

The Blue Economy

an emerging economy for coastal nations

A D Diwan ¹ and S N Harke ²

Mahatma Gandhi Mission's Institute of Biosciences and Technology, Aurangabad (Maharashtra) 431 003

Oceans cover 72% of the surface of our blue planet and constitute more than 95% of the biosphere. Life originated from the oceans and they continue to support entire biosphere by generating oxygen, absorbing carbon dioxide, recycling nutrients and regulating global climate and temperature. Oceans provide a substantial portion of the global population with food a livelihoods and are the means of transport for 80% of global trade. The marine and coastal environment also constitutes a key resource for the important global tourism industry; supporting all aspects of the tourism development cycle from infrastructure. The seabed currently provides 32% of the global supply of hydrocarbons with exploration expanding. Advancing technologies are opening new frontiers of marine resource development from bio-prospecting to the mining of seabed mineral resources. The sea also offers vast potential for renewable 'blue energy' production from wind, wave, tidal, thermal and biomass sources. Human development activities, however, have seriously taxed the resilience of the marine and coastal resource base.

Keywords: Biosphere, Blue Revolution, Coastal nations, Economy

WE are aware of Green Economy in the context of sustainable development and poverty eradication as one of the important tools available for achieving overall exponential growth. It is emphasised that Green Economy should contribute to eradicating poverty as well as sustained economic growth, enhancing social inclusion, improving human welfare and creating opportunities for employment and work for all, while maintaining the healthy functioning of the Earth's ecosystems (UNCSD 2012). The 'Rio +20' United Nations Conference on Sustainable Development, held in Rio de Janeiro, 20 to 22 June 2012, focused on the development and refinement of the policies and framework of the institutional set up for sustainable development and the advancement of the 'Green Economy' concept. While discussion, many coastal countries also emphasized their views to consider for the preparation of a

'Blue Economy' on priority basis. Earlier efforts were made to expand the Blue aspect of the Green Economy as embodied in the 'Green Economy in a Blue World'. Coastal and Island developing nations have remained at the forefront in advocating Blue Economy, recognizing that the oceans have a major role to play in humanity's future and that the blue economy offers an approach to sustainable development better suited to their circumstances, and challenges. The 'Blue Economy' has emerged as a term referring to a healthy ocean and supporting higher productivity. For centuries, marine resources have served the essential components of human life in many different ways by providing food, energy, biodiversity and recreation. Besides this, the oceans, are the lifelines which have the potential to absorb and regenerate many unwanted and wanted resources. All the coastal nations in the world are dependent

on oceans for fishing, minerals, oil and gas, rare earth metals, renewable energy and other living and non-living resources for earning livelihood, achieving holistic growth, empowering native coastal communities and attaining greater social and economic activities. In that context, the role of Blue Economy becomes vital in utilizing optimum and sustainable use of oceanic resources for growth and development. Since a large portion of marine resources is believed to have remained unexplored in different maritime countries, there is a widespread understanding that the future source of growth is probably dependent upon the efficient utilization of those rich ocean resources. Its importance is now realized prominently by many nations when there is unprecedented reduction in global output and employment opportunities affecting the livelihoods of millions of people. There is a major shift in the whole



Fig. 1 and 2. Coastal pollution due to urbanization and anthropogenic activities



Fig. 3. Small-scale entrepreneurship of the fisheries sector

development programmes of all these nations due to realization of the importance of ocean related economy. Even the biggest economies of the world such as the United States of America and China recognized the importance of enormous marine resources for economic growth, social development, restoration of environment, and protection and conservation of marine habitat. The contribution of Blue Economy to the growth of overall economy has been impressive for a number of countries in the recent past with signs of robust performance in the future.

The coastal pollution in most of the maritime states has adversely affected the coastal resources which in turn has created reverse impact on the livelihood and employment opportunities of the coastal communities. Besides, this has also resulted in damaging the living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities.

A thorough Understanding on health of the coastal waters through a systematic pollution monitoring programme is essential on regular basis. Earlier number of programmes were initiated to monitor the coastal belt pollution particularly in the metropolitan cities. Since then, now the number of agencies both private and public institutions are involved in continuously monitoring the status of the pollution in the coastal areas particularly in the urban cities. However, there are no studies on the catastrophic effect of pollution on the blue economy of the various maritime states.

