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Marine Protected Areas in Bangladesh

A Perspective on Governance and Management

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Abstract

To combat the coastal vulnerability to degradation of marine biodiversity and climate change consequences, Bangladesh – a deltaic tropical country situated in the Bay of Bengal Large Marine Ecosystem (BOBLME) – is now on the verge of setting reinforced priorities for the protection of ecologically critical marine and coastal environment as well as the sustainable management of natural resources. The recent settlement of maritime boundary disputes among Bangladesh and its two neighboring countries – Myanmar and India – has added pace to the national and regional efforts towards marine conservation and resilient maritime economy. The current study focuses on the challenges of existing governance framework supporting the coastal-marine biodiversity conservation and sustainable resource management in Bangladesh. The investigation also identifies the opportunities and strategic actions for establishing marine protected areas (MPA) in the country. Considering the available legal provisions for marine conservation and the major limitations therein especially the inadequate integration and coordination among the respective sectors and agencies, it seems logical to craft an integrated coastal-ocean governance framework, which should address the objectives and purposes of protected area management, pollution control, habitat restoration, spatial planning, community resilience, empowerment of coastal people and livelihood development in the coastal-oceanic realm of Bangladesh.

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Contents

Acronyms

BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BIDS	Bangladesh Institute f Development Studies
BoB	Bay of Bengal
BOBLME	Bay of Bengal Large Marine Ecosystem Project
CBD	Convention on Biological Diversity
CCA	Climate Change Adaptation
CCC	Convention on Climate Change
CPUE	Catch per unit effort
CZ	Coastal Zone
CZPo	Coastal Zone Policy 2005
DOALOS	Division of Ocean Affairs and the Law of the Sea
DoE	Department of Environment
DoF	Department of Fisheries
EAF	Ecosystem Approach to Fisheries
ECA	Ecologically Critical Area
EEZ	Exclusive Economic Zone
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GIS	Geographic Information System
GoB	Government of Bangladesh
ICM	Integrated Coastal Management
IHO	International Hydrographic Office
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IWM	Institute of Water Modeling
MAF	Mean annual flow
MoA	Ministry of Agriculture
MoF	Ministry of Fisheries
MoFA	Ministry of Foreign Affairs
MoP	Ministry of Planning
MoWR	Ministry of Water Resources
MPA	Marine Protected Area
MSP	Marine Spatial Planning
Ppt	Parts per thousand
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNCSD	United Nations Conference on Sustainable Development
UNDP	United Nations Development Program
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCED	World Commission for Environment and Development
WSSD	World Summit on Sustainable Development

Introduction

The coast of Bangladesh lies in the Bay of Bengal Large Marine Ecosystem, which is facing threats from marine biodiversity loss due to degradation of habitats and overexploitation of certain commercial species.[1] Moreover, being situated in the largest deltaic floodplain in the world, Bangladesh is critically vulnerable to sea level rise. So, effective governance is crucial for ensuring a healthy and resilient marine ecosystem as well as a robust economy in the country. It certainly calls for a transitional approach – from managing sector-based interventions toward ecosystem-based management – in which social participation plays a fundamental role for inclusive development and sustainability.

Coastal Zone and Maritime Area of Bangladesh

The Bay of Bengal (BoB) is one of the world's 64 Large Marine Ecosystems (LMEs). Eight countries surround the Bay from north, east and west – Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand. The southern part of the bay is connected to the Indian Ocean. The Bay of Bengal is the north-eastern extension of the Indian Ocean, which lies north of 6°N latitude and west of about 95°E longitude, the Andaman Sea and Andaman Islands excluded.[2] Being an extension, BoB shares many oceanic characteristics of the Indian Ocean including cyclones and southwest monsoon, and has dynamic connections to the Andaman Sea, Malacca Strait and Palk Strait.

The BoB is a shallow oceanic extent, 1.0-1.8 kilometer shallower than open ocean basins and it sits on the thickest sediment deposits of the world, 21-22 km at its

[1] Hoq, M.E. and Haroon, A.K.Y. (2012). *Support to Sustainable Management of the BOBLME Project.* Progress Report. Bangladesh Fisheries Research Institute (BFRI), Mymensingh.
[2] IHO (1953). *Limits of Oceans and Seas* (Special Publication No. 23). 3rd Edition. International Hydrographic Organization, Monte Carlo.

thickest[3], with an average of about 16.5 km,[4] and hosts the world's largest so-called *fluvio-deltaic slope complex*, named as the *Bengal Fan*, making it a potential area for large fossil fuel reserves trapped in the sediment.[5]

The bay is one of the least saline seas in the world as it receives the greatest freshwater discharges of all large river systems, 1.6 trillion cubic meters per year[6,7]. The water salinity ranges from almost 'zero' near the coast[8] to below 30 ppt,[9,10] compared with 35 ppt and above for the world average;[11] which means that fresher and lighter water sitting on top of saltier and heavier water makes it harder for the nutrient rich deeper water to turn over and reach the surface in a process called 'upwelling', which is necessary for enhancing primary biological productivity at sea, and at the same time rendering coastal salt-extraction processes less efficient than for other seas.[12]

The Bay of Bengal also receives one of the world's largest volumes of sediment, or about 665 million tons per year as a historical average,[13] making it an ideal place for land reclamation by judicious use and engineering intervention of the incoming sediment, at the same time rendering it one of the most turbid seas favored by some

[3] Allen, P.A. and Allen, J.R. (2005). *Basin analysis: Principles and Applications.* Wiley-Blackwell.
[4] Wasson, R.J. (2003). A sediment budget for the Ganga–Brahmaputra catchment. *Current Science*.
[5] Blakeley, I. (2010). Frontier Exploration: Bay of Bengal - Many Possibilities and Challenges Ahead. *GeoExpro*.
[6] Madhupratap, M.; Gauns, M.; Ramaiah and others (2003). Biogeochemistry of the Bay of Bengal: Physical, chemical and primary productivity characteristics of the central and western Bay of Bengal during summer monsoon 2001. *Deep Sea Research, Part II*
[7] Subramanian, V. (1993). Sediment load of Indian rivers. *Current Science.*
[8] Mahmood, N.; Chowdhury, S.R.; Sharif, A.S.M. and others. (2002). *A review of research works on water quality of the Lotic, Estuarine and Marine environment in Bangladesh* (Review Monograph). Institute of Marine Sciences, University of Chittagong.
[9] Benshila, R.; Durand, F.; Masson, S.; Bourdallé-Badie, R.; Montégut, C.B.; Papa, P. and Madec, G. (2014). The upper Bay of Bengal salinity structure in a high-resolution model, *Ocean Modelling.*
[10] Lagerloef, G. (2012). Satellite Mission Monitors Ocean Surface Salinity, *EOS, Transactions, American Geophysical Union*.
[11] Sverdrup, H.U.; Johnson, M.W. and Fleming, R.H. (1942). *The Oceans: Their Physics, Chemistry, and General Biology*, Prentice-Hall, NY.
[12] Hossain, M.S.; Hossain, M.Z. and Chowdhury, S.R. (2006). An Analysis of Economic and Environmental Issues Associated with Sea Salt Production in Bangladesh and Thailand Coast. *International Journal of Ecology and Environmental Sciences.*
[13] Wasson, R.J. (2003). A sediment budget for the Ganga–Brahmaputra catchment. *Current Science.*

species of fishes (*e.g.*, *Hilsa*), which also indicates the occurrence of less sunlight penetration due to turbidity in concert with intense cloud cover during the monsoons[14] that hinders photosynthesis and makes the sea biologically less productive. The higher turbidity of the bay also makes a greater portion of the coastal shoreline of Bangladesh visually less appealing to tourists.

Being one of the tropical cyclone hotspots of the world the Bay of Bengal experiences 7% of world's cyclones.[15] Unlike other oceans and seas, it has two cyclone seasons each year.[16] Moreover, cyclones and tropical depressions appear to be becoming more frequent in recent years.[17]

The northern BoB is a semidiurnal 'macrotidal' environment, which means tide elevation rises and falls more than 4 meters (>13ft), up to 6m (>19ft) in some places, twice daily, resulting in strong tidal currents creating enormous potential for tapping this dynamic force for mechanical work and power generation; seasonal sea-level in this region rises by about 1m (>3ft) during the south-west monsoon (August) season compared to the cool winter (February) level[18] giving rise to a unique seasonal shift of sea-level (found only here and in the Arabic Gulf) and hence generating shoreline variations having practical implications for natural ecosystems and human activities.

Almost all of the BoB's shallowest 100-200m of water is well-oxygenated whereas the water below this depth is seriously in short of oxygen, a condition referred to as

[14] Gomes, H.R.; Goes, J.I. and Saino, T. (2000). Influence of physical processes and freshwater discharge on the seasonality of phytoplankton regime in the Bay of Bengal. *Continetal Shelf Research*

[15] Gray, W.M. (1968). Global view of the origin of Tropical Disturbances and Storms. *Atmospheric Science Paper* 114. Colorado State University.

[16] Li, Z.; Yu, W.; Li, T.; Murty, V.S.N. and Tangang F (2013). Bimodal Character of Cyclone Climatology in the Bay of Bengal Modulated by Monsoon Seasonal Cycle, *Journal of Climate*

[17] Chowdhury, S.R.; Hossain, M.S.; Shamsuddoha, M. and Khan, M.M.H. (2012). *Coastal Fishers' Livelihood in Peril: Sea Surface Temperature and Tropical Cyclones in Bangladesh*. CPRD, Dhaka.

[18] Chowdhury, S.R. (1993). *Study of the tidal behavior along the coast of Bangladesh with special emphasis on the seasonal variations*. MSc Thesis, Institute of Marine Sciences, University of Chittagong.

'hypoxia'[19] or 'oxygen minimum zones', in which animals find it hard to survive; this suggests a mid-to-deep water body unable to support large fishery at these depths; biological productivity in the BoB is much lower than in the Arabian Sea particularly in the entire summer monsoon season[20,21] which means the BoB can only support a smaller oceanic fish population; and being located in the tropics, it is low in productivity, but rich in biodiversity.

Through the much-awaited verdict on the dispute regarding the delimitation of the maritime boundary between India and Bangladesh in 2014, the latter has received entitlement to 118,813 sq. km in the BoB comprising her territorial sea and Exclusive Economic Zone (EEZ).[22] Earlier in 2012, Bangladesh also settled the maritime dispute with Myanmar. Taking into account major river inlets and estuaries, which are together very much a part of the marine ecosystem, the total marine waters of Bangladesh stands at 121,110 sq. km of which coastal waters and the shallow shelf sea constitute about 20% and 35% respectively, the rest (45%) lying in deeper waters.[23]

The coastal people of Bangladesh are relatively poor economically and significantly dependent on the Bay and its resources for livelihoods. So, lack of modern equipment and harvesting gears ultimately compel the coastal fishers overexploit in-shore coastal seas while off-shore sea resources remain underestimated and possibly underexploited.

[19] Hellya, J.J. and Levin, L.A. (2004). Global distribution of naturally occurring marine hypoxia on continental margins, *Deep-Sea Research, Part I*

[20] Kumar, S.P.; Muraleedharan, P.M.; Prasad, T.G.; and others (2002). Why is the Bay of Bengal less productive during summer monsoon compared to the Arabian Sea? *Geophysical Research Letter.*

[21] Gauns, M.; Madhupratap, M.; Ramaiah, N.; and others (2005). Comparative accounts of biological productivity characteristics and estimates of carbon fluxes in the Arabian Sea and the Bay of Bengal, *Deep Sea Research, Part II*

[22] (2014). Press Release: Press statement of the Hon'ble Foreign Minister on the verdict of the Arbitral Tribunal/PCA. Dhaka, 08 July 2014.

[23] Chowdhury, S.R. (2014). *Maritime Province of Bangladesh (Map)*. Institute of Marine Sciences and Fisheries, University of Chittagong, Chittagong.

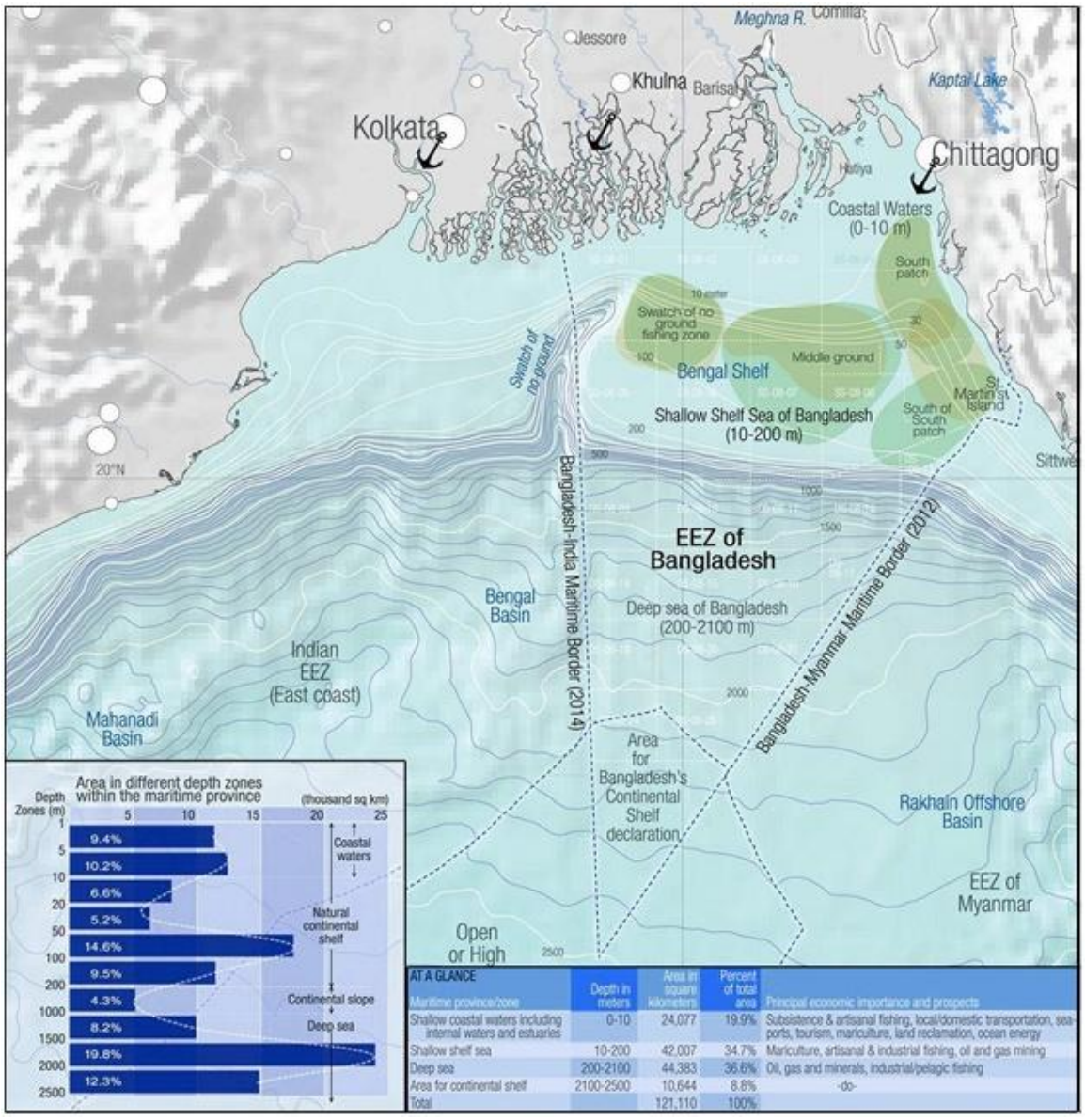

Figure 1: Maritime area of Bangladesh (Chowdhury, 2014)

The recent map (Figure 1) of the maritime area of Bangladesh[24] also shows that the major fishing grounds of Bangladesh are confined within the 200m isobaths on the continental shelf leaving a vast area unexploited in EEZ of the country.

[24] Ibid.

Marine Biodiversity and Resources of Bangladesh

The fisheries sector plays a significant role in fulfilling the demand of animal protein and socio-economic development of the country. This sector contributes about 5% of total GDP and more than sixteen million people (about 11% of total population) of Bangladesh directly or indirectly depend on the fisheries for their livelihood. The BoB of Bangladesh is blessed with rich coastal and marine ecosystems, hosting a wide range of biodiversity, such as fishes, shrimps, molluscs, crabs, mammals, seaweeds, etc. A number of surveys examined the status of marine fisheries resources between 1970s and 1980s, but no recent and comprehensive knowledge is available on the fisheries stocks, systematics, biological and ecological aspects of the coastal and marine fisheries of Bangladesh. The important fish families are Sciaenidae, Ariidae, Nemipteridae, Carangidae, Mullidae, Synodontidae, Trichiuridae, Leiognathedae, Pomadasyidae and Clupeidae, and these ten families make up about 47% of the total biomass, Croakers (Sciaenidae-12.8%) and catfishes (Ariidae-11.99%) being the dominant groups.[25]

The harvest of marine capture fisheries was 379,497 tons during 2000-2001 and went up to 588,988 tons in 2012-2013[26] and sold as frozen (transported to large cities and overseas) or fresh in local markets. A considerable amount of fish is salted and dried, mainly for human consumption. Incidentally, the use of dried fish as a source of fishmeal is gradually increasing due to intensification of fish and poultry farming. Hilsa shad (Tenualosa ilisha) is the largest and single most valuable species with annual catch of 340,000 MT, and generates employment and income for 2.5 million people valued at $US 1.3 billion per year.[27] At present 50-60% of global hilsa catch takes place in the coastal and marine waters of Bangladesh, 20-25% in

[25] Lamboeuf, M. (1987). Bangladesh demersal fish resources of the continental shelf,. R.V. Anusandhani trawling survey results (Sep. 1984 - June, 1986) Rep. Prep. for the FAO/UNDP project strengthening of the national programfor Marine Fish Resources Management Research and Development. FAO, Rome.
[26] DoF (2014). *National Fish Week 2014 Compendium* (In Bengali). Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh.
[27] Hossain et al. (2014). *Opportunities and Strategies for Ocean and River Resources Management*. Food and Agriculture Organization. Bangladesh Country Office, Dhaka.

