Blue Economy:

Potential, Prospects and the Path Ahead



Report by
FICCI Blue Economy Task Force 3.0
November 2023

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Preface

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Blue Economy (BE) encompasses a wide range of economic activities pertaining to sustainable development of resources and assets in our oceans, rivers, water bodies and coastal regions.

Hon'ble PM Narendra Modi's vision accords importance to Blue Economy as a major pillar of economic activity in the coastal areas and linked hinterlands through sustainable tapping of oceanic and water resources.

FICCI took the lead in 2016-2017 by establishing a Taskforce to develop a business model for India's engagement with Blue Economy. FICCI's Taskforce on Blue Economy of which I was a member, produced two knowledge reports in April 2017 and December 2019. The current 2023 report is the third in the series of FICCI's thought leadership and knowledge repository on Blue Economy. FICCI will continue pursuing and supporting Government of India's priority BE agenda through a range of policy dialogues, knowledge reports and industry-led initiatives.

This 2023 Taskforce report has been prepared by the national level experts on Blue Economy, under the leadership of long-time chair Amb Rajiv Bhatia. Thank you to all members of the Taskforce. We hope this report leads to greater business opportunities and turnover for industry, along with government, academia and policy circles.

S K Pathak,
Secretary General, FICCI
November 2023

Executive Summary

The global economy is expected to double within the next quarter of a century. It would certainly be a welcome development for addressing the larger challenges of poverty and under development. An addition of over USD 100 trillion to the world economy will also need massive resources by way of materials and energy. However, a major challenge would be how and where to obtain these additional resources. Efficiency gains through, 'reduce, reuse and recycle' alone will not be able to generate enough for meeting these colossal additional demands. With the land based sources already near depletion, there could be a rush to the oceans for meeting these requirements.

The oceans have historically been providing the mankind with food, energy, maritime transport and recreation. They have also been supporting key planetary functions: producing half of the oxygen, absorbing one third of the carbon dioxide emissions, hosting close to ninety percent of biodiversity, water cycle and climate stabilisation. The oceans have been exceptionally generous to the mankind and can certainly continue to do so and much more. According to the UNSG, sustainable management could help oceans produce six fold more food and forty times more clean energy.

Ironically, the human society has failed to look after the ocean health causing dangerous levels of pollution, acidification, and loss of biodiversity and finally warming. On top, we are also exploring to venture into new sectors of deep sea mining and marine biotechnology. If managed well, these advances could be a blessing for the future of economic development but if carried out unsustainably, they could turn into a curse. We may lose fish stocks, marine tourism may fade, sea levels may rise harming the coastal land and communities, and the extreme weather caused losses may surge.

Ever since the Small Island States (SIDS) highlighted the serious risks of the deteriorating ocean health at the Rio+20 Summit in 2012, the world community has been seeking greater sustainability in the harnessing of the precious ocean resources. This campaign also christened a new concept of Blue Economy (BE) for sustainable harnessing of the ocean resources. The urgency of addressing the deteriorating ocean health has also compelled the global community to seek norms and regulations, including some binding treaties. The UN Convention on the Law of the Seas (UNCLOS) provides the foundational principles for sustainable oceans. This has been followed by several important thematic agreements like: the Agenda 2030 on SDGs, Paris Agreement on climate change, agreement to conserve 30% of land and marine areas by 2030, the WTO agreement on fisheries subsidies, and protection of Biodiversity Beyond National Jurisdiction (BBNJ). These legal provisions are being further expanded through regional and national regulations for strengthening the ocean governance.

India, with its critically important ocean resources, has been at the forefront of the global discourse for sustainable oceans through the BE route. Prime Minister Modi articulated the spirit of the Indian approach to the sustainable harnessing of the oceans during a State visit to Mauritius in March, 2015 through the SAGAR vision, calling for 'Security and Growth for All in the Region', followed by the Indo-Pacific Oceans Initiative (IPOI) announced in November, 2019 at the East Asia Summit in Bangkok. India has also adopted a range of national themes for promoting BE, some prominent initiatives being: SAGARMALA for port led growth, Matsya

Sampada Yojna for promoting the fisheries sector and several initiatives for promoting marine tourism. A steering committee under the Prime Minister's Economic Advisory Council (PMEAC) carried out extensive multi-sectoral consultations and deliberations culminating in a comprehensive draft national policy framework for BE, which is under consideration of the Government for formulating a formal BE policy. The policy is expected soon.

There has been a significant progress in the conceptual and policy frameworks on BE. However, a crucial enabler for the success of the BE vision anywhere, more particularly in India, would depend on the full commitment and participation of the business community in the implementation of such ideas and initiatives. The Federation of Indian Chambers of Commerce and Industry (FICCI) was among the first to recognise the salience of this essential organic link and decided to set up a Task Force of experts under the Chairmanship of Amb Rajiv Bhatia to generate all round awareness on the emerging BE vision, its opportunities and challenges along with the evolving policy and regulatory frameworks for the Indian business community. The objective of this exercise was to prepare a supportive business environment for this important national and global policy transition for the ocean economy.

The Task Force produced FICCI's first Knowledge Paper entitled 'Blue Economy Vision 2025: Harnessing Business Potential for India Inc. and International Partners' in April 2017. The purpose of this knowledge paper was to sensitize Indian business and industry about harnessing ocean resources sustainably.

In the second phase, the Task Force produced another study entitled, 'Blue Economy: Global Best Practices – Takeaways for India and Partner Nations' in December 2019. It offers a detailed exposition of the various sectoral and thematic facets of BE as applicable to India within the wider global context. The report examined the performance and growth projections, as well as the opportunities and challenges for business in the relevant sectors of the BE in India along with a detailed and critical survey of the best practices in developed economies, regional groupings, and a few select countries.

Given the high stakes of the Indian business community in the emerging national and global BE frameworks, FICCI Task Force also actively participated in another significant research-cum-outreach projects with three other institutions – Konrad Adenauer Stiftung (KAS), National Maritime Foundation (NMF), and The Energy and Resources Institute (TERI). This quadrilateral cooperation among major institutions dealing with BE, produced in August 2021, a publication entitled, 'Blue Economy: India's Pathway to Sustainable, Secure, and Resilient Economy.'

The Task Force had also collaborated with the Steering Committee under the PMEAC on BE.

As the BE related initiatives and campaigns have continued, so has continued the work of the Task Force. In its third phase, the Task Force was mandated to critically examine the impact of the important developments in the BE domain in the past four years and explain the insights obtained through deep study, reflections, and widespread consultations for crafting new policy recommendations for consideration of the government and business.

Continuing with the past practice, Task Force 3.0 report provides a succinct review of the BE related developments globally and within India so far and bridges them with the upcoming future pathways. Along with updates on the current state of the major traditional BE sectors like fisheries, tourism, ports and logistics, the third phase has examined in detail the new sectoral and cross cutting thematic segments like deep sea mining, marine and maritime energy transition, biotechnology and pharmaceuticals, and the fast evolving governance framework of Marine Spatial Planning (MSP).

Engagement with the coastal States has continued and their BE interests have been adequately captured. A separate section is devoted to the ongoing multilateral and regional discourse on BE domain as also the current state and potential for bilateral cooperation with prominent regional and global partners. Each section clearly spells out the available business opportunities and challenges along with potential solutions.

A lot has happened since the launching of the last report in 2019 with several ideas and initiatives displaying wider appreciation and maturity, opening new vistas for consideration at policy and operational levels. The current report, accordingly, proposes a set of focused recommendations for the principal BE stakeholders from governance, business and academia.

Given the magnitude of the transition challenge, the report reiterates the importance of wholesome public-private partnership; calls for rechristening the Ministry of Earth Sciences as the 'Ministry of Earth Sciences and BE'; emphasises the salience of mainstreaming sustainability principles along the entire supply-value chains network; promote skill development and enhancement, including application of Underwater Domain Awareness (UDA) framework and offer them to other partners in the Global South; host a regional conference involving IORA and BIMSTEC partners for strengthening regional cooperation and synergies; and finally keep the public awareness at the center of general sustainability advocacy for making our plans of development future ready.

The FICCI Task Force has endeavoured to keep all Indian stakeholders, particularly the business community fully informed on the important emerging BE vision, opportunities, challenges, legal and regulatory framework, and available best practices for making the best of this new paradigm. We hope, the publications produced by the Task Force are found useful in taking beneficial business decisions.

New Delhi.

November 2023

Section I:
Introduction and Approach

The BE trajectory

The Blue Economy (BE) evokes diverse images of oceans, seas, rivers, and coastal regions in the human mind, which contribute enormously to the global economy. Experts are clear that the share of BE in the world economy has been rising and rightly so. As the planet's present population of 8 billion people steadily increases to touch 9.8 billion in 2050, land-based resources will not be adequate to meet the needs of humankind. Inevitably, it will have to turn increasingly to oceanic resources. But it must do so in a wise, sustainable manner. Hence, protecting and nurturing the oceans and rivers is as important as utilizing what they offer for the benefit of human beings. The quest must be for the right balance.

The genesis of BE, as a concept, is deeply interlinked with climate change and the persisting idea of environmental sustainability. While it could be traced to the Earth Summit in June 1992, it really came into prominence in the second decade of the 21st century. At the Rio + 20 conference in June 2012, the Small Island Developing States (SIDS) advocated its cause arguing that their well-being and even existence depended on an increased but prudent use of resources in the oceanic waters surrounding their islands.

This idea gathered momentum with a broader realization dawning on an increasing number of nations that BE is of considerable importance and relevance to them, not just a handful of island states. The idea was enshrined in global discourse by the adoption of the Sustainable Development Goals (SDGs) 2030. Goal 14 stipulates: “Life below water – conserve and sustainably use the oceans, seas and marine resources for sustainable development.”

In the current third decade, BE has undoubtedly become a part of the mainstream narrative relating not only to the global economy but also to the environment, science and technology, geopolitics, ocean governance, and much more. In particular, geoeconomics lends special credence to BE. Therefore, 'Why the Blue Economy? 'is a question that stands adequately answered now.

BE and India

Policy development concerning BE, has unfolded slowly in the Indian polity in the past eight years. This journey was preceded by long years since independence when India's policymakers were primarily focused on Asia's landmass and security threats coming from the north. Critics spoke of their 'sea blindness'. But this began to undergo a notable change from the 1980s onwards when maritime dimensions began to shape policy. As a result, more resources began to be given to the Indian Navy for maritime security and disaster assistance management. The announcement of the SAGAR (“Security and Growth for All in the Region”) doctrine by Prime Minister Narendra Modi was a seminal step. This envisaged a leadership role for India in the Indian Ocean region both for security and economic development purposes. He underlined the significance of the novel approach by depicting the blue chakra in India's national flag as symbolizing “the potential of Blue Revolution or the Ocean Economy.”

A highly relevant initiative, in this context, is the 'Sagarmala' project, spearheaded by the Ministry of Ports,

Shipping, and Waterways. Since its inception in March 2015, over 500 ports and port-related projects have been undertaken for modernization and improvements in connectivity. 'Sagarmala 'envisions port-led growth along India's coasts and includes various infrastructure and skill development projects. As of 2021, 802 projects, valued at Rs 5.5 lakh crores (USD 66.4 billion)[1], have been identified for implementation by 2035, with over half of them under various stages of completion.

On 4 November 2019, Prime Minister Modi launched the Indo-Pacific Oceans Initiative (IPOI) at the East Asia Summit in Bangkok. The main objective of the IPOI is to ensure safety, security, and stability in the maritime domain by fostering dialogue between stakeholders and building on the existing regional architecture for cooperation. IPOI identifies seven pillars for cooperation: maritime security; maritime ecology; maritime resources; capacity building and resource sharing; disaster risk reduction and management; science, technology, and academic cooperation; and trade connectivity and maritime transport. IPOI embodies the essence of the SAGAR doctrine which forms the crux of India's external engagement in the maritime domain.

The draft policy framework on Blue Economy[2], released by the Economic Advisory Council to the Prime Minister in September 2020 represented a major milestone in crafting a holistic national Blue Economy policy. It recommends significant measures such as the formulation of a National Maritime Policy and the establishment of an apex body named the 'National Blue Economy Council 'to draw together various stakeholders on a single platform to facilitate action in the public and private sectors. A Blue Economy Governance Framework and accompanying legislation are also recommended in the immediate term. On financing BE, the draft policy recommends a National Blue Economy Fund to support “cross-cutting projects of strategic importance to India” in sectors related to the BE at central and state levels.

Activities related to BE are currently distributed across different ministries and departments such as the Ports, Shipping & Waterways, Natural and Renewable Energy, Earth Sciences, Fisheries, the Indian Coast Guard etc. The draft policy stresses the need for institutional coordination and recommends the Ministry of Earth Sciences (MoES) as the lead ministry for policy formulation. This ministry circulated the draft policy inviting input and feedback from those concerned and is now in the process of preparing a comprehensive policy document to obtain Cabinet approval.

The second Maritime India Summit was held virtually in March 2021, where Maritime India Vision 2030 was unveiled by the Prime Minister. The vision document[3] identified maritime space as a key driver of economic change for India and to that end, institutional investment in BE was outlined with a focus on the following areas: developing port infrastructure; end to end logistics support by bringing industries closer to ports and increasing cost competitiveness; enhancing logistics efficiency; strengthening policy frameworks; enhancing global share in shipbuilding, repair, recycling; developing ship repair and building clusters; enhance inland waterways; promoting ocean/river/coastal cruise sector; enhancing global maritime cooperation; developing a green, sustainable maritime sector; education, research, training.

Stressing that BE accounts for 4.1% of India's GDP, the Maritime India Vision 2030 emphasizes harnessing the potential of sectors that make up this economy, ranging from traditionally established sectors like fisheries, coastal tourism, marine transport and shipbuilding to new and emerging sectors like renewable energy, deep-sea mining, biotechnology and pharma.

BE and India's G20 Presidency

G20 accounts for 80% of the global GDP, but it is also responsible for “80% of global greenhouse gas emissions.”[4] The United Nations Environment Programme (UNEP) has argued that if one billion people (out of

the 8-billion strong global population) were to adopt “environment-friendly behaviour in their daily lives, global carbon emissions could drop by approximately 20%.”[5]

The Sherpa track of the Indian presidency includes the Environment and Climate Sustainability Working Group (ECSWG). Through its multiple preparatory meetings involving a whole spectrum of stakeholders, this working group has paved the way for the Ministerial meeting that provided appropriate policy inputs to the G20 summit in September 2023. Concerning the Blue Economy, this working group was deeply engaged in accelerating the transition to a sustainable and climate-resilient BE.

As part of its ambitious work programme, the working group hosted Ocean 20, a dialogue among officials and experts as a side event in Mumbai on 21 May 2023. Representing FICCI, Ambassador Rajiv Bhatia, and Chair Task Force 3.0, participated in the session entitled 'Establishing Blue Finance Mechanisms'. He underlined the critical importance of making ample blue finance easily available as a device to motivate business to adopt and implement BE projects. The principle of public-private partnership was suitably invoked. In addition to the plethora of green and blue bonds already available on the market, the Chair stressed, there was an urgent need to create new funds such as a 'Maritime Development Fund' and a 'National Blue Economy Fund (NBEF)'. These were recommended by 'India's Blue Economy: A Draft Policy Framework' released by the Economic Advisory Council to the Prime Minister in September 2020.[6]

Another interesting development was the adoption of the Blue Economy as one of the two key priorities (Responsible AI being the other) by the Supreme Audit Institutions (SAI), an important engagement group of G20. During India's presidency, Girish Chandra Murmu, Comptroller and Auditor General (CAG), took new initiatives such as hosting a cross-cutting seminar on 27 February 2023, where FICCI was represented by the Chair of Task Force 3.0. “The speakers highlighted the need for a holistic approach integrating sustainable development goals and recommended scaling up efforts, developing study papers, and making recommendations on how governments could direct their efforts and policies for sustainable development of the Blue Economy of their nations.”[7] This was followed by SAI 20 Engagement Group Senior Officials Meeting in Guwahati in March 2023 and the SAI20 summit in Goa in June 2023. During these deliberations, SAI 20 stressed the need to develop accounting frameworks and coordinates with the respective accounting agencies of the member nations.

FICCI's engagement

BE was barely an emerging idea in mid-2015 when India's apex business chamber, the Federation of Indian Chambers of Commerce and Industry (FICCI), took the pioneering step of establishing a Task Force of domain experts and commissioned it to research and develop a policy framework. This led to the launching in April 2017 of FICCI's first Knowledge Paper entitled Blue Economy Vision 2025: Harnessing Business Potential for India Inc. and International Partners.[8] It began by offering its own definition, complete and balanced, of BE: “The Blue Economy encompasses a wide range of economic activities pertaining to the sustainable development of resources and assets of the oceans, related rivers, water bodies and coastal regions – in a manner that ensures equity, inclusion, innovation and modern technology”. Since then, it is widely accepted that BE stands on the tripod of maritime security, sustainability, and business productivity.

The purpose of this knowledge paper was to sensitize Indian business and industry about harnessing ocean resources sustainably. The ocean has immense economic value, and as engagement with its multiple sectors grows, it becomes imperative to balance this engagement with maintaining ocean health, especially given their natural role as the single most important CO2 sink and replenisher of oxygen. As the demand for

resources grows with the population, BE is rightly seen as offering a path toward food and energy security.

The legal regime governing the maritime domain, starting with the United Nations Convention on the Law of the Sea (UNCLOS), 1982, is analyzed in the second section. Since BE involves areas of the ocean both in the Exclusive Economic Zones (EEZs) of coastal countries as well as in the high seas, questions of jurisdiction, sovereignty, exploration rights, etc. are relevant areas of interest offering business opportunities. The paper notes that the success of India's engagement with BE will depend as much on the preparedness and participation of the business community as on governmental policy and investment. The third section presents a detailed view of business opportunities and bottlenecks in various sectors. It advocates well-integrated public-private partnerships supported by policy and regulatory frameworks that foster private investment. The targeted sectors include traditional and established sectors like fisheries, shipping and transport as well as new and emerging sectors like deep sea mining, marine biotechnology, and marine manufacture.

The final two sections delineate the global discourse on BE and the policy recommendations made by the task force. India's policy is situated in the context of emerging models and ideas of blue governance. The critical position of the Indian Ocean makes coordination and collaboration among countries of the littorals extremely important. To that end, the paper identifies priority countries and regions for opportunities. Finally, the recommendations stress an integrated approach for India in the Indian Ocean that synthesizes the academic literature already produced by national and international institutions on the subject with the valuable work being undertaken by the Indian Ocean Rim Association (IORA).

FICCI then went on to establish the second Task Force which produced in December 2019 a new study entitled Blue Economy: Global Best Practices – Takeaways for India and Partner Nations.[9] It offers a detailed exposition of various facets of BE as applicable to India within the wider global context. A product of consultations among various stakeholders, it examines the performance and growth projections, as well as the opportunities and challenges for business in the relevant sectors of the Blue Economy in India. The report offers a detailed and critical survey of the best practices in developed economies, regional groupings, and a few select countries such as China. Efforts made by the World Bank and The Organization for Economic Cooperation and Development (OECD) to mainstream BE within the overall paradigm of economic growth and development through enabling financing for these sectors are noted. The paper also stresses the need to collaborate with these institutions and countries like the USA, Norway, Canada, France and Germany. Partnerships with countries in coastal Africa and Southeast Asia, on the other hand, are seen as critical for India's engagement with the Indian Ocean.

On a more micro level, the paper also presents inputs from the consultations carried out with three coastal states in India: Kerala, Gujarat, and Andhra Pradesh. The notable progress made by these states in sectors like shipping and logistics, tourism, conservation, fisheries, energy, and marine research offers models that can be replicated by other states. The study then details the business opportunities nationally and internationally in key sectors of BE. These include fisheries and aquaculture; ports and shipping; marine and coastal tourism; renewable and non-renewable energy; marine biotechnology; innovation and digital technology; insurance and law; and deep-sea mining. At the center of market expansion for these sectors is the imperative to balance ocean health with growth and resource extraction. Thus, the paper argues for the sustainable use of ocean resources through holistic planning and creative financing.

In its concluding section, the study makes recommendations for India at the strategic and institutional levels, while offering sectoral takeaways for public and private stakeholders. In the same vein as the first knowledge paper, a model of public-private partnership is identified to foster greater dialogue and cooperation involving

governments, businesses, and civil society. Such a multidisciplinary approach would involve engaging existing research institutions, banks, and regional and multilateral groupings as well as the creation of mechanisms to formulate new strategies and plans to engage business and industry across sectors.

Resolved to convince policymakers and corporate players of the high stakes involved, FICCI then participated in another significant research-cum-outreach project with three other institutions – Konrad Adenauer Stiftung (KAS), National Maritime Foundation (NMF), and The Energy and Resources Institute (TERI). This quad of institutions published, in August 2021, a publication entitled Blue Economy: India's Pathway to Sustainable, Secure, and Resilient Economy.[10] The Chair and four members of the FICCI BE Task Force 2.0 and the Secretariat were actively involved with this ambitious inter-institutional project.

