

CONCERNS AND CHALLENGES IN HARNESSING OCEAN RESOURCES AND THE WAY FORWARD

INTRODUCTION

1. The ocean provides food in the form of fish and shellfish, a vast quantity of which is caught every year. It is used for transportation—both travel and shipping. It provides a treasured source of recreation for humans. It is mined for minerals and drilled for crude oil and gas for fuel. The ocean plays a critical role in removing carbon from the atmosphere and providing oxygen and thus regulates the climate. It is an important source of biomedical organisms with enormous potential for fighting disease.

2. Humans have been making good use of the oceans for all kinds of possible purposes since time immemorial. The oceans have been a key factor in the development of civilization. The earliest sea worthy boat probably used for fishing and coastal trade might have been developed 45,000 year ago while a representation of a sailing ship appears on a painted disc found in Kuwait that is believed to be from the late 5th millennium BC¹. The history of fishing activities can be traced from the 2,300 BC Sumerian fishing fleets. Interestingly, the history of warfare at sea is also pretty old with it probably starting around sometime near 3,000 years ago with the first recorded one fought in about 1210 BC² when the *King Suppiluliuma II* of the Hittites defeated and burned at sea a fleet from Cyprus.

3. With the progress of human civilisation and notably advent of modern tools and techniques, the world, especially the developed world, now has the ability to exploit the oceans bounty in a manner that might probably be not sustainable. However, sensible governments and people are voicing concern that oceanic resources are not unlimited though at least some of it is yet to be, or to word this more appropriately '*could not be*', tapped.

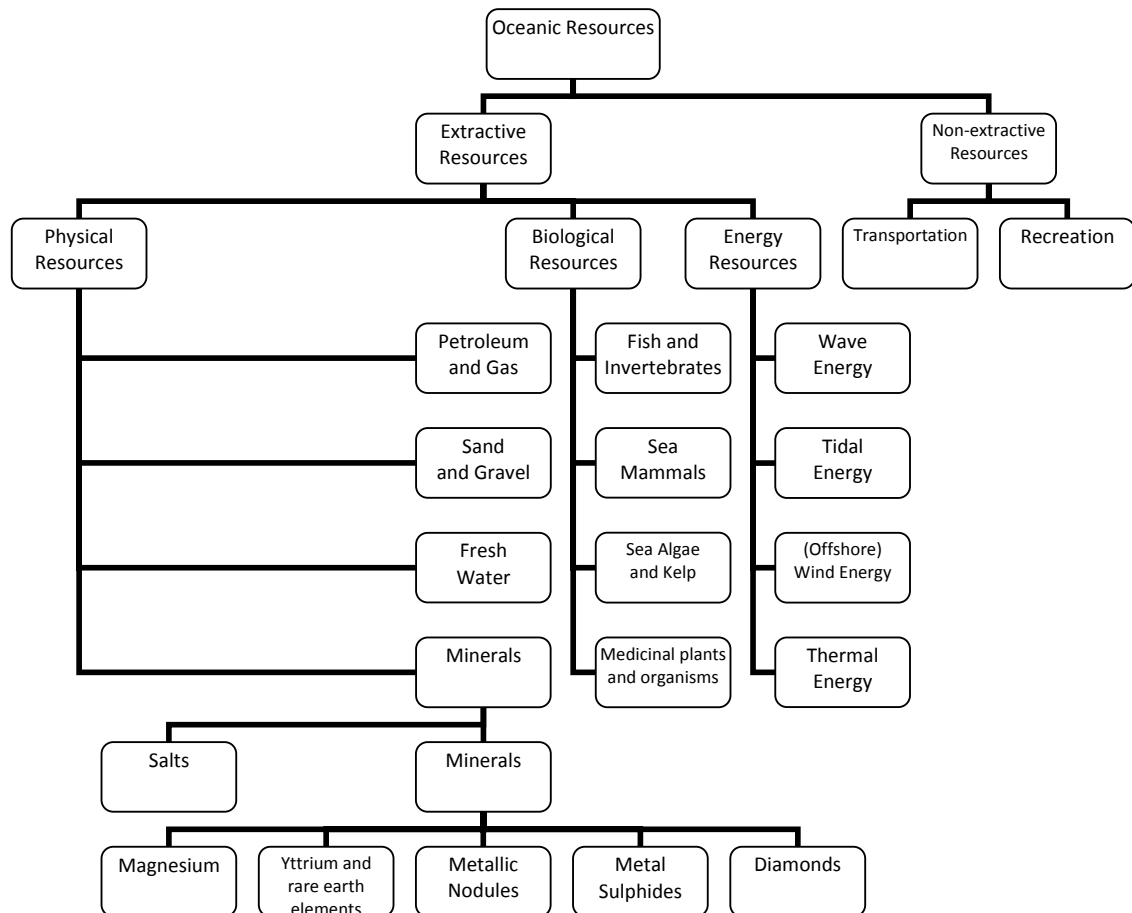
¹ *Maritime history*, online document, 2012, <http://en.wikipedia.org/wiki/Maritime_history>, accessed 29 Oct 2012.

