists believe that sea height also affects cholera outbreaks because tides reach further inland to affect more people who drink or bathe in brackish water carrying cholera. Bangladesh is very low and flat and tidal effects are felt almost halfway up into the country. If the model that worked in Bangladesh could be extended globally.

9.21 Status of Pollution in Our Coastal Zone

Ecological balance of the coastal zone is being threatened due to environmental pollution, affecting the southern part of the country, along the Bay of Bengal. About 35 million people are affected by coastal pollution. The sea is full of resources that keep the natural balance of the ecosystems and support the livelihoods of the coastal people. Due to environmental pollution, the coast has already lost some of its aquatic species including fishes and mangrove forest. Pollution in coastal regions emerges from a variety of sources. Urban and industrial pollution in and around the Khulna-Jessore urban corridor, in the Karnaphuli and Baikkhali rivers and in the Chittagong area, with a good number of industries, are serious and increasing agricultural chemicals are known sources of pollution. Domestic sewage, ship-breaking activities, oil spills, accidental oil spills are major contributors to coastal pollution.

Bangladesh imports around 1.20 million tons of crude oil and 0.5 million tons of refined oil yearly and most of the traffic passes through Chittagong port. A major portion of this oil is transported to inland areas of Bangladesh through smaller tankers. Each year approximately 1500 ocean going vessels including 40 oil tankers call at Bangladeshi ports. Crude or refined oil is transferred at outer anchorage from big tankers to lighter tankers because of the draught restriction in Chittagong port. During this transfer process certain portion of oil leaks into the sea. Further more, there exists the risk of larger pollution resulting from accidents. Burnt oil, oil mixed bilge and other wastes are dumped into sea and rivers from these ships. The total annual input of petroleum hydrocarbons into the sea is approximately three million tonnes of which some 15 per

cent is due to accident related to exploration, production and transportation. This means that on any given day there are approximately 8.25 million tonnes afloat around the oceans. The most recent estimates indicate that the total amount of oil entering the oceans directly as a result of human activity is about 3 million tonnes per day. Approximately 400,000 tons a year spilled into the Bay of Bengal of which 6000 tons is contributed by our country.

The industries which discharge toxic waste into the marine water include 19 tanneries, 26 textiles, one oil refinery, a TSP fertilizer plant, two chemical industries, five fisheries processing units, five pesticide industries, four dyeing factories, Karnaphuli Urea Fertilizer factory (KAFCO), Chittagong Urea Fertilizer Ltd (CUFL), Asphalt Bitumen plant, TSP plant, Karnaphuli Paper Mills and Karnaphuli Rayon Mills. Every day 1.5 lakh litre of crude waste from the tannery industries and 35 tons of China clay, four tons of fibres from KPM and Karnaphuli Rayon Mills are dumped into the river and directly falls into the coastal and marine water. The amount of waste dumped into the river Karnaphuli would have turned it into a dead river many years ago, but it is still alive because of its tidal flow. It is found that about 3,000 kilograms of mercury from the KPM and KRM alone falls into the river Karnaphuli every year.

On an average, the port deals with 1,500-1,600 vessels and 12,000 to 13,000 cargoes annually. Vessels operating through the Mongla Port use 2 million tons of oil annually as fuel. Apart from this oil refinery at port releases 50,000 mt of oil per year, of which a significant amount of oil runs to the coastal water. Chittagong City Corporation area alone produces 1200 tons of solid waste annually. Most of these are dumped in two places. Halisahar is one such dumping ground for 25% of the total waste, which is very close to the sea and is connected by a canal. At Roufabad the other 75% of the waste is collected on 6.5 hector of land. For Domestic solid waste management, Cox's bazaar pourashava collected 75% waste, which is 15 tons/day and dumping near the Bakkhali river. The municipal waste generation in Barisal city is nearly 70 ton/day of which 40-50 tons are dumped in a municipal designed open space and the rest part goes nearby canals, ditches or in small water bodies. Shrimp culture in Cox's Bazar uses 620 tons of urea annually. It also generates 15 tons of waste daily, which comes to the water. About 70 tons of municipal waste is produced in Cox's Bazar daily and 20-30 per cent of it directly comes to canals.

Chapter 10

PROBLEMS AND POTENTIALS

10.1 Problems and Issues

Many problems militate against the effective management of pollution and environmental issues generally in the countries. May be the degree and severity of the problems are not the same in all the countries of a region but the common problems are identified as, ineffective laws, insufficient financial resources, need for capacity building, conflict among agencies/different levels of Government and lack of political will and desire to implement strong enforcement of regulations. The main problems and barriers to addressing these problems, includes:

- Issues of policy, regulation and enforcement
- Technical capacity
- Data gaps
- Inadequate infra structure
- Economic valuation of the resources
- Land tenure
- Loss of traditional management systems
- Development pressures
- Lack of community awareness and education
- Lack of community involvement
- Lack of planning and also other management issues

To mitigate these problems and issues current legal frame works require all implementing agencies to conform to environmental rules and standard, but without a strong support from DoE and proper resources it would remain as the best wishes of the Government with out implementation.

10.1.1 Preventing the Spread of Invasive Species

The introduction of invasive aquatic species into marine ecosystems costs the nation billions of taka a year in economic and ecological damage. A major source of invasive species is the discharge of ballast water from ocean going ships. Number of agencies is

involved in efforts to prevent the introduction of invasive species and many laws and regulations have been developed to combat the problem, but it needs to be done more to reduce this threat. Preventing introductions of invasive species or limiting their impact, will require streamlined programs and increased coordination among agencies, establishment and enforcement of domestic and international ballast water management standards, an educated public and adequate funding.

10.1.2 Identifying Major Pathways for Introduction of Non-Native Species

The discharge of ballast water is considered a primary pathway for introduction of non-native aquatic species. Other ship-related sources, such as sea chests (openings in ship hulls used when pumping water), ships' hulls, anchors, navigational buoys, drilling platforms and floating marine debris, are also important. Other pathways include intentional and unintentional human introductions of fish and shellfish and illegally released organisms from the aquaculture, aquarium, horticulture and pet industries. There is increasing concern that an expanding trade through the Internet and dealers of exotic pets is exacerbating the invasive species problem, including the introduction of diseases.

10.1.3 Ballast Water

Ships carry ballast water to aid in stability, trim (balance) and structural integrity. An estimated 7,000 species are carried in ships' ballast tanks around the world. While most of them perish during the voyage, even a few survivors can be enough to establish a reproductive population when discharged into a waterway. Under certain conditions, the new population can compete with native species and become pests in their new environment. However, even seemingly empty ballast tanks often contain residual water and sediments that can release non-native species to receiving waters when the ships later take on and discharge water during a coastal passage.

10.2 Reducing Marine Debris

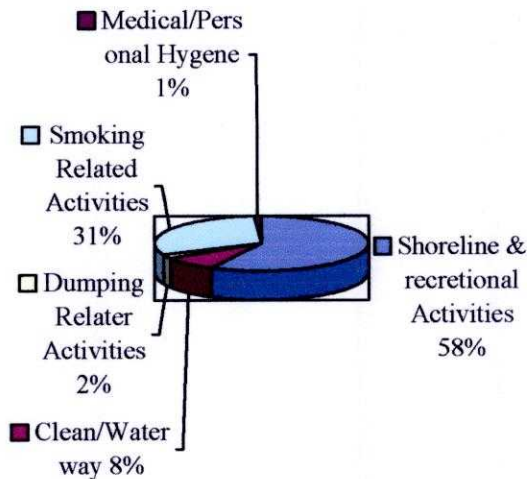
The trash and other waste that drifts around the global ocean and washes up on the nation's shores poses a serious threat to fishery resources, wildlife and habitat, as well as human health and safety. Marine debris is difficult to address because it comes from a

wide variety of sources, both on and off the shore. While marine debris is a global problem requiring international cooperation, many of its negative impacts are experienced at the local level and require local involvement. Re-establishing a marine debris program within the Port Authorities would help address the range of issues associated with marine debris, as would better coordination at all scales-international, national and local. Greater commitment to public education and outreach, partnerships with local governments, communities and industry, and enhanced research, monitoring and source identification will also help reduce marine debris.