Myanmar, 15-20% in India and the remaining 5-10% in other countries. A total of 46,568 MT tiger shrimp (*Penaeus monodon*) was caught from BoB during 2012-2013,[28] most of which directly go to the processing plant and end up in the markets of USA, EU and Japan. Over the last 10-15 years, live giant mud crab (*Scylla sp.*) and estuarine eel have been exported to East Asian countries. Less than 20% exported live crab come from crab fattening by the marginal farmers of Satkhira, Bagerhat and Cox's Bazar coasts. Moreover, the harvest of young and undersized sharks and rays are dried, while the large sharks are dumped overboard after removing their fins and some other body parts. The majority of phaisa (*Setipinna phasa*) caught in the coast are used to make fermented fish product.

The Bangladesh coast supports 441,455ha of mangroves, including the world's largest single tract of natural mangroves, i.e. the Sundarbans.[29] Mangroves play an essential role in maintaining a healthy coastal environment by providing protection for a myriad of juvenile aquatic species, functioning as a habitat for a variety of terrestrial fauna, improving coastal protection and acting as a processor of nutrients that sustains many complex food chains.[30] However, these vital tropical ecosystems in the coastal intertidal zones, covering about 170,000 km^2,[31] continue to be under immense threat from a variety of human activities. During the past 20 years, approximately 35% of the world's mangrove forest area has been lost.[32] One of the greatest limitations to their protection is the lack of proper inventory and monitoring. A recent study analyzed Landsat satellite imagery and assessed spatial

[28] DoF (2014). *National Fish Week 2014 Compendium* (In Bengali). Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh
[29] Hasan et al. (2013). Agricultural land availability in Bangladesh. SRDI, Dhaka, Bangladesh
[30] Kovacs, J.M. (1999). Assessing mangrove use at the local scale. *Landscape and Urban Planning*
[31] Khan, Y.S.A. and Hossain, M.S. (1996). Impact of shrimp culture on the coastal environment of Bangladesh. *International Journal of Ecology and Environmental Sciences*.
[32] Valiela, I.; Bowen, J.L. and York, J.K. (2001). Mangrove forests: One of the Worlds threatened major tropical environments. *BioScience.*

distribution of 27014 ha of existing mangrove forest and 60000 ha of an accretion area for future mangrove planting in the Ganges basin, Bangladesh.[33]

To combat natural disasters, especially tropical cyclone, tidal surges and wave action, the protective benefits of mangrove forest are important and well-recognized. The importance of mangroves as nursery grounds for the larval and juvenile stages of fin fishes, shrimps, crabs, and cockles has been highlighted by many researchers around the world. The annual economic value of mangroves, using the cost of the products and services they provide, has been estimated $200,000-900,000/ha.[34] In Bangladesh, this value would translate to between about $90 billion and $400 billion per annum. To maintain a balance between social and economic aspects, an integrated resource management approach, for example mangrove-nursery-livestock or mangrove-livestock-pond-agriculture, should be examined.

Marine protected areas (MPAs) that effectively safeguard critical habitats, species and ecological functions are essential for recovering, protecting and enhancing biodiversity, productivity and resilience, and for securing these benefits for present and future generations.[35] The basic understanding of MPA is still sparse and immature in different institutional levels and also in the coastal communities of Bangladesh. However, increasing concern among some stakeholders shows an urge to develop effective governance, integrated legislative tools and management frameworks for the conservation of marine-coastal biodiversity and sustainable utilization of the ecological goods and services. Nevertheless, this emerging enthusiasm should enable the governance framework potentially contribute to

[33] Hossain, M.S. (2013). Conserving Mangrove Ecosystem for Climate Change Adaptation in the Ganges Basin. In: Moksness E, Dahl E and Stottup J (eds.), Global challenges in integrated coastal zone Management. Wiley-Blackwell, UK

[34] Wells, S. (2006). *In the front line: Shoreline protection and other ecosystem services from mangroves and coral reefs*. UNEP-WCMC.

[35] Reuchlin-Hugenholtz, E.; McKenzie, E. (2015). Marine protected areas: Smart investments in ocean health. WWF, Gland, Switzerland.

reducing poverty, enhancing food security, creating employment and protecting coastal communities.

Chapter 1 - Understanding MPA in the Context of Bangladesh

1.1. MPA - Definition and Background

The concept of marine protected area (MPA) has gained prominence in the dialogue on fisheries management and biodiversity conservation since the early 1990s. The concept and its application continue to evolve and recent developments – particularly with regard to rapidly increasing recognition of the threat of climate change and the related focus on ecosystem resilience – have brought MPAs to the forefront of discussions in global marine conservation and management strategies. [36]

MPAs such as reserves, sanctuaries and parks can achieve protection of particular, well-defined aim and critical habitats.[37] When properly designed and well managed, a MPA can meet various marine and coastal conservation needs by preserving habitat and important species and protecting specific areas. Coral reef fisheries, m particular, can be effectively managed through implementation of "no-take" areas on reefs. This approach has been adopted by leading conservation organizations as the number one objective in a global strategy for conserving areas of high biological importance and productivity.

> "*Any marine geographical area, that is afforded greater protection than the surrounding waters for biodiversity conservation or fisheries management purposes, will be considered an MPA"*.

This broad characterization includes very large areas, such as exclusive economic zones (EEZs) at the extreme, but the term MPA is usually understood to apply to

[36] FAO (2011). Fisheries management. 4. Marine protected areas and fisheries. *FAO Technical Guidelines for Responsible Fisheries*. No. 4, Suppl. 4. Food and Agriculture Organization, Rome.
[37] Agardy, T.S. (1997). *Marine Protected Areas and Ocean Conservation*. Academic Press, California.

areas specifically designated to protect a particular ecosystem, ecosystem component or some other attribute (e.g. historical site).

However, the MPA concept is applied diversely around the world, and with different names for similar policies. MPAs can range from small village-level community-managed areas to large, zoned national parks. The specific rules associated with an MPA vary by context and names are not used consistently. A 'reserve' in one country may prohibit fishing, while a 'reserve' in another country may allow non-destructive fishing. Other terms used, to name a few, are fully protected marine areas, no-take zones, marine sanctuaries, ocean sanctuaries, marine parks; fishery closed areas, fisheries refugia and locally managed marine areas (LMMAs). Probably the most widely accepted definitions of MPAs have been the ones established by the International Union for Conservation of Nature (IUCN) and the CBD.

IUCN has defined an MPA as:

> *Any area of the intertidal or sub-tidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment.*[38]

More recently, a revised definition of a protected area has been provided by IUCN and developed within the WCPA framework. This definition is applicable to both MPAs and protected areas on land:

> *A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the*

[38] Kelleher, G. (1999). Guidelines for marine protected areas. Best Practice Protected Area Guidelines Series No. 3. Gland, Switzerland, International Union for Conservation of Nature (IUCN); and Cardiff, Wales, UK, Cardiff University.

long-term conservation of nature with associated ecosystem services and cultural values.[39]

The ad hoc Technical Expert Group associated with the CBD Programme of Work on Marine Biodiversity has adopted a similar definition for marine and coastal protected areas:

A 'Marine and Coastal Protected Area' means any defined area within or adjacent to the marine environment, together with its overlying waters and associated flora, fauna, and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine or coastal biodiversity enjoys a higher level of protection than its surroundings.[40]

IUCN has developed a set of guidelines which define a protected area and categorize a protected area through different management types (Dudley, 2008). MPAs are also categorized by these guidelines.

Table 1: Categories and definitions of protected areas (Source: Dudley, 2008)

IUCN Category	**Definition of the protected area**
Ia	*Category Ia are strictly protected areas set aside to protect biodiversity and also possibly geological/ geo-morphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring.*
Ib	*Category Ib protected areas are usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.*

[39] Dudley, N. (Ed.) (2008). Guidelines for Applying Protected Area Management Categories. Gland, Switzerland.

[40] CBD (2004). Conference of the Parties 2004. UNEP/CBD/COP/DEC/VII/28. Programme of Work, activity 1.1.7. Montreal, Canada, Secretariat of the Convention on Biological Diversity.

II	*Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.*
III	*Category III protected areas are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine caverns, geological feature such as a caves or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.*
IV	*Category IV protected areas aim to protect particular species or habitats and management reflects this priority. Many category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.*
V	*Category V protected areas are where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.*
VI	*Category VI protected areas conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in natural condition, where a proportion is under sustainable natural resource management and where low-level non industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.*

1.2. Benefits of MPA

If designed and managed effectively as well as combined with complementary measures through an ecosystem approach, MPAs form safe havens for marine flora and fauna. They protect and restore habitats and species, as well as restoring important ecological functions (such as spawning and nursery areas) and sustaining ecosystem goods and services.

MPAs protect habitats that provide a buffer against the impacts of climate change and a level of insurance against natural disasters. Mangroves can mitigate the impacts of tropical storms, and coral reefs can prevent coastal erosion. Well-placed and functional MPAs defend coastal property and infrastructure from impacts of natural disasters. Species survival and reproduction: MPAs can protect critical habitats, including migration routes, places of refuge against predators, spawning grounds and nursery areas. In other words, they support the reproduction and survival of species, including many valuable fish stocks.

Globally, MPAs have been shown to increase fish size, density, biomass as well as species richness.[41] These increases are also seen beyond the boundaries of the protected area, through the so-called spillover effect. This spillover effect applies to larvae, juvenile and adult fish moving beyond MPA boundaries.[42] The community composition outside the protected area becomes like that inside, essentially exporting recovery beyond the protected zone. As such, MPAs are an important tool in stock replenishment, long-term food security and fishing-related livelihoods.

Increasingly, coastal ecosystems are recognized for their important role in fighting climate change through carbon sequestration – and, conversely, their potential to become sources of carbon emissions when degraded.[43] Coastal vegetation – such as seagrass beds, mangroves and salt marshes – stores and sequesters carbon very effectively. The protection and restoration of coastal vegetation could provide coastal and island communities with important economic opportunities on the carbon offset market. A cost-benefit analysis on community groups managing protected forest areas in Nepal found that local people were more likely to receive a

[41] Lester, S.E.; Halpern, B.S.; Grorud-Colvert, K.; Lubchenco, J.; Ruttenberg, B.I.; Gaines, S.D.; Airame, S. and Warner, R.R. (2009). Biological effects within no-take marine reserves: A global synthesis. *Marine Ecology Progress Series*

[42] ibid

[43] Crooks, S.; Herr, D.; Tamelander, J.; Laffoley, D. and Vandever, J. (2011). Mitigating Climate Change through Restoration and Management of Coastal Wetlands and Nearshore Marine Ecosystems: Challenges and Opportunities. Environment Department Paper 121, World Bank, Washington DC, USA.

net income increase from voluntary carbon market (VCM) if they were able to continue using forest products and had clear tenure arrangements and use rights.[44]

MPAs can support livelihoods for families and communities. They can also create jobs for managers and researchers. MPAs are known to attract and sustain coastal tourism and recreation, supporting growth of employment and commerce associated with these sectors at the local, regional and national level.

The Ocean provides important cultural services – aesthetic, artistic, educational, recreational, scientific and spiritual values. MPAs can be implemented to restore and conserve these values as well.

1.3. Concept and Status of MPAs in Bangladesh

Although there have been legislative mechanisms to govern ecologically critical or significant areas in mostly terrestrial and some coastal environments, there was no explicit designation of marine protected area in Bangladesh even recently. However, after settling the disputes regarding the delimitation of maritime boundary with Myanmar and India in recent years, Bangladesh announced the 'Swatch of No-Ground' – a submarine canyon in the Bay of Bengal – as the country's first ever marine protected area (MPA) in 2014 to safeguard a number of endangered dolphins, whales, sharks and other marine species.

Being a signatory of the Convention on Biological Diversity (CBD), Bangladesh is committed to declare 10% of her EEZ as MPAs by the year 2020. Through the settlement of maritime boundary disputes with its neighboring countries, Bangladesh gained an expanded area of EEZ that has become important both from

[44] Karky, B. and Skutsch, M. (2009). The Cost of Carbon Abatement through Community Forest Management in Nepal Himalaya. *Ecological Economics*.

ecological, biodiversity and economic viewpoints. The total marine water area of Bangladesh, including territorial sea and the EEZ, now stands at 121110 sq-km.

The EEZ of Bangladesh is a relatively little studied habitat for biodiversity and there is virtually no administrative and management control and the renewable biological resources are exploited under nominal supervision from Department of Fisheries and mineral resources. Currently only natural gas survey and exploitation is ongoing under the Energy and Mineral Resources Division (EMRD) of Ministry of Power, Energy and Mineral Resources. However, the artisanal fisheries are overexploited. On the other hand, deep sea fishing from local fishers is negligible and remains underexploited.

There is very little information available about the status of protected areas in the marine environment in Bangladesh. While some of the country's terrestrial protected areas encompass parts of the coastal zone, there are no explicit 'marine protected areas' as defined through legislation. As such, the following sections review information about Bangladesh's terrestrial parks that contain marine components as well as other place-based marine conservation measures, drawing primarily upon journal articles and government reports.

The Bangladesh Wildlife Preservation Act of 1974 defines national parks and wildlife sanctuaries. There are examples of both of these protected area categories in the marine environment. In total, there are currently 15 national parks and 13 wildlife sanctuaries throughout the country, 7 of which encompass parts of the marine environment, notably mangrove ecosystems.

The Environmental Conservation Act of 1995 makes provision to declare the 'ecologically critical area' (ECA), another type of protected area in Bangladesh. ECAs are typically declared in areas that have suffered from intense ecological destruction. Of the four ECAs in the marine zone, the most well known include St. Martin's Island

and the Teknaf Peninsula in Cox's Bazaar.[45] There are also ECAs within the Sundarbans. Bangladesh's only coral reef communities are found in the former ECA 'Jinjira Reefs' (currently being considered for marine national park status), where they occupy an area less than 50km^2. Of all protected areas with marine habitat in the country, only one – the Sundarbans – is recognized internationally for possessing unique ecological diversity and accordingly listed as both a World Heritage and a Ramsar Site.

Unfortunately due to the lack of adequate information and knowledge no area of the EEZ has been declared as ECA yet, though the entire length of Cox's Bazar beach including Sonadia and Saint Martin islands fall in the category of the ECA as declared by the Department of Environment. There is a straightforward method of declaring a site as ECA based on criteria like legal boundary and a map for each of the ECA and it should be delineated and the government should develop a management plan for the ECA. In Bangladesh the declaration of an ECA at Sundarbans known as Sundarbans Reserve Forest (SRF) has been done. However, no map was prepared and there are no management plans, which are obligatory for an ECA. Nonetheless, some measures like harvest of natural resources, hunting and killing of wild animals, destruction of habitats, establishment of industries, which can pollute the environment are prohibited in the ECA and are right steps towards the goal.

Environmental Conservation Act of 1995, which was amended 2010, states that the legal boundary and map for each land-based ECA should be prepared. Now, we need similar initiatives for marine habitat, ecosystem and environments to protect biodiversity and ensure judicious exploitation of natural resources.

[45] Mukul, S.A.; Uddin, M.B.; Uddin, M.S.; Khan, M.A.S.A. and Marzan, B. (2008). Protected areas of Bangladesh: Current status and efficiency for biodiversity conservation. Proc. Pakistan Acad. Sci. S4.5 A(2)

1.4. MPA Governance and Legal Framework in Bangladesh

The Department of Environment (DoE), steered by the Ministry of Environment and Forest (MoEF), is the primary government agency for declaration and management of marine protected areas in Bangladesh. The DoE has the authority to declare ecologically critical areas (ECAs) if it deems an area under threat. The Forest Department is responsible for declaring national parks and sanctuaries, while the Fisheries Department is responsible for identification and declaration of MPAs in other forms (such as closed-fishing seasons and fisheries sanctuaries or reserves).

Other agencies with a peripheral role in the management of marine protected areas include:

- Ministry of Fisheries and Livestock
- Bangladesh Fisheries Research Institute
- Academic Institutions including Institute of Marine and Fisheries at Chittagong University, Fisheries and Marine Resources Technology discipline of Khulna University, Coastal and Marine Fisheries Department at Sylhet Agricultural University, Faculty of Fisheries at Bangladesh Agricultural University.
- Bangladesh Navy and Coast Guard (for enforcing regulations)
- Bangladesh Fisheries Development Corporation (BFDC)

The DoE and MoEF are currently implementing an array of projects in the marine environment, including the United Nations Development Programme (UNDP) / Global Environment Facility (GEF)-funded Coastal and Wetland Biodiversity Management Project in Cox's Bazaar and Hakaluki Haor. The goal of the project is to design and implement an innovative system for managing ecologically critical areas (ECAs), and in doing so, serve as a demonstration site for other ECAs elsewhere in the country.