Present approach

The basic mandate of the Blue Economy Task Force 3.0 is to critically examine the impact of the important developments in the BE domain in the past four years (mid-2019 to mid-2023); explain the insights obtained through deep study, reflection, and widespread interactions with the community of officials, foreign diplomats, experts and business community; and spell out new policy recommendations for consideration of the government and business.

Section II:
Thrust Sectors

The Blue Economy offers a vast area for study, reflection and policy action. After careful deliberations, the Task Force chose a total of seven specific sectors for a deeper examination with a view to offering recommendations from the Indian perspective. The section below presents all the relevant details concerning the seven target sectors: a) Fisheries, b) Shipping, Ports and Logistics, c) Coastal Tourism, d) Marine/Maritime Energy Transition, e) Deep Sea Mining, f) Marine Biotechnology and Pharma, g) Marine Spatial Planning (MSP).

Fisheries

Introduction

The fisheries industry in India is an integral part of the nation's economy, exhibiting remarkable growth rates and playing a crucial role in generating foreign exchange. India possesses abundant marine and inland water resources, which are considered invaluable national assets. Over the years, the fisheries sector has undergone a remarkable transformation. Originally a traditional activity during the early stages of the plan period in the 1950s, it has evolved into a commercialized sector, fostering connections among various stakeholders including fishermen, traders, fish processing units, and export markets. The fishing industry not only sustains the livelihoods of local fishers but also plays a vital role in supporting the economic well-being of coastal communities. Moreover, it provides substantial employment opportunities for individuals engaged in aquaculture and fish processing. The export of marine products generates foreign currency, contributing to the overall economic development of the country.

India's total fish production during 2021-22 stands at 16.25 million tons (mt), which is about 8.0% of total global fish production. Fish and fish products also earn considerable foreign exchange for the country worth over Rs. 60 thousand crores. With the increase in the availability, the per-capita consumption of fish has reached 6.31 kg. The increasing proportion of fish in per capita animal protein consumption contributes to enhancing nutritional security for the population. Furthermore, fish byproducts are recognized for their diverse industrial and medical applications. Therefore, the effective and sustained utilization of fisheries resources serves as a crucial element of India's strategies for developing its Blue Economy.

Contribution of fisheries and aquaculture to Indian Economy

Agriculture, forestry and fishing accounted for 20.3% of the Gross Value Addition (GVA) at current basic prices in 2020-21. However, the share of this sector in overall GVA of the country is showing a fluctuating trend over the years[11]. The recent estimates (2020-21) at the current prices, show the GVA of these sectors combined at 20.3% of the economy, which is a marginal increase from 18.5% since 2011-2012. The output of the fishing and aquaculture sub-sector increased steadily from about Rs. 80 thousand crores in 2011-12 to about Rs. 233 thousand crores in 2020-21, accounting for 6.44% of agriculture, forestry and fishing sectors together (at

current prices), which is 1.29% of the National GVA.[12] Though major states contributing to the total GVA remained more or less the same, Andhra Pradesh recorded large increases in output of fishing and aquaculture, with its share in the all-India output increasing from 17.7% in 2011-12 to about 40% in 2021-22, owing mostly to the shrimp aquaculture operations.

The export of fish and fishery products from the country during 2021-22 was 1.36 million tonnes with an estimated value of Rs. 57.5 thousand crores. The unit value realized during this period was INR 420.05 per unit weight (kg). The exports have seen a growth trend of 4.78% in terms of quantity, 12.94% in terms of value (current prices) and the unit value realization showed an impressive growth rate of 7.79%. The export performance highlights the contribution of the aquaculture sector to the total exports, both in terms of value and quantity[13]. The seafood exports during the last year (2022-23) have further increased to an all-time high in terms of volume and value. The total quantity exported was 1.7 million tonnes of seafood worth Rs. 63,969.14 crores, growing 26.73 percent in quantity and 4.31 percent in terms of value[14]. Frozen shrimp, as is the case in the last few years, was the major contributor accounting for a share of about 41% in quantity and 67.7% in terms of value. Frozen fish exports accounted for 21.2% in terms of quantity and 8.49% in terms of USD value. United States remained the major market, followed by China and the European markets.

Marine resources

The marine resources in India comprise an exclusive economic zone of 2.02 m sq km, and a continental shelf area of 530 000 sq. km and a coastline of 8118 km. The inland water resources include rivers, canals, estuaries, floodplain lakes and ponds and tanks. The combined length of the rivers is about 45,000 km. The reservoirs cover more than 3.0 mha. Estimated potential of Indian marine waters is 5.31 million tonnes[15].

Marine fisheries

An overview of Indian marine fisheries sector is presented in Table 1.		
Coastline	:	7516.5 km
Maritime states		9
Exclusive Economic Zone		2.02 million Km^2
Continental shelf		0.5 million Km^2
Marine fisheries population		2.8 million
		Inland - 2.311 Marine - 0.495
Landing centres		1547
Major fishing harbours		7
Minor fishing harbours		67
Mechanized vessel		42985
Motorized vessel		97659
Non-motorised vessel		25689

Trends in fish production

The total fish production from the India has increased tremendously over the years, and the total fish production during 2021-2022 stands at 16.25 million tonnes (MT), which is about 8% of the total global fish production. The annual growth rate in fish production has been at the rate of 10.34%. The yield of marine fisheries has increased approximately sixfold between 1950 and 2022 and is estimated at 4.13 million tonnes during 2021-22. The estimated marine resource potential of the Indian EEZ at current exploitation rates is 5.31 million metric tonnes (MMT)[16]. Besides conventional resources, the potential yield of non-conventional resources like the oceanic squids, myctophids, jellyfish and marine algae is about 1.85 million tonnes. The production from the inland sector has been tremendous with an average growth rate of about 7.8 % during the period and the total production from the inland waters is 12.2 MT. Another important aspect is the growth, in terms of aquaculture production of shrimps and scampi, which according to the recent estimates is 0.85 million tonnes, with an overall growth rate of 18.2% during 2010-11 to 2020-21.

It is estimated that the combined potential of deep-water species (oceanic) is 0.23 mmt, with the yellow fin tuna contributing about 36% and Skipjack tuna by about 43%. In addition to the above, the share of raw krill from the Indian sector of the Southern Ocean is about 0.1 million tonnes, which can be considered as a potential resource of high value. Analysis of the trend indicate that there is significant increase in the quantity of fisheries catch, but the increase has mostly been contributed by aquaculture sector, and the coastal shrimp farming industry contributing significantly to the value wise exports from the country.

Issues related to decrease in catches and increased bycatch

The recent analysis based on data from 223 commercial stocks[17] shows that about 34.1% of the Indian marine fisheries stocks are only sustainable. From a quantitative perspective, the marine fisheries resources found in coastal waters up to a depth of 100 meters have been extensively exploited, while the deep-water fisheries are largely underutilized. This presents an opportunity to capture qualitatively superior fish species, like yellow fin tuna, which holds economic potential in niche markets that demand sashimi-grade products.

There have also been significant changes in the composition of fish caught mostly in the marine sector and the composition of cultured fish or shrimp in the aquaculture sector has remained more or less the same over the years. Stagnation in the quantity of catches from the marine sector is noticeable, which hints towards maximum exploitation in the traditionally fished grounds, and a need for range extension in fishing. There has been a high demand for fish meal for the fish feed and poultry industry, which is mostly catered by the low value bycatch from the fishing operations, of which trawling is the most important contributor[18].

Increase in capacity of fishing

Reports also show significant increase in the capacity of fishing vessels, both in terms of the number and also the installed engine power of the vessels in the marine sector, which further adds pressure to the fisheries stocks. Despite the fact that India's average emissions are significantly lower than those of the rest of the world[19], the current trend of increasing engine power should be constrained by legislation, as India's total number of vessels, particularly trawlers (about 35,000 in numbers), could contribute to significantly higher emissions in the future. Addressing the issue of higher fuel consumption would require a mix of innovative solutions, technical interventions and operational changes.

IUU fishing, MCS and VMS

In addition to the large number of trawlers in the Indian waters, there are reports of IUU fishing by foreign vessels, fishing in the Indian waters[20], which will further affect the sustainable harvest of resources from the Indian EEZ and also create security issues.

Though there have been multiple attempts to develop and operationalize vessel monitoring systems in the Indian vessels, however, there has not been much development in this front, most due to the duplication of attempts and also due to the lack of a centralized attempt with focus for an effective implementation. Apart from a few states like Kerala, which has included mandatory monitoring systems in the vessels operating, there are no serious attempts to introduce monitoring system in vessels, which will help in many ways both in terms of evaluating the fishing effort, security and also by effective control mechanisms to prevent effort. The two-way system for communication developed in-house by the Space Applications Centre (ISRO-SAC)[21], which has a large number of options for dissemination of information including real-time tracking of fishing vessels, can be effectively implemented in the fishing vessels operated along Indian waters. The govt. of India has funded the first large scale attempt to fit ISRO developed transponders in 5000 fishing vessels operating along Tamil Nadu coast, in which about 600 vessels along Chennai coast, has already been fitted with these[22].

Issues related to export

The export of shrimps from South American and Southeast Asian countries has had a notable impact on the unit value realized for India's high-value item exports, specifically in terms of competition in the recent years. The imposition of a ban on the export of wild caught shrimp[23], in the absence of sufficient measures to mitigate the impact on olive ridleys, represents a pressing concern that requires prompt attention. Efforts to enhance the efficiency of technical devices, such as the implementation of turtle excluder devices, are advancing. Nevertheless, these measures must be implemented at an operational level and achieve greater acceptance among the fishers to resolve this issue.

Though India could defend its stand in the recently concluded ministerial conference at WTO (MC12), the issues related to control of excess fishing power and overfishing in the Indian EEZ, needs to be looked into seriously. As a complete change of fishing vessels to cater them for high seas fishing would not be possible, the initial step should be to equip them for fishing in the deeper waters, within the EEZ and then gradually transform this fleet for fishing in areas beyond national jurisdiction (ABNJ). Many deep-sea fishing vessels have already been fabricated under the umbrella of blue revolution scheme and the dedicated funding source of PMMSY during the years since 2019. The standard design now accepted would cost around 1.5 crores and the base design of the vessel is available with the Department of Fisheries, Govt. of India. The state which was most benefitted was Tamil Nadu under the Scheme, “Diversification of Trawl Fishing Boats from Palk Straits into Deep Sea Fishing Boats” which was launched in 2017 as a centrally Sponsored program as part of blue revolution scheme.

High fuel use in the fishing sector

There is a need for green technologies and adoption of greener fuels in the fishing sector, in addition to the changes in the fishing vessels and fishing gear designs. Though initial attempts to use LNG in fishing vessels[24] were carried out, logistic and other reasons are often found to hinder the usage of these new generation fuels in the fishing industry.

Social issues

The marginalisation of small-scale fishers in the development and distribution of the benefits of technology and capitalisation throughout the fisheries value chain is also a growing concern. Concerns exist among small-scale fishers and the fishing community as a whole regarding initiatives in the BE space. These apprehensions stem in part from the rapid pace at which developments are reported in the media and the involvement of government mechanisms, which are frequently perceived as a threat to their livelihoods by the fishing community. The apprehensions could be alleviated by conversing with the sector's stakeholders and disseminating regular updates on developments in the BE field. In addition, the participation of the communities in this growth process is essential, and the benefits accruing from this development should permeate down to the communities, who would be directly affected by the changes in the sector.

Issues related to credit for fishers both in the marine and inland sectors

The credit systems existing in the system in quite complex and complicated[25] and there is a need for market reforms and penetration of institutional credit in the sector. The Kisan Credit Card in fisheries sector launched by the government[26] is a right step in this direction, which provides for the capital requirement of the fishers and thus aims in socio-economic improvements. Much improvement in the allocation of funds to the fisheries sector has happened in the recent years[27].

The Department supports PM Gati Shakti National Plan that promotes multi-modal connectivity that envisages to bring in a transformative approach by ensuring “first and last mile connectivity” through improved logistics efficiency, reduced logistics cost with focused integration of existing and proposed infrastructure across different agencies[28].

Project titled “Fisheries Sector COVID-19 Response and Recovery Project” with total outlay of Rs. 3,000 crores, supported by World Bank & AFD as a sub-scheme under PMMSY is now approved. The project would be focusing on financial inclusion, risk mitigation, promotion of micro enterprises and expansion of domestic market through safe marketing practices in fisheries sector.

Issues related to processing, exports and trade

The share of exported fish products from India, constitute around 10% of the total fish production in the country. As mentioned earlier, there are three major countries to which the exports are targeted and also in terms of value, frozen shrimp (70%) and frozen fish (9.5%) dominated[29]. The unit value of Indian export is also low and during 2000-01 to 2019-20, the unit price has grown at a rate of 3.46%. Frozen exports often fetch lower prices in the international markets and the percentage of value addition remains very low, leading to low unit value realization in exports. Diversification of Indian exports, improving the proportion of value-added products catering to the international markets, by adoption of high-end processing equipment, and also introduction of ready-to-eat and ready-to-cook products, maintaining high quality standards are very essential. Another option would be live transport of high value species and also venturing to sashimi-grade tuna products, for which greater investment would be required, both in terms of technology and infrastructure funds.

The data regarding the disposition of fish catches (2020-21) indicates that fresh fish marketing is predominant (77.1%), with frozen fish accounting for 13.5% of the country's total fish capture. The estimated percentage of fish destined for reduction is 2.3%, which is surprisingly low when compared to other studies from marine fisheries, where low-value bycatch accounts for approximately 30% of total catches, especially in the case of trawlers operating along the Indian coast.

Despite the fact that there are laws, standards for various foods, and multiple agencies to oversee the trade, major importing nations have periodically declined to import Indian seafood, though this has been reducing over time. High concentrations of harmful microorganisms, parasite diseases, pesticide residues, or heavy metal pollution are the primary problems with food safety in the Indian fish exports.[30]

Shipping, Ports and Logistics

The United Nations Conference on Trade and Development (UNCTAD), a permanent intergovernmental body established by the United Nations, and dealing with global trade and development, in its annual report "Review of Maritime Transport 2022"[31] has observed that maritime transport and the associated trading system could witness structural shifts led by "climate change, energy transition, the need for sustainability and resilience, digitalization and e-commerce". The report calls upon governments and the industry to "embrace digitalization and decarbonization and the transition to alternative sources of energy". Furthermore, according to the report, the maritime transportation sector will need to "adopt smart maritime logistics" as well as shielding the "information and communication systems and infrastructure against ever present threats to cyber security".

The Report also warns that "Greenhouse gas emissions [GHG] from the world's maritime fleet are heading in the wrong direction. Between 2020 and 2021, they went up by 4.7%, with most of the increase coming from container ships, dry bulk carriers and general cargo vessels" and that the "Ship owners face more stringent environmental regulations".[32]

It is evident that the maritime industry is under pressure to not only become smart but also green through decarbonisation by transitioning to cleaner fuels and cut carbon emissions. In fact, the twin requirements of being 'Smart and Green' cut across sectors of the maritime transportation system, be it at sea (shipping), along the coast (ports and harbours) or deep into the heartland (land transport linking inland container depots with seaports and the riverine transport).

Digitalized Maritime Commercial Operations

The use of emerging digital technologies and systems (Artificial Intelligence, Machine Learning, Big Data, Cloud Computing, Cyber Physical Systems (CPS), Digital Twinning, Internet of Things (IoT), and Augmented Reality) to create, store, and manage information-data provide an opportunity to the maritime industry to push sustainability, enhance efficiency, streamline operations and obtain cost-effective solutions thereby improving revenue for the sector. According to a market report the maritime freight transport sector is expected to grow at about 4% during 2023 – 2028[33], and in that, the global maritime digitization market (software, hardware, and services) is expected to grow at a CAGR of 14.2% during 2023 to 2031.[34]

There is widespread acceptability and use of emerging digital technologies in ship operations. Among the many notable advancements in this sector is the arrival of 'smart vessels' driven by at least three factors: first, reduction of personnel on-board ships for cost cutting and using their living spaces for cargo; second, reduce accidents given that nearly 70 to 80 per cent of ship accidents at sea are a result of human error; and third, harness 4IR technologies for enhancing efficiency, reduce down time through predictive maintenance and harmonize ship operations with the supply chain.

However, experts are divided over the introduction of smart vessels and firmly believe that the human factor cannot be totally eliminated out of ship operations. The International Maritime Organisation has designated these vessels as Maritime Autonomous Surface Ships (MASS), and under its scoping exercise, designated four levels of independence of autonomous vessels vis a vis presence of human operators.

The global autonomous ships market is quite encouraging and can be expected to grow by 8.4% annually and touch USD 77.71 billion by 2030, "driven by the demand for operational safety of ships, retrofitting of existing

ships, increase in trade activities, and technological advancements in automation systems".[35]

Another forward looking technology in ship operations is Digital Twining, a process in which a solid object is digitally mapped, mirrored and monitored using data from sensors fitted in the equipment. A 'digital twin' of a ship or an offshore platform can help obtain real-time performance or parameters of various on-board machinery or systems. It "helps predict breakdowns before the equipment fails, and enables remedial measures through replacements and repair, thereby enhancing operational efficiency".[36]

Similarly, cloud-based management helps in monitoring shipping operations. For instance, cruise company Exploris has chosen Lloyd's Register (LR) to provide Cloud Fleet Manager (CFM) platform, an integrated application, which offers a single cloud-based source of real-time information to "manage all aspects of its fleet operations, from maintenance and compliance to voyage planning and purchasing" thereby ensuring "the highest levels of efficiency, reducing downtime and increasing operational reliability".[37]

Port Operations

Historically ports have been transforming to improve operational efficiency by adapting to technological-digital advancements. Many seaports across the globe have begun using emerging digital technologies. These are labelled as 'Smart Ports' and have embraced "new technologies and digitalization, to rationalize, reorganize and streamline port activities".[38] The global Smart Port market was valued at USD 1.59 billion in 2021 and is expected to grow at a CAGR of 24.44% during the forecast period till 2030.[39] However, the majority of Smart Port players are in Europe and the USA, barring a few in Asia in China, Japan, Singapore and the UAE.

At the apex level, the International Maritime Organization has encouraged "digital revolution" and observed that cooperation between stakeholders (shipping, ports and logistics) is important. It has urged Member States to embrace digital technologies in their maritime infrastructure and offer seamless services to its many stakeholders and users. These technologies can help obviate errors in paperwork and information sharing. For instance, the Electronic Data Interchange (EDI) system under the Convention on Facilitation of International Maritime Traffic (FAL) is a good example which "eliminates costly delays and bring international uniformity into the industry".

At the 128th Session of the Council of International Maritime Organisation (IMO), India supported a proposal to include the "element of digitization in the next Strategic Plan as well as the adoption of a maritime single window system as a part of the digitization initiative, since it will help in resolving the regulatory bottlenecks faced in the maritime industry".[40]

The International Association of Ports and Harbors report (2021) too has highlighted that emerging digital technologies will find relevance across multiple sectors associated with ports and result in efficiency and resilience throughout the supply and logistics chain. The report lays emphasis on "accelerating digitalization and critical actions to strengthen the resilience of the future maritime supply chain".[41]

Logistic Transport Network

Emerging digital technologies can potentially revolutionize the entire logistic transport ecosystem, built around multiple stakeholders such as shippers, freight forwarders, port operators, carriers (ships, trucks, and rail) and other connected service providers such as Customs, security agencies and emergency services that are connected to each other in real-time and enhance efficiency and productivity. For instance, the blockchain

technology is being exploited by stakeholders in a number of sectors like marine insurance, supply chains, management of container traffic and several companies are introducing this technology in operations making it more transparent, efficient and secure. In essence, it offers both transparency and traceability. Similarly Big Data facilitates real time collection of data from diverse sources and help in operational decisions. The use of IoT in trucking helps to reduce accidents.

Among the many commercial uses of 5G, this technology will enable quick access to data along the supply chains, i.e., ship-port-transport-production zone and vice versa. It is noted that "automated port control centre and operators can perform operations such as video security monitoring, real-time data collection and disposal by using mobile terminals".[42] The Tianjin Port in China boasts of a "fully digitalised and automated wharf where quay cranes, gantry cranes, stackers and forklifts are all controlled by a command center miles away. Powered by Huawei Technologies' 5G telecommunications infrastructure, the smart port can move 36 20-foot boxes (TEUs) per hour, much faster than humans".[43] Further, it is possible to monitor and manage cargo operations in ports i.e. "200 operators and engineers can manage 1 million TEUs in annual throughput at Tianjin Port's Terminal C, about 25 per cent of the employees needed in a typical year during its pre-digital age".[44]

However, such operations require real-time access to cloud data that is cyber hardened security protection allowing 5G Edge-Cloud Solution to function.[45] For instance, Artificial Intelligence can help process and predict the loading and unloading of goods from crane to the land transport to achieve better operational and capacity performance as well as to trace vehicles. Similarly, digital twin of trucks, lorry and other dockside vehicles such as cranes and fork lifts enables high levels of safety and operational efficiency.