Small-scale entrepreneurship of the fisheries sector

The development of the blue economy holds immense promise for the Indian Ocean region. In the exclusive economic zone of the Indian Ocean there are about 1,300 big- and small-islands. Many of these islands are barren lands without any habitations and no development has taken place in the past several years. All these islands are the great source to add to our blue economy in terms of developing tourist spots, in exploiting the unique resources specific to the islands biosphere and ecosystems, in generating employment opportunities for the coastal communities and also avenue for development of tourist allied industries. The Indian Ocean is the world's pre-eminent seaway for trade and commerce. It is also endowed with a wealth of natural resources, which are, as yet, largely untapped. The development of the Blue Economy in the Indian Ocean region is expected to yield a number of benefits, including: contributing to sustainable development and climate change mitigation, providing boost to coastal and national economies, generating new employment, skill sets and capacities, promoting entrepreneurship in new areas of economic activities, facilitating inter-connected in the regional economy, and utilizing the vast, untapped potential of the Indian ocean.

Indian Ocean Rim Association (IORA), an international organization consisting of coastal states bordering the Indian Ocean considered following some of the top priority areas useful for the development of the blue economy of any coastal country.

1. Fisheries and Aquaculture

2. Renewable Ocean Energy
3. Sea ports and Shipping
4. Seabed Exploration and Minerals
5. Marine Biotechnology, Research and Development
6. Tourism
7. Ocean Knowledge Clusters

The new emerging development shift/trend of the blue economy has a great potential for higher and faster GDP growth scale in the Indian Ocean Region. Blue growth focusing on the long-term sustainability of oceans has become a realistic policy frame within IORA during the last two years, since October, 2014. The Blue Economy advocates the same outcome as the Green Economy, namely improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. Oceans are essential to human life as they provide food security and income for millions of people and act as a highway to global trade. This century is known as the 'Maritime Century'. The upcoming new technologies are paving the way for human interaction with the oceans. They drive economic growth and bring as huge benefits to society. Approximately 350 million jobs are linked with oceans, international trade in fish products spans 85 Nations and involves an estimated US \$102 billion/year and about US \$9 billion is made in eco-tourism related to coral reefs. The ecological health and economic productivity of marine and coastal ecosystems can be increased by giving more emphasis on the areas like generating renewable energy from the seas and promoting eco-tourism, to sustainable fisheries and transport. At a global level the potential economic gains from

reducing fishing capacity to an optimal level and restoring fish stocks; currently 32% of the global stocks are estimated to be overexploited, depleted or recovering from depletion – is in US \$50 billion/year.

Key issues of the blue economy

The main key issues are food security, demand for protein, sustainable use of biodiversity, unsustainable fisheries, climate change and carbon footprint, coastal tourism, management of urbanization in the coastal states, emerging sea-borne international trade, health of the seas and oceans, governance and international cooperation, demand for alternative sources of energy, and marine biotechnology.

Conservation of the ocean resources and their judicious utilization on sustainable basis for the benefit of humanity are the key points for the well establishment of the blue economy concept. This is particularly true in developing countries where economies are more directly related to ocean resources. The ecosystem approach must underpin all aspects of the blue economy incorporating inter-relationships, knock-on effects, externalities and the true costs and benefits of activities in the natural blue capital.

Food security

In the context of the blue economy food security is closely related to the sustainable use of oceanic biodiversity particularly where it pertains to the exploitation of wild fisheries resources. More than 1 billion people in developing countries depend on seafood for their primary source of protein and in India around 14 million people whose livelihood is dependent on coastal and inland fisheries resources. Besides oceanic resources, aquaculture and sea farming activities offer huge potential for the provision of food and livelihoods with all social security to coastal communities. Sea farming and aquaculture under the Blue Economy will definitely support the value of the natural capital in its