In an attempt to protect Olive Ridley turtle populations around St. Martin's Island, the MoEF initiated a project in 1996, which include monitoring nesting turtles, in situ conservation, and awareness-raising activities with local coastal communities. Furthermore, according to the Department of Fisheries regulations and the Marine Fisheries Ordinance, all industrial trawlers in the Bay of Bengal (BoB) must use Turtle Excluding Devices (Bangladesh Marine Fisheries Ordinance). The country also recently began strengthening its integrated coastal zone management policy, drawing funding from the World Bank and the Government of Netherlands for the endeavor.

After ratifying the United Nations Convention on the Law of the Sea (UNCLOS), Bangladesh sought new ways to responsibly manage and conserve its marine resources.[46] It took the first steps towards this goal by introducing the Marine Fisheries Ordinance in 1983, which outlined rules that continue to provide the main legal framework for controlling activities, conservation and development in the marine zone.[47] It was the first comprehensive legal instrument to provide for the exploitation, conservation and management of the marine living resources including but not restricted to fishes. It defines the "Bangladesh Fisheries Waters" in the BoB. It lays out important provisions for protection and conservation of fishery resources therein, *e.g.*, bans and moratoriums, protected areas, regulation of type, class and number of fishing vessels, regulation of nets and fishing methods, etc. It also guides the protection of the rights and livelihood of small fishing communities by laying out provisions of designated exclusive fishing zones for them. One year later, The Fisheries Research Institute Ordinance, 1984 enabled the formation of the institute to 'coordinate fisheries research' and to develop more efficient and economic methods of production, management, processing and marketing of fish.

[46] Chowdhury, D.K. et al. (1998). Country Report: Bangladesh. Country and regional papers presented at the Regional Workshop on Fisheries Monitoring, Control and Surveillance. GCP/INT/648/NOR. Kuala Lumpur and Kuala Terengganu, Malaysia.
[47] ibid

The National Fisheries Policy, 1998 guides that the exploitation, conservation and management of marine fisheries should be achieved through comprehensive stock assessments, fishery education, research, and joint-venture initiatives with foreign and offshore entrepreneurs. It also advocates declaration of shrimp aquaculture as an industry and extension of state patronizations to the industry, and creation of mechanisms to boost export of fishery commodities. It continues to recognize the fishing rights and exclusive zones for small fishing communities.

The National Shrimp Policy, 2014 is broadly based on many principles of the Fish Policy '98, while recognizing shrimps as valuable fishery resources. Besides laying out targets and principles of exploitation, conservation and management of marine shrimps, it also guides the regulation of shrimp brooder (mother shrimps) collection from the sea, technology development to mitigate impacts of climate change, job creation and poverty easing in the shrimp sector, improved cultivation and enhancement of shrimp production, protection of natural breeding and nursing grounds of shrimps, etc. Furthermore, it guides various actions including zoning of coastal land for shrimp farming, export promotion, education, research, credits, insurance, database creation, etc.

Relevant legislation and policy tools for biodiversity conservation and fisheries management in Bangladesh include:

- National Conservation Strategy (NCS)
- National Environment Management Action Plan (NEMAP)
- Environmental Conservation Act (ECA), 1995
- Environmental Conservation Act (Amendment 2000)
- Environmental Conservation Act (Amendment 2002)
- Environmental Conservation Act (Amendment 2010)
- Environment Conservation Rules (ECR), 1997 and Amendments
- National River Protection Commission Act, 2013
- National Conservation Strategy, 2005

- The National Biodiversity Strategy and Action Plan (NBSAP)
- Territorial Waters and Maritime Zones Act , 1974
- Coastal Zone Policy, 2005
- Coastal Development Strategy, 2006
- Bangladesh Climate Change Strategic Action Plan, 2009
- National Water Policy, 1999
- National Water Management Plan, 2001
- Bangladesh Water Act, 2013
- Navy Ordinance, 1961
- Navy (Amendment) Ordinance, 1977
- Coast Guard Act, 1994
- Fisheries Research Institute Ordinance, 1984
- National Oceanographic Research Institute Act, 2015

Some major legal instruments are further briefed in the following –

Environmental Policy, 1992 – maintains ecological balance and overall development through protection and improvement of the environment; protects country against natural disaster; identifies and regulate activities, which pollute and degrade the environment; ensures environmentally sound development in all sectors; ensures sustainable, long term and environmentally sound base of natural resources; and actively remains associated with all international environmental initiatives to the maximum possible extent.

Environmental Action Plan, 1992 – recommends sector specific action plan to achieve the objectives and implement the policy recommendations of the National Environment Policy.

National Environmental Management Plan (NEMAP), 1995 – sets action plan for national concerns including flood damage, river bank erosion, environmental degradation of water bodies, increased water pollution, shortage of irrigation water and drainage congestion as well as various specific regional concerns

Bangladesh Wildlife (Preservation) Order, 1973 (Amended in 1994) – makes provisions for the safety of wildlife, particularly those vulnerable to extinction and provisions for the establishment of wild life sanctuaries and protected areas

Environmental Conservation Act (ECA), 1995 – provides legislation for environment conservation, environmental standards development and environment pollution control and abatement.

Environmental Conservation Act (Amendment 2000) – focuses on ascertaining responsibility for compensation in cases of damage to ecosystems, increased provision of punitive measures both for fines and imprisonment and the authority to take cognizance of offences.

Environmental Conservation Act (Amendment 2002) – elaborates the restrictions on polluting automobiles, restrictions on environmentally harmful items, assistance from law enforcement agencies for environmental actions, detailing of punitive measures, and authority to try environmental cases.

Environmental Conservation Act (Amendment 2010) – introduces new rules and restrictions on destruction of hills and hillocks, improper waste management of ship breaking yards, alteration of remarked water body, and emission of environmental pollutants

Environment Conservation Rules (ECR), 1997 and Amendments – provide categorization of industries and projects and identify types of environmental assessment required against respective categories of industries or projects and also, declare the ecologically critical areas (ECA).

National Water Policy, 1999 - guides both public and private actions in the future for ensuring optimal development and management of water that benefit both individuals and the society at large.

National Water Management Plan, 2001 (Approved in 2004) – provides a framework within which all concerned with the development, management and use of water resources water services in Bangladesh can plan and implement their own activities in a coordinated and integrated manner.

National Fisheries Policy, 1999 – provides provisions for the protection and conservation of fish in fresh water and brackish water bodies.

Coastal Zone Policy, 2005 – provides general guidance for coastal people to pursue their livelihoods under secured conditions in a sustainable manner without impairing the integrity of the natural environment.

Coastal Development Strategy, 2006 - considers the emerging trends like increasing urbanization, changing pattern of land use, declining land and water resources, unemployment and visible climate change impacts following priorities on safety from man-made and natural hazards; sustainable management of natural resources and environmental conservation in the coastal areas.

Bangladesh Climate Change Strategy and Action Plan, 2009 – addresses climate change challenges in Bangladesh to support food security, social protection and health, comprehensive disaster management, infrastructure,

research and knowledge management, mitigation and low carbon development, and capacity building

Territorial Waters and Maritime Zones Act, 1974 – makes provisions for the declaration of the territorial waters, continental shelf and other maritime zones.

Aside from UNCLOS, for marine and aquatic biodiversity conservation, Bangladesh is committed to different international conventions and obligations, such as -

- FAO Code of Conduct for Responsible Fisheries, 1995 and Compliance Agreement, 1993
- UN Fish Stock Agreement, 1995
- Ramsar Convention, 1971
- Convention on Biological Diversity, 1992
- UNEP Regional Seas Conventions
- Convention on International Trade in Endangered Species (CITES)
- Convention on Migratory Species (CMS)

Chapter 2 - Challenges and Opportunities of MPAs

2.1. Prospects in Biodiversity Conservation and Fisheries Management

Notable developments in the marine fisheries sector particularly with respect to conservation and sustainable exploitation are going on. A calculated proportion of the bottom trawls have already been converted to mid-water trawls in order to lessen pressure on the demersal fish stocks, to reduce destruction of sea-bottom habitats, and to exploit the mid-water fish stocks.

A temporary ban on fishing in a certain period of the year has been imposed for several years now to allow breeding and recruitment of important fishes, specifically Hilsa. Several marine protected areas (MPA) are in the process of being declared to maintain marine biodiversity and fish stocks at sustainable levels (although there is no national policy on MPA development needs or priorities). Destructive fishing methods and gear (*e.g.*, set bag net) have been completely banned from operation. Vessel Tracking and Monitoring System (VTMS) with satellite communication links are going to be installed soon in fishing vessels in phases, in order to monitor and control their maneuver at sea for various management purposes.

In the environment sector, a number of ecologically critical areas (ECA) have been enforced in various coastal ecosystems to maintain critical habitats, biodiversity, marine turtle breeding and conservation, and mangrove restoration and growth. Mangrove afforestation in newly accreted intertidal areas has been going on for decades now.

Recently the National Oceanographic Research Institute (NORI) has been founded for coastal and oceanic research of all kinds. Recently an initiative has also been taken to establish a Chief Hydrographer's Officer at the Armed Forces Division of the

Prime Minister's Office to coordinate and lead hydrographic surveys and other related research activities in the BoB.

Hilsa-closed seasons worked successfully to conserve the stock of fish. Patkar (2014) observed that the production of hilsa increased following the institutions of such closed seasons/the ban on catching hilsa fry. It is worth pointing out that these closed seasons occur in *both* marine and freshwater zones. In other words, it is possible that the observed increases in biomass are due to a multi-pronged effort to conserve the species in its many habitats.

The St. Martin's Island in Cox's Bazaar ECA initially had relatively poor management as a direct result of a lack of resources. This has started to change in recent years, however, in part thanks to the introduction of the UNDP/GEF funded program in the area. This program is putting a regulatory framework in place, and conducting ECA mapping/boundary definition activities. It is also conducting community mobilization efforts in conjunction with local NGOs, and performing ecological/economic baseline information.

To lay foundations for a coordinated effort for regional management of the BoB for maintaining its environment and fisheries, eight countries surrounding the Bay joined together under the umbrella of BOBLME (Bay of Bengal Large Marine Ecosystem) Project. One of the objectives of the BOBLME is to improve lives of the coastal populations through improved regional management. There are several components of the BOBLME Project, and it outlined diverse objectives; the objective of Subcomponent 3.2 (Marine Protected Areas in the Conservation of Regional Fish Stocks) is to gain consensus on approaches to the establishment and management of marine protected areas and fish refugia for sustainable management and biodiversity conservation. [48]

[48] BOBLME. 2012. Report of the SAP Process Development Workshop. Phuket, Thailand.

The recent Strategic Action Programme (SAP) 2015 of BOBLME is aimed to ensure a healthy ecosystem and sustainable use of marine living resources for the benefit of the people and countries of the Bay of Bengal Large Marine Ecosystem including Bangladesh.[49] The potential outcomes of the SAP 2015 are –

- *Fisheries and other marine living resources are restored and managed sustainably*
- *Degraded, vulnerable and critical marine habitats are restored, conserved and maintained*
- *Coastal and marine pollution and water quality are controlled to meet agreed standards for human and ecosystem health*
- *Social and economic constraints are addressed, leading to increased resilience and empowerment of coastal people*

The National Aquaculture Development Strategy and Action Plan (NADSAP) of Bangladesh 2013–2020 has been formulated with the key objectives –

> *"To improve the welfare of the resource-poor people depending on the aquatic resources for livelihood, reduce poverty by stimulating employment and improving income, conserve if not enhance the natural resources on which livelihoods are based, promote the sustainable development of rural communities, increase export earnings, and contribute to the creation of wealth for the nation and improvement in the welfare of the people."*

In spite of its central focus on aquaculture development, this document addresses substantial priorities on marine and coastal fisheries management along the conservation of respective biodiversity. It also imparts necessary options and guidelines for improved coastal aquaculture to strengthen the socio-economic resilience of the coastal communities. The strategies in NADSAP 2013-2020 have

[49] BOBLME. 2015. Strategic Action Programme. Bay of Bengal Large Marine Ecosystem Project.

been derived from the Sixth Five Year Plan,[50] the sectoral development plans[51,52] and the Country Investment Plan (CIP).[53]

The strategy for fisheries development provided in the Sixth Five Year Plan (2011-2015) highlights on open-water fisheries management, ensuring biodiversity and preserving natural breeding grounds; product diversification, value addition, capacity building and development of appropriate marketing infrastructure for fishery products; dynamic and responsible capture fisheries; and sustainable aquaculture. It also encompasses the effective participation of non-governmental organizations, private-sector entrepreneurs and community-based fishing communities to ensure enhanced productivity in shrimp culture, necessary stock assessment and effective management of marine fisheries resources.

On the other hand, the fisheries program of the Country Investment Plan (CIP 2010-2015) comprises four priorities for investment (Box 1), which accentuate the sustainable management and utilization of the aquatic resources for improved productivity, better nutrition and increased incomes of the users of marine resources. The social and economic goals of the investment plan are thus concerted with and backed up by the environmental sustainability concerns.

[50] MoP (2011). *Sixth Five Year Plan (FY2011–FY2015): accelerating growth and reducing poverty, Part-1, Strategic directions and policy framework.* Dhaka, Planning Commission, Ministry of Planning, Government of the People's Republic of Bangladesh.
[51] MoFL (1998). *National fisheries policy.* Ministry of Fisheries and Livestock, Dhaka.
[52] DoF (2006). *National fisheries strategy and action plan for the implementation of the national fisheries strategy.* Dhaka, Department of Fisheries, Ministry of Fisheries and Livestock.
[53] GoB (2011). *Bangladesh country investment plan.* Dhaka, Ministry of Food and Disaster Management, Government of the People's Republic of Bangladesh (GoB).

Box 1: Investment Priorities in CIP for Fisheries Development

Investment Priorities in CIP for Fisheries Development

a) Improved management of inland and marine fisheries resources. Restoration of some open-water fisheries, which requires: stronger institutional arrangements and strengthening capacities for coordinated management involving users and communities; the development of community-based resource management, including support for fish sanctuaries through training, technical assistance and access to inputs and credit; and the potential development of community-based open-water culture-based fisheries. Research is needed that would focus on opportunities to increase capture production of small micronutrient-dense fish.

b) Restoration of habitats through rehabilitation of degraded water bodies; establishment of sanctuaries in suitable water bodies; amendment of existing leasing policy from revenue oriented to biological management through public investment and community mobilization; conservation of hilsa fishery and alternative income generation for 'jatka' (juvenile hilsa, mostly Tenualosa ilisha and Ilisha elongate) fishers.

c) Increased productivity of small-scale estuarine and inland aquaculture by: (i) developing low-cost aquaculture technologies, especially for smallholder farmers, and linking aquaculture business with insurance system; (ii) improving hatchery management practices and genetic quality of culture fish species; (iii) strengthening research and development with a focus on the needs of small farmers and opportunities to include micronutrient-dense small fish in culture systems; (iv) improving public and private advisory services for smallholder farmers willing to invest in aquaculture and in particular, in integrated aquaculture (fish–crops–livestock) systems; (v) providing advice and facilitating access to quality inputs (fingerlings, feed) and credit for business development; (vi) enhancing commercial aquaculture productivity under a public–private partnership; and (vii) reversing the

genetic degradation in carps and other farmed fish species. In view of the increasing salinities in the south, supporting the integration of seasonal brackish water culture including export-oriented shrimp and prawn culture with agriculture, which requires public-private partnerships that lead to improvements in the productivity of shrimp production, enhanced disease control, investments in a diagnostic laboratory, improved extension efforts supported by the private sector, capacity building and quality certification to comply with the requirements of the Hazard Analysis and Critical Control Points (HACCP) system and sanitary and phytosanitary standards; and the development, assistance and capacity building for co-management of wetlands.

d) Mariculture of a few important species such as crab, mussel and oyster on coastal areas would be introduced where a substantial number of women can be involved. Owing to climate change, the acidification of the sea would be a deterrent to shrimp aquaculture; it might be an opportunity to introduce other species such as salt-tolerant tilapia, mullet and other marine fish species.

Source: GoB 2011

2.2. Blue Growth Opportunities for Sustainability and Resilience

New research shows there is also a strong economic case for protecting ocean assets through expanding MPAs globally.[54] This and other analyses show MPAs can contribute to reducing poverty, building food security, creating employment and protecting coastal communities. The research by Brander *et al*. (2015) shows expanding the coverage of MPAs to 30 per cent globally is expected to generate major economic benefits that significantly outweigh the costs. This holds true under a range of scenarios for no-take MPAs to cover 10-30 per cent of marine and coastal

[54] Brander, L.; Baulcomb, C.; van der Lelij, J.A.C.; Eppink, F.; McVittie, A.; Nijsten, L. and van Beukerin, P. (2015). The benefits to people of expanding Marine Protected Areas. VU University, Amsterdam, The Netherlands.. VU University, Amsterdam, The Netherlands.

areas with varying degrees of biodiversity and human pressures. The net benefits of increasing protection to 30 per cent range from the most conservative estimate of US$490 billion and 150,000 full-time jobs in MPA management, to the most optimistic estimate of US$920 billion and over 180,000 jobs by 2050. It is clear that MPAs provide a useful pathway to investing in sustainable blue economies.

Blue growth objectives cannot be achieved by implementing one-way conservation instrument. The MPAs should be planned and equipped with such mechanism that it should be able to optimize or maximize the output from the coastal-oceanic realm. Recent settlements of the maritime border disputes with neighboring states have opened up opportunities for ocean-based economic growth and development for the Bangladesh, where About 30 million people (one fifth of the population) are directly dependent on the marine sector for activities like fisheries, aquaculture, tourism, shipping, shipbuilding and ship decommissioning, and offshore oil and gas production.[55]

Bangladesh and other member States of United Nations have recently adopted the Sustainable Development Goals (SDG) as part of a new sustainable development agenda in the seventieth session of General Assembly. This agenda is a plan of action for people, planet and prosperity. It also seeks to strengthen universal peace in larger freedom.[56] The states expressed their determination to take the bold and transformative steps which are urgently needed to shift the world on to a sustainable and resilient path (ibid).

