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Large Marine Ecosystem: Analysis and Approach

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ABSTRACT

A large marine ecosystem encompasses many resources and these are the areas with better primary productivity. Due to the increase of unsustainable marine practices, ignorance of the well being of marine organisms, and polluting of water bodies, the marine ecosystem requires extra measures. To provide aid to the countries and make a joint effort to protect their marine ecosystems, GEF was established. The work describes the comparative analysis and the process involved in large marine ecosystem management. It sheds light on the global environmental facility mode of operation and the factors required to attain the desired change. The paper focuses on management and diagnostic tools like strategic action planning and transboundary diagnostic analysis and how they are being applied using real-time examples. The measures countries are taking to achieve the desired change and the procedure to obtain financial help from various sources are also underlined. It augments the need for the large marine ecosystem and discusses various parts of the 5 modules. It discusses how GEF can contribute to the furtherance of the large marine ecosystem and provide guidance to the countries.

Keywords- Large Marine Ecosystem, Strategic action planning, Transboundary diagnostic analysis, Global environmental facility

I. INTRODUCTION

Oceans cover more than 70 percent of our planet and the most prolific areas are in the coastal waters around the borders of the continents. These areas include 66 naturally occurring large marine ecosystems, which together make 75 percent of global marine fish catches and contribute more than 12 trillion U.S dollars annually to the global economy. Human actions are menacing theses ecosystems by the abundant activities they are part of which leads to misuse of nature. With the passing time, coastal areas are polluted and toxic. Marine organisms are threatened by the polluted and toxic environment and even the economy is affected because of the destruction of the ocean's ecosystem. Human actions affect marine life and marine habitats through overfishing, habitat loss, and the introduction of persistent species, ocean pollution, ocean acidification, and ocean warming. These impact marine ecosystems and food webs and may result in consequences as yet unrecognized for the biodiversity and continuation of marine life forms (Geomar et al., 2019). The system of the Large Marine Ecosystem (LME's) has been developed by the US National Oceanic and Atmospheric Administration (NOAA) to identify areas of the oceans for conservation purposes. The purpose is to use the LME conception as a device for enabling ecosystem-based management to provide a combined approach to the management of resources within ecologically-bounded transnational areas. This will be done in an international environment and consistent with customary international law as reflected in the 1982 UN Convention on the Law of the Sea.

LME-based conservation is based on the acknowledgment that the world's coastal ocean waters are tarnished by weak fishing practices, habitat degradation, eutrophication, toxic pollution, aerosol contamination, and emerging diseases and that affirmative action's to mitigate these threats require coordinated actions by governments and civil society to recover depleted fish populations, restore degraded habitats and reduce coastal pollution. (Olsen et al.,2006). The notion of LMEs emerged from an American Association for the Advancement of Science (AAAS) selected symposium in the mid-1980s concerning variability and management of large marine ecosystems (Sherman *et al.* 1991; Alexander 1993). (Rosenberg et al., 2003) states that the "LME concept is obliging for thinking of the linkages of biological, chemical, and physical factors of transboundary coastal ocean areas. Distressing any one part of the LME can have repercussions throughout the region. The LME provides a framework for thinking about potential impacts." The impacts on fisheries ecosystems including the biological, oceanographic, and physical environment that supports commercial and recreational species within a particular management area and other profitable activities such as sand and gravel mining, submarine telecommunications links, oil and gas energy development, marine transportation, contaminants disposal, recreational tourism, and aquaculture, can occur at the scale of LMEs or may be restricted in range (Rosenberg et al., 2003).

II. MODULE OF THE ECOSYSTEM

There are 5 Modules when it comes to ecosystem-based management.

