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A critical analysis of integrated coastal and ocean management in Bangladesh with lessons from global practices

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A CRITICAL ANALYSIS OF INTEGRATED COASTAL AND OCEAN MANAGEMENT IN BANGLADESH WITH LESSONS FROM GLOBAL PRACTICES

By

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Bangladesh

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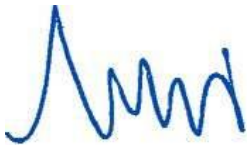
DECLARATION

I certify that all the material in this dissertation that is not my own has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

Signature: 

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ABSTRACT

Title of Dissertation: **A Critical Analysis of Integrated Coastal and Ocean Management in Bangladesh with Lessons from Global Practices**

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The coast of Bangladesh is highly dynamic, unique and diverse, the south-western part of which hosts the world's largest single mangrove forest; the south-central part receives the world's second largest river system (Ganges-Brahmaputra-Meghna system), contributing to form the world's largest delta in Bangladesh; and the south-eastern part provides room for major industrial and economic activities such as ports and shipping, ship recycling (2nd in global ranking), ship building, fisheries and tourism (Beaches in Cox's Bazar – the world's longest).

The earlier land-side coastal management initiatives, which totally ignore ocean issues, have failed to bring a remarkable outcome mainly due to the lack of coordination, weak monitoring and evaluation mechanisms and knowledge gap. After the settlement of maritime boundary disputes with Myanmar (2012) and India (2014), Bangladesh gained a maritime area of 118,813 sq km (about 81% of the country's land area), giving room to explore marine resources and expand ocean-based activities further towards the sea within national jurisdiction, for which the development of a comprehensive ocean governance framework and initiation of an MSP process is now being talked at the highest policy level.

Given the country's vulnerability to climate change and natural disasters that influence the lives and livelihood of the coastal community (28% of the country's total population), development initiatives in the coastal area must consider adequate resilient and adaptive measures and conservation of marine resources for long-term sustainability. Informed decisions based on scientific and traditional knowledge, and past experience, can help the decision making process regarding coastal and ocean management become more sustainable.

KEYWORDS: Coastal and ocean management, ICOM, informed decision, sustainable development, Ocean Health Index

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LIST OF ABBREVIATIONS

BOBLME	Bay of Bengal Large Marine Ecosystem
BFRI	Bangladesh Fisheries/Forests Research Institute
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CMPP	Coastal Management Policy Program
EEZ	Exclusive Economic Zone
FLMMA	Fiji's Locally Managed Marine Area Network
GBM	Ganges-Brahmaputra-Meghna
GDP	Gross Domestic Product
GEF	Global Environment Facility
GMAP	Gulf Maine Action Program
GNP	Gross National Product
ICG	Integrated Coastal Governance
IUCN	International Union for Conservation of Nature
LMEs	Large Marine Ecosystems
MDGs	Millennium Development Goals
MMO	Marine Management Organization

MSP	Marine Spatial Planning
OECD	Organization for Economic Co-operation and Development
OHI	Ocean Health Index
OWG	Open Working Group
PEMSEA	Partnership in Environmental Management for the Seas of East Asia
PDO	Program Development Office
POPs	Persistent Organic Compounds
SAP	Strategic Action Plan
SDGs	Sustainable Development Goals
SST	Sea Surface Temperature
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TCMP	Tanzania Coastal Management Program
TDA	Trans-boundary Diagnostic Analysis
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WARPO	Water Resource Planning Organization
WWF	World Wildlife Fund

1 INTRODUCTION

1.1 Background

Ocean and coastal ecosystems are of significant importance in maintaining ecological balance as well as providing human beings with manifold goods and ecosystem services. The ocean, which covers 70% of the surface of the earth and contains 97% of the planet's water (NOAA, 2015), is considered, as a whole, one system hosting the largest continuous ecosystem on earth, embracing all continents, climate zones and containing over 80% of the earth's biomass (Visbeck, 2013). About 40% of the world's population lives within 100 km of coastline (FAO, 2015), and globally 350 million jobs are directly linked to the coasts and the ocean (World Bank, 2012). One in every six jobs in the USA is marine-related and one-third of the country's GDP originates in coastal areas (NOAA, 2015). One billion people in developing countries depend on fish for their primary source of protein; and, globally capture fisheries and aquaculture harvest more than 400,000 tons of fish everyday (FAO, 2015).In addition to providing mankind with food, provisions, raw materials for different products and medicines, the ocean and coastal ecosystems contribute to regulating global climate, recreation, cultural activities and international trade. About 90% of global trade is carried by sea (IMO, 2015). According to the World Bank's figure, 61% of the world's total GNP originates within 100 km of coastal areas, and 54 coastal and island countries, the majority of which belong to developing nations, count two-thirds of their national territory as oceans (World Bank, 2015). But increased pollution, overfishing and unplanned urbanization and coastal development activities have put the marine ecosystems under threat. Initially sectoral management initiatives were taken as effective management tools for coastal and ocean management but failed to resolve conflicts among different uses of coasts and ocean. After the Rio Declaration in 1992, the ICM (Integrated Coastal Management) concept got its popular shape within different coastal nations of the world (Cicin-Sain & Knecht,

1998). The USA first introduced an ICM approach for its coastal areas management (Marine Law and Ocean Policy Centre, 2007). Other nations followed the USA later on.

In Bangladesh, an ICZM (Integrated Coastal Zone Management) process started through the establishment of a Program Development Office (PDO) in 2001, placed at WARPO (Water Resource Planning Organization) of the Ministry of Water Resources. It produced three main components- a Coastal Zone Policy (2005), a Coastal Development Strategy (2006) and a Priority Investment Program (2006), the objectives of which were economic growth, meeting basic needs, reduction of vulnerabilities, sustainable management and equitable distribution of resources, gender equality and empowerment of women, and preservation and enhancement of critical ecosystems (Iftekhar, 2006). Accordingly, the country developed the National Land-use Policy (2001), National Shrimp Policy (2014) based on the principles of Fish Policy (1998), and a Disaster Risk Reduction Strategy (2008) among others. All of these policies and strategies became dormant with few successes in some areas especially with disaster risk reduction. The country has a 710 km long coastline facing the Bay of Bengal to the south (Deb, 1998); the south-western part of which encompasses the world's largest single intact mangrove forest; the south-central part receives the Ganges-Brahmaputra-Meghna (GBM) river system which forms the world's second largest hydrological region/ delta in this area, and the south-eastern part hosts the 2nd ranked ship recycling industry in the world as well as natural sandy beaches which are ranked as the longest in the world (Rahman & Rahman, 2015).The country is extremely disaster-prone and vulnerable to climate change impacts. More than 35 million coastal people (Iftekhar, 2006) and their livelihoods are under threat of climate change impacts together with different human-induced phenomena such as pollution, unsustainable harvesting of fisheries, unplanned urbanization and industrialization. Export-oriented garment industries are booming in the country, which has created huge employment opportunities for the poor and contributed significantly to the national economy. In line with the economic growth and

the expansion of trade and commerce/export-import, the country now has plans to develop a number of ports, one of which will be a deep-sea port (The Hinu Report, 2015). Fishing in the deep sea and oil and gas exploration and extraction activities are also listed as priority areas in the national plan. There is no doubt that the marine ecosystem will be under tremendous pressure and degraded if a holistic, more comprehensive and integrated coastal and ocean management policy is not adopted and implemented accordingly. The coastal people have experienced the negative impacts of intrusion of saline water for brackish water shrimp farming which has destroyed the agricultural land. Bangladesh is likely to face a number of coastal and ocean issues in the near future as its coastal and ocean-based economic activities grow further. This research paper investigates the major emerging coastal and ocean issues in Bangladesh and their current management approach with drawbacks, and seeks prescriptions from the countries' and regional initiatives which have been described as good practices in the published literature in handling coastal and ocean issues of a similar nature to those Bangladesh is currently facing or, is expected to face in the future.

The rest of this chapter will describe the objectives of the study, methodology, rationale of the study and its scope and limitations. The second chapter is based on a literature review on ICOM background, the need for ICOM, evolution of ICOM, global principles, guidelines and strategies, different stages, and indicators used to monitor and evaluate the ICOM process. The third chapter draws lessons from best ICOM practices around the world, particularly those most relevant to Bangladesh. The experience of two countries (China for coastal development, The Netherlands for Delta management) and one regional initiative (BOBLME) are also reviewed and analyzed. The fourth chapter describes the study area (Coastal area of Bangladesh, ecological features, institutional setting and instruments). On the basis of materials provided in chapter three and four, the fifth chapter includes a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis on coastal and ocean management in Bangladesh based on a set of

governance, ecological, socio-economic criteria and the Ocean Health Index (OHI). The sixth and last chapter makes recommendations based on the analysis made in chapter five, with future prescriptions outlined in the conclusion.

1.2 Objectives

The main purpose of this study is to evaluate the extent to which the current coastal and ocean management strategies of Bangladesh are effective enough to address current and emerging coastal and ocean issues. The study was carried out based on the following sub-objectives:

i)To investigate and evaluate current coastal and ocean management policies, plans and strategies of the country;

ii) To study emerging coastal and ocean issues with their opportunities and challenges; and

iii) To introduce best coastal and ocean management practices from around the world for improved management and sustainable development of coastal and ocean uses of the country.

1.3 Methodology

This research gathered both qualitative and quantitative data from international data bases, peer-reviewed journals, books, institutions and organizations, and online publications. Personal contact was also made with selected persons working in the related fields and organizations and having expertise in this area, to verify the data available as secondary sources. The current and proposed coastal and ocean management plans, policies and strategies, together with emerging issues of Bangladesh, are reviewed. The best integrated coastal and ocean management initiatives of different countries and regions as established by literature and similar in nature with those

relevant to Bangladesh are drawn on as references. Thereafter, based on a set of government, socio-economic and ecological criteria, the current coastal and ocean management approach of Bangladesh will be analyzed and assessed.

A SWOT analysis was conducted to evaluate internal strengths and weaknesses of the current management approach, together with emerging external opportunities and threats to fit it to national plan to maximize the benefits therein. Data comparisons are made where the data allow.

1.4 Rationale of the study

Bangladesh is a densely populated developing coastal state facing a number of coastal, oceanic as well as environmental challenges along with possible future opportunities which requires proper implementation of a sustainable framework to maximize the benefits and minimize the threats more effectively. The coastal area of the country is highly dynamic; the world's largest mangroves – the Sundarbans (Afroz & Alam, 2013), the second largest hydrological region/delta of the world in this area and other ecological and geo-morphological features have made this coast unique in the world (Hossain, 2001). Once, the Sundarbans, which is now at risk, was very rich in species diversity providing coastal people with numerous tangible and intangible benefits. Land-based sources of pollution, marine pollution, lack of knowledge and coordination, unsustainable harvesting of fishes, brackish water shrimp farming and weak management practices and development activities are deteriorating the marine environment, and it is likely to increase further. The lack of inter-sectoral coordination, as well as regional cooperation, has failed to bring successful solutions to address the coastal and transboundary issues the country faces. In addition, the current plans of the government on development activities in coastal and deep ocean areas such as deep sea port development, oil and gas exploration activities, and ecotourism will lead to huge pressure on the marine environment. Hence, research on improved management for

emerging coastal and ocean issues, with possible future challenges and opportunities, is quite realistic and indispensable for finding sustainable solutions to be consistent with the post-2015 sustainable development agenda.

1.5 Scope and limitations of the study

The study was carried out based on available secondary data. Considering time constraints, the study investigated major coastal and ocean issues of the country with their possible solutions, drawing a few references from the countries and regions of the world. Lack of baseline and updated recent country data is another factor limiting the research work. Aggregated sectoral data may lead to confusion, the quantitative data lack accuracy and validity. Thus, the presentation is made in a qualitative manner, in absence of quantifiable data.

2 COASTAL AND OCEAN MANAGEMENT: GLOBAL CONCEPTS AND PRACTICES

2.1 Background

In the past, particularly before the twentieth century, ocean uses were limited to navigation and fishing, and hence, conflicts among different uses of the ocean and coast were few and far between. Single-sector management approaches gained wide acceptance as an effective management tools for coastal and marine resource management. But, with the increase of multiple uses of ocean and coastal resources, conflicts among different uses of the ocean tend to arise and the single-sector management approach proves as no longer an effective management tool to bring satisfactory results (Cicin-Sain & Knecht, 1998).The idea of better and comprehensive coastal management practices with several names and acronyms, started to develop. The USA, known as a pioneer in coastal management, for the first time used the term Coastal Zone Management (CZM) in its Coastal Zone Management Act, 1972 (Sorensen, 1993). In developing countries, the concept was developed as Integrated Coastal Area Management (ICAM) and was mainly focused on specific coastal areas. Later on, it was internationally recognized as Integrated Coastal Zone Management (ICZM) or simply Integrated Coastal Management (ICM).

Traditionally, coastal management began on the land side of the coastal zone and focused on the issues related to the interface between the land and the sea, and the scope of management was limited within a few nautical miles from the coastline towards the sea, i.e., limited to the territorial sea. Ocean management issues, such as extension of the EEZ and delimitation of maritime boundaries of a country with other nations were dealt with separately by separate entities, particularly by ministries of foreign affairs, naval departments or special maritime wings. As people started to move to the coastal areas, pressure on coastal areas started to increase, which triggered massive exploration and

exploitation of marine resources. Nations such as the USA, and South Korea started thinking about managing both the coast and ocean together. Many countries in the world, including Bangladesh, now consider Integrated Coastal and Ocean Management (ICOM), which brings ocean and coastal issues under same umbrella, to be addressed and managed sustainably. However, ICM, ICZM, ICOM almost serve the same purpose in different countries and regions, albeit their names vary. ICM/ICZM/ICOM is not a "one size fits all" concept; it must be tailored to meet each nation's unique situation (Cicin-Sain & Knecht, 1998).

2.2 Integrated Coastal and Ocean Management (ICOM)

ICOM is an approach to manage not only coastal areas but exclusive economic zones and large marine ecosystems as well, serving the purposes of national ocean policies (Belfiore et al., 2006). From the mid-1960s to the end of twentieth century, about 700 ICOM initiatives were taken in more than 140 countries; but almost half of these initiatives were not fully implemented, mainly due to the lack of improved monitoring and evaluation mechanisms (Sorensen, 2002).

Coastal and ocean areas usually involve multiple users, various government agencies at different levels (e.g., national, provincial, local) and, in the case of shared seas, interactions with other nations. In addition, these areas are affected by both land and freshwater issues, which implies the application of knowledge from various disciplines in their management (Cicin-Sain and Knecht,1998). Thus ICOM implies integration within five different dimensions: intersectoral integration, intergovernmental integration, spatial integration, science-management integration and international integration (Cicin-Sain and Knecht, 1998).Chua (1993) described three broad categories of integration– system integration, functional integration, and policy integration. Figure 1 shows how system, function and policy can be integrated for coastal management.

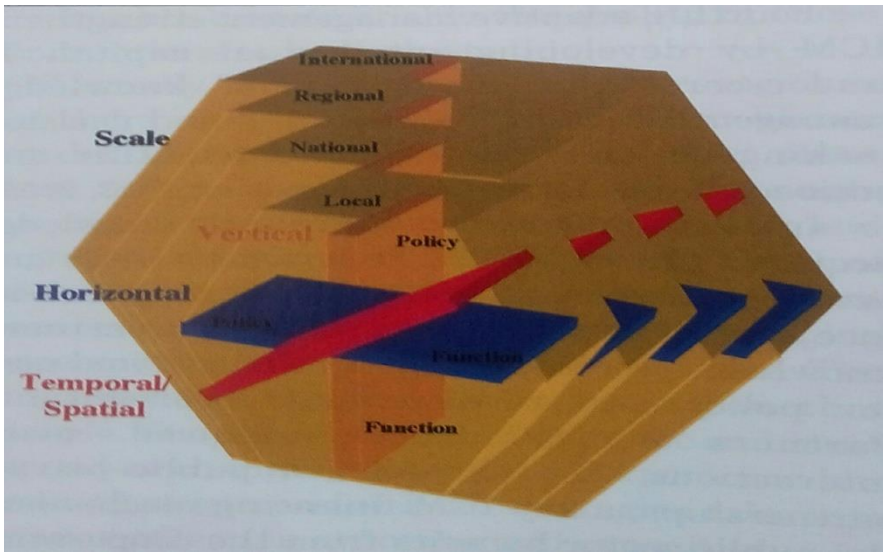


Figure 1: Dimensions of integration and coordination in coastal management
(Source: PEMSEA, 2006)

2.2.1 Goals and Functions of ICOM

Sustainable development is the overarching principle of ICOM. Agenda 21, one of the five output documents of the United Nations Conference on Environment and Development (UNCED), called for integrated management and sustainable development of coastal and marine areas, including Exclusive Economic Zones (Cicin-Sain and Knecht, 1998). It aims at: i) achieving sustainability in coastal and marine areas, ii) reducing vulnerability of coastal areas and coastal communities to natural hazards, and iii) maintaining essential ecological processes, life support systems, and biodiversity in coastal and marine areas (Cicin-Sain and Knecht, 1998).Table 1 shows the major functions of ICOM under its different goals:

Goals	**Functions**
Area Planning	i. Plan for present and future uses of coastal and ocean areas; ii. Provide a long-term vision

Promotion of Economic Development	i. Promote appropriate uses of coastal and ocean areas such as marine aquaculture, ecotourism
Stewardship of Resources	i. Protect the ecological base of coastal and ocean areas; ii. Preserve biodiversity; and iii. Ensure sustainability of use
Conflict Resolution	i. Harmonize and balance existing and potential uses; ii. Address conflicts among coastal and ocean uses
Protection of Public Safety	i. Protect public safety in coastal ocean areas typically prone to significant natural, as well as human-induced, hazards
Proprietorship of Public Submerged Lands and Waters	i. As governments are often outright owners of specific coastal and ocean areas, manage government-held areas and resources wisely and with good economic returns to the public

Table 1: Goals and Functions of ICOM
(Source: Belfiore et al., 2006)

2.2.2 Resources and activities managed under ICOM

Vallega (1996) presents an overview of different models of coastal and ocean uses developed by different authors (Annex-1), in which some authors emphasize the water side of coastal and ocean uses while others focus on the land side. Cicin-Sain and Knecht claim that these models exclude non-consumptive uses of the marine environment and its resources. They provide a revised comprehensive list of major uses

and activities of the coastal zone and ocean (Annex-2) under 10 broad categories- Navigation and Communication, Living Marine Resources, Mineral and Energy Resources, Tourism and Recreation, Coastal Infrastructure Development, Waste Disposal and Pollution Prevention, Ocean and Coastal Environmental Quality Protection, Beach and Shoreline Management, Military Activities, and Research (Cicin-Sain and Knecht, 1998). However, coastal and marine resources and activities are diverse and vary from country to country and region to region. ICOM considers all these uses of the coast and ocean and activities under its 5 broad goals as enumerated in Table 1.