While the Millennium Development Goals (MDGs) addressed the oceans along its environment and resources with a broad and generic goal for achieving environmental sustainability; the SDGs this year give the oceans an essentially required and more focused attention with its own goal (Goal 14) encompassing seven targets and three provisions (Box 2). Goal 14 is the agreed commitment to

[55] Hossain et al. (2014)
[56] A/RES/70/1

"conserve and sustainably use oceans, seas and marine resources for sustainable development".

Box 2: SDG Goal 14 including seven targets and three provisions

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development

14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution

14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans

14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels

14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics

14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information

14.6 By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation*

14.7 By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism

14.a Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and

to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries

14.b Provide access for small-scale artisanal fishers to marine resources and markets

14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want"

** taking into account ongoing WTO negotiations and WTO Doha Development Agenda and Hong Kong Ministerial Mandate*

Source: United Nations, 2015 (A/RES/70/1)

The concept of 'Blue Economy' was an initiative pioneered and forced by the small island developing countries (SIDS) in recent years; however, it now gradually has become a vital concern to all coastal states and countries with an interest in waters beyond national jurisdiction. The Blue Economy conceptualizes oceans and seas as 'Development Spaces' where spatial planning integrates conservation, sustainable use, oil and mineral wealth extraction, bio-prospecting, sustainable energy production and marine transport.

As Bangladesh is charting a course towards the blue horizon through ocean-based economic growth, the recently-adopted SDGs have appeared to boost up the much-required aspiration and enthusiasm to design a national framework and reform necessary policy tools on the basis of environmental sustainability. Especially, the Goal 14 might be the right standard of accountability for Bangladesh's own quest towards marine conservation and blue economy.

The blue economic growth or 'blue growth' fosters the idea of exploring untapped potentials of marine environment and utilizing its resources sustainably to increase food security, improve human nutrition and health, alleviate poverty, create jobs and enhance trade/commercial performance. This concept also encourages to

improve regional security and peace as well as to protect ecosystem and biodiversity of the marine environment. Some potential sectors and activities, as indicated in the SIDS concept paper, relevant to blue growth in Bangladesh are briefed in Table 2.[57]

Table 2: Potential sectors and respective activities for blue growth in Bangladesh.

Sectors	**Activities**
Fishing	Capture fishery, Aquaculture, seafood processing
Marine Biotechnology	Pharmaceuticals, chemicals, seaweed harvesting, seaweed products, marine derived bio-products.
Minerals	Oil and gas, deep-sea mining (exploration of rare earth metals, hydrocarbon)
Marine Renewable Energy	Offshore wind energy production, wave energy production, tidal energy production
Marine manufacturing	Boat manufacturing, sail making, net manufacturing, boat and ship manufacturing and repairing, marine instrumentation, aquaculture technology, water construction, marine industrial engineering.
Shipping, Port & Maritime logistics	Ship building and repairing, ship owners and operators, shipping agents and brokers, ship management, liner and port agents, port companies, ship suppliers, container shipping services, stevedores, roll-on roll-off operators, custom clearance, freight forwarders, safety and training.
Marine Tourism & Leisure	Sea angling from boats, sea angling from the shore, sailing at sea, boating at sea, water skiing, jet skiing, surfing, sail boarding, sea kayaking, scuba diving, swimming in the sea, bird watching in coastal areas, whale, dolphin watching, visiting coastal natural reserves, trips to the beach, seaside

[57] MoFL (2015). *Blue Economy for Bangladesh*. Ministry of Fisheries and Livestock Available from: http://www.mofl.gov.bd/

	and islands,
Marine Construction	Marine construction and engineering.
Marine Commerce	Marine financial services, marine legal services, marine insurance, ship finance & related services, charterers, media & publishing.
Marine ICT	Marine engineering consultancy, meteorological consultancy, environmental consultancy, hydro-survey consultancy, project management consultancy, ICT solutions, geo-informatics services, yacht design, submarine telecom.
Education and research	Education and training, R&D.

Source: MoFL 2015

Government agencies along with academia should march forth to facilitate the availability of relevant ocean data to provide easier access to information for research, planning, and decision support. Furthermore, public opinion, local and traditional knowledge as well as scientific information should be amalgamated to identify and communicate the economic value of ecosystem services, such as healthy and productive wetlands that support spawning, breeding, and feeding of commercially important fish species. Effective information and network of up-to-date knowledge can help policy makers consider the value of these services when evaluating actions that may affect the economy. Expansion and openness of internet resources throughout the country are vital, with attention paid to devolving computer literacy and necessary skills.

Future policies should focus on the improvement of efficiency across government agencies, including permitting, planning, and approval processes to save time and money for ocean-based industries. Interagency work includes land/water use zoning for site-specific activities such as ports and harbor operation, ship building and ship recycling, fishing and aquaculture, oil and gas well, renewable energy plant,

etc. to support marine commercial sectors as well as ensure appropriate environmental and other required safeguards.

Restoration activities offer direct economic opportunities, and healthy natural systems support jobs in industries such as tourism, recreation, fishing and farming. Respective stakeholders should coordinate to protect, restore, and enhance wetlands, mangroves, sea grass beds, coral reefs, and other high-priority ocean, estuary and coastal habitats. With the rapid build-out of the Bangladesh coast due to river sedimentation processes, Bangladesh has an unparallel opportunity to expand its mangrove resources, thereby expanding the varied economic benefits.

To obtain sustainable revenue from the oceanic activities, the health of marine environment must be maintained and restored where necessary. River-borne pollutants, municipal wastes, industrial effluents, agro-chemical residues, ship and tanker discharges have significant adverse economic, public health-related, and ecological consequences. High nutrient discharges from rivers could intensify large-scale hypoxia. Government agencies must take steps to prevent and reverse widespread economic impacts caused by environmental degradation.

Academic institutions should coordinate to ensure that educational programs include diverse student groups and that a highly competent workforce is developed. Appropriate actions by academic institutions may ensure a regular and growing number of students pursuing academic career related to ocean and coastal science and management.

2.3. Challenges in Governance and Legal Framework

The biodiversity in protected areas of Bangladesh face enormous pressure from anthropogenic sources with widespread poverty and one of the highest rural

population densities in the world.[58] The government has responded, in part, by setting aside protected 64 areas encompassing both marine and terrestrial environments across the country. Nonetheless, there is a noticeable lack of information and recent status on the protected areas in Bangladesh. In the existing legal framework, some key shortfalls resulting in slow progress in coastal and ocean governance have been identified:[59]

a) Weaknesses in policy, e.g. the Coastal Zone Policy (CZPo) 2005 fell short of recognizing the sea itself as an important constituent of the coastal-marine zone, except for a few mere mentions of the EEZ.

b) Lack of coordination and integration, i.e. poor mechanism of 'interaction' and the ability to see the marine-coastal system as a highly integrated entity, which would require a top order vision and policy backed by multi-sector strategies translated into highly organized and closely coordinated actions.

c) Lack of knowledge or scientific understanding, e.g. graduate universities which could have been the leaders of knowledge creation are poorly funded for research.

d) Inadequate human resources, e.g. (i) in shipping business, hatchery operation, etc. there are large number of foreign nationals working as experts, (ii) Marine Fisheries Department is run by only a handful of people, the scope of the work is way beyond their human capacity. In general, marine-related departments seem to be inadequately staffed by knowledgeable, educated specialists.

e) Lack of investment, e.g. in tourism, conservation and the mining or petroleum industry.

[58] Mukul et al. (2008). Protected areas of Bangladesh: Current status and efficiency for biodiversity conservation. Proc. Pakistan Acad. Sci. S4.5 A(2)
[59] Hossain et al. (2014)

f) Improper allocation of roles and designation of focal points, i.e. (i) WARPO with an inbreed of civil and water engineers are entrusted with the complex and multidisciplinary task of CZ management, (ii) Bay of Bengal Large Marine Ecosystem (BOBLME) project is represented by Fisheries Research Institute, (iii) International Hydrographic Office (IHO) is represented by BIWTA not having any presence in the sea; (iv) Intergovernmental Oceanographic Commission (IOC) is represented by the Ministry of Education, not by the Ministry of Science and Technology according to the mandate given in the Rules of Business of the GoB.

g) Lack of will: at least partially, ocean development remained stagnant due to lack of political will of the governments.

h) Weak inter-sectoral interaction, particularly on marine policy issues.

i) Inadequate public participation and stakeholder inclusion (tourism enterprises, provincial and state governments, communities, private sector and fishermen among others).

2.4. Management Constraints

Throughout the country more generally, fishery resources are threatened by the overexploitation of inshore marine resources. The indiscriminate fishing of post larvae and juvenile shrimp/finfish in mangrove ecosystems is of particular concern According to one study, the collection of tiger prawn seed for aquaculture farming results in massive by catch, with 97% of (other) shrimp fry and finfish larvae discarded on dry land.

Artisanal fisheries mostly occur close to the shoreline, within 10-20 meters of depth. Non-mechanized and semi-mechanized boats are used in this area, many of which use a destructive gear (marine set bag net) known as *Behundi Jaal*. Industrial

fisheries also operate within 20-30 meters of depth, and are thought responsible for the decline of major species.

Pollution from upstream sources threatens marine biodiversity in Bangladesh's waters and beyond. Major sources of pollution include industrial waste, municipal waste, agro-chemical waste and oil pollution.[60] There are currently over 900 polluting industries, which directly or indirectly discharge untreated liquid and solid wastes into coastal rivers and other waterways that eventually make their way into the Bay of Bengal. Nonetheless, there are few, if any reports on the direct effects of effluents on local fish stocks and post-larvae/juvenile marine species in nursery grounds. According to IUCN, control measures to prevent land-based and *in situ* marine pollution in the Bay of Bengal are largely ineffective, as are efforts to curb the discharge of ballast and bilge water. While the government has moved to ban certain noxious agrochemicals, problems persist.[61]

'Upstream' development activities also have serious effects upon the health of local marine ecosystems. Though such activities only have indirect bearing upon MPAs, they are nevertheless worthy of mention: The use of sluice gates and barrages in construction activities affect natural siltation processes, and in the past have been responsible for silting up rivers. This in turn leads to blocked migration routes, as occurred in the case of hilsa populations in the Kumar River following the Ganges-Kobadak project.

Like the Maldives, Bangladesh will likely suffer disproportionally from the effects of climate change. With its relatively low topographic profile, it is expected that a third of the country may become fully inundated. Taken together with salinity intrusion, this will have profound implications on existing coastal ecosystems like mangrove forests (Mukul 2007). Other impacts will likely include increased temperatures and

[60] Islam, M.S. (2003). Perspectives of the coastal and marine fisheries of the Bay of Bengal, Bangladesh. *Ocean & Coastal Management* 46(8):763–796.
[61] ibid

higher rates of precipitation/more intense cyclones. While these concerns are not unique to Bangladesh, local experts posit that "conventional management approaches will not suffice and integrated long-term management is more appropriate".[62]

There are a number of sensitive marine areas within Bangladesh's Bay of Bengal region that are not adequately protected. Attempts should be made to protect such areas, which include the coral reefs around St. Martin's Island, elephant points (shrimp breeding grounds), Naf River Estuary, Meghna River Estuary (contains hilsa and other fish breeding grounds), the marine areas along the Chakaria Sundarbans (important nursery grounds), and the marine areas bordering the Sundarbans.

[62] Shi, H.; Singh, A. (2003). Status and interconnections of selected environmental issues in the global coastal zones.

Chapter 3 - MPA Governance and Management Issues

3.1. MPA Governance and its theoretical aspects

3.1.1. MPA Governance – Definition and Categories

The political, social and economic issues conceptualized in 'governance' indicate to the fact that social and political dimensions required to be adapted to local needs and particularities.[63] Debates on the governance of marine protected areas are taking place in the much wider perspective questioning how the people should be managed and how the social, economic, political and bureaucratic systems should be. The concept of governance is increasingly concerned with stakeholder representation and with the urge of finding necessary explanations to the problems affecting fisheries and natural resource management beyond a sector-based approach.[64]

The term 'governance' has grown in importance and is used in many contexts including that of protected areas. Governance can be defined as the interactions among structures, processes and traditions that determine how power and responsibilities are exercised, how decisions are taken and how citizens or other stakeholders have their say.[65] It refers to principles, policies and rules regarding decision-making—all clearly relevant in the case of protected areas.

The significance of governance in marine protected areas was unequivocally recognized in several recommendations from different global forums and events,

[63] Christie et al. (2003). Toward developing a complete understanding: a social science research agenda for marine protected areas.
[64] Jentoft, S.; van Son, T.C.; Bjørkan, M. (2007). Marine protected areas: a governance system analysis. Hum Ecol;35:611–622.
[65] Graham, J.; Amos, B.; Plumtre, T. (2003). Governance principles for protected areas in the 21st century. A discussion paper—phase 2. Ottawa: Institute on Governance.

which stress on the need for coherence between natural resource conservation and socio-economic development policies. These advices call for the recognition of and the respect for customary properties, access and use of local populations. They fit within the general trend of recognizing the fundamental role of social, cultural, economic and institutional factors in conservation, aiming to increase civil-society involvement in the decision-making process.[66]

The Marine Protected Area Governance (MPAG) project recently examined a range of different incentives – economic, interpretative, knowledge, legal and participative – in 20 marine protected areas across the globe. The study also identified five broad categories of MPA governance approaches (Jones *et al*. 2013).[67] This categorization is based on the defining characteristics and attributes of MPA governance, namely the allocation of authority and responsibilities between different parties and/or actors involved in governing MPAs, the type of rules that are followed in MPA decision-making and conflict resolution, and key incentives used to steer related processes.

Approach I: MPAs managed primarily by the government under a clear legal framework (government-led)

MPA governance under this category is characterized by having a well-established legal framework, with clearly defined MPA objectives, restrictions on different uses, jurisdictions and responsibilities of different government institutions, and rights and obligations of the public. Legal incentives are the key drivers in most MPA-related processes, ensuring that the statutory conservation objectives are fulfilled in MPA decision-making. However, the legal framework also provides a basis for community participation, which is guided by specific legal provisions as a means of promoting transparency, equity and compliance in achieving statutory MPA objectives. It is important to note that the MPAs categorized as government-led also

[66] Jones, P.J.S.; Qiu, W.; De Santo, E.M. eds. (2010) *Governing marine protected areas: getting the balance right*, Vol. 2; 2010 p. 157–64. Technical Report to Marine & Coastal Ecosystems Branch, UNEP, Nairobi.
[67] Jones, P.J.S.; Qiu, W.; De Santo, E.M. (2013) Governing marine protected areas: Social-ecological resilience through institutional diversity. *Marine Policy*.

employ the other four categories of incentives and that having a strong government lead certainly does not preclude opportunities for community participation, though legal incentives were most frequently cited as being both used and needed. MPAs adopting this governance approach are the Great Barrier Reef Marine Park (Australia), Darwin Mounds candidate Special Area of Conservation (UK), North-East Kent European Marine Site (UK), Wash and North Norfolk Coast European Marine Site (UK), California Marine Life Protection Act (US) and US National Marine Sanctuary System (US).

Approach II: MPAs managed by the government with significant decentralization and/or influences from private organizations (decentralized governance)

MPA governance under this category is characterized by a sharing of authority and responsibilities between central/federal governments and lower levels of government, or between government institutions and non-governmental/private organizations. MPAs are managed in accordance with formal regulations and/or through partnerships and negotiations between different parties. MPAs adopting this governance approach are the Sanya Coral Reef National Marine Nature Reserve (China), Seaflower Marine Protected Area (Columbia), Galápagos Marine Reserve (Ecuador), Karimunjawa Marine National Park (Indonesia), Wakatobi National Park (Indonesia), Tubbataha ReefsNatural Park (the Philippines), and Ha Long Bay World Natural Heritage Area (Vietnam).

Approach III: MPAs managed primarily by local communities under collective management arrangements (community-led)

MPA governance under this category is characterized by local communities taking a lead in the conservation and sustainable use of marine resources, which is essential for the long-term social and economic well-being of communities. Community institutions (e.g. local fishing cooperatives) are often granted a significant level of autonomy to collectively decide the rules governing MPA management. External organizations, such as government departments and conservation NGOs, may have an important role in enabling and reinforcing such community initiatives, and

ensuring that such community efforts are consistent with existing legal and policy frameworks, including the fulfillment of fisheries and biodiversity conservation objectives/obligations. MPAs adopting this governance approach are Isla Natividad (Mexico) and Os Miñarzos Marine Reserve of Fishing Interest (Spain).

Approach IV: MPAs managed primarily by the private sector and/or NGOs granted with property/management rights (private-led)

MPA governance under this category is characterized by non-governmental and/or private organizations taking the main responsibility for MPA management and enforcement. Such organizations are often granted with permanent property rights or temporal management rights to a particular area of sea, where they fulfill conservation and resource management responsibilities. Such organizations work independently, but often collaborate with public institutions to enhance the effectiveness of their conservation efforts. Incentives employed to steer MPA management vary between MPAs that belong to this category depending on the context as well as the core values of the leading organization. MPAs adopting this governance approach are Chumbe Island Coral Park (Tanzania) and Great South Bay Marine Conservation Area (United States).