Table 1. Classification of Blue Economy sectors and activities

Sectors	Activities
Fishing	Capture fishery, Aquaculture, seafood processing
Marine biotechnology	Pharmaceuticals, chemicals, seaweed harvesting, seaweed products, marine derived bio-products
Minerals	Oil and gas, deep-sea mining (exploration of rare earth metals, hydrocarbon,
Marine renewable energy	Offshore wind energy production, wave energy production, tidal energy production
Marine manufacturing	Boat manufacturing, sail making, net manufacturing, boat and ship repair, marine instrumentation, aquaculture technology, water construction, marine industrial engineering
Shipping, port and maritime logistics	Ship building and repairing, ship owners and operators, shipping agents and brokers, ship management, liner and port agents, port companies, ship suppliers, container shipping services, stevedores, roll-on roll-off operators, custom clearance, freight forwarders, safety and training
Marine tourism and leisure	Sea angling from boats, sea angling from the shore, sailing at sea, boating at sea, water skiing, jet skiing, surfing, sail boarding, sea kayaking, scuba diving, swimming in the sea, bird watching in coastal areas, whale/dolphin watching, visiting coastal natural reserves, trips to the beach, seaside and islands
Marine construction	Marine construction and engineering
Marine commerce	Marine financial services, marine legal services, marine insurance, ship finance and related services, charterers, media and publishing
Marine ICT	Marine engineering consultancy, meteorological consultancy, environmental consultancy, hydro-survey consultancy, project management consultancy, ICT solutions, geo-informatics services, yacht design, submarine telecom
Education and research	Education and training, R&D

Sources: Compiled from Morrissey et al. (2010), EIU (2015a), Government of Ireland (2012) and Marine Institute (2005)

development, respecting ecological parameters throughout the cycle of production, creating sustainable resources, decent employment avenues and offering high value commodities for export. The fisheries sector including aquaculture and mariculture also contributes sizeable cheap and quality proteins, fats and calories supply which supports food security situation in almost all coastal countries. Besides conventional measures of addressing food insecurity, blue economy offers ample opportunities to meet the growing demand for healthy and safe food by enhancing marine fishing. A good number of finfish and shellfish varieties in raw as well as processed forms are used as seafood worldwide. Fishing areas in the Indian Ocean region represent a rich endowment of fishery resources. Persistence in the decline of catch fish was a major concern for the world economy including India. However, the biological stocks of many of those species are depleting due to overfishing and illegal, unreported

and unregulated fishing. Since capture fisheries is either getting stagnated or depleting, the dependence on sea farming/mariculture for fish supply has grown significantly in the recent years.

Demand for protein

Less attention was paid so far to fish as an important agricultural commodity or food security and nutrition purpose in most of the countries. Fisheries sector provides more than 4.5 billion consumers with at least 1% of their average per caput intake of animal protein. Fish is a delicious and nutritious food containing high amount of good quality of protein, rich in numerous micronutrients that are often missing in diets, particularly those of the poor.

The presence of essential nutrients such as iodine, vitamin B₁₂ and D, the long-chain fatty acids, eicosapentaenoic and docosahexaenoic omega-3 fatty acids, and fish's very rich content in calcium (Ca), iron (Fe), zinc (Zn) and vitamin A, is

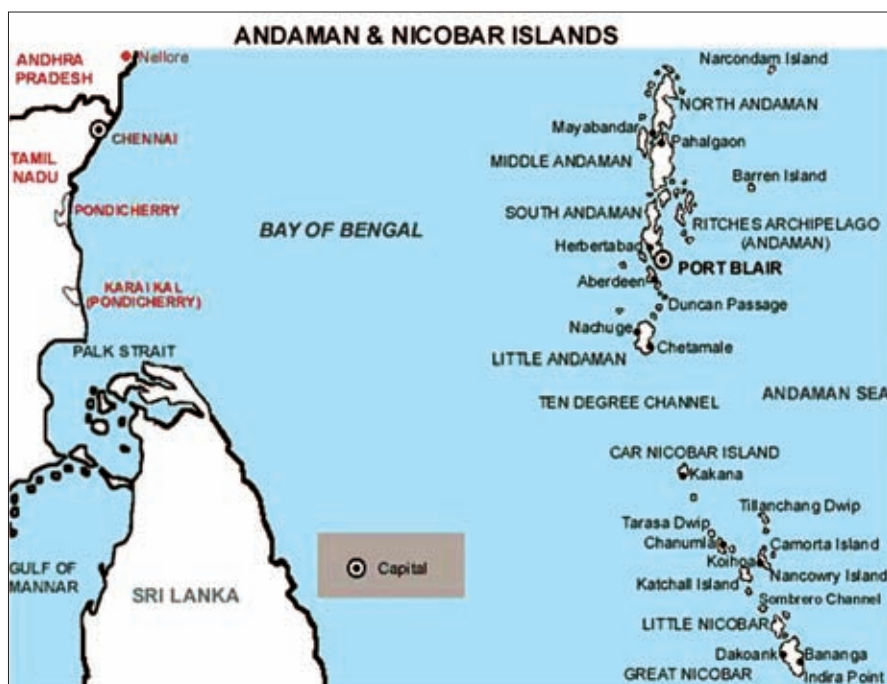


Fig. 4. Some of the islands of the Indian continent

already well documented in the literature.