2.2.3 Capacity, Institutions and Authority needed for ICOM

To carry out an ICOM program successfully, various kinds of capacity are needed. These are: i) Legal and administrative capacity for designating a coastal zone, developing and carrying out coastal plans, and for regulating development in vulnerable coastal zones, ii) Financial capacity, required for carrying out the planning and implementation of coastal management efforts, iii) Technical capacity, needed for gathering information and monitoring coastal and marine ecosystems and processes through establishment and maintenance of a coastal database and information system, and iv) Human resources capacity with personnel from different interrelated specializations for effective management (Belfiore et al., 2006).

A proper institutional mechanism is required in the ICOM process to harmonize the various activities and programs that affect the coastal and ocean areas and their resources. The success of ICOM process depends on the proper functioning of the institutional mechanism. Agenda 21 emphasizes the establishment of coordinating mechanism and strengthening it by creating national oceanographic commission to catalyze and coordinate needed research (Cicin-Sain & Knecht, 2009). Cicin-Sain and Knecht (1998) mentioned four major attributes for such an institutional mechanism. These are: i) There must be appropriate authoritative power i.e. the institution must be

empowered with legal/legislative authority, ii) It must be able to affect the activities of other decision-making bodies of the government at different levels linked to related fields, iii) It must be seen as legitimate and an appropriate part of the whole process, iv) It must be capable of making informed decisions, i.e. it must have access to appropriate scientific and technical expertise and data.

The authority of a coastal management entity at higher bureaucratic levels for harmonizing sectoral actions, adequate financing and staffing, and the integration of coastal management plans into the national development planning,- help to enhance the effectiveness of the coastal management process.

2.2.4 Principles and International Guidelines of ICOM

The UN Convention on the Law of the Sea (UNCLOS), 1982 which came into force in 1994, is considered as the constitution of the ocean that founded a new regime for the governance of the oceans of the world (Koh, 1983). The 1992 UN Conference on Environment and Development emphasized emerging environmental and development issues for which it produced five important output documents: the Rio Declaration on Environment and Development, a set of 27 principles which guides national and international actions, the Statement of Forest Principles, Agenda 21, particularly chapter 17 which calls for the sustainable development of oceans and coasts, the UN Framework Convention on Climate Change (UNFCCC), and the Convention on Biological Diversity. The World Summit on Sustainable Development (WSSD), 2002 reviewed the progress since 1992 and called for further actions to implement Agenda 21 which led to the Millennium Development Goals (MDGs). Then the Rio+20 Conference, held in 2012 in Rio de Janeiro, Brazil, called for the formulation of a set of Sustainable Development Goals (SDGs) for the post-2015 period, and accordingly an Open Working Group (OWG) was formed to carry out the major tasks. Final intergovernmental negotiations on SDGs ended on 31 July, 2015. A total of 17 goals, 169 targets and 100 indicators proposed to be adopted by the UN Member States at a conference in

September, 2015 at UN Headquarters, New York (IISD, 2015). Although several goals of SDGs are linked to coastal areas and ocean sustainability, the fourteenth SDG is directly related to ocean sustainability, which emphasizes conservation and sustainable use of ocean, seas and marine resources for ensuring sustainable development.

The principles of UNCLOS, and the Rio Declaration, especially Agenda 21-chapter 17, provide a legal basis for coastal and marine resources management (Cicin-Sain and Knecht, 1998). However, some issues related to coastal and ocean management were left unsettled by UNCLOS. UNCLOS is silent on issues such as guidance to nations on how to govern ocean resources in an integrated manner, how to deal with the effects of one use on other uses, how to bring ocean and coastal management together, and conflicts among uses. PEMSEA recognizes all related international instruments (Figure 2) together as a standard for managing the marine environment, which provides an overarching integrated framework for the protection of marine environments and resources (Thia-Eng, 2006).

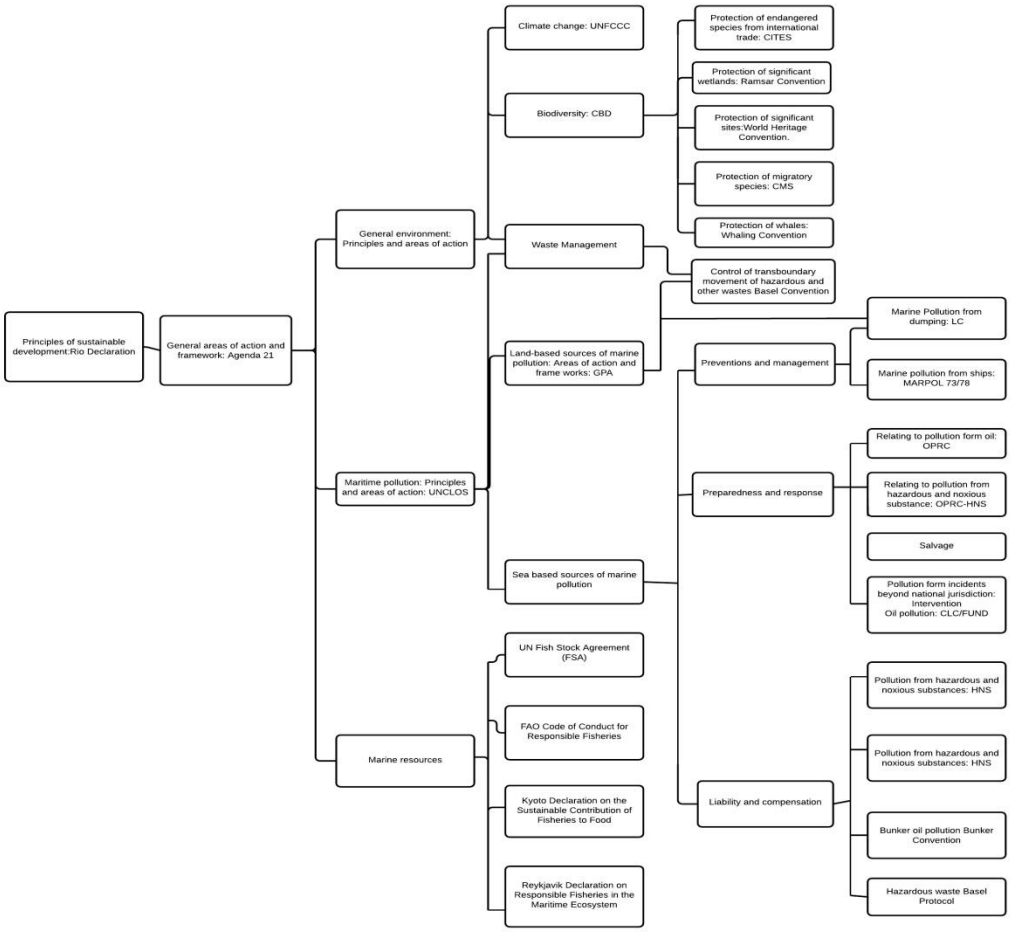


Figure 2: International Conventions in an integrated implementation framework
(Source: PEMSEA, 2006)

2.2.4.1 ICOM Principles

Integrated coastal and ocean management involves principles (both substantive and procedural), a management strategy, and particular approaches, methods and techniques (Cicin-Sain and Knecht, 1998). It has two broad categories of guiding principles: principles related to environment and development that have originated from the Earth Summit, and principles related to the special character of oceans and coasts (Cicin-Sain and Knecht, 1998; Sorensen, 2002). Sustainable development is the ultimate goal of coastal and ocean management (Belfiore et al., 2006). Putting sustainable development at the apex, substantive and procedural principles of coastal and ocean management can be arranged in hierarchical conceptual tiers (Figure 3). The second tier of the conceptual framework represents the fundamental principles, followed by substantive principles, while the lowest level tier indicates the procedural principles. These fundamental principles are the broad-based approaches that underpin sustainable development. The substantive principles are strategies that flesh out the fundamental principles, while procedural principles direct operational tools (Thia-Eng, 2006).

Figure 3: Conceptual Framework of ICOM Principles arranged in hierarchical tiers
(Sorce: PEMSEA, 2006)

2.2.4.2 International Guidelines on coast and ocean management

There are several sets of global prescriptions/guidelines for ICOM as developed by different international bodies such as the World Bank, UNEP, OECD, IUCN and the World Coast Conference. Cicin-Sain and Knecht (1998) compared these five sets of guidelines under ten variables and summarized under them four criteria which are shown in Table 2.

Principles of ICOM	The purpose of ICOM is to guide coastal area development in an ecologically sustainable fashion.
Principles	ICOM is guided by principles in the Rio Declaration on Environment and Development with special emphasis on the principle of intergenerational equity, the precautionary principle, and the "polluter pays" principle. ICOM is holistic and interdisciplinary in nature, especially with regard to science and policy.
Functions	ICOM strengthens and harmonizes sectoral management in the coastal zone. It preserves and protects the productivity and biological diversity of coastal ecosystems and maintains amenity values. ICOM promotes the rational economic development and sustainable utilization of coastal and ocean resources and facilitates conflict resolution in the coastal zone.
Spatial Integration	An ICOM program embraces all coastal and upland areaswhose use can affect coastal waters and the resources therein and extends seaward to include that part of the ocean that can affect the land of the coastal zone. An ICOM program also includes the entire ocean area under national jurisdiction (EEZ) over which national governments have stewardship responsibilities under both the UNCLOS and UNCED
Horizontal and Verical Integration	Overcoming the sectoral and intergovernmental fragmentation that exists in today's coastal management efforts is a prime goal of ICOM. Institutional mechanisms for effective coordination among various sector active in the coastal zone and among the various levels of government operating in the coastal zone are fundamental to the strengthening and rationalization of the coastal management

	process. From the variety of available options, the coordination and harmonization mechanism must be tailored to fit the unique aspects of each particular national government setting.
The Use of Science	Given the complexities and uncertainties that exist in the coastal zone, ICOM must be built on the best science (both natural and social) available. Techniques such as risk assessment, economic valuation, vulnerability assessment, resource accounting, cost-benefit analysis, and outcome-based monitoring should be built into the ICOM process, as appropriate

Table 2: ICOM Guideline in brief
(Source: Cicin-Sain and Knecht, 1998)

2.2.5 Stages of ICOM Process

The integrated coastal management policy goes through different stages of development. The guidelines prepared by the World Bank in 1993 outlined six stages of the ICOM process (World Bank, 1993). These stages are- issue identification and assessment, program planning and preparation, formal adoption and funding, implementation, operation, and evaluation (Figure 4). However, depending on the need and basis of physical, socio-economic, cultural and political aspects, various nations have developed their own forms of ICOM programs.

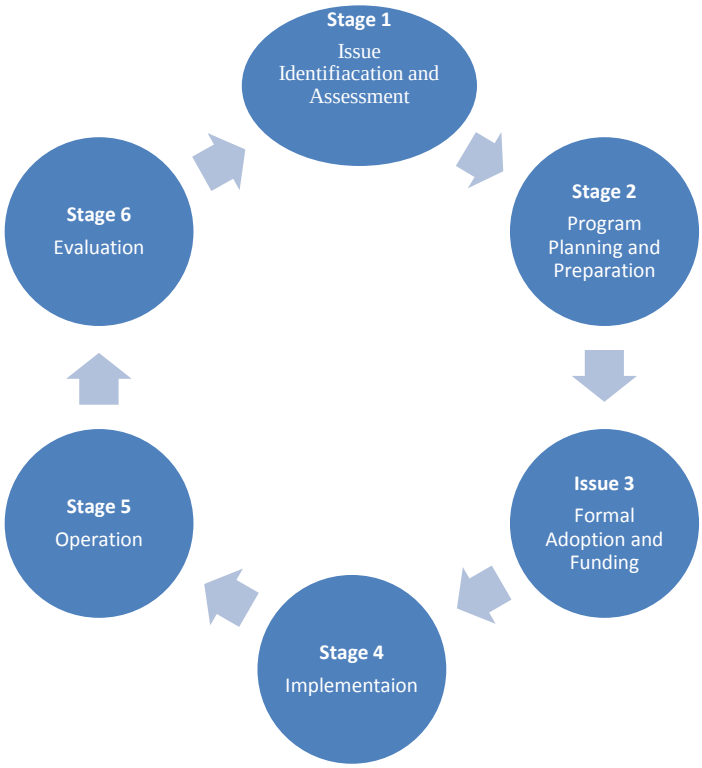


Figure 4: Different stages of an ICOM Process (Source: World Bank, 1993)

2.2.6 Indicators of ICOM

Indicators are quantitative/qualitative statements or measured/observed parameters that can be used to describe existing situations and measure changes or trends over time, the three main functions of which are simplification, quantification and communication (Belfiore et al., 2006). Lord Kelvin says, "You can't manage what you can't measure". Therefore, most international guidelines for ICOM call for the use of indicators to monitor the state of the coastal zone and assess the performance of ICOM efforts (Santoro, Lescrauwaet, Giraud, Lafitte, & Barbiere, 2013). Indicators play a significant role in monitoring and evaluating ICOM programs. But, there are no global standards or uniform indicators that judge the performance of ICOM programs. It varies from country to country, region to region, depending on socio-economic, cultural, ecological, political

and other aspects. In general, indicators can be divided into three broad categories- Governance indicators, Ecological indicators, and Socio-economic indicators, which respectively reflect three elements of ICOM (Belfiore et al., 2006).

Governance indicators measure the performance of program components as well as the progress and quality of interventions and of the ICOM governance process itself. Example- status of ICOM planning and implementation (Belfiore et al., 2006).

Ecological indicators measure trends in the state of the environment. They can be descriptive (when they describe the state of the environment in relation to a particular issue, e.g., eutrophication, loss of biodiversity or over-fishing) or performance indicators (when they compare actual conditions with targeted ecological conditions) (Belfiore et al., 2006).

Socioeconomic indicators reflect the state of the human component of coastal and marine ecosystems (e.g., economic activity) and help measure the extent to which ICOM is successful in managing human pressures in a way that results not only in an improved natural environment, but also in improved quality of life in coastal areas, as well as in sustainable socioeconomic benefits (Belfiore et al., 2006).

There are 15 governance indicators, 9 ecological indicators and 13 socioeconomic indicators as shown in the Table 3.

Governance Indicators	**Ecological Indicators**	**Socio-economic Indicators**
Coordination mechanism(G1)	Biological diversity (E1)	Total economic value (SE1)
Legislation (G2)	Distribution of species (E2)	Direct investment (SE2)
Environmental assessment(G3)	Abundance (E3)	Total employment (SE3)
Conflict resolution mechanism (G4)	Production and Reproduction (E4)	Sectoral diversification (SE4)

Integrated Management Plan (G5)	Tropic interactions (E5)	Human pressures on habitat (SE5)
Active management (G6)	Mortality (E6)	Pollution (SE6)
Monitoring and evaluation(G7)	Species health (E7)	Disease and illness (SE7)
Human, technical and financial resources (G8)	Water quality (E8)	Weather and disaster (SE8)
Inputs from scientific research (G9)	Habitat quality (E9)	Population dynamics (SE9)
Stakeholder participation (G10)		Marine dependency (SE10)
NGO &CBO activity(G11)		Public access (SE11)
Education and training (G12)		Cultural integrity (SE12)
Technology (G13)		Protection of coastal heritage resources (SE13)
Economic instrument (G14)		
Sustainable Development Strategy (G15)		

Table 3: ICOM Indicators (Belfiore et al., 2006)

For the purpose of this study, G1, G2, G4, G5, G7 to G13, E1, E8, E9, SE1, SE3, SE5, SE6, SE8, SE10, SE11-SE13 will come under consideration. The selection of indicators has been made considering priority issues for Bangladesh in terms of sustainable development.

2.3 Ocean Health Index (OHI)

A healthy ocean is fundamental to human well-being and an indispensable part of the Earth's life-support system. It sustains the species and the ecosystem upon which we

depend (Blue Ribbon Panel, 2013). The ocean is said to be healthier if we can derive maximum benefits from it by ensuring its sustainability and without jeopardizing the future health or function of the web of life that it contains.

The Ocean Health Index, started in 2012, is the first comprehensive global measurement of ocean ecosystem health that provides a useful framework and instrument to help us manage our oceans more thoughtfully and sustainably. It is a quantifiable assessment of the capacity of the ocean on how sustainably the ocean delivers the benefits and resources that people want and need from the ocean (http://www.oceanhealthindex.org/). The index assesses the ocean ecosystem on the basis of ten widely-held public goals, scoring from 0 to 100. It scientifically compares and combines biological, physical, economic and social dimensions of ocean health, aimed at providing an accurate snapshot of the health of the ocean controlled and managed by every coastal country and globally (Halpern et al., 2012). Table 4 shows the ten goals of OHI with a brief description.

Goals of OHI	**Description**
Food provision	-Divided into two sub-goals: i) Wild caught commercial sea food -evaluates the maximal wild fish harvests without hampering the productive capacity of the ocean for the future, and ii) Mariculture-supports food provision needs to be maintained over the long term through best practices
Artisanal Fishing opportunities	-Measures the scope of opportunities and access to small-scale fishing by artisanal fishers, who depend upon fishing for their lives and livelihoods.
Natural Products	-Measures how sustainably people harvest non-food products from the sea.