Approach V: No clearly recognizable effective governance framework in place

The development of MPA governance in this category is hindered by a lack of political will, leadership and capacity from all levels to develop effective governance structures and arrangements that would support the achievement of any MPA objective, often in the face of strong driving forces counter to conservation. MPAs adopting this governance approach are Pirajubaé Marine Extractive Reserve (Brazil), and Cres-Lošinj Special Marine Reserve (Croatia).

3.1.2. Incentives in MPA Governance

There is a strong argument that – regardless of the MPA governance approach adopted (i.e. government-led, decentralized, private or community-led) – resilience in MPA governance systems derives from employing a diversity of inter-connected incentives. The significance of institutional diversity to governance systems parallels that of species diversity to ecosystems, conferring resilience to the overall social-ecological system.[68] In the face of strong stressors, rather than relying on particular types of incentives and institutions, it is important to recognize that the key to resilience is diversity, both of species in ecosystems and of institutions in governance systems. In the MPAG case studies, a variety of different incentives were identified in supporting biodiversity conservation and sustainable resource management.

Box 3: Incentives applied for effectiveness of MPA governance (Jones et al. 2013)

1. Economic

- Promoting economically and ecologically sustainable resource use, through spill-over effects and enhancing direct and indirect use values from resources
- Green marketing of products and services from the MPA
- Measures to reduce the 'leakage' of the economic benefits from the MPA away from local people
- Providing economic compensation for restricted users for profits foregone
- Payments for the flow of ecosystem services provided by the MPA
- Allocation or reinforcement of community/user property rights
- Promoting alternative livelihoods
- Improvements in local infrastructure and living standards
- Protection from incoming users
- Funding from private or NGO sources to promote the effectiveness of the MPA through the use of various incentives, provided that this funding does not lead to 'institutional capture' – undue influence on MPA governance that undermines the effectiveness of the MPA

2. Interpretative

- Public communication, education and awareness raising on the importance/vulnerability of marine ecosystems and the benefits of the MPA e.g. through newsletters, web sites, education programs, media campaigns etc.

[68] Jones et al. 2013

- Role of celebrity 'champions'
- Promoting recognition of the potential benefits from well-managed MPAs e.g. spillover to surrounding fisheries, enhanced resilience, ecosystem services
- Promoting recognition of MPA regulations and restrictions, including boundaries

3. Knowledge

- Integration of local/traditional/indigenous knowledge in MPA decision-making
- Maximizing scientific knowledge to guide/inform MPA decision-making and monitoring/evaluation
- Promoting mutual respect and collective learning between different knowledge owners e.g. scientists and local resource users
- Developing mechanisms for independent advice &/or arbitration in the face of conflicting information &/or uncertainty
- Agreed basis for the role of precautionary approaches in the face of uncertainty

4. Legal

- International-regional-national-local regulatory obligations that require effective MPA conservation, including the potential for top-down interventions
- Clarity and consistency in defining the legal objectives of MPAs, general and zonal restrictions, jurisdictional boundaries, and roles/responsibilities of different authorities and organizations
- Effective judicial system for penalizing transgressors
- Legal provisions to ensure public rights and transparency in MPA management
- Legal or other official basis for cross-sectoral/cross-jurisdictional restrictions to support the achievement of MPA objectives
- Performance standards/conditions/criteria/requirements related to the MPA's conservation objectives and attached to user/property rights, participatory governance structures, etc.
- Scope for flexibility – adaptive management and local discretionary action, maintaining building on and working through local customary institutions, provided that this does not undermine the fulfillment of conservation objectives
- Ensuring that sufficient national-local-state capacity, political will, surveillance technologies and financial resources are available to enforce all restrictions equitably on all local and incoming users, including addressing driving forces – pressures from immigration, corporate mass tourism, fisheries market forces etc.

5. Participative

- Participative governance structures and processes such as user committees, public consultations, participative GIS planning etc., including training to support such processes
- Participative enforcement, e.g. peer enforcement, community rangers and wardens etc
- Building trust/social capital between different actors
- Transparent participation and decision-making processes
- Clear rules on the means and degree of participation from different groups, and the unbiased representation of all user groups in participation processes
- Bringing in 'neutral' facilitators to facilitate participative processes

It should be apparent that the 'governance' is different from the 'management'. The focus of governance is not on technical or economic solutions to socio-political problems but somewhat on the authority or power relations between stakeholders that determine the application of norms.

3.2. MPA Establishment and Implementation

In Bangladesh, 'community-based' collaborative management has been acknowledged, as a means of effective conservation and sustainable resource utilization, for last couple of years. Establishing and managing a marine protected area (MPA) occur through a process that covers several phases. The planning and implementation phases in the community-based approach described below take place somewhat sequentially yet several may run concurrently. The process for developing and implementing an MPA is adapted by the principles described by Christie and White (2007)[69]. This set of principles is grounded in decades of trial and error, as well as carefully designed empirical research. A standard planning process generally follows these phases.

Phase 1: Issue identification and baseline assessment

Phase 2: Plan preparation and adoption

Phase 3: Action plan and MPA implementation and enforcement

[69] Christie, P. and White, A.T. (2007). Best practices in governance and enforcement of marine protected areas: an overview. In FAO, 2007.

Phase 4: Monitoring and evaluation

Phase 5: Information management, education and outreach

Phase-1: Issue identification and prioritization, and baseline assessment

The initial steps in developing an MPA involves site selection, size, justification for site choices and others that may or may not be controlled by the local stakeholder community. This process can either be community-based or top-down depending on the context and MPA goals. It may be a national government decision to select a remote site based on ecological criteria for example. Near-shore areas used for fishing will likely require a more participatory process. Once a commitment has been made to proceed with MPA establishment, there is a need to assess issues and collect baseline information using participatory and scientific methods so that results can be measured through time. Baseline information sets the stage for a well-managed MPA of all purposes and provides a means to begin education of stakeholders from the outset. It also clarifies priority issues that need to be addressed. Issue identification and baseline assessment, if done in a participatory manner that fully engages the majority of stakeholders, will ensure better chances for successful implementation and long-term enforcement and compliance. But a key factor is that the affected communities fully endorse and buy into the need for and management of the MPA. Several key activities at this stage include:

- Community organization and mobilization: This activity includes fielding community education and organizing staff in the MPA area, learning more about the stakeholder community and its socio economic and political context, and determining the expectations of the stakeholders that should ultimately be engaged in management or stewardship of the area.

- Baseline study: This covers compiling of all existing data on the area but most importantly begin to engage the people at the site level together with outside professionals who may also have a long term interest in the management area.

- Information, education and communication (IEC): The education process occurs throughout all stages of development and implementation of an MPA. Depending on the level of awareness and involvement of the stakeholder community, the IEC process needs to evolve and be responsive to the needs of MPA management.

Phase-2: Plan preparation and adoption

Preparation of participatory, fair and transparent plan leads to stakeholders' compliance. A first and crucial step is the formation of the core group. The core group should be considered as an 'anchor' that is directly interested and committed to planning, implementation and management of the MPA. In countries where planning and management are strictly government functions, the core group may be less important, but can still serve an important role to link government management with the stakeholder sector that might not uniformly support the goals or existence of the MPA. The preparation of a management plan must include definition of goals and objectives, preparation of management strategies and actions, determination of MPA boundaries and zones, determination of management procedures and many other decisions that are basic to an effectively managed MPA. The key again is participation in the decision process so that enforcement over time is not an uphill battle.

Much of the planning process focuses on determination of use zones within an MPA. In many countries the placement of no-take zones and their boundaries must be

highly sensitive to local use patterns and stakeholder preferences to improve chances for adequate compliance. Thus much effort must be placed on determining boundaries so that they do not cause undue conflicts for potential compliance later on.

Phase-3: Action plan and project implementation

The action plan is crucial to long-term governance of an MPA because it contains the strategies for encouraging compliance through law enforcement, threats and sanctions as needed, ongoing education, various means of observation and monitoring among others. The development and implementation of an action plan depends on institutional capacity (e.g. presence of reliable local government, community groups, coast guard, etc.), resources for enforcement and human capacity.

Implementation refers to several key steps: formalizing the MPA, implementing management strategies, enforcement of regulations and strengthening the community by implementing the key recommendations of the management plan. The process leading up to full implementation could take several months to years depending on the institutional capacity of the management body.

Strategic activities for managing an MPA, being combined with objectives of both fisheries management and biodiversity conservation, are varied and may include the following among others:

- Demarcating use zones according to use patterns and the objectives of management
- Regulation and control of fishing gear inside and adjacent to an MPA and in relation to the use zones of the area as determined in the management plan

- Placement of permanent mooring buoys to prevent bottom habitat damage, especially in coral reef and other fragile environments
- Designation of boat trails or travel-ways for heavily visited areas
- Establishment of regular embarkation points to control access to sanctuaries
- Permits and user fees for access to resource areas for tourism and/or fisheries uses under local MPA jurisdictions or government
- Strengthening community and local government involvement
- Promotion of ecotourism ventures that support MPA protection
- Development of partnerships through neighboring MPA programs through networks or partnerships for long term

Phase-4: Monitoring and evaluation

MPA case studies from many countries emphasize that monitoring MPAs should be repeated at regular intervals throughout the management process. Assessing key biological and governance indicators begins with baseline studies. Increases in fisheries stocks and diversity both inside and outside of no-take reserves confirm the value of conserving the stock within the MPA. Changes in a standard list of governance indicators also reveal how well the MPA is being managed. The results of evaluation should be conveyed to the communities.

It is important to identify indicators for measuring progress toward the objectives of the MPA management plan early in the management process. Once such indicators are determined, such as changes in fish diversity, size of individual fish, percent live coral cover or another habitat or ecological indicator, it is important that these parameters are monitored using standardized methods as described in one of numerous manuals. Indicators for improved management and enforcement such as administrative processes, community support, marker buoys and signs in place, and

others can be measured and monitored by applying the respective MPA management rating system and agreed standards.

There is always a need for a simple but effective monitoring program that involves local stakeholders. Planners, local communities, user groups, NGOs, academics and the private sector should be involved in the participatory monitoring and evaluation of a project since all should share in the responsibility for implementing the plan and reaping the benefits. Such monitoring should also be complemented with careful, and constructive evaluations using rigorous social and natural science methods.

Phase-5: Information management, education and outreach

The data collected through monitoring is often the best information to develop education materials and to provide feedback on the status of the MPA to stakeholders (White *et al*. 2006). Local MPA education plans and programs can evolve from the results of monitoring and evaluation that in turn raise public awareness. Another form of education that is increasingly being used to enhance awareness among MPA managers and stakeholder communities is that of cross visits.

It is apparent that a well-managed MPA requires an adaptive management approach. The best practices of day-to-day implementation of a successful MPA cannot be easily separated from the participatory planning, implementation and enforcement process that leads directly into management and continues with periodic monitoring and evaluation. Thus, the one major 'best practice' that should be gleaned is that a well-managed MPA is always refining its management through planning and testing of strategies that may or may not be appropriate, many of which are discussed briefly above.

3.3. Socio-economic considerations

Coastal communities have depended for generations on ocean and coastal resources for their lives and livelihoods. Over time, they have developed ecosystem-related knowledge and skills, and have evolved institutions that regulate their interactions with each other, with the resource base and with the outside world. There are multi-level efforts to support and grow marine economies, protect and conserve the environment that supports quality of life, and sustain unique social and cultural identities. Different stakeholders share an interest in growing their economies and providing jobs that support strong communities, which they address through a diverse and often unique array of marine uses. For example, their interests range from conventional boating to shipping, they have different subsistent and commercial fisheries, and they offer distinct tourism and recreational activities. They also have different priorities for environmental protection and the use of ocean resources. In the Saint Martin's Island, coral reef ecosystem conservation is a focus area, whereas in the Moheshkhali and Kutubdia Islands, addressing living shoreline with shellfish reef development is suitable for coastal defense and food production; and mangrove afforestation in the Meghna deltaic regions is a top priority. In the marine and coastal ecosystems, fish habitat suitability modeling efforts are essential to enhance natural recruitment through habitat-specific marine protected area establishment.[70]

With much of the population dependent upon the extraction of natural resources for their livelihoods, there are profound difficulties in balancing biological conservation with socioeconomic development. Unsustainable resource extraction is an issue in and around the reefs of St. Martin's Island for example, and there is mounting pressure on local reef systems from human activities, a growing tourism industry and increased shoreline construction.

[70] Hossain et al. 2014

Those involved in protected area governance include a broad variety of actors, from staff of government agencies and ministries at various levels to elected and traditional authorities, from indigenous peoples and local communities to private landowners, businesses, non-profit trusts, staff of NGOs and international agencies, professional organizations, religious and educational organizations, etc. Often, all actors possessing significant interests and concerns are subsumed under the broad concept of 'stakeholders'.

MPAs also create positive and negative socio-economic impacts and will affect different groups of resource users in different ways, depending on how they are planned, designed and implemented, and according to the case-specific context. All management measures – for fisheries management and for biodiversity conservation – are about directing and influencing human behavior. Thus this behavior needs to be understood. Stakeholder involvement is crucial, and MPA objectives, to be successful, must reflect a balance between scientific, social and economic needs and realities.

Well-designed MPAs that are planned through a participatory process and use the best available information can offer important benefits to specific user groups and local communities, in addition to longer-term benefits to governments and to the common good. MPA establishment can also spur economic development or poverty reduction if the revenues generated from visitor use or payments for environmental services (PES) are funneled back to local communities. In some cases, MPAs are used to gain certification for fisheries products, adding value to those fisheries and increasing profit margins for fishers.

MPAs can also empower marginalized communities or user groups, especially if co-management arrangements exist. Similarly, drawing stakeholders into MPA planning processes can create opportunities for better government and civil society engagement in general. In areas where traditional uses are at risk, MPAs can safeguard them, as well as areas of cultural importance. From a governance

perspective, multiple-use MPAs can provide a demonstration of how to effectively integrate management across sectors (and bridge the worlds of fisheries management and biodiversity conservation). Finally, MPAs – by flagging the special value of specific places – can be used to generate political will for more-effective marine management in general.

Implementing MPAs in fishery-dependent communities requires a very good understanding of the local situation. The livelihoods of stakeholders may be vulnerable to changes, in particular if poverty is an issue. Research suggests variation in the social impacts of MPAs on four principal dimensions of poverty: wealth, health, political empowerment and education.[71]

With respect to wealth, MPA establishment generally induces shifts in resource access and use and hence has – as mentioned earlier – a reallocation effect within and among stakeholder groups. For those gaining preferential resource accesses, MPA establishment tends to result in increases in income, food security and material assets, while those losing access may suffer corresponding losses or have to adopt mitigation strategies by shifting resource-use patterns or livelihood strategies.

MPA design in a poverty context needs to take these circumstances into account and to ensure that poorer stakeholder groups are not negatively affected. This could include securing resource-use rights for specific groups of fishers, or researching alternative or supplementary livelihood opportunities. The social impact of MPAs on health, political empowerment and education would generally follow shifts in patterns of access to fishery resources. However, variation (spatial, temporal and across MPAs) in the magnitude and extent of these social impacts remains largely unexamined and unexplained, highlighting the need for further study to better understand MPAs in relation to poverty reduction.

[71] Mascia, M.B. (2004). Social dimensions of marine reserves, pp. 164–186. In Dahlgren & Sobel (2004).

3.4. Climate Change Concerns

Emissions of carbon dioxide (CO_2) are the driving force of climate change and ocean acidification. The ocean reservoir of carbon is much greater than both of the terrestrial and atmospheric systems and provides an important net sink for carbon through exchange of CO_2 across the air-sea. Over the past 200 years, atmospheric CO_2 has increased from 280 ppm to a global average of nearly 390 ppm due to burning of fossil fuels, cement production and land-use changes. Atmospheric CO_2 concentrations are expected to reach 467-555 ppm by Year 2050 that would cause surface ocean pH to decline, on average, to 7.8 in Year 2050. Over the past two decades, there have been measurable decreases in the weight of calcium carbonate ($CaCO_3$) shells of pteropods (marine snail) and foraminifera (unicellular protists) in the Southern Ocean, and corals of the Great Barrier Reef, suggesting a recent decline in calcification, a process in which body tissue is harden by calcium salts or deposits. Trend analysis showed that pH is decreasing over the period with an increased trends at higher latitude.

Bangladesh is one of the most disaster prone countries of the world and here climatic events are considered an integral part of the social fabric. The heat status of the Ocean in the form of Sea Surface Temperature (SST) is one of the most important variables used in climate change monitoring programs and is often related to other variables such as sea level change and hurricane intensity. The Bay of Bengal is a potentially energetic region for the development of cyclonic storms; about 7% of the global cyclonic storms are formed in this region. A study reported that night SST has increased by 0.30-0.48°C during 1985-2009 at rates between 0.0126° and 0.0203° per year. Results indicate that at the low and mid-latitude zones early summer temperature is dropping while the late summer temperature is rising more quickly. In other months and at other latitude zones SST is consistently rising at a rate of about 0.02°C per year. The cyclone seasons in the Bay of Bengal

are likely to widen further as the cooler months also become warmer. Moreover, as the usually cooler high latitude zones get warmer, cyclones will get larger replenishment area for gaining heat energy, thus increasing the risk of cyclones at the coast.[72]

Since mid 1980s and early 1990s Bangladesh has been widely talked about for its vulnerability to future Sea-Level Rise (SLR) due to global warming. Confirmations of the Relative SLR (RSLR) in Bangladesh started coming soon thereafter. Indication of its intensification (more than 5mm per year increase) in recent years has also been found.[73] The reference to RSLR is made since the level of the sea relative to the land is not only due to the movement of the sea (global sea level rise), but also local physico-chemical processes (giving rise to seasonal changes) and tectonic processes such as subsidence and compaction/ consolidation of the Ganges-Bramaputra-Meghna River deltas in the BoB.

