Transboundary Environmental Issues of Bay of Bengal Large Marine Ecosystem (BOBLME) and Role of Evolving International Environmental Law Obligations

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Abstract

The Bay of Bengal Large Marine Ecosystem (BOBLME) is bordered eight countries, from largest to smallest, India, Maldives, Myanmar, Sri Lanka, Indonesia, Thailand, Bangladesh and Malaysia. The combine total population of BOLME countries account to 1.78 billion, which is equivalent to 25% of the world population. The region comprises rich living and non living resources that sustain major fisheries of the world and energy resources. The current fisheries production is estimated to 6 million tonnes per year, which account to 16% of the world's marine catch. With the rapid expansions of populations, high dependency on aquatic resources for food, trade, livelihoods and as well as increased land use are having major impacts on the marine ecosystem. Transboundary diagnostic analysis and causal chain analysis has been conducted on overexploitation of the marine living resources, degradation of mangroves, coral reefs and seagrass and marine pollution. Review of causal chain analysis indicates that the existing international environmental regime has failed to adequately deal with the BOBLME countries. As a result, there is little commitment across the world community to the success of the global environmental regime – and little sense of the importance or legitimacy lodged in the institutions that make up this regime. The ecosystem approach is more practical than zones defined by law of the sea to manage oceans with the context

of present day issues. LMEs need an active involvement and participation of all multi state stakeholders and sufficient law should be ensured collectively.

Introduction

World Oceans

The ocean has in recent times been involved in unprecedented conditions due to concurrent influences, from climatic change and subsequent changes in biogeochemical cycles to globalization and expanding and intensifying human pressure (Clark, 2001). The human approach to the ocean is moving from modern conditions, where the ocean ecosystem was considered as an exhaustible resource reservoir, to postmodern ones, where it has been increasingly regarded as a space for communication, movement, settlement, and esthetic and cultural fruition (Vallega, 2000).

Certain uses of the oceans and their resources are traditional, going way back to the earliest days of human settlements along the coast. The oceans are a reliable source of extractable resources, living and non-living, and still a multitude of resources remain unexplored and are yet to be developed (Chen and Chiau, 2003). The interaction between uses and biotic and abiotic resources is going to be dealt with through the operation of integrated management patterns (Vallega, 1999). These patterns aim at framing all the essential components of the ocean system, assumed to be an ecosystem with human presence and resources exploitation, into one unique view.

It is ironic that United Nations Convention on the Law of the Sea (UNCLOS) came into force on 16th November 1994, marine and coastal areas were under threat from various anthropogenic factors (Borgese, 1998). The international law of the sea, designing national jurisdiction

and regulating international ocean spaces, has become an essential component of this approach. Integration has been pursued also on the geographical scales of management (i.e. global, regional, and local).

The population of coastal areas are increasing fast and much more than any other areas. At the end of the twentieth century, about two-third of the world's population were living within 100 km border of the coast and the numbers were expected to increase continuously (Clark, 2001). At present, 65 percent of cities with populations above 2.5 million are located on the seashore. Soon, the world's coastal area will be home to 70 percent of the total human population (Miyazaki et al., 2005).

Climate change and subsequent sea level rise has influenced decision making process. Meanwhile Deep Ocean is under increasing pressure from expanding marine transportation, biomass exploitation through wild catch of fish and the expected rise in exploitation of immense mineral resources located in the deep sea beds and sub soil. (Cicin-Sain and Knecht, 1998).

A Large number of goods that are essential to human populations are derived from sea. That can be categorized as,

I. Oil, gas, sand and other mineral resources
II. Foods for humans and domestic animals
III. Space for recreational activities
IV. An educational amenity and
V. Primary ingredients for biotechnology

In addition to the above, marine ecosystems provide a series of services that are essential to the proper functioning of nature driven systems.

I. Production and mineralization of organic materials
II. Storage of carbon
III. Storage of pollutants and waste products from land
IV. Buffering the climate and climate change impacts
V. Coastal protection by natural barriers

When attention shifts to the organic components of the ecosystem, it should first be noted that, at present, the ocean is supposed to host at least 15 000 species of fish and 15 000 to 20 000 species of algae (Vallega, 2003). This enormous ecological and economic patrimony is marked by high diversity at all of the three levels regarded by the UN Convention on Biological Diversity (UNCBD) as being of major importance:

I. genetic diversity, concerned with the populations and individuals included in the individual species;
II. species diversity, concerned with the number of species within an individual ecosystem; and
III. Ecosystem diversity, concerned with the number of ecosystems coexisting in an individual area.

The protection of endangered species and habitats is a rapidly growing need in the marine environment. Understanding genetic structure permits identification of stocks and the magnitude of gene flow and exchange. Identification of individuals permits evaluation of dispersal and homing behaviour and genetic origin. By using different genetic

markers differences between individuals can be aged in evolutionary terms, which allows for evaluation of evolutionary versus ecological factors that determine the present status of threatened species. The criteria for the design of protected areas are largely derived from terrestrial ecological theory and little scientific basis exists for an integrated policy of conservation in the marine environment that takes into account the particulars of marine life histories (Heip, 2004).

Industrialized fishing fleets are capable of harvesting huge amounts of fish from the world's oceans. One fishing fleet, in four months, can produce 10,000 tons of fish products, 1000 tons of fish meal, 10,000,000 cans of fish and 100 tons of fish oil. Many non-food species such as dolphins and sharks are killed in fishing nets (Miyazaki et al., 2005). These conditions and prospects led to a focus on the need to safeguard the ocean ecosystem as a whole, and particularly its biodiversity, in order to mitigate and prevent stress and to guarantee a sustainable use of its biotic and abiotic resources (Vallega, 2003).

The world fleet of ocean-going merchant ships above or equal to 100 gross tonnage (GT), representing a typical Merchant ships in international trade, consuming about 140–150 million tons of bunker fuel, carry about 5.4 billions of tons of cargo annually (Fearnleys, 2001). Crude oil followed by coal, iron ore, petroleum products, and grains account for roughly 60% of the total international sea-born cargo (Fearnleys, 2001). These principal cargoes are mainly transported in large vessels within a fairly well defined system of international sea routes. Merchant ships in international traffic are subject to International Maritime Organisation (IMO) regulations.

The size of the human population has increased exponentially over a million years. This increase, together with a ten-fold increase in the per capita use of energy and resources in the last century has led to a major increase in resource requirements and use, particularly during the twentieth century. As a result of this pressure, humans now use, directly or indirectly, about 40 percent of all primary production on land, have transformed over half of the territory into domesticated (agricultural and pasture) land, and use about 40 percent of the readily available freshwater resources in the world. In addition to a major physical modification of terrestrial and freshwater ecosystems, humans have also perturbed the biogeochemical cycles of nutrients and carbon over the entire biosphere. Continuously increasing use of fertilizers to enhance crop yield over the past fifty years has led to a perturbation of the global nutrient cycle by humans: industrial nitrogen fixation now represents more than 50% of the total nitrogen fixation in the biosphere, the export of nitrogen to rivers from watersheds and the riverine nitrogen concentration are tightly related to the population density in the watershed, and the carbon dioxide concentration in the atmosphere has been raised by about 20 percent due to human emissions.

Large Marine Ecosystems (LMEs)

The ocean comprises large part of the biosphere on the earth, and is the place where the life evolved first. Living in a viscous fluid, such as seawater, imposed particular constrains on the structure and functioning of ecological systems, including the special and temporal scales of variability, the dispersal of organisms, and the connectivity between populations.

The ocean ecosystem, even though the number of marine species is 100-fold less than that on land, and the discovery of new life forms in the ocean is an on-going process. When compared with terrestrial and marine food webs in the higher number of trophic levels, and the dominance of heterotrophic biomass marine systems are unproductive. In addition, marine photosynthesis is limited to the upper layer of the ocean, which is nearly 100 meters. Most of the ocean volume is occupied by a dark ecosystem that depends on organic matter settling from the upper, illuminated layer.

The ocean ecosystem contains a greater diversity of life forms than the terrestrial ecosystem, even though the number of marine species is almost 100-fold less than that on land, and the discovery of new life forms in the ocean is an on-going process. Marine food webs contrast with terrestrial food webs in the higher number of trophic levels, and the dominance of heterotrophic biomass, particularly in planktonic, unproductive ecosystems. In addition, marine photosynthesis is restricted to the upper skin of the ocean (100m), whereas most of the ocean volume is occupied by a dark ecosystem, dependent on organic matter settling from the upper, illuminated layer or exported laterally from the coastal shelf.

More than 75% of the ocean is occupied by oceanic deserts, where the supply of nitrogen, the main deriver of biological production in the ocean, is limited by poor mixing of upper and translucent waters up to bottom. Coastal ecosystems dominated by larger plants (sea grass, macro-algae and mangroves) are highly productive and organic matter production is excess from the local requirements. In recent years, the

management of large marine ecosystems (LMEs) has become a focus in international ocean governance. Comprehensive and systematic research on this subject would be of great significance in both theory and international practice.

The rates of habitat destruction in the coastal ocean are huge. About half of the area of mangrove forests existing after the Second World War have been lost due to deforestation, reclamation, and the use of mangrove areas for aquaculture, largely shrimp rearing, activities. About 30 percent of all estuarine wetlands have been destroyed by humans, due to direct physical disturbance and also as a result of major changes in river discharge resulting from the proliferation of dams, with about 40,000 large reservoirs presently in operation in the world. Seagrass loss is a worldwide phenomenon, resulting from coastal eutrophication, constructions along the coastline, mechanical damage by anchors and fishing gear, and submarine erosion associated with sea level rise. About 20 percent of the coral reefs in the world have been lost, and about two thirds of the remaining reefs are forecasted to be lost within the next two generations, due to eutrophication and siltation of coastal ecosystems, and damage from destructive fishing practices (including dynamite and cyanide fishing). Macroalgal-dominated communities are also affected by eutrophication effects, as well as from the competitive displacement of the local species following the accidental introduction of invasive species by human activities (e.g., *Caulerpa taxifolia* to the Mediterranean, *Sargassum miticum* to the Atlantic), which have caused important changes in macroalgal-dominated communities throughout the world. The introduction of invasive species is, in fact, a broader problem, including also introduced animals, such as the planktonic ctenophore

Mnemopsis leidy, the introduction of which to the Black Sea has completely altered the planktonic food web there, and the displacement of native bivalve populations by the introduction of alien bivalve species. Invasive species are introduced through fragments transported in anchors, escapees from aquaria, and, in the case of planktonic organisms, and the discharge of ballast water from ocean-going ships.

Ecological Ocean Diversification

Species diversity can be regarded as the base for understanding interaction between ocean ecological context and human impact, a chain of relationship should be considered. This indicates the ecological ocean diversification and interaction between the individual ecosystems, each endowed with its own species and genetic variability (Table 01).

The Definition of Biodiversity as accepted at the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro is:

"The variability among living organisms from all sources, including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

Ocean diversification varies according to the biotic and abiotic components of the ocean ecological reality. As far as the biotic component is concerned, the cardinal characteristic is that the ocean biomass mostly involves the continental shelves, particularly those of the boreal temperate latitudes, where about 50% of yield is located. As a result, the continental shelves have constituted the marine environments

where fisheries and fish farming have extended in all forms. Technological advances lead to expanding catchments seawards, therefore involving the continental slope and rise, and deep-ocean areas. Due to the construction of open-sea installations, fish farming is also expected to expand seawards (McDonald, 1995).

Table 01. The estimated number of species in different phyla on land and in the ocean (Duarte, 2003)

Oceans		Land	
Phylum	Number of species (estimated)	Taxa	Number of species (estimated)
Porifera	9 000	Insects	10 000 000
Cnidaria	9 000	Acarid	750 000
Nematoda	35 000	Spiders	170 000
Anelida	15 000	Nematods	1 000 000
Arthropoda	37 000	Molluscs	20 000
Mollusca	29 000	Other	100 000
Bryozoa	15 000		
Chordata	15 000		
Others	14 000		
TOTAL ANIMALS	178 000		12 040 000
Vascular plants	< 100		300 000
Pluricellular algae	7 000		
TOTAL	185 100		12 340 000

Exploitation of Ocean Biomass

With regard to envisaging the ocean as an extended life-support system, first and foremost it should be noted that biomass exploitation has

become the key and most critical use. Sea fisheries developed slowly up until the beginning of the twentieth century but increased rapidly during the decades after World War II at a time of increasing world population (Orrego, 1996). Between the mid-1940s and the early 1960s world fish catches increased from 18 to 30 million tons. In the course of the 1960s, this figure almost doubled, and by the early 1970s the world's population was consuming 60 million tons a year. A rapid increase in the rate of exploitation of ocean biomass characterized the next decades to the point that 83 million tons of production (inclusive of aquaculture) was reached in 1992—at a time when the Rio Conference was focusing on the need to apply the rationale of sustainable use of living resources to both national and international waters. At the end of the twentieth century, production approached 90 million tons a year while 100 million tons was considered the maximum catchable threshold (Table 02).