Greening Ships, Ports and Logistic Transport

There are nearly 50,000 ships operating on international shipping lanes and use fossil fuels for propulsion. It is estimated that the shipping sector produces 2–3% of global CO2 emissions and if left unregulated, could rise to 17% by 2050.[46] It is also worrying to note that nearly 60,000 deaths annually happen due to air pollution exposure from shipping, mostly among coastal communities which corresponds to USD 160 billion yearly in health-associated costs.[47]

Although ships pollute less than as compared to air and land transport,[48] the shipping industry is under pressure to decarbonize through transition to cleaner fuels and new ship designs to reduce fossil fuel consumption and cut carbon emissions. The International Maritime Organisation is committed to the reduction in carbon intensity of international shipping. Its GHG strategy envisages reduction in CO2 emissions across international shipping, by at least 40% by 2030, 70% by 2050, compared to 2008. It has adopted a slew of policies under the IMO's pollution prevention treaty (MARPOL), the energy efficiency design index (EEDI) which is mandatory for new ships, and the ship energy efficiency management plan (SEEMP).

Similarly, the shipbuilding industry too has assumed the responsibility for building energy efficient ships and naval architects are engaged in hull modifications and new propeller design to enhance operational efficiency. India has announced plans to be the 'Global Hub for Green Ship' building by 2030. Under the Green Tug Transition Programme (GTTP), Indian shipyards will build Green Hybrid Tugs, and subsequently switch to "alternative fuel sources like Methanol, Ammonia, and Hydrogen".[49]

Energy Transition

The Glasgow COP26 deliberated, among other issues, on the shipping sector and the international maritime community including governments, the private sector and civil society. It unequivocally endorsed the critical need to both transition and transform the maritime sector by decarbonising through alternative sources of clean energy such as electric, hydrogen, wind, methanol, etc. Consequently, 20 countries including the US signed the Clydebank Declaration.

Further, the QUAD comprising member countries (Australia, India, Japan and the US) agreed to build green port infrastructure and clean-bunkering fuels. The Quad Shipping Taskforce will "invite leading ports, to form a network dedicated to greening and decarbonizing the shipping value chain". It will also examine, QUAD low-emission or zero-emission shipping corridors, "Clean-Hydrogen Partnership" including technology development including delivery infrastructure and "stimulating market demand to accelerate trade in clean hydrogen in the Indo-Pacific region".

At home, the national mission of Blue Economy coupled with the National Hydrogen Mission and International Solar Alliance are the triggers for accelerating use of clean hydrogen in the ships-ports-trucking ecosystem including the inland water transport for river transportation. In this context, India plans to build two hydrogen hubs (storage, handling and generations) at Deendayal Port (Gujarat) and VO Chidambaranar Port (Tamil Nadu).[50]

Similarly, 'Smart Port' operations also envisage decarbonisation given that seaports account for nearly 3% of total carbon emissions worldwide. In fact, decarbonisation is "mission-critical" for seaports wherein a balance is achieved between economic objectives and environmental protection relating to reduction of energy consumption. The emissions from seaport originate from at least three sources: (a) seaside operations i.e. ships that make port calls; (b) landside through seaport operations including transport-trucking; and (c) anthropogenic activity including fishing vessels and other water transport. India has chosen Jawaharlal Nehru Port, Mumbai and VO Chidambaranar Port, Tuticorin, Tamil Nadu to become smart port by 2024.[51]

Seaports are expected to be sustainable and climate friendly necessitating all stakeholders involved in port management and operations i.e. seaport authorities, shippers, freight forwarders and truckers to be responsible actors and play their part and become smart and green. Also, there are fishing harbours close to seaports and are home to large number of boats. Besides, fishing harbours are centers of high anthropogenic activity. Ironically, fishing boats in the coastal and offshore fisheries are old and fuel-inefficient and are feared to produce enormous amounts of GHG.

Port-City Cluster

It is well known that coastal areas have high level of concentration of people. In 2015 of the 513 cities having a population above 1 million, 271 i.e. 52.8% were located less than 100 kilometers from a coastline.[52] This corresponds to 59.4% of the global urban population. By 2050, two-thirds of the world's population is expected to live in cities and by then an estimated 800 million people will live in more than 570 coastal cities.[53]

Cities along the coastline have a complex relationship with the water front and in some cases have been centers of economic activity since ancient times. It is quite natural that seaports are intimately linked to large population centers which are the primary supplier of human resource, skilled, semi-skilled and unskilled, of

diverse occupation-trade. Besides, maritime service activities such as banks, financial institutions, management firms, techno-support professionals, commodity trading professionals and operation managers conduct their respective business in the port cities. Some of these are large enough to be labeled as maritime capitals. The clustering of these professionals and their activities adds to the urban GHG emissions of the city which is already under GHG stress emanating from means of public transport such as buses, cars, ferries and boats for commutation to work places.

It is evident that the port as well as the adjoining city must necessarily synchronize strategies to address GHG issues. The city leaders in partnership with the port administration can fast-track joint deployment of zero emission solutions. The recent inauguration of the Kochi Water Metro offers not only modern and cheap intermodal connectivity transport and backwater tourism, it also eases traffic congestion in the city.[54] The ferries connect 10 islands and stop at 38 different terminals reducing load on the highly stressed urban transport network. Above all, these are electric power ferries and plans envisage building as many as 78 vessels, making it the largest 'electric ferries network' in the world. This is a good example of technological revolution in inland water transport and revolutionary electric and hybrid vessels can be a model for Indian Inland Water Transport (IWT) system network comprising of approximately 14,500 kilometers of rivers, canals, backwaters, and creeks.[55]

In this context, the Green Ports Forum[56] is a global platform that offers opportunities for cities and ports to exchange information and knowledge and help them to “collaborate, reduce emissions, and tackle the climate crisis through collective action” through “coordinated, equitable, and economically sustainable way” and “realise shared climate goals”.

Coastal Tourism

Introduction

Ocean is a part of the world economy. Global ocean economy contributes about USD 1.5 trillion per annum, contributing approximately 2 to 3 per cent to the world's gross domestic product. The economic benefits of the oceans are expected to double from USD 1.5 trillion in 2010 to USD 3 trillion by 2030.[57] Tourism and shipping provide the largest proportion (USD 880 billion), marine resources (USD 377 billion) and marine manufacturing (USD 107 billion).[58] About 350 million jobs globally are linked to the oceans.[59] Coastal states are exploring new opportunities for economic growth in their marine waters. The Blue Economy concept seeks to promote economic growth, while ensuring environmental sustainability of the oceans and coastal areas. Oceans and the ocean-related activities are considered as a fulcrum for the modern economic growth, which can lead towards the sustainable development. This section examines how coastal tourism could be viewed as one of the vital components of India's BE. It focuses on challenges (maritime threats) and opportunities to enhance tourism in India.

Coastal Tourism

Tourism is seen as one of the most important industries on a global scale and expected to grow 100% over the next 10 years.[60] Coastal tourism is vital sector of the economy in many coastal countries that includes dive tourism, maritime archaeology, surfing, cruises, ecotourism, and recreational fishing operations. It not only generates revenue but also protects and respects local cultures, traditions, and heritage. It becomes an important source of foreign exchange and is linked to the social, economic, and environmental well-being of many countries. It is instrumental for the economic survival of many coastal states and is a key sector in developing Blue Economy. Eighty per cent of tourism takes place in coastal areas. Tourism, becoming the largest global business, employs 1 out of every 11 persons globally. Tourism industry was estimated to become the largest segment of ocean economy by 2030. However, tourism is highly dependent on environmental quality to attract visitors.

Coastal tourism provides opportunities to local people to raise their incomes and enhances local infrastructures and contributes to the welfare of local communities. Its development can eliminate social or national prejudices, promote mutual understanding between hosts and guests. It promotes cultural traditions and identity. It provides local communities to benefit from the industry: to alleviate poverty, improving livelihoods and encouraging better management and conservation practices by the local communities. It has brought opportunities: increased standards of living, more employment and training opportunities, diversification for local communities and the socio-cultural benefits associated with interactions between people from differing cultural backgrounds. Economic growth, increasing populations, increasing urbanisation, changing work patterns with more flexibility of travel plans, migration, stress management are some of the factors for attracting coastal tourists.[61]

Coastal Tourism in India

India is having 7,516.5 km of coast-line, 2.37 million sq km of Exclusive Economic Zone (EEZ), 5, 30,000 sq km of continental shelf and 1,197 islands. It is in the 16th position in terms of possession of EEZ in the world. About 18 percent of population lives in the 72 coastal districts in India that comprise 12 percent of India's mainland.

India is having the potential and an opportunity to increase its economic growth rate through maritime domain. India has a long coast and needs to promote coastal tourism, which could enhance in developing Blue Economy (BE).

India was ranked 34th in the Travel and Tourism Competitiveness Report 2019 published by the World Economic Forum (WEF). The Government is involved in developing 17 spots around the country to make use of the country's bountiful coastline.[62] India has potential to explore avenues in heritage tourism, cultural tourism, leisure tourism, ecotourism, and others. Of the 32 most popular beaches in India, the Indian government has identified 8 beaches: Shivrajpur (Gujarat), Ghoghla (Diu), Kasargod and Padubidri, (Karnataka), Kappad (Kerala), Rushikonda (Andhra Pradesh), Golden beach (Odisha) and Radhanagar (Andaman and Nicobar Islands). It has approached the Foundation for Environment Education (FEE) for blue flag certification. The beaches will promote high-value tourism and will attract many tourists to the country. India has potential to lead the tourism sector. For instance, total annual expenditure by tourists engaged in dolphin watching in the Outer Channel of Chilika Lagoon (India) is USD 2,013,000 (over USD 2 million) per year.[63] The World Travel and Tourism Council reports that tourism in India generates Rs 15 lakh crores (USD 200.billion) which amounts to 9.4% of GDP. About 42 million jobs are created in the tourism sector and tourism could grow at an annual rate to 32.05 lakh crores by 2028. Developing tourism in the coastal areas is one of the priorities for the country.

Sagarmala project has focused on promoting coastal tourism in maritime states and key coastal tourism projects include: development of coastal circuits under Swadesh Darshan Scheme of Ministry of Tourism; development of infrastructure for promoting cruise tourism; development of lighthouses; National Maritime Heritage Museum Complex at Lothal; underwater viewing gallery and restaurant at Beyt Dwarka."[64] The Indian government has taken initiatives to: develop 5 ports as cruise tourism hubs include: Mumbai, Goa, Mangalore, Chennai and Kochi; to develop infrastructure at ports for handling cruise vessels and facilitating ease of movement of passengers; to attract cruise ships with dedicated terminals and other related infrastructure for berthing of cruise vessels and embarking and disembarking of cruise passengers; and to create an enabling ecosystem for the development of cruise tourism in India.

Cruise industry is one of the major parts of coastal and marine tourism. Industry data suggest that the cruise industry generates over USD 150 billion in economic activity annually.[65] India can promote coastal tourism from mainland to Island: Andaman & Nicobar Island and Lakshdweep Islands through cruise vessels/tourism. It is to be noted that there is a need to have cooperation and coordination between/among neighbouring coastal countries in developing Blue Economy. The Bangladesh, Bhutan, India, and Nepal (BBIN) countries have tourism potential which includes rich history, cultural heritage and ecotourism and world's major Buddhist sites are situated in this region. The integration of BBIN countries in developing tourism sector would benefit in greater revenue for each country especially for the land-locked Nepal and Bhutan which mostly depend upon tourism for their economic sustenance. Coastal tourism can play a role in the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) to promote regional tourism through luxury cruises, Buddhist and temple circuits, circuits' tourism and cruises. The BBIN initiative is also expected to bring infrastructural development in the region like railways and road which will also in turn promote tourism. The Asian Development Bank (ADB) Board of Directors have provided an amount of USD 57.5 million for the South Asia Tourism Infrastructure Development Project to establish new and improved infrastructure along with traditional services for major tourism sites in the four countries. Incorporating and enhancing cruise tourism, surfing and "niche tourism" activities like deep-sea diving can diversify a destination's offerings and attract a wide range of tourists. Improving and promoting cruise tourism to the neighboring countries can foster economic growth, cultural exchange, infrastructure development, and can improve cordial relations between them.

Further, identifying tourist places and assessing the demand for various types of tourism is essential for sustainable tourism development. It empowers destinations to offer appealing experiences, allocate resources efficiently, and create a balanced and resilient tourism ecosystem that benefits tourists, local communities, and the environment.

Blue Clusters

Blue clusters[66] play a significant role in bringing industry and government stakeholders together to promote development of the different sectors including tourism sector. The cluster is a focal point for all: companies, institutions, research centres acting at various levels in the transformation of products, including the programming of maritime activities. The role of cluster is to promote, coordinate and represent the needs of the sectors. The cluster supports companies from different sectors such as fishing, aquaculture, shipbuilding, maritime transport, coastal tourism, maritime research and training, ports and port activities and industries. Tourism and fisheries can both benefit from proper management of marine protected areas.

Marine Spatial Planning

Marine Spatial Planning (MSP) is a dynamic process that addresses the use of sea areas by humans, with efficiency and efficacy concerns and principles. A single location can be designed for multiple uses. MSP is the tool to manage the use of seas and oceans coherently and to ensure that human activities take place in an efficient, safe and sustainable way. Tourism is highly dependent on environmental quality to attract visitors (security). Maritime biodiversity needs to be protected. Presently, only 3.4 per cent of seas and oceans are covered by marine protected areas (MPAs). The MPA network creates jobs. "A global MPA network that meets the World Parks Congress goal of conserving 20–30 percent of the world's seas could cost between USD 5 billion and USD 19 billion per year. It is estimated that such a network would create about 1 million jobs."[67]

Challenges

There is a 'crisis of the oceans' caused by pollution, jurisdictional disputes, over-exploitation and widespread ignorance.[68] Strengthening Ocean governance is nothing but to enhance global maritime growth and security. Ocean governance is prerequisite to secure healthy oceans. Environmental issues apparently are gaining importance for most countries today.

Following factors have serious effect on oceans: degradation of coral, reefs-resulting from climate change, discharge of fuel and emissions by ships and land-based pollution.

Coastal waters are being polluted by drainage schemes. Due to increased inland irrigation schemes, there is decrease in fresh water supply, and the mangroves are being destroyed. Fifty thousand tons of oil and fuel are routinely dumped daily in the Indian Ocean region by large tankers. There were a few incidents of oil spills in the sea. The MV Tasman Spirit, the Greek tanker which broke into two on 28 July 2004 was carrying as much as 67,500 tons of crude. It leaked nearly 25,000 tons of crude. As a result, much of marine life off the Karachi coast was destroyed. Heavy Fuel Oil (HFO) spilled into the sea in the early hour of 28 January 2017, following the collision between two cargo ships MT Maple and MT Dawn at Kamarajar Port, Ennore, and Chennai. The oil spill off the coast has been estimated to have affected 52 sq. km. Two hundred and eight tonnes of sludge were removed as were 90,000 litres of oil mixed with water by super sulkers.

Climate change will contribute to the gradual destruction of mangrove vegetation, coastal sea life, and degradation of tourism destinations, thus threatening major economic activities. Climate change and rising sea levels will cause coastal erosion, loss of beach area, higher costs to protect and maintain waterfront tourism precincts. More than 60% of the total factories in India exist in the coastal states. Some sectors of Ocean Economy tend to create habitat loss, biodiversity loss, pollution and effects on ecosystems that adversely affect coastal and marine tourism. Activities related to aquaculture, minerals exploration and extraction, garbage from merchant shipping etc. can degrade the suitability of coastal and marine locations for tourism purposes.

Strengthening the resilience of coastal and marine tourism is crucial for the protection of ecosystems, livelihoods, and overall sustainability of the coastal regions. Resilient measures should address vital issues such as ecosystem preservation, biodiversity conservation, natural resource sustenance, economic stability, sustainable tourism, adaptive capacity, community resilience and disaster risk reduction. We need to ensure that oceans are safe, secure, clean and sustainably managed, which would enhance benefits for tourism sector.

Conclusion

Coastal tourism improves the local environment, provides opportunities for economic prosperity and revives and sustain local communities and culture. It can play a role to help communities to return to traditional culture, customs, heritage and knowledge and creating a sense of local identity. However, its revenue is seasonal and unstable. This will reduce the profits, the quality of jobs available and the benefit to local communities. Initiatives to be taken to extend the tourism season, reduce seasonal risks, increase productivity, reduce overall costs and increase profits and look for alternative sources of income for those who serve tourists.

Marine/Maritime Energy Transition

Introduction

Climate change and the resultant global warming have rightly been projected as an existential threat to life on the planet. If left unchecked, the higher global temperatures could affect the entire living space, disrupting basic planetary functions like the water cycle, gaseous balance, biodiversity, ecosystem productivity, sea level rise and land submergence, and mass migrations. In fact, unmitigated warming could undermine the whole campaign for sustainable development under the "Agenda 2030". Various organisations have also assessed the broad socio-economic impacts of unmitigated climate change and most agree that the consequences of inaction would be extremely serious. Considering the heavy costs of unchecked climate change, the world community has been busy planning an appropriate clean energy transition for all major contributing sectors. This section will map and examine the energy transition for the marine and maritime sectors.

Impact of Climate Change

By 2050, the world's population is expected to expand close to 9 billion, increasing the pressure on already scarce resources. Prominent projected trends are: the global GDP is projected to double every 22-23 years, the population will progressively age, reducing productivity and further burdening the health care sector; and over 70% people will migrate to cities, requiring an enormous expansion of urban infrastructure. Without major mitigation efforts, this expansion will require much higher amounts of energy, and without profound improvement in the energy mix, this will result in significant expansion of fossil fuel usage. As a result, emissions will not only continue but increase. As per some reports, this scenario of inaction could result in global average temperatures reaching up to 3-6 degrees above pre-industrial levels by the end of this century, much beyond the agreed target of 1.5 degrees Celsius. In the absence of serious mitigation measures, the GDP losses could add up to 18% by 2050, even if we succeed in limiting the temperature rise to 3.2 degrees Celsius. On the other hand, even though entirely stopping the warming seems improbable now, a combination of well-crafted emission reduction efforts could ease the transition to the projected net zero emissions by 2050.

Other consequences of inaction by way of no new measures could be: serious drop in global biodiversity; massive shrinkage of mature forest cover; reduction in cultivable land; shortage of safe drinking water. Over a billion people could remain without basic sanitation and face greater health risks because of unsafe water, polluted air, and enhanced incidence of tropical diseases.

According to the latest Climate Transparency Report to the 18th G20 Summit, India would be amongst the countries most affected by global warming. India suffered a loss of 5.4% of GDP in 2021 from climate events. If this trend continues, the annual damage from climate events may rise by 49% and labour productivity may fall by 5%. Nearly 10% of our population could soon be exposed to climate disasters.

Greenhouse Gases (GHG) are the primary cause of warming and fossil fuel combustion-based energy is the predominant source of these emissions. Therefore, the only plausible escape from the disastrous impact of climate change is to minimise emissions through greater energy efficiency and a major shift to cleaner sources of energy to replace fossil fuels.

GHG emissions are mostly contributed by the following sectors		
SECTOR	GLOBAL	INDIA
a) Agriculture and farms	11.6%	21%
b) Housing/ Commercial	6.2%	5%
c) Manufacturing/construction/processes	18.8%	22%
d) Electricity and heat	31.8%	37%
e) Transport/International bunker	16.9%	9%
f) Forestry/ waste	6.6%	4%

The world community is now fully convinced of the climate risks and has been working on agreed solutions for limiting temperature increases through a series of measures, the broad pathways being: energy efficiency, phasing out of fossil fuels, carbon capture and storage and finally resilience and adaptation.

Marine and Maritime Energy Transition

In keeping with the theme of this report, this section will map and examine the energy transition for the marine and maritime sectors, which broadly covers ports, logistics, and the shipping industry. It will examine the entire supply/value/operations chains for these sectors including the current state and the way forward for energy transition, relevant technology and skills, policy and regulatory enablers, challenges, and some actionable recommendations.

The maritime industry is heavily fossil fuel dependent and uses heavy fuels that are generally more polluting. The industry produces close to 1.2 gigaton (GT) of Carbon dioxide (CO2) equivalent emissions, accounting for nearly 3% of global GHG emissions (2020). Ironically, because of the trans-border nature of these emissions, they are also excluded from the measures to address nationally determined contributions (NDCs). The industry also produces 5-10% of global Sulphur dioxide (SO2) and 17-31% of total Nitrogen dioxide (NO2) emissions. Considering that nearly half of these emissions are released in the coastal regions, they can have very serious health risks for coastal communities. The International Maritime Organisation (IMO) has called upon the shipping industry to cut their emissions by half vis-a-vis a 2008 base by 2050. The sector will need to transition through efficiency and clean energy gains across four major value chains: shipbuilding, greening of ports, clean energy induction, and operations. The process would need matching support from an appropriate mix of incentives and cost through policy, regulation, and financial tools.