² *Naval warfare*, online document, 2012, <http://en.wikipedia.org/wiki/Sea_warfare>, accessed 29 Oct 2012.

4. To better understand why we must keep the ocean healthy for future generations, the relevant aspects need to be discussed and sorted out. This is the job of every coastal nation in smaller sense; and in broader sense for every nation who uses the sea for transportation of goods or extraction of resources. In this paper resources in the world's oceans will be discussed in brief. While doing so, "not so frequently spoken" resources will be a little more elaborated. This will be followed by the concerns like current problems of level of extraction, methods, availability of technology, prospect, sustainability, etc for each type of resource. This part will also include additional concerns, like effect of sea level rise due to global warming, overlapping maritime boundary claims by littoral states, etc. The challenges will include discussions on ways and means to mitigate the concerns while pursuing the objective of sustainable extraction of oceanic resources. The last part of the paper will be on measures to way forward where some options that may be pursued will be suggested along with a number of practical physical means.

RESOURCES IN THE OCEAN

5. Oceanic resources can be broadly classified as shown below:



Transportation

6. The oceans provide the cheapest mode of transportation of goods and cargo worldwide. Tankers, bulk carriers and container ships are the most important means of transportation of our time. Each year they carry billions of tonnes of goods along a few principal trade routes but the single most important mode of carrying cargo now is containerization.

7. Modern ships are large (*TI Class* super tankers at 441,585 tonne; though not as large like the now disposed of 657,019 tonne *Seawise Giant*), fast (average 15knots; the 15,000 TEU *Maersk E Class* container ships will make 31knots cruise speed), and highly specialized to carry principally oil, containers, and dry cargo. The global merchant fleet now has a capacity of 1,192 million dwt of total 53,005 ships (estimated in Jul 2009).

Recreational Uses of the Oceans

8. Every year millions of visitors worldwide visit ocean coasts for purposes like simple visits to activities like surfing, sailing, recreational diving fishing, etc. Others take to the sea onboard cruise ships or visit aquariums, nautical museums, and seaside communities to learn about the oceans and their history. The money they spend in doing so generates a large number of jobs in the destinations and in some cases can also be the principal source of income for the local economy.

Petroleum and Gas

9. It is interesting to note that around 30% of the world's energy needs is met by sea based oil and gas rigs, which are usually found together. Technological progress is enabling production from offshore oil and gas fields at increasingly ambitious 3,000m depths. Investment in offshore production is running at around \$100 billion per year, accounting for one-fifth of all investment in oil exploration and development worldwide. In 2010, offshore production regions represented nearly 20% of known remaining global oil and 25% of known gas reserves. In 2010, the offshore industry produced 30% of global production totalling to about 23.6 million barrels per day and 27% of global gas production amounting to 2.4 billion m³ per day³.

³ *Panorama 2012*, online document, 2012, <<http://www.ifpenergiesnouvelles.fr/content/download/71890/1531277/file/D%C3%A9fis%20et%20enjeux%20des%20hydrocarbures%20offshore.pdf>>, accessed on 03 Nov 2012.