Despite the process being slow and gradual, the consequences of RSLR for Bangladesh are reckoned to be grave, especially given the low-lying nature of the country as a whole. Not only the coastal ecosystems are likely experience drastic and irreparable damages, inundation of coastal low lying lands will lead to loss of mangrove forests, loss of agricultural land, damage to properties, and displacement of coastal populations and mass exodus, to name just a few.

[72] Chowdhury, S.R.; Hossain, M.S.; Shamsuddoha, M. and Khan, M.M.H. (2012). *Coastal Fishers' Livelihood in Peril: Sea Surface Temperature and Tropical Cyclones in Bangladesh*. CPRD, Dhaka, Bangladesh.
[73] Rana Y (2013). *Investigation of Relative Sea-Level Change in the Eastern and Western coast of Bangladesh from tidal record*, MSc Thesis, Institute of Marine Sciences and Fisheries, University of Chittagong.

Chapter 4 - Strategic Tools for Implementing MPAs

4.1. Marine Spatial Planning

Ocean resources are being depleted drastically both in space and abundance.[74] No area of the world's oceans is entirely unaffected by human impacts, and 41 percent of the oceans are strongly impacted by multiple human activities.[75] Many marine ecosystems have lost their resilience to recurrent natural and man-made disturbances and have undergone long-term shifts to new, degraded regimes.[76] The stress on the marine environment, resulting from increased maritime activities, has been overwhelming in many places instigating two vital types of conflicts – 'user vs. user conflicts' causing political tension, intolerance, social insecurity, economic loss etc. and 'user vs. environment conflicts' bringing about the degradation of oceans, the decline of marine ecosystems, and the collapse of important fish species.[77] These conflicts can and have been avoided or reduced through marine spatial planning by influencing the location of human activities in space and time. During recent years, marine spatial planning has become ever more imperative tool to make ecosystem-based management a reality in coastal and marine environments.[78]

Marine spatial planning (MSP) is an area-based management framework that addresses multiple management objectives. It is not a single tool, but rather an approach or framework to provide a means for improving decision-making as it relates to the use of marine resources and space.[79]

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[74] Ehler, C. and Douvere, F. (2009). Marine Spatial Planning: a step-by-step approach toward ecosystem-based management. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No. 53, ICAM Dossier No. 6. Paris: UNESCO.
[75] Halpern et al. (2008). A Global Map of Human Impact on Marine Ecosystems. *Science*.
[76] Hughes et al. (2005). New paradigms for supporting the resilience of marine ecosystems. Trends in Ecology and Evolution.
[77] Worm, B. et al. (2006). Impacts of biodiversity loss on ocean ecosystem services. *Science.*
[78] Crowder, L. et al. (2006). Resolving mismatches in US ocean governance. *Science.*
[79] CBD-GEF (2012). *Marine Spatial Planning in the Context of the Convention on Biological Diversity: A study carried out in response to CBD COP 10 decision X/29*, Montreal.

Marine spatial planning (MSP) is a practical way to create and establish a more rational organization of the use of marine space and the interactions between its uses, to balance demands for development with the need to protect marine ecosystems, and to achieve social and economic objectives in an open and planned way.[80]

MSP is regarded as a new form of public process that collects, analyses, and allocates parts of three-dimensional marine spaces to specific uses in order to achieve ecological, economic, and social objectives that are usually specified through the political process.[81] Pivotal features of effective MSP programs include consideration of multiple scales; a long-term perspective; recognition that humans are an integral part of ecosystems; an adaptive management perspective; and concern for sustaining ecosystem goods and services.

MSP provides managers and policy-makers with information about the geography, environment, natural phenomena, present and potential uses, etc. for better planning of current and future exploitation of resources and space. The existing practice of fragmented planning and strategies governed by discrete laws and regulations, and implemented by disconnected agencies and bodies results in multiple uses often leading to competition or conflict with each other. MSP brings all these spaces, resources, agencies, uses, and times together in one analytical framework to resolve and/or reduce conflicts. In essence, effective MSP helps us finding a balance between nature conservation objectives and resource use goals in a more sustainable way.[82]

[80] DEFRA (2007). A sea change. A Marine Bill White Paper. In: Presented to parliament by the secretary of state for environment, food and rural affairs by command of Her Majesty. London.
[81] Ehler, C. and Douvere, F. (2009).
[82] BALANCE (2008). Towards Marine Spatial Planning in the Baltic Sea, BALANCE (Baltic Sea Management – Nature Conservation and Sustainable Development of the Ecosystem through Spatial Planning) Technical Summary Report 4/4, Copenhagen, Denmark.

Marine protected areas serve as platforms for commencing participatory planning processes, and for integrating different uses of ocean space. The planning processes for MPA and for MSP are not necessarily different, except in scale and scope. Besides, MPAs further contribute to MSP by serving as the foundation for zoning to safeguard what is ecologically important, biologically diverse, or vulnerable. However, MSP is not a substitute for MPAs, but rather a broader framework that can use and systematically extend or amend protected area management to go far beyond what even well-planned and well-managed MPAs can achieve. Similarly, MSP is not a substitute for Integrated Coastal Management (ICM) or Integrated Coastal Zone Management (ICZM), but rather builds on these important approaches and the policies that support them. MSP also builds on other, more circumscribed spatial tools, such as area-based fisheries assessments, local or municipal land use plans, area-based biodiversity measures such as identification of Ecologically and Biologically Significant Areas (EBSAs), and the identification of sites for MPAs. The management that flows from MSP, broadly defined, includes ICM, MPA design and implementation, and the spatial allocation of maritime uses (e.g. shipping lanes, oil & gas leases, fisheries closures, scientific research sites, etc.).

It is important to remember that we can only plan and manage human activities in marine areas, not marine ecosystems or components of ecosystems. We can allocate human activities to specific marine areas by objectives or by specific uses. Besides a set of people capable of designing and running the MSP framework and analyses, we would require information on various oceanic phenomena, marine resources, their uses and users, managers and agencies, their interactions and responses to different patterns of uses, seasonality, etc.

For designing and implementing an effective MSP for the Bay of Bengal, a range of data variables and information would be necessary (Table 3), which may be ascertained by and/or collected from different government agencies, NGOs, universities, research organizations and existing literature.

Table 3: List of potential data variables useful for designing and implementing an MSP

Sector	Probable sources of information	Data variables
Shipping	Department of shipping and Port Authorities	Shipping routes, shipping density, port locations, port limits, anchorages, channel depth, wreckage, navigability
Trade	Ministry of Commerce, EPB, NBR, Investment Board	Cargo volume, cargo density, container volume
Fisheries and aquaculture	Department of Fisheries, Fisheries research Institute	Fish habitats, fish migration routes, life cycle of estuarine fishes and shrimps, mother shrimp collection sites, aquaculture farming areas, mariculture sites, fishing areas, vessels density, effort density, catch density, catch composition, fishing gears and methods, protected areas, moratoriums, breeding seasons (dates),
Energy and Mining	Department of Energy, PetroBangla, research articles	Leasing blocks, gas fields, oil & gas wells, offshore platforms, liquification plants, pipelines, salt farming areas, potential tidal power plant locations, potential offshore wind farm locations
Communication	BTRC	Submarine cables, landing stations and distribution
Environment and conservation	Department of Environment	Marine Protected Areas, sanctuaries, Ecologically Critical Areas, pollutants entry points/pathways and dispersal pattern, waste disposal, shipbreaking, blue-carbon sequestration
Forest	Department of Forest	Mangrove forests, afforestation sites
Geomorphology	Water Resources	Erosion and accretion areas, river discharge, sediment

		input, sediment transport, sediment texture, potential land reclamation sites, coastal defense
Oceanography	NORI, Universities, research literature	Oceanic current, tidal regimes, wave characteristics, upwelling and eddies, biological productivity, salinity, sea surface temperature, research sites and transects, sites of moored platforms, bottom mounted instruments, rover and robotic instruments
Hydrography	Navy, BIWTA	Bathymetry, wreckage
Meteorology	Dept. of Meteorology, SPARRSO, Universities, research literature	Tropical cyclones and depressions, monsoon onset and development, weather variables, wind speed and direction, moisture and cloud cover, sunshine, radar coverage, drone flying zones
Climatology and Climate Change	Universities, research literature	Rates of Sea-level change, ocean acidification,
Hazards and disasters	MoDM, SPARRSO, DoM, research literature	Historical cyclone trajectories, landfall locations, storm surge height, coastal elevation and inundation models, tsunami prone areas, cliff erosion
Tourism	DoT	Marine cruise routes, coastal tourism zones, marine sports and recreation sites,
Military	Navy and Coast Guard	Bases, exercise zones, petrol

Source: Hossain *et al*. 2014

4.2. Integrated Coastal and Ocean Management

Integrated coastal and ocean management (ICM) can be defined as "a continuous and dynamic process by which decisions are taken for the sustainable use, development, and protection of coastal and marine areas and resources".[83] It is a process that recognizes the distinctive character of the coastal and marine area – itself a valuable resource – and the importance of conserving it for current and future generations.

Integrated Coastal and Ocean Management (ICM) comprises those activities that achieve sustainable use and management of economically and ecologically valuable resources that consider interaction among and within resources systems as well as interaction between humans and their environment. ICM encompasses coastal resources management, being a broader set of activities that emphasizes integration within government, non-government, and environmental realms.

The goals of ICM are to attain sustainable development of coastal and marine areas; to reduce vulnerability of coastal areas and their inhabitants to natural hazards; and to maintain essential ecological processes, life support systems and biological diversity in coastal and marine areas. ICM is multi-purpose oriented; it analyzes and addresses implications of development, conflicting uses, and interrelationships between physical processes and human activities, and it promotes linkages and harmonization among sectoral coastal and ocean activities. An ICM program should ideally operate within a closely integrated, coherent management framework within a defined geographical limit.[84]

World Commission on Protected Areas (WCPA) developed a set of principles and guidelines for the better linkage between marine protected areas (MPA) and

[83] Cicin-Sain B. and Knecht, R.W. (1998). *Integrated coastal and ocean management: concepts and practices*. Washington, DC: Island Press.
[84] Chua, T.E. (1993). Essential elements of integrated coastal management. *Ocean Coastal Management*.

integrated coastal and ocean management (ICM). These guiding principles (Box 4) were based on discussions by an international group of experts participating in two workshops on ''Integrating Marine Protected Area Management with Coastal and Ocean Governance: Principles and Practices,'' held, respectively, at the Coastal Zone 2003 Conference in Baltimore, USA on July 12–14, 2003 and at the Fifth World Parks Congress, Durban, South Africa, on September 10, 2003.[85]

Box 4: Guiding principles for managing MPAs within ICM[86]

A. Strengthening linkages between MPAs and the wider coastal/marine area

Principle 1

Connectivity between the terrestrial and marine side of the coastal area and between MPAs and the surrounding coastal and marine area should be recognized and maintained. To this end, a good scientific understanding of the ecological, socioeconomic, and cultural linkages and connectivity between ecosystems and humans in the coastal zone has to be developed. This is essential for ensuring that management of MPAs and the wider coastal and marine area is well integrated.

Principle 2

MPA management should be based on the best available knowledge and information, and much of this information is relevant to, and should draw from, the basis of broader coastal and marine area management programs.

Principle 3

Successful integration of ICM and MPAs depends on sustained management processes and programs that will produce perceived benefits and tangible outcomes that contribute to improved quality of life and ecosystem integrity.

B. Developing governance arrangements to incorporate MPAs into the broader framework of ICM

Principle 4

[85] Cicin-Sain, B. and Belifore, S. (2005). Linking marine protected areas to integrated coastal and ocean management: A review of theory and practice. *Ocean & Coastal Management.*

[86] Belfiore, S.; Cicin-Sain, B. and Ehler, C., eds. (2004). *Incorporating Marine Protected Areas into Integrated Coastal and Ocean Management: Principles and Guidelines*. IUCN, Gland, Switzerland and Cambridge, UK.

Strengthened and more effective relationships – vertically and horizontally – are needed to allow appropriate stakeholder participation at every stage of development and implementation of MPAs, and to achieve adequate linkage of MPAs with ICM institutional structures and planning processes.

Principle 5
MPA management should be an integral part of ICM governance: in cases where no ICM institutions have been put into place, MPA managers will need to relate to sectoral institutions concerned with watershed management, fisheries, tourism, maritime transportation, etc.

Principle 6
Planning of individual MPAs should be participatory and integrated within broader spatial management and economic and social development frameworks to ensure their sustainability and promote creation of functionally connected networks of MPAs.

C. Fostering implementation of MPAs through enhanced policy and management tools

Principle 7
Mobilizing adequate resources and capacity is essential for successful implementation, sustainability, and integration of MPA and ICM programs.

Principle 8
The effectiveness of MPAs and their incorporation into ICM frameworks has to be assessed through appropriate tools, guidelines, and trained personnel. Evaluation of MPAs should be conducted at the individual site, sub-national, national, and regional levels.

Principle 9
Ecologically coherent networks of MPAs, including geological and oceanographic considerations, provide a spatial management tool to prioritize biodiversity conservation and ensure maintenance and enhancement of environmental goods and services, which are essential objectives of ICM.

Source: Belfiore et al 2004

In reference to ICM, governance means the structures and processes used to rule both public and private behavior in coastal and ocean areas under the jurisdiction of a state, and the resources and activities they contain. ICM refers to the process through which the use of specific resources or portions of the coastal/ocean area are managed to achieve desired objectives. [87]

ICM represents the ability to create a governance system capable of managing multiple uses in an integrated way through the cooperation and coordination of government agencies at different levels of authority, with nongovernmental organizations and among different economic sectors.[88]

With an aim to ensure conservation of biodiversity of coastal and marine environment as well as sustainable utilization of resources therein, a group of experts in Bangladesh recently proposed a framework (Figure 2) for integrated coastal and ocean governance.[89] At the top of the scheme they suggested an Integrated Coast and Ocean Management Policy (ICOMP) driven by obligations and aspirations leading to an Integrated Coast and Ocean Management Plan. There should be a strong mechanism to integrate and coordinate the implementation of plans in different sectors at various levels (horizontal and vertical interplay among agencies and other actors). This framework can be further extended to include cross-border and regional collaborations particularly in the fields of environmental management, conservation, scientific research, etc.

[87] Cicin-Sain, B. and Belifore, S. (2005)

[88] Graham, J.; Amos, B.; Plumtre, T. (2003). Governance principles for protected areas in the 21st century. A discussion paper—phase 2. Ottawa: Institute on Governance.

[89] Hossain et al. (2014).

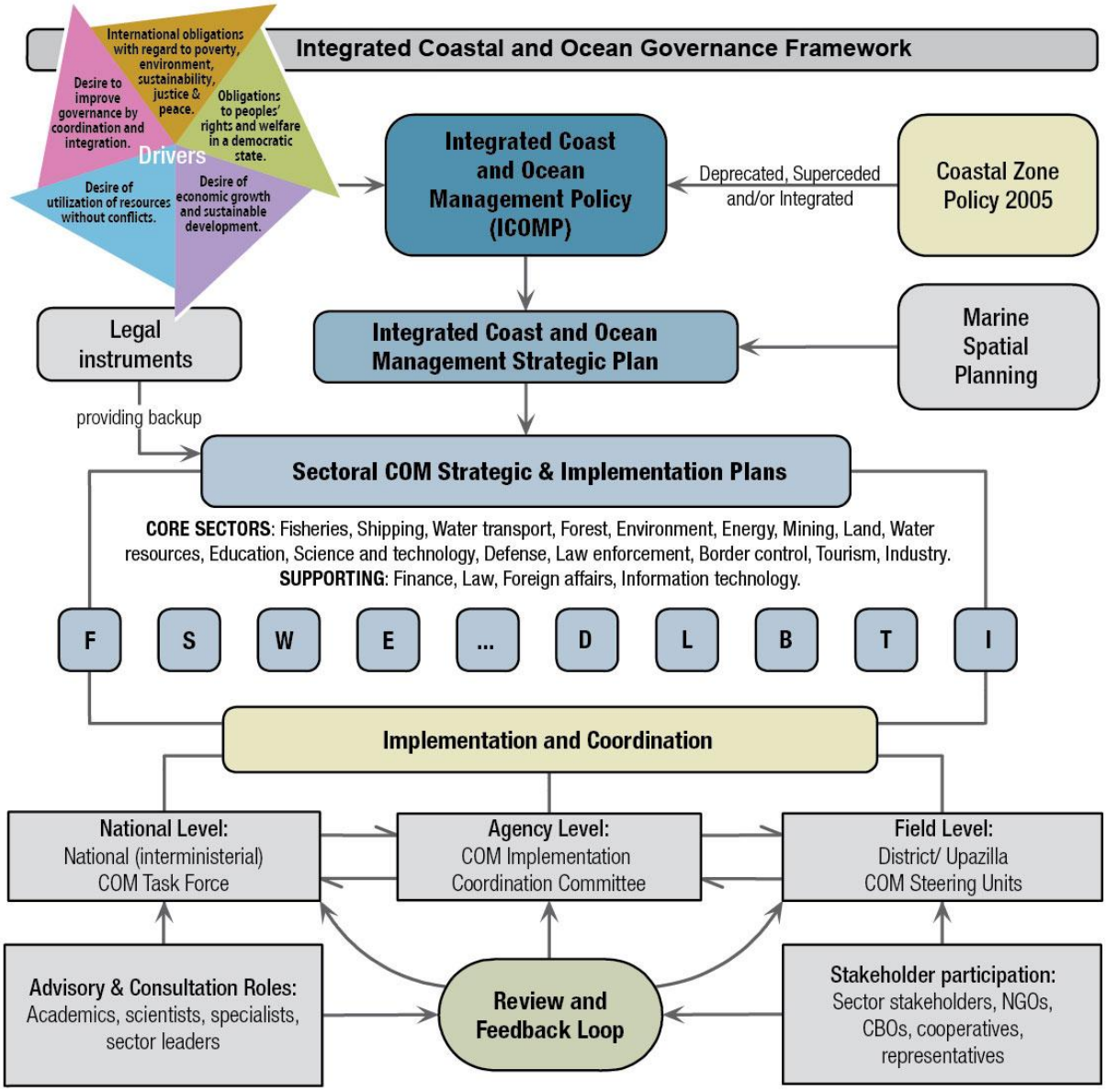

Figure 2: A proposed framework for Coastal and Ocean Governance in Bangladesh (Hossain et al. 2014)

4.3. Ecosystem Approach to Fisheries

Many of the world's fish populations are overexploited, and the ecosystems that sustain them are degraded.[90] Unintended consequences of fishing, including habitat destruction, incidental mortality of non-target species, evolutionary shifts in population demographics, and changes in the function and structure of ecosystems, are being increasingly recognized.