10.2.1 Assessing the Sources and Consequences of Marine Debris

Most trash has the potential to become marine debris; cigarette filters, plastic bags, bottles, sponge containers, floating smuggle goods, cans and straws can all be found scattered along beaches and in the seas. Marine debris degrades slowly and is buoyant, often traveling for thousands of miles in sea currents. Approximately 80 per cent of debris is washed off the land, blown by winds, or intentionally dumped from shore, while 20 per cent comes from vessels and offshore platforms. In 2002, more than 8.2 million pounds of debris were collected and analyzed as part of a worldwide beach cleanup effort. The largest source of marine debris was from land-based human activities; shoreline and recreational activities alone contributed almost 58 per cent of the number of items collected. Beaches yielded over 1 million cigarette butts, 444,000 food wrappers or containers, 220,000 bottles, 190,000 plastic bags, 32,000 pieces of fishing line, and 8,000 tires. Cigarette smoking related activities was the second largest source. Sea based activities, including cruise ship operations, commercial fishing, recreational boating, commercial shipping, military vessel operations and offshore oil drilling, were also a significant source of debris. Cargo lost overboard from freighters poses another concern. Large containers have broken open and released their contents including everything from sneakers to computer monitors into the ocean.

Figure 10.1: Source of Marine Debris



Source: The Ocean Conservancy. The 2002 International Coastal Cleanup. Washington, DC, 2003.

Marine debris threatens wildlife through entanglement and ingestion. A 1997 study found that at least 267 species have been affected by marine debris world wide, including 86 per cent of all sea turtle species, 44 per cent of all seabird species and 43 per cent of all marine mammal species, as well as numerous fish and crustaceans. Entanglement can wound animals, impair their mobility, or strangle them. Birds, sea turtles and marine mammals can swallow debris such as resin pellets, convenience food packaging and plastic bags, which interfere with their ability to eat, breathe and swim. Sea turtles often ingest floating plastic bags, mistaking them for jellyfish. 'Ghost fishing' entanglement of fish and marine mammals in lost fishing gear represents a serious threat to marine life, including endangered species. Coral reefs, sea grass beds and other fragile coastal habitats have been harmed by trash in the sea. Derelict fishing gear, pushed by wind and waves, can become snagged on coral reefs and other structures. Floating debris can also transport non-native, potentially invasive species over long distances.

10.2.2 Addressing Marine Debris: Nationally Existing Programs

Efforts to reduce marine debris must take place at all levels, from international to local. Internationally, marine debris is addressed by Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL), which prohibits all overboard

disposal of plastics and limits other discharges based on the material and the vessel's location and distance from shore. The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (known as the London Convention) is another international agreement that addresses the problems of marine debris. Domestically in recent days, reductions in marine debris have been the focus of a number of agency initiatives and volunteer efforts, ranging from local adopt-a-beach programs to international beach cleanups. The Ocean Conservancy, a nonprofit ocean advocacy group, coordinates the annual International Coastal Cleanup campaign with support and funding from the U.S. Environmental Protection Agency (EPA) and private and corporate foundations. The one-day event takes place in September, with volunteers from all over the world collecting trash along the coasts and in the sea. Since its inception in 1986, the campaign's original 2,800 volunteers have grown to almost 392,000 in 2002 world wide. From 1986 to 2002, the International Coastal Cleanup removed 89 million pounds of debris from more than 130,000 miles of shoreline. Starting in 1995, more than 108,000 divers also collected 2.2 million pounds of trash in over 3,900 miles of underwater habitat. The program is effective not only because of the visibility it receives as the largest single-day volunteer event for the marine environment, but also because of the amount of data collected during the event. Debris collection results are posted by source, calling attention to the activities that create the most debris with the hope of improving prevention. The vast data collection potential demonstrated during International Coastal Cleanup events led to development of the National Marine Debris Monitoring Program, implemented by The Ocean Conservancy with EPA funding. This program is designed to systematically assess the success of Annex V of MARPOL by identifying sources and trends of marine debris. EPA and The Ocean Conservancy also created the Storm Drain Sentries program in response to research indicating that storm drains are significant sources of marine pollution. This program raises public awareness of the consequences of dumping trash and other pollutants into sewer systems. Volunteers stencil storm drains with educational messages and collect information on the types of contaminants found around storm drains.

10.2.3 Interagency Coordination

The Marine Plastic Pollution Research and Control Act may be introduced and an interagency marine debris coordinating committee may be formed with membership

comprised of senior officials from Marine Science Institute, Environmental department, the Coast Guard and Bangladesh Navy. The committee may be charged with furthering public outreach, education and information sharing efforts. Such a committee could support existing marine debris efforts by agencies and nongovernmental organizations. Potential functions for the committee are described below:

10.2.3.1 Education and Outreach

While existing public education and cleanup initiatives have made a substantial contribution to improving the sea environment, the volumes of trash that continue to appear on beaches and in the sea indicate that many people and communities have not yet changed their behavior. Many people consider their actions to be negligible when compared with those of large-scale polluters.

10.2.3.2 Working with Communities

Cigarette filters, food wrappers, caps and lids accounted for nearly half of all debris collected in the 2002 International Coastal Cleanup. For the past thirteen years, cigarette filters have been the most commonly found debris item. Not only is trash left on beaches and shores, allowing it to wash into the sea, litter is also washed off streets and parking lots and through storm drains far inland. People generally have not made the connection between actions taken far from the coast and their impacts on the shore and sea areas. While public education can send the message not to litter, active management of debris entering and exiting sewer systems can also be improved by adding controls for local sewer systems, such as screens and netting and making catch-basin modifications. Floatable controls can help reduce or eliminate solid waste emitted from sewer systems. Placing sufficient trash receptacles throughout communities can also make it easier for people to dispose of the materials that might otherwise end up in the marine environment.

10.2.3.3 Working with Industry

Cooperation with industry, particularly companies whose products are ending up on the shores and in the sea, presents another opportunity to reduce marine debris. The Coca-Cola Company, Dow Plastics and Philip Morris (all US) are all examples of companies

that have helped sponsor the International Coastal Cleanup. Morton Salt, the maker of products used by many commercial shrimp boats to treat their catches at sea, took action after blue plastic bags with the Morton Salt label started washing up on Gulf of Mexico beaches. Since the company started printing reminders like 'Stow It, Don't Throw It' on the bags, fewer Morton Salt bags have been reported as washing up on shores. Working in concert with the U.S. Department of the Interior's Minerals Management Service, the offshore petroleum industry has instituted marine debris education training for personnel working on offshore platforms, mobile drilling rigs and other facilities in the Gulf of Mexico. This initiative requires the posting of marine debris reminder signs and the mandatory viewing by all personnel of a film demonstrating proper waste disposal practices and the impacts of marine debris on the ocean. Plastics comprise about 60 per cent of the trash found on beaches and about 90 per cent of debris found floating in the water. Industry support for reducing plastic trash and encouraging greater recycling rates could reduce the amount of litter reaching the coasts and oceans.

10.3 Initiatives of Different Organisations

10.3.1 Government

Department of Environment takes action against environmental degradation and pollution. To check environmental degradation, the government has already signed a number of international treaties and conventions. As a result, mass awareness is increasing. A project of the Ministry of Environment and Forest is engaged in keeping the Saint Martin's Island beach clean from tourism related pollution. Ministry of Labour with assistance from the UNDP has taken an initiative to reduce the pollution resulting from ship breaking. Department of environment in collaboration with BCAS and IUCN has undertaken two initiatives namely Minimum Environment Flow Requirements for Ecosystem Function and Management of Land based Coastal Pollution in Bangladesh, to suggest some mitigation measures to control the coastal pollution. Bangladesh Fisheries Development Corporation is a semi government organization, which authorizes one fish processing plant and a terminal. Now a days, there are more and more environmental rules are taken into accounts as the foreign exporters are coming to visit the processing centers. They are now practicing Hazard Analysis Critical Control Point (HACCP) to

reduce the pollution level in their fish processing centers. The local government and the owner's associations are supporting this change.