Table 02. Areal extent, biomass, and production of marine primary producers (Duarte, 2003)

Primary producer	Area covered 10^6 km^2	Mean biomass g DW m^{-2}	Mean production g DW m^{-2} yr^{-1}	Total production 10^{15} g C yr^{-1}
Oceanic phytoplankton	332	3	323.8	43
Coastal phytoplankton	27	10	416.7	4.5
Microphytobenthos	6.8		125.0	0.34
Coral reef algae	0.6	2 000	2 500.0	0.6
Macroalgae	6.8	40.7	937.5	2.55

Seagrass	0.6	461	2 041.7	0.49
Marsh plants	0.4	767	2 750.0	0.44
Mangroves	1.1	3 000	2 500.0	1.1
Total marine production	360			53

There is a growing consensus that sustainable exploitation of living resources can occur only through increasing use of aquaculture, which in the long term will become the key source for ocean-derived foods and therefore will contribute to mitigating ecological impacts. In order for this to occur, three developments are necessary. Firstly, an expansion is required in the number of large-scale coastal aquaculture plants, predominantly located in internal and territorial waters overlying the continental shelf. Conflicts between these and other coastal uses will become more common, fundamentally because aquaculture plants need the local ecosystem to be protected against any alteration to its abiotic and biomass properties. Secondly, deep-ocean aquaculture plants, consisting of artificial islands, need to spread within both national jurisdictional zones, such as the exclusive economic zone and the exclusive fishery zone, and international waters.

Exploitation of Non-Living Marine Resources

Shifting from biotic to abiotic resources, the main role of the ocean as life-support system has been its ability to provide energy sources. Oil and gas from offshore fields have been widely used to supply the world's energy demand, especially in the developed countries concentrated in northern temperate latitudes. This has been successfully realized by means of power plants capable of exploiting ocean winds, tides, and

currents. Technologies that produce energy from the thermal gradients in inter-tropical deep-ocean waters have been also been designed. Looking to the future, two questions arise: to what extent can offshore oil and gas fields be further exploited; and can potential renewable energy sources be exploited to the extent that they serve as a pivotal component of the world's energy supply?

Research on the use of renewable ocean resources has been intensifying since the early 1970s. This has been due to a number of factors. Firstly, the crisis in the oil and gas market provoked in 1973/1974 by the Organization of the Petroleum Exporting Countries (OPEC) encouraged the search for, and use of, alternative energy sources. Secondly, there has arisen a perceived need to minimize the use of non-renewable resources. In this respect attention has been focused on the prospects for exploiting ocean winds, the movements of the water column (especially tides and coastal surface currents), the chemical (salinity) and physical (temperature and density) properties of the water column (exploiting gradients between different sea layers of deep-ocean areas), and the energy incorporated in marine biomass (Falkowski, 1999). Theoretical studies in the design and practicality of such power plants have resulted, however, in comparatively few real-world facilities. Two reasons have been influential in this. On the one hand, oil and gas prices decreased markedly during the 1980s and 1990s, to the extent that investments in other energy production patterns were discouraged. On the other hand, except for ocean wind-based plants and to some extent those exploiting the water movement, many of these technologies cause environmental damage to the biotic niche (thermal, salinity, and density gradients) or the trophic webs (biomass). Whatever technological

progress is made in the future, the use of these potential energy sources is likely to disturb the ocean's abiotic niche. As a result, it is difficult to envisage their widespread implementation in the short or medium term and it seems unlikely that they will acquire a substantial role in the world's energy system

This being the case, it makes sense to concentrate on the prospects of increasing the use of offshore oil and gas resources in order to supply both energy and petrochemical industries. This poses two questions. Firstly, to what extent will offshore sources be able to meet the demands of energy production and manufacturing industries given the fact that oil serves as both an energy source and a raw material for the petrochemical industry? Secondly, how may exploitation be spatially extended? At present, the proven reserves of offshore oil have been estimated at 22% of the world's reserves and those of offshore gas at 17%. At the end of the twentieth century, drilling operations were conducted in water depths of over 2000 m, while production facilities operated in over 1000 m of water (Falkowski, 1999).

These depth thresholds will be easily overcome in the short term, but it is difficult to predict the end result of this process. The more installations move seawards the greater the constraints imposed by water column dynamics and the higher the risks of hazardous events, thereby imposing limits on possible locations for production platforms. Considering that the continental shelf and slope extend to 300 m in width and 4000–5000 m in depth, respectively, it is evident that current technology enables operations to be conducted over a significant proportion of the shelf and slope. In the short and medium terms (the first two or three decades of the twenty-first century), the rapid proliferation

of offshore plants and production facilities may be expected to spread too many important ocean areas. This includes Southeast and East Asia, the Persian Gulf and Red Sea through extension of fields from the Arabian Peninsula, and the offshore areas of the former Soviet Union, notably the Caspian and Barents Seas.

As regards other mineral ocean resources, there is a wide spectrum embracing several groups located in different parts of the column water and ocean crust, and concentrated in various ocean regions. Phosphorites are mixtures of minerals including dolomite, silica, magnesium-rich clays, glauconite, manganese, calcite, and organic matter. They are most abundant on continental shelves and on continental slopes to depths of around 300 m. In the deep ocean they are generally found in depths of less than 2000 m, but are not known up to 4000 m (Mann, 1998). They may be used for producing phosphate fertilizers and phosphate-based chemicals, and may be found in the shape of:

I. phosphorite nodules: this is the most common form, ranging from small pebbles to slabs up to one meter long;
II. phosphatic pellets and sands: these are fairly common, have the shape of small grains up to about one millimetre in size, and contain many impurities;
III. phosphatic mud: this is similar to the pellets and sands and consists of granular deposits;
IV. Consolidated phosphate beds: these are sedimentary deposits similar to those located on land.

Hard rocks are another resource of the continental margin. They are abundant within shelves and include coal, phosphates, carbonates,

potash, ironstone, limestone, metal sulphides, and metal salt chemicals. The prospect of undertaking exploitation seems quite far off for two concurrent reasons: the cost would be too high and the environmental impacts too damaging.

Proceeding seawards from the continental margin, the large variety and quantity of recently discovered minerals on the seabed and subsoil of deep-ocean areas may be the key to meeting the world's requirements during the twenty-first century. These resources may be found in a number of forms: nodules, rich in manganese, cobalt, nickel, copper, etc.; crust, mostly containing phosphorite, cobalt, and manganese; mounds and stacks, containing copper, gold, lead, silver, and other metals.

The primary resource is certainly manganese nodules. Ranging from 1 to 20 cm in diameter, nodules contain as much as 2.5% copper, 2.0% nickel, 0.2% cobalt, 35% manganese as well as a number of other metals. An estimated 1.5 trillion tons lie in the Pacific Ocean alone. In the 1970s total ocean resources were estimated at three trillion tons (Falkowski, 1999).

This rich resource of manganese nodules is an environmental concern. Mining companies created several technological systems to exploit and process nodules. In simple terms, all systems consisted of five elements:

I. a nodule collection mechanism, often based on bucket or collector mechanisms;
II. a lift mechanism, based on mechanical or hydraulic engines;

III. vessel storage, in the form of special medium-sized (100 000–150 000 dead-weight tonnage) bulk vessels serving as terminals for the lift mechanism;
IV. transportation from the deep-ocean area to the unloading terminal; and
V. Processing of nodules to produce metals.

All elements have unsolved environmental problems. These are that collection damages seabed abiotic conditions over extensive areas; transfer and storage may cause turbulence and turbidity in the water column; processing, which substantially differs from that of land minerals, requires huge quantities of freshwater and specialized plant to avoid pollution.

Gas hydrates are the latest discovery in deep-ocean mineral resources. In the 1990s, scientists discovered extensive fields of gas hydrates, usually called "gas crystals," on the deep seabeds. They were formed from natural gas at low temperature and high pressure. This discovery caused a great deal of excitement since gas crystal deposits seem to dwarf the land reserves of coal, oil, and natural gas. They were estimated as being so abundant as to double the world's fuel reserve but their exploitation raises similar issues to those of nodule collection and transfer. Moreover, the gas crystals are supposed to incorporate bacteria, therefore their extensive exploitation may influence deep-ocean trophic webs.

The Sustainable Ocean

The increase in diversity and spatial extent of ocean resource uses, the progressive complication of the legal and jurisdictional frameworks, and the increasingly widespread perception of the need to pursue sustainable ocean development have all resulted in a complex web of consequences (National Research Council, 2000).

The ocean management is a mosaic of spaces within which the ecosystem is protected or jeopardized according to different criteria not generally tailored to the natural configuration of the ocean concerned. Commonsense would argue that only two basic designs of governance pattern are necessary: those concerning the continental and the deep-ocean realms. The effectiveness of ocean governance is harmonized by geography of policy and geography of nature (Miller & Koblick, 1984). In order to close the gap between these two spatial extents, to increase the rationale of ocean governance, and thereby to move towards sustainable development, much effort is still needed.

Focusing on the interaction between the ecosystem and social contexts: Future efforts in ocean research will be increasingly concerned with the interaction between the ecosystem, involved in global change, and human communities, involved in processes triggered by the postmodern organization of society. Research has dealt with this subject by carrying out sectoral investigations and designing partial views essentially supported by the reductionist principle, which leads to considering the individual aspects of the ocean separately. This approach is likely to be replaced by the continuing adoption of the principle of holism, emphasized by Agenda 21, which leads to considering the ocean from a global perspective. Given its historical ability to bridge the natural

and social sciences and its theoretical strengths in spatial differentiation, region, and rationalization, geography would seem well placed to offer a significant contribution to future efforts in this area.

When the ocean is considered as a complex system, the role of science becomes one of providing organizational patterns focusing on the interaction between ecological and social elements and processes with a view to pursuing effective sustainable development.

Research is expected to make efforts to consider the two realms—continental and deep ocean—contextually, with the aim of determining how human presence and activities in each of these realms have interacted in the past; and how they could efficiently interact in the future to optimize our approach to the ocean as a whole.

The prospect of achieving the sustainable development of the oceans will depend essentially upon the design and operation of new uses while simultaneously protecting traditional ones and respecting society's historical and cultural heritage. Moreover, it will be essential to integrate effectively the various geographical scales, from global to local, on which ocean management is based (Vidas and Østreng, 1999).

Designing patterns of optimum ocean governance The final expected result of research implementation and conceptual progress is the design of optimum ocean management patterns tailored to various scales, local and regional, national, meso-regional (multinational), and global. In this respect, the views of ecosystem biocenosis, social organization, jurisdictional frameworks, and political systems need to be harmonized.

Objectives of the Investigation

BOBLME countries, Indonesia, Malaysia, Thailand, Myanmar, Bangladesh, India, Sri Lanka and the Maldives, have a combine total population of 1.78 billion. This is equivalent to 25% of the world's population, and includes a coastal population of 450 million people. The region is rich in natural resources that include extensive mineral and energy resources, marine living resources that support major fisheries, and forest and land resources. The current fisheries production is 6 million tonnes per year, which amounts to more than 16% of the world's marine fishery.The Large Marine Ecosystem (LME) supports a wide range of habitats, including extensive tracts of mangroves (12% of the world's mangroves), coral reefs (8% of the world's coral reefs) and seagrass beds. It is an area of high biodiversity, with a large number of endangered and vulnerable species. The LME and its natural resources are of considerable social and economical importance to the bordering countries. Activities such as fishing, marine farming, tourism and shipping contribute to food security, employment and national economies.

Rapid population growth, high dependence on aquatic resources for food, trade, livelihood and as well as increased land use are having major impacts on the marine ecosystem. As a result, it is not clear how much longer the Bay of Bengal will be able to support the aspirations of the many sectors wanting to use the resources, including the marginal coastal communities that depend on then for survival.