Carbon storage	-Measures carbon storage capacity of the natural coastal ecosystems. -Preservation of the coastal ecosystems (mangroves, sea grasses etc.) increases carbon storage capacity, while destroying these ecosystems, not only stop sequestering carbon, but also start to release carbon that triggers climate change.
Coastal protection	-Measures the condition and the extent of critical habitats such as mangroves, sea grasses, and corals, that protect the coastline from various natural disasters.
Coastal livelihoods and economics	-Divided into two sub-goals: Livelihoods and Economies -Evaluates the jobs and/or wages generated from ocean-based sectors such as fishing, tourism and recreation, ports and shipping, and their contribution to the national economy
Tourism and recreation	-Measures the proportion of the total labor engaged in the coastal tourism and travel sector
Sense of place	-Contains two sub-goals: i) Iconic species (green turtle, great white shark, humpback whale, polar bear), and ii) Protected places of cultural, spiritual and aesthetic importance -Measures the condition of iconic species and percent of coastlines protected and some of the intangible benefits the ocean provides us.
Clean water	-Measures pollution load
Biodiversity	-Measures how successfully the richness and variety of marine life is being maintained around the world

Table 4: Goals of Ocean Health Index (www.oceanhealthindex.org)

3 BEST COASTAL AND OCEAN MANAGEMENT PRACTICES: LESSONS FROM AROUND THE WORLD

3.1 Background

A review of coastal and ocean management practices around the world such as coast and delta management in the Netherlands, comprehensive coastal and ocean management policy in the USA, and ICM in China, indicates that there is no uniform or single coastal and ocean management recipe that suits all. After the UN Conference on Environment and Development in 1992, coastal area management gained its momentum, which led different coastal countries to test and adopt strategies that fit their unique developmental, environmental, social and political situations. Some countries emphasize specific issues, such as tourism development or shoreline erosion; others are most concerned about certain critical coastal ecosystems or large marine ecosystems, coastal and marine biodiversity conservation, placing a priority on establishing marine protected areas and no-take reserves (Hale & Robadue, 2002). As such, different models have been developed in different countries for coastal and ocean resources management; some have been successful, and some have not (Sorensen, 2002). No model incorporates all the elements underlying the ICOM concept nor successfully integrates political, functional, and ecosystem factors; and no model has achieved the level of integration and harmonization of decision-making required to achieve ICOM (Meltzer, 1998).This chapter draws lessons from some coastal and ocean management programs around the world, through an extensive literature review to evaluate the coastal and ocean management practice of Bangladesh.

3.2 Best coastal and ocean management initiatives around the world

There are diverse reasons for initiating coastal and ocean management programs around the world. The first coastal program was initiated in the USA in San Francisco Bay,

California through a voluntary state-led approach in which a set of principles and tools was proposed by the San Francisco Bay Conservation and Development Commission in 1965 (Ye et al., 2015), particularly to combat the Federal plans to fill up the bay to create new land and dispose of the municipal solid waste of Berkeley' city to the Bay (Meltzer, 1998). Among developing nations, Sri Lanka and Costa Rica were the early program innovators. Sri Lanka initiated its coastal management program to address coastal erosion to protect its two vital economic sectors- tourism and transportation infrastructure along the coast for which a successful initiative started with stopping illegal coral mining when it was found that the hard solutions were not adequate enough to address the problem (Sorensen, 2002). The earliest ICM program in China began in Xiamen in 1994 in which China coined its own coastal management mode, Integrated Coastal Governance (ICG) and the experience gained from Xiamen coastal management program is now being applied to other coastal programs (e.g. coastal programs in Dongying and Quanzhou) in China (Kong, Xue, Mao, Derrick Ngoran, & Yang, 2015). Ecuador began it coastal program when it observed declining productivity of its shrimp and mariculture industry and loss of mangroves due to unsustainable shrimp farming practices and urbanization (Meltzer, 1998).Thus, coastal management programs were initiated in different countries and regions depending on their unique situations and needs which reasonably vary from country to country and one region to another.

3.3 Eleven Focus Areas of ICOM

The three sets of ICOM indicators as discussed in the previous chapter, represent 11 focus areas (Table 5) which are the goals of ICOM, and the achievement of these goals represents the level of success of ICOM programs (Belfiore et al., 2006). However, no ICOM initiative in the world is said to be successful in achieving all these goals together. A few goals, drawing references from different countries and regions are described here, and the coast and delta management of the Netherlands, which Bangladesh has long followed and is still following today and the ICG concept of China

in coastal management, as Bangladesh needs to follow a developing nation. The BOBLME has been drawn as a regional initiative to which Bangladesh is a party, the strengthening of which means the betterment of the coastal and ocean management of Bangladesh

Indicators		Focus Areas/Dimensions/Goals
G	G1, G2, G3, G4	i)Institutional coordination and coherence
	G5, G6, G7, G8	ii) Quality and effectiveness of management
	G9, G10, G11, G12	iii) Improved knowledge, awareness and support
	G13, G14, G15	iv) Mainstreaming ICOM into sustainable development
E	E1, E2, E3	v) Biological organization of the ecosystem/ Biodiversity
	E4, E5, E6	vi) Vigor of the ecosystem/ Productivity of the ecosystem
	E7, E8, E9	vii) Abiotic properties (Geological, physical and chemical) of the ecosystem/ Oceanographic processes and quality of environment
SE	SE1, SE2, SE3, SE4	viii) Economic dimension
	SE5, SE6	ix) Environmental dimension
	SE7, SE8	x) Public health and safety dimension
	SE9, SE10, SE11, SE12	xi) Social dimension

Table 5: Focus areas/ Goals of ICOM (Source: Belfiore et al., 2006)

3.3.1 Institutional coordination and coherence

For effective ICOM, three main institutional approaches are used throughout the world:

i) Concentrate authority in a new centralized agency: For coordinating management efforts and development, Sri Lanka established a Coastal Conservation Department, the UK has a Marine Management Organization under its Marine and Coastal Access Act-2009, Japan has a Cabinet Council of Oceans under its Ocean Basic Law-2007 and the USA has created the National Ocean Council which is in charge of implementing national ocean policy within a single structure.

ii) Expand and enhance the duties of an existing agency: The Department of Environment in New Zealand has been given significant powers under the Resource Management Act-1991, and the Department of Environmental Affairs and Tourism of South Africa leads the coastal management programs (Ehler, 2003).

iii) Establish an inter-agency coordinating committee: The Netherlands has a very well established framework for inter-sectoral coordination at the national level. The government established a "harmonization policy" in 1984, which requires coordination of all Dutch ministries involved in North Sea matters. The government has established and institutionalized an inter-agency coordinating committee. In Ecuador, an inter-agency committee was established and placed at the highest level of government.

3.3.2 Quality and effectiveness of management

The Gulf of Maine Action Program (GMAP) is a unique, active, multilateral integrated management approach which brings river basins management and ocean uses of 5 jurisdictions (2 Canadian provinces and 3 USA states) together. The Chesapeake program and the Great Barrier Reef Authority have set good examples of reaching their goals by ensuring effective monitoring and evaluation mechanism. Regarding funding, Sri Lanka has a recurrent funding mechanism from national government and support with stable staff. Mexico gets its long-term funding mainly from different national sources, while Ecuador gets much of its funding from international donors (Ehler, 2003).

3.3.3 Improved knowledge, awareness and support

ICOM programs support and utilize applied research to make complex and dynamic coastal ecosystems more understandable, and to enable rational decision-making based on the application of the best available knowledge and technology to solve use and conservation problems (Hale & Robadue, 2002). In the UK, scientific monitoring data

are brought together and an integrated assessment is made and progress is evaluated, which helps to inform decisions (Safeguarding our seas, 2002). In Australia, the Coastal Management Policy Program (CMPP) follows a more holistic view and considers humans and nature as one system. Fiji's Locally Managed Marine Area Network (FLMMA), a community-governed network, guides national marine resource management (Hale & Robadue, 2002).

3.3.4 Mainstreaming ICOM into sustainable development

There must be a balance between development and conservation. The Philippines adopted ICM as a national strategy to ensure sustainable development of their coastal, marine environment and resources, with a supporting mechanism to implement it through Executive Order No.533 in 2006 (Safeguarding our seas, 2002) The integrated management plan of the Bahia de Santa Maria area of Mexico, that focuses on fisheries, freshwater inflows and bay circulation, helps define a balance between long-term economic growth and conservation. The guidelines prepared under the leadership of the Tanzania Coastal Management Program (TCMP) for mariculture and tourism development, promotes income-generating businesses while protecting the coastal environment. Proyek Pesisir, a national program in Indonesia based on the experience of Ecuador, has worked well in a village of Sumatra island to improve economic and environmental stewardship (IUCN, 2010).

3.3.5 Biodiversity and Productivity of ecosystem

The Convention on Biological Diversity (CBD) calls for implementing an ecosystem-based management approach (Hale & Robadue, 2002). Germany, Denmark and Netherlands share the Wadden Sea, which is a highly productive ecosystem enriched with biodiversity. Through establishing the Wadden Sea Common Secretariat, these three countries have set a good example for conservation of biodiversity, and habitats of 10-12 million birds passing over the area (Belfiore, 2006). Coral reef conservation in

Phuket Island, Thailand is also a successful initiative that has helped improve ecosystem health.

3.4 Integrated Coastal Governance (ICG) – an adaptive ICOM practice in China

China decided to initiate an integrated coastal management program in the 1990s, to address environmental and management challenges in coastal areas, and accordingly implemented its first CM program in 1994 in Xiamen in the name of ICG-an adaptive ICOM with Chinese characteristics. Now 12% of China's coastline has come under an ICM governance framework (Ye et al., 2015).The experience of the last two decades' coastal and ocean management programs shows that local government-based ICM, with active participation of all stakeholders, is a suitable integrated coastal and ocean management approach for China (Kong et al., 2015).There were two reasons behind the development of ICG concept in China. They were, firstly, the strong capacity of the government against the weak capacity of NGOs. NGOs or non-profit organizations are not very active in China due to the lack of financial support and public interests. The second reason was operational management boundary; China implements an adaptive ICM program within an operational and controlled management boundary. The Central Government exercises a centralized administration all over the country, but local government is authorized to formulate, implement and evaluate its own sets of coastal and ocean-related programs. The dual leadership system works in coastal and ocean governance of China, what they call Tiao-kuai mode (Figure 5); Tiao means vertical administrative structure while kuai means horizontal administrative structure.

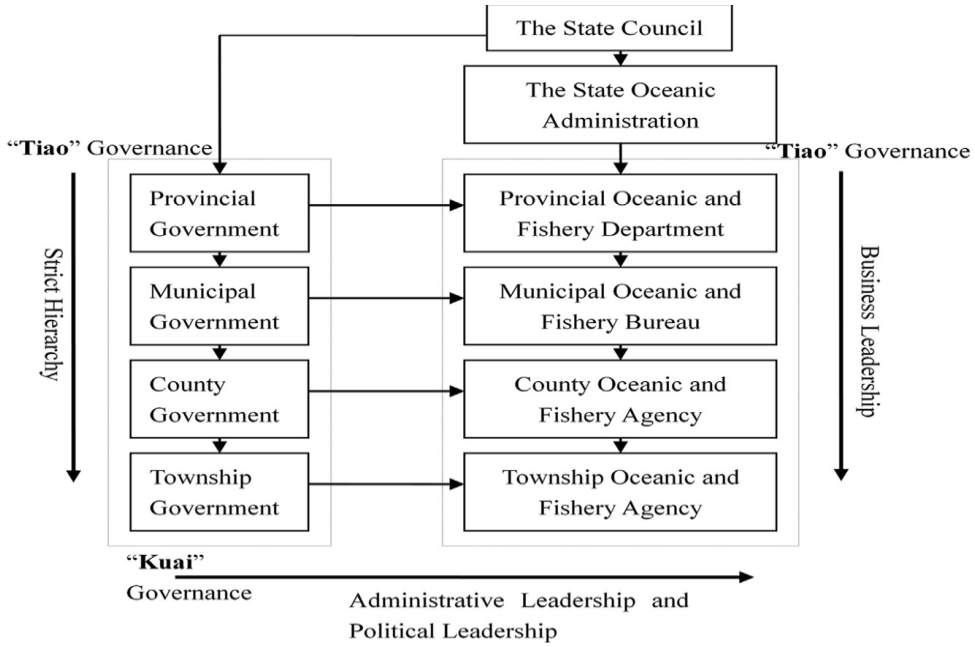


Figure 5: Dual Leadership System in Ocean and Coastal Governance in China
(Source: Kong et al., 2015

To date, nearly 20 coastal cities in 9 coastal provinces of China have adopted integrated coastal management programs in continuing cooperation with GEF/UNDP/IMO Regional Program and PEMSEA (Partnerships in Environmental Management for the Seas of East Asia). A recent 9-year (2004-2012) comparative study of coastal programs of three coastal cities of China (Xiamen, Quanzhou and Dongying) shows that the ICG approach is working well. Out of its own sets of 12 governance indicators for evaluation of governance performance of these three programs, Xiamen shows improvement in almost all indicators except coordination mechanism (G1), and resources allocation and funding (G8), while the scores of the other two cities show improvement of 11 indicators except funding. Coming to the ecological index, Dongying had the highest annual growth rate while Xiamen had the lowest. In Xiamen, water quality (E8) declined, E1 was unchanged and E2, E3 increased. For Quanzhou, water quality (E8) showed fluctuation, E1 and E5 remained unchanged and others increased. For Dongying, five indicators increased, except biological diversity. In the case of the socio-economic

index, population density, income, GDP, fisheries resources exploitation, port and tourism development-all showed a higher trend in all three coastal cities (Ye et al., 2015).

3.5 Coast and Delta Management in the Netherlands – the concept of Building with nature

The Netherlands is a low-lying country with 9 million people living below sea level and 70% of its GDP is earned in areas below sea level. Hence, traditionally protecting this low-lying hinterland from flooding by sea has become the prime focus of the coastal policy of the Netherlands (Mulder, Hommes, & Horstman, 2011). This country has a long history of fighting against floods, but now it is said that the Dutch live with water instead fighting it. The Netherlands has developed the concept of "Building with nature". Currently 75% of the country's total coast (451 km) is protected by natural means i.e. by sandy dunes varying in width from 100 m to several kilometers. The next 15% is protected by hard structures such as sea walls, dykes and other barriers, and the remaining 10% is by forming beach flats (Mulder et al., 2011). Delta management, safety measures against flooding, flood defense standards in the Netherlands have been established by enacting various laws such as the Delta Act, 1958, Flood Defense Act, 1996 and Water Act, 2009 (Mulder et al., 2011). The Eastern Scheldt of the Netherlands, a part of the European Natura 2000 network, protected under the European bird and habitat directives, is a good example, where coastal nourishment by sandy solution has proven effective in mitigating the negative impacts of the tidal flats (van der Werf, Reinders, van Rooijen, Holzhauer, & Ysebaert, 2015).

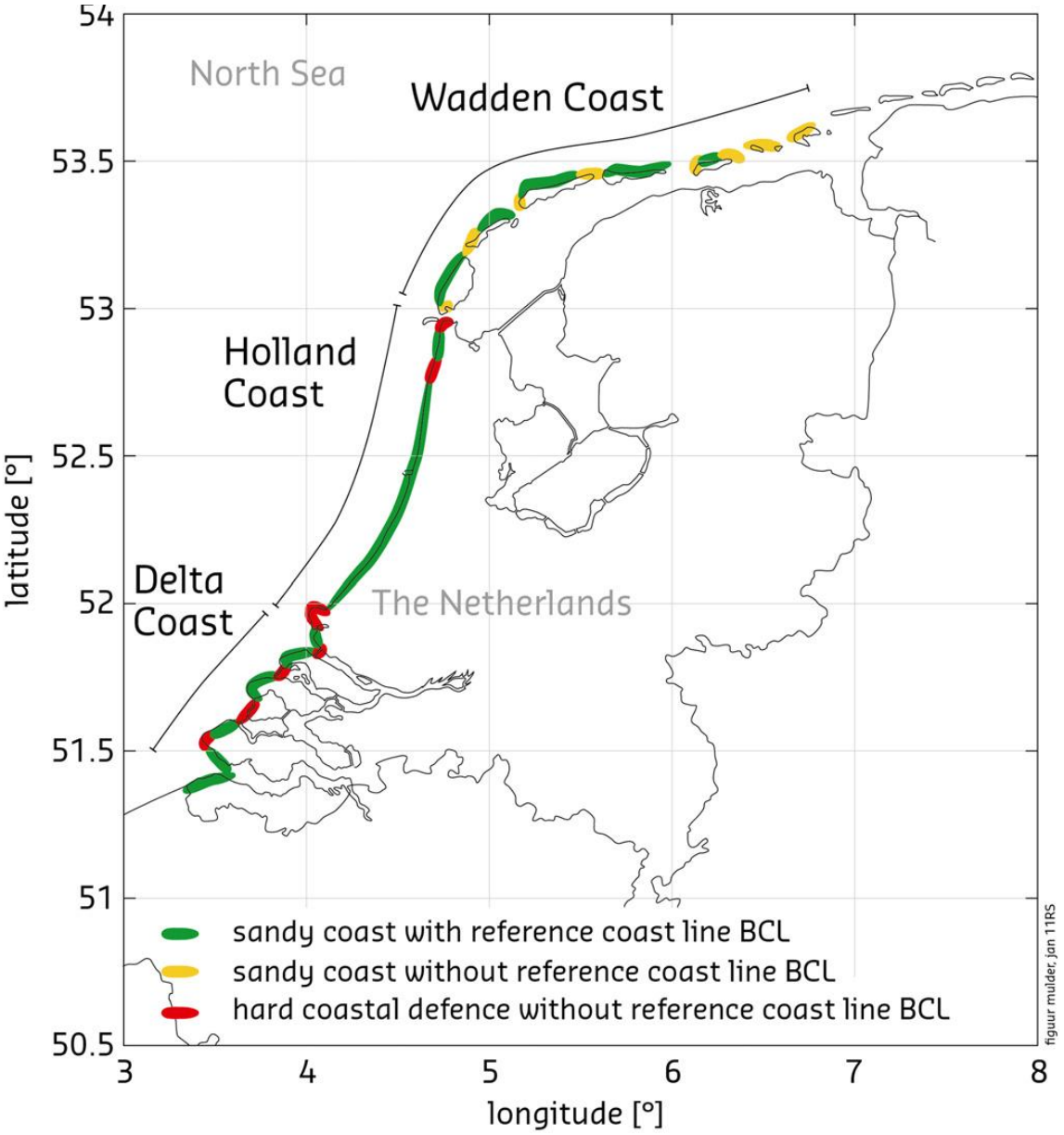


Figure 6: The Dutch coast with three sub-regions
(Source: Mulder et al., 2011)

3.6 Regional costal and ocean management –The BOBLME

Following the UN Conference on the Human Environment (Stockholm, 1972), which indicated the benefits of a regional approach for contributing to the solution to global environmental problems (UN General Assembly, 1972), UNEP initiated the Regional Seas Programs in 1974. At present, there are 18 Regional Seas Programs around the world, and the 64 Large Marine Ecosystems (LMEs) programs also fall within the boundaries of 18 Regional Seas. In addition to these programs, several regional initiatives for coastal and ocean management are also seen throughout the world, established under bilateral or multilateral agreements.