The capture fisheries and aquaculture provide 3.0 billion people with almost 20% of their average per caput intake of animal protein, and a further 1.3 billion people with about 15% of their per caput intake. This share can exceed 50% in some countries. In West African coastal countries for example, where fisheries have historically been a central element in local economies, the proportion of total dietary protein from fish is remarkably high. Likewise, in Asia, where fisheries are extremely important and fish farming has developed rapidly over the last 30 years: total dietary protein from fish is between 50 and 60% in Cambodia, Bangladesh, Indonesia and Sri Lanka. Fish provides a similarly significant proportion of protein in the human diets in most small island states. The sustainability of fisheries in their environmental and natural resource dimensions is therefore recognized to be indispensable for food security and nutrition.

Sustainable use of biodiversity

In recent past many marine and coastal ecosystems were degraded to a large extent due to number of anthropogenic activities impacting upon the provision of services and livelihoods. There are reports that

approximately 20% of the world's coral reefs were lost and another 20% degraded and on the verge of getting eroded. Mangroves were reduced to 30 to 50% of their historical cover and it is estimated that 29% of seagrass habitats have disappeared since the late eighteen hundreds. Therefore, an ecosystem approach is required which helps in restoration of biodiversity and renewable resources, and proper management of resource extraction. In fisheries sector for example, the contribution of the harvest sector of the world's marine fisheries to the global economy is substantially smaller than it could be. The lost economic benefits are estimated to be on the order of US \$50 billion/year. Over the past three decades, this cumulative global loss of potential economic benefits is on the order of US \$2 trillion. By improving governance of marine fisheries, one could capture a substantial part of this US \$50 billion annual economic loss. The 'sunken billions' is a conservative estimate of this loss. The estimate excludes consideration of losses to recreational fisheries and to marine tourism and losses attributable to illegal fishing are not included. Through comprehensive reform, the fisheries sector could become a basis for economic growth and the creation of alternative livelihoods in many countries. The

Table 2. World per caput meat and fish food supply (kg/caput/year) 1969–2009

Types of meat	1969	1979	1989	1999	2009
Pig	9.4	11.5	13.1	15.1	15.8
Meat	25.2%	27.7%	28.2%	28.1%	26.3%
Poultry	3.8	5.6	7.3	10.7	13.6
Meat	10.2%	13.5%	15.7%	19.9%	22.7%
Capture	10	10.4	11	10.5	10
Fisheries	26.8	25.1	23.7	19.6	16.7
Aqua-culture	0.7	1.0	2.4	5.1	8.2
Capture	1.9	2.4	5.2	9.5	13.7
Fisheries	10.7	11.4	13.4	15.6	18.2
Fisheries	28.7	27.5	28.8	29.1	33.3
Total	37.3	41.5	46.5	53.7	60

Figures in per cent are the respective contribution of each sector to the total figure
Source: FAO Stats

estimate also excludes consideration of the economic contribution of dependent activities such as fish processing, distribution, and consumption. It excludes the value of biodiversity losses and any compromise to the ocean carbon (C) cycle. These exclusions suggested that the losses to the global economy from unsustainable exploitation of living marine resources substantially exceed more than US \$50 billion/year. For over three decades, the world's marine fishstocks have come under increasing pressure from fishing, from loss of habitats, and from pollution. Rising sea temperatures and the increasing acidity of the oceans are placing further stress on already stressed ecosystems. Illegal fishing and unreported catches undermine fishery science, while subsidies continue to support unsustainable fishing practices. As far as India is concerned, though there is considerable improvement in marine capture fisheries production in recent years, however, for the past number of years the same was stagnated even after increasing the catch efforts. The potential estimates of marine fish production from the capture fisheries was predicted as 4.41 mm tonne and at present the production showed to the tune of 3.6 mm tonne. Due to unscientific management of exploitation marine fishery resources, ill-legal fishing practices, severe coastal pollution is in some of the maritime states and other anthropogenic activities, number of

fishery resources either they are depleting or getting vanished. This will have severe impact on sustainability of the fishery resources and related biodiversity.