Therefore, the effort of this investigation is to identify present situation of the BOBLME and transboundary issues while reviewing the present law enforcement from a scientific, legal and political perspective.

Further to identify the extent of degradation of wide range of habitats, including extensive tracts of mangroves, coral reefs and seagrass beds. Overexploitation of the living marine resources such as declining overall availability of fish, changes in species composition of catches, high proportion juvenile fish in the catch and changes in the marine biodiversity, specially through loss of vulnerable and endangered species will be studied. Protection given to marine resources by UNCLOS and other international environmental laws will be discussed and the context of current issues, strengths and weaknesses of international laws in protecting living resources, and other issues will be addressed.

Bay of Bengal Large Marine Ecosystem (BOBLME)

Characteristics of the BOBLME

Large Marine Ecosystems (LEMs) are ocean regions that comprise coastal areas from river basins and estuaries extending up to seaward boundaries of continental shelves and outer boundary of the major ocean current system. The extend of these areas are more than 200,000 km^2 or greater, with unique bathymetry, hydrography, productivity and tropically dependent populations (Table 03) (BOBLME, 2004).

Table 03. Important facts about BOBLME

Area
Total maritime area = 6.2 million km2
Total area of EEZs = 4.3 million km2
Combined length of coastline = ~14,000km
Productivity
Primary production around 500gC/m2/year
average 730gC/m2/year in the EEZs
People
Total population of countries3 = 1.78 billion (25% of the world)
Population of the coastal zone = 450 million
Fisheries
Employment in fisheries = 4.5 million
Number of fishermen = 2.2 million
Number of fishing boats = more than 415,000
Total fisheries production = 6 million tonnes
Value of fisheries production = USD 4 billion
Major issues of the BOBLME
Overexploitation of the marine living resources
Degradation of mangroves, coral reefs and seagrass
Pollution

Source: BOBLME Project 2010

The extent of Bay of Bengal is 6.2 million km^2 with depths ranging between 2000 and over 4000m for most of its area. Java Trench of south eastern side of the Bay from the Andaman Island in the north to the coast of Sumatra is very deep with depths reaching over 5000 m. In total extent 66% of the BOBLEM belongs to Exclusive Economic Zones

(EEZs) of countries bordering BOBLEM, thus a larger portion of the BOBLEM is subjected to national jurisdictions. The bordering countries of BOBLEM with largest to small in extent are India, Maldives, Myanmar, Sri Lanka, Indonesia, Thailand, Bangladesh and Malaysia. Average primary production has been estimated to 700gC/m^2/year in the coastal waters (Zeitzchel, 1990), while sea-surface temperature is 2.6 8 °C and has been rising slowly. It has been recorded that average temperature is 0.5 °C higher than it was in 1957.

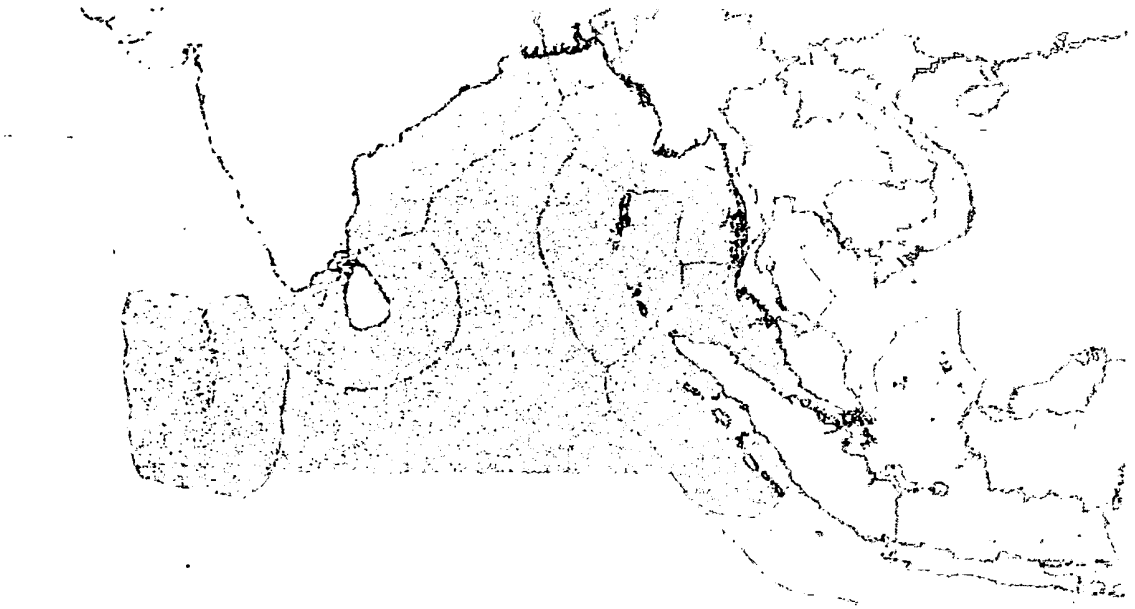


Figure 01. Bay of Bengal Large Marine Ecosystem Boundaries and EEZ boundaries

Ganges, Brahmaputra and Meghna are large rivers flow into BOBLEM from Bangladesh and India, from the Myanmar Ayeryawady and Thanlwin, and from west of India flows are reaching from Mahanadi, Godavari, Krishna and Cauvery.

The current fishery production (in 2008) of BOBLEM is account to 6 million tonnes (i.e. 16.3% of the world's brackish and marine catch) (FAO Fishstat, 2010). Further, BOBLEM is home for three important

critical habitats; mangroves (11.9% of the world) coral reefs (8% of the world) and seagrass. The largest fishery of the BOBLEM is taken by Myanmar while largest area of mangroves is also recorded from Myanmar. Maldives has the largest area of coral reefs.

With respect to species diversity, BOBLEM records a high biodiversity with a large number of endangered and vulnerable species. The Bay of Bengal is considered to be one of the largest hydrocarbon-rich areas of the world, compared to Gulf of Mexico, Persian Gulf and Bohai Bay in China. Due to lack of financial support and international boundary disputes Bay of Bengal has poorly explored.

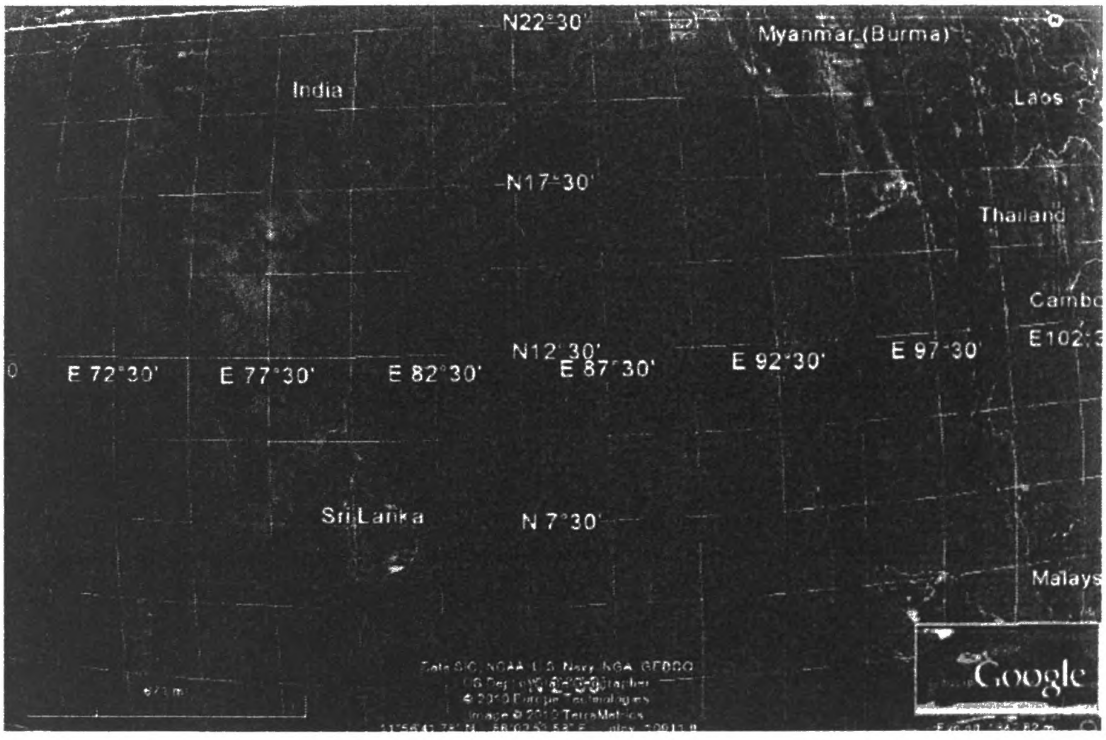


Figure 02. Bathymetry of the BOBLME. Source Google Earth (NOAA add-on)

In the Bay of Bengal itself, the continental shelf tends to be quite narrow except in the northern part of the BOBLME (Figure 02). An increasing emphasis on the exploration for and exploitation of oil and gas in the BOBLME presents many different opportunities and threats. At

regional level the boundary disputes (particularly between India, Myanmar and Bangladesh) may be a threat to international cooperation. There is also increasing risk of pollution.

Socio-economic characteristics

BOBLEM countries include some of the largest populations on the earth, i.e. India, Indonesia an Bangladesh being among the top ten populations of the world. In total BOBLEM countries have 1.78 billion population, approximately quarter of the world's population. The coastal population living in the region of Bay of Bengal is account to 450 million, with a population about 4.5 million employing on fisheries, of which fisherman comprise 2.2 million, engage on more than 415,000 fishing boats.

Although, populations in BOBLEM countries are relatively large they have comparatively small economies. As the growth of industries and servicers sector has taken long-term Gross Domestic Product (GDP), economies of the BOBLEM countries are reducing their dependence on the agriculture sector, including fisheries. Therefore GDP in fisheries is relatively low. However, despite this low GDP, marine living resources are extremely important to people and communities to sustain their lives, as a source of food. Compared to the other countries, the consumption of seafood is relatively high in this region. The population trajectories indicate that by 2020 BOBLME countries will comprise 2.03 billion people from its current population of 1.78 billion.

Fish and seafood products make a significant contribution to the sources of protean contribution to the diets of the BOBLME countries, i.e. 76% for Maldives, 62% for Indonesia, 57% for Bangladesh and 52% for Sri Lanka.

With respect to the governing systems of Bay of Bengal countries, all the governments are promoting economic growths and development, including through exploitation of living resources. As a result, all the countries have set ambitious marine and freshwater production targets, which in many cases do not consider the biological limits of the inheriting production of these renewable resources. However, most countries have well-developed legislative systems and polices in the different sectors, but these policies are often not harmonized across sectors.

Driving Forces Impacting the BOBLME

Overexploitation of marine resources, degradation of critical habitats and pollution are key issues of the BOBLME that are contributed by numerous human induced activities. These key issues are hard to address. In general, any action designed to implemented to address those issues can be grouped into;

I. Socio-economic drivers
II. Institutional, legal and administrative drivers; and
III. Climate change

The main social issues affecting BOBLME countries are;

I. Growth of populations and migration to coastal regions
II. Development of coastal infrastructure
III. Lack of alternative solutions for food security, livelihood and shelter in poor coastal communities
IV. Lack of stakeholder awareness of the issues and lack of commitment

The main economic drivers are;

I. Contribution from foreign exchange through exports, specially processed fish, live food fish and ornamental fish.
II. Expansion of aquaculture parallel to the expanding markets
III. Unacceptable financial and other incentives provided by governments
IV. Increased agricultural production due to enhanced irrigation and increased agricultural technology
V. Underestimate of services provided by the marine living resources, undervaluation of critical habitats, and undervaluation of damages caused to marine ecosystems
VI. Undervaluation of impact due to pollutants and contaminants on human health

The fast growing populations is probably the most important underlying driver of all the key issues associated in the region. The human population in the region is still growing exponentially leading to a expansion of nearly 2.0 billion by 2020 for the countries as a whole. The fraction of coastal population which presently account to 450 million is also expected to increase, both in parallel to overall population growth and coastal migration. Population densities such as 410 people per km2 regionally, which is a 30% increase overall along the coastal and marine environment of the BOBLME is likely to be one of the highest will create an immense pressure on natural systems. Further, solid waste and sewage production, disposal of large quantities of waste are exacerbated by the increasing number of tourists to the region, in addition to local residents growth.