3.6.1 The Bay of Bengal Large Marine Ecosystem (BOBLME)

About 90% of all kinds of fish and other living resources are extracted from the world's 64 LMEs (Shermam and Hempel, 2009). The Bay of Bengal Large Marine Ecosystem (BOBLME), one of the world's 64 LMEs, covers a maritime area of 6.2 million km^2 and has a length of coastline of 14,000 km which includes the coastal watersheds, islands, reefs, continental shelves and coastal and marine waters of the Maldives, Sri Lanka, the east coast of India, Bangladesh, Myanmar, the west coast of Thailand, the west coast of Peninsular Malaysia, and the Indonesian provinces of Aceh, Riau, and North and West Sumatra. It is an area of high biodiversity and vulnerable habitats such as mangroves, coral reefs and sea grasses. This LME supports 8% of the world's mangroves and 12%, of its coral reefs. The BOBLME countries are home to 50% of the world's coastal poor. Two million fishers and more than 5.5 million people are directly employed with coastal-based ancillary activities in the BOBLME area, putting huge pressure on coastal and marine resources (BOBLME, 2012). FAO as an executing agency, started the BOBLME project in 2009 with five components, divided into two phases. The first phase, the Transboundary Diagnostic Analysis (TDA) was performed to develop a baseline by gaining knowledge of marine resources, and then came a Strategic Action

Plan (SAP), which is the main document that guides how the work is to be performed for sustainable management of the resources and to address the major challenges (BOBLME, 2012).

3.7 State of the global ocean and the best scorers (OHI) in 2014

The measurement of Ocean Health Index was started in 2012 and until 2014 three measurements were conducted. In 2012 and 2013, only the EEZs of the coastal states were assessed; in 2014, the entire ocean including the Antarctic and the high seas, were covered for assessment for the first time. The global score improved by 1 point (from 67 to 68) on an average last year, mainly due to the high score of the Antarctic, whereas per-country scores improved by only 0.06 points. Globally, the individual goal "coastal economies" showed the highest increase (by 6.5 points) last year, whereas "the natural products" decreased by 1.2 points, indicating that the latter has more room for improvement to deliver future benefits if managed sustainably and extracted accordingly (Halpern et al., 2015).

3.7.1 The best scorers of OHI

The island territories/nations, on average, achieved the best scores in OHI in 2014. The top ten scorers were Howland Island and Baker Island (95), Prince Edward Islands (93), Heard and McDonald Islands (93), Kerguelen Islands (87), Macquarie Island (87), Javis Island (86), Crozet Islands (86), Malta (84), Greenland (83) and Johnston Atoll (82). These island territories also scored the highest in 2013. The index of 2012 was reassessed by improved methods to make it more acceptable and the average goal score in 2012 was 67 (Blue Ribbon Panel, 2013)

Table 6 shows the highest scorers under 10 goals of OHI in 2014.

Goals of OHI (Global scores in 2014)	**Highest scorers in 2014**
Food provision (51)	Tovalu (99), Papua New Guinea (98), Solomon Islands (98), Palau (97), and Marshall Islands (96)
Artisanal Fishing opportunities (68)	Most of the countries/regions provided access to small scale fishing for the artisanal community near shoreline, and Qatar scored the highest (100) in 2014
Natural Products (42)	Though the overall global score for this goal was low (42) in 2014, Myanmar, New Caledonia, South Korea and Lebanon scored 100
Carbon storage (74)	Bangladesh, Belgium, Denmark, Netherlands- a total of 19 countries scored 100 in 2014. The global score is likely to change by -14% in future due to critical habitat destruction.
Coastal protection (76)	Bangladesh, Finland, Sweden, Estonia- a total of 19 countries scored 100
Coastal livelihoods and economics (82)	Bangladesh, Cape Verde, Morocco, Oman, Turkey – 39 countries scored 100
Tourism and recreation (44)	Anguilla, Bahamas, Malta, Seychelles- 17 countries scored 100
Sense of place (67)	A total of 11 countries including Estonia, Finland, Lithonia, Latvia, Poland had a score of 100
Clean water (78)	Antarctica, Macquarie island, Javis island – 17 regions had 100 score
Biodiversity (83)	Finland scored the highest (98). Projects implemented by IUCN, WWF and other NGOs helped to increase this score

Table 6: Global best scorers of Ocean Health Index under its 10 goals in 2014
(Source: www.oceanhealthindex.org)

4 COASTAL AND OCEAN MANAGEMENT IN BANGLADESH

4.1 Background

Bangladesh is a low-lying coastal state in South Asia, with 70% of its land area being less than 1 meter above sea level and 80% of it being flood plain (Hossain et al., 2014). The country is geographically located in the low-lying deltaic plain of the Ganges-Brahmaputra-Meghna river basin, and at the interface of two contrasting settings i.e. the Bay of Bengal to the south and the Himalayas to the north (Rahman & Biswas, 2004), bordering India, Myanmar, Nepal and Bhutan. The geographical location, low and almost flat topography, very high population density and other factors have made this country one of the most vulnerable countries of the world to be affected by the impact of climate change (Rahman & Biswas, 2004). The country has a land area of 147, 570 km^2 and a population of 160.4 million, representing 2.29% of the world population which makes the country the 8^{th} most populous country in the world (World Population Review, 2015). Upon the settlement of maritime boundary disputes with its two neighboring countries, Myanmar (2012) and India (2014) through two separate international verdicts, the country has established a maritime territory of 118,813 km^2 with a 200 nm EEZ and extended its continental shelf upto 354 nm (MoFA, 2014). The coastal zone of Bangladesh lies in the southern part of the country, covering an area of 47,201 km^2 (Islam & Rahman, 2015) which constitutes 32% of the country's total area, touches 19 out of 64 districts facing, or in proximity to, the Bay of Bengal, and encompassing 153 upazilas (sub-districts) and the EEZ (Ministry of Water Resources, 2005). More than 36.8 million people (28% of total population) live in the coastal area of Bangladesh and more than half (52%) of them are poor (Islam, 2008), and highly dependent on the coastal and marine resources for their livelihoods.

The coastal area of Bangladesh is neither uniform, nor static; it is dynamic and so are the people (Brammer, 2014).The 710 km long coastline is composed of the interface of

various ecological and economic systems, including mangroves, estuaries, islands, accreted land, beaches, a peninsula, rural settlements, urban and industrial areas, and ports (Iftekhar, 2006).

The coastal management and development programs of the country started in the early 1960s through undertaking a number of initiatives such as construction of coastal embankments, coastal greenbelt, land reclamation and delta development (Iftekhar, 2006), the main purpose of which was to protect agriculture from salinity intrusion and tidal surges, and to control erosion. The Coastal Embankment Project (CEP), with assistance from the World Bank, was established in 1967 and the Dutch concept "Polderization" was applied, in which the designated areas were surrounded by dykes or embankments, separating them hydro-logically from the main river system and offering protection against tidal floods, salinity intrusion and sedimentation (Islam, 2006).It continued until the 1980s as it helped to increase the scale of production; but in the 1990s, extensive polderization created drainage congestion inside and heavy siltation outside the polders in the hydro-dynamically active delta, causing the areas to become unsuitable both for agriculture and, in extreme cases, even for human habitation, leading it to be termed as a man-made disaster (Rahman, 1995). Then the traditional system of allowing the natural siltation process was adopted, which made the land again suitable for agriculture. At that time, increased demand and the high price of shrimp, stimulated a class of people to begin shrimp farming in agricultural lands, by allowing saline water to come into the polders, and turning them into shrimp farms and destroying mangroves; eventually the local people lost their lands as well as jobs in the agricultural fields, which later on created conflicts among different land users. To reduce conflicts, the government started land-use zoning, and developed different laws, policies and strategies such as the National Water Policy (1999), the National Agricultural Policy (1999), Draft Shrimp Strategy (2004), and finally decided to initiate Integrated Coastal Zone Management (ICZM) by adopting a Coastal Zone Policy (2005) and Coastal Development Strategy (2006), which focused mainly on the land side of the coastal area.

Ocean management and governance issues, especially beyond the territorial sea, were totally ignored in the coastal policy and strategy. However, currently, the government is considering to developing a comprehensive ICOM policy by bringing coastal and ocean uses together. This chapter will give a vivid picture of the coastal setting of Bangladesh, major land uses/activities in the coastal areas and in the ocean, current and emerging coastal and ocean issues, and the institutional setting and legal regime of coastal and ocean management of the country.

4.2 Features of Coastal areas of Bangladesh

The interior and exposed coasts, rivers and part of the Bay of Bengal form the coastal zone of Bangladesh. The coastal zone is divided into three distinct regions (Figure 7), namely the western, central and eastern regions (Ahmed, 2011). The western zone is very flat and low and is criss-crossed by numerous rivers and channels, hosting the world's largest mangrove ecosystem, the Sundarbans (Iftekhar, 2006). The central region is the active delta where a continuous process of accretion and erosion takes place. The more stable eastern region, covered by hilly areas, hosts the world's longest beach, a coral island and several industrial activities (e.g., ship recycling industry, fisheries). The western part, as covered with mangroves, have some capacity to stand against cyclones, whereas other areas, especially the central part, has no significant protective barriers to dissipate cyclones and other natural disasters (Rahman & Biswas, 2004).

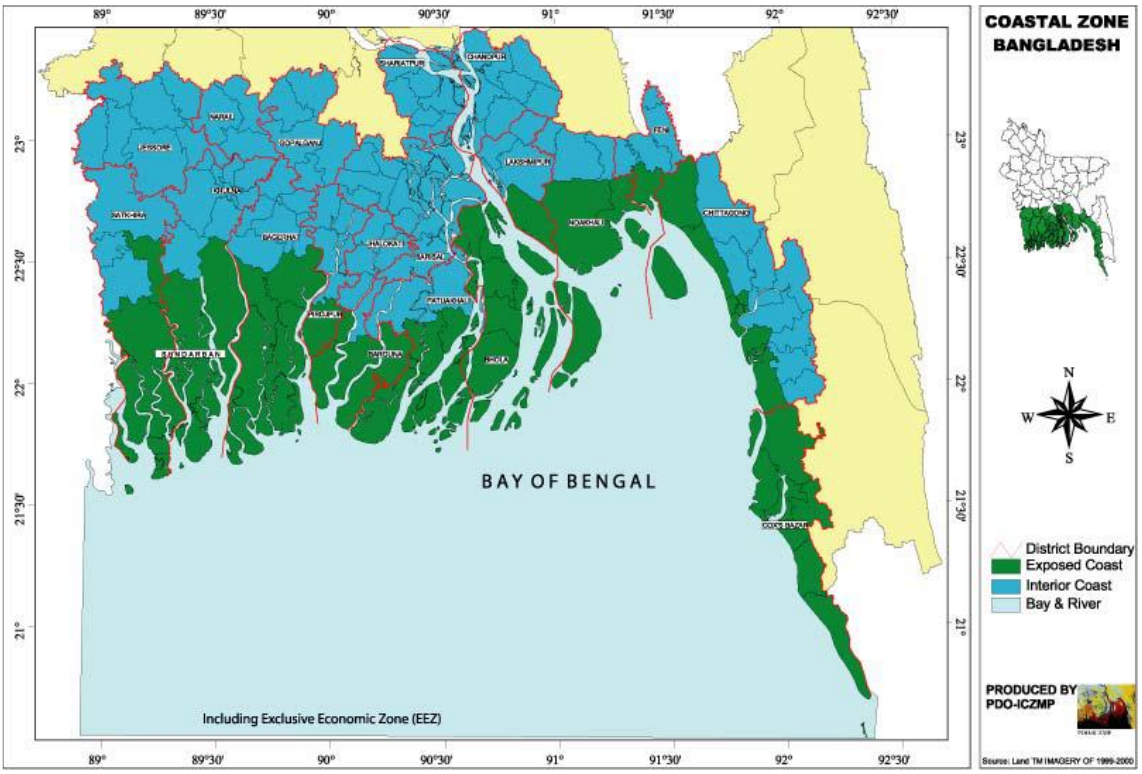


Figure 7: The coastal zone of Bangladesh
(Source: PDO-ICZMP, 2006)

4.2.1 The Sundarbans - the world's largest single mangrove ecosystem

Mangrove is a type of forest growing along tidal mudflats and shallow water coastal areas, extending inland along rivers, streams and their tributaries where the water is generally brackish (Sarker, Kuri, Chowdhury, & Rahman, 2010). The Sundarbans cover an area of 6,017 km^2, extending from the western coastal area of Bangladesh to the neighbouring India. The southeastern part of the country along the northeastern coast of the Bay of Bengal, also covers a small patch of hundred-year old natural mangrove forest known as Chakaria Sundarban, which is one of the oldest mangroves in the subcontinent (Sarker et al., 2010). Excessive human interference and expansion of shrimp farming have completely destroyed the Chakaria Sunderban, causing the loss of

coastal habitat and aquatic resources, and making the coast more vulnerable to natural disasters. The Sundarbans are high in biological diversity; some 245 genera and 334 plant species have been recorded in the Sundarbans. Over 120 species of fish, 290 species of birds, 42 species of mammals, 35 species of reptiles and 8 amphibians frequent the ecosystem, representing 36–37% of the birds, 28–30% of the reptiles and 33–34% of the mammals of Bangladesh (Iftekhar, 2006). It is a unique habitat for the Royal Bengal tiger (*Pantheratigris*). The Sundarbans provide coastal communities with numerous resources and services (Figure 8) such as food and provisions, household and construction materials, fuels, medicines, textiles, and serve as a nursery area for fisheries, a barrier against natural disasters, and tourism opportunities. The economic value of goods and services provided by the mangrove ecosystem in Bangladesh is estimated between $90 billion and $400 billion (Hossain et al., 2014).

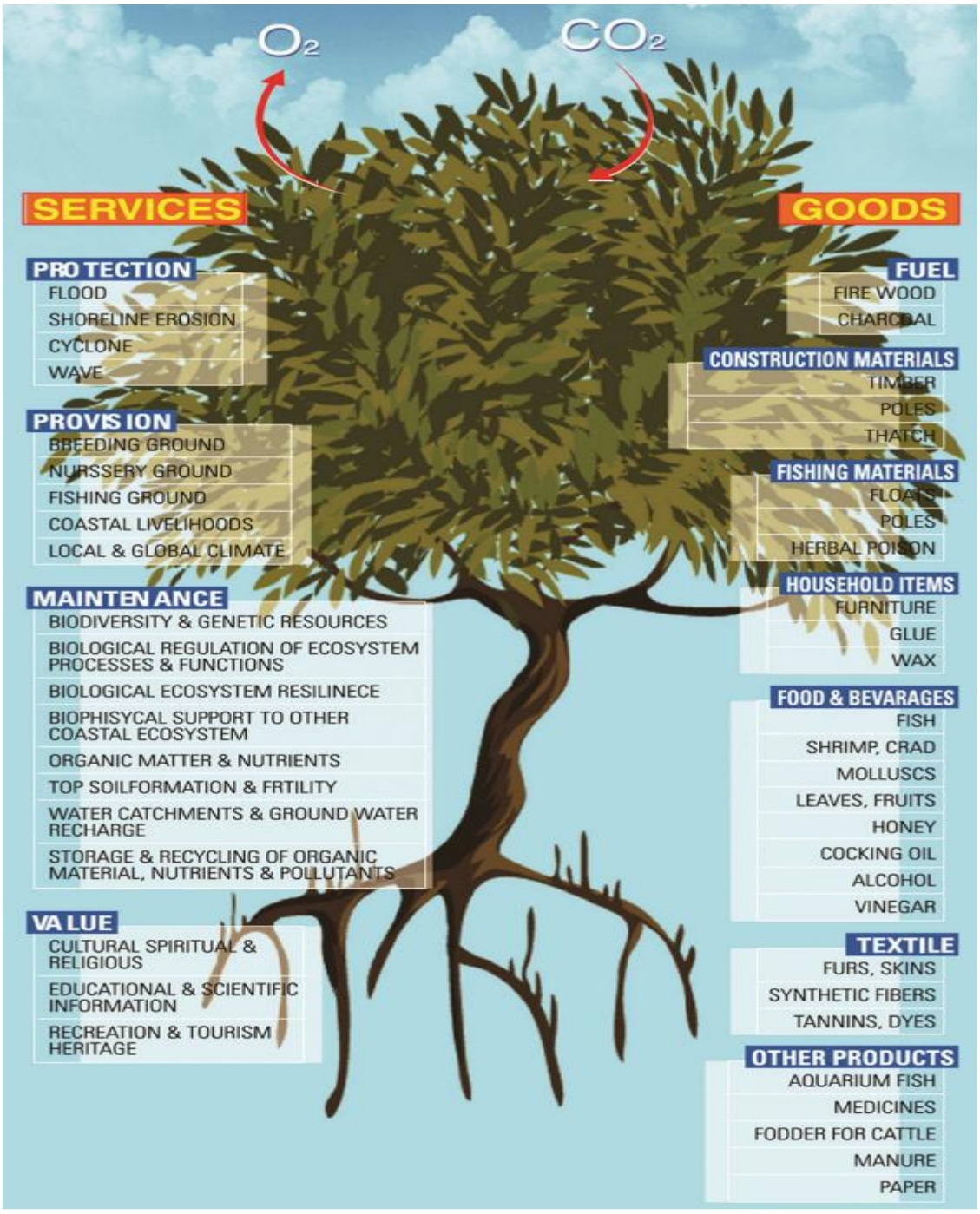


Figure 8: Goods and services provided by mangrove ecosystem in the Ganges basin, Bangladesh (Source: Hossain, 2013)

4.2.2 The Central Deltaic region

Bangladesh is the largest delta in the world (Sarker et al., 2010). The Ganges-Brahmaputra-Meghna basin(Figure 9), the third largest freshwater outlet to the world's ocean, covering an area of 1.7 million km^2 across India, China, Nepal, Bhutan and Bangladesh, hosts more than 700 million people in the vicinity of the combined basin area(Papa et al., 2015), and empties into the Bay of Bengal in the central coastal region of Bangladesh.