Sand and Gravel

10. Marine sand and gravel extraction is the second most income earning physical resource after oil and gas. This sand and gravel is used for various applications in construction and landfills; the biggest ongoing project being the Palm Islands in the UAE. Another item is Argonite which is naturally occurring rich calcium carbonate commercially extracted in the Bahamas for production of cement and use as soil neutraliser.

Freshwater

11. The oceans are the largest source of freshwater; this is especially important for regions where freshwater reservoirs do not occur naturally and rain is also scarce. Freshwater is obtained from the oceans through distillation, freeze separation, and reverse osmosis. Being the simplest and also the least expensive, the most popular method to obtain freshwater from the seas is reverse osmosis.

Salt and Magnesium

12. Magnesium is usually found dissolved in seawater, and many sources of magnesium are actually mineral deposits left behind by oceans. It is worth noting that approx one-third of the world's table salt comes from the sea.

Minerals

13. Humans began to mine the ocean floor for diamonds, gold, silver, metal ores like manganese nodules and gravel mines in the 1950s. Mining of manganese nodules containing nickel, copper and cobalt began in the 1960s after it was discovered that Papua New Guinea was one of the few places where nodules were located in shallow waters.

14. Past explorations indicate that the ocean floors contain huge amounts of precious minerals like gold, copper, and cobalt. Other potential deposits poly-metallic sulphides, ferro-manganese crusts, and rare earth elements.

15. Poly-metallic nodules or ferro-manganese nodules became the first discoveries to generate considerable interest in mining the oceans. The cobalt-rich ferro-manganese crust contain mainly cobalt but also iron, manganese, nickel, platinum and other metals. Recent studies have shown large potentials of rare earths and yttrium⁴ to be found in sea-floor sediments (mud).

Renewable Energy from the Ocean

16. Almost 90% of global wind energy is contained in the turbulence above the world's oceans. Wind, waves and currents together contain 300 times more energy than humans are currently consuming. For a long time, this abundance went untapped. It is only in recent years that there have been serious attempts to harness this energy.

17. Among the developments to harness renewable resources for energy, that on wind energy is currently at the most advanced stage of development with signs of a promising future. Experts estimate that wind energy plants alone in Europe will supply about 340 TW-hr a year by 2015. The global technical potential of wave energy is estimated at 11,400 TW-hr per year.

18. It has been estimated that ocean current power stations and tidal power plants together could harness several 100 TW-hr of electricity per year worldwide. Ocean thermal energy conversion has the potential to harness several 1000 TW-hr of electric power each year. Unlike wind and wave energy, this form of electricity production is not subject to fluctuating weather conditions. Sustainable

⁴ Yttrium (Y, atomic number 39) is a *rare earth element* with a silvery-metallic transition metal chemically similar to the lanthanides. It is a soft, silver-metallic, lustrous and highly crystalline metal used for different industrial and medical applications.

global production capacity of osmotic power could in future amount to 2,000 TW-hr annually.

Biological Resources

19. Fish and other invertebrates like shell fish (anything from clams, oysters, lobster, shrimp) and crustaceans are an important source of food for people and livelihood as well. The estimated annual landed value of fish globally is around US\$90 billion.

20. The next animal resource extraction business after fishing, though not as glamorous as it once used to be, is whaling. Commercial whaling was banned in 1985 though it still continues in limited numbers. Commercial culling of seals and sea otter for meat and fur and to regulate their stock to sustainable numbers is also at times allowed though under tighter regulations and more rigorous watch than whaling.

21. Sea algae or more commonly seaweeds are harvested from the wild and also farmed for food and food additives, chemicals, medicinal and herbal extracts, hair care, fertiliser, beach landfills, and other industrial purposes. Algae can be commercially farmed and harvested without harming naturally occurring areas.