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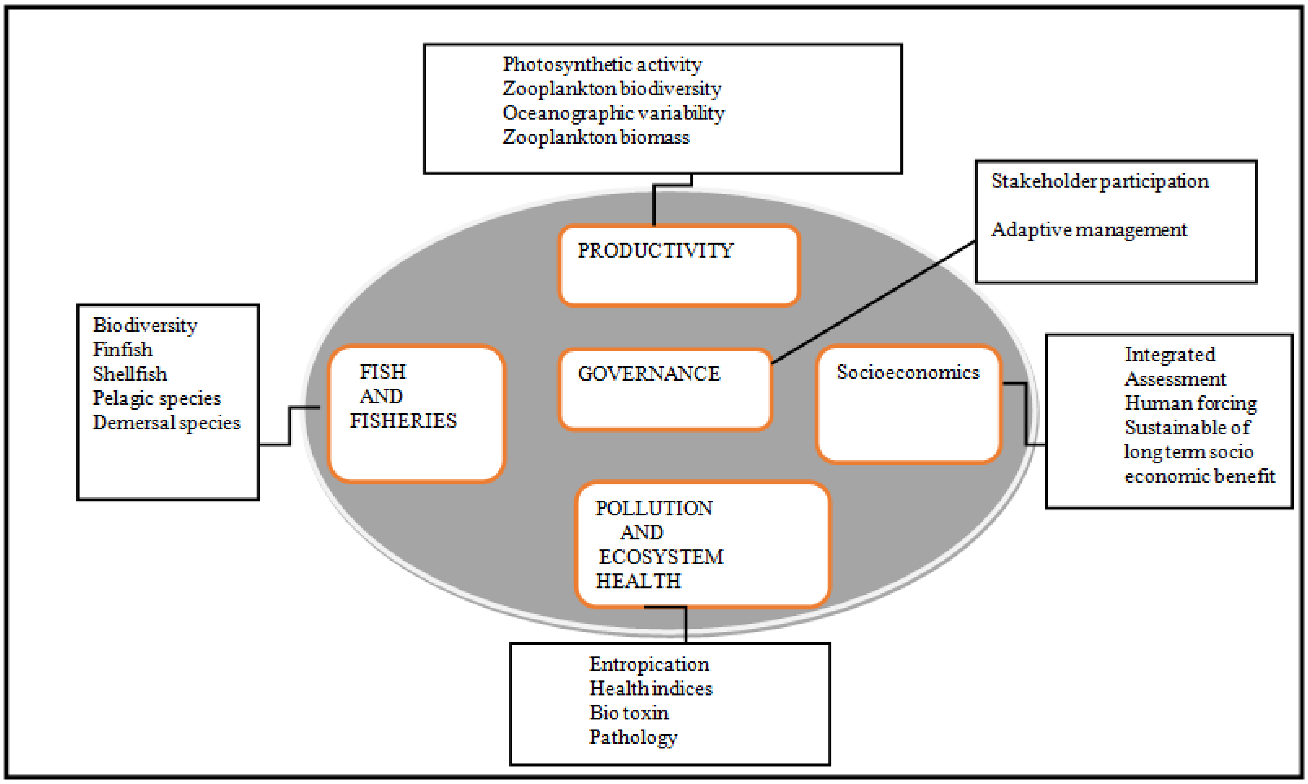

Figure1: 5 modules of the Large Marine Ecosystem

1. Productivity

The productivity of a marine ecosystem can be measured in several ways. Measurements of zooplankton biodiversity and species composition, zooplankton biomass, water-column structure, photosynthetically active radiation, transparency, chlorophyll-a, nitrate, and primary production are used to assess changes in LME productivity and potential fisheries yield (Pauly et al., 1995)

The productivity module concern the base of marine food webs: primary productivity (i.e., phytoplankton) and zooplankton, which constitute the next tropic level up from phytoplankton. Both of these workings can be related to a marine ecosystem's carrying capacity for commercial fisheries and other forms of marine biodiversity. In this regard, primary productivity provides the initial level of carbon production to support marine life, and zooplankton serves as prey for larval stages of fish and the principal food source for forage species like mackerel and herring((Duda and Sherman et al., 2002).

2. Pollution and Ecosystem Health

The wellbeing of a marine ecosystem is tied to many factors, counting its resilience and its upholding of metabolic activity level, internal structure, and internal organization over relevant time and spatial scales (Costanza et al., 1992). Given the many considerations related to ecosystem health, it should be no surprise that the pollution and ecosystem health module is extremely broad. It concerns not only marine pollution and contaminants but also any other indicators or issues related to marine ecosystem health that is not covered by the other modules. Pollution, while a factor that impacts ecosystem health, is specifically referenced in the module because it has been a principal driving force in changes of biomass yields in several LMEs (Sherman et al., 2009). Other common concerns that fall within the scope of the module are marine habitat integrity, emergent diseases, invasive species, eutrophication, and harmful algal blooms. The broad scope of the pollution and ecosystem health module ensures that the LME approach will remain relevant as new issues affecting ecosystem health emerge over time.

3. Socioeconomics

The Global Environment Facility (GEF) aids in managing LMEs off the coasts of Africa and Asia by creating resource management agreements between environmental, fisheries, energy, and tourism ministers of bordering countries. This means participating countries share knowledge and resources of local LMEs to promote longevity and recovery of fisheries and other industries dependent upon LMEs (Juda and Henessy et al., 2001)

By integrating socioeconomic metrics with ecosystem management solutions, the scientific result can be utilized to profit both the environment and economy of local regions. The Department of Natural Resource Economics at the University of Rhode Island has shaped a way for measuring and understanding the human dimensions of LMEs and for taking into consideration both socioeconomic and environmental costs and benefits of

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managing Large Marine Ecosystems. (Sutinen et al., 2000).

