Marine Environment Protection of the Bay of Bengal: A Key Issue for Regional Ocean Governance and Sustainable Blue Economy

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[Abstract]

The Bay of Bengal is an area of 2.2 million square kilometres of the northern eastern part of Indian Ocean and underneath a part of the great Indo-Australian Plate. 13 Sea ports, 27 sea beaches including the longest sea beach of the world- the Cox's Bazar and the largest mangrove forest- the Sundarbans, a world heritage site are on the Bay of Bengal. It is one of the world's 64 largest marine ecosystems with varied biological diversity consisting of inter alia – coral reefs, estuaries, fish spawning and nursery areas. It produces 6 million tons of fish corresponding to nearly 4% of the total global catch. More than 20% of the world's population live in South Asia and it is the most densely populated region in the world. Bangladesh, India, Maldives, Pakistan and Sri Lanka are five coastal states which are dependent on the Bay of Bengal for their livelihood.

The Ganges, the Brahmaputra and the Meghna River system is one of the most dynamic river systems in the world, which carries lots of sediments and pollutants from the upper catchments. These are ultimately deposited in the Bay of Bengal and mixed with water and soil. Due to climate change, salinity intrusion, rapid population growth and urbanisation in recent decades, there has been a dramatic change in water pollution levels in the runoff of major South Asian rives including Bangladesh. For various reasons, nations of this region are less advanced to comply international legal instruments to prevent, reduce and control of marine pollution.

According to SDG 14.1, countries must prevent and significantly reduce marine pollution of all kinds, including marine debris and litter by 2025. Therefore, national capacity building and regional binding and non-binding legal framework are essential to reduce trans-boundary marine pollution of the Bay of Bengal for sustainable blue economy.

Key Words: *Bay of Bengal, pollutants, UN conventions, regional agreement, governance.*

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2. Background of the Study:

A number of studies (e.g., Islam, 2003; Sarkar et al., 2006; Roy et al., 2006) have demonstrated the environmental, ecological and legal issues on the management of the Bay of Bengal on the basis of qualitative and quantitative assessment of pollution levels and their implications on ecology. Sewage-borne pathogens, persistent organic pollutants, heavy metal concentration in water, sediment and their toxic effect on sea shells and oyster along the east coast of the Bay of Bengal are evident. Lead, cadmium, iron, and copper in the eastern coast near Myanmar are relatively 3027, 3, 19 and 122 times higher than the standard sea water (Rashid et al. 2015).

According to the Earth Day Network of the USA 2018, Bangladesh is the 10th most polluting countries in the world. Every year about 200,000 tons of plastics enter the Bay of Bengal from Bangladesh and fishes of the Pacific coast are estimated to consume over 2,200 tons of plastic in a year (Daily Star, Nov 4, 2019). Most of the industries in Bangladesh discharge untreated effluent and solid waste into the Karnaphuli River of Bangladesh leading to the Bay of Bengal.

Every year, 60-65 ships are broken in Chattogram and Khulna (Daily Star, Nov 4, 2019). The toxic effect of lead and zinc from these ships can reduce the growth of sea shells and oysters and presents great threat to the marine ecosystem. Natural disasters such as cyclones, storm surges, floods, river erosion and soil salinity, which also increase the severity of marine pollution in the Bay of Bengal.

In India, 6,000 tons of plastic waste lies uncollected every day. Some of these wash up in Tamil Nadu state, where it pollutes and contaminates the food and water of communities living along the Bay of Bengal (Guardian, 2017). Indian coastal sediment contains some heavy metals such as cadmium, copper, lead and zinc (Jayaraju, et. al. 2009). The nutrient status and load of pollution for six heavy metals such as copper, zinc, iron, manganese, lead and cadmium in the sediment of Jagannath canal, which receives municipal sewage and brackish water from the Bidyadhari River of north Sundarbans, West Bengal, and the concentration of different heavy metals hierarchy is iron, manganese, zinc, copper, lead and cadmium (Saha, et. al 2001).In the Jagannath canal of India, the pollution load index value of the heavy metal is 1.71 (Jayaraju, et. al. 2009).