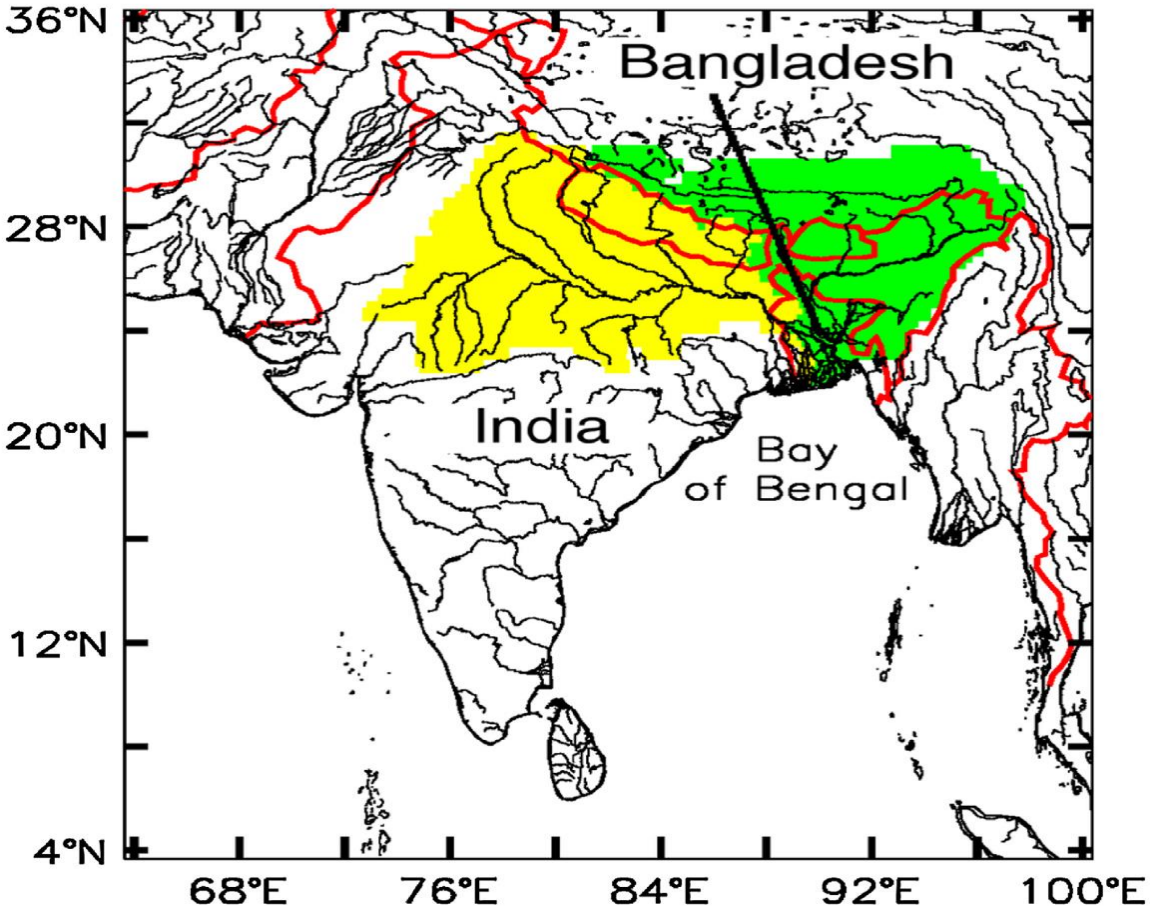


Figure 9: The Ganges-Brahmaputra-Meghna Basin with the respective catchment areas(colored portion) and political boundaries demarcated by red line
(Source: Papa et al., 2015)

The central coastal region of the country is highly dynamic, where continuous accretion and erosion of land takes place (Figure 10). Between 1984 and 2007, there was a net land gain of 451 km^2 in the Meghna estuary, representing an average annual growth rate of 19.6 km^2(Brammer, 2014). The newly formed lands in the Meghna estuary, which are badly exposed to cyclones and storm surges, are unstable and less suitable both for settlement and agriculture than the older land eroded.There were considerable land losses due to erosion in the Meghna estuary, such as 40% loss in the east of Sandwip island and remarkable erosion in the north of Hatia, north-east of Bhola and the south-west of the former Ramgati island. The rate of land loss in the Meghna estuary alone is around 3,199 ha/year. Beyond the estuary, rates of coastal change in other areas are small or undetectable (Brammer, 2014).

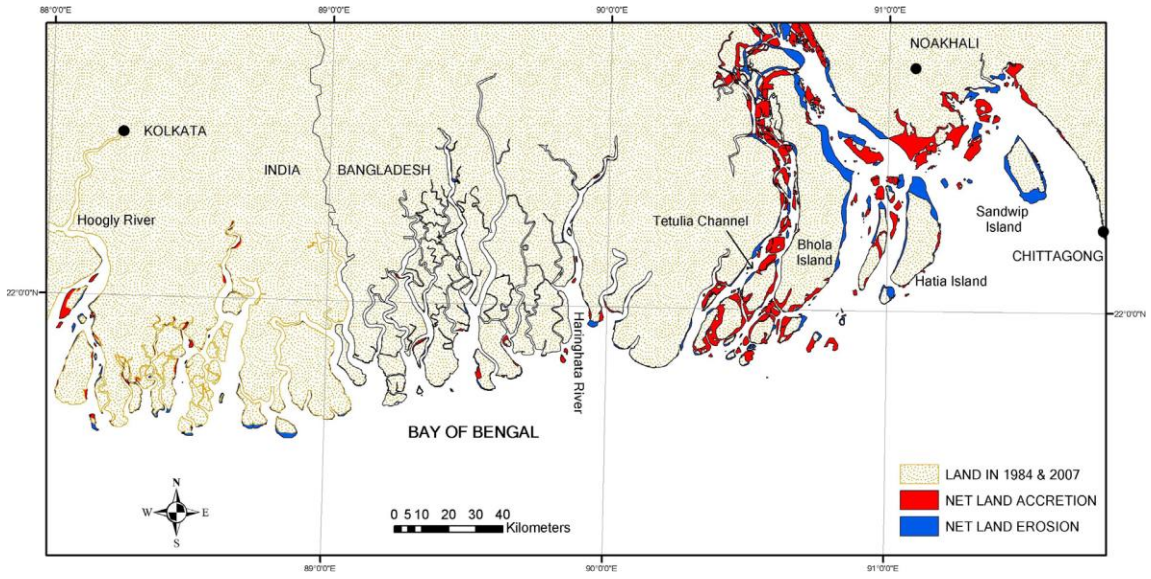


Figure 10: Gains and losses of land in the Ganges-Brahmaputra-Meghna delta, Bangladesh between 1984 and 2007
(Source: Brammer, 2014)

4.3 Major Land uses and coastal and ocean-based activities in Bangladesh

The lands in the coastal area of Bangladesh are intensively used for multiple purposes including agriculture, human settlements, forestry, fisheries and shrimp farming, salt production, urban development, ship recycling, tourism and others. Figure 11 shows the major land uses (Agriculture 59%, Fisheries and wetlands 17%, Forests 11%, Urban and other uses 13%) in the coastal areas of Bangladesh.

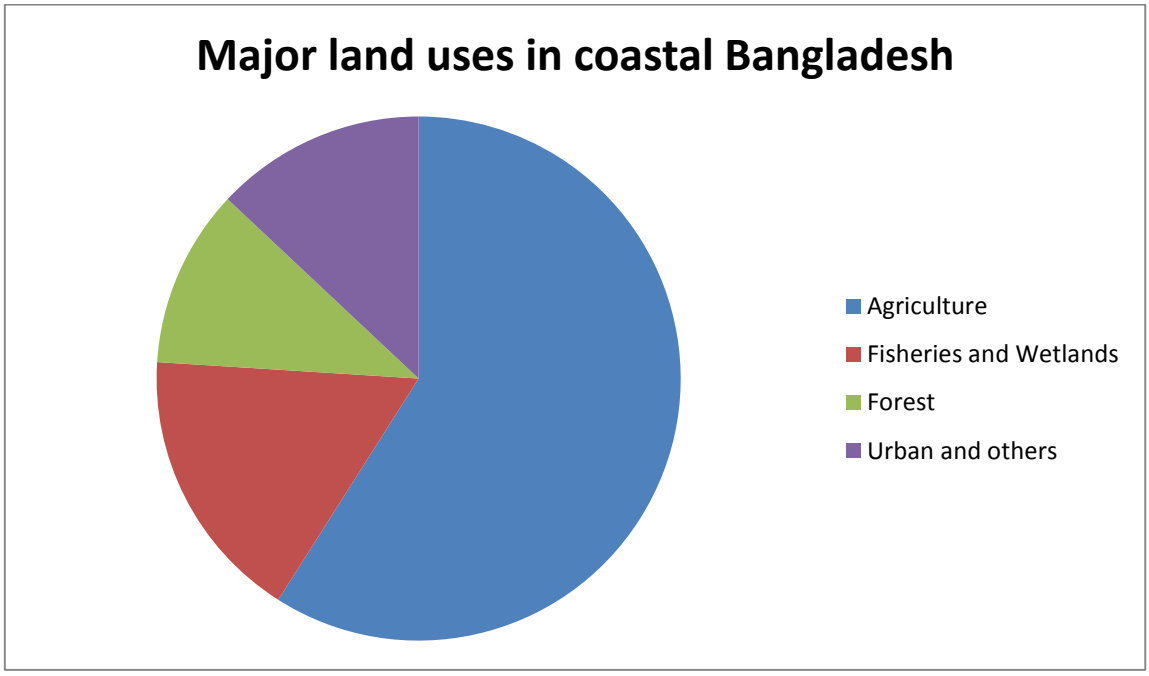


Figure 11: Major land uses in the coastal areas of Bangladesh
(Source: Ahmed, 2011)

4.3.1 Agriculture

Coastal livelihoods are largely dependent on agricultural crops, mainly rice, and the coastal regions contribute to 16% of the country's total rice production. In addition, the coastal zone produces a significant portion of pulses, oilseeds, betel nuts and leaves, potatoes and other seasonal vegetables. But the production of rice and other crops in the

coastal areas is affected by various factors such as flooding, physiography, soil salinity, drainage congestion and irrigation facilities, limiting the production to one season only. Three coastal districts- Gopalganj, Pirojpur and Barisal also have a history of practicing soil-less or floating agriculture (Islam, 2006).

4.3.2 Fisheries and Wetlands

The fisheries sector plays a significant role in fulfilling the demand of animal protein and socio-economic development of Bangladesh. More than 16 million people, representing 11% of the country's total population, directly or indirectly depend on this sector for their livelihood (Hossain et al., 2014). A vast network of river systems, "beels" (natural depressions), "baor" (dead river sections), ponds, flood lands and low-lying marshy lands of coastal areas are used both for capture fisheries and aquaculture, where pond aquaculture and shrimp farming predominate (Ahmed, 2011). About 116,000 hectares of ponds (40% of the country's total pond area), 1,752 hectares of *baors* (32%), 1,655 hectares flood lands (3%) and 5,488 hectares of *beels* (5%) in the coastal areas are used for aquaculture (Islam, 2006). No recent data on fisheries stocks, or biological and ecological aspects of coastal and marine fisheries, is available. Earlier studies from the 1970s and 1980s show that ten fish families (Sciaenidae, Ariidae, Nemipteridae, Carangidae, Mullidae, Synodontidae, Trichiuridae, Leiognathedae, Pomadasyidae and Clupeidae) make up about 47% of the biomass, with croakers and catfishes being the predominant groups (Hossain et al., 2014).

4.3.3 Forestry

The Bangladesh Forest Department starteda coastal afforestation program in 1966 with the primary objective of saving lives and livelihoods of coastal people from cyclones and tidal surges (Das & Siddiqi, 1985). Later on, massive coastal afforestation programs were undertaken by different forest divisions and circles under various projects between the period 1960-61 and 1999-2000 and still continue. Bringing approximately 190,000

hectares of accreted lands under coastal mangrove plantation programs in 2010, a total of 192,395 hectares of mangrove, 8,690 hectares of non-mangrove, 2,873 hectares of Nypa, and 12,127 km of strip plantation were raised until 2013 in the coastal areas, with dominating species *Sonneratia apetala* (80%) and *Avicennia officinalis* (15%) in the mangrove plantations (Islam & Rahman, 2015).

4.3.4 Urban development and others

The metropolitan cities such as Chittagong, Cox's bazaar, Barisal, Khulna and the other 74 municipalities lying along the coastal areas of Bangladesh, are contributing to an enhanced urbanization process and industrial development (Ahmed, 2011). Agriculture, fisheries, tourism and small scale industrial development predominate in the coastal areas of Khulna and Barisal, while industrial development, particularly ship-recycling activities, occur along the coast of Chittagong, and tourism, salt production and shrimp farming are the major coastal activities in Cox's bazaar, where the world's longest beach is situated (Rahman & Rahman, 2015).

4.4 Major coastal and ocean-based economic development issues in Bangladesh: Potential opportunities

Bangladesh is bestowed with potential marine resource opportunities. The ocean-based economy plays a significant role in enhancing the growth of the society as well as the national economy of the country. One fifth of the country's total population is directly dependent on the marine/maritime sector for activities including fisheries, aquaculture, tourism, port and shipping, shipbuilding, ship dismantling, and oil and gas production (Hossain et al., 2014).

4.4.1 Prospects of marine capture fisheries and aquaculture

The harvest of marine capture fisheries in the coastal and marine waters of Bangladesh in the financial year 2012-2013 was 588,988 tons (Dof, 2014), and Hilsa shad

(*Tenualosa ilisha*) is the largest and single most valuable species with an average annual catch of 340,000 mt, representing 50-60% of the global hilsa catch and generating employment and income for 2.5 million people valued at US$ 1.3 billion a year (BOBLME, 2012).The traditional shrimp farming in Bangladesh produces 60-230 kg of shrimp per hectare, whereas other region in southeast Asia produces as much as 6,000 kg per hectare using advanced technology (Hossain et al., 2014). Besides, the Black tiger shrimp *(Penaeus monodon)*, locally known as *bagda*, is the only brackish water (coastal) aquaculture species predominantly cultivated in the coastal areas (Satkhira, Khulna, Bagerhat and Cox's Bazar) of Bangladesh, contributing to the national economy by earning the second largest foreign exchange for the country, amounting to US$ 478 million per year (Hossain et al., 2014)

4.4.2 Ports and Shipping, Shipbuilding and Ship recycling

Bangladesh has two major sea ports- one in Chittagong and another in Mongla. Ninety two percent of the country's international trade is performed through Chittagong port. In the financial year 2012-2013, 43.37 million mt of cargo including 1.47 million mt TEUs of containerized cargo were handled through this port, earning a provisional income of about US$ 200 million. The growth rate of container traffic in Chittagong port is almost double (14%) the country's GDP growth rate (CPA, 2015). Recently, a seminar was held in Chittagong on "Blue Economy-Bangladesh" organized by the International Business Forum of Bangladesh, where Mr. Md. Khurshed Alam, the honorable secretary, Maritime affairs, Ministry of Foreign Affairs informed that the sea-borne trade through Chittagong port is valued at about US$ 6 billion of which the Bangladesh-flagged vessels cover only 40%. He also mentioned that the shipbuilding industry of Bangladesh is in the 13^{th} position in the world and ship recycling occupies 2^{nd} in the world. About 80 raw materials of the county's re-rolling mills come from scrapped ships. On average, 110 ships (60% of global recycling) are dismantled by the beaching method in the ship yards of Chittagong, creating employment for a huge number of people (Ahsan, 2015).

4.4.3 Coastal and marine Tourism

In spite of having potential prospects of development of the tourism sector in Bangladesh, especially coastal and marine tourism, it has yet remained underdeveloped in comparison with other south Asian countries such as India, Sri Lanka and Maldives. Bangladesh has the world's longest beach as well as the largest single mangrove forest-the Sundarbans, which could be potential tourism destinations and thereby contribute to the national economy if only proper steps would be taken (Brammer, 2014).

4.4.4 Oil, gas and mineral resources

Bangladesh is yet to assess the true potential of its offshore oil and gas prospects (Alam, 2013). So far, 26 TCF (Trillion Cubic Feet) of gas reserve has been discovered in Bangladesh, of which the offshore gas reserves constitutes only about 1 TCF, and the drilling success ratio is also less attractive i.e. 9:1 in comparison with 3:1 in onshore (Hossain et al., 2014). The shallow offshore oil/gas blocks of Bangladesh, adjacent to the Arakan offshore blocks of Myanmar, are being considered as prospects of potential reserve as Arakan offshore blocks have some recent discoveries of remarkable oil and gas reserves. Deposits of 17 potentially valuable minerals such as zircon, rutile, ilmenite, leucoxene, kyanite, garnet, magnetite and monazite have so far been discovered along the coastal belt from Patenga to Teknaf (eastern coastal region), -the extraction and commercialization of which may enhance the growth of different local industries such as welding electrodes, glass, paper and ceramics (Alam, 2004).