3. Governance

Like the socioeconomics module, the governance module pertains to the human dimensions of an LME. Exclusively, it concerns the formal and informal actions or mechanisms that influence human behaviors having a material impact on an LME and its assets. Although we usually think of laws, policies, and institutional arrangements in this context, governance also includes market forces and cultural norms that affect how humans interrelate with an LME (Juda and Hennessey, 2001). There is 3 key mechanism of this module- Market place, Government institution, and non-government institution. This module provides a framework for the implementation of an effective marine ecosystem.

4. Fish and Fisheries

This module is not only concerned with the commercially important fishes, it encompasses any factors and causes that can fluctuate the ecosystem balance. This module deals with important points such as a) Food Security b) Economic value c) Cultural heritage d) Impact on the marine ecosystem.

This module emphasizes the human impact on marine life and deals with issues like overfishing and the ways it can affect the economy as well as the marine system.

III. GLOBAL ENVIRONMENT FACILITY (GEF)

The GEF emerged from the Rio Earth Summit in 1992 and was restructured after a three-year pilot phase. The GEF's mandate is to provide catalytic funding to developing and economically transitioning countries to allow them to address global environmental concerns in any of six areas: (i) biodiversity loss, (ii) climate change, (iii) degradation of international waters, (iv) ozone depletion, (v) persistent organic pollutants, and (vi) land degradation (Duda and Sherman et al., 2002). According to the GEF's 1995 Operational Strategy, the goal of the International Waters focal area is the promotion of collective management for transboundary freshwater and marine systems and the implementation of reforms and investments to ensure sustainable use and maintenance of ecosystem services (GEF, 1995a). Significantly, the GEF Council adopted the concept of LMEs in the 1995 Operational Strategy as a program area for promoting the ecosystem approach in its International Waters focal area.

The commitment to LMEs by the international community has been remarkable. According to a report compiled by NOAA's Large Marine Ecosystem Program in 2010, GEF-supported projects that benefited LMEs received $3.1 billion in financial support during the period 1995–2009 (Sherman et al., 2010a). Another roughly $1 billion in funding has been committed to LME-related projects during the GEF's fifth funding cycle, covering the period 2010–2014 (Sherman et al., 2010a). Both figures include not only catalytic funding from the GEF in the form of grants but also investment funds (loans) from the World Bank and substantial co-financing funds from the countries themselves and other international partners. At present, 110 GEF recipient countries and 20 non-recipient countries are collaborating on projects involving 23 of the world's 64 LMEs (Hume and Duda et al., 2012). These GEF supported projects are implemented through partnerships with one or more U.N. agencies, including the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the World Bank, the Food and Agriculture Organization of the United Nations (FAO), and the United Nations Industrial Development Organization (UNIDO) (Hume and Duda et al., 2012). Additionally, at the project level numerous intergovernmental organizations, non-governmental organizations, and community-based organizations actively participate in the execution of project initiatives (Chazournes, et al., 2005).