Several large rivers from Indian territory empty into the Bay carrying vast tides of untreated sewage, plastic, industrial waste and effluent from the agriculture and aquaculture industries (Kaly, 2004). This high load of organic pollutants, coupled with the diminution of the fish that keep them in control, could lead to massive plankton blooms, further reducing the water's oxygen content. Apart from sulphur-oxidising bacteria and marine worms, few creatures can live in these oxygen-depleted waters (Bristow et.al. 2017). This zone already spans some 60,000 sq km and appears to be growing (Jayaraman, 2016). The dead zone of the Bay of Bengal is now at a point where a further reduction in its oxygen content could have the effect of stripping the nitrogen from water. This transition could be triggered either by accretions of pollution or by changes in the monsoons, a predicted effect of global warming (Ghosh et. al. 2017). That's why framing regional legal instruments are emergence to protect the environment of the Bay of Bengal for sustainability of marine resources.

3. Objective of the Research:

a. To visit international legal instruments pertinent to prevent and reduce marine pollution of all kinds and its compliance to South Asian nations.

b. To study regional agreements and best practices to protect marine environment and see how far those provisions can be periodically applied to the Bay of Bengal for sustainable marine resources in South Asian region.

4. Research Questions:

(a) What are the binding and non-binding international and regional legal instruments to protect the marine environment from pollution?

(b) Which International conventions and recommendations are signed, accessed, ratified and denunciated by South Asian coastal countries and whether those provisions are incorporated in major national legislations to protect marine environment.

(c) What are the best practices of regional environmental agreements that can be applied to South Asian coastal countries to strengthen regional habitats and ecosystems.

5. Research Methodology:

At the outset, the study has examined the existing pollution situation of the Bay of Bengal, particularly in the onshore and off shore regions of Bangladesh, India, Myanmar, Maldives, Pakistan and Sri Lanka in comparison with global acceptable range of pollutants through literature review of secondary internal and external sources.

The research has focussed on whether biodiversity, ecosystem, soil and biota are being affected with the increase of such pollutions and to what extent the life of the coastal people are being affected or may be affected in future. Beyond the theory of precautionary principle, polluter's pay principle and global concept of cooperation in ocean management, international environmental law and conventions are studied through perusing different regional and international legal frameworks and agreements.

Explicative process of law relating to industrial pollution, legal control and administrative action are reviewed. Opinions of experts, policy makers, academics, administrators, industrialists and environmentalists are evaluated to recommend a regional marine governance system for sustainability of marine resources and coastal habitats.

5.1 Sources of Secondary Data:

Researches and publications of different government, non-government and autonomous bodies of South Asian nations such as the Ministry of Environment, Forest and Climate Change, Bangladesh; Bangladesh Institute of International and Strategic Studies (BIISS); Bangladesh Oceanographic Research Institute (BORI), Cox's Bazar; Faculty of Marine Sciences and Fisheries, University of Chittagong; Department of Soil, Water and Environment, University of Dhaka, Bangladesh; Centre for Environmental Planning and Technology (CEPT), India; National Environmental Engineering Research Institute (NEERI), India; Centre for Ocean and Coastal Studies, University of Madras; Centre for Marine Living Resources and Ecology; Ministry of Earth Sciences, Kochi, Kerala, India; Centre for Advanced Study in Marine Biology and Oceanography (CASMB), Annamalai University, Tamil Nadu, India; Indian National Centre for Ocean Information Services (INCOIS), Hyderabad; Integrated Coastal and Marine Area Management Project Directorate (ICMAM PD), Pallikaranai, Chennai, India; Myanmar Maritime University, Yangon Institute of Marine Technology, Advanced Water Management

Centre (AWMC), etc are enormously useful to draw a pen picture of various pollutants, their sources, and their impact on soil, water, ecosystem, biota and coastal population of the region. Study of those institutes shows the glimpse of probable way out. Beyond this, international journals, articles and books are available. Finally, recommendation for a regional cooperation framework is drawn to develop sustainable yields, manage marine resources and after all non-traditional security of the Bay of Bengal.