22. The oceanic eco-system holds tremendous potential for human health benefits. Over 15,000 natural products have so far been discovered. The use of such compounds are varied but the most exciting potentials are in inhibition of cancer cell growth, bone grafting, and use as anti-inflammatory agents⁵. By 2005, over 28 marine natural products were being tested in human clinical trials while many more were in various stages of development.

⁵ Maxwell, Sarah, *Medicines from the Deep*, web document, 2005, <<http://www.ourfutureplanet.org/newsletters/resources/Ecosystems/MEDICINES%20FROM%20THE%20DEEP%20The%20Importance%20of%20Protecting%20the%20High%20Seas%20from%20Bottom%20Trawling.pdf>>, accessed 03 Nov 2012.

CONCERNS IN HARNESSING OCEAN RESOURCES

Marine Pollution

23. Eutrophication⁶ may cause unusual proliferation of certain plant forms where entire habitats may be temporarily altered. The other major marine pollutant is sewage which is almost always contaminated with various industrial wastes and other toxic materials added from surface water drainage. Sewage might also contain hazardous viral and microbial particles. Some additional pollutants like Poly-Fluorinated Carbon (PFC) and Poly-Chlorinated Biphenyls (PCB) could only be identified after adverse effects in marine life forms were noticed.

24. Another form of marine pollution is the 'biological pollution' by invasive alien marine and land species (aquatic nuisance species) inadvertently introduced to a region by shipping principally through ballast waters (and accompanying sediments) but at times also along with cargo. Such alien species may displace native species by degrading/altering native habitats, spread diseases, and disrupt human social and economic activities that depend on water resources. It is estimated that up to 10,000 alien species of plants and animals are inadvertently transported per day in ships around the world⁷. Ballast water and sediment management and treatment plants are an answer but a complete solution is still not available.

Tourism

25. Tourism industry, if left not so regulated and/or managed, usually adversely affects local ecosystems. Tourists often may have little regard for local people and environment. Garbage and sewage generated by visitors can add to the

⁶ Eutrophication of a marine area happens as rivers transport run offs generated by excessive use of agricultural nutrients and untreated wastewater from inland.

⁷ *Sustainable Ballast water Management Plan*, online document, 2012, <<http://www.bawapla.com/objectives.htm>>, accessed 03 Nov 2012.

already existing waste and much of it often ends up dumped in the ocean in untreated form. Other problems with tourism include the over exploitation of local seafood, the destruction of local marine habitats through careless scuba diving or snorkelling and the dropping of anchors on underwater features.

Marine Litter

26. A large amount of plastic and nylon litter is discarded in the sea every year. As most of such mass is of materials that little decompose naturally the amount of such debris in the oceans is steadily increasing with fatal consequences for sea birds and other marine creatures. Derelict net segments from torn or old gear deliberately dumped at sea further add up to the problem.

Oil Pollution

27. Oil pollution is one of the most visible forms of damage to the marine environment. Oil enters the seas not only as a result of catastrophic tanker or oil rig disasters, but primarily from other sources like leaks during oil extraction, illegal tank-cleaning operations at sea, and discreet discharges into the rivers. The aftermath of major oil pollution accidents and the associated cost of cleanup operations can be huge.

Ocean Acidification

28. The burning of fossil fuel carbon leads to an increase in atmospheric CO₂. A part of this is absorbed in the ocean with a reduction in its alkalinity. Presence of ever increasing levels of CO₂ in the atmosphere means that this will be even worse in the future. This may be serious, particularly for organisms which make their shells from calcium carbonate.

Mineral Extraction

29. Pursuit of exciting potential for extracting metallic minerals from the deep sea as predicted has shown that the occurrence and quality of such resources is not nearly as rich as originally claimed.

30. Dredging the ocean for commercial mining can be devastating to the natural ecosystems as it pulls up the ocean floor resulting in widespread destruction of marine animal habitats, as well as displacing resident fishes and invertebrates. The rising column of sediment thus stirred blocks access to sunlight and interferes with photosynthetic processes of phytoplankton and other marine life and introduces heavy metals into the food chain. This can bring devastating consequences for communities that depend on the sea as the only means of livelihood. Strict sustainable management of mining in the oceans is so essential for reconciling economic interests with the environmental impact.