Manufacturing and service industries in the world are relocating to countries in the BOBLEM regions to benefit from lower production costs that may in part be related to lower environmental standards. The damage to the environment is not added to the cost of investments and is not reflected in prices, taxes nor national financial and development plans.

Institutional, Legal and Administrative Drivers

With respect to Bay of Bengal marine ecosystem, lack of an appropriate forum at the regional level, which should be the main institutional driver affecting countries ability to implement change is not well-built. Therefore, opportunities for BOBLME-wide multi-national discussion, mechanism for planning, monitoring and reporting is not properly taking place. This is due to lack of a over-arching mechanism in the BOBLME countries. However there are number of organizations with a partial mandate to coordinate some activities in the region. Institutions currently in operation are too narrow in their mandate (for example Asia Pacific Fisheries Commission (APFIC)), restricted into their geographic competence with respect to the BOBLME (for example Association of Southeast Asian Nations (ASEAN)), or both (for example Bay of Bengal Programme - Intergovernmental Organization (BPBP - IOG), no BOBLME-wide organization that can be addressed all of these issues interconnected in terms of geographical and subject specific.

Important issues pertain to BOBLME extend beyond the one or more national political jurisdiction that has not been recognized timely and that the causes and remedial measures of priority issues are out of control in the region. As a region there are benefits largely if those issue can be addressed through coordinated action at the regional level by

establishing supportive institutional and legal framework that can be facilitate inter-sectoral and transboundary planning and management in the member countries of the BOBLME region.

In the context of country level key issues due to lack of effective governance and inability to gain compliance with many of the existing laws, rules and regulations that include;

I. poor law enforcement and regulations, including corrupt officials not enforcing government policies and regulations;
II. poor unified planning and inadequate communication, including exchange of information between relevant and legally responsible sectors.
III. Lack of local community stakeholder consultation and involvement in planning, decision making, implementation and enforcement.
IV. Lack of management capacity at all levels for managing a resource in an ecosystem context with a precautionary approach and
V. Inadequate finical commitments to the costs of implementation and enforcement of relevant legislations.

In a strict sense, a transboundary issue is defined as an environmental problem in which either the cause of the problem and/or its impacts is separated by a national boundary. A broader interpretation is one in which ecosystem degradation/loss contributes to a global environmental problem and finding regional solutions is considered a global environmental benefit.

"Shared" issues are described as transboundary issues between two or more countries while "common" issues are similar issues that occur across all the eight BOBLME countries but not necessarily transboundary in nature.

"Common" issues are included in this Tranceboundary Diagnostic Analysis (TDA) where they promote regional and/or local solutions that achieve economies of scale and cost advantages which accrue from addressing the issues in a collaborative fashion.

The TDA identifies, water related environmental issues and their causes to the severity of environmental and/or socio economic impacts. In this analysis it identifies three main areas of concern.

I. Overexploitation of the marine living resources
II. Degradation of mangroves, coral reefs and seagrass
III. Pollution

Overexploitation of Marine Living Resources

Fishing in EEZ of one country affects the available stokes of the other country. In the BOBLME many of the living resources including fish cross international boundaries of adjacent, and sometimes non-adjacent countries. Particularly, large pelagic fish species such as tuna and billfishes inhabit over a large ocean space and traverse through EEZs of many countries inside and outside BOBLME.

Transboundary issues and overexploitation of marine living resources

Greater variety of species at higher trophic level is exploited in sea than on land. In general human exploit over 400 species as food resources from seas. With compared to the early days of human development,

exploitation technologies are so advanced that many marine species are threatened to extinction.

The main four transboundary issues according to BOBLME Report, (BOBLME Project, 2010) are:

I. Decline in overall availability of fish resources
II. Changes in species composition of catches
III. High proportion of juvenile fish in the catch
IV. Changes in the marine biodiversity, specially through loss of vulnerable and endeared species

The exponential growth of human population on this planet in the last decades have led to an overexploitation of marine resources largely to meet the growing demand of food. Fishing fleets all over the world are two to three fold needed to take present day catches of fish and as what our oceans can sustainably support. For BOBLEM, many indicators point to the depleted state of the fisheries resources (BOBLME Project, 2010):

I. Stagnation of production in six of the eight BOBLME countries at least for the past decades;
II. Changing species composition of the catch over the past thirty years;
III. High proportion of juvenile fish now being taken;
IV. Stock assessments of major fish group reported by Asia-pacific Fishery Commission (APFIC and Indian Ocean Tuna Commission (IOTC);
V. decline catch rates in trawl surveys carried out over long time series;
VI. Anecdotal evidence from fisherman.

Root causes of overexploitation of marine living resources

All fishing activities, if not conducted in sustainable and non destructive manner can lead to overexploitation of marine living resources. The proximate causes as identified by BOBLME (BOBLME Project, 2010) are as follows;

I. Declining coastal fishery resources,
II. Changing species composition,
III. High proportion of juvenile fish and
IV. Changing marine biodiversity.

Aggressive change of marine biodiversity can be attributed to (BOBLME Project, 2010);

I. Excessive fishing effort and overcapacity;
II. Destructive fishing methods;
III. Unselective fishing practices and gear; and
IV. Illegal, unregulated and unreported (IUU) fishing, both national and international.

These in turn are caused by:

I. The 'open access' regime,
II. Government emphasis on increasing production,
III. Increasing fishing effort, specially trawlers and purse seiners,
IV. High consumer demand for fish, including for seed and fish meal for aquaculture,
V. Weak fisheries (monitoring, control and surveillance) MCS and enforcement,
VI. Strong incentivise to encroach into areas with better returns.

'Open access' regime can be identify as one of the main root cause that run across all the issues (Table 4). With this understanding, the traditional and customary laws and regulations with respect to fishing of the BOBLME needs to address to regulate. Under 'open access' policy any person has the right to fish, either as a source of food or earnings. Experience gathered out of the BOBLME shows that although the policy provides a safety net for the poor to survive, specially in difficult periods, an free entry to marine living resources results in overexploitation and overcapacity in the fishing sector (specially in extensive industrial fisheries) and a hammering in the benefits that the resources can potentially provide. Therefore it is vital to encourage through co-management as a path to 'limited access' leading to change in customary law, rules and regulations currently in practise.

Also in BOBLME it is imperative to declare at least some areas as highly ported area of the sea where disturbances are minimized, allowing to maintain the natural biodiversity or, more often, to restore it to natural state. Very little area (less than 1%) of the earth oceans are protected, when compared to 12% of the land surface. Also Marine Reserves are of cultural importance to science and education, essential for conservation, useful in resource management and necessary for reserving the effects of overexploitation.

Table 04. Detailed causal chain analysis for overexploitation of marine living resources.

Transboundary nature of the concern	• stocks shared among BOBLME countries either through transboundary migration of fish or larvae; • Fishing overlaps national jurisdictions, both legally and illegally - overcapacity and overfishing in one location forces a migration of fishers and vessels to other locations; • All countries (to a lesser or greater degree) are experiencing difficulties in implementing fisheries management, especially the ecosystem approach.			
Issues	Decline in overall availability of fish resources	Changes in species composition of catches	High proportion of juvenile fish taken	Changes in marine biodiversity plus vulnerable/endangered spp.
Proximate causes	Excessive fishing effort and overcapacity;Unselective fishing practices and gear	Excessive fishing effort and overcapacity;Unselective fishing practices and gear	Unselective fishing practices and gear	Destructive fishing methods
Intermediate causes	Increasing fishing effort, especially trawlers and purse seiners;Illegal, unregulated and unreported (IUU) fishing, both national and international;Weak fisheries MCS and enforcement	Increasing fishing effort, especially trawlers and purse seiners;Illegal, unregulated and unreported (IUU) fishing, both national and internationalWeak fisheries MCS and enforcement	Weak fisheries MCS and enforcement	Weak fisheries MCS and enforcement
Root causes	"Open access" regime; Strong incentives to encroach into areas with better returns; High consumer demand for food fish	"Open-access" regime;Strong incentives to encroach into areas with better returns;High consumer demand for food fish;High consumer demand for seed and fish meal for aquaculture	"Open access" regime;High consumer demand for food fish;High consumer demand for seed and fish meal for aquaculture;	"Open access" regime;High consumer demand for food fish

Degradation of Critical Habitats

This has been based on the assessment of the status of mangroves, coral reefs and seagrass, examined in this TDA. Mangroves have been classified as either degraded or under threat in all countries. Over

4,500km^2 of mangrove have been lost in the region over the last 30 years of which the majority has been lost in Myanmar, (3,001km^2) where the total area lost exceeds the sum of all losses in the other countries. Net loss of mangroves peaked at 1,374 km^2 during 1990–2000, increasing from 976km^2 during 1975–90, and declining to 139 km^2 during 2000–05. The major cause of loss of mangrove has been conversion to agriculture (82%) and conversion for aquaculture (12%).

Coral reefs are also classified as degraded or under threat. Coral reefs in South Asia suffered large scale bleaching in 1998 caused by high water temperatures associated with the 'El Nino' Southern Oscillation (ENSO)/Indian Ocean Dipole (IOD) effect - up to 90% mortality on some reefs in the Maldives but much less in the Gulf of Mannar and the Andaman and Nicobar Islands (Wilkinson, 2008). Corals in most shallow reef areas of Sri Lanka were destroyed. Some recovery has occurred but further damage with sea temperature rises may occur. Since early 2010 a massive bleaching of similar scale is occurring region-wide (BOBLME Project, 2010).

The transboundary issues of degradation of critical habitats

Mangrove forests are found in all the BOBLME countries and, in some, are of global importance in coverage. About 12% of the world's mangrove cover occurs in the BOBLME. It is the home of the largest mangrove system in the world, the Sunderbans, shared by India and Bangladesh – an area declared as a Biosphere reserve.

Coral reefs found in all the BOBLME countries together account to 8% of the world and some are ecologically very significant. For

example Coral reefs found in Mannar Basin belongs to India and Sri Lanka, part of that has been declared as a United Nations Education, Scientific and Cultural Organization (UNESCO) as Biosphere Reserve in India. River run offs from land during monsoon and strong water currents associated with wind created a turbid environments which is not suitable for corals and are limited in distribution making habitable offshore where it is shallow enough them to grow healthy.

Seagrass is usually found on mud/sand flats or between coral and mangroves. Seagrass beds are found in all the BOBLME countries. However, information on their regional areal extent and actual degradation state is unavailable.

Three transboundary issues were identified:

1. Loss and degradation of mangrove habitat;
2. Degradation of coral reefs; and
3. Loss and damage to seagrasses

Reefs considered to be of greatest risk from a combination of (i) coastal development, (ii) overexploitation and destructive fishing practices, (iii) the impact of inland pollution and erosion, and (iv) marine pollution are the reefs around Aceh and the islands off Sumatra in Indonesia, Malaysia west coast, Myanmar, Sri Lanka and the Gulf of Mannar (Bryant, et.al., 1998 and Reefbase, 2010).

Among the BOBLME countries Myanmar has some of pristine reefs, but status of the reefs is difficult to conclude due to lack of baseline information. However it has been observed that destructive fishing is increasing, trawling and long-line fishing near reefs are escalating and use of explosive for fishing is mounting to a threatening level. Also, there

are records that illegal and destructive fishing by foreign fishers, gathering of reef invertebrates for ornamental and aquarium trade and collection of collection of sea cucumbers for export are increasing to a threatening level. The corals of Andaman Sea coast area of the Bay of Bengal is a fringing reef ranging from near shore to off shore areas. Rapid development activities along the cost over the past three decades pose a threat to the reefs. Due to multiple stress, from sedimentation, coastal tourism and other users, in Bangladesh corals are limited around the island of St Martin.

Assessments carried out after the great tsunami in 2004 December indicate that coral reefs of the region suffered only minimal damage. Only 8% of pre-tsunami coral cover was lost, even if all of the tsunami-damaged corals dies. However the region is still struggling to recover from 1998 bleaching due to El-Nino and smaller impact due to great tsunami in 2004. Some reefs in the region have changed considerably from their original state in terms of composition of species and ecological functionality, in most cases changing to a algal turf bed.