Unsustainable fisheries

According to the FAO report the proportion of marine fish stocks estimated to be underexploited or moderately exploited declined from 40% in the mid-1970s to 15% in 2008, and the proportion of overexploited, depleted or recovering stocks, increased from 10% in 1974 to 32% in 2008. Globally 350 million jobs are linked to marine fisheries, with 90% of fishers living in developing countries. The value of fish traded by developing countries is estimated at US\$ 25 billion making it their largest single trade item. Global catch rose from 4 million tonne in 1900 to 86.7 million tonne in 2000 but has stagnated subsequently. In 2009 marine capture production was 79 million tonne. Overall catch risks decline with 75% of stocks fully exploited or depleted. Human activity has directly reduced ocean productivity, additional deficits may be due to climate change increasing ocean stratification and reducing nutrient mixing in the open seas. It is estimated that US \$50 billion/annum is lost to overfishing and could be progressively recovered through stock restoration. The implementation of sound management measures bring the promise of increased sustainable catches, lower energy utilization and costs and thereby securing livelihoods and enhancing food security.

Aquaculture is the fastest growing food sector now providing 47% of the fish for human consumption globally. The last three decades showed massive expansion in aquaculture operations raising concerns of environmental damage and unsustainable development models. Brackishwater aquaculture sites have often been constructed out of important natural coastal habitats with rapid expansion. Aquaculture with artificial feed, if not managed properly, can impact biodiversity and ecosystem functions through excessive nutrient release, chemical pollution and the escape of farmed

species and diseases into the natural environment. In India huge losses were reported in the shrimp industry due to outbreak of viral and bacterial diseases. There are several factors involved in the outbreak of diseases including not observing GMP at the farm level, contamination of feed, use of excess feed and antibiotics, bad water quality etc. Therefore, it is essential that integrated ecosystem approaches are necessary while exploitation of fishery resources from the wild and also from aquaculture system-based on the latest scientific information and technologies.

Climate change and carbon footprint

The effects related to climate change involving oceans, coasts and freshwater ecosystems, are bound to affect fisheries and habitats together with the composition and production of the fishery resources and will have major impacts on aquaculture productivity and security. Climate change imperils the structure and function of already stressed coastal aquatic ecosystems. Estuaries, coral reefs, mangroves and sea grass beds are critical for production of wild fish. In freshwater systems, ecosystem health and productivity is linked to water quality and flow, and the health of wetlands. Small wild fish are sensitive to changes in ocean conditions. They are found in schools in the ocean and are also processed into fish-meal used to feed other fish as well as poultry and pigs. Though precise consequences cannot yet be forecast, climate change is likely to affect fisheries and aquaculture, their dependent communities and related economic activities. Fishers, fish farmers and coastal inhabitants will bear the full force of these impacts through less stable livelihoods, changes in the availability and quality of fish for food, and rising risks to their health, safety and homes. Many fisheries-dependent communities already live a precarious and vulnerable existence because of poverty, lack of social services and essential infrastructure. The fragility of these communities is further undermined by overexploited fishery resources and degraded ecosystems. Recently it has been reported that the

Gulf of Oman turns green twice a year, when an algal bloom the size of Mexico spreads across the Arabian sea all the way to India. Scientists who study the algae say the microscopic organisms are thriving in new conditions brought about by climate change, and displacing the zooplankton that underpin the local food chain, threatening the entire marine ecosystem. It is well known that algae can paralyse fish, clog their gills, and absorb oxygen to suffocate them. Whales, turtle, dolphins and manatees have died, poisoned by algal toxins in the Atlantic and Pacific oceans. The implications of climate change for food security and livelihoods in small island states and many developing countries are profound. Sea level rise and change in ecosystem status due to changing temperatures, from coral bleaching to impacts upon migration patterns were reported at length earlier. Relatively new issues are now coming up like ocean acidification and blue carbon.