31. Extraction of most marine minerals proved to be difficult as poly-metallic nodules are spread out over the ocean floor at about 4,500-5,500m depth and ferro-manganese crusts are often situated in areas with steep angles and rugged bottom making excavation particularly challenging. Attempts to harvest so called manganese nodules were made in the 1970s but had to be abandoned after meagre results.

Issues with Renewable Energy Sources

32. Renewable energy resources from the sea are believed to have the potential to meet the energy requirements of the entire world. But, only a small proportion of their potential can now be utilised as many marine regions are too deep to be developed and prohibitively costly to be connected to the national electric grids. In some places many potential locations can not be used because these are either reserved for fishing or shipping, or are protected areas. Additionally, extraction of wind and wave power can be highly dependent on

weather and season. Some recent innovations like the Osmotic Power technology is still in its infancy.

Bio-Medicine

33. The marine flora and fauna is often devastated due to human activities like trolling, dredging, and wasteful and damaging fishing practices. This is particularly harmful in benthic layers as animals and organism that live in these areas grow and reproduce at comparatively slower rates. So, once displaced or destroyed they take a long time to regenerate to previous levels.

Climate Impacts

34. The ocean can hold and circulate more water, heat and CO₂ than the atmosphere. The ocean can make the atmosphere above it warmer while releasing its stored heat and delay the onset of regular seasons. The ever increasing levels of CO₂ in the atmosphere allow more heat to be stored in the ocean and thus influence the seasons more. Heat energy stored in the ocean in one season will affect the climate almost an entire season later. The many chemical cycles between the ocean and the atmospheric elements also influence the climate by controlling the amount of radiation released into eco-systems and environment.

35. It is an established fact that the we are now experiencing global warming caused by accumulation of excessive levels of heat trapping CO₂ from the burning of fossil fuels in our atmosphere. Records dating back 100 years indicate a rise in global mean sea level amounting to 2.5 to 5.0cm per every 25 years. Global average sea level rose at an average rate⁸ of around 1.7 ± 0.3 mm per year between 1950-2009 and at a satellite-measured average rate of about 3.3 ± 0.4 mm per year between 1993-2009.

⁸ *Current sea level rise*, online document, 2012, < http://en.wikipedia.org/wiki/Current_sea_level_rise>, accessed 06 Nov 2012.

36. Low-lying countries with increasing populations like Bangladesh, Myanmar and Egypt could see large parts of their surface areas vanish. Experts in Bangladesh estimate that a one-metre rise in sea levels would swamp 17% of the country's land. The Pacific islands such as Tuvalu and the Maldives would face complete destruction.

Shipping and Transport

37. In theory, shipping can have a low impact on the environment. However, ships and other watercraft with engines disturb the natural environment with loud noises, large waves, frequently striking and killing animals like manatees and dolphins. Serious problems may also be caused by accidents involving oils, wastes, and chemicals used and transported by the shipping with constant and inevitable air and water pollution occurring from propulsion engines.

38. The growth of maritime traffic volume has been experiencing a slow growth due to the ongoing global economic crisis. The growing threats of piracy and terrorism could also compromise shipping as the threat has led to higher costs such as increased insurance premiums. Fortunately, piracy is still a local problem in some of world shipping hotspots. Protection against terrorist attacks has to be more robust and may prove to be of appreciable cost.

Over Exploitation of Living Resources

39. Since the fishing fleets began to be mechanised in the late 19th Century, their numbers increased rapidly and in many cases over-exploitation of fish varieties occurred leading to reduced wild stocks and diminishing incomes for the fishing industry. Consequently, the resultant excessive fishing fleets with their high-tech gears and more efficient techniques engaged in a desperate competition over fish in less exploited fishing grounds overseas. With over fishing the food chain in the ocean eco-system is disturbed and about 25% of the planet's biological diversity is in danger of extinction within the next 30 years.