10.3.2 Non Government

Some NGOs are working in Khulna, Cox's Bazar and Barisal are involved in the treatment of the municipal waste, clinical waste and cleaning of the beach area. For clinical waste management a national NGO named Pradipan is playing in Barisal. On 15 Dec 2003 a lecture session was held on global program of action for protection of marine environment from land-based pollution (GPA) organised by Asia-Pacific Forum of Environmental Journalists (APFEJ) and Forum of Environmental Journalists of Bangladesh (FEJB) at FEJB conference room, Dhaka. Speakers called for launching immediately a national program of action to protect coastal and marine environment from land-based pollution. They also asked for attaching priority to tackle the ship-breaking industries as part of the land-based pollution and conduct baseline study of marine pollution. Dr. Anjan Datta of United Nations Environment Programme gave a run-down of the current state of coastal and marine pollution and terrestrial issues. Ecological integrity of coastal and near-shore environments is at the mercy of social, business, institutional and regulatory norms that dictate human behavior not just at sea, but on land. Oceans are apparently considered as the waste basket as the state of coastal lagoons, estuaries, harbours, semi-enclosed seas, and even the open ocean, is a mirror of anthropogenic activities on land that alter or destroy habitat, pollute groundwater, creeks and rivers that drain into the sea and fill the atmosphere with particulate that settle on the sea.

10.3.3 Regional / International Inventiveness

The 1990 UN report on the state of the marine environment indicate that about 12% of marine pollution results from maritime transport and a further 10% from dumping by ships of land generated wastes. The UN report estimates that the measures taken in the IMO have prevented as much as 10 million tons of oil being discharged into the sea each year from tank cleaning and ballasting operations.

A South Asia regional plan of action for the protection of the marine environment from land-based activities for 2003-2006 is in the offing. The coastal and marine environment in South Asian countries is threatened by physical alterations and destruction of coastal eco-systems, including destruction of habitats of vital importance to maintain eco-system health, said a study of the United Nations Environment Program (UNEP) adding that almost 50 per cent of the coasts are threatened by development-related activities. The South Asia regional plan of action is expected to raise awareness and build capacities within governments of the coastal countries of the region to address the urgent threats to coastal zones, amongst other through strengthening their legislation and regulatory capacity and facilitating

10.3.3.1 Multi-Stakeholder Partnership

The initiative of UNEP under its Global Plan of Action (GPA) program is expected to raise awareness for the interactions between river basin and coastal and marine environment and promote on global, international, national and local scales the Integrated management of river and coast. The primary reason for the degradation in Bangladesh, India, Pakistan, Sri Lanka and Maldives, the UNEP study said, appears to be water pollution and increasing inadequacy of freshwater inflow to the coastal zone. The study also voiced concerns for unregulated cutting and clearing of mangroves for firewood, shrimp farming and flood protection. Apparently, the UNEP study pointed out, very little emphasis is placed on conservation and protection of the mangrove habitats. Agricultural activities carried out in the upstream eventually affect the downstream users, the UNEP study mentioned adding that indiscriminate use of pesticides is a threat to both marine and riverine aquatic life. Ship breaking and oil spills are other major pollution sources that have regional relevance. The UNEP-GPA program emphasized the need for launching a major awareness campaign in the region about the existing scale of problems and measures to prevent and alleviate further pollution of fresh and coastal water environment. The above scenario is not sufficient at this point of pollution level; the coastal zone policy has some guideline to protect the environment from pollution and the survival of the sustainable ecosystem or the mankind. In the strategy, the coastal pollution is addressed as a crosscutting issue, where some actions also to be prioritize and to be implemented in near future through priority investment programs by the respective agencies.

10.3.4 Other National and International Inventiveness

10.3.4.1 National Obligations

Industrial and agricultural production increases the nutrient and pollutant loading of rivers and nearshore waters, which can result in algal blooms and contaminated seafood products. All these activities generate impacts that cumulatively affect the health of the coastal and marine environments upon which we are dependent. It is therefore essential that we manage our activities on land so as to preserve these ecosystems for sustainable use and development. Waste treatment plant for Industries should be in place to minimize the waste into the coast. By introducing waste treatment plant in the industries, the most polluting source can be controlled or minimized. The alleviation of the sewage problem and the creation of a long term viable economy will necessitate a political commitment to develop and enforce legislation relevant to the management of residential and tourism development in the coastal zone, as well as adherence to planning policies taking into account the potential environmental impacts of development. Improving existing sewage disposal facilities, or building new ones where necessary, is important, as is ensuring that individual houses and resorts have sewage disposal systems, such as septic tanks. Larger resorts should use existing municipal sewage systems, where available, or install and manage their own packaging plants.

10.3.4.2 International Obligations

Solid wastes dumped at sea come from shipping, commercial fisheries and other offshore activities. Annex V of the MARPOL 73/78 Convention regulates the disposal of solid wastes by ships in near Shore. The Maritime Environment Committee of the International Maritime Organization (IMO) in July 1991 designated the Wider Caribbean region as a 'Special Area' under the above regulations. However, in order to comply with Annex V of MARPOL, most countries in the region will need to provide port reception facilities for Annex V, wastes generated by shipping activities. At present, many countries in the region lack such facilities. The lack of adequate port reception facilities could result in solid wastes being disposed of at sea and being transported by wind and currents to shore often in locations distant from the original source of the material. Ship generated wastes account for approximately 80% of solid wastes in the coastal area. Beach cleanups are

performed in many countries of the region. Generally plastics are very common, while glass, metal containers, paper products and other materials are also commonly seen. The most effective way to reduce this pollution is to stop it at the source. To this end, increasing public awareness, strengthening local legislation, promoting proper garbage collection, transportation and dispersal system, including the development of port reception facilities to comply with Annex V of MARPOL, are some potential solutions for the problem of ship generated pollution.

10.4 Offshore Energy, Minerals and Emerging Uses

Valuable oil and mineral resources are found off our shores and in the sea bed; they fuel our cars and our economy, provide materials for construction and shoreline protection and offer exciting opportunities for the future. These energy supplies also provide a major source of revenue and lot of jobs. While advances in technology are enabling the offshore industry to drill deeper, cleaner and more efficiently, increasing energy demands coupled with environmental concerns have spurred efforts to find alternative sources of power. In addition to energy, our offshore waters and the underlying seabed are also rich sources of non-petroleum minerals and sand. Minerals, such as phosphates, polymetallic sulfides and deposits that form around high-temperature events, may also have commercial value some day if technical and economic barriers to their extraction can be overcome. Interest in the ocean goes beyond the traditional resource industries. The telecommunications industry's investment in submerged cables will continue as international communication needs expand. There is also growing interest in other offshore uses including aquaculture, carbon dioxide sequestration, conservation areas, research and observation facilities.

10.5 Exploration, Inspiration and Education

Throughout history, the ocean's mysteries and our reliance on its resources have inspired great works of literature and art, spurred the human instinct to explore and provided diverse forms of entertainment. Shipwrecks, prehistoric settlements and other submerged sites document and preserve important historical and cultural events, while offering unique opportunities for both professional archeologists and recreational divers and for educating the public. Only thirty years ago, no one contemplated the existence of vast biological communities living in the deep sea at hydrothermal vents or the associated

mineral rich flows that form towers more than 50 feet high. Today, we are just beginning to learn about the immense scope of microbial life within and below the sea bed. The sea provides an exciting way to engage people of all ages in learning and inspire academic achievement in the nation's schools. Using the oceans as a unifying theme, students can participate in research at sea and teachers can connect mathematic and scientific principles with real-world problems, environmental issues and the use of modern technology. From young to old, in formal and informal education, the ocean offers an unparalleled tool to improve the literacy and knowledge of our citizens. If we are sufficiently creative, we can produce an entire new generation of experts and cultivate a fresh appreciation and understanding that will deepen the stewardship ethic within our society.

10.6 Global Water Quality

Water quality is closely linked to water use and to the state of economic development. In industrialized countries, bacterial contamination of surface water caused serious health problems in major cities throughout the mid 1800s. By the turn of the century, cities in Europe and North America began building sewer networks to route domestic wastes downstream of water intakes. Development of these sewage networks and waste treatment facilities in urban areas has expanded tremendously in the past two decades. However, the rapid growth of the urban population (specially in Latin America and Asia) has outpaced the ability of governments to expand sewage and water infrastructure. While waterborne diseases have been eliminated in the developed world, outbreaks of cholera and other similar diseases still occur with alarming frequency in the developing countries. Since World War II and the birth of the chemical age, water quality has been heavily impacted worldwide by industrial and agricultural chemicals. Eutrophication of surface waters from human and agricultural wastes and nitrification of groundwater from agricultural practices has greatly affected large parts of the world. Acidification of surface waters by air pollution is a recent phenomenon and threatens aquatic life in many area of the world. In developed countries, these general types of pollution have occurred sequentially with the result that most developed countries have successfully dealt with major surface water pollution. In contrast, however, newly industrialized countries such as China, India, Thailand, Brazil and Mexico are now facing all these issues simultaneously.