Oceans are estimated to have absorbed approximately 25% of anthropogenic carbon dioxide (CO₂) since the commencement of the industrial revolution resulting in a 26% increase in the acidity of the ocean. The ocean acidification is known to have a significant impact as many organisms show adverse effects, such as reduced ability to form and maintain shells and skeletons, as well as reduced survival, growth, abundance and larval development. Acidification will also affect carbon accretion in coral reef building organisms causing net decreases in global coral reef coverage and associated species. Projections suggest that pH for the more vulnerable ocean regions could reach the aragonite tipping point within decades changing the very chemistry of ecosystems with potentially disastrous effects. As ocean acidity increases, its capacity to absorb carbon dioxide (CO₂) from the atmosphere decreases, thereby reducing the ocean's capacity to moderate climate change. At present there is no mechanism to address this issue at the international level.

Several important coastal habitats

such as mangroves, salt marshes and sea grasses areas were found to fix carbon at a higher rate per unit area than land-based systems and be more effective at the long-term sequestration of carbon (C) than terrestrial forest ecosystems. It is reported that mangroves were reduced from 30 to 50% of their historical cover and 29% of seagrass habitats are estimated to have been lost in the last 150 years. This reduction may be due to various factors and human interference. This carbon sequestration role re-emphasizes the importance of maintaining, and rehabilitating, such ecosystems as an opportunity for ecosystem climate mitigation and to also including them in carbon trading mechanisms. The blue economy approach will set in place the policies, legislation, infrastructure and incentives to facilitate the transition to a low carbon (C) economy utilizing all the tools at its disposal including the oceans' enormous potential for renewable energy (wind, wave, tidal, thermal and biomass) generation.

Coastal tourism

Many coastal communities depend on healthy coastal ecosystems and clean coastal waters for their survival. Yet rapidly growing coastal populations, increasing numbers of visitors, and unsustainable coastal development are degrading the water quality and destroying the habitats that are the main attractions of coastal areas. Although tourism and recreation-related development are major factors shaping the use and management of ocean and coastal resources, this sector has not been regarded as requiring policy, management, planning, and resources. The coastal nations and their respective governments can help tribes and states, which have key roles in managing coastal tourism, achieve their goals of protecting vital coastal ecosystems while promoting economic growth and economic stability. Published data indicated that international tourist arrivals increased by 4% to 1.035 billion in 2012, generating US\$ 1.3 trillion in export earnings. Tourism brings challenges



Algal bloom in the Gulf of Oman due to climate change

in increased greenhouse gas (GHG) emissions, water consumption, sewage, waste generation and loss or degradation of coastal habitat, biodiversity and ecosystem services. A large portion of global tourism is focused on the marine and coastal environment and it is set to rise. Trends in aging populations, rising incomes and relatively low transport costs will make coastal and ocean locations even more attractive. Cruise tourism is the fastest growing sector in the leisure travel industry. A blue economy approach where ecosystem services are properly valued and incorporated into development planning will further advance this transition, guiding tourism development and promoting lower impact activities, such as eco-tourism and nature-based tourism, where the natural capital is maintained as an integral part of the process.

Urbanization of coastal states management

Rapid developments in urbanization and industrialization in most of the coastal states all over the world has led to severe problems in the coastal areas particularly that of environment concern both inshore and off shore zones of the seas and oceans. The catastrophic effects are loss or depletion of marine living and non-living resources, coastal pollution, livelihood of the coastal communities, loss of artisanal fishery and day-to-day income of the

fishermen folk, reverse impact on coastal tourism industry etc. The demographic pressure and increase in the density of population in the coastal cities day-by-day is creating severe problems of effective management of the various issues of the sustainability and health of the environment in the coastal areas of the cities. Added to that half hazard developmental plans to meet the demands of requirement of public is creating a nuisance in effective management of the urban plans. The environmental consequences of urbanization represent one of the most urgent challenges for humankind in this century. The magnitude and time lines involved are under-appreciated by professionals and the public at large. Our administrative governance often exhibit inadequate response times to insure solutions to rapidly developing problems; they must develop new approaches to coastal management that consider both the inevitability of urbanization and the urgency of addressing the special environmental challenges that high human density represents. Novel governance structures plus research protocols that advance our understanding of human dominated coastal ecosystems and urban environments are essential.