Greening of Shipbuilding

Until a major breakthrough in clean fuel alternatives becomes available, efficiency gains could help reduce emissions at all stages of the industry's value and operations chain, starting with the shipbuilding process itself. While the majority of emissions from shipping vessels accrue during operations, emissions from the building stage are quite significant. In addition, design and technology decisions taken during the building stage will determine vessels' emissions during their entire lifecycle. This calls for greening of the shipbuilding process towards the net zero targets. In the absence of a rigorous emission compliance regime at the shipbuilding stage, this exercise assumes greater significance. The drivers for yard efficiency or greening include: a) capacity building and climate sensitisation of the workforce; b) energy efficient technology induction, including digitialisation and automation for better design, more efficient supply chains and

inventory management, cyber security and compliance with the IMO emission norms; c) use of better fuel and cleaner energy where possible, including micro/smart grid options. Industry 4.0 applications can significantly improve energy efficiency and emissions. d) need to adopt optimal circular economy operations. These upgrades could contribute towards achieving net zero emission targets, enrich the quality of human resources, not the least improve productivity and profitability of the ship yards.

Greening of ports

Ports are the next candidate for significant efficiency gains, offering a whole logistics network for multiple stages for improvement by way of efficient operations and use of cleaner energy. The first and foremost factor to address is vessel turnaround time; i.e., the amount of time a vessel spends at port when delivering or picking up cargo. The longer they stay more pollution they cause. Some of the important measures that could be taken include: 1). Digitialisation, including connected ports and vessels, could help ease this congestion by way of advance sharing of details of cargo content for clearance by various border control authorities like customs, quarantine or security to minimise individual inspection needs. This would allow direct movement of cargo between the vessels and delivery/pick up vehicles; 2). Real time communication between the ports and vessels could facilitate just in time arrival of the vessels to minimise their hold up at the harbour and speed optimisation, reducing avoidable extra emissions; 3). Cold ironing and grid connectivity of the parked vessels: the vessels berthed in the harbour need to keep their auxiliary engines on to provide power. This emits NO2, SO2, CO2 and particulates causing harmful pollution. This could be mitigated by connecting such vessels to a grid-based port power system. If the port power is renewable, all the better; 4). Relatively simple improvements in the auxiliary port infrastructure could reduce emissions significantly. There are all kinds of operations like port vehicles, cranes, dredgers, tugs, fork lift trucks running on diesel. All these operations could migrate to cleaner sources of energy like CNG, LNG or preferably green hydrogen and electricity.

Decarbonisation of maritime operations

This is the epicentre of maritime emissions on account of inefficient operations, structural lags and poor-quality fuel. This section would briefly examine them all to suggest practical improvements.

Measures for operational efficiency

Voyage performance could be streamlined across several parameters to optimise energy usage. Important measures include: i). speed optimisation and better coordinated timing of arrival at the port reduces the berthing time and increases energy efficiency of the engine; ii). On-route real-time weather-based guidance software can enable ships to optimise their routes, thus avoiding disruptions and enhancing fuel efficiency through speed optimisation and timely arrivals; iii). Modern auto-pilot systems can minimise rudder deviation, which enhances safety and fuel efficiency; iv). Trim/draft/ballast optimisation can save up to 5% fuel which depends on ship design as well as cargo distribution. These relatively simple operational measures can not only reduce emissions but also enhance safety.

Energy efficiency audit: Ships have a large network of systems that consume most of the fuel during voyage. Small leakages can make a significant difference to the fuel efficiency and emissions. Therefore, the vessels' energy management should be monitored on a regular basis, including third party audits from time to time.

Another important energy saving measure is the good maintenance of the hydrodynamics of the vessel, which should include hull and propeller cleaning. Proper hull and propeller roughness could reduce sailing

friction and reduce energy consumption to the tune of 20-30% in some cases. This is a major saving on account of fuel and emissions, and needs close attention.

Efficient design and structural features

Improved designs and other structural features of the vessels can also enhance energy efficiency. Larger ships (up to 8000 TEU capacity) are more efficient than smaller ships on account of economies of scale. This efficiency, though, diminishes in very large ships because of operational difficulties of berthing and difficulty in full capacity utilisation. Ships' structural weight is another factor that could reduce or enhance efficiency. The lower the structural weight, the higher is the efficiency. This could be achieved by using light high tensile steel. Propeller design, size, number of blades, RPM rate, alignment and lubrication can also significantly enhance fuel efficiency and reduce emissions. Finally, the most important structural components are the main and auxiliary engines. Their specifications, quality and maintenance are responsible for the largest gains or losses in the energy consumption of a vessel. They demand utmost care and maintenance as they are the initial choice of efficient technology. There are several other design features which could help reduce fuel consumption.

Finally, the decarbonization: of the energy/fuel mix is definitely at the core of greening the maritime sector. Post Cold War, the global GDP has multiplied several folds requiring a corresponding expansion of the maritime sectors. So far, the expansion of maritime sector has been directly correlated with expansion of energy consumption and emissions. This dependency could be decoupled by way of energy efficiency and greening of energy sources.

Evolving IMO Regulations

The IMO has been concerned over the pollution caused by ships and has adopted a series of measures both for vessel efficiency and improved fuels; the important regulations are: A) Energy Efficiency Design Index (EEDI): these regulations were mandated by the organisation in 2011 under the International Convention for Prevention of Pollution from Ships (MARPOL). It mandates 10% CO2 reductions for cargo vessels and 5% for passenger ships through energy efficiency by 2019, 15-20% by 2024 and 30% by all vessels from 2025 onwards. B) Ship Energy Efficiency Management Plan (SEEMP): this regulation makes it compulsory for ships larger than 400 GT to have an SEEMP on board, which operates through four cyclical stages of planning/implementation/monitoring/self-evaluation and improvement. C) Energy Efficiency of Existing Ship Index (EEXI) applies to all vessels above 400 GT and seeks a measurable reduction in emissions over fixed time cycles. D) Energy Efficiency Operational Indicator (EEOI) measures the overall performance of Energy Efficiency (EE) parameters for monitoring and improvement. E). Carbon Intensity Indicator (CII) fixes CO2 per deadweight mile for all ships beyond 5000 GT and rates the ships from A to E grades. The reduction norms become progressively more rigorous. The compliance with these regulations has resulted in a visible improvement in carbon and energy intensity of all vessels and this process is set to become increasingly tighter.

The IMO 2023 regulation sets GHG emission reductions of 40% by 2030 and 70% by 2050 over a 2008 base line. Such a reduction will not be possible without the induction of cleaner fuels. Several alternate fuels are currently being studied and these basically fall into three categories: (i) Blue Fuels from reformed natural gas with CCS (Carbon Capture and Storage); (ii) Biofuels from sustainable biomass sources (Biogas and Biodiesel) and (iii) Electro-fuels or e-fuels produced by using renewable energy with non-fossil carbon or nitrogen (e-ammonia, e-methanol and green Hydrogen). These fuels are at different stages of research, testing or

induction. Their further integration with maritime energy/ fuel mix will depend on ease and adequacy of availability, economic viability, engine compatibility and safety.

Biofuels

Biofuels (Biodiesel/Biogas), Ethanol and Methanol are already being used in different mixing combinations and are compatible with many engines as such or with minor modifications. These fuels do help reduce emissions and if they are produced using renewable sources, their net emissions could well be zero. However, as their sources are biomass in some form or the other, their large-scale induction into the energy mix could potentially have a bearing on food security. Moreover, these fuels are already being extensively used in the land transport sector and could face further scalability issues. Some induction is certainly possible but scalability needs deeper assessment.

Green Hydrogen

Green Hydrogen is being projected as a potential game changer for maritime energy transition. Green Hydrogen can be produced through hydrolysis using renewable electricity. Liquified Hydrogen can potentially be used in direct combustion, through steam energy, for fuel cells or as building blocks for other e-fuels such as e-Ammonia or e-Methanol.

The advantages of Hydrogen are: their abundant availability, simple extraction process and zero emissions. However, there are many challenges as well, namely their highly combustible nature, cryogenic storage requirements, many fold space required for storage, complex and costly supply infrastructure, and expensive extraction process.

Though the first hydrogen powered ferry has been launched, more research is needed for scaling up the entire supply chain with adequate safety and competitive pricing. Therefore, in the short term, hydrogen could be used for shorter distance transport, and this field experience could help with technology improvements and developing adequate regulation for further expansion.

Green Ammonia

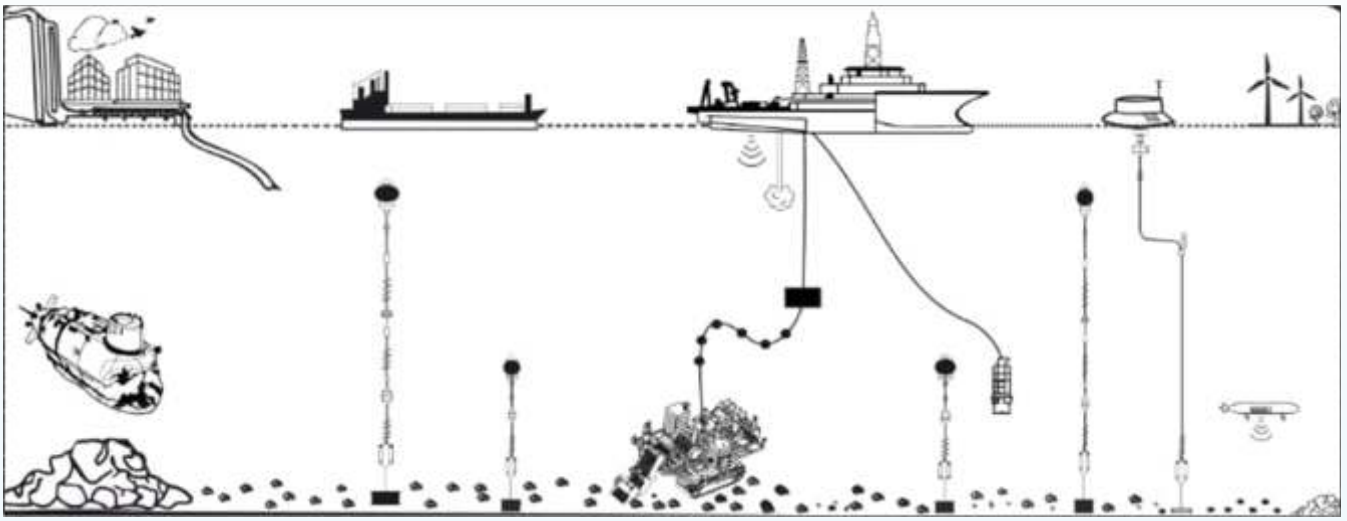
Green Ammonia produced using renewable energy or Blue Ammonia produced using by-products of fossil fuels could be good options for emission reduction in maritime fuel. Advantages of Ammonia are: existing industry experience of production, transport and storage; lower cost than hydrogen, normal temperature for storage, suitable for long distance travel; and could be used as drop-in fuel or through fuel cells.

Though Ammonia is being considered as a promising candidate for green energy substitution in maritime sector and some companies are already working on Ammonia ready vessels with suitable engine modifications and storage tanks, there remain several challenges which need to be addressed namely: (i) high toxicity, (ii) corrosive nature, (iii) its combustion without suitable system adaptations may emit nitrous oxide (a powerful Green House Gas), (iv) requires changes to existing engines and new storage facilities. This could impact safety and economic viability.

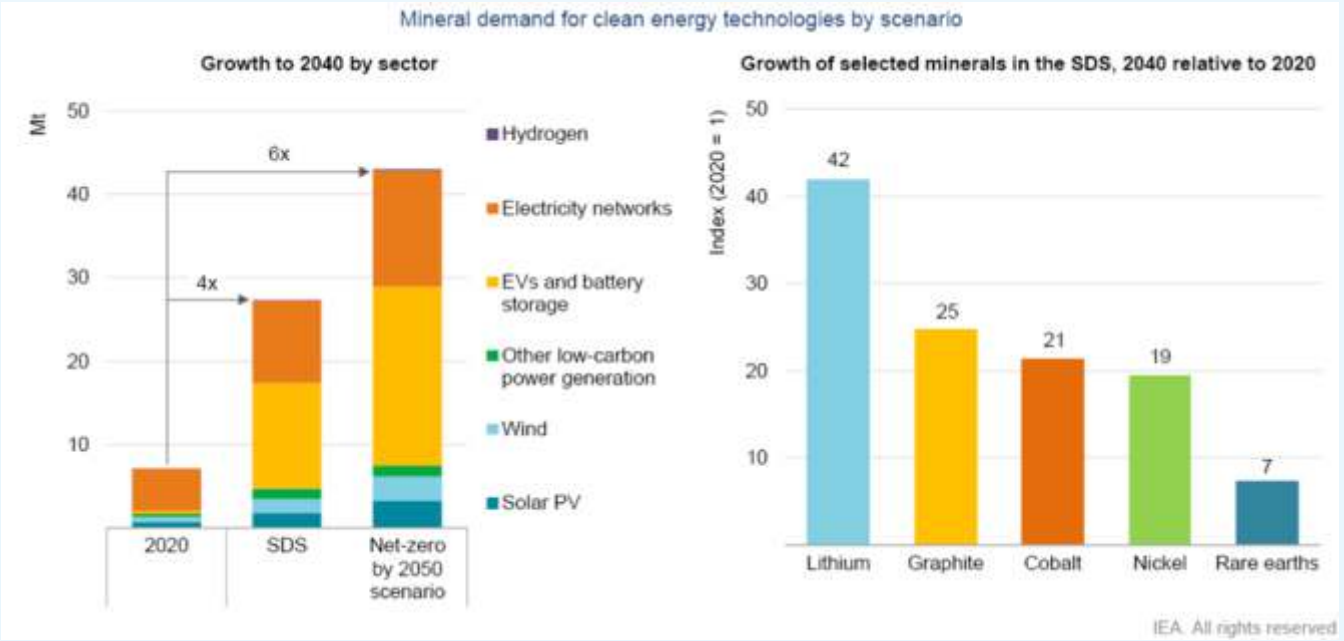
To sum up, there is ample evidence and convincing arguments in favour of an early energy transition along the entire value/supply chains of the maritime sector for achieving the larger global goal of carbon neutrality before it is too late. Given the complexity and novelty of the available transition pathways, along with technical competence, it would be equally important to create an all-round enabling and supportive policy, regulation, R&D, industry, civil society and financing ecosystem.

Deep Sea Mining

Deep Sea Mining– An Overview and Opportunities



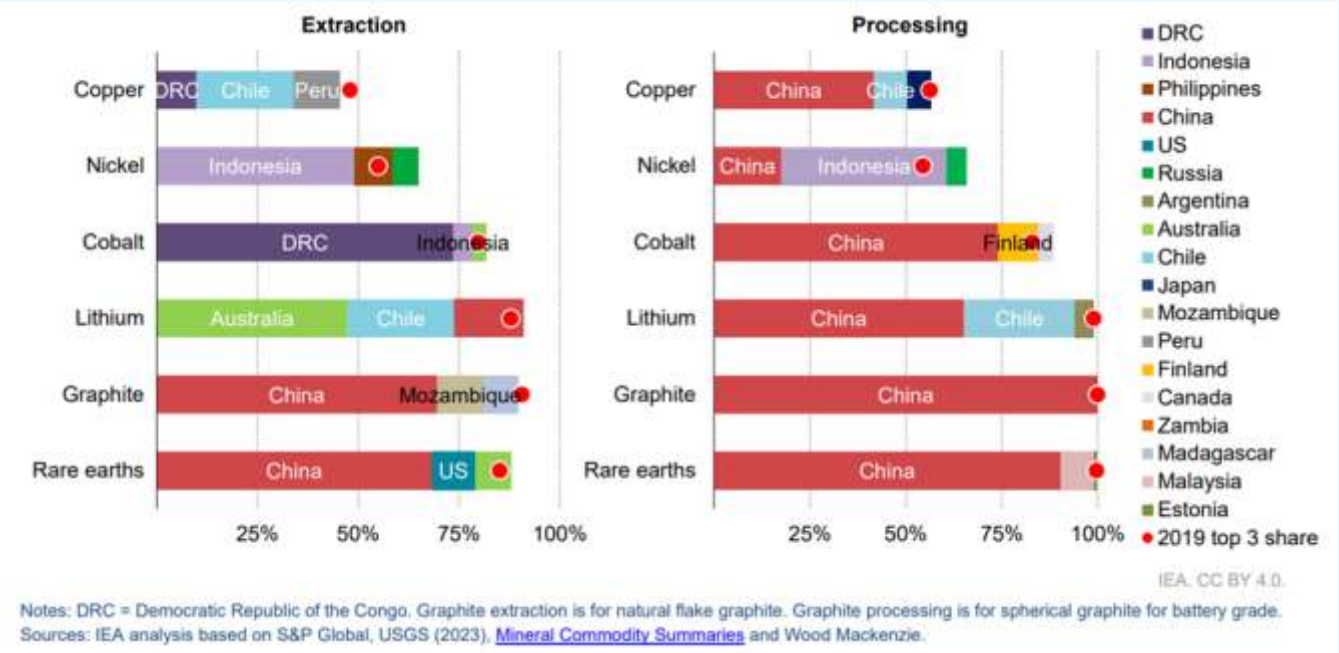
Deep Sea Mining of mineral resources has been attracting attention around the world and is a sunrise industry, intertwined with the development and sustenance of numerous other established industries. With a growing world population and increased urbanisation, there is a global thrust on green technology in order to meet the climate change goals. The direction of this global drive has been in extensive electrification based on renewable energy, with stress on reduced fossil fuel use, and adoption of electric vehicles (EVs) for transportation, both public and private. Consequently, this has necessitated in high energy density and efficient power storage systems - thereby resulting in the rising global demand for Cobalt (Co), Nickel (Ni), Copper (Cu) and Rare Earth Elements (REE).



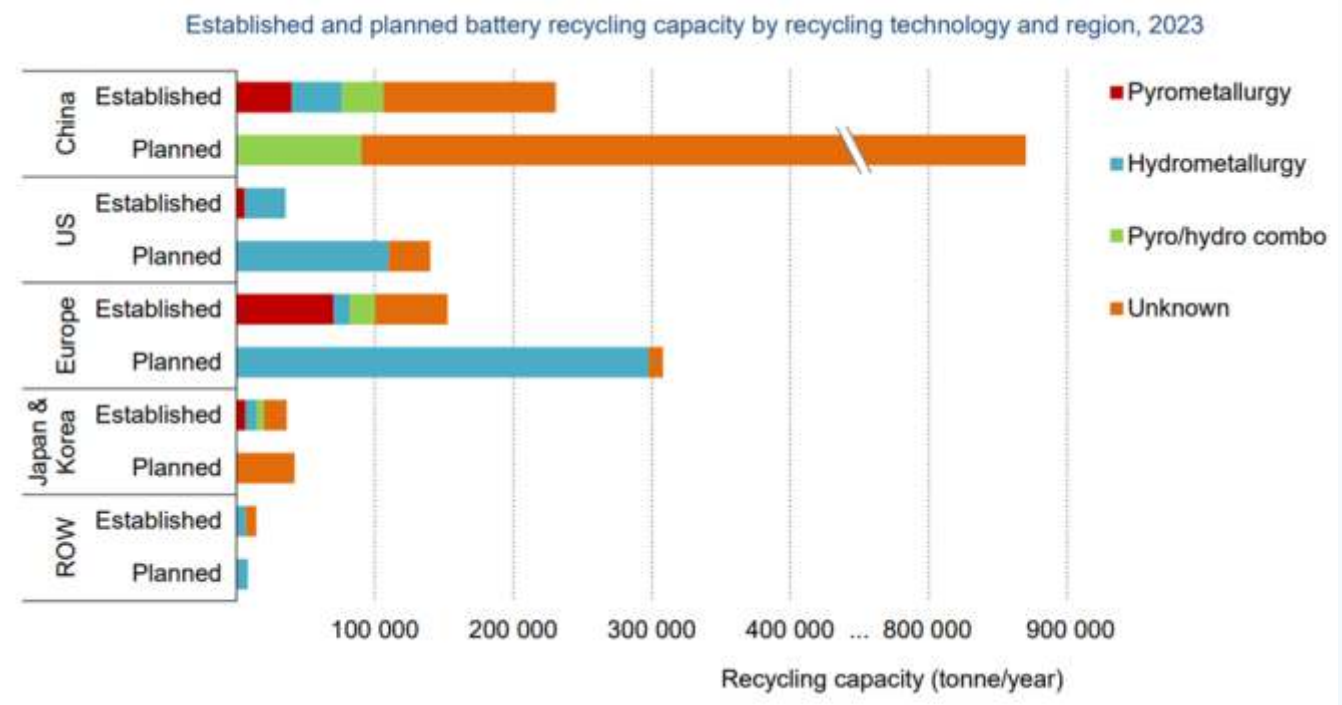
Electric vehicle production is projected to increase from 5 million in 2016 to 245 million by 2030; more than 30 times above today's level[69]. An electric vehicle with a 75 kWh high energy density battery is estimated in having 56 kg nickel, 12 kg manganese, 7 kg cobalt and 85 kg copper for electric wiring[7071].



These metals are in short supply from the known terrestrial sources in limited locations around the world. Even progressive recycling and attempts at developing a circular economy would not meet the explosion of the demand forecast over the next 20-30 years. India is deficient in all these major metals and could have an enormous economic impact on growth and national security.



Notes: DRC = Democratic Republic of the Congo. Graphite extraction is for natural flake graphite. Graphite processing is for spherical graphite for battery grade.
Sources: IEA analysis based on S&P Global, USGS (2023), Mineral Commodity Summaries and Wood Mackenzie.