11.1 Addressing Coastal Water Pollution

Comprising over 70% of the Earth's surface, water is undoubtedly the most precious natural resource that exists on our planet. Without the seemingly invaluable compound comprised of hydrogen and oxygen, life on earth would be non-existent. It is essential for everything on our planet to grow and prosper. Although we as humans recognize this fact, we disregard it by polluting our rivers, lakes and sea. Subsequently, we are slowly but surely harming our planet to the point where organisms are dying at a very alarming rate. In addition to innocent organisms dying off, our drinking water has become greatly affected as is our ability to use water for recreational purposes. In order to combat water pollution, we must understand the problems and become part of the solution.

11.1.1 Working for Next Generations

For years, we have battled the tides, enjoyed the beaches and harvested the bounty of our coasts. The Bay of Bengal is among nature's greatest gift to us. The responsibility of our generation is to reclaim and renew that gift for ourselves, for our children and if we do the job right for those whose footprints will mark the sands of beaches from Chittagong to Teknaf long after ours have washed away. Our sea and coastal assets are extremely valuable to our society and untold more to the earth and its complex ecosystems. Although losses in some areas have been significant and continue, in other areas sound policy and sustained investments have slowed or reversed harmful trends. There is every reason to believe that wise actions taken today, based on the best available science, can restore what has been lost and create benefits even greater than we see today. But to obtain these benefits, our nation's leaders must take immediate steps to formulate a coherent, comprehensive and effective national sea water policy. Implementation of the far-reaching recommendations can halt the losses and help restore, protect and enhance our sea assets.

11.2 National Water Quality Monitoring Network

Other major sea related legislation enacted during this period included measures to improve our water quality, regulate ocean dumping, designate marine sanctuaries, prohibit the taking of marine mammals, protect endangered species, license deep-water ports, promote aquaculture and encourage the development of ocean thermal energy conversion as a renewable source of power.

11.3 Creating Disincentives to Pollution

Environmental concern is increasing in Bangladesh. When Bangladesh was born, environmental concern was almost non-existent. The country had only started urbanising in that period and urban pollution of different forms witnessed today in coastal area and other major cities of the world were unknown at that time. The degraded source of fresh water such as rivers from the discharge of untreated industrial and other toxic wastes and effluents is another very big source of environmental worry. Country's biodiversity is at stake from deforestation resulting mainly from population growth and other factors like aridity and desertification caused by the interference in the flow of rivers that flow to it from the neighbouring country. Its wildlife is diminishing from the threat of salinity and excessive human encroachments affecting its main abode - the Sunderbans mangrove forests. Bangladesh at one time was famous for over four hundred species of sweet water fishes. Only about sixty or seventy such species have survived human greed and the rest have become extinct or nearly so.

11.4 Pollution Prevention

Pollution prevention primarily aims at achieving reduction of pollution at the source. This leads to 'Up front' reduction or doing away with waste from a process. The term 'Pollution Prevention' has been in use since 1990 with the perception of 'Waste Minimization' in the context of pollution prevention. The pollution prevention measures actually leads to compliance of the environment. A reasonable hierarchy for the pollution prevention is shown below:

- Safe disposal
- Treat for discharge

- Recover energy value in waste
- Re-cycle
- Segregate and reuse
- Minimize introduction
- Minimize generation

This integrated waste management and pollution prevention hierarchy may be broken down into four components:

- a. Source Reduction: Changes in the procedure, technology, raw materials and product.
- b. Re-cycling: Re-covering a usable material from the waste within a closed loop or at the end of pipeline.
- c. Treatment: Separation, concentration and waste treatment by physical, chemical, biological or thermal process.
- d. Ultimate disposal: Land farming, land fill, deep well, injection, ocean dumping or atmosphere dispersion.

11.4.1 Introducing Green Tax for Pollution

It was no wonder that the economists and the environmentalists came together a seminar at the press club last year to draw attention to the very pressing need for environmental regulation to control the environmental drift. They recommended the pollution tax which is unprecedented in the history of this country. The suggestion from the seminar was to introduce such a tax which is likely to be described as the green tax for its environmental objective. The proposers of the tax are of the view that such a tax will rein in the polluters. Apart from the pollution tax which is a penal tax, the seminar participants recommended other measures such as reduction of duty for the import of environment friendly automotive vehicles/ vessels and substantially increased duty for the import of unfriendly ones. The proposed fiscal measures such as a penal tax for environment polluters or reduction of duty or increase of duty to promote or discourage environment friendly and unfriendly imports respectively might sound somewhat novel in the context of Bangladesh. But their appropriateness or usefulness can be hardly doubted. They are frequently resorted to in countries where environmental concerns are high. For instance,

in Singapore, a penalty in the financial sense could be required even for shredding bits of paper on a road which might be considered as a trivial or no offence in our country. But the fiscal measures that have been proposed stand a good chance of succeeding by creating adequate disincentives to polluters to wind up their polluting activities in view of the penal taxes or the inability to bear the heavy import costs of the polluting agents.

11.5 Strengthening Vessel Safety, Security and Environmental Compliance

Vessel owners, operators and government agencies responsible for oversight of vessel operations share responsibility for continued improvement in vessel safety, security and environmental compliance. Improvements to date have been based on a combination of voluntary and regulatory measures, including a broad array of guidelines and mandatory regimes for domestic and international operations. Over the past few years, attention has been focused on better implementation, oversight and enforcement of existing requirements. The success of all these efforts will depend on a broad domestic and international framework with several components. A key component of the framework is a strong voluntary commitment on the part of vessel owners and operators to build a culture that incorporates safety, security and environmental protection as important and valued aspects of everyday vessel operations. Another important component is an international commitment to effective oversight and enforcement. This applies particularly to those with primary responsibility for vessel operations and receiving ports.

11.5.1 A Culture of Compliance and Safety

Voluntary partnerships between government agencies and vessel owners and operators are an important, non-regulatory means of promoting vessel safety and encouraging compliance with environmental regulations. Such partnerships have been credited for reductions in vessel accidents and oil spills. However, the process of building a culture of safety also requires a strong commitment within industry. Safety and environmental plans should be effectively incorporated into routine vessel operations, including investments in improved workplace safety and training. Also important to success are reliable means of measuring the success of these initiatives, as reflected in crew and company performance, including extensive use of third-party audits. The most effective incentives are those that facilitate cargo delivery or other vessel operations, such as reduced

government oversight or inspections, which translate directly into lower operational costs.

11.6 Prevention: the First Line of Defense

11.6.1 Ballast Water Management

Exchanging ballast water in the middle of the sea to reduce the risk of transferring organisms from one ecosystem to another is the primary management tool currently available for ships to control the introduction of invasive species. To strengthen invasive species management, concern government agency may finalize regulations mandating ballast water exchange nationwide. However, new technologies may also provide alternatives to mid-sea ballast water exchange by finding ways to eliminate stowaway species in ballast water. To encourage development, testing and adoption of these technologies, that agency may also establish an enforceable treatment standard and a shipboard testing program. This approach will ensure a required level of protection against the spread of non-indigenous species and speed progress toward an ultimate goal of preventing all introductions of organisms, including bacteria and viruses.

11.6.2 Controlling Other Pathways

Ballast water is a clearly identifiable source that can be managed through traditional regulatory means but other sources of non-native species, such as the shellfish importing, aquaculture, aquarium, horticulture and pet industries are far more diffuse and less amenable to our controls. Preventing introductions through these pathways will require a mix of legislation and public education. Public education is a vital component of a prevention strategy. Individuals must understand that their actions can have major, potentially irreversible, economic and ecological consequences. Increasing the public's awareness and suggesting actions that boaters, gardeners, scuba divers, fisherman, pet owners and others can take to reduce introductions, can help prevent the spread of invasive species. Currently, a number of unconnected education and outreach programs exist, generally focusing on individual species, but a more coordinated, national plan is needed. As international markets continue to open and Internet use grows, access to the purchase and importation of non-native animals and plants from all over the globe is

likely to increase. Some industry representatives have expressed concern that efforts to ban unwanted species and otherwise prevent introductions of non-native species may interfere with the flow of free trade and the need to protect public health and ecosystems will have to be balanced against these individual interests.