Emerging sea borne international trade

All over the world, countries are looking for the ways and means to transport the essential goods and raw

materials through fastest routes and cost effective means. Seas and oceans are being used traditionally as routes for effective transportation of the bulk materials. Over the years till recent past lot of improvements have taken place in the cargo ships transportation particularly in the modernization of engines and infrastructure facilities so that bulk materials can be transported in a faster manner and also retain the quality. While transportation care is also being taken to minimize pollution in the water and maintain the health of the oceans and seas. As on today about 90% of world trade is conducted through the sea and ocean routes. Advances in shipping technology improve efficiency of shipping and contributed to the sustained rise in the world seaborne trade. There are about 50,000 merchant ships in operation which include container ships, bulk carriers, ferries and cruise ships engaged in international trade. As per the latest reported data, the size of seaborne trade is approximately 9,600 million tonne. Dry cargo accounts for more than 70% of the total volume of seaborne trade in the world. These include trade in bulk commodities such as iron ore, coal, grain, bauxite, alumina, phosphate rock, containerized trade and general cargo. Due to rapid urbanization and industrialization the demand for raw materials or other products is increasing day-by-day and in future this quantity may go up and to meet this demand, there will be tremendous increase sea borne trade. From the blue economy point of view this aspects becomes an important factor and therefore the coastal nations should formulate appropriate policy frame work in a holistic manner to facilitate this kind of international trade for the mutual benefits.

Health of seas and oceans

The growing human population, anthropogenic activities and the rapid urbanization of coastal areas are all key land based factors causing higher levels of pollution in our seas. Documented marine 'dead zones' now number more than 400 covering

an area of over 240,000 km² including some of the formerly most productive areas of estuaries and shelf. There has been an approximate three-fold increase in the loads of nitrogen (N) and phosphorous (P) enrichment to the oceans since pre-industrial times. A recent study estimated that mangroves and coastal wetlands annually sequester carbon at a rate two- to four-time greater than mature tropical forests and store three- to five times more carbon per equivalent area. Sea-based sources of pollution are likely to be a growing issue as maritime shipping increases and submarine hydrocarbon/mineral exploration and extraction continue to expand. Marine debris threatens the integrity of marine food chains. Plastic materials and other litter are widespread from the oceanic collection zones and gyres, through the glutinous mass of micro-plastics that can now be trawled from some waters to the debris and pellets often found in the gastrointestinal tract of sea and bird life. In the context of blue economy, now the awareness is coming among the nations about the severe concern on the impact of pollution on the precious resources of the oceans.

Integrated coastal zone management

Integrated coastal zone management is, a process of using coastal areas as an integrated approach, regarding all aspects of the coastal zone, including geographical and political boundaries, in an attempt to achieve sustainability. This concept was born in 1992 during the 'Earth Summit of Rio de Janeiro'. The Integrated Coastal Zone Management is a dynamic and multidisciplinary process to promote sustainable management of coastal zones. The Integrated Coastal Zone Management uses the informed participation and cooperation of all stakeholders to assess the societal goals in a given coastal area, and to take actions towards meeting these objectives. The Integrated Coastal Zone Management (ICZM) seeks, over the long-term, to balance environmental, economic, social, cultural and recreational objectives, all within the limits set by natural



Cargo ship carrying bulk materials

dynamics. It means integration of the terrestrial and marine components of the target territory, in both time and space. Number of coastal nations were recognised the importance of ICZM and the benefits of implementation of this process have started accruing wherever it has been introduced. The guidelines of ICZM were also framed by number countries but no much efforts have been made to follow or realize these. To achieve the benefits of blue economy coastal nations should strictly observe the ICZM rules not only to facilitate sustainability alone but the sustainability-based upon rapid development including both urbanization and industrialization of the coastal states.

Governance and international co-operation.

Each sovereign country is responsible for its own resources and sustainable development. This national responsibility and importance of national policies and development strategies should not therefore be down played. The principle of common but differentiated responsibilities, however, still applies. Indeed the need for structured international cooperation underpins all aspects of the Blue Economy.

Demand for alternate source of energy from oceans

The oceans have a tremendous amount of energy and also resources of energy production which are close to many, if not most concentrated populations. Ocean energy has the potential of providing a substantial amount of new renewable energy around the world. In 2009 offshore

fields accounted for 32% of world-wide crude oil production and this is projected to rise to 34% in coming few years and higher subsequently, as almost half the remaining recoverable conventional oil is estimated to be in offshore fields. Methane (CH₄) gas, a potentially enormous source of hydrocarbons, are now also being explored and tapped from the seabed. Oil will remain the dominant energy source for many decades to come but the Ocean offers enormous potential for the generation of renewable energy – wind, wave, tidal, biomass, thermal conversion and salinity gradients. Of these the offshore wind energy industry is the most developed of the ocean based energy sources.