The next best source of these metals after land, is in the deep oceans. There are three principal deep-sea minerals of interest:

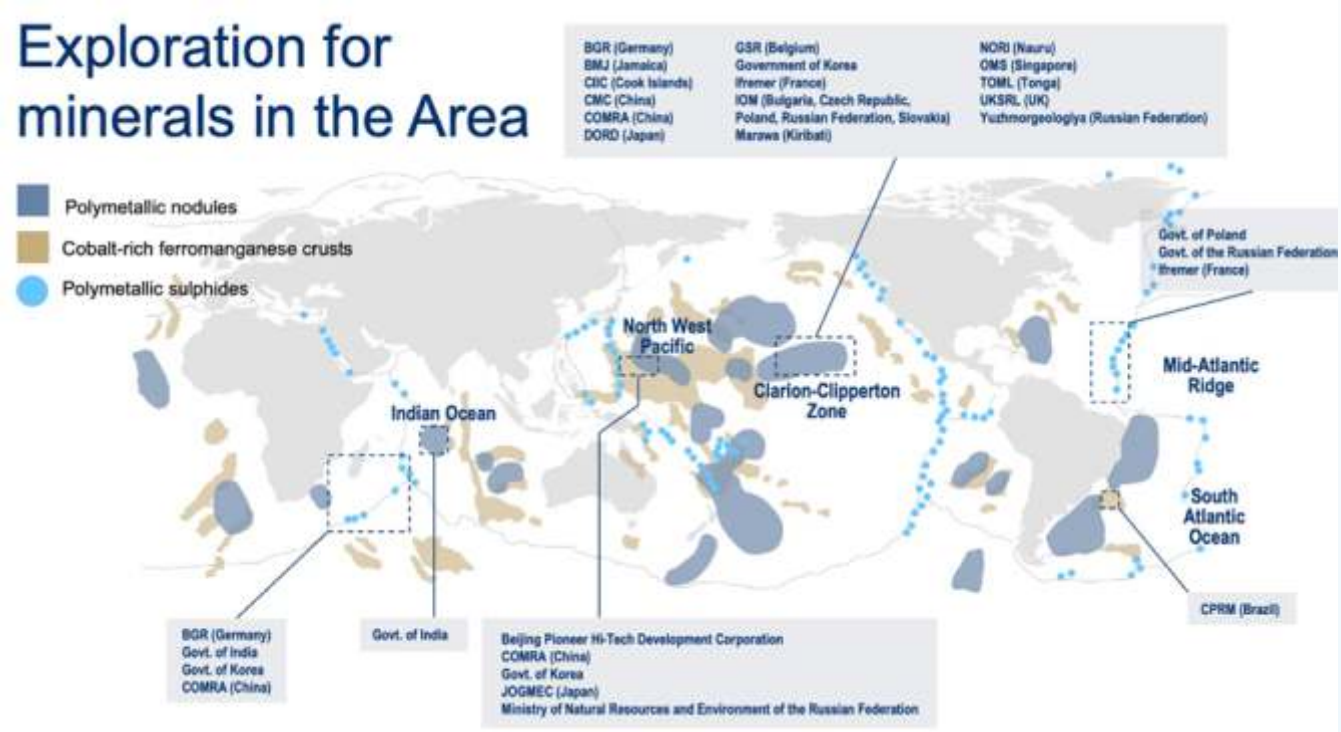
Polymetallic Nodules (PMN) – These are potato shaped nodules of normal size 5-70 mm, found on the soft sediments of the abyssal plains of the deep ocean at depths of 4000-6000 m. These have accreted over millions of years about a hard-fossil core, and are essentially ferro- manganese nodules, with nickel, cobalt and copper being more than 2.5%, and with traces of REEs. Deep sea fauna has been found resident on the nodules and the sediments.

Polymetallic Sulphides (PMS) – These deposits are found as high mounds (normally 15 – 50 m high) or covered with subsea overburden at the mid-ocean ridges of all the oceans, with active or inactive hydrothermal vent activity. Found usually at depths of 1000-4000 m, the active vent areas are extremely rich in marine bio-diversity with a majorly self-sustaining ecosystem. The mineral deposits are encouraging sources for copper, gold, silver, and zinc. Considering the rich bio-diversity at the active vents, only inactive vents would be potential sources, allowed for deep sea mining.

Cobalt Rich Crusts (CRC) – These are ferro-manganese hard crusts of varying thickness, accreted on the flanks and summits of the sediment-free sea mounts and plateau. Normally occurring at depths of 400 – 4000 m, these are sources for cobalt, nickel and platinum. Marine fauna has been observed resident on these crusts. Also, the depths being lesser, these sources as closer to the photic zone in the ocean.

Of the three principal deep-sea minerals detailed above, PMN, is presently the most promising for harvesting in industrial quantities. These are mineral rich in the principal metals of current interest, often termed as the EV Metals, viz. nickel, cobalt and copper[3], with traces of REEs. The rich finds of PMN are in the Clarion Clipperton Zone (CCZ) of the North Pacific Ocean, spread over about 9 million km^2 of seabed area; in the enormous EEZ of the island nations in the Pacific, viz. Cook Islands, Nauru, Tonga, Kiribati etc.; and in the Central Indian Ocean (CIO) over an area of about 150,000 km^2. In the CCZ of the North Pacific Ocean, the nodule

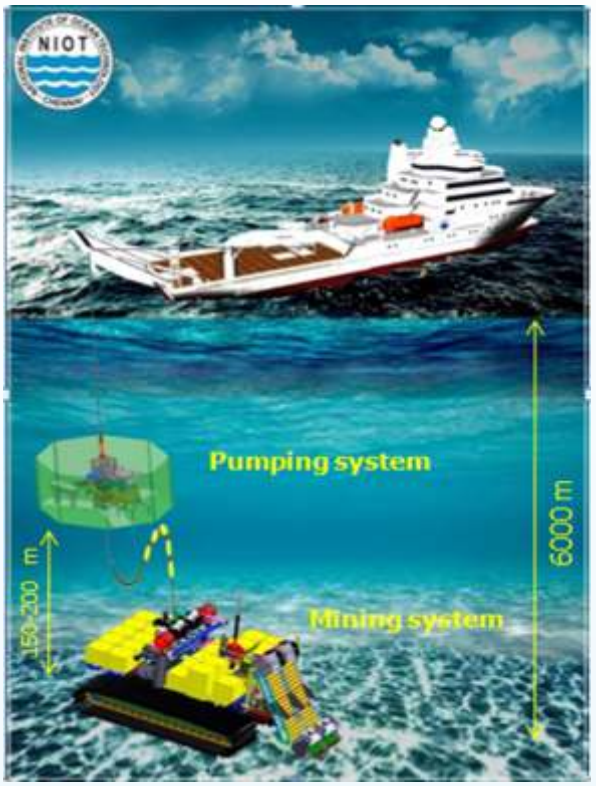
abundance is higher and the quality better, making the area highly sought after. The depths in the area range 4500 – 5200 m. Eighteen out of the 20 PMN contracts with the International Seabed Authority (ISA) have the Area allotted in the CCZ for survey and exploration[72]. Ministry of Earth Sciences (MoES) under Government of India (GOI) is the only PMN contractor in the CIO where the depths range 5100m – 5600 m.



Ministry of Earth Sciences(MoES)/Government of India (GOI), through numerous Research and Development (R&D) institutions and public undertakings, has been working on deep sea mining for PMN by way of survey and exploration and niche technology development, for the last many decades and identified potential areas for mining in the CIO.[73] Council of Scientific and Industrial Research (CSIR) – National Institute of Oceanography (NIO), Goa had carried out the seabed survey and exploration work along with the study on Environment Impact Assessment (EIA) on mining. MoES/GOI had been allocated a seabed area of 75,000 km^2 in the CIO for survey and exploration in the nodule rich international waters by the ISA.

National Institute of Ocean Technology (NIOT), Chennai under MoES, has been working in developing an integrated mining technology to harvest and reliably transport the nodules from the depths of 5500m - 6000m to the surface through a pilot demonstration - which would form a representative basis for developing a commercially viable system for the industry[74]. Recently in 2021, NIOT successfully demonstrated the seabed mining machine system trials at a depth of 5270 m. CSIR- Institute of Minerals and Material Technology (IMMT), Bhubaneswar and the associated public undertakings have developed and demonstrated technology for extracting Cobalt (Co), Nickel (Ni), Copper (Cu) and Manganese (Mn) from polymetallic nodules. Both pyrometallurgy and hydrometallurgy routes have been developed in pilot demonstration of the extraction process. It would be fitting to state that the Indian R&D efforts and the outcomes demonstrated are comparable with the contemporary work in progress internationally.

MoES/GOI, through the National Centre for Polar and Ocean Research (NCPOR),[75] Goa is working on survey and exploration for polymetallic sulphides in the CIO. The ISA has allocated an Area of 10,000 km^2 at the Indian Ocean Ridge systems for this work. The other countries that have similarly been allocated an area at the Indian Ocean Ridge system are Germany, China, and South Korea.



The drivers for the deep-sea mining technology development and operational perspective have been the offshore engineering concepts and systems developed by the deep water oil and gas drilling industry[76]. The deep-sea mining system configuration for polymetallic nodules typically consists of a large ship, suited for open ocean operations, supporting the subsea systems of a very long and heavy vertical steel riser system, connected to a seabed miner – either self-propelled or towed. The vertical steel riser system majorly has a large diameter pipe for transporting the seawater-nodule slurry collected by the seabed miner from the sea bottom to the surface ship. It also provides for the deep water power lines to supply the enormous power required underwater in megawatts for the subsea operations. The hydraulic lift of the nodule slurry over 4500m-5500 m is achieved by using the air lift method, which is very power intensive, or by using a series of inline booster slurry pumps at intervals. The nodule slurry on receipt at the top is put through an enormous dewatering system to separate out the nodules, nodule particles disintegrated during flow and the seabed sediment that would have been also sucked up by the miner.

The separated sea water is discharged overboard below the mesopelagic layer of the water column or at the same depths of the sea bed where the nodules were collected. As the seabed miner moves on the seabed collecting nodules on a pre-defined path, monitored by suitable subsea systems, the ship on the surface moves in follower-mode to the miner in a controlled manner. The complete vertical riser system continues to be suspended from the derricks on the ship - suitably adapted, to absorb and withstand the high heave loads in open ocean conditions.

A typical commercial mining operations is envisaged to be about 250-300 days at sea, in continuous round-the-clock operation. This is apart from the breaks for planned routine maintenance, unpredictable downtimes, and even severe ocean conditions, necessitating temporary suspension of the subsea and the water column operations and moving to a safe area. The mining ship also functions as a temporary storage of the harvested nodules, before it is shipped out at sea to a series of transport bulk carriers, transporting the nodules to shore

for metallurgical refining operations, while the mining operations is concurrently in progress. From the economic studies of polymetallic nodule mining, collection, extraction and the forecasted price of the metals, an economical quantity of 1.5 – 4.5 million tons of dry polymetallic nodules is estimated to be collected per year[77]. The quantity of the annual collection eventually stems from the cost and the economical plant size being set up for metallurgical extraction. Consequently, the size and the number of the mining ships, the mining system of seabed miner, vertical riser and the pumps and the operational periods are sized to meet the annual collection estimates.

Contemporary development work is also in progress around the world in developing pilot and prototype systems for deep sea mining of nodules. Global Sea Minerals Resources (GSR), DEME Group, Belgium with a mining Area in the Clipperton Fracture Zone (CCZ), successfully tested a 25 ton pre- prototype of a nodule collector at depths of 4500 m in the Pacific Ocean in April 2021. Full scale prototype testing with vertical slurry transport is planned by 2025. GSR is understood to have partnered with Transocean and Ocean Mineral Singapore in development of the mining ship and the riser systems for the planned prototype trials. The Metals Company (TMC), Canada in partnership with Allseas, Netherlands undertook integrated mining system prototype trials in Oct-Nov 2022. With a large drill ship converted to be the mining ship, a 95 ton seabed miner prototype and a rigid steel riser system supplied by OSI, UK, over 3000 tons of polymetallic nodules were successfully pumped up using the airlift transport method from about 5000 m depth at the CCZ, Pacific Ocean. UK Seabed Resources, a deep-sea mining subsidiary of Lockheed Martin, USA, with exploration area in the CCZ, plans a deep water nodule collector test in 2023-24. Incidentally, the parent company, Lockheed Martin, was part of a consortium which successfully tested the design and the deep-sea mining systems during the trials in the Pacific Ocean in 1976.

The International Seabed Authority (ISA) under United Nations Convention on The Law of The Seas (UNCLOS) has the authority over the seabed in international waters. Presently, only survey and exploration rights have been contracted by the ISA. Over the next 2-5 years, the ISA is expected to bring out the 'PMN Mining Code', recognising the need for sustainable mining, with strict environmental oversight.The overriding spirit of the Mining Code will be that the resources that are being harvested are the “Common Heritage of Mankind” and thus should benefit mankind overall. This Mining Code would enable commercial mining in the nodule rich areas of the oceans in international waters and give a kick start to the deep-sea mining industry worldwide. While there may be reservations currently on the deep-sea environmental impact aspects, the Mining Code is expected to also address these issues. This is expected to give fillip to the allied industries of heavy and offshore engineering, offshore support, environmental monitoring and classification, mineral extraction, shipping and logistics, insurance and finance.

The Mining Code of the ISA and the fillip that it is expected to provide for deep sea mining, is an opportunity for India. In addition to developing the deep-sea mining technology, which would be beneficial to the Indian industry, India could also strive to position itself as the primary and preferred destination of the harvested nodules by the major players in commercial deep-sea mining. With a very well-developed terrestrial mining and metal extraction industry existing in India, with healthy marine logistics and shipping to support, repositioning, and repurposing some of these strengths could be advantageous. The likely competitors are China and other South Asian countries like Vietnam and Indonesia which are closer to the CCZ, Pacific Ocean. Metal extraction of cobalt, nickel and copper, with manganese in large quantities, provides the opportunity for growth of the downstream industries and the high value segment of electric vehicles, high power density batteries and the associated technology.

With a growing market in India over the next two decades, it portends well to competitively plan the resources, products, and the technology, to meet the demand. A major factor in this regard would be the policies that would enable this direction. The Mining Code of the ISA would require suitable review of the Indian marine mining laws, to permit the Indian companies to engage competitively in deep sea mining under the Indian or

foreign sponsorship or in mutually beneficial international consortiums. In particular, there would be the need for enabling laws that provide clarity in terms of taxation and duties, and consideration of liabilities, in mining in international waters and moving the mineral resources to India and other destinations. As an important emerging domain deep sea mining offers attractive opportunities. For it the Indian industry needs to be incentivized suitably.

The World Bank has estimated that over 3 billion tons of minerals and metals will be needed by 2050 to enable energy transition, thus necessitating harnessing the seabed resources. To sum up, the seabed mining offers new vistas for business partnership and joint venture among different industries in the underwater mining supply chains including exploration, extraction, transportation, storage and processing.

Marine Biotechnology and Pharma

The harnessing of the marine resources has historically evolved in sync with the development of technologies for easier and deeper access to the ocean spaces. Ever advancing and more powerful technologies led not only to the expansion of the traditional blue economy sectors like fisheries, transport and recreation but also progressively opened new sectors like energy, mining, and biotechnology. They also provided more effective tools for research, monitoring and management. Marine Biotechnology and

Pharma is one such sector which is heavily dependent on the cutting edge technologies but offers unprecedented industrial solutions in a variety of sectors of food, energy, industrial applications, conservation and human health. This section will briefly bring out the potential of this important emerging sector, especially food and health sector applications.

The vast expanse of the oceans covers over 70% of the planet, and has wide environmental variations and immense marine biodiversity which are the principal triggers for the potential for marine biotechnology and pharmaceutical applications. Over 90% of the earth's biodiversity dwells in the oceans and they live under challenging pressures of chemical, physical and biological variations, demanding a variety of structural, physiological, biochemical and behavioural adaptions. Many of these special adaptations are enabled by a band of very unique secondary metabolites that these organisms produce for surviving adversities. These extraordinary adaptive features also offer possibilities of novel food and health care applications. The potential and scope of marine biotechnology applications could be assessed from the fact that over a million species of algae, corals, sponges, molluscs, fish and mammals live in the oceans. Additionally, there are countless species of bacteria, viruses, fungi and other microbes with rare stocks of functional bio-molecules and secondary metabolites. So far, we have succeeded in identifying, classifying or studying only about 10% of these marine species, leaving a large treasure of potential applications unexplored.

The most likely marine biotech applications would include: enhanced food production and quality, cosmetics, biofuels, new materials for industrial applications and finally health care including rare pharmaceuticals. For the purpose of this section, we would briefly illustrate food/feed/nutritional, biomedical, cosmetics, biofuels and pharmaceutical applications.

The marine based food, feed, and nutritional supplements could emerge as a major line of business opportunities. Marine fishing has always been an important source of food and nutrition. However, with the fast depleting wild catch, fish production has been migrating to aquaculture as a major source, and we always look for new methods for enhancing yield through tools such as optimising species mix, improving feed, disease mitigation and finally adopting more environment friendly technologies and processes. Biotech applications have potential answers for many such interventions. High yielding and disease resistant fish varieties can and are being developed using genetic engineering; biological controls of pathogens are being effectively explored; and better feeds are being introduced for greater biomass formation and minimising environmental pollution. Rare nutritional products are being developed using marine bio active ingredients with anti-cancer, anti-inflammation, anti-oxidation, and anti-microbial qualities. Marine sourced polymers have interesting uses in food industry such as gelling, stabilising, thickening and binding agents. Phytoplanktons and sea weeds are being used for producing bio-fertilisers, bio- stimulants and as natural suppliers of plant growth hormones for increasing crop yield.

Cosmetics offer another good segment for marine biotech applications, as the society has long been using such products as shell-based creams/powders, gels, and mud. Some marine bacteria, algae and shell species produce substances that are used in sunscreens and anti-aging products.

Marine Organism	Species	Product	Application in cosmetics	Firm
Macroalga	*Undaria Pinnatifida*	Ephemer	Anti-aging	BiotechMarine®
Microalga	N.I.	Silidine	Reduce the dilation of blood vessels and the redness in legs.	Greentech®
Macroalga	N.I.	Xcell-30	Anti-aging and active against psoriasis and dandruff	Greentech®
N. E.	N.I.	Cellynkage	Anti-aging	Lipotec®

*N.I.: not informed by the manufacturer. **N.E.: not found.
Source: BIOTECHMARINE 2016; GreenTech 2016; LIPOTEC 2016.

Macroalgae	Microalgae
Acrosiphonia orientalis	Dunaliella tertiolecta
Ulva fasciata	Isochrysis galbana
Ulva lactuca	Botryococcus braunii
Enteromorpha compressa	Chlamydomonas reinhardtii
Caulerpa peltata	Chaetoceros calcitrans
Valoniopsis pachynema	Euglena sp.
Bryopsis pennata	Spirogyra sp.
Padina tetrastromatica	Cyanobacteria
Lobophora variegate	Scenedesmus obliquus
Centroceras clavulatum	Phaeodactylum tricornutum

Marine resources used in biofuel production (Baskar et al. 2018)

CVS agents		
Organism	**Chemical compound**	**Uses**
Laminaria angustata	Laminine	Hypotensive agent
Eptatretus stoutii	Eptatretin	Potent cardiac stimulant
Antitumour agents		
Bugula neritina	Bryostatin	Stimulate haemopoitic cell
Dolabella auricularia	Dolastatin	Active Antineoplastic agent
Anthelmintic agents		
Chondria armata	Domoic acid	Anthelmintic activity
Digenia simplex	Alpha-Kainic acid	Anthelmintic activity
Anticoagulant agents		
Chondrus crispus	Carrageenans	Anticoagulant
Iridaea laminarioides	Galaxtan Sulphuric acid	Anticoagulant
Antimicrobial agents		
Cephalosporium acremonium	Cephalosporin	Antibiotic
Thelepsus setosul	Thelpin	Antimicrobial agent
Antiinflammatory agents		
Sinularia flexibilis	Flexibilide	Antiinflammatory
Flustra foliaceal	Flustramine- A	Muscle relaxant

Marine sources of drugs for various therapeutic activities
Source: Sujay Mistry, 2021

The most exciting applications of marine biotech resources relate to health care and novel drugs. Several pharmaceutical compounds have been derived from algae, fungi, sponges, corals, fish and shell fish. These are high value substances useful in cancer treatment, pain and inflammation relief, anti-microbial agents and many other therapies. Some formulations have already reached markets, including some of the most strictly regulated. Some species of algae, jellyfish, sponges, and shell fish produce substances like unique polysaccharides, bio ceramics, enzymes, and other materials with applications in tissue engineering, bio-adhesion, implants, and bone structures.

Some marine creatures possess biochemical capabilities of degrading harmful pollutants thereby restoring ecosystem health through bioremediation. Several microbes, especially bacteria and fungi have demonstrated capacity of bio-degrading a variety of harmful chemicals, including petroleum products and plastics. Further research on such capabilities of marine microbes could offer new solutions for conservation. Micro and macro algae could be a viable source for bio-fuels which could help improve Green House Gas (GHG) emissions and reduce other pollutants. Macro and micro algae are good agents for marine carbon sequestration as well.