5.2 Limitations of Primary Data:

Lacking of required time, communication, fund, scientific and technological support, multiple places of testing pollutant substances and their reactions, collection of primary data were not possible excepting interview and focus group discussion of experts, coastal people and stakeholders.

5.3 Rationale of the Study

It is believed that life originated in ocean approximately 3.6 billion years ago, compared to several hundred million years ago for terrestrial life. Among 36 divisions (phyla) of living things, 34 categories are found in the marine environment (Arrieta et al. 2010). Ocean covers over 70% of the surface of the planet containing 97% of earth's water (UN SDG 14, 2016). Ocean holds 99% of the biosphere and it is the largest absorber of carbon dioxide. (Terney 2017). The global total aquaculture is about 106 million tons out of which brackish water aquaculture holds nearly 8% and marine water aquaculture covers about 50% amounting approximately $50 billion dollars. Apart from this, marine plants are worth of $4 billion and marine animals earn $43 billion (FAO 2016). Thus, marine pollution is not only a threat to marine resources rather a risk factor of mankind.

6. Literature Review regarding Marine Pollution:

6.1 Impact of Marine Pollution: A Threat to Life:

The reasonableness of our study lies in protecting marine environment from pollution to sustain human health and marine resources both biota and abiota which are now under threat.

6.1.1 Impact of Fertilizers, Pesticides and Agrochemicals:

It has been reported that about 9000 metric tons of different pesticides and more than 2 million metric tons of fertilizers are annually used in Bangladesh and about 1800 tons of pesticide residues per year are added to the coastal waters through run off. Similar figures can be expected from India, Myanmar and other neighbouring countries (Islam et al. 2004).

In agricultural land, nearly 53 herbicides, 28 insecticides, 10 fungicides and other acaricide, nematocidal defoliant, soil fumigant are worldwide used (Goldenberg 1995). In industries, chemicals like cadmium, dioxin (2,3,7,8-TCDD), lead, mercury, PBBs, PCBs, pentachlorophenol (PCP), penta- to nonylphenols, phthalates, styrenes, etc are commonly used. Such chemicals have reproductive and endocrine-disrupting effects (Colborn et al. 1993). As per National Oceanic and Atmospheric Administrative Service of the US Department of Commerce estimate 2017, 80% of pollution to marine environment comes from the land.

6.1.2 Domestic and Municipal Wastes and Sewage Sludge:

It is reported that the annual production of sewage is as high as 1.8 · 108 m3 for a population of 800,000 (Cheevaporn et al. 2003). Sewage effluent contains industrial waste, municipal wastes, animal remains and slaughterhouse wastes, water and wastes from domestic baths, utensils and washing machines, kitchen wastes, faecal matter and many others. It contains in itself a diverse array of polluting agents including pathogens, organic substances, heavy metals and trace elements and so on, which pose direct and indirect effects on ecosystems and organisms. A study recorded 14 types of bacterial species from 2 species of marine mammals- the cetaceans and the pinnipeds (Grillo et al. 2001). Solids suspended in sewage may also blanket river and sea beds preventing respiration of the benthic flora and fauna. Faecal streptococci bacteria are more closely associated with human sewage which can cause illness, especially gastroenteritis. Other disease-causing agents which may be present in sewage include enteric viruses, Salmonella and the Hepatitis A virus.