Marine biotechnology

Marine biotechnology has the potential to address a suite of global challenges such as sustainable food supplies, human health, energy security and environmental remediation. Marine bacteria are a rich source of potential drugs. In 2011 there were over 36 marine derived drugs in clinical development, including 15 for the treatment of cancer. One area where marine biotech may make a critical contribution is the development of new antibiotics and biomaterials. On the energy front algal biofuels offer promising prospects.

Contribution of blue economy to GDP

The European Science Foundation postulated a production volume of 20-80 thousand litres of oil/ha/year can be achieved from micro-algal culture, with even the lower part of this range being considerably higher than terrestrial biofuel crops. However, as this sector is a knowledge intensive, public support for marine science education and research may be necessary to inspire greater applications of innovations in marine biotechnology.

With depletion of land resources, sustainable development plan has gained lot of importance in almost all areas of development. At present there is a need for a development

strategy which can promise high growth with sustainable use of resources for economic development. Blue Economy has lot of potentials in fulfilling these objectives by relying on the ocean health and resources generated from it. The ocean can create ample of opportunities, but sustainability norms need to be adhered to access these possibilities. About the contributions of blue economy to the total GDP, there is a large amount of variations in attributing plans and speculations of the figures from nations to nations. For example in USA, the European Union (EU) and China, contribution of Blue Economy to total GDP differs significantly whereas in small countries like Mauritius, Iceland and Denmark, contribution of Blue Economy was more to total GDP. Indonesia and Canada have witnessed impressive contribution of Blue Economy in their country's total GDP. Similar level of contribution by Blue Economy has been done by the countries like Japan, China, Ireland and Iceland. The contribution of Blue Economy to overall GDP of China, and Mauritius is quite significant and it is reported to be more than 10%. Some countries reported about their Blue Economy contributing between 20 and 25% of their GDP and some of these countries include Malaysia, Indonesia and Iceland. This indicated complex nature of estimation procedure involved in the valuation of the Blue Economy.

SUMMARY

Blue economy is considered as a holistic development based upon the optimum and efficient utilization of oceanic resources without compromising on the sustainability. Coastal nations whose economic developments depend on the marine resources particularly the small island countries, they should follow this kind of approach. Even the advanced countries like USA, Canada and Australia consider the Blue economy as the new source of economic growth especially after the recession in overall economy in recent past. By

Table 3. National estimates of Blue Economy

Country	Size of the Blue Economy		% of GDP
	Year	Output (US \$ billion)	
Australia	2004	17.00	3.6
Canada	2004	15.98	1.5
France	2006	16.69	1.4
New Zealand	2006	2.14	2.0
United Kingdom	2008	84.27	4.2
United States	2009	138.0	1.2
China	2010	239.09	4.0
Ireland	2007	1.9	1.0

Source: *Prospects of Blue Economy in the Indian Ocean* by S.K. Mohanty, Priyadarshi Dash, Aastha Gupta, Pankhuri Gaur, RIS Research and Information System for Developing Countries, 2015

and large, all coastal nations are of the view that the Blue Economy is an important sector of their economies which should get priority in their respective legislation and action plan for ocean development. Many coastal countries including India consider the blue economy as a strategic economic sector for achieving substantial overall economic growth and other developmental objectives. Blue Economy broadly covers living resources such as fisheries and aquatic plants and non-living resources such as polymetallic nodules, cobalt crust, rare earth metals and other minerals, oil and gas, port and shipping, coastal tourism, marine biotechnology, marine commerce and so on. Of those, capture fishery, oil and gas exploration, shipping, coastal tourism etc. are the traditional sectors whereas multi-species aquaculture, fish processing, marine derived bio-products, seaweed products, coastal tourism and high-tech marine products are some of those emerging sectors of Blue economy. Besides their current level of contribution, there is immense potential existing in the above mentioned sectors for diversification and industrial applications.

¹Former ADG (Fisheries, Division of Fisheries Science) and ²Scientist, ICAR, Corresponding authors' e mail: arvinddiwan@yahoo.com