Root cause analysis conducted for the critical habitats

Proximate causes identified as a result of degradation of mangrove habitats include:

I. Conversion of coastal wetlands for agriculture, aquaculture and salt production;
II. Expanding coastal development for industry, tourism, human settlements and reclamation;
III. Unsuitable logging of mangroves and
IV. Increasing sedimentation and pollution.

Coral reefs around the world are dying. There are direct and indirect causes that can be identified studying the present context. Major causes of degradation are:

I. Coral bleaching associated with natural phenomenon;
II. Coastal modification, including degradation and coral, limestone and sand mining;
III. Increasing nutrients (eutrophication) due to anthropogenic activities;
IV. Overexploitation reef fish and associated destructive fishing methods;
V. Direct impact from increasing coastal tourism; and
VI. Sediments, pesticides and pollutants from land-based activities.

Many natural and human induced activities are responsible for degradation of seagrass. Natural disturbances that are most commonly responsible for seagrass losses includes hurricanes, earthquakes, disease and grazing by herbivores. Human activities most affecting seagrass are those which alter water clarity, nutrient and sediment loading, sewage disposal, dredging and filling, pollutants, and certain fishing practices. The main causes identified here are;

I. Sedimentation and eutrophication
II. Destructive fishing practices (trawling and push-netting); and
III. Coastal modifications, including dredging and sand mining.

These in turn are caused by:

I. Lack of proposer coastal planning at the national, provincial or state level;
II. Food security needs of the marginal coastal populations;

III. Coastal development and establishment of industries in the coastal belt;
IV. Ineffective marine protected areas and weak law enforcement;
V. Increasing landbased activities including agriculture;
VI. Increasing coastal tourism.

Clearing mangrove for aquaculture (e.g. shrimp), agriculture (e.g. paddy rice), and salt production as well as mangrove clearing for land reclamation for housing, resorts, roads and harbours are the major causes of mangrove loss. As expected, causes of deforestation also vary with space and time, but over 1975-2005, unlike many areas of Asia; conversion to aquaculture was not the major cause of mangrove deforestation in the region. Conversion of mangroves for agriculture was the main cause in most countries, although aquaculture conversion was the main cause in Indonesia while both agriculture and aquaculture were important in Thailand. Indiscriminate tree felling and lopping, mainly for fuel wood, woodchip, pulp and charcoal production, fodder and timber for houses, especially in areas close to human habitation also contributes to the problem. There is often a lack of interest or awareness of private landowners (village communities and individuals) in conserving and developing the mangroves on their lands. Other unsustainable practices include removal (including selective overharvesting) of mangrove animals for food, and trade, especially brood stock for shrimp seed (Table 05).

As a result of global warming sea temperature in the BOBLME has increased by 0.5°C since 1957. Bleaching of corals occurs when the tolerance level of corals and their photosynthetic symbiosis

(zooxanthellae) is exceeded. Forecasting simulations conducted based on climate research indicates that the thermal tolerance of reef-building corals may exceed every year within the next few decades. Events experienced as 1998, the most terrible on record, are likely to repeat frequently within next twenty years. Records on recent research suggest that the capacity for acclimation by corals are already exceeded.

Collecting fish on coral reefs, mainly for ornamental reef fish has exceeded the sustainable level. Traditional and sustainable fishery for domestic and local consumption has changed to a overexploited commercial industry. The live food fish trade for both human consumption and ornamental is a globally connected market system, linked with fishing communities and markets. Fish on coral reefs are mostly captured with poisons (cyanide) or dynamiting (Table 06).

Disposal of land-based liquid and solid waste is another major cause of loss, specially to coral reefs. High nutrients loading form sewage and agricultural runoff is another major cause that ultimately may lead to a algal turf on bleached corals. Effect of agrochemicals, pesticides and herbicides are numerous. Coastal aquaculture effluents and solid wastes coming from farms may enter into sea adding nutrients and chemicals that may affect corals.

Leaching of sea-based oil, release of ballast water at harbours and dumping of solid and liquid waste into coastal zones are threats to coral reefs and mangroves. Lack of proper technology and infrastructure for management of industrial and domestic wastes is seen as a root cause that could be addressed.

Increasing siltation and sedimentation due to clearance of forests, agriculture and coastal constructions, all impact on critical habitats along coastal belts with changes in salinity caused by the diversion of the flow of freshwater by onshore activities. Unregulated and uncontrolled tourist activities including trampling and destructive tourist related activities, boat anchoring and mooring, destructive fishing practices including explosions, cyanide poisoning and bottom trawling and harvesting coral building materials and beach replenishment (sand) are all recognised proximate causes as identified by BOBLME (BOBLME Project, 2010).

Two important causes for seagrass loss are reduction of underwater light due to large amount of suspended solids and excessive growth of epiphytic communities on their leaves. The first issue is directly related to deforestation and rapid development activities along the coastal areas and the latter is related to release of high nutrients from agricultural runoffs. High nutrients also responsible for the growth of phytoplankton blooms over sea grass beds and as a result reduction of incident light on seagrass. Large quantities of sediment also clogged coastal hydrological structures, sea walls and causeways.

Table 05. Detailed causal chain analysis for degradation of critical habitats: Preliminary causal chain analysis for the causes of the loss of mangrove habitat in the countries surrounding the BOBLME.

Root causes	Penultimate causes	Intermediate causes	Proximate causes	Issues	Tbm boundary nature of the concern
				Loss of Mangrove Habitat	• 11% of global mangroves border the BOBLME • All countries contain mangroves
Growth in coastal population	Food security of coastal poor	Subsistence production (%)	Conversion for agriculture (82%)		
National & Regional Economic development drivers	National Demand for hard currency earnings	Export production (%)			
Lack of a "green ethic" in business	Corporate demand for "profit"				
Lack of economic alternatives	Individual demand for higher incomes				
Growth in coastal population	Food security of coastal poor	Subsistence production (%)	Conversion to aquaculture (12%)		
National & Regional Economic development drivers	Demand for hard currency earnings	Export production (%)			
Lack of a "green ethic" in business	Corporate demand for "profit"				
Lack of economic alternatives	Individual demand for higher incomes				
Lack of alternative livelihoods	Lack of economic alternatives	Subsistence & cash income	Conversion for salt production (2%)		
National & Regional Economic development drivers	Demand for hard currency earnings	Increasing tourism	Conversion for coastal tourism (2%)		
Growth in coastal population			Conversion for human settlement (1.5%)		
National & Regional Economic development drivers			Conversion for Industrial purposes (2%)		
Lack of a "green ethic" in business	Corporate demand for "profit"	Export demand	Clear felling for Wood chip production (2%)		
		National demand for paper			
Lack of capacity (financial and manpower) to enforce controls	Where plans exist lack of political will to enforce plans	Lack of national provincial/state coastal development plans	All of the above		
		Lack of National, Provincial, state mangrove management plans			

Table 06. Detailed causal chain analysis for degradation of critical habitats: Preliminary Causal chain analysis for the causes of coral reef habitat loss and degradation in the countries surrounding the BOBLME.

Root causes	Penultimate causes	Intermediate causes	Proximate causes	Issues	Trans boundary nature of the concern
					• 8.0% of global coral reefs border the BOBLME • All countries contain coral reefs
Uncontrolled tailings discharge	Mining	Increased Sedimentation	Land Based Activities	Loss and degradation of Reef Habitat	
Coastal Tourism	Coastal Construction				
Infrastructure development					
Maritime Transport (ports and harbours					
Food security	Agriculture				
Coastal Tourism, Port & harbour construction	Coastal Construction	Land reclamation			
Development	Industry/Ports/Agriculture	Coastal Pollution			
Population growth	Agriculture urban sewerage	Nutrient increase			
Population growth	Coastal urbanization	Solid waste			
Lack of enforcement	Lack of surveillance	Destructive fishing	Marine Based Activities		
Population growth	Coastal poverty	Blasting			
Global demand	Aquarium fish trade	cyanide			
Lack of alternative material	Construction materials and Lime production	Coral mining			
Lack of Management control	Lack of Management information	Overfishing			
		Discarded fishing gear			
		Crown of thorns outbreaks	Natural, Episodic events		
	Increased seasurface temperature	Bleaching			
		Storm damage			

Pollution of BOBLME

A pollution phenomenon highlighted by the regional thematic review (Kaly, 2004), but not identified in national reports, is that of severe episodic events such as floods, cyclones, and storm surges. These periodically mobilise pollutants from relatively immobile compartments such as lagoons and coastal sediments, and can render waste management systems such as landfills and sewerage systems that do exist ineffective. Such catastrophic events can cause the release or transfer of large quantities of contaminants to the coastal and marine environment (Kaly, 2004), but conversely could act to flush contaminants from coastal areas.

Tran boundary nature of the issues of pollution

In general pollution includes range of threats and can be transboudary in nature both in the strict sense that pollutants or the effects of pollution are spread across national boundaries. Threats includes land-based sources, oil spills, untreated sewage, heavy siltation, nutrient enrichment, invasive species, persistent organic pollutants, heavy metals, acidification, radioactive substances, marine litter, overfishing and illegal fishing leading to destruction of marine habitats (McCook, 1999, Bellwood et al., 2004). Among the above categories, the priority transboundary pollution issues in the BOBLME (BOBLME Project 2010) are as follows:

I. Sewage-borne pathogens;
II. Organic load from land-based sources;
III. Marine litter;
IV. Nutrient enrichment;
V. Oil pollution;
VI. Persistent Organic Pollutants (POPs);

VII. Persistent Toxic Substances (PTSs) and

VIII. Mercury including organomercury compounds

Biological pollutants such as some pathogenic bacteria and viruses can remain live up to several months in marine environments. Though, when organisms are settled on sediments and relatively immobile sewage-borne pathogens are deposited in sediments they are unlikely to be transported long distances from their point of discharge (Ashbolt, 1995). High organic compounds are oxygen demanding due to rapid degradation and likely to localise near the source where mixing and dilution that typically accompany transport by currents. The best example is the Brahaaputra-Meghna system where sewage and other organic contaminant are likely to be transboundary due to high river discharge and ocean circulation pattern.

Non degradable matter such as plastics and discarded fishing gears can be transported long distances in the marine environment which is clearly a major transboundary issue. most other components of solid wastes tend to remain close to their source in the marine environment.

Nutrient enriched water near river mouths have the potential to create a inner-shelf hypoxic zones, which could expand or transport across borders, or adversely affect transboundary fish stocks. This hypoxic conditions due to nutrient inputs could create natural oxygen minimum zones that could be lethal to shelf and shelf fish. Maritime transport associated discharges are inherently transboundary (BOBLME Project 2010).

Causes of pollution

The proximate causes for the identified priority issues are (please refer Table 07 for a summery)

I. Extensive discharges of untreated or inadequate treated domestic, industrial and agricultural water;
II. Lack of proposer solid waste management practices including widespread discharges of untreated wastes into natural water causes which will end up at sea, and open burning of solid waste into rivers and coastal waters and the open burning of solid waste, which generates dioxins and furans;
III. Escalating emissions of nutrients from fertilizer productions used in agriculture and atmospheric emissions from industry and fossil fuel burning;
IV. Expanding aquaculture in the coastal zones and release of biologically and chemically polluted water into close by seas; and
V. Operational discharges of oil from ships and dumping of waste oil by vessels.

These proximate causes are, in turn caused by (BOBLME Project 2010):

I. Increasing density of coastal populations and urbanization threatening to natural habitats and coastal tourism;
II. Increasing population density associated per capita consumption of goods and services which has a multiplying effect;
III. Low per capita GDP that leads to preclude public investment in environmental management measures including waste management practices and regular environmental monitoring;

IV. The migration of industries into BOBLME countries from elsewhere, often driven by actual relaxation of environmental regulations and constrains compared to other countries. These industries are inherently difficult to regulate and manage the wastes produced.

V. Lack of awareness of the impacts of marine pollution among the public, the judicial system, and policy makers. This make public behaviour that increases pollution, reduced enforcement of environmental legislation and regulations.