11.7 Control and Prevention of Marine Pollution

Once the nature of pollution and the sources of pollution have been established, there need to be some avenues through which the control and prevention of marine pollution can be implemented. The most obvious control strategy is to completely prevent the introduction of the pollutant in the environment. The methods of control vary from depending of the nature and the source of the pollutant. The control methods for a few of major sources of pollutants are discussed in the succeeding paragraphs.

11.7.1 Dredging

Maintenance dredging of harbours and channels would not be required at all, if there were no sediment supply shoal up major channel areas. This type of dredging is a periodical and sometimes continual necessity to re-dredge the accumulated sediment. This continual sedimentation is a normal phenomenon irrespective of human involvement. Man can best accelerate this process. The most obvious solution to the problem of maintenance dredging is to cut off the sediment supply to the places where sedimentation has been a major problem. This can be carried out in a number of ways as follows:

- a. **Prevent Upstream Erosion.** This is possibly the most effective but perhaps the most difficult. The entire watershed needs to be policed to ensure that the natural landscape gets changed to such an extent that erosion no longer takes place. This implies extensive terracing and replanting of areas that have already been denuded. Extreme measures need to be taken in areas that do not have natural cover.
- b. **Provision of Settling Ponds.** Another method of preventing sediment from reaching the undesired area is the provision of settling ponds. The water is released after it has released major portion of its load and is allowed to proceed

downstream. The major disadvantage of this system is that it is essentially a temporary solution since the ponds would fill up rapidly, needing either building of new ponds or dredging.

c. **Bottom Stabilization.** Sometimes the sediment load is introduced from nearby sources rather than upstream. This happens when a channel gets dredged with unstable sides so that the material just tends to slough up into deeper regions. This needs constant dredging as bottom material from the sides almost immediately replaces the removed sediment. One method of correcting this is by stabilization of the bottom. Adding larger, denser material such as gravel is a technique that is occasionally used since it is more expensive than dredging.

d. **Changing Circulation Patterns.** Another method to prevent the accumulation of sediments is to change the natural circulation patterns so that the sediments get deposited in an area where they do no damage. This could be achieved by changing the physical dimensions of the estuarine areas, by putting dams in selected areas and even by changing the circulation pattern by planting grass to increase bottom friction.

11.7.2 Combating Oil Pollution

Once an oil spill has taken place, the events that follow are spreading, evaporation, dissolution, emulsification, oxidation and finally bio-degradation. Therefore, depending on the quantity, type, age and state of the oil spill different types of equipment are required to combat oil spills. In order to effectively contain and recover the spilled oil various countries have response teams, which are provided with a variety of equipment both surface and air-borne. These can be divided into four groups as follows:

a. **Containment Equipment.** These are barriers known as booms made of a variety of equipment and are utilized to stop the spread of oil, collect the oil to enable higher recovery rates and also to deflect oil from sensitive areas towards collecting points. Depending on the physical description and structural behavior, these booms can be classified as curtain booms, fence booms, inflatable booms, flexible booms or rigid booms. The basic requirements of a boom are means of flotation, a skirt, ballast and a longitudinal strength member. The booms are

deployed in various configurations depending on the area, availability of surface craft, weather conditions, sea state and the rate of spread.

b. **Mechanical Recovery Equipment.** These are mechanical devices, also called skimmers, which are designed to recover oil or oily water from the water surface. All skimmers have an oil recovery element, a means of flotation and a pump to transfer the collected material. In certain advanced skimmers a number of recovery elements, storage devices and means of propulsion are available.

c. **Dispersants and Spraying Equipment.** Dispersing of oil is the chemical means of dealing with an oil spill. The dispersants are usually a blend of surface active agents (surfactants) in a solvent. In other words they are solvents designed to carry the surfactants. The dispersants when sprayed on the spilt oil penetrates the oil layer and breaks the oil into small droplets by reducing the surface tensions. The droplet size (of dispersant), type, age and thickness of oil, wave and current, and area of application affect the effectiveness of a dispersant. The main limitation in dispersion of oil spill is the fact that the longer the oil stays on the water surface the lesser the chances of it being dispersed. Experiments carried out show that generally dispersants are effective up to 4 to 8 hours after the spill. The dispersants being highly toxic should never be used in confined waters as the toxicity of water increases thereby becoming a danger to the marine life and environment as such. This therefore defeats the very purpose for which dispersants are used.

d. **Storage Equipment.** In any given spill situation the storage and disposal of the recovered oil poses a major problem. Salvage barges are used to aid storage, transfer and disposal of recovered oil. The salvage barges are uncompartmental rubberised cylinders, which are attached to the outlet of the skimmer. The oil or oily water collected by the skimmer is pumped into these barges. The barge when full can be detached and towed away to a given point.

11.7.3 Combating Industrial Pollutants

Most industries use large quantities of water either for cooling or as an integral part of manufacturing process. Consequently, industrial effluents tend to have waste products, heat, leached material from heat exchangers etc, which may have toxic products being

discharged into the sea. Consequently, it is important that all industrial effluents are treated before they are discharged. Some industries have tried to modify the process rather than just clean up the effluent. However, in many cases there has been no increase in operating efficiency, with the net result being an increase in manufacturing costs passed on to the customer. Society must therefore make a decision as to how much it is willing to pay for a particular product vis a vis the amount of pollution introduced in the manufacture of the product.

11.7.4 Combating Municipal Water Pollution

Municipal water pollution consists of waste water from homes and commercial establishments. For many years, the main goal of treating municipal wastewater was simply to reduce its content of suspended solids, oxygen-demanding materials, dissolved inorganic compounds and harmful bacteria. In recent years, however, more stress has been placed on improving means of disposal of the solid residues from the municipal treatment processes. The basic methods of treating municipal wastewater fall into three stages: primary treatment, including grit removal, screening, grinding and sedimentation; secondary treatment, which entails oxidation of dissolved organic matter by means of using biologically active sludge, which is then filtered off; and tertiary treatment, in which advanced biological methods of nitrogen removal and chemical and physical methods such as granular filtration and activated carbon absorption are employed. The handling and disposal of solid residues can account for 25 to 50 per cent of the capital and operational costs of a treatment plant. The characteristics of industrial waste waters can differ considerably both within and among industries. The impact of industrial discharges depends not only on their collective characteristics, such as biochemical oxygen demand and the amount of suspended solids, but also on their content of specific inorganic and organic substances. Three options are available in controlling industrial wastewater. Control can take place at the point of generation in the plant; wastewater can be pretreated for discharge to municipal treatment sources; or wastewater can be treated completely at the plant and either reused or discharged directly into receiving waters.

11.7.5 Waste Water Treatment

Raw sewage includes waste from sinks, toilets and industrial processes. Treatment of the sewage is required before it can be safely buried, used or released back into local water systems. In a treatment plant, the waste is passed through a series of screens, chambers and chemical processes to reduce its bulk and toxicity. The three general phases of treatment are primary, secondary and tertiary. During primary treatment, a large percentage of the suspended solids and inorganic material is removed from the sewage. The focus of secondary treatment is reducing organic material by accelerating natural biological processes. Tertiary treatment is necessary when the water will be reused; 99 percent of solids are removed and various chemical processes are used to ensure the water is as free from impurity as possible.

11.7.6 Agricultural Source Treatment

Agriculture, including commercial livestock and poultry farming, is the source of many organic and inorganic pollutants in surface waters and groundwater. These contaminants include both sediment from erosion cropland and compounds of phosphorus and nitrogen that partly originate in animal wastes and commercial fertilizers. Animal wastes are high in oxygen demanding material, nitrogen and phosphorus and they often harbor pathogenic organisms. Wastes from commercial feeders are contained and disposed of on land; their main threat to natural waters, therefore, is from runoff and leaching. Control may involve settling basins for liquids, limited biological treatment in aerobic or anaerobic lagoons and a variety of other methods.

Careful stewardship of our sea and coastal resources is imperative to conserve and enhance the financial, ecological and aesthetic benefits we have come to rely upon and enjoy. This study pulls together information from a wide range of sources and clearly shows that our sea and coasts are among our nation's most vital economic assets. Governments at all levels, universities and corporations provide many other jobs in sea related fields ranging from management and law enforcement to pollution prevention and research. Born of the sea are clouds that bring life-sustaining rain to our fields and reservoirs, microscopic plankton that generate the oxygen we breathe, energy that fuels our industry and sustains our standard of living and biological diversity that is unmatched

on land. Our sea and coasts are among the chief pillars of our nation's wealth and economic well-being. Yet our lack of full understanding of the complexity of marine ecosystems and our failure to properly manage the human activities that affect them, are compromising the health of these systems and diminishing our ability to fully realize their potential.