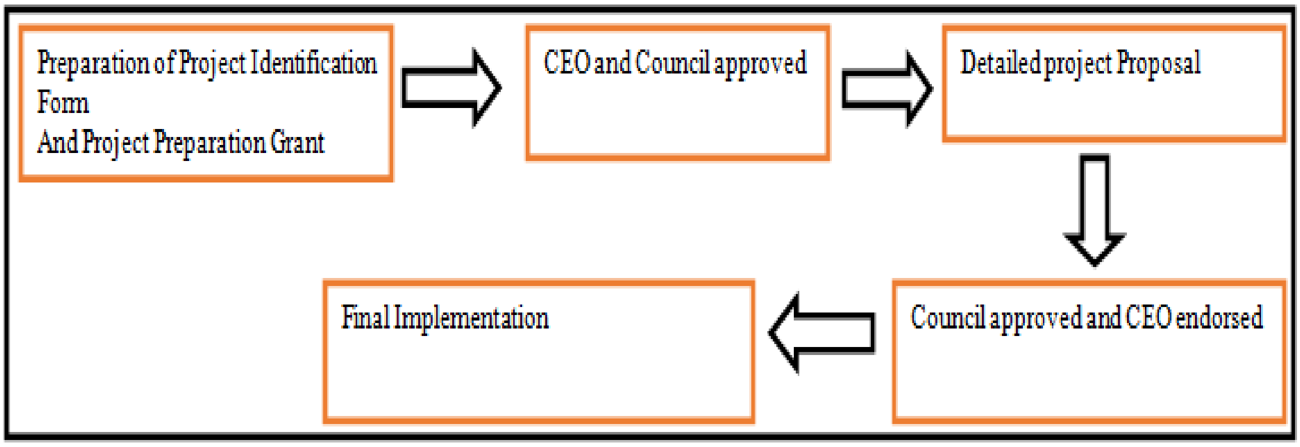

Figure 2: GEF Project cycle

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IV. TRANSBOUNDARY DIAGNOSTIC ANALYSIS (TDA)