VI. Poor institutional framework to enforce environmental regulations. Most BOBLEM countries have adequate environmental legislation and supporting regulations which can be attributed to;

i. insufficient financial and/or human monitoring and enforcement capacity;

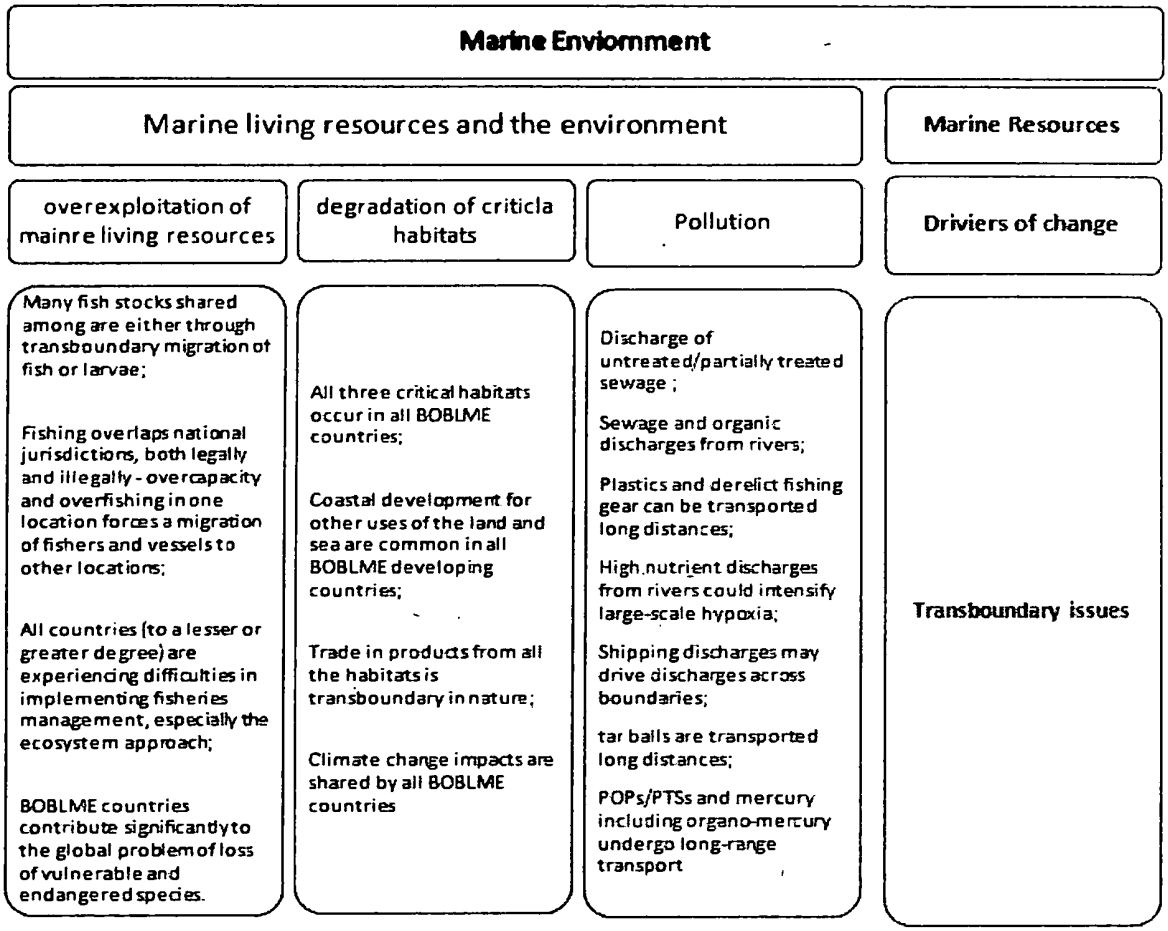
ii. Responsibility for implementing and enforcing environmental policy and legislation without adequate coordinating methods;

iii. Lack of awareness of the importance of environmental legislation, so that violations of environmental laws;

Table 07. Detailed causal chain analysis for pollution

Root causes	Penultimate cause	Intermediate causes	Proximate causes	Issues	Tranboundary nature of the concern
Increasing coastal population density	Lack of capital investment	Lack of sewage treatment facilities	Untreated or only partially treated sewage	1. Sewage-borne pathogens	• Discharge of untreated/partially treated sewage is a common problem; sewage and organic discharges from the Ganges-Brahmaputra-Meghna system are likely to be transboundary; • Plastics and derelict fishing gear can be transported long distances across national boundaries; • High nutrient discharges from rivers could intensify large-scale hypoxia; atmospheric transport of nutrients is inherently transboundary; • Differences among countries with regard to regulation and enforcement of shipping discharges may drive discharges across boundaries; tar balls are transported long distances; • POPs/PTSs and mercury including organomercury undergo long-range transport; • Sedimentation and most heavy metal contamination tend to be localized and lack a strong transboundary dimension.
	Lack of low cost alternative treatment options				
Increasing coastal population density	Lack of capital investment	Lack of sewage treatment facilities	Untreated or only partially treated sewage	2. Sewage-borne organic load	
	Lack of low cost alternative treatment options				
Increasing coastal population density	Lack of dump site capacity	Improper siting and management of solid waste dumps	Discharges of solid waste into rivers and coastal waters;	2. Solid waste/marine litter	
Increasing consumption					
	Lack of management controls	Dumping in coastal rivers and the marine environment			
Increasing coastal population density	Lack of capital investment	Lack of sewage treatment facilities	Untreated or only partially treated sewage	3. Increasing nutrient inputs	
Increasing population	Lack of low cost alternative treatment options				
	Need for maximum productivity	Improper use of fertilizers	Increasing fertilizer use in agriculture		
Increasing population	Need for maximum productivity	Improper use of feeds	Increasing coastal aquaculture		
	Lack of capital investment	Lack of regulations for flue emissions	Increasing atmospheric emissions of nitrogen from industry and fossil fuel burning;		
	Lack of port reception facilities and enforcement	Non adherence to IMO agreements regarding oil and	Operational discharges of oil from shipping, dumping of used oil from small boats and land vehicles	4. Oil pollution	
	Lack of capital investment	Lack of regulations and or monitoring of flue emissions	Burning of solid waste;	5. POPs/PTSs	
			Industrial emissions		
Lack of awareness of policy makers, legal system, and civil society	Lack of capital investment	Lack of regulations and/or monitoring and control	Coastal Construction	6. Sedimentation	
			Land-based mining & tailings discharge		
			Coastal Dredging		
Lack of awareness of policy makers, legal system, and civil	Lack of capital investment	Lack of regulations and/or monitoring and control	Industrial discharges	7. Heavy metals	

Figure 03. Summary of the Tran boundary Environmental Issues in BOBLME



The implementation of BOBLME activities and reform agenda need to be assessed against the overall legal, administrative and political context and constraints of the BOBLME countries individually and collectively. The regional context is particularly important because the BOBLME countries share the same marine environment; consequently, national activities have transboundary impact. In recent years, many of the BOBLME countries have made substantial progress in improving their national domestic policies, legal and institutional frameworks to achieve the sustainable management of the BOBLME. However, the effectiveness of these efforts has been hampered by a number of

constraints. These constraints can be summarized into four broad categories:

(a) legal and policy;

(b) institutional;

(c) fiscal; and

(d) community participation and public awareness.

First and foremost, the effectiveness of BOBLME activities and reform agenda need to be analyzed against international marine conservation and sustainable resource conservation standards and principles. Some of these international instruments are legally binding and require ratification and legislative implementation at the national levels; whilst others are non-binding policy documents but require domestic policy or legal implementation.

International and domestic legal context

Initially governed on the basis of the "free seas" principle established at a time when the marine environment was still a vast, unexplored desert, the high seas are gradually being subjected to regulation through international navigation rules and fisheries agreements. However, the grip of the law on activities taking place in areas beyond national jurisdiction remains largely fragmentary and fails to ensure the sustainable management of the various elements of marine biodiversity. Furthermore, recent research has revealed exceptional sources of biodiversity within deep-sea ecosystems. As a result, the high seas have become the focus of new challenges, such as the exploitation of marine genetic resources, which are not covered by the legal instruments in force. Hence, what is lacking today is the implementation of an integrated

system for the management of marine ecosystems beyond national jurisdiction.

International Agreements

International environmental law evolves with an integrated legal approach to environmental management and solves environment related conflicts at regional and global levels. The negotiation of resolutions, recommendations or declarations in important global forums often carries normative weight and facilitates their entry into customary law. The 'soft approach' of a nonbinding framework or 'umbrella legislations' becomes a step on the way to 'hard law' in the form of conventions, agreements, treaties or protocols. Gradually, it incorporates elements of responsibility, liability and compensation followed by penalties, sanctions, implementation and dispute settlement. However, the changing institutional structure of international cooperation and governance has created new trends where conferences of parties (COPs) and systems of implementation reviews (SIRs) have become vital elements. Regional laws, bilateral agreements and national instruments play a complimentary role. The UN Declarations on environment commencing with the Stockholm Declaration of 1972 and over a 150 international instruments which followed, provided ample evidence of State obligations in regard to Environment Law.

Some of these international instruments are legally binding and require ratification and legislative implementation at the national levels; whilst others are non-binding policy documents but require domestic policy or legal implementation. Tables 08 provide a list of the major international instruments whose implementation at the national level will

support the achievement of the BOBLME objectives. The Tables also evaluate the status of these instruments in the BOBLME countries.

Table 08. Status of Major Environmental Treaties of BOBLME Countries

Environmental Treaties	Indonesia	Malaysia	Thailand	Myanmar	Bangladesh	Sir Lanka	India	Maldives
Law of the Sea Convention (LOSC)	✓	✓	✓	✓	✓	✓	✓	✓
Convention on Biological Diversity (CBD)	✓	✓	✓	✓	✓	✓	✓	✓
Convention on International Trade in Endangered Species (CITES)	✓	✓	✓	✓	✓	✓	✓	✓
Convention on Migratory Species (Bonn Convention)	✓	✓	✓	✓	✓	✓	✓	✓
Ramsar Convention on Wetlands of International Importance (Ramsar)	✓	✓	✓	✓	✓	✓	✓	✓
Stockholm Convention on Persistent Organic Pollutants	✓	✓	✓	✓	✓	✓	✓	✓
UN Framework Convention on Climate Change (FCCC) and Kyoto Protocol	✓	✓	✓	✓	✓	✓	✓	✓
Basel Convention on the Control of Tran boundary Movements of Hazardous Wastes and Their Disposal	✓	✓	✓	✓	✓	✓	✓	✓
UN Fish Stocks Agreement	×	×	×	×	×	✓	✓	✓
FAO Compliance Agreement	✓	✓	✓	✓	✓	✓	✓	✓
Fund Convention	×	✓	×	×	×	×	✓	✓
International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)	✓ (Annex I-II)	✓ (Annex I, II, V)	✓ (Annex I & II)	✓ (Annex I &II)	✓ (Annex I - VI)	✓ (Annex I - V)	✓ (Annex I - V)	✓ (Annex I, II, V)

Of particular importance in the context of the BOBLME Project is the FAO Code of Conduct for Responsible Fisheries (Code of Conduct) which provides principles and standards applicable to the conservation, management and development of all fisheries, including the capture, processing and trade of fish and fishery products, fishing operations, aquaculture, fisheries research and the integration of fisheries into coastal area management. The Code of Conduct is supported by the FAO Compliance Agreement and specific International Plans of Action which require the development and implementation of corresponding national plans of action.

Collectively, these binding and non-binding international instruments provide the framework for the implementation of sustainable and responsible fishing practices and sound marine environmental management, including better management of fisheries, protection of migratory and threatened species, ecosystem and biodiversity protection and marine pollution prevention.

Most of the BOBLME countries are parties to major international agreements pertaining to biodiversity and protection of ecosystems, including, the United Nations Convention on the Law of the Sea, Convention on Biological Diversity, the Cartagena Protocol on Biosafety to the Convention on Biological Diversity. Except for the Maldives, all BOBLME member countries are parties to the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention); and the Convention on International Trade in Endangered Species of Wild Fauna and Flora. All BOBLME countries are also parties to key international instruments concerning the protection of the atmosphere such as the United Nations Framework Convention on Climate Change and the Kyoto Protocol to the United Nations Framework Convention on Climate (Table 08).

Only a few of the BOBLME countries have ratified the UN Fish Stocks Agreement and none have accepted the FAO Compliance Agreement. Only a few BOBLME countries have developed national plans of action to implement the various FAO International Plans of Action, namely on capacity, seabirds, sharks and illegal, unreported and unregulated (IUU) fishing.