11.8 Recycling Facility at the Chittagong Port

The incoming vessels are randomly dumping wastes in the Bay of Bengal due to lack of recycling facility at the Chittagong Port, causing serious marine pollution. Recycling of wastage is mandatory as per the International Maritime Organisation act. The Environment Department issued several notices to the authority to develop the facility. The lack of the recycling facility is one of the main reasons behind the environmental pollution in the port areas of Bangladesh. Recently the authority undertook a Tk 6 crore project to build the facility for the port. However, until the project gets underway the vessels are to be forced to release wastage in the next port where the recycling facility is available.

11.9 Education and Training for Pollution Control

Pollution education campaigns have generally focused on the impacts of pollution on marine animals. Signs stenciled on storm drains remind people that dolphins live downstream. However, additional attention should be given to the fact that human food supplies and recreational areas are also downstream. Reductions in pollution from urban area runoff, sewage outflows, agricultural pesticides and many other sources are needed to avoid creating harmful conditions in the oceans and the best way to start is with a higher level of public education. Education campaigns should also continue to inform people of the potential risks some fish and shellfish pose to their health because of the bacteria, viruses or chemicals they carry. These programs should incorporate messages that seafood may be contaminated even when no visible algal bloom is present and conversely that some unattractive algal blooms are not harmful.

11.10 Awareness Raising for Various Groups

A number of measures have been taken by the world community to reduce the pollution of the oceans. Greater understanding of the causes, identification of the sources, improved technology and innovations in combating pollution have resulted in both prevention and containment of marine environmental hazards. Most encouraging of all have been the measures taken under the leadership of international agencies. Today when our economy has been liberalized it would be in order to reflect on what would happen to our trade and consequently our economy if we do not increase our awareness of this problem and improve upon the ways and means of pollution control. The consequences of not doing so will be disastrous.

11.10.1 Imagining a Brighter Future

The potential benefits associated with sea and coasts are vast; however, the problems we face in protecting them and realizing their full potential are numerous and complex. There is a growing awareness of the connectivity within and between ecosystems and the impacts of human activities on the marine environment. The need for change emerged as a compelling theme-change not only in management and policies, but also in public awareness and education and in the use of science and technology. In the desirable future, the sea and coasts would be clean, safe and sustainably managed. The sea would contain a high level of biodiversity and contribute significantly to the economy, supporting multiple beneficial uses, including food production, development of energy and mineral resources, recreation, transportation of goods and people and the discovery of novel lifesaving drugs and other useful products. The coasts would be attractive places to live, work and play, with clean water and beaches, easy public access, vibrant economies, safe bustling harbours and ports, adequate roads and services and special protection for sensitive habitats. Beach closings, toxic algal blooms, proliferation of invasive species, and vanishing native species would be rare. Better land use planning and improved predictions of severe weather and other natural hazards would save lives and money. In the desirable future, management of the sea and coasts would follow ecosystem boundaries, looking at interactions among all elements of the system, rather than addressing isolated areas or problems. In the face of scientific uncertainty, managers would balance competing considerations and proceed with caution. Ocean governance

would be effective, participatory and well coordinated among government agencies, the private sector and the public. Following may also be considered:

- **Preservation of Marine Biodiversity:** Downward trends in marine biodiversity should be reversed where they exist, with a desired end of maintaining or recovering natural levels of biological diversity and ecosystem services.
- **Best Available Science and Information:** Ocean policy decisions should be based on the best available understanding of the natural, social and economic processes that affect ocean and coastal environments. Decision makers should be able to obtain and understand quality science and information in a way that facilitates successful management of ocean and coastal resources.
- **Adaptive Management:** Ocean management programs should be designed to meet clear goals and provide new information to continually improve the scientific basis for future management. Periodic reevaluation of the goals and effectiveness of management measures and incorporation of new information in implementing future management, are essential.
- **Understandable Laws and Clear Decisions:** Laws governing uses of ocean and coastal resources should be clear, coordinated and accessible to the nation's citizens to facilitate compliance. Policy decisions and the reasoning behind them should also be clear and available to all interested parties.
- **Participatory Governance:** Governance of ocean uses should ensure widespread participation by all citizens on issues that affect them.
- **Timeliness:** Ocean governance systems should operate with as much efficiency and predictability as possible.
- **Accountability:** Decision makers and members of the public should be accountable for the actions they take that affect ocean and coastal resources.

- **International Responsibility:** The United States should act cooperatively with other nations in developing and implementing international ocean policy, reflecting the deep connections between the global oceans.

11.11 Implementation of Integrated Coastal Zone Management

Bangladesh urgently requires integrated coastal zone management to alleviate chronic resource depletion, overpopulation and wide spread poverty on one of the world's most dynamic and disaster prone coastal delta environments. In an attempt to achieve integrated coastal zone management, the 1992 Bangladesh Environment Policy contained a number of coastal and marine management policies and administrative changes to enhance policy implementation. The Bangladesh coastal zone is rich in natural resources. However, its natural coastal resources face multiple and critical problems. Including non-sustainable forest and fishery exploitation and frequent cyclone disaster set with in a human context of wide spread poverty, landless and unsanitary living conditions. As a result clear, coordinated coastal zone management efforts are an urgent requirement in Bangladesh. Implementation of Integrated coastal and marine management and sustainable development plans and programs are required at appropriate levels. We should consider the international coastal management initiatives described in the Agenda 21, provide us a strong stimulus to formulate coastal Zone Policies and Plans, which very much in line with Bangladesh Environmental Policy 1992.

11.12 Implementation of Recommendations

Sewage, solid waste, agricultural and industrial activities, urban runoff and physical alterations have been identified as primary sources of coastal pollution in the marine environment. However, following programs/activities have been designed for implementation under the Coastal Development Strategy, 2005:

1. Marine and Coastal Environmental Development
2. Sustainable fisheries and aquaculture
3. Land use zoning for efficient use of land resources.

Other than these nominated activities some other activities are also need to be initiated at earliest to restore the environmental degradation due to pollution, such as: managing coastal and marine diversity and protected areas, monitoring environmental effort, management of pollution hot spots located in the coastal zone, waste management in the metropolitan cities in the coastal zone and strengthen pollution controlled ship breaking activity. The immediate actions are to be taken to overcome the situation on an emergency basis. Government Departments, agencies, international organizations and NGO's are to give their attention to eliminate the barriers to mitigate the coastal pollution. Environmental Policy and implementation Plan 1992, CZP 2005 and compliance with international treaties and conventions are needed. However it is concluded that the implementation of coastal management initiatives including pollution issues through administrative channels, as detailed in the Environment Policy 1992, will not significantly improve without strong political commitment and high level strategic policy directives and guidance.

11.12.1 Enabling Conditions

In order to initiate pollution control, prevention and reducing its severity there are a number of prerequisite including following broad based enabling conditions to be in place for land based pollution. Such as:

- Proper implementation of EIA and environmental related Acts.
- Introduction and implementation of ICZM.
- National capacity building on assessing and monitoring pollution.
- Regional cooperation.
- Awareness program and community approach.
- Development of the national action plans for systematic collection of solid waste and sewage and their treatments in a phased manner depending on the availability of financial resources.
- Promotion of adoption of best available technology and best environmental practices for disposal of waste from industries developing of an Industrial Action Plan including zoning plan for location of new industries; adaptation of an environmental criteria while determining industrial zones; providing economic incentives to industries.

- Establishment of a long term monitoring program to monitor the health of the coast.
- Protection of the feeding and nursery grounds of commercially important species through establishment of the protected areas.

Similarly following broad based conditions have to be grounded to control Sea based pollution:

- Impact assessment of oil spillage
- Introducing "Polluters Pay Principals"
- Establishment of "Marine Environmental Laboratory"
- Regional /International cooperation (IMO, UNEP, IOC, IMCO, IAEA)

Factors contributing to the need for a coherent national system of sea governance include rising coastal populations, increased competition for ocean space, demand for port facilities, the emergence of potential new sea uses, the decline of vital commercial fishery stocks, unresolved debates over offshore energy and mineral development, the persistence of marine pollution, the contamination of seafood, the loss of coastal wetlands and the prospect that enhanced knowledge of the oceans will improve our ability to comprehend the causes of climate variability and other not yet fully grasped environmental threats.