40. With such huge fishing capacity the global total catch has increased but has resulted in overfishing along with wasteful and destructive fishing practices that now threaten the lives of hundreds of millions of people dependent on fishing for food and livelihoods. They face depleted incomes, unfair and overmatched competition from distant water industrial fleets, and loss of access to traditional marine food supplies.

41. Many millions of animals other than fish are severely injured or killed each year through deadly interactions with fishing gear. Millions of turtles, sharks, dolphins, porpoises, and whales die each year in different nets intended for other fishes. An estimated 44,000 albatrosses are killed each year by tuna loglines.

42. One-quarter (25%) of all the fish pulled from the sea never make it to market. Almost 27 million tons of unwanted (by-catch) or excess fish catch (ie, more than what the boat is allowed to land per trip or in a season) are thrown back each year on average; this amount is more than half of all fish produced globally in a year from marine aquaculture.

43. Fish farming or aquaculture is also not always a healthy alternative as most fish farmed are carnivores and thus require other fish to be caught to be fed; up to two kg of fishmeal is necessary to produce each kg farmed fish. Fish farms also produce a lot of waste that is dumped in the sea. Farmed fish are raised in intensive farming where the number per square area is more than the wild. This makes these stocks more susceptible to diseases which in turn might be passed on to the wild stock.

Availability of Technology and Methods

44. Technology used for the research, exploration, and exploitation of oceanic resources is principally in the purview of a few developed world nations due to their traditional interest in matters relating to the sea, technological prowess, financial capability, and at times strategic requirement. The technology and

methods are too sophisticated to be obtainable or accessible by developing nations, and most probably may not be sustainable for long even if made accessible. This is particularly applicable for high-tech applications requiring complex and sophisticated systems that study, acquire, and analyse data on subjects of more recent interest from the ocean's depths.

CHALLENGES IN HARNESSING OCEAN RESOURCES

45. **Tourism.** A way of benefiting from tourism may be sustainable tourism like eco-friendly boating, whale and dolphin watching, snorkelling and scuba diving, fishing, and other forms of tourism, encompassing responsible use of natural resources for recreation which can actually promote conservation of the environment. Ecotourism and cultural tourism are a new trend that favours low impact tourism and fosters a respect for local cultures and ecosystems. However, such approaches require imposing limits on tourist numbers and their activities which might be eyed as a hindrance to economic development.

46. **Marine Litter.** The problem with marine litter is not something to go away easily as almost all of it is of materials that do not decay naturally. There is still no effective measure than physical removal which is way too costly and cumbersome due to the sheer size of the problem. The only viable option might be to live with the problem for the time being and motivate people to minimise and eventually stop altogether discarding things at sea.

47. **Oil Pollution.** Mandatory use of oily water separators onboard ships, designation of marine protected areas, increased controls with stiff penalties, double hull for tankers, etc are some of regulatory measures that are making a slow progress in minimising oil pollution at sea. Such measures and preparedness need considerable investment. So, regional approach may be a viable solution.

48. **Extraction of Minerals.** Mining and exploitation in the seas is still to deliver anything of significant worth. But, today's situation about deep sea mining is different as methods and technologies are more developed than ever and there is scope for a strong international legal understanding through UNCLOS.

49. **Renewable Energy for the Ocean.** Erection of plants to generate power from wind has been alleged to affect surrounding areas through presence of constant low frequency noise generated by the turbine fans. The adverse influence of wave and ocean current powered plants are yet to be known as these are yet to come in common or wide spread use. However, such allegations may be offset by erecting wind farms in sparingly populated with humans.

50. **Marine Bio-Medical Extracts.** Most marketed marine bio-medicinal products till date have come from the shallows and often tropical marine organisms. But increasing technological capability now allows scientific interest to be focused on the potentials found in the depths. Sensible and selective exploration of the depths in search of medicinal extracts might result in containing the damage to the animals and flora and fauna to as minimum as possible.