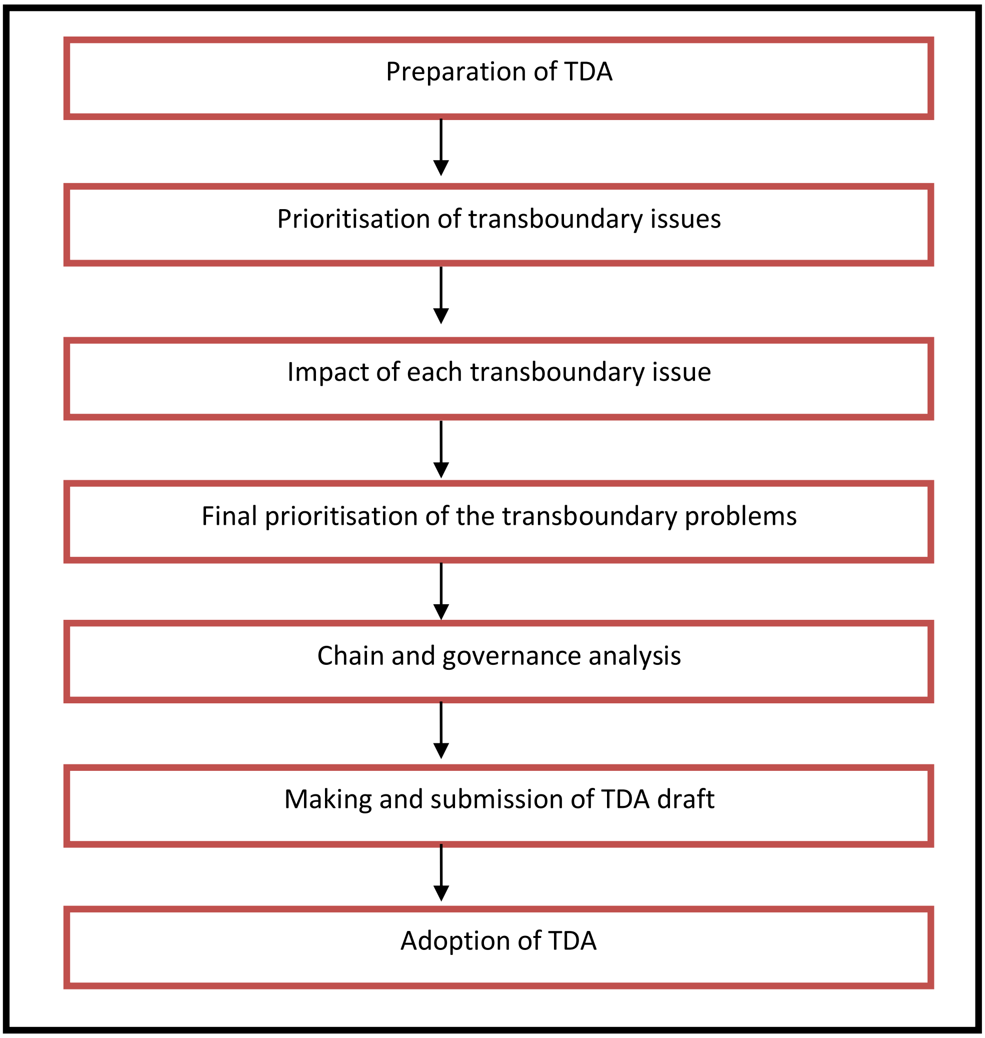

Figure 3: TDA progress

The TDA is a combined fact-finding procedure undertaken by the countries to identify and prioritize major transboundary water concerns and to decide their impacts and root causes (Wang et al., 2004b). The development of a TDA should be based upon the best obtainable scientific, socioeconomic, and technical information. Teams of experts usually referred to as Technical Task Teams, and are established to assist with this process (UNIDO/GEF, 2011). It must be recognized, however, that LME countries commonly lack sufficient information upon which to base strategic action and often do not have the ability or funding to develop absent information before TDA finalization. Where extra information is required to fully assess concerns and develop organization strategies, this need not necessarily delay TDA finalization. Instead, the TDA should make clear orientation to any information deficit, and the countries should plan to fill the gaps as best possible during the next major phase of a project, the development of a Strategic Action Programme (SAP). The TDA must also clearly indicate which of the identified concerns are transboundary, as the GEF only funds the section of LME initiatives that produce global, or transboundary, benefits. In the GEF dialect, the covered costs are referred to as "incremental costs" (GEF, 1995a). All other costs (i.e., those associated with achieving benefits only at a national level) are supposed to be borne entirely by the countries themselves (GEF, 1995a). Transboundary concerns for the GEF's purposes include transboundary issues with national causes; regional or national issues with transboundary causes; national issues that are common to at least two countries and require a common strategy and collective action to address; and issues that have transboundary elements or implications (Wang et al., 2004b). The TDA provides the scientific and factual basis for the SAP, which is very basic terms is a joint program of action among LME countries that describes national and regional reforms, strategies, and funding plans required to fulfill LME long-term sustainability objectives (Duda and Sherman et al., 2002).

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V. STRATEGIC ACTION PROGRAMME

The SAP represents a political commitment of the governments concerned to accept agreed management principles and to apply decided actions that are based upon scientific evidence of key drivers and changing conditions in the LME. The activities are developed by each country and are ultimately compiled and agreed upon by all countries in a negotiated SAP. Very often, countries also develop individual national action plans, referred to as NAPs, which generally describe the commitments that a country makes in response to the multi-country SAP (Duda et al., 2002).SAP is a political document that highlights the negotiated agreement approved by all participating countries. The SAP is built over TDA and provides aid in ecosystem-based management. After the identification of the goal, negotiations are done and an action plan is created. The SAP is adopted by countries and funding is instated. SAP should have a flexible system that allows it to include revised guidelines over time and a way to endorse those revisions. After the endorsement, the implementation of SAP can start.

VI. TDA AND SAP IN PRACTICE

A) Yellow Sea

Pollution based issues -Pollution and Contaminants; Eutrophication; Harmful Algal Blooms (HABs); Fishing Effort Exceeding Ecosystem Carrying Capacity; Mariculture Facing Unsustainable Problems; Habitat Loss and Degradation; Change in Ecosystem Structure; Jellyfish Blooms; and Climate Change-related issues.

The Regional Working Group (RWG) - Pollution identified inorganic nitrogen and phosphate, fecal substances, heavy metals, persistent organic pollutants (POPs), polycyclic aromatic hydrocarbons (PAHs), and marine litter as the major contaminants in the Yellow Sea 9GEF 2007). Inorganic nitrogen and phosphate are important nutrients that sustain phytoplankton (single-celled algae) communities, which form the basis of the marine food chain. However, high concentrations stimulate excessive phytoplankton growth that cannot be consumed by zooplankton leading to eutrophication. Frequently, the eutrophication promotes phytoplankton growth to such an extent that the bloom collapses, and the resulting bacterial decomposition causes oxygen depletion in the surrounding water causing fish kills and mass mortality of other less mobile organisms, especially in mariculture establishments (GEF 2007).

Ecosystem-based issues – change in Biomass abundance; change in species composition; Harmful Algal Blooms increase; benthic habitat loss in coastal areas.

Changes in the biomass and composition of phytoplankton and zooplankton communities could have serious consequences for fisheries' productivity as these groups form the basis of the food chain. The national reports by the YSLME project indicated increases in the biomass of phytoplankton fraction > 77 µm, but decreases in the zooplankton > 500 µm on the Chinese side, while on the Korean side of the Yellow Sea increased biomass of zooplankton > 330 µm were recorded (GEF/UNDP 2007). The ratio of diatoms to dinoflagellates was reported to have decreased in recent years, possibly in response to the increasing eutrophication and decreased ratio of Si: N (GEF 2007)as mentioned previously. Benthic biomass also appears to have decreased and the proportion of polychaetes seems to have increased (GEF/UNDP 2007)

Fisheries related issues- Increased low-value fishes species and decline of the high ones; problematic maricultural practices. There is a rapid increase in catches2 in the Yellow Sea from 400,000 tonnes in 1986 to almost 2.5 million tonnes in 2004, which indicates that fishing effort has exceeded Ecosystem Carrying Capacity (UNDP/GEF 2007). The over-exploitation is evidenced by the decrease in mean size at the catch of some species over the same period [29]. Mariculture accounted for approximately 14 million tonnes in 2004 of which the greatest increases were from mollusc culture. However there are signs that these increases are facing some problems, and recently the productivity per unit area has begun to fall as the area under cultivation grows (UNDP/GEF 2007). This fall in productivity maybe because only unsuitable cultivation areas now remain, or that increased proximity of farms has resulted in: increased disease transmission between farms; raised concentrations of organic wastes; and competition for food resources amongst cultivated organisms (UNDP/GEF 2007). These factors all increase stress and lower the growth and survival rates of the culture organisms, thus reducing productivity.