The potential benefits of marine biotech applications are immense but so are the challenges in accessing and processing them. The stages for converting these special properties of the marine species or their secondary metabolites into practical applications involve i) discovery of these novel features or metabolites, ii) understanding their biochemistry, mechanism of action and potential applications followed by iii) isolation, iv) optimal production processes in nature or laboratory, v) standardization and trials, and vi) compliance with the regulatory norms. Though various marine products have been used by the societies for centuries for traditional medicines and cosmetics, their exploration for large scale business operations still face numerous challenges some of which are summarized below.

The discovery of the new marine features and products of biotech relevance is a tedious task primarily because of the difficulty in accessing remote habitats of these organisms, sheer magnitude of species diversity, complex symbiotic mechanisms involving multiple organisms, lack of taxonomical references, and extremely low concentrations of the target metabolites. These complexities make the operations very expensive, time consuming and skill dependent. The good news is that new technologies are being developed for remotely controlled deep sea vehicles for exploration, sample collection and extraction. The researchers and the industry are also employing novel high-throughput screening methods for leads on useful compounds. These tools can certainly accelerate and scale up the discovery of potential bio-active materials. Faster and low cost methods of DNA mapping along with bioinformatics applications can surely enhance the success rate of bio-discovery.

The next challenge relates to manufacturing these bio-active compounds at scale and in a sustainable manner. These compounds could be produced by synthetic replication of the relevant molecules or using substitute hosts through recombinant gene technology, cultivation of source organism under artificial laboratory conditions or aquaculture especially for macro organisms. Research is under way for better replication of natural conditions in labs and also on the other pathways to enhance production and standardisation for quality and cost reduction.

Finally, the commercialisation process is slowed down by stringent regulatory requirements for quality and safety standards. As food products, feed, cosmetics, fertilisers, bioremediation agents and biofuels could face relatively easier registration and marketing restrictions, they are being seen as immediate candidates for business operations. Pharmaceuticals may need more process maturity even though some formulations are already available.

As the marine biotech products and processes are intertwined with other relevant conventional sectors, it is

not easy to assess their precise market value. Yet, some preliminary efforts have been made and according to some researchers, the global marine biotech market is currently estimated at USD 6 billion and is expected to expand to over USD 11 billion by 2030. Major market leaders are the United States of America; European Union (EU); China; Japan and Canada. India is also emerging as a big market for these products and applications. The growing demand is driven by several factors, mainly, rising public consciousness and preferences for sustainability; climate change concerns; new technologies for aquaculture; and emergence of ocean friendly research tools.

India was one of the first countries to set up a department of biotechnology to streamline and commercialise research in modern biology and biotechnology. India has focused on four major areas of biotechnology namely Bio-Pharmaceuticals, Bio- agriculture, Bio-IT and Bio- Services. India is amongst the biggest suppliers of low cost drugs and vaccines in the world. It also leads the market in bio-similar. Biotechnology techniques have been used in industrial processes for manufacturing and waste management. The size of India's bio-economy is estimated at USD 80.12 billion as of 2021. The Indian biotechnology industry is expected to reach USD 150 billion by 2025 and has the potential to reach USD 270-300 billion by the year 2030.

In marine biotech, in spite of immense potential and growing number of research papers, India is still at a nascent stage of technology development and applications. India is blessed with more than 7500 km of coastline and over 2 million sq km of exclusive economic zone (EEZ). Being in the subtropical zone, the Indian waters possess one of the richest marine biodiversity. Given India's strong technical capacity and experience in the field of biotechnology, and the high projection of our Blue Economy ambitions, the interest in marine biotechnology is on the rise. Many important institutions and industry players are heading into research and applications, especially for aquaculture, agricultural applications and traditional medicine. With exceptional general biotechnology capabilities, India should be able to replicate similar success in marine biotech. However, some support mechanism to nudge more research and investment in these sectors must be encouraged.

Marine Spatial Planning (MSP)

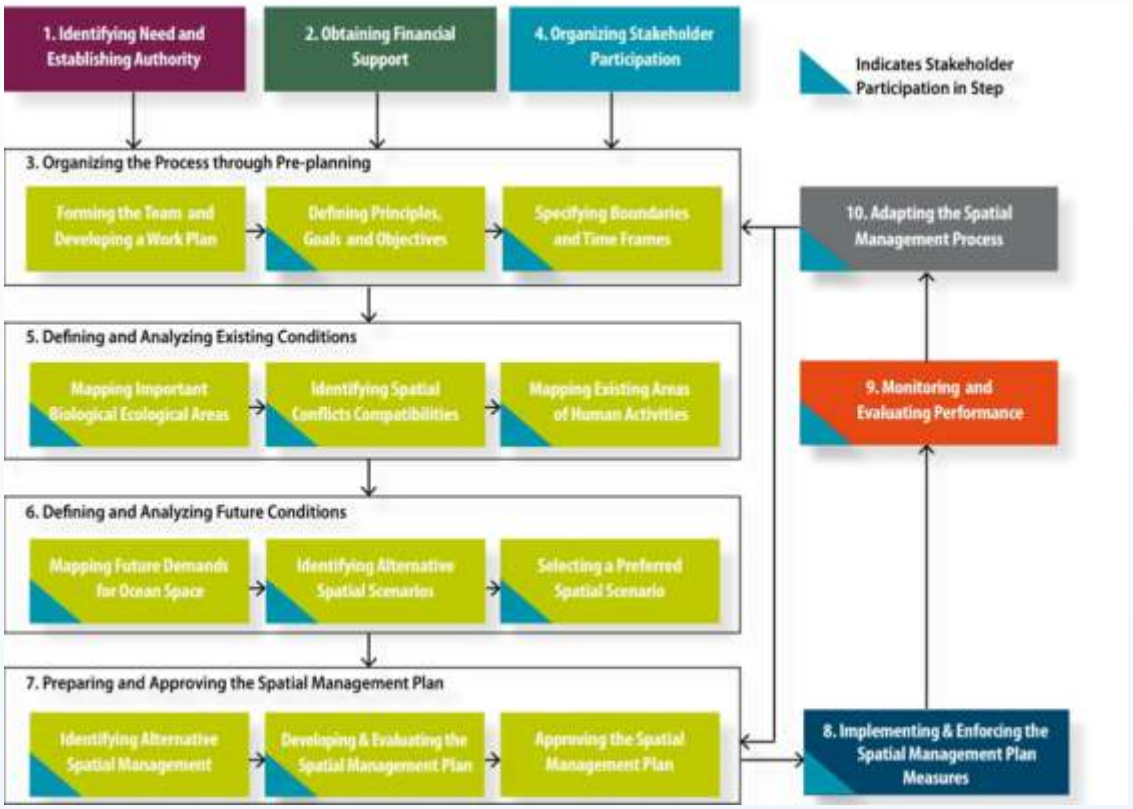
The human societies have been engaging with the oceans since time immemorial. In the absence of technological implements, such interaction used to be small scale mostly for food, short travel or recreation and purely in keeping with the local conditions. The character of this man-ocean relationship progressively changed in the post-industrial era. With ever evolving technologies, the scale, diversity and depth of human engagement with the oceans started expanding not only in magnitude but in many more new areas. Small fishing boats turned into all-weather trawlers with unimaginable capacities, oil rigs started drilling the ocean floors, community recreation turned into industrial scale marine tourism, large and modern sea ports emerged all along with thousands of mega cargo ships connecting far off places, submarine cables, network of oil/gas pipelines with matching maritime security infrastructure, turned the man-sea relationship into sheer exploitation causing immense damage to the marine environment by way of pollution, acidification, warming and loss of biodiversity.

The emergence of many new ocean economy sectors namely renewable energy, biotechnology and pharma have further crowded the ocean spaces raising serious concerns of inter-sectoral conflicts. In addition to harming the efficiency of the economic activities, such cross cutting conflicts also further increase the risk of environmental degradation. This has caused a global alarm with the world community seeking immediate and effective solutions for biodiversity protection and climate stabilisation. Ocean being the single most critical factor for climate stabilisation on the one hand and an important source of future resources, a lot of attention is being given for aligning the economic activities with their carrying capacity. Marine Spatial Planning (MSP) is emerging as an important management tool for optimising economic engagement and environmental health by minimising the scope of such conflicts.

The Intergovernmental Oceanographic Commission (IOC)-UNESCO has defined Marine/Maritime Spatial Planning (MSP) as a "public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that have been specified through a political process". Basic MSP initially emerged as area-sector-specific management systems for better coordination of a few major economic activities and for ensuring protection of marine environment. Some important examples could be marine protection areas (MPAs) and integrated coastal zone management plans (ICZMPs). With multiplying marine and maritime sectors, better understanding of the consequences of such interactions, availability of enabling technologies, and growing demand for sustainability, these management plans are becoming more comprehensive and science driven, integrating wide range of economic, social, policy, governance and sustainability parameters. Given the complexity of the evolving MSP framework, the IOC-UNESCO has developed a very detailed reference guide for helping member States to develop MSPs for diverse areas and policy aims.

As the modern concept of MSP is relatively new, its application is at best a work in progress and limited to small zones of clearly identifiable priorities. MSP Roadmap (2022-27), jointly developed by IOC-UNESCO and EU, proposes six priority areas. They could either be cross- cutting enablers like i) knowledge support, ii) capacity development and awareness, and iii) trans-boundary cooperation or they could be thematic goals namely: a) climate, b) marine protection and restoration, and c) sustainable Blue Economy (BE).

Figure 1: A step by step guide to Marine Spatial Planning (Source – UNESCO IOC, 2009)



The UN General Assembly in its proclamation of 2021-2030 as the 'Ocean Decade', calls for transformative ocean science solutions for sustainable development, connecting people and our oceans. This approach demands integration of all round knowledge, including ocean science, traditional and local knowledge, with the MSP exercise. Quality data of the select zone will be the key to an effective spatial planning. The impact and interaction of all the activities in the identified ecosystems will need to be regularly studied and monitored for measuring their final adverse consequences. Wide range of data sets will need to be generated for physical, chemical, biological, community or any other relevant parameters and determine the tolerable limits of their activities for achieving the set policy goals. Such data management would help keep all the activities within sustainable scales. This data based approach could also help generate standard models for comparable zones for easier replication with or without local adaptations. Such information, data and knowledge should preferably be freely shared on open access platforms at local, regional and national levels.

The next prerequisite for MSP would be capacity building and wholesome participation of all the relevant stakeholders. Developing knowledge and data based systems and platforms and their operation would require relevant skills and expertise. This will require comprehensive mapping of skill needs, availability, and capacity building programmes to plug gaps, which would further require effective coordination between the MSP teams and capacity building infrastructure, including universities, research centers, civil society, relevant industry and other stakeholders.

Even though marine spatial plans may have developed with a priority goal for localised area and sectors, we need to appreciate that the marine ecosystems do not behave in compartments. Sooner or later, the impact of activities in one zone will spread to a larger area. On the other hand, some of the marine special plans could cover large areas across territorial jurisdictions ab initio and require trans-boundary coordination and

cooperation. The coastal states should endeavour to integrate such provisions in their marine management legal frameworks to minimise trans-boundary conflicts.

Climate change has emerged as a top concern for the global community and most of the States have agreed to limit their greenhouse gas (GHG) emissions in a time bound manner. These commitments are reflected in their respective nationally determined contributions (NDCs) for meeting their committed targets under the Paris Accord. The oceans being the single most important factor in causing or mitigating global warming, it would be logical to integrate climate change priorities in any MSP by way of mitigating or adaptation measures. Such approach will strengthen the sustainability of harnessing of the ocean resources and the protection and long term welfare of the coastal communities.

The MSPs could also take into consideration the need of environment protection and restoration, especially in vulnerable zones. This could also help achieve various conservational commitments like the 30:30 goal of conserving 30% of land and water by 2030 adopted under the UN Biodiversity Conference or the commitments under the Biodiversity Beyond National Jurisdiction (BBNJ).

Finally, the MSP would be an essential tool for promoting sustainable Blue Economy. With the expanding scale, spread and scope of BE sectors, intra and inter sectoral conflicts would increase, causing avoidable delays, losses and unpredictability for the investors. A quality MSP should transparently lay out the available BE opportunities and their operational limits right from the beginning.

The World Bank has produced another comprehensive guide to MSP formulation, implementation and evaluation for attracting investments into resilient and inclusive BE projects. An effective sequence of steps would include: a) making the case, b) creating enabling conditions, c) formulating the plan and d) implementation. Each step needs to examine available opportunities; techno-economic viability based on scientific data and knowledge, stakeholder participation and ownership, potential conflicts and resolution mechanism, sustainability compliance, legal and institutional framework. These actions would not only enhance the viability but also promote chances of success. This will further strengthen the stakeholders' confidence for greater commitment, including investments.

Benefits of MSP go beyond pure economic gains. Being an ecosystem based approach to harnessing of marine resources; it also promotes environmental conservation, climate resilience and community development. A good plan integrates all relevant sectors and finds an optimal balance, including, invoking appropriate tradeoffs in keeping with the overall plan objectives and priorities. As MSP involves regular evaluations of the desired outcomes, it should be able to identify upcoming disruptions well in time for rectification to reduce long term risks.

According to the World Bank, there are over 100 documented cases of MSP worldwide, operating at different scales and levels. A few have been fully implemented, primarily in advanced economies like Australia, USA, Canada, EU and New Zealand. With growing investor interest in MSP driven BE projects, more countries are adopting this approach. Even the multilateral financial institutions are considering the benefits of MSP for de-risking their investments. India, though, has a long experience of ICZMPs, the application of MSP framework has been very slow. Only recently, Puducherry and Lakshadweep have introduced limited MSP programmes in collaboration with Norway. Given the indigenous capacities in India, there is scope for expansion of MSP frameworks to other coastal states and it should be explored by all stakeholders.

As the human engagement with the oceans expands, the scope for conflicts will grow not only amongst the competing economic sectors but also with the health of the ocean and development of coastal populations. Left unregulated, such disruptions would not only impact the efficiency of harnessing of the BE resources but also the overall sustainability of the process. This calls for better planning, management, regulation, and

monitoring of our economic engagement with the oceans so as to minimise inter-sectorial conflicts and adverse impact on the ocean health or coastal societies. Such management has been exercised by the societies for many years but initially it was limited to general conservation of specific ocean ecosystems, for instance the MPAs, Coral reef protection, coastal management systems or the guidelines under MARPOL to limit maritime pollution.

With the economic activities growing in scale and diversity in multiple sectors, over time, the ocean health has been severely deteriorating by way of pollution, acidification, loss of biodiversity, gaseous balance and finally warming with potential systemic risks for the larger planetary functions. Climate change is being labeled as an existential threat and oceans are perhaps the single most important factor in this, both as a source of warming or a mitigating solution. Therefore, the global community is promoting the idea of ecosystem-based management of oceans for more efficient and sustainable allocation and management of ocean space by way of marine spatial planning. This is a very comprehensive system encompassing economic, social, legal, and administrative and most importantly the sustainability aspects. Such plans are designed for balancing multiple eco-environmental goals supported by scientific data, evidence, understanding of the underlying mechanisms and feedback loops with corresponding legal framework for regulation.

India with over 7500 kms coastline and over 2.3 million square km of EEZ must start this process in the right earnest to stay ahead. These aspects must be integrated with our policy, society, industry, education, research, and skill systems at all levels for generating indigenous capacities and capabilities lest we are left at the mercy of others.

For the optimization of Blue Economy, MSP is the best way forward and it cannot be ignored. We could also offer capacity building for other developing partners in various MSP-related aspects.

Section III:

International Cooperation: recent trends, opportunities, and challenges, future prospects

Backdrop

The Blue Economy largely relates to oceans which, unlike land surfaces, do not recognize national boundaries. Yet international law, developed over centuries, defines and sets limits on what nations and other entities can or cannot do in territorial waters, Exclusive Economic Zones (EEZs), and the High Seas. Many treaties, agreements, and conventions have been in force that form the bedrock of ocean governance. The present order is based on the conviction that general orderliness, a balance between rights and obligations, and maritime security are prerequisites for advancing the cause of optimal utilization of BE's development potential.

Another noteworthy aspect is the asymmetry between advanced economies such as the US, EU, Canada, and China which have invested vast financial resources in developing BE, and the Global South which is in need of capital, technology, technical know-how, and best practices to be able to profit from the expansion and modernization of both the traditional and newer sectors of BE.

Existing and emerging international cooperation in the BE domain should, therefore, be studied and assessed from the specific perspective delineated above.

In its section IV, FICCI's first Knowledge Paper presented 'A Global Perspective' which remains valid. FICCI's second study offered 'A Critical Survey of Best Practices'. It offered a detailed exposition of how international institutions and important nations have been engaged in promoting BE in its diverse facets. 'A Mosaic of Good Models' illustrated several success stories in this realm.

Recent trends

Developments in the past four years (mid-2019 to mid-2023) indicate how the COVID-19 pandemic, Ukraine conflict, and other manifestations of geopolitical contestations slowed down the global economy. How they may have affected the growth of BE needs to be studied as well.

Nevertheless, Blue Economy continues to figure preeminently on the global agenda. This is reflected in the following trends, analyzed from an Indian perspective with a focus on pinpointing opportunities and challenges.

Section A: Multilateral

UN conferences and related platforms

The UN has proclaimed this as the decade from 2018 to 2028 as that of the Water Action Agenda, while the 2021-2030 decade is that of Ocean Science. Within the structures of these two calls to action, the UN and its various platforms address different aspects/sectors of the Blue Economy. In 2021, the FAO supported its Blue Growth initiative with guidelines on blended finance to achieve this growth across the three pillars of Blue Communities, Blue Production, and Blue Trade. At its 12th Ministerial Conference in June 2022, the World Trade Organisation approved the Agreement on Fisheries Subsidies prohibiting subsidies that contribute to illegal, unreported, and unregulated (IUU) fishing. The Agreement also creates WTO Fisheries Funding Mechanism, which calls on developed countries to provide targeted technical assistance and capacity-building help to developing and least-developed countries in the Agreement. The Fund is operated by the WTO with FAO, the World Bank Group, and the International Fund for Agricultural Development.

In March 2022, the United Nations Environment Assembly recommended the convening of an intergovernmental negotiating committee to develop an international legally binding instrument on plastic pollution, which would build on the principles of the Rio Declaration.

In June 2022, the UN also hosted the Oceans Conference in Nairobi, Kenya. The conference addressed issues of climate change, implementation of SDGs, protection of marine biodiversity, and ocean health. The resolution adopted at the Conference reiterated the participants' commitment to “act decisively and urgently to improve the health, productivity, sustainable use and resilience of the ocean and its ecosystems”. Acknowledging and appreciating the voluntary commitments made by member states to conserve or protect at least 30% of global oceans in Marine Protected Areas by 2030, the resolution called for a balanced, transformative, and robust post-2020 global biodiversity framework to address areas-based conservation and ocean health, to be adopted by the Conference of the Parties to the Convention on Biological Diversity.[78]

A landmark agreement is the United Nations High Seas Treaty, a draft that was signed on 4 March 2023. The Treaty addresses biodiversity loss and ecosystem degradation due to climate change impacts in international waters. It also contains provisions for fair and equitable access and use of marine genetic resources, benefit sharing in research, and in capacity building. Taking into account the special needs of landlocked developing states, the Treaty creates a space for all parties, “irrespective of their geographical location,” to carry out and claim access to marine research in areas beyond national jurisdiction. For its implementation, the Treaty calls for the establishment of a new international authority for the high seas, its own secretariat, and a Conference of Parties, while a Global Environment Facility trust fund is recommended to secure funding for projects in the maritime space. Once formally approved and ratified by member nations, the High Seas Treaty fills a regulatory gap in the UNCLOS while also providing legal backing to SDG 14.[79] The Treaty is vital for achieving ocean-related SDGs as outlined in the UN's 2030 Agenda for Sustainable Development, as well as the goals set in the Kunming-Montreal Global Biodiversity Framework's “30 by 30”.[80] Member states and regional economic integration organizations will now have to ratify the Treaty according to their respective processes. To enter into force, the Treaty requires ratification, approval, or acceptance by 60 member states of the UN.[81]

G20

At the Osaka Leaders' Summit in June 2019, the Osaka Blue Ocean Vision, or the "G20 Implementation Framework for Actions on Marine Plastics Litter" was adopted to facilitate concrete actions on marine litter, especially marine plastic litter and microplastics. This framework complements the UNEP's work on marine litter. With the Osaka Blue Ocean Vision, member nations committed to reducing additional pollution to zero by 2050 through the promotion of international cooperation for innovative solutions, sharing of best practices, and encouraging scientific research and education. Subsequent summits at Riyadh, Rome, and Bali in 2020, 2021, and 2022 respectively have reaffirmed the Vision.