Bossart et al. (1990) suggested that some viruses are transferred to marine mammals by human sewage and are zoonotic in nature. Influenza, respiratory synctial virus, herpes, cytomegalovirus and measles are also zoonotic viruses capable of infecting marine mammals. Bacteria associated with sewage water contaminated with human pathogens (Olivieri, 1982), have been documented in marine mammals

include Escherichia coli, Mycobacterium tuberculosis, Vibrio cholera and Salmonella sp. Sewage-borne fungi could also, theoretically, infect marine mammals living in contaminated waters.

6.1.3 Exotic Algal Blooms:

Chemical and physical factors cause exotic algal blooms and lead to eutrophication which is often called red tides. This massive growth of phytoplankton, often dinoflagellates, may contain highly toxic chemicals that can cause illness, and even death, to marine organisms and humans. Outbreaks of these organisms can result in different discolorations of the waters- (Goldenberg 1995). Along with the direct ingestion of pathogens, the algal diseases are important causes of human mortality from exposure to the components of the marine environment. Recent event of algal blooms are chronicled in Harmful Algae News published periodically by the Intergovernmental Oceanographic Commission of UNESCO. There have been four types of human illness associated with algal toxins so far identified: (i) Amnesic Shellfish Poisoning (ASP) was first identified in Canada in 1987 resulting in memory loss; (ii) Diarrhetic Shellfish Poisoning (DSP) brings about diarrhoea and nausea; (iii) Neurotoxic Shellfish Poisoning (NSP) causes diarrhoea, vomiting, abdominal pain, muscular weakness with other symptoms.
(iv) Paralytic shellfish poisoning (PSP) causes numbness and can result in human deaths;

Thus, joint monitoring system of the Bay of Bengal is a crying need to predict algal bloom and develop the preventive measures because undesirable effects from red tides can involve the offing, even two or more nations.

6.1.4 Plastics, Microplastics, Sediments, Metals, Oils, Ballast Water, etc:

Plastics can affect animals through entanglement and ingestion causing starvation and suffocation of wildlife. It also endangers the life of biota through leakage of harmful chemicals. Fishes of the Pacific coast are estimated to consume over 2,200 tons of plastic per year. Humans are the last resort of this potential debris resulting fatal diseases like cancer. Hypoxia and anoxia can come about near the water-sediment interface. Such effects may seriously interfere with the normal functioning of ecosystems and may alter the make-up of life on the sea floor (Goldberg 1995). Bright and Burger (1997) examined 58 species under 3 categories of marine birds and reported that 100% of surface-feeding procellriiforms, 75% of shearwaters and 39% of the purcuit-diving alcids contained plastics in their guts (Islam et al 2004).

Metals concentrate in protein-rich tissues such as liver and muscle cause lymphocytic infiltration, lesions and fatty degeneration in bottlenose dolphins, malnutrition and lung pathology (siebert et al. 1999). Cadmium, lead and mercury are potential immune-suppressants (Law et al. 1999). Long persistence and high mobility of mercury in the marine ecosystem exposes age related accumulation and strong bio-magnification in the food web (Nigro and Leonzio 1996). Xenobiotic organic compounds such as halogenated hydrocarbons, PCBs, DDT, TBT may disrupt normal metabolism hormonal system, neuroendocrine functions, delayed sex maturity, smaller gonads, reduced fecundity, reduction in cellular protein level, vitamin A deficiency and overall growth retardation (Goldberg 1995, Crews et al 1995, and Hontela et al 1995).

As 13 sea ports are situated on the Bay of Bengal, marine oil pollution is grave concern. Globally nearly 16,000 tons of oil enters the marine environment each year as run-off and waste from land-based municipal and industrial sources (Nelson 2000). Diesel pollution causes death and even elimination of sea-stars and sea urchins. Phenol occurring in oil refinery effluents irritates the gills and causes heavy secretion and erosion of the mucus membrane, and also affects the central nervous and endocrine systems. Bottom-feeding fish near oil refinery is observed changes in the cell membrane caused by hydrocarbons leading to cellular changes and thus to cancer (Russel and Kotin 1956). Toxic dinoflagellates exist in ballast water (Hallegraff & Bolch, 1991). 40% of world oceans are heavily affected by human activities, including pollution, depleted fisheries and loss of coastal habitats (SDG 14, 2016) let alone ships accidents, explorations and dumping oil and garbage (Terney 2017).