The Oceans Act should state that the national ocean policy should promote protection of life and property, responsible stewardship of ocean and coastal resources, protection of the marine environment and prevention of marine pollution, enhancement of marine commerce, expansion of human knowledge of the marine environment, investment in technologies to promote energy and food security, close cooperation among government agencies and coastal activities. In developing its recommendations, we must give equal consideration to environmental, technical feasibility, economic and scientific factors.

12.1 Conclusion

Coastal waters are subject to cumulative impacts from a variety of pollutants from near and far, and from point, nonpoint, and airborne sources. For this reason, any solution must be founded on an ecosystem-based and watershed management approach involving a broad range of agencies, programs and individuals. Solutions will also require a substantial financial investment and will take time. Over the last few decades, great strides have been made in controlling water pollution from point sources, although further improvements could be realized through increased funding, strengthened enforcement and promotion of innovative approaches. However, substantial enhancement of coastal water quality will require significant reductions in nonpoint source pollution—a technical and political challenge. Establishing measurable pollution reduction goals for coastal areas is needed, as is coordination of the many related agencies and programs to effectively target the various laws, programs, funds, training, technical assistance,

incentives, disincentives and other management tools to address nonpoint source pollution of coastal waters.

Ongoing monitoring is essential to assess the health of ocean and coastal ecosystems and detect changes over time. More than any other measure, monitoring provides accountability for management actions. The nation needs a coordinated, comprehensive water quality monitoring network that can provide the information necessary for managers to make informed decisions, adapt their actions as needed and assure effective stewardship of public resources. Input from states, territories, tribes, counties and communities where much of the monitoring will be conducted is also essential. In addition, because of the inherent overlap among inland, coastal, and open-ocean monitoring and observing, the national water quality monitoring network should be closely linked with the Integrated Ocean Observing System and, ultimately, incorporated into a broad earth observing system. Existing policies regarding the state of coastal water pollution of the Bay of Bengal have to be significantly changed and existing rules and regulations have to be strictly enforced.

The benefits from vessel activities are significant, but they also present risks to people and the environment that need to be effectively addressed. Limiting vessel pollution, improving vessel safety and addressing potential security threats associated with vessel operations depend on responsible owners and operators, conscientious crews, enforceable national and international standards and development of new technologies and management approaches. There is also a need for heightened awareness and better real time information about the full array of offshore activities to ensure safety, security and environmental quality. Strengthening commitments to environmental protection, flag state oversight and port state control will help prevent and reduce the impacts of vessel pollution. However, effective reduction of vessel pollution will also require the development of new control measures. Of particular concern are vessel waste discharges containing pathogens and nutrients, air emissions and oil releases.

The introduction of invasive aquatic species into marine ecosystems costs the nation millions, or possibly billions of dollars a year in economic and ecological damage. A major source of invasive species is the discharge of ballast water from ocean-going ships. Few agencies are involved in efforts to prevent the introduction of invasive species and

many laws and regulations have been developed to combat the problem, but more needs to be done to reduce this threat. Preventing introductions of invasive species or limiting their impact, will require streamlined programs and increased coordination among agencies, establishment and enforcement of domestic and international ballast water management standards, an educated public and adequate funding.

Increased shipping, spurred by the country's expanding economy, is creating unprecedented levels of pollution. Some agency should work to establish a compensation regime for oil pollution from ships to guarantee financial support for cleanup operations and compensation for the victims of oil leaks. While promoting compulsory insurance against oil pollution from ships, the administration may plan to set up a fund by levying a charge on ship owners and cargo consignors as they should take responsibility for oil pollution and compensating the victims of oil spills. The oil pollution fund is to be set up as soon as the draft of the legal document is put forward for approval by the authority. However, at the moment, the economic burden of dealing with oil spills always falls on the government. Once there is an oil spill, efforts then have to be made to contain the damage and minimize the impact to the environment.

The trash and other waste that drifts around the global ocean and washes up on the nation's shores poses a serious threat to fishery resources, wildlife and habitat, as well as human health and safety. Marine debris is difficult to address because it comes from a wide variety of sources, both on and off the shore. While marine debris is a global problem requiring international cooperation, many of its negative impacts are experienced at the local level and require local involvement. Because of its role as the nation's lead ocean agency, re-establishing a marine debris program would help address the range of issues associated with marine debris, as would better coordination at all scales- international, national, state and local. Greater commitment to public education and outreach, partnerships with local governments, communities and industry and enhanced research, monitoring and source identification will also help reduce marine debris.

Clearly, the problems associated with water pollution have the capabilities to disrupt life on our planet to a great extent. But the government alone cannot solve the entire problem. It is ultimately up to us, to be informed, responsible and involved when it comes to the problems we face with our water. We must become familiar with our local water

resources and learn about ways for disposing harmful household wastes so they don't end up in sewage treatment plants that can't handle them or landfills not designed to receive hazardous materials. In our yards, we must determine whether additional nutrients are needed before fertilizers are applied and look for alternatives where fertilizers might run off into surface waters. We have to preserve existing trees and plant new trees and shrubs to help prevent soil erosion and promote infiltration of water into the soil. Around our houses, we must keep litter, pet waste, leaves and grass clippings out of gutters and storm drains. These are just a few of the many ways in which we, as humans, have the ability to combat water pollution. As we head into the 21st century, awareness and education will most assuredly continue to be the two most important ways to prevent water pollution. If these measures are not taken and water pollution continues, life on earth will suffer severely.

The oceans are the cradle of life on earth, the engines that govern our climate, the repository of a vast and diverse wildlife. They are an integral part of all our lives and their protection and preservation is our greatest challenge. Global environmental collapse is not inevitable. But the developed world must work with the developing world to ensure that new industrialized economies do not add to the world's environmental problems. Politicians must think of sustainable development rather than economic expansion. Conservation strategies have to become more widely accepted, and people must learn that energy use can be dramatically diminished without sacrificing comfort. In short, with the technology that currently exists, the years of global environmental mistreatment can begin to be reversed.

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Appendices

Action Plans relating to Coastal and Marine Environment of Bangladesh and their Implementing Agencies

Action	Implementing Agencies
A special cell should be constituted in the Ministry of Environment and Forest to coordinate and supervise all activities related to the protection and development of the coastal and marine environment.	-Ministry of Environment and Forest -Department of Forest -Department of Environment -Forest Research Institute
Newly accreted lands should be handed over to the Department of Forest in order to conserve these lands under forestation programs.	-Ministry of Land -Department of Forest
Guarding against any incident of pollution within territorial waters by Bangladesh Navy.	-Ministry of Defense -Bangladesh Navy -Ministry of Port Shipping and Inland Water Transport -Department of Shipping
In order to control marine pollution due to any accident of water transport there should be local and national contingency plans and finance and it has to be coordinated on a regional basis.	-Ministry of Port, Shipping and Inland Water Transport -Ministry of Defense -Bangladesh Navy -Marine Transport Department
Environmentally sound facilities should be developed for transportation of wastes from ships and unloading and disposal of waste oil, bilges and other related wastes in Chittagong and Mogla ports on an emergency basis.	-Ministry of Port Shipping and Inland Water Transport
A special cell should be created in the Ministry of Shipping and Inland Water Transport to determine the composition, nature and environmental impact of wastes prior to dumping in the sea.	-Ministry of Port Shipping and Inland Water Transport -Department of Environment
Creation of a contingent of Coast Guard on an emergency basis under the Ministry of Shipping and Land Water Transport to help interalia environmental management and security of the coastal marine areas and resources.	-Ministry of Port Shipping and Inland Water Transport
Appropriate measures should be taken in order to: protect from marine pollution, protection of coastal and marine environment, monitoring and conservation of newly accreted lands and rational use of all coastal resources.	-Ministry of Defense -Bangladesh Navy -Ministry of Port Shipping and Inland Water Transport -Department of Shipping -Department of Forest -Space Research and Remote Sensing Organisation (SPARRSO)

Greetings! I am conducting a research on **A STUDY ON COASTAL WATER POLLUTION OF BANGLADESH IN THE BAY OF BENGAL** in our coastal area and require to conduct interviews with households and coastal habitants to know about your concern on pollution. This research is solely for academic reasons and all your responses will remain confidential. I shall try best to share the results of the research with you once completed. I shall be extremely grateful if you agree to collaborate with me and give some of your time to answer a set of questions I have. Thank you for your time and eagerly hope for your cooperation.