In keeping with the Osaka Blue Ocean Vision, in December 2020, India and UK launched the UK-India Marine Litter Twin Cities project, through which three coastal cities in both countries were twinned to promote bilateral engagement between scientists and policymakers to share best practices for managing marine litter. A similar agreement is in force with Germany, that is the 'Cities Combating Plastic Entering the Marine Environment' agreement, part of the Joint Declaration of Intent in the field of 'Prevention of Marine Litter' between the two countries. The project is being undertaken at the national level, in select states (Uttar Pradesh, Kerala and Andaman & Nicobar Islands), and in the cities of Kanpur, Kochi and Port Blair for a period of three and a half years since 2021.[82]

Under the leadership of Indonesia, the centrality and commitment to Blue Economy was spelt out within the context of developing countries, Small Island Developing States, Least Developed Countries (LDCs) in the Pacific and Caribbean, and in Africa. The Bali Declaration underscored the need for mutual assistance and partnership among member nations for technological transfer, capacity building and, most importantly, addressing the financing gap for green transition.

An important development during the Indonesian Presidency was the initiation of the Climate and Sustainability Working Group to engage experts from G20 countries and other international organizations.[83] The CSWG proposed a G20 Partnership for Ocean-based Actions for Climate Mitigation and Adaptation to explore the opportunities therein. Among its final reports was one on Strengthening Action and Partnership for Sustainable Ocean Initiatives, produced by the United Nations Development Programme (UNDP), the Global Green Growth Institute (GGGI), and NDC Partnership (NDCP). To implement this partnership, the CSWG recommended the drafting of a communique outlining the objectives and action items in the immediate and long term. Promoting the partnership in G20 meetings as well as in meetings and dialogue with partners and launching a similar Global Ocean-Climate Partnership at the COP27 is recommended in the immediate term. In the long term, it recommends the integration of ocean-based solutions in climate mitigation and adaptation strategies and developing a strategy on climate change that is embedded in existing and forthcoming ocean governance measures.[84]

Parallelly, the Oceans 20 Dialogue was also piloted by the Indonesian Presidency as a forum to bring together experts and stakeholders to discuss the Blue Economy. The Dialogue has continued under the Indian Presidency, under the Environment and Climate Sustainability Working Group (ECSWG), which operates under the Sherpa Track and is led by the Ministry of Environment, Forests, and Climate Change. This culminated in the Environment and Climate Ministers' Meeting (ECMM), held in Chennai on 28 July 2023. An ECMM Outcome Document and Chair's Summary was adopted, which contains a section on promoting a resilient blue/ocean-based economy, recognizing that this is the basis of livelihood for nearly 3 million people globally. The Document reiterates the G20's commitment and support to the UN Decade on Ocean Science for Sustainable Development, Kunming-Montreal Global Biodiversity Framework (KMGBF) and welcomes the adoption of the

UN High Seas Treaty complementing the principles of the KMGBF to address ocean conservation and biodiversity loss. The ECMM also outlined the G20's commitment to the Osaka Blue Ocean Vision, and building on the G20 Marine Litter Action Plan, welcomed the Fifth Report on the G20 Implementation Framework for Actions against Marine Litter, which was coordinated by India and Japan.[85]

Additionally, the ECMM adopted the Chennai High Level Principles for a Sustainable and Resilient Blue/Ocean-based Economy. These principles build on a whole network of international agreements and conventions on the Blue Economy and ocean conservation and provide an outline for G20 members to accelerate the transition to a sustainable and inclusive Blue Economy based on national priorities and circumstances. These include, among others, the need to prioritize ocean health, promote equity and inclusive growth, the need to leverage science and technology for an integrated approach to Blue Economy, as well as the need to enhance international cooperation, monitoring mechanisms, and ocean finance.[86]

The corresponding document is also a Technical Study on Accelerating the transition to a Sustainable and Resilient Blue Economy which, like the High-Level Principles, provides a framework to assist G20 members in promoting this transition. It does so by identifying three areas that need immediate attention: (i) Addressing Marine Litter for a Sustainable Blue Economy; (ii) Conservation and Restoration of Coastal and Marine Ecosystems; and (iii) Marine Spatial Planning for a Sustainable and Resilient Blue Economy. Furthermore, the study also collates and highlights the best practices among G20 member states and makes recommendations and action points for all three priority areas.[87]

The Supreme Audit Institutions (SAI) 20 Engagement Group, which was initiated during the Indonesian Presidency, has been carried forward during India's G20, wherein it focused on the Blue Economy as a key priority area (the other being Artificial Intelligence). The SAI20 Summit was held in Goa, India from 12-14 June 2023. In its final Communiqué, the delegates reaffirmed the role of audit institutions in ensuring efficiency, accountability and transparency in the widespread adoption of both these priority sectors. The Communiqué mandates member SAIs to work towards a comprehensive policy framework to promote sustainable and inclusive growth in the Blue Economy while also supporting social and gender-inclusive investment in coastal communities. Finally, it outlines the focus for the SAI20 in the future: fostering dialogue among audit institutions; and formulating widely applicable and actionable global auditing guidelines for the Blue Economy. At the Summit, the Comptroller and Auditor General of India also presented a Compendium on the Blue Economy, a document bringing together voices and practices on the Blue Economy and related sectors from the G20 member nations' supreme audit institutions.[88]

The G20 Leaders' Summit held in New Delhi on 9-10 September 2023 builds on this by incorporating a section titled 'Harnessing and Preserving the Ocean-based Economy'. The New Delhi Declaration endorses the work done by the Environment and Climate Sustainability Working Group (ECSWG) and welcomes the adoption of the Chennai High-Level Principles for a Sustainable and Resilient Blue/Ocean-based Economy. It also supports Oceans 20 as a forum for dialogue in this regard. On marine biodiversity, member nations are called on to facilitate the speedy implementation of the UN High Seas Treaty addressing ocean conservation and biological diversity in areas Beyond National Jurisdiction (BBNJ). Similarly, the Commission for the Conservation of Antarctic Marine Living Resources and the Antarctic Treaty system are endorsed as frameworks to address biodiversity in Marine Protected Areas (MPAs) of the Antarctic region. On marine litter and pollution, the declaration builds on the Osaka Blue Ocean Vision and the G20 Marine Litter Action Plan, noting the establishment of the intergovernmental negotiating committee to develop a legally binding instrument on plastic pollution.[89]

European Union

According to the European Commission, the Blue Economy provides 4.5 million direct jobs within the European Union. Placing sustainable development at the centre of its focus, the Commission in May 2021, proposed a new approach for the Blue Economy as part of the European Green Deal and Recovery Plan. This approach stresses the need to transition from Blue Growth to a modern, resource-efficient, and sustainable Blue Economy.[90] Noting that the transition to a sustainable Blue Economy is indispensable to the achievement of Europe's SDGs, this new proposal looks to mainstream the Blue Economy by addressing cross-cutting sectors like fisheries and aquaculture, ports, maritime transport, and energy production.

The EU Commission facilitated the creation of a European Blue Forum, a pan-European stakeholder group to foster dialogue and overcome challenges associated with the Blue Economy and related sectors.[91] It also emphasizes the need to invest in research and innovation for resource extraction, carbon-neutral and low-carbon technologies; emerging and critical technologies in spatial mapping. To finance BE projects in Europe, it suggests working with investors through dedicated financial instruments such as the Invest EU Blue Economy Fund, while also reworking existing modes of finance like the European Maritime, Fisheries, and Aquaculture Fund, and European Investment Bank Group (EIB) to create funds for BE.[92]

At the Our Ocean Conference in October 2019, the European Investment Bank launched the Blue Sustainable Ocean Strategy (Blue SOS) with which it committed to lending over $2.5 billion to sustainable ocean projects between 2019 and 2023. As of December 2021, the EIB has deployed funds corresponding to 30% of the target.[93]

In February 2023, the European Commission hosted the third Blue Economy Forum with the aim of exploring ways to align the EU's goals for sustainable livelihoods with the UN's SDGs.[94] In early 2023, the European Commission and the Horizon Europe Programme launched the Sustainable Blue Economy Partnership to encourage private innovation and investment and fund projects at the pan-European level and establish close cross-sectorial cooperation in the science, innovation, and economic sectors.[95]

African Union

In October 2019, the African Union–Inter-African Bureau for Animal Resources (AU-IBAR) launched a Blue Economy Strategy. It was developed in the aftermath of the Sustainable Blue Economy Conference held in Nairobi, Kenya in 2018. Emphasizing that the Blue Economy generates $296 million in revenue and creates 49 million jobs in the AU, the strategy identifies tourism, minerals and mining, and fishing as the main drivers of the Blue Economy. The strategy recommends strengthening these through investment in allied fields like capacity building, logistical and infrastructural upscaling in ports and shipping industries, and education and research.[96] In the immediate term, economic, environmental, governmental, and strategic challenges — like piracy, drug trafficking, and ocean pollution — are identified for the AU to overcome to truly harness the continent's Blue Economy potential.

The Department of Agriculture, Rural Development, Blue Economy and Sustainable Environment (ARBE) leads the AU's Blue Economy programme, with the Division on Blue Economy dealing with marine resources and ocean governance.[97] The division was established in 2021 following the adoption of the Strategy.[98] On the sidelines of the UN Oceans Conference in June 2022, the African Union Commission co-hosted an event on 'Shaping Africa's Sustainable Blue Economy'. The event brought together stakeholders and partners (within and outside the African Union) to discuss the sustainable development of Africa's maritime space.[99]

Quad

In their summits since 2021, Quad leaders have emphasized their commitment to a free and open Indo-Pacific as the key to security and prosperity in the region. The Quad's economic agenda, especially regarding encouraging the transition to clean economies, works through the Indo-Pacific Economic Framework for Prosperity (IPEF).

In May 2022, at the Tokyo Leaders' Summit, the Indo-Pacific Partnership for Maritime Domain Awareness (IPMDA) was launched and is currently in its pilot phase. The IPMDA provides Quad countries with a framework to share and provide near-real-time integrated and cost-effective maritime domain data to oceanographic and maritime agencies in Southeast Asia and Pacific regions. At the 2023 Leaders' Summit at Hiroshima in May, the joint statement affirmed the Quad's intention of extending the coverage of the IPMDA to partners in the Indian Ocean region. Similarly, the Quad Indo-Pacific Oceans Research Alliance (QIPORA) links ocean research agencies among the member nations to foster scientific and technical collaboration in the maritime domain.[100]

While the Joint Statement from the Quad Leaders' Summit 2023 does not spell out 'Blue Economy' as a concept, it recognizes the role that Quad has to play in areas like green shipping and ports, disaster risk management, exchanging climate information, and capacity building within the framework of the Paris Climate Agreement.[101] The statement reiterates Quad's commitment to working with partners in the Indo-Pacific, and especially the centrality of the Association of South East Asian Nations (ASEAN), Indian Ocean Rim Association (IORA), and the Pacific Islands Forum (PIF) to Quad's efforts in areas of climate transitions, mitigation, and adaptation. Thus, the Hiroshima summit endorsed the ASEAN's and IORA's respective Outlooks for the Indonesia-Pacific, reiterating that the Quad's activities and objectives in the region must consider the priorities and concerns of partners and stakeholders in the region.[102]

The 2023 statement also included accompanying documents, like the Quad Statement of Principles on Clean Energy Supply Chains in the Indo-Pacific, 2023 endorses the need to support clean energy transitions and calls for the promotion of Environmental, Social, and Governance (ESG) practices for clean energy supply chains to promote sustainable development.[103]

Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC)

Economic cooperation has been part of the BIMSTEC's Trade, Investment, and Development Sector, with Bangladesh as the Lead Country since 2021. The group identifies three key sectors of cooperation — i) close public-private partnership to promote economic cooperation; ii) identification of sectors, sub-sectors and projects for economic cooperation, and iii) elimination of non-tariff and tariff barriers through government-to-government negotiations.[104]

The 19th BIMSTEC Ministerial Meeting held virtually in March 2023, approved the inclusion of Blue Economy as a Sub-sector under the Trade, Investment, and Development Sector. (It did so along with accepting Mountain Economy as a Sub-sector under the Environment and Climate Change sector, and Poverty Alleviation as a Sub-sector under the People-to-People Contact sector). The Meeting calls for the establishment of an Intergovernmental Expert Group on the same to coordinate policy in this domain.[105] The expert group has not materialized yet.

Forum for India-Pacific Islands Cooperation (FIPIC)

India engages with 14 Pacific Island nations through the FIPIC. On the sidelines of the 74th UNGA in September 2019, the India-Pacific Islands Developing States Leaders' Meeting was hosted by Prime Minister Modi. The Leaders' deliberated on a wide range of issues including sharing of development experiences for the attainment of SDGs, enhancing cooperation in renewable energy, capacity building, and a roadmap for future India-PSIDS cooperation.[106] Independently, the Pacific Islands Development Forum's (PIDF) 2019-2039 Strategic Plan lays the foundation of the PIDF's outlook toward a Blue Economy and assesses the ways forward for the islands through partnerships and integrated ocean management.[107]

The third FIPIC Summit was held in May 2023 in Papua New Guinea, co-hosted by India and Fiji. This was the first meeting held since the outbreak of the COVID-19 pandemic. India reiterated its commitment to enhancing cooperation in healthcare, food, and energy security, and capacity building in the region.[108] In his address to the summit, Prime Minister Modi referred to SIDS as "Large Ocean Countries", highlighting their centrality to India's Indo-Pacific presence and outreach which has involved infrastructural investment and support for capacity-building initiatives among member nations.[109]

The Quad Joint Statement from May 2023 also endorsed the Pacific Islands' centrality to the Indo-Pacific. To that end, each of the four Quad members have ongoing engagements with these groupings, such as the Forum for India-Pacific Islands Cooperation, India's membership of the IORA and the periodic India-ASEAN Summits, the U.S.-Pacific Islands Forum meeting, the Japan-led Pacific Islands' Leaders Meeting (PALM), and finally Australia's membership of the PIF.[110]

Indian Ocean Rim Association (IORA)

The third Blue Economy Ministerial Conference in Dhaka in September 2019 culminated in the adoption of the Dhaka Declaration, which identified six pillars crucial to the Blue Economy: fisheries and aquaculture, renewable ocean energy, seaports and shipping, offshore hydrocarbons and seabed minerals, marine biotechnology, research and development, and tourism development. A Blue Economy Working Group was established in 2019 with the objective to formulate and implement a work plan for Blue Economy. It brings together dialogue partners and stakeholders and discusses resourcing and financing of the initiatives therein. Currently, South Africa chairs the working group. The IORA Working Group on the Blue Economy (WGBE) met for the first time in Mauritius in September 2019, after a preparatory meeting in 2018 in Port Elizabeth, South Africa. The second meeting of the Working Group was held virtually in 2021, to work out ways to implement the Work Plan for Blue Economy.[111]

India convened the sixth edition of the Indian Ocean Dialogue in New Delhi on 13 December 2019, as part of the IORA's aims to enhance Indo-Pacific collaboration in Maritime Security, Economic Cooperation, Disaster Risk Management, and Blue Economy. The seventh edition, hosted by Australia, was held virtually in February 2021. India hosted the eighth Indian Ocean Dialogue in December 2021 with the aim of developing a post-pandemic outlook and engagement with the oceans.[112] The ninth IORA Indian Ocean Dialogue was hosted by the Ministry of Blue Economy and Fisheries of Zanzibar in April 2023.[113] The dialogue concluded with the adoption of the Zanzibar Consensus, a set of policy recommendations to advance the Blue Economy in the Indian Ocean Region. The participants also highlighted that Blue Economy development requires collaboration and cooperation among various relevant stakeholders, including academicians, researchers, regional/international organizations, and private sectors, among others, to identify and address potential

challenges or drawbacks of promoting the Blue Economy, such as the potential negative impact on marine ecosystems in the IOR.[114]

IORA Outlook on the Indo-Pacific was adopted at the 22nd Council of Ministers Meeting held in Dhaka in November 2022. Noting the interconnectedness of the Indian and Pacific Oceans, the Outlook affirms the body's commitment to fostering dialogue among members and stakeholders to boost connectivity, infrastructure, and collaboration in areas of mutual interest in the Indian Ocean region. These include maritime security and connectivity, ensuring a rules-based order, marine conservation, and inclusive and sustainable economic growth within the region.[115]

Since it was finalized, the IOIP has been acknowledged as a central framework for IORA's activities in the region. The 2023 Quad Leaders' joint statement noted India's leading role in finalizing the IPOI, along with reaffirming the integral position of IORA as the Indian Ocean region's premier forum.[116]

Association of South East Asian Nations (ASEAN)

On February 6-7, 2020, India, Australia, and Indonesia co-hosted the 4th East Asia Summit (EAS) Conference on Maritime Security Cooperation in Chennai, India. The conference focused on maritime security, maritime safety, and the Blue Economy among the EAS participating countries.

The ASEAN Outlook on the Indonesia-Pacific (AOIP) was adopted during the ASEAN Senior Officials Meeting held in Bangkok in June 2019. Viewing the Indo-Pacific as a closely integrated and interconnected region, the AOIP stressed the need for regional cooperation and dialogue in shared areas of interest in the maritime domain like connectivity, infrastructure build-up, and UN SDGs. The AOIP currently remains in the policy space and does not yet have a framework for implementation.

The 4th ASEAN-India Workshop on Blue Economy was held in New Delhi in December 2022, with the theme 'Advancing Partnership for Sustainability'. The workshop was jointly organized by the Ministry of External Affairs of India and Indonesia's Ministry of Maritime Affairs and Investment and Ministry of Foreign Affairs, in cooperation with the ASEAN-India Centre, Research and Information System for Developing Countries, and the National Maritime Foundation. The first workshop of this kind was held on 24-25 November 2017 in Nha Thang, Vietnam, followed by the second (18 July 2018) in New Delhi, India, and the third (12 September 2019) in Bangkok, Thailand.[117]

The principles of these workshops were affirmed in the ASEAN Leaders' Declaration on the Blue Economy during the 38th ASEAN Summit in October 2021, which recognized the Blue Economy as a critical and emerging sector and a “multi-faceted and cross-cutting concept” involving “all three pillars of the ASEAN Community”. The Declaration outlines a common definition of the Blue Economy and identifies areas for cooperation in fisheries and aquaculture, addressing marine pollution, coastal development, trade, ocean governance, and so on. It tasks the ASEAN Coordinating Council to oversee the implementation of its recommendations, which also include engaging and partnering with stakeholders in private sectors, in academia and the scientific community, financial institutions, and with MSMEs.[118]

At the 18th ASEAN-India Summit in October 2021, the two partners released a joint statement on Cooperation on the ASEAN Outlook on the Indo-Pacific for Peace, Stability, and Prosperity in the Region. The ASEAN Outlook for the Indo-Pacific (AOIP) and India's Indo-Pacific Oceans Initiative (IPOI) both have a common grounding in securing and fostering peace and prosperity in the region and to that end, the joint statement builds on the

ASEAN-India Strategic Partnership and explore avenues for cooperation in the Indo-Pacific. This specifically includes the four outlined in the AOIP: maritime cooperation, connectivity, Sustainable Development Goals (SDGs), and economic cooperation.[119]

The 43rd ASEAN Leaders' Summit, held in Jakarta from 4-7 September 2023 produced the ASEAN Blue Economy Framework. It identifies gaps in the grouping's conceptualization of the Blue Economy and attempts a redefinition of the same. Blue Economy is now defined as an "integrated, holistic, cross-sectorial, and cross-stakeholder approach" that creates "value-added and value-chain of resources" in the marine sphere. The framework is structured around guiding principles for a Blue Economy, strategies for member states, and enablers to unlock and accelerate the development of the same. It lays specific emphasis on the need for infrastructural scale-up, capacity-building, enhanced connectivity, and institutional setting that drives Blue Economy holistically and in conversation with all stakeholders.[120] The Leaders' Declaration endorses this framework and calls for the elevation of collaborative efforts "to advance Blue Economy as a new engine of ASEAN's future economic growth" through its speedy implementation.[121]

Commonwealth Blue Action Charter Group

The Blue Charter was signed in 2018 at the Commonwealth Heads of Government Meeting in the U.K. It is an agreement among the 56 Commonwealth member countries to actively cooperate to solve ocean-related challenges and meet commitments for sustainable ocean action.[122] 49 of the 56 Commonwealth countries have marine coastlines. To that end, the Commonwealth Blue Charter works through 10 Action Groups addressing marine pollution, biodiversity protection, ocean observation, sustainable fishing, and aquaculture, including a sustainable Blue Economy.[123]

The Action Group on Sustainable Blue Economy is led by Antigua and Barbuda and Kenya to develop an integrated approach to BE through collaboration and dialogue between Commonwealth countries, sharing of best practices, facilitating technological and scientific exchanges, developing economic resilience, and mainstreaming sustainable economic instruments.