4.4.5 Marine biotechnology and marine genetic resources

Marine biotechnology or blue-technology is a young subset of biotechnology that mainly deals with the uses of marine bio-resources such as fish, algae, bacteria, invertebrates and other marine organisms to bring desirable products and benefits for mankind. Only 20% of living marine species are currently known and have been screened for their use in chemical and pharmaceutical applications (Schlosser, 2013). Research on marine

biotechnology in developed countries is growing very fast to exhaust marine genetic resources. Surprisingly, there is no research yet developed in this field in Bangladesh. The fast growing pharmaceutical industries of the country, and aquaculture and livelihoods of the coastal community, can be benefit if application of marine biotechnology would be enhanced to bring marine bio-resources into useful products such as medicines, bioactives, nutrient supplements and other compounds and marine food.

4.5 Major challenges for the blue growth in Bangladesh

Though Bangladesh has numerous prospects of potential marine resources' utilization, it is threatened by the challenges lying behind the sustainable uses of these resources. The major challenges the country is now facing and will face in future, are overexploitation of marine resources, pollution and degradation of the marine environment and critical habitats, natural disasters and climate change adaptation, conflicts among different coastal and ocean uses, and maritime safety and security (Brammer, 2014).

4.5.1 Overexploitation of marine resources

The marine and coastal capture fisheries sector of Bangladesh is the onlyprimary source of income and nutrition for over 484,000 households and 2.7 million family members in the coastal region of Bangladesh (BOBLME, 2011). The fishers still use traditional methods and fishing boats to capture fish. The traditional fishing boat can fish upto 60 meters out to sea. So, inland and shallow marine water fish have been overexploited and unsustainable fishing practices have led to enhanced depletion of fish stock (BOBLME, 2012).

4.5.2 Pollution, degradation of the marine environment and habitat destruction

Marine pollution originates mainly from two sources - land-based sources of marine pollution and sea-based or vessel sources of marine pollution, and it is estimated that 80

% of marine pollution originates from land-based sources. Marine pollutants again can be categorized as liquid, metal, gaseous, solid or harmful microbes (BOBLME, 2011) which include nutrients, heavy metals, refinery waste, waste generated from offshore platforms, oil spill, POPs (Persistent Organic Compounds), agricultural waste, sewage, siltation and turbidity. In Bangladesh, major land-based sources of pollutants include untreated sewage and industrial effluents, sediments, plastic and heavy metal such as mercury (Hg), and Asbestos (As), while major sea-based pollution includes oil spills, grease and other chemicals, liquids and garbage coming mainly from ship-breaking yards lying in the eastern coast of the country. A significant amount of inorganic nitrogen is found in the sediments of the Bay of Bengal drainage basin and around the Sundarbans. Heavy pollution in the inland and coastal waters has led to serious depletion of fish stocks and other living marine resources and caused the destruction of critical habitats such as mangroves, coral reefs and sea grasses (Hossain et al., 2014).

4.5.3 Natural disasters and climate change adaptation

Bangladesh, being a low-lying country, is most vulnerable to natural disasters and climate change. Over the past 50 years, around 718,000 people died due to cyclones and huge property and crop damages were also recorded (Haque et al., 2012). Coastal vulnerability is much higher than in other parts of Bangladesh, with cyclone and storm surges; floods, drainage congestion and water logging; drought and salinity intrusion; erosion; and ecosystem degradation. Climate change exacerbates all vulnerabilities. Livelihoods and food security are threatened. More population and less socio-economic development in the exposed zone would result in a high risk situation (IUCN, 2010).

4.5.4 Conflicts among different coastal and ocean space uses

In the past, there were huge conflicts among different land uses in the coastal areas, particularly when paddy fields were turned into commercial shrimp firms by allowing brackish water into agricultural land for shrimp firming, which made the agricultural

lands saline and unsuitable for crop production. The conflict led to the deaths of a number of people. Application of engineering structures in polders, which worked well for few years, later created havoc for the people by drainage congestion inside the polders. Conflicts also grew concerning the mangrove afforestation, shrimp farming and salt production, which led to the complete destruction of the hundred-year old Chakaria Sundarban in the eastern coastal region of Bangladesh (Iftekhar, 2006). As the government is planning to target much deeper ocean space uses with development of a deep sea port, oil and gas exploration, fisheries, tourism and other ocean-based activities, conflicts among these uses are expected to emerge.

4.6 Institutional setting, legal basis and policy framework for coastal management and ocean governance

Bangladesh has ratified most of the international conventions related to coastal and ocean management, and signed a number of bi-lateral and regional agreements and accordingly, developed numerous national laws, policies, strategies and action plans (Hossain et al., 2014). But most of these laws, policies and strategies apparently just lie in a file cabinet, not reaching the field. The key ministries involved are the Ministry of Water Resources and Planning, Ministry of Environment and Forests, Ministry of Land, Ministry of Fisheries and Livestock, Ministry of Agriculture, Ministry of Shipping and Ministry of Planning. The main departments, organization and research institutes under different ministries dealing with coastal and ocean issues are WARPO (Water Resource Planning Organization), BFRI (Bangladesh Fisheries Research Institute), BFRI (Bangladesh Forests Research Institute), DOE (Department of Environment), IMSFCU (Institute of Marine Science and Fisheries, Chittagong University)

4.6.1 Major international instruments related to coastal and ocean management that Bangladesh has ratified

The major international instruments that Bangladesh has ratified are the UNCLOS,1982, FAO Code of Conduct for Responsible Fisheries, 1995 and Compliance Agreement of 1993, UN Fish Stock Agreement, 1995, Ramsar Convention, 1971, Convention on Biological Diversity, 1992 and UNEP Regional Seas Conventions (Hossain et al., 2014). UNCLOS, known as the constitution of the ocean, calls for collective responsibility of all coastal states for sustainable uses of ocean and to prevent it from all sources of pollution and degradation within the national jurisdictions of each state. The FAO Code of Conduct for Responsible Fisheries is a non-binding instrument that addresses almost every aspect of fisheries, and encourages countries to develop and implement their own national fisheries policies based on the standards set in the Code. The UN Fish Stock Agreement is a legally binding instrument that provides a long-term and sustainable management framework for staddling and highly migratory fishes. The Ramsar Convention, also known as "Convention on Wetlands of International Importance, especially as Waterfowl Habitat" aims at conservation and sustainable use of the world's wetlands having ecological, economic, socio-cultural and, scientific and recreational importance. Bangladesh, is signatory to the Ramsar Convention, has three Ramsar recognized sites- Hakaluki haor, Tanguar haor and a part of the Sundarbans. The Convention on Biological Diversity, originating from the Rio declaration in 1992, has three goals- conservation of biodiversity, sustainable use, and fair and equitable sharing of benefits arising from biological resources. Bangladesh ratified this convention in 1994. The Regional Seas Convention of UNEP provides a legal framework for regional action plans to mitigate marine environmental problems in different regions. Bangladesh is not a party to the Regional Seas Program, but is an active participant in the Bay of Bengal Large Marine Ecosystem (BOBLME) program.

4.6.2 National laws, policies, strategies and plans for coastal and ocean management

There is no lack of laws, policies and strategies in Bangladesh and each and every law is satisfactory, but the problem lies with the comprehensiveness and that most of the laws, as adopted, cannot reach the phase of implementation. The Territorial Waters and Maritime Zones Act, 1974 is the first law in independent Bangladesh that governs the coastal issue, especially delimiting maritime territory. The Coastal Zone Policy (2005) and Coastal Development Strategy (2006), which were adopted earlier with the aim of implementing sustainable coastal development programs, failed to bring any positive outcome as promised (Hossain et al., 2014).

The Protection and Conservation of Fish (Amendment) Ordinance, 1982 is the first instrument developed for fisheries resources management. Then, the Marine Fisheries Ordinance was enacted in 1983, which is the first comprehensive legal instrument dealing with the sustainable exploitation, conservation and management of marine living resources including fishes. For expanding research on the fisheries sector, the government established the Bangladesh Fisheries Research Institute (BFRI) through adopting the Fisheries Research Institute Ordinance, 1984. The National Fisheries Policy, that came into being in 1998 calls for comprehensive stock assessments, fishery education, research, and joint-venture initiatives with foreign and offshore entrepreneurs for exploitation, conservation and management of marine fisheries sustainably (Islam, 2006). The recently developed National Shrimp Policy, 2014 guides zoning and technological development, thus creating employment, throughout the collection of mother shrimps from the sea, production and protection of breeding and nursery grounds of shrimps.

The Bangladesh Petroleum Act, 1974, and the National Energy Policy, 2004 provide a basis for planning and organizing exploration, exploitation, development and production of petroleum wealth from the territorial waters, continental shelf and the EEZ (Islam,

2006). These two instruments also guide the state in using renewable energy from tides, ocean waves, and wind power.

For environmental protection, conservation and climate change adaptation, a number of laws, policies, strategies and action plans have been adopted, some of which are- i) Bangladesh Environment Conservation Act, 1995, and subsequent amendments in 2000 and 2002, ii) Bangladesh Environment Conservation Rules, 1997, and subsequent amendments in 2000 and 2001, iii) National River Protection Commission Act, 2013, iv) National Action Plan for Adaptation to Climate Change, and v) Bangladesh National Conservation Strategy 2005. For water resources management, there are three main instruments - National Water Policy 1999, National Water Management Plan 2001, and Bangladesh Water Act, 2013.

At present, two sea ports (Chittagong and Mongla ports) are in operation, which have been created under two separate acts, and the Paira Port Authority Act, 2013 lays the foundation for future operation of the country's third sea port- Paira. The Bangladesh Shipping Corporation (BSC), the national flag carrier, was established under the Bangladesh Shipping Corporation ordinance order, 1972 to provide safe and efficient shipping and ocean transport services to ensure smooth trade and commerce in the country without any disruption. The Bangladesh Merchant Shipping Ordinance, 1983 is a comprehensive law by which the Department of Shipping was established and which determines, regulates and controls various operational aspects of maritime sector including shipping.

Coming to the tourism sector, there are also current developments of numerous laws, policies, rules and strategies. The National Tourism Policy, 2009, and the Bangladesh Tourism Board Act, 2010 call for establishing a supervisory organization to frame necessary rules and regulations and advise concerned agencies on the overall development of this sector and the environment. The Bangladesh Tourism Protected

Areas and Special Tourism Zone Act, 2010 and the Bangladesh Tourism Protected Areas and Special Tourism Zone Rules, 2011 provide options for declaring and managing potential areas exclusively for tourism.

4.6.2.1 Proposed Ocean governance framework for Bangladesh

A comprehensive, holistic ocean governance framework has recently been proposed in a background paper prepared for the 7th Five Year Plan (2016-2020) of the country, entitled as "Opportunities and strategies for ocean and river resources management" by the Planning Commission of Bangladesh. This is the first coastal and ocean management policy framework that includes the ocean as part of integrated coastal and ocean management. The proposed policy framework is shown in Figure 12.

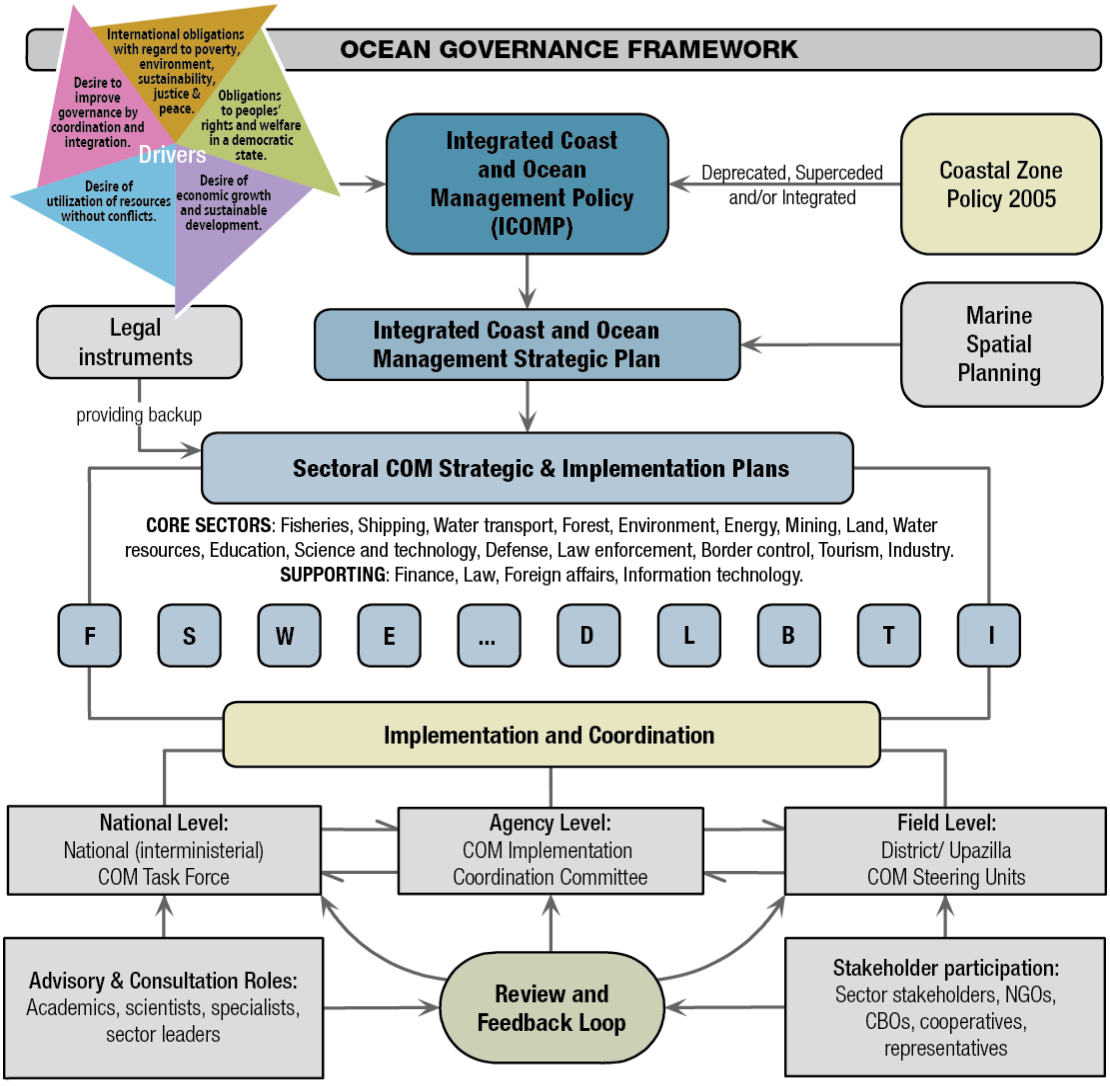


Figure 12: Proposed Ocean Governance Framework for Bangladesh
(Source: Planning Commission, 2014)

4.7 Ocean Health Index and Bangladesh's scores under its 10 goals

The average OHI score in Bangladesh in 2014 was far better than the previous years, with a one point increase in each year since 2012 (from 67 in 2012 to 69 in 2014) and in the future, is expected to change by +2%. The OHI scores from 2012 to 2014 under 10 goals of OHI for Bangladesh are presented in Table 7.

Goal	2012	2013	2014
Food Provision	05	05	06
Artisanal Fishing Opportunities	58	58	58
Natural Products	91	94	94
Carbon Storage	100	100	100
Coastal Protection	100	100	100
Coastal Livelihoods & Economies	100	100	100
Tourism and Recreation	13	13	11
Sense of Place	59	59	70
Clean Water	53	56	57
Biodiversity	91	91	91

Table 7: Ocean Health Index of Bangladesh from 2012 to 2014
(Source: www.oceanhealthindex.org/countries/Bangladesh)

5 THE EFFECTIVENESS OF COASTAL AND OCEAN MANAGEMENT IN BANGLADESH: A SWOT (Strengths, Weaknesses, Opportunities, and Threats) ANALYSIS

5.1 Background

Three sets of ICOM indicators (Governance indicators, Ecological indicators and Socio-economic indicators) were introduced in chapter two, the better performance of which fulfills11 goals/ focus areas of ICOM as described in chapter three. Chapter three also presents lessons from a few coastal and ocean management initiatives from around the world, regarded as good practices in the published literature; while chapter four gives a vivid picture of different features of coastal and maritime areas of Bangladesh with a description of the past and present coastal and ocean management perspective and the future plan as well. This chapter will present a SWOT analysis on key issues/focus areas of current coastal and ocean management practice of the country and its future plan, based on the key aspects of governance, ecological and socio-economic criteria that ICOM needs to fulfill. Table 8 shows the major strengths, weaknesses, opportunities and threats of current and future coastal and ocean management issues of Bangladesh which have been concentrated under the discussion of coastal and ocean governance, environmental stewardship and socio-economic development of Bangladesh.

Strengths	**Weaknesses**	**Opportunities**	**Threats**
Diverse coastal habitats, Productive estuaries, Existing & potential fishing ground, Shipbuilding and	Lack of interagency coordination, Weak monitoring and evaluation mechanism, Lack of a Lead agency,	Eco-tourism, Biotechnology and bio-resources development, Development of shipping and commerce,	Sea-level rise & coastal inundation Salinity intrusion and loss of agricultural land, Loss of habitats, Depletion of fishes

Ship recycling, Fertile land, Huge population that can be turned into useful manpower	Knowledge gap, Lack of awareness, education and training, Lack of advanced technology, Lack of human, financial and technical resources, Lack of a central Database, Lack of baseline data	Natural products, pharmaceuticals and minerals extraction, Deep sea fishing and developing sustainable aquaculture	and other living resources, Pollution, Increasing frequency of natural disasters River bank erosion, Conflicts among different coastal and ocean space uses and with different sectors

Table 8: Major Strengths, Weaknesses, Opportunities and Threats of coastal and ocean management in Bangladesh (Compiled by author)

5.2 Coastal and Ocean Governance

An integrated coastal and ocean governance framework for Bangladesh has been proposed (Figure 12) in the background paper prepared for incorporating it into the 7th Five Year Plan (2016-2020) of the country by the Planning Commission of Bangladesh. It has recently been submitted to the FAO. Although Sri Lanka started the first coastal management program in South Asia, Bangladesh is a pioneer in initiating the integrated concept for coastal management in this region (Islam, 2006). Although the country started ICZM through the development of the Coastal Zone Policy (2005), it only covers the land-side management of the coastal region, not the entire maritime area of its national jurisdiction (Hossain et al., 2014). In addition, it created conflicts among different coastal land uses such_agriculture vs. shrimp farming which later led to the

creation of some other instruments such as Land use policy, Fisheries policy, and National Shrimp policy.