7. Environmental Law and Conventions to Protect Marine Environment:

7.1 Multilateral Environment Agreements (MEAs):

Multilateral Environment Agreements (MEAs) are a subset of the universe of international agreements which distinguishes them from other agreements focusing on environmental issues, creation of legal binding and involvement of multiple countries. MEAs are considered to be classified into two inter-related and overlapping generations: a first generation, of single issue, use oriented and mainly dealing with sectoral programmes; and a second generation that adopt more holistic approach focusing on sustainable development and long run use of natural resources (Mace et. al 2006).

The stages of MEAs include pre-negotiation, negotiation, adoption and signature, ratification and accession, and entry into force. Once an MEA 'enters into force', it has legal effect and implementation begins (Mace et. al 2006). Between 1951 and 1995, 3,666 new multilateral treaties were concluded including environmental conventions (Ku 2001).

First generation environmental agreements primarily address the preservation and use of particular natural resources- such as wildlife, air and the marine environment especially the Ramsar Convention 1971, Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter 1972, and the 1973 International Convention for the Prevention of Pollution from Ships (MARPOL). Principles of these MEAs deal with threats to living natural resources, global common resources, and marine environment (Mace et. al 2006).

Many of the second generation MEAs more 'holistic' in nature evolved following the United Nations Conference on Environment and Development (UNCED) 1992 with the presence of 180 States. Two conventions were opened for signature: the UN Framework Convention on Climate Change (UNFCCC) 1992 encompassing recognition of the broader impacts of climate change on ecosystems, food production and sustainable development; and the Convention on Biological Diversity (CBD) seeking to bring together agriculture, forestry, fishery, land use and nature conservation in new ways. After the conference, the UN Convention to Combat Desertification (UNCCD) was adopted aiming at combating desertification and mitigate the effects of drought. These three conventions are often referred to as 'the Rio Conventions' (Mace et. al, 2007).

The Agreement on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade 1998 (Rotterdam Convention); the Convention on Persistent Organic Pollutants (Stockholm Convention); and the UN Convention on Access to Information, Public Participation and Decision Making and Access to Justice in Environmental Matters, 1998 ((Mace et. al 2006).

7.2 Global and Regional Agreements:

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1989 applies throughout the world, but the Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Waste

within Africa is applicable only within African region. Unfortunately, South Asia is far behind in formulating effective marine environment protection mechanism.

7.3 Appendix-driven and Annex-driven Convention:

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has listed animal and plant species in different categories of endangerment in three appendices, subject to different degrees of regulation. The International Convention for the Prevention of Pollution from Ships (MARPOL) contains Annexes addressing different types of pollutions, e.g. oil (Annex I), noxious liquid substances (Annex II), harmful substances (Annex III), sewage (Annex IV), garbage (Annex VI), and air pollution from ships (Annex VII) which are very much pertinent to transboundary marine pollution.

7.4 Framework Convention:

Some conventions anticipate the adoption of further protocols or agreements to achieve their objectives. For example, the UNFCCC was agreed in 1992 but its Kyoto Protocol was later agreed in 1997 built upon the convention. The Vienna Convention on the Protection of the Ozone Layer was agreed in 1985 but its Montreal Protocol was later agreed in 1987 and set time tables for the phase-out of ozone-depleting substances (Mace et. al 2006). Apart from this, bilateral environmental agreements also exist involving only two Parties, e.g. the Canada-Chile Agreement on Environmental Cooperation.