Biodiversity related issues- Habitat loss and degradation; Pollution ; Changes in river discharge; Overexploitation of marine and coastal living resources; Introduction of xenobiotic (alien) species; Decline of endemic species. The combination of the loss of wetlands, deterioration in coastal water quality, and overexploitation of resources has reduced the ecosystem carrying capacity of the Yellow Sea. The loss of the capacity of the Yellow Sea to provide services such nutrient regulation combined with increased pollution is driving changes in the food chain that may not support the current productive ecosystem and are encouraging the red tides and harmful algal blooms (HABs) currently experienced in the Yellow Sea(Officer, Ryther, et al.,1998)]. The loss of biodiversity reduces the ecosystem's ability to respond to change (McCann wt al.,2000). Thus the loss of key fish species through over-fishing is thought to allow the blooms of flagellates and jellyfish (Jordan et al.,2007) currently reported in the region (Ohtsu et al.,2006). These changes may signal the beginning of a shift towards an ecosystem dominated by worthless jellyfish, as has happened in

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various other areas including the Benguela Current Region (bakun et al.,2006) and the Black Sea (Daskalov et al.,2006)

Table 1: YSLME Regional SAP

TARGETS	ACTIONS
25-30% reduction in fishing effort	Control fishing boat numbers • Stop fishing in certain areas/seasons • Monitor and assess stock fluctuations
The rebuilding of over-exploited marine living resource	Increase mesh size • Enhance stocks •Improve fisheries management
Improvement of mariculture techniques to reduce environmental stress	Develop environment-friendly mariculture methods and technology • Reduce nutrient discharge • Control diseases effectively
Meeting international requirements on contaminants	Conduct intensive monitoring and assessment • Control contaminants discharge concerning Codex alimentations and Stockholm Convention • Implementing MARPOL 1973/78 effectively
Reduction of total loading of nutrients from 2006 levels	Control total loading from point sources • Control total loading from non-point sources and sea-based sources •Apply new approaches for nutrient treatment
The reduced standing stock of marine litter from the current level	Control source of litters and solid wastes • Improve removal of marine litter • Increase public awareness of marine litter
Reduce contaminants, particularly in bathing beaches and other marine recreational waters, to nationally acceptable levels	Conduct regular monitoring, assessment, and information dissemination particularly in bathing beaches and other recreational waters • Control pollution in bathing beaches and other marine recreational waters
Better understanding and prediction of ecosystem changes for adaptive management	Assess and monitor the impacts of N/P/Si ratio change • Assess and monitor the impacts of climate change • Forecast ecosystem changes in the long-term scale • Monitor the transboundary impact of jellyfish blooms • Monitor HAB occurrences
Maintenance and improvement of current populations/distributions and genetic diversity of the living organisms including endangered and endemic species	Establish and implement a regional conservation plan to preserve biodiversity
Maintenance of habitats according to standards and regulations of 2007	Develop regional guidelines for coastal habitat management Establish network of MPAs • Control new coastal reclamation • Promote public awareness of the benefits of biodiversity conservation
Reduction of the risk of introduced species	Control and monitor ballast water discharge • Introduce precautionary approach and strict control of introduction of non-native species

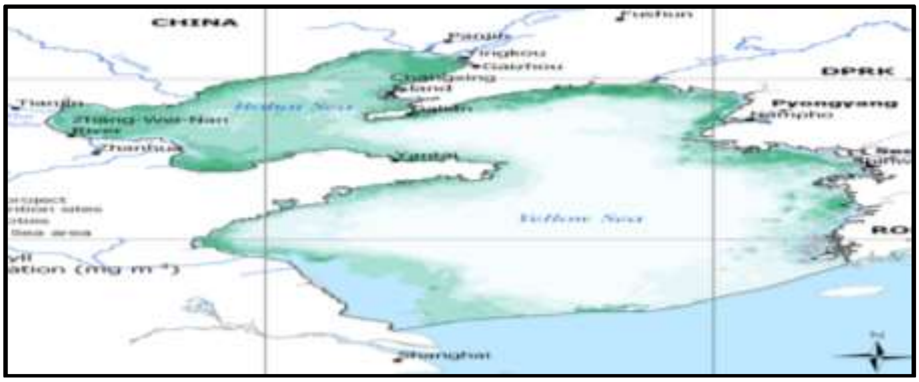

Figure 4: Yellow Sea (MDPI)