5.2.1 Institutional arrangement, legal set up, inter-sectoral coordination and improved management

As discussed in chapter four, it is apparent that there have been a number of sectoral laws, policies, plans and action programs related to marine management and development in Bangladesh and various institutions and organizations have been created by law to perform specific tasks. But lack of harmonization of these instruments and lack of interactions among different sector organs of the government, fail to bring a comprehensive, integrated and holistic view into place for improved management (G5). The lack of an inter-sectoral coordinating agency (such as MMO in the UK and other countries) or the weakness and the lack of experience of the current leading agency (WARPO) responsible for this task, has led to weak coordination mechanisms (G1). There is also a debate about vesting the responsibilities to WARPO for this task, which has created conflicts (G4) among different sectoral agencies. Lack of integration of different dimensions of ICOM (as discussed in chapter two) has also made the mechanism weak. As no baseline has yet been developed, monitoring and evaluation (G7) mechanisms have been buried. Despite these drawbacks, some sectoral policies and management initiatives have led to success, especially in coastal forestry and fisheries mainly due to including them into priority programs of the government plan (Brammer, 2014). The currently proposed ocean governance framework which calls for a comprehensive, integrated coastal and ocean management policy and an MSP (Marine Special Planning) process, if put into place, may help improved management. Inadequate and discontinuous flow of resources (human, technical and financial) is another barrier to ensuring long-term improved management in the coastal areas of Bangladesh.

5.2.2 Improved knowledge, awareness and support

While having a number of research institutes in various fields (e.g. BFRI, BRRI) across the country for many years, the government has just recently undertaken an initiative to establish a maritime university (BBSMRMU) and the National Oceanographic Research Institute (NORI) to expand maritime education and conduct coastal and oceanographic research of all kinds including biological, physical, chemical and geological of the coastal and maritime area of Bangladesh (G9, G12). Scientific knowledge and its combination with traditional knowledge are hardly seen in the decision-making process of Bangladesh. A baseline, required for monitoring and evaluation of progress of management, has not yet been developed. Public participation (G10) at various levels such as regional and community levels, and by certain classes of stakeholders, is very weak and threatens the inclusionary politics, which is required for a true democratic process to work positively. The activities of NGOs and CBOs are not monitored properly in Bangladesh and the standards of their working procedures vary from one to another; different NGOs work in the same area to which the funds are available, leaving the major oceanic research untouched.

5.2.3 Mainstreaming the proposed ocean governance framework into sustainable development

The country heads are going to meet in a summit at UN headquarters, New York at the end of September, 2015 to adopt a sustainable development agenda and set of Sustainable Development Goals (SDGs) for the next 15 years, comprising 17 goals, 169 targets and 100 indicators. Goal 14 is related to conservation and sustainable use of the ocean, seas and marine resources for sustainable development. Bangladesh is to incorporate the sustainable development agenda as well as incomplete targets of MDGs into its next (7^{th}) Five-Year Plan (2016-2020), which is still under preparation. The burden of fulfillment of incomplete targets to realize the country's vision 2021 of turning it into a middle-income country by 2021 will also fall on the 7^{th} Five-Year Plan

of the country. The proposed ocean governance framework is a comprehensive policy framework that requires mainstreaming with the global sustainable development agenda that is going to be adopted in September this year (2015). Transfer and sharing of technology (G13) and proper economic instruments (G14) are required to mainstream policy into action for sustainable development.

5.3 Environmental stewardship

Conservation of biodiversity and protection of critical habitats/MPAs (Marine Protected Areas/ECAs (Ecologically Critical Areas) are significantly important to enhance productivity of the marine ecosystem. In addition, the abiotic marine environment plays a significant role in the whole process of ecosystem functioning. The Bay of Bengal, located in the tropical region, is high in biodiversity but less in productivity. Pollution, unplanned coastal development activities, and unsustainable fisheries have led to degradation of the marine environment in this region (Hossain et al, 2014).

5.3.1 Biodiversity conservation and enhanced productivity of the ecosystem

Environmental pollution, mainly from land-based sources (untreated industrial effluent, surface and agricultural runoff, sewage, dumping plastic and other waste material), has reduced biological diversity (E1-E3) and productivity of the marine ecosystem (E4-E6). Upstream pollution in rivers and siltation has damaged the breeding ground of fishes and reduced species richness (Islam, 2015). No recent data are available on species diversity in the maritime area of Bangladesh. The neighboring country, Myanmar has already engaged a Norwegian research vessel to assess fish stocks and biodiversity and other resources in its jurisdictional maritime area. The complete destruction of Chakaria sundarban, has led to diminishing species diversity and breeding grounds of aquatic fauna (Islam, 2015). The biological diversity as assessed three decades before, which is presented in chapter four, shows the coastal and maritime area of Bangladesh is high in

biodiversity, but the unavailability of recent data makes it difficult to assess current level of species richness.

5.3.2 Abiotic marine environment

Bangladesh is one of the most disaster-prone countries in the world. Increased Sea Surface Temperature (SST) causes cyclonic storms and about 7% of the world's cyclonic storms are formed in this region. During the period from 1959 to 2009, a 0.30-0.48^{0}c SST increase is assumed as reported by Chowdhury (2012). Water quality has not been assessed and monitored in a timely manner. Dissolved oxygen has reduced while increased carbon has led to damage to corals. Habitat quality has also reduced tremendously.

5.4 Socio-economic Development/ Blue growth- A way forward to sustainable development

The ultimate goal of coastal and ocean management is to ensure sustainable development and public health and safety. The proper functioning of economic, environmental and social dimensions, as represented by various indicators, charts the way forward to sustainable development provided that disease, illness, weather and disaster situations, under the public health and safety dimension, are managed accordingly (Belfiore et al., 20060.

5.4.1 Economic Dimension

As discussed in chapters two and three, the economic dimension is represented by the total economic value (SE1), employment opportunities (SE3), direct investment (SE2) and sectoral diversification (SE4). In Bangladesh, the economic value of goods and services provided by mangroves (Figure 8) alone is estimated between $90 billion and $400 billion as presented in chapter four. The Black tiger shrimp (*Penaeus monodon*), extensively cultivated in the western and eastern coastal regions of Bangladesh,

contributes significantly to the national economy by earning the 2nd largest foreign exchange for the country, amounting to about $478 million annual return (EPB, 2012). The capture fishery also makes a significant contribution to the national economy and employment opportunities. The Hilsh shad (*Tenualosa ilisha*), the largest and single most valuable fish species, contributes $1.3 billion annual turnover creating employment opportunities for more than 2.5 million people in Bangladesh (BOBLME, 2012). About 30 million people (20% of the total population) depend on the maritime sector and coastal economic activities for their livelihoods. The OHI score under the goal "livelihoods and economies" for Bangladesh for the years 2012, 2013 and 2014 was 100, meaning that the coastal and ocean-based economy plays a significant role or meets the target of this OHI goal by providing adequate livelihoods and economies for the coastal community.

5.4.2 Environmental Dimension

The coastal area in Bangladesh is densely populated and with more than 52% of people in this area being poor; their dependence for livelihoods on natural resources, poses huge pressure on coastal habitats and marine resources (SE5), which leads to quick depletion of marine resources and environmental degradation. The country's only coral reef located at St. Martin's Island, is now in a vulnerable position due to excessive coral mining, destructive, unsustainable and unmanaged resource harvesting. The development of new ports is likely to pose threats to the marine environment and marine biodiversity unless compensation dunes are created as we see in the case of the Netherlands, where compensation dunes have been created through natural means to compensate the negative effects of current port extension towards the sea in Rotterdam through land reclamation. River erosion alone claims about 20,000 acres of land each year that leaves up 200,000 people homeless every year. The water brings down 1.2 to 2 billion tons of sediment through the channel of the GBM basin, which can be well managed to reclaim land to accommodate homeless people in the coastal areas and to

combat sea-level rise and climate change adaptation. In June 2015, the government signed a deal with the government of the Netherlands to cooperate in land reclamation efforts (Reuters, 2015). A hundred-year delta action plan has also been prepared, and is now undergoing review with the assistance of the Netherlands. All these initiatives should be carefully assessed and implemented.

5.4.3 Social Dimension

The OHI score under the goal "artisanal fishing opportunities" for Bangladesh was moderate (58) in the years 2012, 2013 and 2014, while food provision had very low score (05 in 2012 and 2013, and 06 in 2014). Public access (SE11) to sustainable resource consumption may be enhanced and food and natural product extraction can be made more sustainable through the development of research on biotechnology. Marine dependency (SE10) on mangroves products and fisheries can be diversified, especially redesigning the tourism sector, expanding port and shipping activities and involving technology. The Sundarbans-the World's 52nd heritage site, should be protected to provide sustainable goods and services. Cultural integrity (SE12), as concerns the coastal community, is to be respected and prioritized in the coastal development policy. Coming to population dynamics (SE9), the huge population can be turned into useful human resources and migrated to other sectors and places to reduce high pressure on marine resources.

5.4.4 Public health and safety issues

The coastal areas, being more vulnerable to natural disasters and climate change, public health and safety issues remain in question. Flooding and other natural disasters create huge economic loss, habitat loss and spread water-borne and other diseases. Deep sea fishing by small traditional boats and vessels is not monitored as these fishing boats and vessels are not equipped with VMS (Vessel Monitoring System), which requires them to

come under monitoring and tracking for safety issues as well as to control illegal fishing. Weather forecasting and cyclone warning has improved significantly in Bangladesh through regional and international cooperation. The capabilities of the coast guard to patrol the maritime area still needs to be further strengthened.

6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The world is now looking to step up from green to blue growth. Managing coastal and ocean activities is a big challenge for the days ahead. Despite having sets of principles, guidelines, and policies developed by international bodies available in place, no uniform standards/indicators have yet been developed that can be used universally for sustainable management of coasts and the ocean. A number of global, regional and national initiatives have been taken to date, almost half of which have been unsuccessful. However, regional initiatives taken in the South China Sea (PEMSEA), Mediterranean and Black Sea (PEGASO Project), UNEP's few Regional Seas programs and some LMEs efforts and at country level- e.g., China's ICG concept, Netherlands' building with nature concept and living with water instead fighting it, Mexico's simultaneous conservation and development steps, bringing coastal and ocean uses together in South Korea, a more comprehensive and holistic approach in the USA, Australia's Great Barrier Reefs conservation initiative, and Sri Lanka's erosion control measures are some of the good coastal and ocean management initiatives that can be taken as models to be used to best suit others depending on similarity and other perspectives. Bangladesh and the Netherlands have similarities in many aspects – both are low-lying countries with a greater portion lying below mean sea level and must fight with flooding and other natural disasters. Bangladesh, in cooperation with the Netherlands, has undertaken a number of projects to manage water and floods. The Dutch concept of polderization worked well for almost two decades in the past in Bangladesh. A number of organizations are working on the coastal and marine issues in Bangladesh and numerous laws, policies and strategies have been developed, but interaction among different organizations is hardly seen and there is a lack of harmonization, consistency and integration of all legal instruments which is necessary to bring a fruitful outcome. Traditional methods of fishing and unsustainable fishing practices are a barrier to

efficient fish production. Heavy dependence of more than 35 million coastal people on natural resources has led to resource depletion. The contribution of scientific knowledge and traditional knowledge to the decision-making process is hardly entertained. Climate change, sea-level rise, river erosion, siltation and various natural disasters and pollution are big challenges Bangladesh is now facing and is likely to face in the future. Eco-tourism/coastal tourism, expanding shipping and commerce through development of new deep sea ports, extraction of minerals, natural products, salt production, and deep-sea fishing are a few emerging opportunities that Bangladesh can grasp for its socio-economic development and at the same time conservation of nature to be considered for deriving long-term benefits.

6.2 Recommendations

Bangladesh must work hard to realize its Vision-2021 by incorporating the global post-2015 development agenda (SDGs) and incomplete targets of MDGs to its next (7^{th}) Five-year plan (2016-2020). Harmonization of different policies, and making them consistent with one another to produce one comprehensive single document, will be a big challenge and there is no way to escape it if sustainable development is desired. To mange and govern coastal and marine resources and environment, the following recommendations can be taken into consideration and incorporated into the policy framework.

6.2.1. Integration, harmonization and consistency of policies and strategies is required to turn them into a single comprehensive policy document. Interagency coordination can be strengthened by establishing a lead agency and placing it at the highest level of government to work as the catalyst to translate the programs into action. The ocean governance framework as proposed recently, must come into effect as early as possible.

6.2.2. Facilities and capacities in the existing institutions and organizations must be increased to turn their weaknesses into strengths, and the currently proposed two new institutions (NORI, BBSMRMU) for expanding coastal and oceanographic research

should be established very soon and capacity building in human resource development in this field must be given top priority.

6.2.3. There should be a long-term sustainable funding mechanism which can be generated through contributions from revenue earned by various coastal and ocean-based economic development activities, particularly taking the initiative of developing Public Private Partnership (PPP). Technical capacities must be enhanced for efficient use of the resources.

6.2.4. No recent and exclusive data are available on marine resources, features and oceanographic processes. Scientific and traditional knowledge must be combined with past experiences to develop a baseline on which management can be established and at the same time a strong monitoring and evaluation mechanism should be developed and ensured. EIA must be conducted before any development initiative to predict future environmental impacts arising out of it and to manage them. A central database for multipurpose uses required by different concerned agencies should be established.

6.2.4. Once baseline information is available, a Marine Spatial Planning (MSP) process is to be put in place. The MSP, proposed in the background report (Annex 3) prepared for the 7th Five-year plan of the country, needs review to make it more comprehensive before any development initiative is undertaken.

6.2.5. Coastal and ocean-based economic activities such as ports and shipping, shipbuilding, and ship recycling can be expanded and made sustainable and eco-friendly. There is a huge prospect and potential for eco-tourism in Bangladesh which can generate alternative employment opportunities for the coastal communities who largely depend on natural resources and fisheries for their livelihoods.

6.2.6. Traditional methods of fishing should be replaced with advanced technology to increase current levels of production to meet future demand. Fishing areas are to be expanded further toward the deep sea by acquiring sophisticated fishing boats.

Aquaculture should be given priority over capture fisheries. Newly developed advanced shrimp farming should be made widespread.

6.2.7. Marine Biotechnology research should be initiated as soon as possible to harvest natural products sustainably. Minerals and other resources should be explored, extracted and utilized considering economies of scale. Salt extraction from seawater has long been practiced and still has room for further development.

6.2.8. Natural disaster resilient and climate change adaptive measures must be undertaken through extensive coastal afforestation programs (as currently done by the Forest Department), and land reclamation toward sea using the sediment flowing through river channels from upstream. Alternative employment can be created and the vulnerable group of people can be relocated elsewhere.

6.2.9. Critical habitats such as mangroves, coral reefs and other marine ecosystems can be protected by bringing them under MPAs and ECAs to derive maximum benefits from them and to enhance ecosystem productivity.

6.2.10. Regional initiatives such as the BOBLME program and other bi-lateral and multi-lateral agreements which are now in place must be strengthened, and implemented to settle trans-boundary issues affecting the ecosystem process. The whole watershed may come under consideration but should not be overlooked as it may divert the plan of coastal and ocean governance from its core principle.

Thus, if all policy documents are integrated into a comprehensive framework, a leading agency is established to coordinate activities of all related existing organizations, a sustainable funding mechanism is ensured, technical and human resource capacities are built up, a baseline is developed with a combination of scientific and traditional knowledge on which the MSP process will take place, public participation is entertained, right persons are put in place to give expert advice, monitoring and evaluation

mechanism functions well to assess the progress- then the whole system can work as an effective tool to bring sustainability in coastal and ocean management in Bangladesh.

7 REFERENCES

Afroz, T., & Alam, S. (2013). Sustainable shrimp farming in Bangladesh: A quest for an Integrated Coastal Zone Management. *Ocean and Coastal Management*, *71*, 275–283. http://doi.org/10.1016/j.ocecoaman.2012.10.006

Ahmed, A. (2011). Some of the major environmental problems relating to land use changes in the coastal areas of Bangladesh: A review. *Journal of Geography and Regional Planning*, *4*(1), 1–8. http://doi.org/ISSN 2070-1845

Ahsan, B. (2015, May 31). Falling demand decreases- imports of old ships. *The Financial Express*, p. B5. Dhaka. Retrieved from http://epaper.thefinancialexpress-bd.com/?archiev=yes&arch_date=31-05-2015#

Alam, B. (2013). *Energy resoueces of Bangladesh, 2nd edition*. Agargaon, Dhaka.

Alam, M. K. (2004). *Bangladesh's maritime challenges in the 21st centuary*. Dhaka: Pathak Shamabesh Book.

Belfiore, S., Barbière, J., Bowen, R., Cicin-Sain, B., Ehler, C., Mageau, C., … Siron, R. (2006). A handbook for measuring the progress and outcomes of integrated coastal and ocean management. *IOC Manuals and Guides*, *46*, 224.

Blue Ribbon Panel. (2013). *Indespensible ocean: Aligning ocean health and human well-being*.

BOBLME. (2011). *Country report on pollution in the BOBLME-Bangladesh. BOBLME-2011-Ecology-01*.

BOBLME. (2012). *Managing advisory for the Bay of Bengal Hilsa fishery*.