In June 2022, the Commonwealth Blue Charter Project Incubator was launched at the Heads of Government Meeting in Kigali, Rwanda. It assists governments in developing pilot projects that accelerate the transition to sustainable and inclusive maritime development. The initiative is supported by the Commonwealth Fund for Technical Cooperation along with voluntary contributions from various partners.[124] The Communique reaffirmed the Commonwealth's commitment to the Blue Charter. Additionally, it also encouraged the Secretariat to work towards the establishment of a Blue Charter Action Fund.[125]

Section B: Bilateral Cooperation

Along with engagement through regional and multilateral groupings on the Blue Economy, India has signed Memoranda of Understanding (MoUs) with Norway, Bangladesh, Iceland, Indonesia, Morocco, and Vietnam to promote bilateral cooperation in fisheries and aquaculture industries.[126]

The April 2023 MoU between the Ministry of Ports, Shipping and Waterways of India and the Ministry of Infrastructure and Water Management of the Netherlands addresses sustainable port development, green shipping, and maritime education and research. Technological and regulatory cooperation are also identified as subjects for cooperation.[127] A similar MoU covering infrastructure, green shipping, technological and research collaboration, was signed between the Ministry of Shipping and the Ministry of Industry, Business and Financial Affairs of Denmark in 2019.[128]

Norway

In 2019, the India-Norway Task Force on Blue Economy for Sustainable Development was launched during the visit of Prime Minister, Erna Solberg. As part of the Task Force, India and Norway have the following initiatives –

1. Initiative on Integrated Ocean Management and Research
2. Initiative on Marine Pollution
3. Joint Working Group Maritime
4. Joint Working Group Marine

The Task Force has held regular meetings since 2019, with the fifth meeting held in June 2022 between the Norwegian ambassador and Secretary Dr M Ravichandran of the Ministry of Earth Sciences.[129] The two countries have also collaborated on marine research through a framework on Integrated Ocean Management and Research and the Deep Ocean Mission, a multi-ministerial programme sanctioned in September 2021, which aims at developing technologies for marine exploration and biodiversity mapping.[130] As part of this partnership, the Marine Spatial Planning initiative was piloted in Puducherry and Lakshadweep Islands with the aim of balancing growth alongside coastal development. The work was implemented through the National Centre for Coastal Research (NCCR), the Institute of Marine Research (IMR), and the Norwegian Environment Agency (NEA).[131]

The cooperation between India and Norway covers sustainable use and protection of oceans, the use of technology, innovation, and resources in mutually beneficial ways, as well as cooperation in international fora. Along with the existing areas of cooperation, the Indo-Norway Task Force has also identified areas to strengthen cooperation in, during 2022-23. These include harnessing offshore wind resources, aquaculture and fisheries, deep ocean exploration, and mineral extraction.

France

India and France launched a joint roadmap on Blue Economy and ocean governance in 2022. The roadmap lays out four pillars for collaboration —

1. Institutional pillar to forge a common legal and governance framework for oceans

2. Economic pillar to harness Blue Economy as a sustainable avenue for growth and development
3. Infrastructure pillar: collaborating on sustainable and resilient coastal infrastructure.
4. Scientific and academic pillar involving coordinating and facilitating scientific research, academic exchanges, and knowledge and skill transfers.

The India-France partnership is broad and encompasses maritime trade in goods and services, ports, fisheries, marine technology, and scientific research, ocean observation, forecasting services, biodiversity, renewable marine energy, marine manufacturing industries, integrated coastal management, marine eco-tourism, inland waterways, administrative cooperation on civil maritime issues and finally, international law of the sea and related multilateral negotiations.[132]

Bangladesh

In 2022, the governments of India and Bangladesh signed an MoU to enhance cooperation in various areas of the Blue Economy and develop an inclusive model of maritime cooperation. The MoU is a broad-based plan that covers Research and Development (R&D) in marine biotechnology; capacity building, skill development; knowledge and skill transfers, and sharing of best practices; strengthening maritime pollution response cooperation; green tourism; exchange of maritime data, especially that dealing with disaster warnings; maritime domain awareness; and addressing the issue of the inadvertent crossing of international maritime boundaries by fishermen among the two nations.[133] For its implementation and to coordinate activities, the MoU calls for the establishment of an India-Bangladesh Joint Working Group on Blue Economy and Maritime Cooperation.

Sri Lanka

As neighbours and maritime countries with shared priorities and concerns in the Indian Ocean – such as piracy, illegal and unregulated fishing, and disaster preparedness – India and Sri Lanka cooperate in the maritime domain bilaterally and through multilateral groupings like BIMSTEC and IORA. As part of India's Security and Growth for All in the Region (SAGAR) doctrine, India and Sri Lanka signed an MoU in March 2022 to set up a Maritime Rescue Coordination Centre in Colombo to foster greater cooperation in maritime security.

Sri Lanka and India are also part of the Colombo Security Conclave (CSC), a trilateral that includes the Maldives. In the NSA-level meeting in 2020, Mauritius, Bangladesh, and Seychelles were invited as observer nations, and in March 2022, Mauritius joined as the fourth member of the CSC. The CSC works to foster cooperation and communication among the member nations, with the aim to make maritime security, marine pollution response, and maritime search and rescue priorities for the region. Additionally, through the framework, member nations enable knowledge sharing to enhance maritime domain awareness in the shared Indian Ocean region, especially in the EEZs of the four countries.[134]

As part of the CSC, India-Sri Lanka-Maldives trilateral exercise 'Dosti' is aimed at fortifying and enhancing mutual operational capability, information sharing, and exercise interoperability to build cooperation between the Coast Guards of the three countries. The 15th edition of the Dosti exercise was concluded in November 2021.

The India-Sri Lanka Joint Working Group on Fisheries also held its fifth meeting in March 2022 in virtual mode.

The working group was led on the Indian side by the Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, and on the Sri Lankan side by the Ministry of Fisheries, and discussed, among other things, the need to transition to sustainable fishing practices and ways of doing the same.[135]

Mauritius

The Indo-Mauritius Maritime Dialogue on Blue Economy was launched in 2016 between the Ministry of Earth Sciences on the Indian side, and the Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping, and Outer Islands on the Mauritian side. Through this dialogue, both countries explore possible areas of cooperation in the Blue Economy, such as scientific and technological knowledge exchange, early warning systems for tsunamis, capacity-building, and maritime domain awareness.[136]

Australia

In 2020, India and Australia decided on a Shared Vision for Maritime Cooperation in the Indo-Pacific, reiterating both countries' commitment to a free and open Indo-Pacific and a rules-based order rooted in the United Nations Convention on the Law of the Sea (UNCLOS). Australia also agreed to work closely with India's Indo-Pacific Oceans Initiative to improve the “management of shared oceanic domains” in key areas like addressing marine pollution, sustainable use of marine resources, capacity building and resource sharing, scientific, technical, and academic cooperation, and facilitating trade, connectivity, and maritime transport.[137]

Japan

Japan and India are committed to a free and open Indo-Pacific. Their collaboration in the Indo-Pacific works at the bilateral level through G2G engagements, and the multilateral level through groupings like Quad, IORA (Japan is a Dialogue Partner), and G20. During PM Fumio Kishida's visit to India in March 2023, he outlined Japan's plan for a Free and Open Indo-Pacific. The plan stressed three pillars of cooperation for FOIP, that is, principles for peace and rules for prosperity, addressing challenges with a focus on cooperation and equal partnership among nations, and finally working towards a multi-layered connectivity to boost economic growth in the region.[138]

Section IV:
Recommendations

General

1. Following over a decade of important developments, the domain of Blue Economy is now ready for take-off, particularly in the Indian context. Therefore, it is desirable for the Government to finalize and announce its Blue Economy policy as soon as possible. The announcement should be followed by a series of dissemination measures for various stakeholders. FICCI should collaborate with the authorities concerned to apprise business and industry about the role envisaged for it under the new policy.

2. Considering the size, level, stakes, and rich potential of the Blue Economy, it will be difficult for the Government or the industry to achieve desired goals by working in compartments. Hence, it is essential to adopt a holistic strategy anchored in the Public Private Partnership (PPP). It should be designed to accelerate growth, while ensuring sustainable development.

3. In order to implement the new BE policy effectively, the Government may consider re-naming The Ministry of Earth Sciences as The Ministry of Earth Sciences and Blue Economy (MoES and BE).

4. Blue Economy projects should be designed to adhere to climate change standards and guidelines suggested by the World Bank and other agencies. It will be desirable to establish linkages between ocean-based and land-based industries and evolve a mechanism on how the Blue Economy would work in the overlapping areas. India should build skills in related sectors and then move to help other countries, especially the countries of the Global South, on the Blue Economy opportunities.

5. Women's economic empowerment through an optimal utilization of BE potential should be a priority goal.

6. As the Blue Economy is a new frontier, it is essential to disseminate awareness by embedding this concept into the education and training system, especially at business schools and in economic diplomacy modules by the relevant institutions.

7. An international conference on the Blue Economy may be hosted in New Delhi during 2024. Representatives of EU, ASEAN, IORA, and BIMSTEC and a few other select countries should be invited with the specific purpose of strengthening G-to- G and B-to-B dialogue and tangible cooperation.

8. The new Blue Economy policy realisation will require massive scale acoustic capacity & capability building, comprising research, skilling, academic programs, innovation and policy interventions. The digital transformation in the form of Marine Spatial Planning (MSP) is the way forward.

9. A structured approach that will provide nuanced policy and technology intervention along with acoustic capacity and capability building will be critical. The Underwater Domain Awareness (UDA) framework, has merit to drive a national and regional initiative, particularly to manage the challenges and opportunities in the tropical waters of the Indian Ocean Region (IOR) and beyond.

Sector-Wise

Fisheries

1. The implementation of robust regulatory frameworks within the Exclusive Economic Zone (EEZ) extending beyond territorial waters, where current regulations are either absent or very minimal, is imperative. It is estimated that around 70% of the total fisheries harvest originates from these waters, wherein the application of sustainable fishing principles is only loosely adhered to. Given that the majority of fish catches are from this region, using technologically advanced vessels, and highly efficient gear, the regulation of fishing in this zone is of utmost importance.

2. The utilization of advanced technological tools, such as space technology, into fisheries management to improve forecasting capabilities, ensuring the safety of fishermen, and effective implementation of regulations, and monitoring of fishing activities, should be taken up on a larger scale and disseminated effectively.

3. Undertake measures aimed at decreasing fishing capacity, encompassing reductions in the number of fishing vessels and the imposition of restrictions on installed engine power, as a crucial strategy in mitigating the adverse impacts arising from fishing activities. Such interventions assume critical significance within the context of sustainable fisheries management and align with the goal of optimal resource utilization and long-term conservation objectives.

4. The adoption of alternative, environmentally friendly fuels and the transition to renewable energy sources for propulsion and other deck applications in fishing operations, along with the implementation of optimised machinery and sensor-based decision support systems in aquaculture operations, is crucial to reducing energy consumption in fishing and culture activities. Standardising or mandating energy-efficient fishing vessel and gear designs can reduce fuel use even more. These strategies will help fisheries achieve energy efficiency, sustainability, and lower environmental impact.

5. With the increased use of big data in recent years, information from vessel monitoring systems can be used to understand the pattern of fishing by the industry and contribute to stock assessment studies by utilizing appropriate machine learning techniques. This would also aid in monitoring, control, and surveillance, thereby aiding in the reduction of illegal, unreported, and unregulated (IUU) fishing. The traceability of seafood, which is of great concern, can also be addressed in a big way using monitoring of vessels and fishing grounds.

6. The significance of certification of fisheries is growing as an increasing number importing nations stipulate the requirement for certified products aligning with consumer preferences. The higher premium enjoyed by certified products in the marketplace not only augments economic gains but also permeates downstream to benefit the producers. Consequently, it is advisable to undertake the certification of eligible fisheries which meet the stringent requirements of certification, accompanied by the implementation of strategic improvement plans to enhance certification processes for other fisheries.

7. Understanding that the future demand for fish must be met through aquaculture, the significance of aquaculture is paramount. Steps should be taken to increase fish production from both freshwater and saltwater aquaculture fisheries.

8. As a requirement for adhering to the international sanitary and phytosanitary measures, India needs to

have a strong domestic food safety regulatory regime given that the importing countries have established strict quality control standards for the fishery products that are being imported into their countries. It is crucial to have an extensive national monitoring system in place for tracking down and reporting cases of pollutants and residues.

9. Improving credit, insurance and market institutions in inland and marine fisheries is crucial. These institutions must take substantial efforts to improve operating efficiency, accessibility, and functionality, which include strengthening credit and market frameworks, encompassing financing choices, market linkages, and information dissemination.

10. It is imperative to address the existing skill gaps across all domains of the fish value chain, encompassing harvest operations, post-harvest operations, advanced processing techniques, marketing information, and beyond, to enhance and optimize operational efficiency, and effectively meet the growing demands of the markets. Efforts must be directed towards bridging these gaps through targeted interventions through skill development, training programs, and knowledge dissemination.

Shipping, Ports and Logistics

1. There is a need to promote and strengthen communication amongst the stakeholders particularly the industry about the strategies and initiatives of the government for greening of the entire shipping sector.

2. Effective measures for addressing the physical and infrastructure constraints at the seaports.

3. Greater convergence between the governance parameters of ports and port cities.

4. The decision-making systems need to be strengthened to fully accommodate the contingent implementational risks.

Coastal Tourism

1. There is a lack of data on coastal tourism in India. Tourist data is crucial for understanding the preferences and interests of tourists visiting coastal destinations and provides insights into the demographics of visitors, their travel patterns, duration of stays, and activities they engage in. Hence, collecting data will help in effective management, sustainable development, and ensuring maximum benefits for both tourists and the local community from the tourism industry.

2. Identifying and establishing blue clusters (the geographic concentrations of interconnected businesses, research institutions, and other stakeholders within maritime industry) can be an approach to enhance economic development in the maritime sector. The clusters promote collaboration, innovation, and knowledge sharing, leading to overall growth of the sector.

3. Identifying tourist places and assessing the demand for various types of tourism is essential for sustainable tourism development. It empowers destinations to allocate resources efficiently and create a balanced and resilient tourism ecosystem that benefits tourists, local communities, and the environment.

4. Incorporating and enhancing cruise tourism, surfing and “niche tourism” activities like deep-sea diving can diversify a destination's offerings and attract a wide range of tourists. Improving and promoting cruise tourism to the neighbouring countries can foster economic growth, cultural exchange, infrastructure development, and can improve cordial relations between them.

5. Strengthening the resilience of coastal and marine tourism is crucial for the protection of ecosystems,

livelihoods, and overall sustainability of the coastal regions. Resilient measures should address vital issues such as ecosystem preservation, biodiversity conservation, natural resource sustenance, economic stability, sustainable tourism, adaptive capacity, community resilience and disaster risk reduction.

Marine/Maritime Energy Transition

1. Genuine and regular consultations with all stakeholders along the entire maritime sector both nationally and globally.
2. Suitable policy and regulatory intervention for promoting cleaner energy mix at all stages.
3. Setting practical national targets for emission reduction followed by strict compliance.
4. Set up quality and safety standards to enhance industry/public confidence in the new technologies and processes.
5. Advocacy with higher education and research institutions to promote research for plugging technology gaps for the entire value chain, especially hydrogen and ammonia supply chain management; and improvements in the engine technology.
6. Skilling and up-skilling infrastructure and incentives.
7. India with its capacity and experience in energy transition technologies should offer capacity building programmes for Global South.
8. Set up financial support systems.

Deep Sea Mining

1. The International Seabed Authority (ISA) is expected to bring out Mining Code, especially for polymetallic nodules (PMN), within the next few years. This is expected to give fillip to the deep sea mining industry worldwide. It is an opportunity for India.
2. In addition to developing the deep sea mining technology, which would be beneficial to the Indian Industry, India could also strive to position itself as the primary and preferred destination of the harvested nodules by the major players in commercial deep sea mining worldwide. With a very well-developed terrestrial mining and metal extraction industry existing in India, with healthy marine logistics and shipping to support, repositioning and repurposing some of these strengths could be advantageous. The likely competitors are China and other South Asian countries like Vietnam, Indonesia etc., which are closer to the Clarion-Clipperton Zone (CCZ), Pacific Ocean.
3. Metal extraction of cobalt, nickel and copper, with manganese in large quantities, provides the opportunity for growth of the downstream industries and the high value segment of electric vehicles, high power density batteries and the associated technology. With a growing market in India over the next two decades, it portends well to competitively plan the resources, products, and the technology, to meet the demand.
4. A major factor in developing this industry and making the investments attractive would be the policies and laws. The Mining Code of the ISA would require suitable review of the Indian marine mining laws, to permit the Indian companies to engage competitively in deep sea mining under the Indian sponsorship or foreign or in mutually beneficial international consortiums. There would also be a need for enabling laws that

would give clarity in respect of taxation and duties, and consideration of liabilities, in mining in international waters and moving of the mineral resources to India and other destinations.

5. The deep sea mining industry demands enormous investments and has long gestation periods to profitability. The industry having both economic and strategic value for the country, it bodes well to look at the opportunities and bring in enabling provisions that strengthen and incentivize the Indian industry.

Marine Biotechnology and Pharma

1. Like other BE sectors, the growth will have to necessarily come through public-private partnerships. However, research in marine biotech would need to be largely supported through public sector because of high cost, uncertainty of returns and heavy skill dependence. On the other hand, given the long-term strategic importance of the ocean spaces, we cannot afford to lag behind
2. There is a compelling need and justification for integrating traditional knowledge with the marine biotechnology development so that the existing wealth of expertise and knowledge is not lost
3. Promoting information sharing through national platforms for research and outcomes to promote synergies and avoid wasteful duplication.
4. Develop a suitable regulatory framework for greater clarity to the business and investors
5. Set up norms for intellectual property generation and protection
6. Promote international cooperation for capacity building and enhancement and open doors for cooperation with other developing countries
7. Develop sectoral Standard Operating Procedures (SOP's) for sustainability
8. Develop a platform for consultations with all stakeholders from academia, industry, civil society and governance for minimising conflicts.

Marine Spatial Planning (MSP)

1. As MSP is heavily science, skills and data dependent, universities and the concerned R & D labs/institutions need to be sensitised for including MSP relevant knowledge and data in their work plans.
2. MSP will need to be managed by relevant coastal authorities at appropriate levels (State/District/Block). There will be a need for specific capacity building for such authorities.
3. Most effective system to measure, monitor and address the impact of human activities in the oceans would be the underwater domain awareness (UDA), Steps will need to be taken for integrating MSP with the evolving UDA framework.
4. We also need to start identifying target priority sites for introducing MSP.
5. Following the global best practices, India should also develop its own legal and administrative framework for MSP.
6. As MSP may spread across jurisdictions, we should promote regional approaches, including through capacity building programmes for regional partners.

Section V:
Conclusion

FICCI Task Force 3.0, the author of this report, sincerely believes that proper utilization of BE resources is both a desirable and essential goal that will help advance India's economic progress in the coming decade. A long-term and sustainable development of oceanic resources, in conjunction with appropriate international cooperation, is the right path to take for the government and other concerned stakeholders.

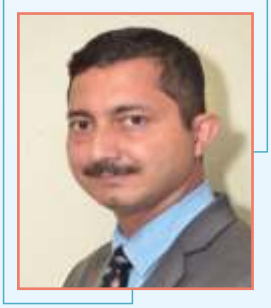
A wide dissemination of the BE philosophy and strategy is the need of the hour.

Even after the submission of this report, BE Task Force will remain committed and available to handle whatever tasks that maybe assigned to it in the future.

Chair and Members of Taskforce Members- Blue Economy Taskforce 3.0



Ambassador **Rajiv Bhatia** is Distinguished Fellow, Gateway House, and a former Ambassador of India. As Director General of the Indian Council of World Affairs, he helped strengthen India's Track-II research and outreach activities. He has been the Chair of FICCI Task Force on Blue Economy since 2016. During a 37-year tenure in the Indian Foreign Service, he served as Ambassador to Myanmar and Mexico and as High Commissioner to Kenya, South Africa and Lesotho. South Asia is a region of special interest to him. A prolific columnist, he is also a regular speaker on foreign policy and diplomacy in India and abroad. He was Senior Visiting Research Fellow from 2011 to 2013 at the Institute of South East Asian Studies (ISEAS), Singapore. He holds a Master's degree in political science from Allahabad University. His three books – India in Global Affairs: Perspectives from Sapru House (KW Publishers, 2015), India-Myanmar Relations: Changing contours (Routledge 2016) and India-Africa Relations: Changing Horizons (Routledge 2022) have received critical acclaim



Dr (Cdr) Arnab Das, is a researcher, innovator, strategist, and entrepreneur. He served in the Indian Navy for over two decades as an Electrical Officer and been appointed on board in frontline Indian Coast Guard Ship. He did his Master's and PhD from IIT Delhi on Underwater Technology. He was invited to Tokyo University as a visiting researcher for his contribution to the freshwater Dolphin monitoring research and field deployment in the Ganga River and Chilika Lake. He joined the Acoustic Research Laboratory (ARL), at the National University of Singapore for a year as a Research Fellow. He has over 70 publications, two book chapters and a book to his credit. He founded Maritime Research Center (MRC) and M/S NirDhwani Technology Pvt Ltd (NDT) in 2017. MRC is a not-for-profit, section 8 company formulated as a technology driven think tank, and NDT is a Start-up to drive innovation and field validation. Both MRC and NDT are together driving the Underwater Domain Awareness (UDA) framework for safe, secure, sustainable growth for all in the tropical waters of the Indo-Pacific region and beyond. The UDA framework have received significant recognition both nationally and globally, for its research, innovation, skilling, knowledge and policy driven body of work.



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