A major gap in the BOBLME is the lack of widespread ratification of international agreements pertaining to marine pollution prevention. None of the BOBLME countries are party to the Convention for the Prevention of Marine Pollution from Land-Based Sources, nor the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) (de La Fayette, 1998). Among the BOBLME countries, only Malaysia is party to the International Convention on Civil Liability for Bunker Oil Pollution Damage, and only India, Malaysia and the Maldives have ratified the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND Convention).

The participation of BOBLME countries in many relevant international instruments demonstrates significant levels of commitment to address cross-cutting issues of transboundary concern. However, many of these international commitments remain to be implemented in domestic legislation.

The Environmental Performance Index (EPI) (EPI, 2010) provides a benchmark of the environmental performance of a country's policies. The 2010 EPI ranks 163 countries on 25 performance indicators tracked across ten well-established policy categories covering both environmental public health and ecosystem vitality. The performance of the BOBLME countries in the 2010 EPI was very low; with the highest-ranked BOBLME country being Maldives at 48 and the lowest-ranked being Bangladesh at 139. Despite the comprehensive scope of the EPI, there is still the need for a study assessing how BOBLME member countries meet their nationally-set environmental objectives and how these objectives fulfil their international obligations and commitments.

Domestic Legislation

While there is considerable variance across the BOBLME countries in regard to their respective political, legislative and administrative structures, they have all enacted a number of legislations that seek to regulate activities in the BOBLME to ensure that the marine living resources and critical habitats of the BOBLME are afforded a certain level of protection (Table 09). The existing legal and policy framework among the BOBLME countries dealing with coastal and marine resource management and sustainable use of the BOBLME are, in general, comprehensive in their content and coverage. However, they are fragmented, sectoral in scope, and not effectively implemented. Table 3.3 provides a summary of relevant national legislation of the BOBLME countries. The laws can be classified into three broad categories, namely: fisheries management and development, marine biodiversity protection and marine pollution.

Analysis of the laws of individual BOBLME countries in the context of achieving the objectives of the BOBLME reveals that many of the laws do not embody modern management concepts reflected in international instruments and sustainable marine environmental management practices. Major gaps relate to ensuring the objectives of long term sustainable use, the precautionary approach and ecosystem approach to underpin governmental actions in the marine sector.

There is a complex suite of laws and regulations on, e.g., aquaculture, coastal zone management, environment, capture fisheries, forests, pollution, critical habitats and certain defined commercially

attractive and/or endangered species. The domestic legal and administrative structures are largely sectoral, uncoordinated and need to be simplified, streamlined and harmonized in order for national and regional efforts to manage the BOBLME to be effective. Other major constraints are insufficient budgetary commitments, and lack of community stakeholder consultation and empowerment.

Some legislation exists to protect the BOBLME to a certain extent from the main forms of pollution, although it is largely in the form of controls on effluent discharges. Even if these controls are rigorously enforced (which they tend not to be; see also institutional root causes), controlled discharges can still destroy an ecosystem if there are enough of them. The effluent control approach also does not take into account the effect of combinations of pollutants on ecosystems, or whether ecosystems are already polluted, physically damaged or otherwise stressed (e.g., by floods). A further inadequacy of pollution-specific legislation in the region is the absence of the "polluter-pays" principle and other penalties severe enough to ensure that breaking the law is a serious economic cost of doing business (i.e., it is more expensive to break the law than to comply with it).

Table 09. Marine-related legislation of BOBLME countries

Indonesia
Act concerning Indonesian Waters (No. 4 of 1960), 1960
Act No. 9/1985 Fisheries Act
Fisheries Law No. 31/2004, 2004
Act No. 9/1990 concerning Tourism
Law 23/1997 regarding Environmental Management
Act on the conservation of biological resources and their ecosystems (Act No. 5

of 1990)
Law No. 24/1992 regarding Spatial Planning
Presidential Decree No. 196/1998 regarding the Agency for the Control of Control of Environmental Impact
Environmental Impact Act No. 21/1992 regarding Maritime Transportation
Government Regulation No. 60/2007 regarding the conservation of fishery resources, 2007
Regulation of the Minister of Finance No. 113/PMK.04/2007 regarding the exemption from import duty on the import of sea products caught by permitted catching instruments, 2007
Regulation of the Minister of Finance No. 105/PMK.04/2007 regarding the exemption from import duty on the import of parent stocks and seeds for the establishment and development of farming, breeding, or fishery industry 2007
Law No. 16/2006 on Agricultural, Fishery and Forestry Extension System, 2006.
Government Regulation No. 15/2002 concerning fish quarantine, 2002
Decree of the Minister of Agriculture No. 646/KPTS/KP.150/7/1996 re establishment of a team for fostering and controlling the supply of fishing vessels, 1996.
Joint Decree of the Minister of Agriculture and the Minister of Communications No. 492/Kpts/IK.120/7/1996 and No. SK.1/AL.003/PHB-96 of 4 July 1996 re the simplification of licensing for fishing vessels, 1996
Joint Decree of the Minister of Agriculture and the Minister of Communications No. 493/KPTS/IK.410/7/96 and No. SK.2/AL.106/PHB-96 of 4 July 1996, re the operation of fishing ports as fishing infrastructures, 1996
Decree of the Minister of Agriculture No. 805/Kpts/IK.120/12/95 on the stipulation on the use of fish-carrying vessels, 1995
Decree of the Minister of Agriculture on appointing a port as a fishing base for chartered foreign flag fishing vessels for fishing in the EEZ (No. 144 of 1993),

1993
Decree relative to Licenses for any Foreigner or Foreign Corporate Body to Catch Fish in Indonesian Exclusive Economic Zone (No. 475/Kpts/IK.120/7/1985), 1985
Decree of the Minister of Agriculture on the Determination of Total Allowable Catch in the Indonesian Exclusive Economic Zone (No. 473a/KPTS/IK 250.6/1985), 1985. Fisheries Law (No. 9 of 1985), 1985
Regulations on Fishery Resource Management in the Indonesian Exclusive Economic Zone (EEZ) (Government Decree No. 15 of 1984), 1984
Presidential Decree regarding Seafarming Development in Indonesian Waters (No. 23 of 1982), 1982
Decree No. 608/Kpts/Um/9/1976 on the delimitation of fishing lanes for vessels owned by state fishing entities, 1976
Decree No. 607/Kpts/Um/9/1976 on Fishing Lanes, 1976
Decree of the Minister of Agriculture on the Fishing Areas for Sea-bed Trawlers (No. 609 of 1976), 1976
Decree No. 123/Kpts/Um/3/1975 establishing the size of mesh in the purse seine nets used for fishing certain fish species, 1975
Decree No. 1 of the Minister of Agriculture on the Conservation of the Riches of the Fish Resources of Indonesia, 1975
Decree No. 561 of the Minister of Agriculture on the Utilization of the By-products of Fisheries, 1973
Foreign Ships - Innocent Passage in Indonesian Waters (Govt Decree No. 36 of 1962), 1962
Malaysia
Malaysian Maritime Enforcement Agency Act, 2004
Environmental Quality Act
Exclusive Economic Zone Act
Merchant Shipping Ordinance
Merchant Shipping (Amendment and Extension) Act

Protection of Wildlife Act
Fisheries Act 1985 (No. 317 of 1985)
Waters Act, 1920 (as amended 1989)
Fisheries (Prohibited Areas) Regulations, 1994
Fisheries (Riverine) Rules, 1990
Fisheries (Maritime) (Licensing of Local Fishing Vessel) Regulations 1985, 1985
Fisheries (Prohibition of Method of Fishing) Regulations 1980, 1980
Thailand
The Fisheries Act (1947, as amended in 1953 and 1985)
Wildlife Conservation and Protection Act (1992)
Enhancement and Preservation of Natural Environmental Quality Act (1992)
Regulation of the Department of Fisheries on the Application and Permission for Aquaculture in Public Fishing Grounds (1990)
National Park Act (1961, as amended)
Navigation in Thai Waters Act (1913, as amended).
Regulation of the Fisheries Department on the application for a license for overseas fisheries b.e. 2532, 1989.
Act Governing the Right to Fish in Thai Fishery Waters (B.E. 2502), 1939
Bangladesh
Territorial Waters and Maritime Zones Act, 1974 (Act No. XXVI), 1978.
The Bangladesh Environment Conservation Act, 1995
The Bangladesh Wild Life (Preservation) Order, 1973
The Embankment and Drainage Act, 1952 (East Bengal Act)
The Environment Conservation Rules, 1997
The Environment Court Act, 2000
The Environment Pollution Control Ordinance 1977
The Ground Water Management Ordinance, 1985
Water Development Board Act, 2000

The Marine Fisheries Ordinance, 1983
The Marine Fisheries Rules, 1983
The Private Fisheries Protection Act, 1889
The Protection and Conservation of Fish Act, 1950
The Fish and Fish Products Ordinance, 1983;
The Tanks Improvement Act, 1939
Bangladesh Merchant Shipping Ordinance, 1983 (No. XXVI of 1983)
Protection and Conservation of Fish Act, 1950 (East Bengal Act XVIII of 1950)
Fisheries Research Institute Ordinance, 1984 (Ordinance No. XVL of 1984), 1984.
Protection and Conservation of Fish Rules, 1985.
Bangladesh Fisheries Development Corporation Act, 1973.
Government Fisheries (Protection) Ordinance, 1959 (E.P. Ordinance No. XXIV of 1959), 1959.
The Inland Shipping Ordinance, 1976
India
Territorial Waters Continental Shelf Exclusive Economic Zone and other Maritime Zones Act, 1976
Environment (Protection) Act, 1986
Environmental Impact Assessment Notification, 1994.
Water (Prevention and Control of Pollution) Act, 1974 (as amended)
Water (Prevention and Control of Pollution) Cess Act, 1977 (as amended)
Guidelines for Sustainable Development and Management of Brackish Water Aquaculture, 1995.
Hazardous Wastes (Management and Handling) Rules (1989, as amended)
Wildlife (Protection) Act (1972, as recently amended in 2003)
Biological Diversity Act, 2002.
The Air (Prevention and Control of Pollution) Act 1981, amended 1987
Coastal Aquaculture Authority Rules, 2005.
Marine Products Export Development Authority Act, 1972 (Act No. 13 of

1972), 1972, 1986.
Maritime Zones of India (Regulation of Fishing by Foreign Fishing Vessels) Rules, 1982.
Maritime Zone of India (Regulation of Fishing by Foreign Vessels) Act, 1981 (Act No. 42), 1981.
Sri Lanka
Aquaculture (Monitoring of Residues) Regulations 2002, 2002.
Aquaculture Management (Disease Control) Regulations 2000, 2000.
National Institute of Fisheries and Nautical Engineering Act (No. 36 of 1999), 1999.
National Aquaculture Development Authority of Sri Lanka Act, No. 53 of 1998, 1998.
Fish Products (Export) Regulations, 1998.
Export and Import of Live Fish Regulations, 1998, 1998.
Fish Processing Establishments Regulations, 1998, 1998.
Aquaculture Management Regulations of 1996, 1996.
Fishing Operations Regulations of 1996, 1996.
Inland Fisheries Management Regulations of 1996, 1996.
Fisheries and Aquatic Resources Act 1996 (No. 2 of 1996), 1996.
Madel (Beach Seine) Fishing Regulations 1984, 1984.
National Aquatic Resources Research and Development Agency Act 1981 (No. 54 of 1981), 1981.
Foreign Fishing Boat Regulations, 1981, 1981.
Sri Lanka Ports Authority Act (No. 51 of 1979), 1979.
Inland Water Fishing Regulations, 1978, 1978.
Proclamation of the President delimiting the breadth of the maritime zones (unofficial title), 1977.
Spiny Lobster and Prawn (Shrimp) Regulations, 1973.
Fisheries Regulations, 1941, 1968.