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VII. CONCLUSION

YSLME SAP set regional management targets, actions to obtain them as well as management goals. This SAP was unique because its approach was ecosystem-based and was specific about the aim and ways to obtain them. The SAP was flexible enough to include regional coordination and cooperation to provide solutions to problems of the Yellow sea.

b) Bay of Bengal

Overexploitation of marine living resources

Maldives, India, Sri Lanka, Bangladesh, Myanmar, Thailand, Indonesia, and Malaysia are the BOBLME countries involved in the project. They share their fish stocks and even if one area is affected, the difference can be analyzed by all. These countries have contributed significantly to the issue of endangered species and the vulnerable ones. Overfishing like in other situations is also a major issue and gives rise to unsustainable marine practices. There has been a change in the composition of catches and increment in the number of juvenile fishes. Fisheries in the Bay of Bengal are 6 million tonnes per year, which is about more than seven percent of the world's catch. Such high stakes are thin rules can be a destructive combination. One of the main origin causes that run across all the issues is the so-called "open access" regime. While noting that conventional and customary laws and regulations are in place in some coastal areas of the BOBLME, governments have an "open-access" policy to fishing. Under this policy, any person has the right to fish, either as a source of food or income. Experience elsewhere in the world has shown that, although the policy provides a safety net for the poor to survive, especially in hard times, uncontrolled harvesting of marine living resources results in overexploitation and overcapacity in the fishing sector (especially in large-scale industrial fisheries) and a loss of the socio-economic profit that the resource can potentially provide. Governments should take the direct and limit entry to fisheries based on a sound analysis of the socio-economic context of a particular fishery. Customary law and rules and regulations, where they still exist, should be encouraged through a co-management system, as a path to a more "limited access" regime. (BOBLME TDA)

Degradation of mangroves, coral reefs, and sea grasses

The three critical habitats- Mangroves, coral reefs, and sea grasses occur in all the BOBLME countries. The issues are meager fulfillment of poor coastal needs. Increment in product trade from coastal areas which has led to industrialization. Traditional agricultural practices need an upgrade and tourism needs to be highlighted more to see a positive change. Clearing mangroves for aquaculture, agriculture, salt production, and for land reclamation for housing, resorts, roads, and harbors, are the major causes of mangrove loss. As expected, causes of deforestation vary with space and time, but between 1975 and 2005, conversion to aquaculture was not the major cause of mangrove deforestation in the region (in contrast to many other parts of Asia). Conversion of mangroves for agriculture was the main cause in most countries, although aquaculture conversion was the main cause in Indonesia; both agriculture and aquaculture were important causes of mangrove loss 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 contribute to the problem. There is often a lack of attention, or awareness by private landowners (village communities and individuals) to preserve and extend 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. (BOBLME TDA)

Pollution and water quality

Sewage is a major issue and plays an important role in pollution increment. Discharge of partially or non treated sewage in the water body has made it very polluted. High nutrient discharges from rivers could strengthen large-scale hypoxia; atmospheric transport of nutrients is inherently transboundary. Differences between countries regarding regulation and enforcement of shipping discharges may drive discharges across boundaries; tar balls are transported long distances. POPs/PTSs and mercury, counting organo-mercury, undergo long-range transport. Sedimentation and most heavy metal contamination tend to be contained and lack a strong transboundary dimension. (BOBLME TDA). Increasing nutrient inputs from rivers have the possible to lead to inner-shelf hypoxic zones near rivers which could expand or be carried across borders, or adversely affect transboundary fish stocks. Increasing river and atmospheric nutrient inputs could also intensify the natural oxygen minimum zone in deeper waters offshore, potentially leading to increasing incursions of hypoxic deep water onto the shelf. An increase in nutrients is also resulting in harmful algal blooms (HABs), also known as red tides. Atmospheric inputs ensuing from long-range transport are inherently transboundary, as are shipping and linked sea-based discharges of oil. Disparities between countries in the regulation and enforcement of operational discharges could be acting to drive such discharges from one country to another. For example, in Bangladesh, discharges of oil ballast water are unregulated (Hossain, et al., 2003). Residual oil in the form of tar balls is known to be transported long distances across national boundaries