The ecosystem approach to fisheries (EAF) strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties of biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries. The purpose of an EAF is to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without compromising the options for future generations to benefit from the full range of goods and services provided by the aquatic ecosystems.[91]

The World Summit on Sustainable Development (WSSD) (Johannesburg, South Africa, 2002) adopted a Political Declaration and a Plan of Implementation in relation to capture fisheries, ecosystem health and the conservation of biodiversity. In the Declaration, the Heads of States agreed to: "develop and facilitate the use of diverse approaches and tools, including the ecosystem approach, the elimination of destructive practices, the establishment of marine protected areas ... and the integration of marine and coastal areas into key sectors".

The FAO Code of Conduct for Responsible Fisheries (CCRF) was unanimously adopted in 1995 by the FAO Conference. The CCRF is voluntary, although parts are based on international law, including the 1982 United Nations Convention on the Law of the Sea (UNCLOS). The CCRF covers all aspects of management and development of fisheries, including capturing, processing and trade of fish products,

[90] FAO (2002). *The State of World Fisheries and Aquaculture*. Food and Agriculture Organization, Rome.
[91] FAO (2011)

fishing operations, aquaculture, fisheries research and the integration of fisheries into integrated coastal area management (ICAM).

The CCRF is a global set of recommendations about how responsible fisheries and aquaculture can be conducted in a manner that contribute to sustainable development. Sustainable development can best be defined as "Development which meets the needs of the present without compromising the ability of future generations to meet their own needs". Development as used in this definition refers to improvement in the overall quality of life, as "human well-being" that needs to be balanced with "ecological well-being" to ensure that future generations have the same options and choices for development as does the present generation.[92]

The phrase "ecosystem approach" was first coined in the early 1980s, but found formal acceptance at the Earth Summit in Rio in 1992 where it became an underpinning concept of the Convention on Biological Diversity (CBD) that was later described as:

> *A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.*

In other words, the ecological approach is a strategy to endorse sustainable development. The application of the ecosystem approach helps reach a balance of the three objectives of the CBD – conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

FAO's definition of the ecosystem approach to fisheries (EAF) also reflects similar concept as a more general definition of the ecosystem approach:

[92] Staples, D. and Funge-Smith, S. (2009) *Ecosystem approach to fisheries and aquaculture: Implementing the FAO Code of Conduct for Responsible Fisheries.* FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.

> *An Ecosystem Approach to Fisheries (or Aquaculture) strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries.*

EAF is intimately connected to other approaches (such as the sustainable livelihoods approach and integrated management etc.) in the field of development, natural resource and spatial area management. There is a significant overlap in terms of their underlying principles, objectives and methods. MPAs can support the ecosystem approach for better fisheries management, while EAF can be served as a management approach to implementing MPAs. EAF offers an explicit bridging mechanism between fisheries management and biodiversity conservation.

MPAs do not address all the key issues for the overall fisheries management, especially of the area beyond the boundary; nor do they always restore historical failures of conventional fisheries management leading to overexploitation, ecological degradation and economic loss; however, MPAs – as a core management measure – can achieve the best results with a combination of fisheries and ecosystem management tools. Designed and implemented wisely, MPAs can generate both ecological and socio-economic benefits.

MPAs can be an effective instrument for controlling fish mortality as it does not mandatorily require a reliable estimate of population size, as do some alternative management tools. So, in the data-deficient context, MPAs can be particularly useful. They might be of a great use in reducing bycatch and its associated loss as well. On the other hand, this spatial measure also offers protection of fish habitats and biodiversity.

MPAs may be used in a blend with other fisheries management tools as a hedge against ambiguity and toward a more robust management. In case the conventional management fails, MPAs can provide a buffer against the consequences of failure. In some marine or coastal areas, where co-management arrangements provide a way to share the fisheries management between government and local communities or users, MPAs can demarcate the vicinity in which the management targets can be achieved.

The CBD encourages "the establishment of protected areas that benefit indigenous and local communities, including by respecting, preserving and maintaining their traditional knowledge". When indigenous communities are concerned about the conservation and maintenance of traditional and customary practices, MPAs can be employed to protect customary use rights and practices, as well to achieve fisheries management and biodiversity conservation objectives. On the other hand, in areas where user conflicts occur, zoning through the establishment of MPAs with different use patterns can help resolve such disputes.

BOBP-IGO (Bay of Bengal Programme Inter-Governmental Organisation) presented a comprehensive review (APFIC 2009) of the preparedness of its member countries including Bangladesh for implementation of an EAF in the region.[93] The analysis considered six dimensions and a suite of parameters under each dimension corresponding to the existing fisheries management system in the countries. The analysis identified a number of constraints that challenge the national move toward EAF. The key shortfalls are listed below.

- Lack of regular stock assessment or survey
- Lack of regular fleet assessment and weak fleet regulation

[93] APFIC (2009). APFIC/FAO Regional consultative workshop. *Practical implementation of the ecosystem approach to fisheries and aquaculture*, 18–22 May 2009, Colombo, Sri Lanka. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.

- Weak management in reducing bycatch, juvenile catch, fish discards, ghost fishing etc.
- Lack of effective mechanism in controlling IUU fishing
- Poor access to institutional finance and insurance (esp. for small fishers)
- Insufficient technical capacity for controlling discharge of ballast water, polluted/untreated water and oil spill
- Weak or no participation of stakeholders in policy formulation
- Inefficient scientific data collection, sampling and analysis
- Absence of proper communication and knowledge dissemination

However, the study looks forward to mitigating these shortfalls and sees prospects of moving toward an EAF in near future.

Biodiversity conservation is vital to fisheries management, especially so when it is implemented according to EAF. At the same time, fisheries management considerations are critical in effectively conserving biodiversity (FAO 2011). To gain maximum benefit, both the fisheries management and biodiversity conservation effects must be taken into account in MPA planning and implementation processes, which should be considered in a holistic and integrated spatial management framework.

4.4. Ecosystem-based Adaptation to Climate Change

Climate change is no longer a conceptual concern; rather the harsh realities of its impacts are being encountered by millions of people across the globe.[94] Climate change is already impacting the ability of marine and coastal ecosystems in

[94] Munang, R.; Thiaw, I.; Alverson, K.; Mumba, M.; Liu, J. and Rivington, M. (2013). Climate change and Ecosystem-based Adaptation: a new pragmatic approach to buffering climate change impacts. Current Opinion in Environmental Sustainability

providing food, income, protection, cultural identity, and recreation to coastal inhabitants, especially vulnerable communities in tropical areas.[95]

Marine fisheries and aquaculture provide more than 15% of global protein in people's diets and directly support more than 43 million jobs. Fish provide more than 50% of dietary protein for people in many small island developing states and coastal countries like Bangladesh, Cambodia, Ghana, and Sierra Leone (FAO, 2008). In addition, marine and coastal ecosystems provide a wide range of other important services to human society, including medicines, natural shoreline protection against storms and floods, water quality maintenance, and other cultural and spiritual benefits.[96] Marine and coastal ecosystems have long been under severe stress from habitat degradation, overexploitation and pollution (Millennium Ecosystem Assessment, 2005).

There is an immediate need for a significant reduction in greenhouse gas emissions to reduce the impacts of climate change and avoid catastrophic consequences in the long term. In the absence of such strong mitigation action, it is possible that the most vulnerable ecosystems, such as coral reefs, will cease to function in their current forms within a few decades.[97]

Even if mitigation measures aimed at reducing greenhouse gases and slowing climate change are implemented now, the earth's climate will continue changing over the short to medium term, due to lag effects of temperature in response to the build-up of CO2 already in the atmosphere. This will result in significant impacts,

[95] Hale et al. (2009). Ecosystem-based Adaptation in Marine and Coastal Ecosystems. *Renewable Resources Journal*.
[96] UNEP (2006). *Marine and coastal ecosystems and human wellbeing: A synthesis report based on the findings of the Millennium Ecosystem Assessment*. United Nations Environment Programme
[97] Hoegh-Guldberg, O., P. J. Mumby, and A. J. Hooten. (2007). Coral reefs under rapid climate change and ocean acidification. *Science.*

particularly in the marine and coastal environments. Measures to increase resilience in the face of these changes are a necessary complement to mitigation actions.[98]

Ecosystem-based adaptation aims to:

- *Preserve and restore natural ecosystems that can provide cost-effective protection against some of the threats that result from climate change. For example, coastal ecosystems like wetlands, mangroves, coral reefs, oyster reefs, and barrier beaches all provide natural shoreline protection from storms and flooding in addition to their many other services (CBD, 2009).*
- *Conserve biodiversity and make ecosystems more resistant and resilient in the face of climate change so that they can continue to provide the full suite of natural services. This is particularly important for sustaining natural resources (e.g., fish stocks, fuel, clean water) on which vulnerable communities depend for their subsistence and livelihoods (Hale et al, 2009).*

Ecosystem-based adaptation requires collective action among governments, communities, conservation and development organizations, and other stakeholders to plan and empower action that will enhance environmental and community resilience to climate change impacts. In addition, it can be a major opportunity for community-based adaptation. Vulnerable coastal communities can be engaged, employ local knowledge and participate directly in developing and applying ecosystem-based solutions.

Ecosystem-based Adaptation (EbA) integrates the use of biodiversity and ecosystem services into an overall strategy to help people adapt to the adverse impacts of climate change. It includes the sustainable management, conservation and

[98] Hale et al. (2009).

restoration of ecosystems to provide services that help people adapt to both current climate variability, and climate change.[99]

Ecosystem based approaches to adaptation harness the capacity of nature to buffer human communities against the adverse impacts of climate change through the sustainable delivery of ecosystems services. Deployed with focus on specific ecosystem services with the potential to reduce climate change exposures, the forms used are targeted management, conservation and restoration activities.[100]

For instance, mangrove forest and coastal marshes buffer storm surges energy and research and practical work have shown that restoring or conserving mangrove ecosystems can therefore help protect coastal communities from current and projected rise in the number of tropical storms due to the changing climate. Ecosystems deliver services that can help meet adaptation needs across multiple human development sectors including disaster risk reduction (through fold regulation and storm surge protection), food security (from fisheries to agro-forestry), sustainable water management and livelihood diversification (through increasing resource-used options). EbA can also generate significant multiple benefits such as carbon sequestration and other social, economic and cultural benefits. Healthy ecosystems and their services provide opportunities for sustainable economic prosperity (Figure: 3) while providing defense against the negative effects of climate change.[101]

[99] Colls, A.; Ash, N.; Ikkala, N. (2009). *Ecosystem-based Adaptation: a natural response to climate change*. Gland, Switzerland: IUCN.
[100] Munang et al. (2013).
[101] Ibid.

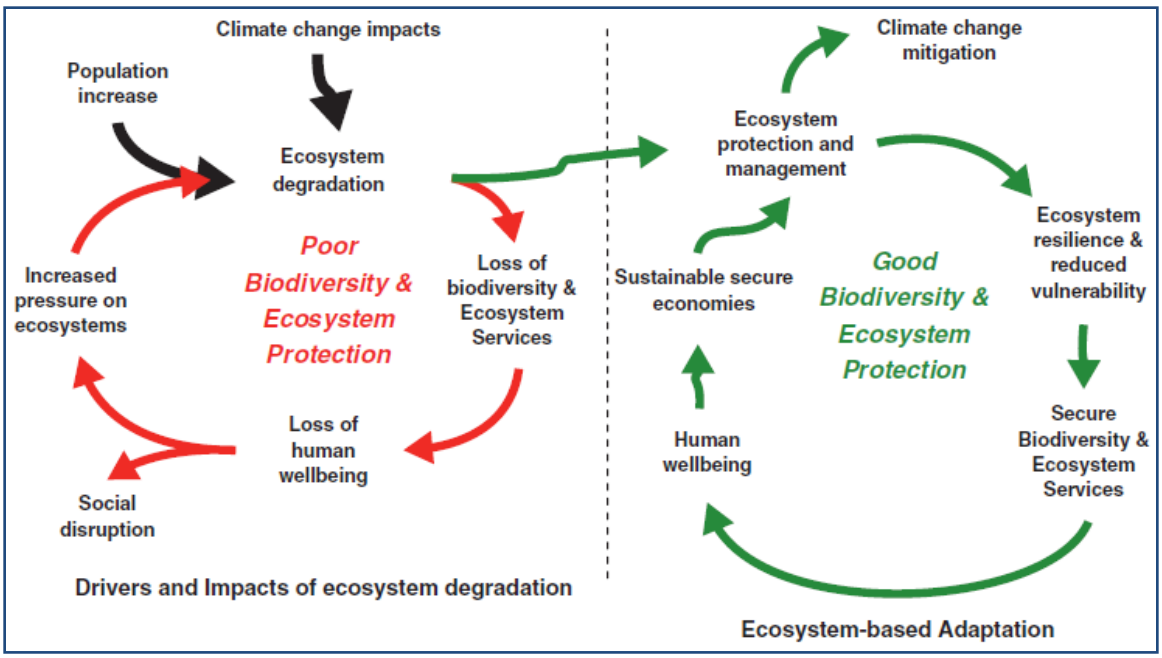

Figure 3: Status of Biodiversity and Ecosystem Protection and their respective effects.

Marine protected area can be an effective tool for reducing local threats, and can contribute to fisheries management and biodiversity conservation in the face of climate change.[102] The design and effective management of the MPAs is critical to maximize the benefits to fisheries management, biodiversity conservation, and climate change adaptation.[103]

Changes in climate and ocean chemistry represent a serious and increasing threat to tropical marine ecosystems.[104] Of particular concern is the increasing frequency and severity of mass coral bleaching primarily due to increasing sea-surface temperatures (SST), inundation of coastal habitats such as mangroves, tidal wetlands and turtle nesting areas due to sea-level rise, and weakening of calcareous

[102] Lester et al. (2009).
[103] McLeod, E.; Salm, R.; Green, A. and Almany, J. (2009). Designing marine protected area networks to address the impacts of climate change. *Frontiers in Ecology and the Environment*.
[104] Burke, L.M.; Reytar, K.; Spalding, M. and Perry, A. (2011). *Reefs at Risk Revisited*. Washington. D.C.: World Resources Institute.

skeletons of corals and other organisms due to ocean acidification.[105] The effects of these changes on habitats and species vary based on different internal (e.g. genetic) and external (e.g. environmental) factors, which results in varying degrees of resilience.[106] Scientists hypothesize that areas where habitats and species are likely to be more resistant or resilient to climate and ocean change include: areas where habitats and species are known to have withstood environmental changes or extremes in the past; areas with historically variable SSTs and ocean carbonate chemistry, where habitats and species are more likely to withstand changes in those parameters in future; and areas adjacent to low-lying inland areas without infrastructure that coastal habitats can expand into as sea levels rise.[107] Such potential climate change refugia should be protected within marine protected areas, because they are likely to be important for maintaining biodiversity in the face of climate change.[108] They are also likely to provide fisheries benefits, since habitat loss is a major threat to tropical coastal fisheries in the face of climate and ocean change.[109]

Although the EbA approach has not been included officially in discussions around development and adaptation landscapes in Bangladesh, in practice there are some examples of development/adaptation activities that address ecosystem management, livelihood enhancement and disaster risk reduction. A few examples of ecosystem-based adaptation to climate change in the coastal areas of Bangladesh are briefed in Box 5.[110]

[105] Hoegh-Guldberg, O.; Mumby, P.J. and Hooten, A.J. 2007. Coral reefs under rapid climate change and ocean acidification. *Science.*
[106] West, J.M., and R. V. Salm. 2003. Resistance and resilience to coral bleaching: Implications for coral reef conservation and management. *Conservation Biology.*
[107] McLeod et al. (2009).
[108] West, J.M., and R. V. Salm. 2003. Resistance and resilience to coral bleaching: Implications for coral reef conservation and management. *Conservation Biology.*
[109] Bell, J. D., J. E. Johnson, and A. J. Hobday, eds. (2011). *Vulnerability of tropical pacific fisheries and aquaculture to climate change*. Secretariat of the Pacific Community, Noumea.
[110] Rahman, M. (2014). Framing Ecosystem-based Adaptation to Climate Change: Applicability in the Coast of Bangladesh, Dhaka, Bangladesh: IUCN.