7.5 Legal Binding of Environmental Law, Conventions and Principles:

MEAs are formulated through pre-negotiation, negotiation, adoption and signature, ratification and accession. Once an MEA 'enters into force' it has legal effect and implementation begins. In brief, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention) entered into force on 30 August 1975; the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal entered into force on the 24th of May 1992; the Convention on Persistent Organic Pollutants (Stockholm Convention) became effective on 17 May 2004; the Convention on Biological Diversity came into effect from December 29, 1993; Annexes I and II of the MARPOL Convention came into force on 2 October 1983; and above all, the United Nations

Convention on the Law of the Sea (UNCLOS) entered into force on November the 16th 1994 and as of 9 March 2020, it is binding upon 168 States all over the world.

The Convention on the Transboundary Effects of Industrial Accidents emphasizes "the principles of international law and custom, in particular the principles of good-neighbourliness, reciprocity, non-discrimination and good faith." In addition, the 'polluter pays principle' can be considered to be "a general principle of international environmental law," as it has been underlined in numerous international and regional environmental conventions and can be relevant when considering the issue of marine pollution due to the interconnectedness of marine bodies.

In the Draft Guidelines for the Development of National Legislation on Liability, Response Action and Compensation for Damage Caused by Activities Dangerous to the Environment noted in the fourth programme for the Development and Periodic Review of Environmental Law at the Governing Council of the UNEP in 2008, the polluter pays principle had been emphasized to be taken into account to establish an effective regime on environmental liability, redress and compensation. Apart from this, a commentary prepared by UNEP Consultants and Secretariat also expressed that a national or domestic law should make explicit references to the polluter pays principle as a basic organizational concept for environmental liability, redress and compensation. Thus, countries of this region should comply the Prevention of Marine Pollution Convention 1972, Basel Convention 1989, Trans-boundary Watercourses Convention 1992, and the Persistent Organic Pollutants Convention 2001.

The United Nations Law of the Sea (UNCLOS) provides a comprehensive framework for ocean governance and resource exploitation. Under the Convention, States are bound to "prevent and control marine pollution and are liable for damage caused by violation of their international obligations to combat such pollution" (Arif & Karim 2013). UNCLOS was adopted as a package deal so that States are bound to comply with all aspects of the legal regime and are not permitted to make reservations to any substantive rules in the Convention (UNCLOS, Article 309).

Article 192 of UNCLOS, the opening provision of Part XII, provides that 'states have the obligation to protect and preserve the marine environment. Some Tribunals have upheld the normative status of Article 192 suggesting that it imposes a distinct duty on State Parties.

Although there is no definition of the marine environment in UNCLOS, in principle, it applies to areas within and beyond national jurisdiction ((South China Sea Arbitration 2016)), and it can be applied to areas in which jurisdiction is contested (South China Sea Arbitration 2015). Even if, it explicitly covers pollution of the marine environment from or through the atmosphere (UNCLOS, Article 194).

In addition to this, Article 192 covers all types of harm to the marine environment and many of the provisions in Part XII are focused on the prevention of pollution. The principle in Article 192 covers all potential impacts, such as physical harm, destruction, or alteration of the marine environment and its components, whether it falls or not within the definition of pollution (Kluwer Law International 1998).

However, Article 192 refers to both protection and preservation of the marine environment and the obligation is plausibly 'erga omnes' in character, meaning that it is owed to the international community as a whole because of the interconnected nature of the seas. For example, serious pollution from land based activities may spread beyond the territory of the State of origin and affect marine resources of another States. Among the 57 transboundary rivers of Bangladesh, 54 are shared with India and 3 with Myanmar. Thus, transboundary water course management and marine environment protection of the Bay of Bengal are essential for South Asia.