51. **Climate Impacts.** There is no answer to the problem of ocean impacting the regularity of the seasons by storing or discharging heat from the world's atmosphere. Another dimension of the problem that has started to be prominent is the sea level rise. The reasonable response is to adapt and prepare to face the calamities when those actually start happening. Physical flood protection barrier, coastal embankment, elevated construction (ie, leaving the ground floor vacant), floating structure, floodable development, coastal afforestation, gradual and managed retreat to higher grounds, etc are some of the measures that are expected to alleviate the problem.

52. **Shipping and Transport.** Shipping is now more regulated and watched activity than any time in the past; all measures aim at ensuring that shipping leaves as low an impact on the marine environment as possible. Tighter

regulations leading to safety of life at sea and respect for environment means occurrence of marine disasters leading to great loss of lives with damage to the surroundings is now a rarity. However, precautions to prevent accidents and preparedness to face it as that actually occurs shall continue to be an utmost requirement.

53. The threats of piracy and terrorism could be dealt with international consensus and a set of robust rules of engagement. While the waters where pirates are active can be patrolled by the navies, it is to be remembered that the pirates must come ashore. So, international consensus is required for a set of rules that allow top level perpetrators or masterminds of piratical acts to be investigated and prosecuted.

54. **Over Exploitation of Living Resources.** The underlying principle in exploitation of living resources may be to extract only up to that where the current stock remains viable for the future also, this might actually mean to fish less than you now can. Additionally, exploitation of such resources needs strict enforcement of physical measures like specifying the duration of harvesting season and maximum harvest limit for a particular species, placing limits on method, and type and number of gears, inclusion of exclusion gears to warn un-intended species, encourage minimising bycatch, etc. Creating awareness among the fishing community along with the need for self regulation may also be encouraged.

55. **Availability of Technology and Methods.** The oceans are often unforgiving and no easy place to work, let alone explore the depths for benefits. Such attempts will need technical prowess, financial capability, and political will much of which is not common in the developing world. Fortunately, at least some sophisticated technology and know how that used to be the exclusive purview of developed states is now available commercially. Availability of a lot of information floating in today's world of world wide web may also help.

56. **Overlapping Claims.** There are numerous examples of littoral states having claimed overlapping maritime boundaries. Oceans do not have lines to indicate which part belongs to which state, but an agreed demarcation between adjacent areas is a necessary pre-requisite for any exploration at sea. It is for the security of the investment and. Fortunately, the UNCLOS provides an agreed system of such delineation along with resolving of such disputes.

WAY FORWARD

57. **Management of Ocean Resources.** Any viable management regime for oceanic resources should ideally be targeted at striking a balance between sustainable economic growth with adequate conservation to achieve healthy marine resources and environment.

58. **Suggested Principles.** Suggested principles for the management of oceanic resources may be as below:

a. **Sustainability**, for which governments may formulate their ocean policy so designed that it meets the needs of the present generation by attaining a balance between social needs, economic opportunities and environmental stewardship without compromising the ability of future generations to meet their own such needs.

b. **Comprehensive Policy**, the ocean policy should recognise the inter-dependence and inter-relation between the oceans, land, and atmosphere. The policy should provide for inter-governmental collaborations, both at regional and international levels, for management of geographic areas based on ecosystem rather than political boundaries.

c. **Integrated Management**, so that government and stakeholders are encouraged towards good communication and informed decision-making process vital to sustainable use and development for different competing users of ocean resources while encouraging and supporting economic development.

d. **Conservation**, of coastal and marine ecosystems is essential to maintaining natural resources at sustainable levels for future generations by reversing the downward trend of biodiversity as far as possible.

e. **Knowledge Based Decisions**, the decisions and actions in pursuit of the ocean policy are to be based on proper and scientific understanding of the issues that affect the oceanic and coastal environments. Prior making such decisions, governments are to obtain and make good use of all available scientific data through appropriate means and methods.

f. **Adaptive Management**, wherein there will be a systematic approach to learn from the experiences of management actions with continuous adaptations for improved and effective management. This means that the policy guidelines will be flexible and adaptable in order to deal with emerging issues and new opportunities.

g. **Creating Public Awareness**, where governments may adopt appropriate means and methods to inform and educate their citizens about the importance of the oceans and coasts to earn support for policies and measures undertaken and to enable them to use the ocean and its resources responsibly.