Box 5: EbA to climate change in the coastal areas of Bangladesh

Community-based large-scale mangrove afforestation in the coastal zone

- *Location: Three upazilas (sub-districts) in three coastal districts (Barguna, Bhola and Noakhali).*
- *Ecosystems: Coastal mudflats/ intertidal lands, mangrove ecosystem.*
- *Lead Agency: Community-based Adaptation to Climate Change through Coastal Afforestation (CBACC-CF) project of the Ministry of Environment and Forests (MoEF) and executed by the Forest Department (FD).*

The project is building social-ecological resilience by planting mangroves on 6,100 hectares of newly accreted coastal land that is exposed to cyclones and storm surges. The planted mangroves provide multiple adaptation benefits to coastal communities through various ecosystem services. They also have mitigation benefits through carbon sequestration. This intervention contributes to building the resilience of coastal ecosystems and biodiversity and is helping to build resilient coastal communities in the face of climate change impacts.

Ditch-and-dyke schemes for year-round cultivation in saline-prone coastal lands

- *Location: Three coastal districts of Bangladesh (Barguna, Bhola and Noakhali).*
- *Ecosystems: Coastal saline-affected (inter tidal) lands.*
- *Implementing Agency: Ministry of Environment and Forests (MoEF) and Forest Department (FD) as lead agencies; they also involved other agencies like DoF (Department of Fisheries), DAE (Department of Agriculture Extension), DoL (Department of Livestock), BAU (Bangladesh Agricultural University), MoL (Ministry of Land) and BARI (Bangladesh Agriculture Research Institute).*

The project has worked with the community to change the land form of this saline-affected area by excavating ditches and raising dykes with the excavated soil, creating a series of ditches and dykes from flat land. The ditches retain monsoon rainwater (freshwater) in sufficient volume to maintain water levels almost year-round, making them suitable for fish culture. The dykes are raised to a level that keeps them free from tidal inundation and helps protect the scheme areas from salinity intrusion. Ditch-and-dyke schemes provide adaptation benefits through year-round crop production and beneficial use of saline-affected lands, while mitigation benefits are generated through carbon sequestration by the trees grown on the dykes.

Hydroponics – floating agriculture in waterlogged areas

- *Location: Initially started in the southwest coastal zone, and then expanded to other wetland areas.*
- *Ecosystem: Wetland ecosystem - mainly caused due to water logging/drainage congestion.*
- *Agencies involved: Local communities initiated hydroponics in the southwest and then various NGOs disseminated this technology in other wetland /waterlogged areas of the country.*

This innovative method of floating agriculture was invented in the late 1960s before the climate change discourse, but it has become particularly relevant in this new scenario, which will likely bring more intense rains and exacerbate existing water logging issues. This farming system provides adaptation benefits through crop production during the monsoon season in waterlogged areas, which otherwise would have remained non-productive. This innovative form of floating agriculture is beneficially exploiting the water resources which result from both climate (high rainfall) and non-climate (poor drainage due to faulty water management) factors.

Integrated fish-vegetable/ fruit-rice cultivation in drainage-congested rice fields

- *Location: Pirojpur-Bagerhat- Barisal areas.*
- *Ecosystem: Cropland ecosystems.*
- *Implementing agency: Local communities.*

A new cultivation practice locally called the "lease farming system" is being practiced in some parts of Pirojpur District, which is located in a coastal area of the southwest. Farmers in the area have excavated trenches in their rice fields to hold excess rainwater and raised dykes to prevent further rainwater entering from adjacent lands. They cultivate a variety of vegetables and fruit trees on the raised dykes, or bunds, as well as aquaculture in the trenches. The lease farming practice has some similarities to the ditch-and-dyke schemes as practiced by the households under the UNDP-CBACC project in the coastal areas; both involve fish culture in ditches, or drains, and vegetable cultivation on raised dykes. This type of farming system is suitable in coastal areas where localized water-logging affects traditional agricultural farming systems.

(Source: Rahman 2014)

Currently, there is no explicit policy or strategy at the national level that recognizes and facilitates implementation of EbA in Bangladesh to address the adverse impacts of climate change on social-ecological systems. However, there are two guiding documents that facilitate the adoption of adaptation-mitigation measures at national scale. The first – National Adaptation Program of Action (NAPA) - was prepared and submitted to UNFCCC in 2005 with 15 priority adaptation interventions. The first intervention relates to 'community-based adaptation to climate change through coastal afforestation (CBACC-CF)', which is now being

implemented in four coastal upazilas as a pilot by the FD under the supervision of the MoEF and technical backstopping of UNDP. Activities that support mangrove afforestation and reforestation and community livelihoods are globally treated as EbA and in this sense Bangladesh NAPA addressed EbA in its priority adaptation planning. The other strategy document is the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) which was first developed in 2008 and then updated in 2009.[111]

Climate change adaptation should necessarily include suitable measures and technologies to support agriculture in the coastal areas of Bangladesh for resilience and sustainability. A study, conducted by Center for Environmental and Geographic Information Services (CEGIS) and commissioned by the Climate Change Cell, found that introduction of high yielding salt tolerant variety of rice (BRRI-47) could ensure sustainable crop yield in the coastal regions of Bangladesh.[112] It was also observed that salinity did not impact on rice production during monsoon due to sufficient rainfall; however, in the rain-depleted post-monsoon period the salinity of soil had a propensity to go up and might hinder the optimum production of rice. So, salt tolerant T. Aman varieties like BR-23, BRRI-40 and BRRI-41 may be the effective substitute to overcome salinity impact at the later stage. The study also observed that tomato, okra and aroid were grown effectively under improved management practices with raised bed and mulch in the medium saline soils in southern part of the country. The investigation further recommended that the conventional cropping pattern of Fallow-T.Aman (Local)-Fallow or Fallow-T.Aman (Local)-Boro (Local/HYV) may be replaced with the pattern of Okra - T.aman - Boro (HYV) or Okra - T.aman – Tomato to achieve better yield.[113]

[111] MoEF (2009). Bangladesh Climate Change Strategy and Action Plan 2009, Ministry of Environment and Forests, People's Republic of Bangladesh, Dhaka,
[112] CCC, 2009. *Adaptive Crop Agriculture Including Innovative Farming Practices in the Coastal Zone of Bangladesh.* Climate Change Cell, DoE, MoEF; Component 4b, CDMP, MoFDM. June 2009, Dhaka.
[113] Ibid.

To provide an alternative approach for adaptation to coastal erosion and flooding, the ECOBAS (Eco-engineered Coastal Defence Integrated with Sustainable Aquatic Food Production in Bangladesh) project has been carrying out an investigation, in which the natural resistance of shellfish reefs against hydrodynamic forces reduces human vulnerability to coastal erosion and flooding by using the concept of eco-engineering, and delivers a source of aquatic food. The study team, comprised of Dutch and Bangladesh researchers, observed that the reef structure can facilitate accretion on the lee side of the reef by influencing the wave climate,[114] which might enhance the growth of mangrove saplings and salt marsh vegetation. Living oyster reefs grow naturally with and require least maintenance. Besides, they afford a wide range of ecosystem services such as shelter for many marine organisms by providing biodiversity and protection benefits as well as food sources (e.g. fish, oyster, crab, mussels, sea weed) to local communities.

Bangladesh is considered as a pioneer in developing adaptation practices in response to climate related hazards. The historical experience and skills of Bangladeshi communities in living with and adjusting to the effects of a range of climate-induced hazards (such as flooding, cyclones, storm surges, and drought) has helped the communities and relevant institutions to become adaptable. Their recent ecosystem-based adaptation responses, as documented here, can provide valuable lessons to other countries vulnerable to the impacts of climate change.

[114] Wave climate is defined as the distribution of wave height, period, and direction averaged over a period of time for a particular location.

Conclusion

Marine protected area (MPA) has become progressively more popular as a tool for protecting biodiversity and habitats and for preserving sites with particular importance. Spatial management, including MPA measures, with its historical application in fisheries, and fisheries management is evolving into ecosystem approach in fisheries (EAF), paying increased attention to ecosystem linkages and overall health. Further attention to the synergy between fisheries management and biodiversity conservation is vital to obtain the optimized benefit of MPAs.

Effectively planned and managed MPAs across the world have been experiencing improved fish harvest through successful 'spilling over'. However, the management context needs to be understood and combinations of appropriate measures should be implemented accordingly.[115]

The success of fisheries management depends on achieving optimal sustainable utilization of fishery resources. Ecosystem approach in fisheries (EAF) expands the conventional fisheries management framework to explicitly consider a wider range of aspects of the fishery and its ecosystem, including its human dimensions. A precautionary approach to the management of marine resources should be adopted, endorsing the use of the best tools and measures available according to defined objectives and case-specific circumstances (ibid). MPAs generally have both biodiversity conservation and direct fisheries management outcomes. To gain the most benefits, the two concepts need be bridged when planning and implementing MPAs.

The collective experience with MPAs provides valuable lessons that should make MPAs more effective in the future. This section summarizes some key conclusions

[115] FAO (2011).

and looks into future opportunities and challenges in planning and implementing MPAs in support of both biodiversity conservation and sustainable fisheries in Bangladesh – providing benefits to those who depend on marine resources for their livelihoods and to society overall.

The current trend towards greater emphasis on MPAs as a fisheries management and biodiversity conservation tool should continue, within the framework of EAF and in the context of the international commitments made to conservation and sustainable development. In order to make the most of the contribution of this spatial management measure to achieving healthy marine ecosystems and sustainable fisheries, and meeting broader societal objectives – including poverty reduction and food security where these are a major concern – there are both opportunities and challenges.

The goals associated with MPAs can often create conflicts among different interests, user groups, levels of government and national government agencies as seen in Belize, the Philippines and Indonesia.[116] Where competition for coastal resources exists, careful design and implementation of integrated coastal management (ICM) can help ensure continued benefits and sustainable management of coastal resources.[117]

MPAs can be one important management strategy within a larger area-wide coastal management framework with broader goals such as maintaining essential ecological processes and life support systems, maintaining genetic diversity, ensuring sustainable utilization of species and ecosystems, watershed management and others. Depending upon community needs and management concerns within the context of a larger ICM plan, MPAs can be designed and managed to accommodate various objectives and activities.

[116] Christie et al. (2007)
[117] Ibid.

Against the backdrop of SDGs, to achieve the goals of blue growth, Bangladesh should set priorities, which may include restoring marine and coastal ecosystems, adopting science based management for sustainable marine fisheries, reducing land based pollution, and ensuring proper access to marine resources for small-scale artisanal fishers. Besides, National Environment Policy, National Fisheries Policy, Coastal Zone Policy, Bio-safety Guidelines of Bangladesh and National Sustainable Development Strategy (NSDS) 2015-2020 should be modified in line with the targets and provisions of SDG 14 for conservation and judicial use of the oceans, seas and marine resources for sustainable development. Furthermore, the country needs to impart appropriate strategies, policy frameworks and action plans for ecosystem restoration through encouraging community based cooperative enterprises in deep sea fishing.

'Blue Growth' or the economic development utilizing ocean resources and potentials appears promising for Bangladesh. Nonetheless, sustaining any economic growth or progress is seriously contingent on maintaining good health of the ocean, its ecosystem and biodiversity and on the success of acting on precautionary and sustainability principles. On the other hand, considering the global ratio of economic contributions of maritime services and manufacturing sectors (US$1,130 billion) to that from capital resource exploitation (US$432 billion) (Our Ocean Wealth, 2012), Bangladesh should not expect to achieve a dramatically different outcome, particularly when conventional fisheries are already showing signs of decline and degradation.118

Therefore, Bangladesh should focus broadly on (i) protecting and managing the fisheries for the present and the future generations, (ii) developing a strong renewable energy sector using ocean and atmospheric forces, (iii), maintaining existing (e.g., ship building) and developing new maritime industries; (iv) extending fishing areas using new technologies and methods even beyond EEZ in the

[118] Haroon, M.I. (2014). Marine fisheries potentials, trends and development. Seminar of World Oceans Day 2014, Institute of Marine Sciences and Fisheries, University of Chittagong, Bangladesh,

international waters, (v) developing a strong human resource base for domestic utilization, and export to foreign job markets, (vi) substantially increasing fisheries production and export earnings through improved aquaculture and introduction of mariculture, (vii) creating a competitive tourism industry, including ecotourism and marine cruises, (viii) further increasing revenue from shipping and commerce by the expansion of domestic fleet and destinations, transhipment and transit provisions, linking neighboring states to the sea-ports, etc. (ix) give special priority to anticipated Climate Change impacts on all relevant matters, and adjust policies and plans, (x) maintain the inland river systems and ecosystems for fishery, sediment transport, and inland shipping; and (xi) building a solid science, research and education base. Above all, for maintaining seamless and coordinated planning and actions (xii) an integrated Coastal and Ocean Management Policy should be put in place.[119]

Sustainable fisheries resource management should get highest priority considering the importance of this resource for sustaining livelihood of millions of poor people, as a source of protein and export earnings. Stock assessment and maximum sustainable yield/total allowable catch (quota) determination must be carried out regularly. Therefore, capacity building and proper actions in the marine fisheries sector should be brought to immediate focus.

As conservation of fish biodiversity and healthy stock are keys to sustainable fisheries resources, suitable areas in the EEZ and coastal waters should be declared as Marine Protected Areas (MPA) of appropriate kind to facilitate conservation and protection of fish diversity, and also protection of breeding, nursing, growth, habitats and migration.

Land based pollution consisting primarily of solid wastes (e.g. plastics, polythene, toxic substances) and untreated industrial effluents must be banned from entering

[119] Hossain et al. (2014)

into the sea, and be enforced with rigor and determination, if the habitats and the lives of fishes are to be protected. Shore-based and ship-borne pollution should also receive due attention.

No industrial practices should be allowed on the continental shelf and onshore areas which may cause destruction and degradation of fish habitats, and decline of fish stocks. Such activity may include irresponsible and destructive means of oil and gas explorations/exploitation. All hydrocarbon exploration on the shelf and coastal waters should be carried out using internationally accepted practices. Oil and gas as well as other mineral resource exploration and exploitation should include active involvement by operators and owners in marine policy, legal and regulatory debates, and should be active partners in effective monitoring and preservation of living marine resources.

Bangladesh has already gained global reputation for excellence in ship building industry. This growing sector should be promoted and nurtured in all possible ways, including its horizontally and vertically linked businesses, and given opportunities and incentives for growth and expansion.

Marine biotechnology and industries based on biotechnology research are now overdue. Universities and research institutions should be encouraged and given funding & logistics for opening up this promising field for future industrial growth.

Bangladesh's marine fishing is effectively limited to the continental shelf only, i.e. up to a depth limit of 200m, and most fishing boats and vessels operate even closer to the shore - within 40-50m depth. This limitation in fishing area is primarily due to smaller tonnage of the vessels, but also due to fishing gear preference of the operators. The implications of this limited fishing zone are threefold, firstly, fishing effort is intense on a smaller space and volume of water putting excess pressure on the stock therein; secondly, some open ocean high value fishes (for example, species of pelagic tuna/Scombridae, mackerel, Indian salmon/Polynemidae, etc.) only rarely

appear in Bangladeshi fish catch despite their availability in deeper areas; and finally, the large area within the EEZ and beyond has tremendous untapped potential. It is, therefore, imperative for Bangladesh to create the necessary environment to encourage fishing operators to venture into deeper and open ocean areas with high-tonnage vessels, using alternate gear, such as tuna long-lines and hooks, and expanding the fishing horizon not only on the geographic front, but also on economic and nutritional fronts.

A large eligible population places Bangladesh in a suitable position to produce skilled human resources in almost any sector imaginable. A thrust in blue economic growth may come from a large pool of skilled coastal and offshore engineers, navigators, merchant mariners, fisheries technologists, biotechnologists, etc. and in a variety of other professions. Targets to produce skilled human resource for domestic and international job markets, and its export should be given special attention in strategic planning.

The export earnings from shrimp production can be gradually increased by improving the culture techniques and adopting better aquaculture practices. Some species of fishes, for example, sea bass (Koral), can be cultivated within temporary enclosures (e.g. cage) in open sea. Introduction of improved techniques in mariculture or marine farming can add additional income generation for people and the country. Moreover, new fish and shellfish species should be brought into the process of domestication in order to diversify coastal aquaculture practices for improved productivity.

The tourism industry, despite its huge potential and recent developments, still remains locked in a 'go-see-dine-sleep' model of the past years. In spite of growing appetites, 'action tourism' (e.g. tracking, climbing, surfing, diving, boating, sport fishing, etc.) is virtually non-existent. Coastal and marine tourism has great potentials for expansion not only in terms of activities, but also of destinations, modes of travel and accommodations, amenities, target demographics, and overall

philosophy. This sector should undergo an overhaul - in planning and operation, to include, for example, luxury marine cruises to distant destinations. The tourism sector also should be a major face in the development of marine policy, laws and regulation.

The shipping industry, in general, and the ports in particular, are already contributing a large proportion to the country's economy and growth. However, the true potential is far from being tapped yet. Bangladesh's flag bearing cargo fleet carries only a small portion of import and export commodities. Expansion of the fleet in terms of its size and capacity, and of destinations will substantially lift the economic face of the country in a short time. Serious planning and actions are required to increase maritime shipping and trade activities and earnings. Inland water transport should also be brought to focus, and issues about inland ports/terminals and river navigability should be addressed in a systematic manner.

To ensure the sustainability and proper health of marine and coastal space of Bangladesh, future policies and strategic action plans should made to include and existing policies and plans updated to include where necessary mitigation and adaptation to climate change and associated phenomena including sea-level rise, weather and climatic shift, changing rainfall patterns, intensification of tropical cyclones and ocean acidification.

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