Brammer, H. (2014). Bangladesh's dynamic coastal regions and sea-level rise. *Climate Risk Management*, *1*, 51–62. http://doi.org/10.1016/j.crm.2013.10.001

Cicin-Sain, B., & Knecht, R. (1998). *Integrated Coastal and Ocean Management: Concepts and Practices* (Vol. Book Revie). Washington D.C.: Island Press. Retrieved from http://books.google.com/books?id=cDD_4xDoiOEC&pgis=1

Cicin- Sain, B., & Knecht, R. W. (2009). Implications of the earth summit for ocean and coastal governance. *Ocean Development & International Law*, *24*(4), 323–353. http://doi.org/10.1080/00908329309546016

CPA. (2015). Economic Importance of Chittagong Port. Retrieved from http://cpa.gov.bd/

Das, S., & Siddiqi, N. A. (1985). The Mangroves and Mangrove Forests of Bangladesh. Mangrove Silviculture Division, Bulletin No. 2. *Bangladesh Forest Research Institute*, 142.

Deb, A. K. (1998). Fake blue revolution: environmental and socio-economic impacts of shrimp culture in the coastal areas of Bangladesh. *Ocean & Coastal Management*, *41*(1), 63–88. http://doi.org/10.1016/S0964-5691(98)00074-X

Dof. (2014). *National Fish Week 2014 Compendium*. Dhaka.

Ehler, C. N. (2003). Indicators to measure governance performance in integrated coastal management. *Ocean & Coastal Management*. http://doi.org/10.1016/S0964-5691(03)00020-6

EPB. (2012). *Export Statistics (2010-2012)*. Dhaka, Bangladesh.

FAO. (2015). Fisheries, aquaculture, oceans and seas, (December 2014), 2014–2015. Retrieved from http://www.fao.org/fileadmin/user_upload/post-2015/14_themes_Issue_Papers/EN/14_themes__december_2014_/fisheries-09.pdf

Hale, L. Z., & Robadue, D. D. (2002). *International Experience in Integrated Coastal Resources Management*. Suva. Retrieved from http://www.crc.uri.edu/download/International_Experience.pdf

Halpern, B. S., Longo, C., Hardy, D., McLeod, K. L., Samhouri, J. F., Katona, S. K., … Zeller, D. (2012). An index to assess the health and benefits of the global ocean. *Nature*, *488*(7413), 615–20. http://doi.org/10.1038/nature11397

Halpern, B. S., Longo, C., Lowndes, J. S. S., B.D., B., M., F., & Katona, S. K. (2015). Patterns and Emerging Trends in Global Ocean Health. *PLoS ONE*, *10*(3). http://doi.org/10.1371/journal.pone.0117863

Haque, U., Hashizume, M., Kolivras, K. N., Overgaard, H. J., Das, B., & Yamamoto, T. (2012). Reduced death rates from cyclones in Bangladesh: What more needs to be done? *Bulletin of the World Health Organization*, *90*(2), 150–156. http://doi.org/10.2471/BLT.11.088302

Hossain, M. S. (2001). Biological aspects of the coastal and marine environment of Bangladesh. *Ocean & Coastal Management*, *44*(3-4), 261–282. http://doi.org/10.1016/S0964-5691(01)00049-7

Hossain, M. S., Chowdhury, S. R., Navera, U. K., Hossain, M. A. R., Imam, B., & Sharifuzzaman, S. M. (2014). *Opportunities and strategies for ocean and river resources management*. Dhaka. Retrieved from http://www.plancomm.gov.bd/7th-five-year-plan/

Iftekhar, M. S. (2006). Conservation and management of the Bangladesh coastal ecosystem: Overview of an integrated approach. *Natural Resources Forum*, *30*(3), 230–237. http://doi.org/10.1111/j.1477-8947.2006.00111.x

IISD. (2015). UN Finaalizes 2030 Agenda for Sustainable Development. Retrieved August 25, 2015, from http://nr.iisd.org/news/un-finalizes-2030-agenda-for-sustainable-development/

IMO. (2015). Overview. Retrieved July 29, 2015, from https://business.un.org/en/entities/13#tab_overview

Islam, M. R. (2006). Managing Diverse Land Uses in Coastal Bangladesh : Institutional Approaches. *Environment and Livelihoods in Tropical Coastal Zones*, 237–248. Retrieved from http://www.iwmi.cgiar.org/publications/CABI_Publications/CA_CABI_Series/Coastal_Zones/protected/Hoanh_1845931076.pdf

Islam, M. R. (2006). Pre-and post-tsunami coastal planning and land-use policies and issues in Bangladesh. *Agriculture*, 55–80.

Islam, S. A., & Rahman, M. (2015). Coastal afforestation in Bangladesh to combat climate change induced hazards, *02*(01), 13–25. Retrieved from http://www.journalbinet.com/jstei-volume-02.html

IUCN. (2010). *Integrated Coastal Management (ICM): Best Practices and Lessons Learned : workshop report*. Colombo.

Kong, H., Xue, X., Mao, Z., Derrick Ngoran, S., & Yang, W. (2015). Towards integrated coastal governance with Chinese characteristics – A preliminary analysis of China's coastal and ocean governance with special reference to the ICM practice in Quanzhou. *Ocean & Coastal Management*, *111*, 34–49. http://doi.org/10.1016/j.ocecoaman.2015.04.008

Marine Law and Ocean Policy Centre. (2007). *Review of International Approaches to Integrated Coastal Management*. Galway. Retrieved from http://corepoint.ucc.ie/FinalDeliverables/Publications/Effectiveness_of_CurrentSpatialPolicies/Review of International Approaches to ICM.pdf

Meltzer, E. (1998). International Review of Integrated Coastal Zone Management. *Oceans Conservation Report Series: Integrated Coastal Zone Management - Marine Protected Areas - Marine Environmental Quality*, 109pp.

Ministry of Water Resources. (2005). *Coastal Zone Policy*. Dhaka.

Mulder, J. P. M., Hommes, S., & Horstman, E. M. (2011). Implementation of coastal erosion management in the Netherlands. *Ocean and Coastal Management*, *54*(12), 888–897. http://doi.org/10.1016/j.ocecoaman.2011.06.009

NOAA. (2015). Ocean. Retrieved August 3, 2015, from http://www.noaa.gov/ocean.html

Papa, F., Frappart, F., Malbeteau, Y., Shamsudduha, M., Vuruputur, V., Sekhar, M., … Calmant, S. (2015). Satellite-derived surface and sub-surface water storage in the Ganges–Brahmaputra River Basin. *Journal of Hydrology: Regional Studies*. http://doi.org/10.1016/j.ejrh.2015.03.004

Rahman, M. A., & Rahman, S. (2015). Natural and traditional defense Mechanisms to reduce climate Risks in coastal zones of Bangladesh. *Weather and Climate Extremes*, *7*, 84–95. http://doi.org/10.1016/j.wace.2014.12.004

Rahman, M., & Biswas, S. K. (2004). Feasible Solution of Protection and Adaptation Strategy for Coastal Zone of, *8*(15), 9–19.

Reuters. (2015, September 9). To help climate migrants, Bangladesh takes back land from the sea. *The Express Tribune*. Dhaka. Retrieved from http://tribune.com.pk/story/953627/to-help-climate-migrants-bangladesh-takes-back-land-from-the-sea/

Santoro, F., Lescrauwaet, A.-K., Giraud, J.-P., Lafitte, A., & Barbiere, J. (2013). A Set of Indicators for ICZM. In E.Ozhan (Ed.), *Proceedings of the Global Congress on ICM: Lessons Learned to Address New Challenges* (pp. 23–33). Marmaris.

Sarker, S., Kuri, K. C., Chowdhury, M. S. M., & Rahman, M. T. (2010). MANGROVE : A LIVELIHOOD OPTION FOR COASTAL COMMUNITY Overview of

Mangrove forest in Bangladesh. *Bangladesh Research Publications Journal*, *3*(4), 1187–1192.

Schlosser, P. (2013). Ocean services - what is their value? In P. Pissulla, M. Visbeck, & Schlosser (Eds.), *Sustainable oceans: Reconciling economic use and protection* (p. 15). Kiel: Drager Foundation.

Sorensen, J. (1993). The international proliferation of integrated coastal zone management efforts. *Ocean & Coastal Management*, *21*(1-3), 45–80. http://doi.org/10.1016/0964-5691(93)90020-Y

Sorensen, J. (2002). Baseline 2000 Background Report: The Status of Integrated Coastal Management as an International Practice (Second Iteration). *Urban Harbors Institute Publications*. Retrieved from http://scholarworks.umb.edu/uhi_pubs/31

The Hinu Report. (2015, July 29). India eyes deep sea port in Bangladesh. *Coastal News Today*. Retrieved from http://coastalnewstoday.com/bangladesh-india-eyes-deep-sea-port-in-bangladesh/?utm_source=Coastal+Engineering+News+%26+Subscription+List&utm_campaign=26fbf76b8d-Coastal+News+Today&utm_medium=email&utm_term=0_4fc585b6c5-26fbf76b8d-310285549

Thia-Eng, C. (2006). *The Dynamics of Integrated Coastal Management: Practical Application in the Sustainable Coastal Development in East Asia*. Quezon: GEF/UNDP/IMO Regional Programme on Building Partnership in Environmental Management for the Seas of East Asia.

Van der Werf, J., Reinders, J., van Rooijen, a., Holzhauer, H., & Ysebaert, T. (2015). Evaluation of a tidal flat sediment nourishment as estuarine management measure. *Ocean & Coastal Management*, *114*, 77–87. http://doi.org/10.1016/j.ocecoaman.2015.06.006

Visbeck, M. (2013). Why are the oceans important to human society? In P. Pissulla, M. Visbeck, & P. Schlosser (Eds.), *Sustainable oceans: Reconciling economic use and protection* (p. 15). Lubeck: Drager Foundation.

World Bank. (2012). Sustainable Development- The Living Oceans. Retrieved August 4, 2015, from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSDNET/0,,contentMDK:23168627~pagePK:64885161~piPK:64884432~theSitePK:5929282,00.html

World Bank. (2015). Oceans, Fisheries and Coastal Economies. Retrieved August 5, 2015, from http://www.worldbank.org/en/topic/environment/brief/oceans

World Population Review. (2015). Bangladesh Population 2015. Retrieved August 24, 2015, from http://worldpopulationreview.com/countries/bangladesh-population/

Ye, G., Chou, L. M., Yang, S., Wu, J., Liu, P., & Jin, C. (2015). Is integrated coastal management an effective framework for promoting coastal sustainability in China's coastal cities? *Marine Policy*, *56*, 48–55. http://doi.org/10.1016/j.marpol.2015.02.009

Annex 1: Ocean and coastal use model

Couper's Global Marine Interaction Model (Couper, 1983)	Sorensen and McCreary (1990)	Pido and Chua (1992)	Vallega Coastal Use Framework (Valega, 1992)	Hawaii Ocean Resources Management(Example of CZM Approach) (1991)
Navigation and communication Mineral and energy resources, Biological resources, Waste disposal and pollution, Strategy and defense, Recreation, Research, and Marine environmental quality	Fisheries, Natural area and protection systems, Water supply, Recreation development, Tourism, Port development, Energy development, Oil and toxic spill contingency planning, Industrial sitting, Agriculture, and Mariculture	Agriculture, Fisheries and aquaculture, Infrastructure, Mining, Ports and harbors, Industry, Tourism, Urban development, Forestry, and Shipping	Seaports, Shipping, Sea pipelines, Cables, Air transportations, Biological resources, Hydrocarbons, Metalliferous renewable resources, Renewable energy resources, Defense, Recreation, Waterfront structural development, Waste disposal, Research, Archaeology, Environmental protection and preservation	Research, Recreation, Harbors, Fisheries, Marine ecosystem protection, Beaches and coastal erosion, Waste management, Aquaculture, Energy, and Marine mammals

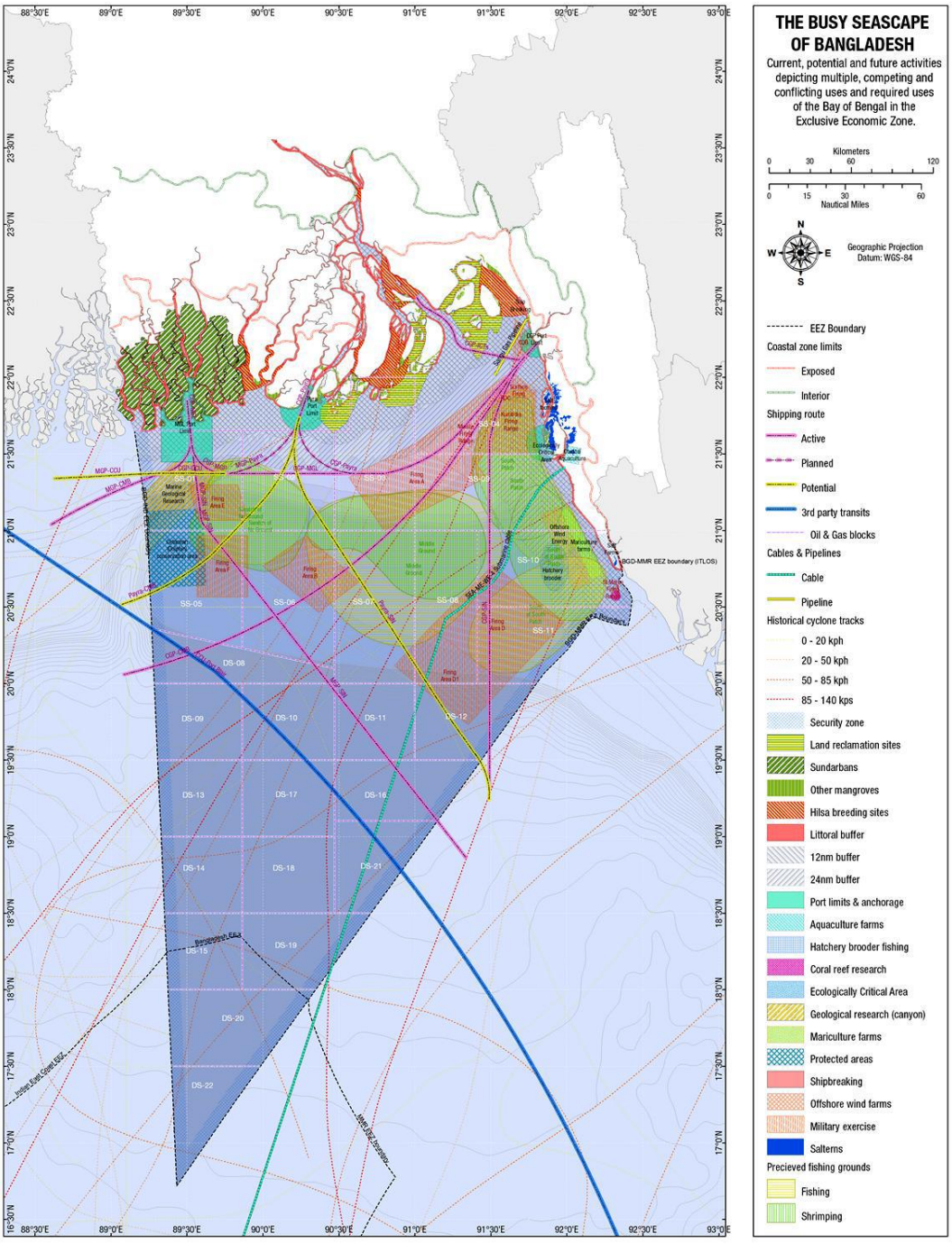
Source: Valllega, 1996

Annex 2: Major coastal and ocean activities

1	**Navigation and Communication:** Shipping, ports and harbor development, navigational aids, communication cables
2	**Living Marine Resources:** Fishing, aquaculture, gathering seaweeds and marine creatures (e.g. snails, shells, pearls), tropical fish collection, collection of marine mammals and watching marine mammals (e.g. whale watching), marine biotechnology application, use of marine organisms or processes for product development
3	**Mineral and Energy Resources:** Hydrocarbon (oil and gas) exploration and production, offshore installations, exploitation of sand and gravel aggregates, exploitation of other minerals (gold, manganese nodules), ocean energy (wave energy, tidal power, ocean thermal energy)
4	**Tourism and Recreation:** Hotels, vacation homes, tourism infrastructure, swimming and driving, underwater parks, recreational fishing, boating and other non-consumptive aesthetic uses
5	**Beach and Shoreline Management:** Erosion control programs, protection structures (against storms, waves), beach nourishment, prevention and mitigation of coastal hazards (storms, inundation sea-level rise)
6	**Military Activities:** Transit and maneuvers by navies, military special areas (test ranges, exercise areas), enforcement of national ocean zones
7	**Coastal Infrastructure Development:** Transportation infrastructure (roads, bridges), water supply and treatment, reclamation or alteration of coastal waters (building of human settlement, impoundment for aquaculture ponds), desalination facilities.
8	**Waste Disposal and Pollution Prevention:** Siting of industrial facilities, sewage disposal, dumping of degraded materials and dispoasal of other wastes, non-point sources of marine pollution (e.g., run off, river sedimentation), oil and toxic spill contingency planning
9	**Ocean and Coastal Environmental Quality Protection:** Protection of the ocean's global role in regulating climate, protection of the oceans from pollution, protection of the oceans from transport and disposal of hazardous materials (radioactive, chemicals), establishment of marine and coastal protected areas, parks to protect critical habitats (e.g., coral reefs, wildlife sancturies), marine mammal protection, protection of cultural heritage (e.g., religious sites, archaeological sites), protection of the oceans from transfer of alien species (e.g., through ballast water), prevention and mitigation of harmful algal bloom
10	**Research:** Oceanography, marine geology and coastal processes, fisheries and marine mammal research, marine biology, biodiversity, biotechnology, archaeoloy, and studies of human uses of the ocean

(Source: Cicin-Sain & Knecht, 1998)

Annex 3: A proposed MSP Framework for Bangladesh



(Source: Planning Commission, 2014)