59. **Some Practical Measures**. Having said about the suggested principles, governments may follow those with a set of practical measures like:

a. Industries that practice sustainable use of coastal and ocean resources may be patronised.

b. Development of sustainable coastal communities may be supported.

c. Marine and coastal ecosystem health may be managed by minimising or mitigating risks of irreversible environmental harm.

- d. Collaborating and consultation with other nations at regional and international levels may be necessary to better handle trans-border issues.
- e. In-country collaboration with industry sectors, NGOs, academicians, and the general public to find the best approach for coastal and ocean management may be pursued.
- f. Appropriate coastal preserves to protect endangered habitats and no-trawl zones to protect the benthic organisms may be established and maintained, if necessary.
- g. Regulatory measures, for extraction of biological resources, like -
 - limits on the amount of marine biological resources to be harvested per season;
 - establishment and enforcement of legal time period (season), areas, methods, and means of harvesting marine biological resources; and
 - encouragement for use of exclusion devices in nets and other gears to minimise the inadvertent catch of non-targeted species.

CONCLUSIONS

60. The oceans have been a key factor in the development of human civilization. The oceans provide a vast quantity of fish and shellfish every year. The oceans also provide the cheapest mode of transportation of goods and cargo worldwide. Every year millions of visitors worldwide visit ocean coasts for recreational and educational purposes. Marine sand and gravel extraction is the second most income earning physical resource after oil and gas. These have been discussed to explain why we must keep the ocean healthy for future generations.

61. Humans began to mine the ocean floor in the 1950s. Past explorations indicate that the ocean floors contain huge amounts of precious minerals. Poly-metallic nodules or ferro-manganese nodules became the first discoveries to generate considerable interest in mining the oceans. However, mining the oceans is yet to deliver anything significant.

Almost 90% of global wind energy is contained in the turbulence above the world's oceans. Wind, waves and currents together contain 300 times more energy than humans are currently consuming. The oceanic eco-system holds tremendous potential for human health benefits.

62. Concerns about marine resources include marine litter and oil pollution, which are reasons for some of the most visible forms of damage to the marine environment. Dredging the ocean for commercial mining can be devastating to the natural ecosystems as it pulls up the ocean floor resulting in widespread destruction of marine animal habitats, as well as displacing resident fishes and invertebrates. Strict sustainable management of mining in the oceans is so essential for reconciling economic interests with the environmental impact.

63. Global average sea level is now rising at an increased average rate. Low lying countries might face partial or total annihilation due to sea level rise caused by global warming. Experts in Bangladesh estimate that a one-metre rise in sea levels would swamp 17% of the country's land.

64. Over-exploitation of fish varieties occurred leading to reduced wild stocks and diminishing incomes for the fishing industry in many ocean areas. Many millions of animals other than fish are severely injured or killed each year through deadly interactions with fishing gear. One-quarter of all the fish pulled from the sea never make it to market. Fish farming or aquaculture is also not always a healthy alternative as most fish farmed are carnivores and thus require other fish to be caught to be fed.

65. Mandatory use of oily water separators onboard ships, designation of marine protected areas, increased controls with stiff penalties, double hull for tankers, etc are some of regulatory measures that are making a slow progress in minimising oil pollution at sea. Such measures and preparedness need considerable investment.

66. There is no answer to the problem of ocean impacting the regularity of the seasons by storing or discharging heat from the world's atmosphere. Another dimension of the problem that has started to be prominent is the sea level rise. There is no immediate cure for this, but some physical measures are available for mitigating its effects.

67. Any viable management regime for oceanic resources should ideally be targeted at striking a balance between sustainable growth with adequate conservation to ensure availability of healthy marine resources and environment for the future generations. A suggested framework for policy may be aimed at sustainability while be comprehensive and provide for integrated management aimed at conservation based on proper scientific knowledge to enable an adaptive management and creating awareness among the users and beneficiaries. The policies are to be augmented by a set of suggested physical measures.

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