Maldives
Maritime Zones of Maldives Act No. 6, 1996
Navigation Act (Law No. 69/78)
Mandate of the Ministry of Transport, Environment and Construction - 138/2009/34 (2009)
Customs Control over International Ships in Ports Act (Law No. 62/78),
Police Act (Law No. 5/2008) (2008)
Levy of Fees of Maritime Vessels Act (Law No. 19/83)
National Security Service and Coast Guard Act (Law no. 1/2008)
Navigational Lights Act (Law No. 65/78)
Outwards Clearance Permit for Ship Embarking on International Voyage Act (Law No.61/78)
Port Dues Act (Law No. 66/78)
Regulation for Vessels Navigating within the Maritime Zones, (1999)
Ship Levies Act (Law No: 19/83)
Ship Station License Act (Law No. 36/78)
Ship Wrecks and Collision within Maritime Zones of Maldives act (Law No:7/96),
Ships Engaged in International Import/ Export Trade other than Ships Granted Diplomatic Immunity Act (Law No. 63/78)
Fisheries Law of the Maldives (Law No. 5/87), 1987.
Environment Protection Law of 1993
Law No. 1/74 relating to Fishing in the Lagoons of Maldives (enacted 1374 Hejira, amended by laws 19 of 1971 and 22 of 1975), 1975.
Regulations for Issuing the License to Fish in the Exclusive Economic Zone of the Republic of Maldives, 1986.

At the local level, where community-based management or co-management is being developed, specific devolution of power and

authority from higher levels of government down to locally constituted bodies is necessary. These bodies may range from local authorities or communities, to committees made up of a representative selection of stakeholders in the resources or the habitats. This in turn requires enabling legislation at the national or state level, coupled with appropriate local by-laws that give effect to the co-management arrangements and adequate consultation and participation.

In a number of critical areas, there is absence of any legislation, policies or strategies. For example, there is inadequate legislation to protect the BOBLME from principal forms of land-based pollution, a key priority area identified as a BOBLME transboundary environmental problem which needs to be addressed in a coordinated manner across national and supra-national institutions. Another noticeable common trend in the BOBLME is that often, even where legislation is in place, it has ambiguous, overlapping, or conflicting provisions. There are often no enabling subsidiary rules or regulations to implement the laws.

There is considerable variance in the legal, administrative and political situation across the eight BOBLME countries (Table 10). Some of the countries have federal systems of government and others are unitary States. Some are republics and some are monarchies. Despite these variations, however, administrative structures and national marine conservation and utilization legislation share similar characteristics and constraints.

Table 10. Ministries, Departments and Agencies with marine and environmental functioning of BOBLME countries.

Country	Ministries and Departments	Agencies
Indonesia	Ministry of Marine Affairs and	Agency for Marine and

	Fisheries	Fisheries Research
	Ministry of Environment	
	Department of Agriculture	
	Department of Forestry	
	National Coordinating Agency for Survey and Mapping (BAKOSURTANAL).	
	Meteorological and Geophysics Institute of Indonesia (BMG).	
	Agency for the Assessment and Application of Technology (BPPT).	
Malaysia	Federal Department of Fisheries	
	Department of Environment	
	Ministry of Agriculture and Agro-based Industry	
	Fisheries Development Authority of Malaysia	
	Fisheries Research Institute Malaysia	
	Fisheries Development Authority of Malaysia	
Thailand	Ministry of Natural Resources and Environment	Department of Fisheries
		Department of Marine and Coastal Resources
		Department of Water Resources
		Office of the Natural Resources and Environmental Policy and Planning
		Department of Environmental Quality Promotion
		Pollution Control Department
	Ministry of Agriculture and Cooperative	
Myanmar	Department of Fisheries	Marine Fisheries Resources Survey and Research Unit
	Hotel and Tourist Department	
	Forest Department	
Bangladesh	Ministry of Fisheries and Livestock	Department of Fisheries
		Bangladesh Fisheries Research Institute

		Bangladesh Fisheries Development Corporation
		Marine Fisheries Academy
	Ministry of Environment and Forest	Department of Environment
	Ministry of Water Resources	
India	Department of Agriculture & Cooperation	
	Department of Animal Husbandry, Dairying & Fisheries	
	Department of Agricultural Research & Education	
	Ministry of Food Processing Industries	
	Department of Ocean Development	
	Department of Bio-Technology	
	Indian Council of Agricultural Research	
	Central Institute of Brackishwater Aquaculture	
	Central Inland Fisheries Research Institute	
	Central Institute of Freshwater Aquaculture	
	Central Institute of Fisheries Technology	
	Central Marine Fisheries Research Institute	
	Central Institute of Fisheries Education	
	National Bureau of Fish Genetic Resources	
	National Research Centre on Coldwater Fisheries	
	Fishery Survey of India	
	Integrated Fisheries Project	
	Central Institute of Fisheries, Nautical & Training	
	Central Institute of Coastal Engineering for Fisheries	
	Coastal Aquaculture Authority	

Sri Lanka	Ministry of Fisheries and Ocean Resources	Coast Conservation Department
		Department of Fisheries and Aquatic Resources
		National Aquatic Resources Research and Development Agency
		Marine Pollution Prevention Authority
		Ceylon Fisheries Harbours Corporation
		National Aquaculture Development Authority
	Ministry of Environment and Natural Resources	Central Environment Authority
		Department of Wildlife
		Department of Forests
	Ministry of Tourism	
	Ministry of Science and Technology	
	Ministry of Plantation, Infrastructure and Construction	
	Ministry of Irrigation and Water Management	
	Ministry of Provincial Councils and Local Government	
	Provincial Ministry of Local Government, Education, Industries and Environment	
Maldives	Ministry of Fisheries Agriculture and Marine Resources	Marine Research Centre
	Ministry of Environment Energy and Water	
	Ministry of Tourism	

As a result of the many different institutions that exist with overlapping mandates and jurisdiction, responsibility and accountability among different levels of government they are not always clearly assigned or delineated, which may lead to conflict among agencies and confusion among stakeholders. This can have a negative impact on the

management of the BOBLME resources. At the grassroots level, the lack of local community stakeholder consultation and involvement in planning, decision-making, implementation and enforcement undermine effective implementation by responsible agencies. There is thus a need for continuous coordination and collaboration between agencies, and between the central government and the various sub-national units in order to ensure sustainable conservation and management of the BOBMLE. Institutional arrangements, in order to be effective, necessitate that enforcement powers are assigned to clearly identified agencies, fines and other penalties are specified and act as deterrents, and monitoring is promoted to ensure compliance.

The lack of clarity with regard to responsibility and accountability resulting from overlapping institutional mandates also gives rise to levels of corruption. The performance of the BOBLME countries in the Corruption Perception Index which measures the perceived level of public-sector corruption is indicative of the need to address wider issues of governance, including corruption.

Traditional Systems and Customary Rights

The recognition of traditional systems and customary rights through mechanisms such as customary marine tenure and community-based management have proven to be successful in managing marine living resources and improving the livelihoods of traditional fishermen, as well as the management and conservation of marine resources. Among the BOBLME countries, local customary management practices which regulate the use, access, and transfer of resources have been developed

through generations of human interaction with the environment. These are often distilled from indigenous ecological knowledge and are culturally embedded in customary land and sea tenure institutions.

The implementation of customary marine tenure, practices and traditional knowledge is exemplified in the BOBLME region in various forms such as temporary closure of particular areas to fishing (i.e. closed for several months to provide supplies of fish for a feast) or permanently (where spirits reside, for example); limiting who can harvest certain species, using certain gears, fishing in certain areas; and restricting the quantity of a harvest. However, with colonization and adoption of western cultures, community-based management and co-management schemes have weakened. Where they still exist, the adoption of such approaches into the domestic legal framework and resource management practices of the BOBLME countries should be encouraged and promoted as a positive step towards ensuring the sustainable management of the BOBLME.

At present, the opportunities for stakeholder participation in the BOBLME are limited under existing laws, regulations and policies and their own low level of capabilities. There is a need to strengthen, improve and further expand avenues for increased participation of all major stakeholders at the regional, national and local levels in coastal environment and resources conservation and management of the BOBLME. In order to strengthen the participation of the community stakeholders, appropriate policies, laws and regulations would need to be put in place. The capacity building of stakeholders themselves should be made a separate goal in itself which could be achieved through the development of training and information transfer projects as well as

institutional arrangements which will allow for standard participation. The involvement and participation of all relevant stakeholders in establishing a transparent and practicable management of the BOBLME should be ensured, and not merely limited to perfunctory consultation.

At the regional level, broad and enduring partnerships among and within the BOBLME countries and with key regional/international agencies and donors should be built in order to achieve a coordinated implementation process which will harness the comparative advantage of the respective co-financing institutions. In light of the size and complexity of the BOB, achieving a high degree of regional cooperation with a large number of government agencies, many of which would likely be directly involved in project implementation, will ensure long-term viability of BOBLME projects and activities.

Insufficient Legitimacy

Present international environmental organizational structure has failed to address the burden issue of the BOBLME countries. This has lead to an insignificant commitment across the BOBLME region in par with the global context. Two proximate causes for this is that insignificant prominence to the region and effectiveness of legal framework established in the institutions of the region. The Commission on Sustainable Development (CSD), set up to address economic, social and environmental objectives in the integrated manner has not been successful to stimulate the world community in support of sustainable development. CSD has failed to identify the challenges ahead and address the issues by a translating into a concrete action plan. There should also

be organized around good governance principles such as subsidiarity, integration, participation, transparency, and accountability.

Decision-Making: sound environmental decision-making hinges on the availability of data, information, and analysis. To ensure sensitivity to the diversity of circumstances and values that exists across countries, any new body must be committed to open process and vigorous debate.

Another important fact is that the reliability of data of high quality and comparability that would support an integrated, ecosystem-based approach to issues and an assessment based on the that. Building up a strong data foundation allows to act correctly and vigorously identifying the causes correctly. Also it enhances dissemination of information on best practises in policies and technology involved in realms. Reliable long-term predictions of environmental trends, early warnings, and impact assessments could be devised on the basis of such data.

Networking of experts, wide range of sources for information and data, identification of problems, analysis of impacts, development of policy options and evaluation of programmes are important components in the process. Owing to inherent complexity of the process and uncertainty in the environmental policy making, it is specially important that problems be approached from multiple perspectives so as to facilitate agreements on the best route forward.

Consensus building on the scope of the problems and ultimate movement toward largely accepted norms are steps promote with broader access to data, information and knowledge. Rule-making which starts with the establishment of policy guidelines and international norms

develop over time into more format set of rules. The analytical groundwork for guidelines, identifying ways to address problems requires common response and international negotiations, specially with respect to transboundary externalities and the management of shared resources.

Implementation of global environmental agreements and harmony with international commitment becomes a matter of execution at the national and local level. Thus, capacity building for implementation of environmental agreements within a nation is critically important. Reliability of comparative data and public revelation of findings represent important tools in the push for worldwide environmental progress. Shared information allows best practices, know-how and polices to be identified.

Monitoring capacity should include the regular and systematic collection and evaluation of data on environmental performances and trends. Data and information are vital gears for good decision making. Central repository for such information and a mechanism for making information available to concerned parties could provide a better platform to be function as regional and national organizations.

Conflict resolution needs a mechanism to resolution, including convincing authority and agreed dispute settlement mechanism that draw on appropriate scientific and technical expertise.

The concept and definition of LMEs are for international campaign of LME management. However human understanding of LME is not sufficient or complete. The knowledge obtained so far by humans shows that a multispecies or a comprehensive ecosystem approach to the

management of the marine environment and resources has a greater probability of being more effective than a species-specific approach. The better part of the concept of LME is that it provides the scientific evidence for a more rational approach to the administration of marine environment and its resources. An ecosystem is theatrically the optimal tool to deal with the complexity of LMEs.

The adoption of an ecosystem approach to LME management is not only a scientific and legal issue, but also to a greater extent it can be considered as a political choice. The international ocean management now is in an age of adjusting and harmonizing the political maritime boundaries and ecological marine boundaries, aiming at a more rational protection of the ocean resources. After a process of "consolidation" and "harmonizing" of the regimes from the sea areas under national jurisdiction in the 1980s.

The traditional international law of the sea adopted a zonal approach in ocean management. The LME management approach the area considered to manage requires to coincide with ecological domains of resources and not by the limits of artificial national maritime boundaries. The LME management requires coordination of different jurisdictions within the LME due to its transboundary nature. The major deficiency of the zonal approach is that states exercise different approach and adopt different systems of resource management that are not consistent with ecosystem boundaries. This zonal approach in the law of the sea therefore has become root of many maritime conflicts, such as conflicts between coastal interests and high seas interests and conflicts between interests of development and conservation. The successful implementation of an ecosystem approach to LME management requires

collective political will and the mutual cooperation of the states concerned.

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