8. Compliance of MEAs and Legislations of South Asian Nations

It is mentionable that all the aforesaid five South Asian coastal states are common law countries with almost similar provisions of written arrangement. The Constitution of Bangladesh Article 18A, the Constitution of India Article 48A and the Constitution of Maldives Article 22 and Article 67 (h) have emphasized to protect and improve the environment as fundamental duty, but Article 145 of Bangladesh Constitution, Article 253 of Indian Constitution, Article 115(j) of Maldivian Constitution and Article 157 of Sri Lankan Constitution prohibits to enforce international instruments signed and ratified by the State until and unless relevant domestic legislations are enacted (Arif et. al 2013) .

It is noted that these countries are the party to the UNCLOS 1982 and the Convention for the Prevention of Pollution from Ships 1973/1978. Pakistan and Sri Lanka ratified the Geneva

Convention on High Seas 1958, and the International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969 is ratified by other four countries excepting Maldives. India is a signatory to both the Basel Convention and the MARPOL Convention. Section 11 of Pakistan Environmental Protection Act 1997 prohibits import of hazardous waste into Pakistan and its territorial waters, Exclusive Economic Zone and historic waters (Arif et. al 2013).

However, South Asian nations have attempted to address marine pollution. For example, Bangladesh formulated the Territorial Water and Maritime Zones Act 1974 of which section 8 Bangladesh has formulated various laws such as the Marine Pollution Ordinance 1989, Environment Protection Act 1995, Water Policy 1999, Water Act 2013, Water Rules 2018, and on 7 December 2021 Bangladesh enacted the Territorial Water and Maritime Zones (Amendment) Act 2021and significant outcome is yet to attain as 54 rivers out of 57 are emptied to the Bay of Bengal through Indian territory. Henceforth, regional Framework Agreement on Marine Environment Protection is essential to reduce transboundary marine pollution of the Bay of Bengal for sustainable blue economy.

9. Regional Ocean Governance and Best Practices:

Rigorous comparative study of different regional ocean governance- the Mediterranean, Black, Baltic and the Caspian Seas may be useful to support regional framework convention for sustainability of marine resources of the Bay of Bengal. The 1973 Treaty of Itaipu between Brazil and Paraguay, the 1995 Agreement of the Mekong River Basin, the International Commission for the Protection of the Danube 1998, etc are noteworthy. The EU Strategy of the Baltic Sea Region, The Mediterranean Science Commission, the marine biotechnology activity of the Caribbean Sea are best practices of regional cooperation.

Chinese government has formulated and implemented the Marine Environment Protection Law as well as the National Marine Development Priority Zone Plan. The government has formulated regulations on the administration of sea reclamation and established the ecological red line system for the whole area. More than 250 marine protected areas have been selected covering about 120,000 square kilometers. The sum of the central governmental awards and subsidies to local government to repair coastal environment is more than 2 billion dollars from 2013-2017.

More than 36 million Chinese are involved in ocean related jobs and more than 100 universities offer ocean oriented courses but Bangladesh has not yet declared and established specific Marine Protected Areas (MPA) and Ecosystem Approach to Fisheries Management (EAFM) according to FAO Code of Conduct 1995.

9.1 The Baltic Experiences:

The Baltic Sea is one of the largest brackish-water bodies in the world. The Ministers of Environment from seven Baltic Sea states signed the Convention for the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention) on 22 March 1974 and came into force on the 3rd of May 1980. A revised Helsinki Convention was adopted in 1992 and signed by nine Baltic Coastal states as well as the then Czech and Slovak Federal Republic, Norway and the European Economic Community, which came into effective in 2000.

The marine and coastal ecosystems in the Baltic Sea are affected by numerous human activities. Eutrophication has reduced water quality and hazardous substances have accumulated in the biota with negative consequence on biodiversity. In 2005, the HELCOM member states and the EU resolved to develop a Baltic Sea Action Plan to reduce pollution and repair the damage. Sound scientific data is considered to be the foundation for measuring the trends and effectiveness of the action. In March 2006, HELCOM set four strategic goals on eutrophication, biodiversity, hazardous substances and friendly environment. HELCOM is now analyzing the costs and benefits of their actions and evaluating relationships between a clean environment and human health, and between clean environment and a prospering economy.