POST GRADUATE PROGRAM IN DISASTER MANAGEMENT
BRAC UNIVERSITY
Questionnaire for Coastal Inhabitants
A Study on Coastal Water Pollution of Bangladesh in the Bay Of Bengal
(Only use for academic purposes)

Date: _____

1. Serial No : _____
2. Name of the interviewer : _____
3. Date of interview : _____

A. General Information

1. Name of the respondent : _____
2. Address : _____
3. How long did you stay in any of the coastal area of Bangladesh?
☐ < 6 months
☐ > 6 months
☐ > 1 year but < 2 years
☐ 2-3 years
☐ 3-5 years
☐ Over 5 years
 4. Ideographic information of the Coastal Inhabitants :

Age	Education	Occupation	Earnings	Family members

Education	Occupation	Earnings
1. Illiterate	1. Farmer	1. Less than Tk 100.00 per day
2. Primary	2. Fisherman	2. Tk 100.00 – 150.00 per day
3. Secondary	3. Shrimp Cultivator	3. Tk 150.00 – 200.00 per day
4. Graduate	4. Landless Farmer	4. Tk 200.00 – 250.00 per day
5. Others	5. Employee	5. Tk 250.00 – 500.00 per day
	6. Business	6. More than 500.00 per day
	7. Others	

B. Socio-economic Information

1. How many times did you find oil layer in the seawater at the Outer Anchorage, Port Channel, Kutubdia, Cox's Bazar, Sandwi, and other coastal belts following the oil spillage by the vessels?

- ☐ Never
- ☐ Only once
- ☐ 2-3 times
- ☐ 4-5 times
- ☐ 5-10 times
- ☐ More than times

2. Waste disposal pattern found onboard last boarded:

- ☐ Shooters
- ☐ Disposable tanks/container
- ☐ Recyclable bags
- ☐ Directly throwing to sea
- ☐ Open space/basket
- ☐ Others

3. Type of Toilet used onboard ever boarded:

- ☐ Sanitary
- ☐ Open to sea
- ☐ No Toilet
- ☐ Others

4. What are the effects of coastal water pollution on human health you have ever experienced or heard from your friend?

- ☐ Eye irritation
- ☐ Nose and throat irritation
- ☐ Irritation of the respiratory track
- ☐ Gases like hydrogen sulphide, ammonia and mercaptans caused odour nuisance even at low concentrations.
- ☐ Initiation of asthmatic attacks by a variety of particulates particularly pollens.
- ☐ Chronic pulmonary diseases like bronchitis and asthma, aggravated by a high concentration of sulphur di-oxide, nitrogen oxides.
- ☐ Causing of cancer by carcinogenic agents

5. Did you find any fisherman dumping the discarded fishes in the Bay

- ☐ Yes
- ☐ No

6. Due to bathing in the sewage polluted water upstream did you ever suffer from any respiratory and intestinal diseases and infections?

- ☐ Yes
- ☐ No

C. Pollution abatement

1. Do you find anybody to take any preventive measure to control pollution?

- ☐ Yes
- ☐ No
- ☐ Did not notice

2. What are the measures you can take to control sea water pollution from wastage?

- ☐ Safe disposal
- ☐ Treat for Discharge
- ☐ Recover energy value in waste
- ☐ Re-cycle
- ☐ Segregate and Reuse
- ☐ Minimize introduction
- ☐ Use of big slush tank
- ☐ Minimize Generation

3. What are the effects you noticed due to sea water pollution?

- ☐ Causing marine lives including fish and Barnacles
- ☐ Salinity increase
- ☐ Impact on human health
- ☐ Bio-diversity problem
- ☐ Sea water temperature rising

4. Do you think that we have clear national standards for abatement of marine pollution, specially from chronic point and nonpoint sources?

- ☐ Yes
- ☐ No

5. If not, what default strategy is needed?

- ☐ Introducing new laws
- ☐ Strict implementation of existing laws
- ☐ Complying UNCLOS

6 Why is the timeline for pollution abatement so long?

It is a

- ☐ Primarily financial issue
- ☐ Technical problem
- ☐ Primarily political
- ☐ Others

7. Do you think that it is possible to improve recreational boater, passenger ferry, cruise, fishing and shipping infrastructure to minimize point and non-point sources of pollution?

- ☐ Yes
- ☐ No

8. Is there any impacts of trans-boundary movements of pollutants on coastal waters and the marine environment?

- ☐ Yes
- ☐ No

POST GRADUATE PROGRAM IN DISASTER MANAGEMENT
BRAC UNIVERSITY
Questionnaire for Officials
A Study on Coastal Water Pollution of Bangladesh in the Bay Of Bengal

(Only use for academic purposes)

Date:

A. General Information

1. Name of the respondent :
2. Designation :
3. Address/Organisation :
4. Type of Organisation :
 - ☐ Government
 - ☐ Semi-government
 - ☐ NGOs
 - ☐ International Organisation
 - ☐ Others
5. Status of Organisation:
 - ☐ National
 - ☐ Regional
 - ☐ Local
 - ☐ Others

B. Prevention

1. Do you take any preventive measure to control coastal water pollution of our Bay of Bengal?

- ☐ Yes
- ☐ No

2. If yes, what type of measures?

Structural measures

.....

.....

Non-structural measure

.....

.....

3. How do you do that?

- ☐ Through the workers of your organisation
- ☐ Through the workers of other organisation
- ☐ Coordination with government
- ☐ By helping International agencies
- ☐ Others

4. Are there any rules and regulations initiated by your organization as preventive measures?

- ☐ Yes
- ☐ No

5. If yes, mention the rules and regulation.

.....

.....

6. What do you prefer to reduce point and nonpoint source of pollution

- ☐ A technological approach which is expensive and requires extensive engineering
- ☐ Implementing strict laws and regulations on ocean users which is cheaper but more bureaucratic

7. With regard to the marine environment, which pollutants, or types of pollutants, should be of greatest concern to the nation?

- ☐ Point source
- ☐ Nonpoint source
- ☐ Nutrients
- ☐ Atmospheric deposition

8. Do you agree that the incoming vessels are randomly dumping wastes in the Bay of Bengal due to lack of 'recycling facility' at the Chittagong Port which cause serious marine pollution.

- ☐ Yes
- ☐ No

9. What are the different sources polluting our coastal water?

1	2	3	4	5	6	7	8	9	10

Industrial wastes	Municipal wastes from coastal cities	Agro-chemical residues	Oil spills	Surface runoff and sediment flux	Pollutant discharge from ships and boats including bilge	Inorganic and organic carbon and associated sediment flux	Debris	Discarded fish	Others
A	B	C	D	E	F	G	H	I	J

10. Which out of the following bad impacts you noticed on human life and livelihood due to coastal water pollution?

- ☐ Change of landscape
- ☐ Deforestation
- ☐ Salinity
- ☐ Migration of population
- ☐ Acid rain
- ☐ Greenhouse gases and global warming
- ☐ Ozone depletion in stratosphere
- ☐ Smog and haze
- ☐ New kind of diseases and health hazards
- ☐ Radiation hazards
- ☐ Lead in air from the motor vessel exhaust (Using leaded gasoline)

C. Awareness Generation

1. Do you take any awareness generation programme to control pollution?

- ☐ Yes
- ☐ No

2. What are the reasons for not having such programme?

.....

3. What suggestions do you have to initiate such programmes in this study area?

.....
.....
.....

4. Is there any fine scale connections between human health and the sea water pollution?

- ☐ Yes
- ☐ No

5. If yes, then in what areas?

- ☐ Nutrition
- ☐ Pollution/contaminants
- ☐ Natural toxicants (e.g. shellfish poisoning)
- ☐ Natural product-derived pharmaceuticals
- ☐ Disease of both human and natural origin (e.g., hepatitis)
- ☐ Injury (e.g. bites, stings, cuts)

D. Community Participation

1. Does your organization involve community into pollution abatement planning?

- ☐ Yes
- ☐ No

2. If yes, then in what kinds of activities they involved?

.....
.....

Thank You