5. Reasons for SAP

1. The pressure on marine resources is reaching critical levels
2. There is a need to take action to meet global expectations
3. Sustainable development requires a well constructed and agreed plan

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4. The SAP will provide an engagement and coordination mechanism for countries and their agencies
5. Business, as usual, is not an option

Table 2: SAP objectives and Targets of BOBLME project

THEMES	OBJECTIVES	TARGETS
Marine living resources	1. Restore fisheries resources that are degraded 2. Restore and maintain species composition 3. Reduce the proportion of juvenile fish caught and/ or retained 4. Restore biodiversity status of 1980 by 2025	Abundance and Biomass increase by 5%(2025) Decreased fishing in degraded fisheries by 10% and by 20% in the IUU region Increase tropical level catch by 5% and increase in biomass of tropical species by 2025. Decrease in juvenile fish catch by 10% and 255 of commercially juvenile ones. Decrease destructive fishing and fishing of juvenile ones by 20%. Enhancement in species richness in selected ecosystems and eliminating destructive fishing gear and practices. Decrease catch of endangered and vulnerable species by 50%
Critical habitats	1. Protect, manage and restore mangrove habitats in order to increase mangrove coverage and improve biodiversity of mangrove habitats 2. Restore, protect and sustainably manage existing coral reef ecosystems, habitats and associated biodiversity, and prevent land and marine-based sources of pollution and destructive activities 3. Protect and manage sea grass habitats and associated biodiversity (in order to increase/maintain their extent and biodiversity)	20-255 Mangrove area restored by 2050. And 50% under conservation management. More than 10% original diversity restored. By 2025,10% of Mangrove area restored, under conservation management and original diversity restored. Sustainable management of 10% coral reefs by 2050 and 5% by 2025.Sea grass managed by 15%
Water quality	1. Reduce or minimize the discharge of untreated sewage and waste water into river, coastal and marine waters 2. Reduce and minimize solid waste and marine litter in coastal and marine waters 3. Reduce and control nutrient loading in coastal waters	Increase by 5% in urban and coastal town connections to municipal or onsite sewage treatment. 100% effluent discharged from sewage treatment to meet national waste water quality standards. 5% reduction in solid waste, plastic and e-waste and 105 increase in municipal waste collection Improvement in nutrient efficiency at source, 50% nitrate reduction and phosphates from water water.100% sludge recovered and reused by 2025.
Social and economic considerations	1. Reduce vulnerability to natural hazards, climate variability and climate change, and increase climate resilience 2. Improve the living and working conditions of coastal fishing communities 3. Empower coastal people to participate in and benefit from sustainable development practices	Coastal communities involved in climate change adaption programmes by 30%, climate change adaption information disseminated to communities of another20% of coastlines. Including Disaster Risk management and climate change adaption in Regional and Sub-regional plans. Improving working conditions of vulnerable groups Coastal communities involved by 30% in improving living and working conditions.

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Figure 5: Bay of Bengal

VIII. CONCLUSION

The large marine ecosystem is facing a huge threat. There are many underlying issues beyond bullet points,. disposing of sewage waste, treated and untreated in ocean bodies, overfishing, oil spills, climate shifts, and eutrophication are just a few problems of many. More awareness is required for these things on many fronts. The government needs to invest in its marine ecosystem to protect its resources and endangered species. The global environmental facility was established in the Rio Earth Summit to tackle environmental pressing problems. GEF has collaborated with 170 countries on various projects; it provides funding sources to the countries as well. There are 66 large marine ecosystems around the world and due to human activities, most of them are under threat. GEF has worked on many projects similar to the Yellow Sea and Bay of Bengal with the motive of ecosystem management and restoration. Their approach is to ensure that countries are aware of the problems and can join hands to work for it.

The whole process is divided into two categories, transboundary diagnostic analysis, and strategic analysis program. This approach helps the countries to identify the underlying issues and find a long-lasting solution. The GEF driven projects are mostly in the authority of countries but with the results from TDA/SAP approach, it is the best way to ensure that the approach is flexible enough to include necessary changes later. It's mostly in the country's command to ensure that all the protocols and discussed points are taken care of and there is high involvement of authorities. The awareness programs need to be organized to ensure that citizens and officials are aware of the situation. Sometimes it might take a considerable amount of time like in the case of the Bay of Bengal, the world's largest bay but the project has many phases and includes eight countries. There is a lot to consider apart from the environment when it comes to a large marine ecosystem. The political ties and connection also play a rule, many communities' lives are dependent on fishing, and when making a decision such things need to be kept in mind as well.

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