The United Nations Law of the Sea (UNCLOS) provides the basic framework for ocean governance and resource exploitation. The UN SDG 14- "Life below water" can be a useful vehicle to carry forward the agenda of Indian Ocean Region (IOR). Indian Ocean rim Association (IORA), Indian Ocean Naval Symposium (IONS) and Galle Dialogue should focus more on understanding the potential of marine resource utilization, opportunities, challenges, dangers of unsustainable exploitation and manmade pollution which are detrimental to ocean life. The IORA Jakarta Accord of May 2017 specially focuses on sustainable economic growth and development for the IOR and underscores the importance of regional synergies and cooperation to promote peace, stability and prosperity.

10. Conclusion:

From the literature review it is quite evident that persistent pollutants are spoiling the marine environment which is a threat to biota and abiota of the Bay of Bengal. As there is no regional binding legal instruments, noticeable advancement to mitigate marine pollution of the Bay of Bengal is yet to achieve. Through formulating a regulatory and monitoring system in the subregion, we can contribute to sustain marine ecosystem, value addition in blue economy and congenial environment for the coastal people.

The first regional initiative to control marine pollution was taken by UNEP regional seas programme in 1974 as a response to the Stockholm Declaration 1972. South Asian Seas Action Programme (SASAP) was adopted and the South Asia Cooperative Environment Programme (SACEP), the Action Plan Secretariat, was established in Sri Lanka in 1995.

Fortunately enough, Bangladesh Delta Plan 2100 addresses transboundary river issues especially emphasizing water sharing issues on dry and monsoon flows, salinization, siltation of rivers and sediment deposition. Bangladesh and India signed a “Framework Agreement on Cooperation for Development” in September 2011, and basin-wise basin wide strategy but remarkable advancement is not seen in environment protection of the Bay of Bengal.

Due to geographical location and interdependent water course, the precautionary principle, polluter pays principle, principle of source to sea should be considered in line with the principle of absolute territorial integrity, absolute territorial sovereignty, shared commitment, mutual cooperation, participation in development, source to sea principle, basin-wise basin-wide strategy beside International Environmental Law and Conventions. Management group, research institutions and polluting bodies should work together to protect the marine environment of the Bay of Bengal for sustainable blue economy.

11. Recommendation:

As waters are interconnected, protection of marine environment should be considered a common concern of human kind like the protection of ozone layer and conservation of biological diversity to protect one of the largest marine ecosystems- the Bay of Bengal, the largest mangrove forest- the Sundarbans, 13 sea ports and 27 sea beaches including the longest sea beach of the world- the Cox's Bazar.

Rigorous comparative study of different regional ocean governance, such as the Mediterranean, Black, Baltic and Caspian Seas will be pragmatic sources to formulate a regional framework for sustainability of marine resources of this region. Regional frameworks such as the 1973 Treaty of Itaipu between Brazil and Paraguay, the 1995 Agreement of the Mekong River Basin, and the International Commission for the Protection of the Danube 1998 will be assistive in this regard. The EU Strategy of the Baltic Sea Region, the Mediterranean Science Commission, and the marine biotechnology activity in the Caribbean Sea will be effective tools to develop a Regional Agreement for sustainability of marine resources of the Bay of Bengal.

Arrangement of regional and subregional meetings and conferences with policy level members regarding reduction of transboundary marine pollution, signing of regional agreement and enactment of national law for enforcement, formation of scientific and technical committee and allocation of budget for research and establishment, introducing strategic action plan in national and regional level to reduce land based and ocean based pollution, periodical data sharing, monitoring and evaluation of marine pollution, capacity building of national and regional infrastructures for sustainability and taking joint collaboration development projects on the basis of marine resources are recommended for reducing marine pollution of the Bay of Bengal and to achieve SDG 14.

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