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Indicative zoning of ocean spaces for accounting and blue economic development in India

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Received 06 Nov 2025; Accepted 16 Dec 2025; Published 2 Jan 2026

DOI: https://doi.org/10.64171/JAES.6.1.10-22

Abstract

The Blue Economy seeks to harness ocean resources for economic growth, employment generation, and livelihood enhancement while safeguarding marine ecosystems and biodiversity. Achieving this balance requires robust frameworks that integrate ecological sustainability with economic development. Global initiatives such as the World Bank's Blue Economy Development Framework (BEDF) and the United Nations Department of Economic and Social Affairs (UN DESA) emphasize marine spatial planning, sustainable fisheries, and ocean conservation. Central to these efforts are ocean accounting systems that combine environmental and economic data, often aligned with the System of Environmental-Economic Accounting (SEEA), to measure natural capital, monitor sectoral progress, and capture the interdependence of ecological health and economic well-being. "Technical Guidance on Ocean Accounting, shared by GOAP (Global Ocean Accounts Partnership) is an important tool for ocean accounting.

Along with ocean accounting, India has articulated its own vision of the Blue Economy, highlighting the need to integrate the production and consumption of ocean goods and services within the ecological capacity of marine systems. This vision necessitates sectoral coordination, jurisdictional alignment, and administrative integration through marine spatial planning and resource accounting. Against this backdrop, the present study examines the extent of India's ocean zones, the range of economic activities they support, and the frameworks linking the ocean zones covering ecosystem extent, condition, physical flows, and monetary benefits. This ocean zones classification strengthens evidence-based policymaking, enhances transparency in ocean governance, and supports India's transition toward sustainable and resilient blue economic development.

The views expressed in this publication are those of the authors and do not necessarily reflect the affiliated research institutions.

Keywords: Ocean Accounting, Stock and Flows, Environmental Economics

1. Introduction

The concept of the Blue Economy, as defined by the United Nations Department of Economic and Social Affairs (UN DESA, 2017) [46], encompasses a wide array of economic sectors and policy frameworks that collectively determine the sustainability of ocean resource use. It presents two core challenges: first, to understand and manage the multifaceted dimensions of oceanic sustainability from fisheries and ecosystem health to pollution prevention and second, to foster cross-border and cross-sectoral collaboration on an unprecedented scale. These challenges are particularly acute for Least Developed Countries (LDCs), which face significant resource and capacity constraints (UN DESA, 2017; Unmana Sarangi, 2023) [46, 39]. The importance of this endeavour is further underscored by Sustainable Development Goal 14, which calls for the conservation and sustainable use of oceans, seas, and marine resources (UN DESA, 2017; UN Working Group, 2019) [46, 53].

India has articulated a working definition of the Blue Economy as "exploring and optimising the potential of the oceans and seas which are under India's legal jurisdiction for socio-economic development while preserving the health of the oceans." The Blue Economy links production and consumption to ecological capacity and envisages an integrated approach to economic development and environmental sustainability. It covers both marine (offshore) and coastal (onshore) resources (Working Group 1, 2019; Gowri Ramesh, 2025) [53, 36].

As India aspires to become the world's third-largest economy by 2030, its maritime strategy must evolve beyond naval strength to include a resilient and inclusive maritime economy. This requires a comprehensive framework that integrates offshore sovereignty, resource management, trade routes, and energy systems-both fossil-based and renewable. India's strategic location at the heart of the Indian Ocean Region further amplifies its maritime potential, making ocean governance a cornerstone of national development (Unmana Sarangi, 2023) [39].

In this context, ocean accounting emerges as a critical tool. Ocean accounts are structured frameworks that organize data on environmental assets, economic activities, and social indicators such as employment. Unlike traditional economic metrics, which often overlook ecological health and community impact, ocean accounts provide a coherent basis for measuring progress toward sustainable ocean development.

They enable the estimation of externalities, the flow of ecosystem benefits, and the sustainability of maritime activities. The OECD (2016) [30] considers that any definition of the ocean economy is incomplete unless it also encompasses non-quantifiable natural stocks and non-market goods and services. In other words, the ocean economy can be defined as the sum of the economic activities of ocean-based industries, and the assets, goods, and services of marine ecosystems (OECD, 2016; UN DESA, 2017) [30, 46].

This paper assesses the indicative spatial units in the ocean zones to account for goods and services within the scope of India's blue economic activities. The accounting tables and methods are presented in the Technical Guidelines for Ocean Accounting for Sustainable Development (TG-OASD) (2025) [16]. The ocean is not uniform. Assets, physical, chemical, biological, socio-economic and activities are different. The Law of the Sea divided the oceans, defining nations' rights, duties, and jurisdictions over ocean spaces, covering navigation, resources, and marine protection. Economic activities in the ocean accounting shall also be based on the spatial extent of the zones. The zoning offers advantages by enabling performance evaluation, fostering localised decision-making, improving assets and flows, boosting efficiency, and promoting accountability, allowing businesses to tailor strategies to different zones while maintaining overall control and sustainability. This spatial unit's accounting framework aims to capture the spatial extension of economic activities, evaluate physical and ecological conditions, quantify benefit flows, and estimate equivalent economic values. By aligning with national priorities and global commitments, this approach seeks to strengthen ocean governance and support India's transition to a sustainable Blue Economy (Gowri Ramesh, 2025) [36].

2. Extent of Ocean Zones of India

The Territorial Waters, Continental Shelf, Exclusive Economic Zone (EEZ) and Other Maritime Zones Act, 1976 serves as the foundational legislation governing India's maritime jurisdiction. Notably, the Act incorporates key principles of the United Nations Convention on the Law of the Sea (UNCLOS), aligning India's legal framework with international norms (Government of India, 1976; United Nations, 1982) [17, 49]. The Legal and Treaties Division of the Ministry of External Affairs functions as the nodal agency for matters relating to the Law of the Sea (Balakrishnan, 2024) [1].

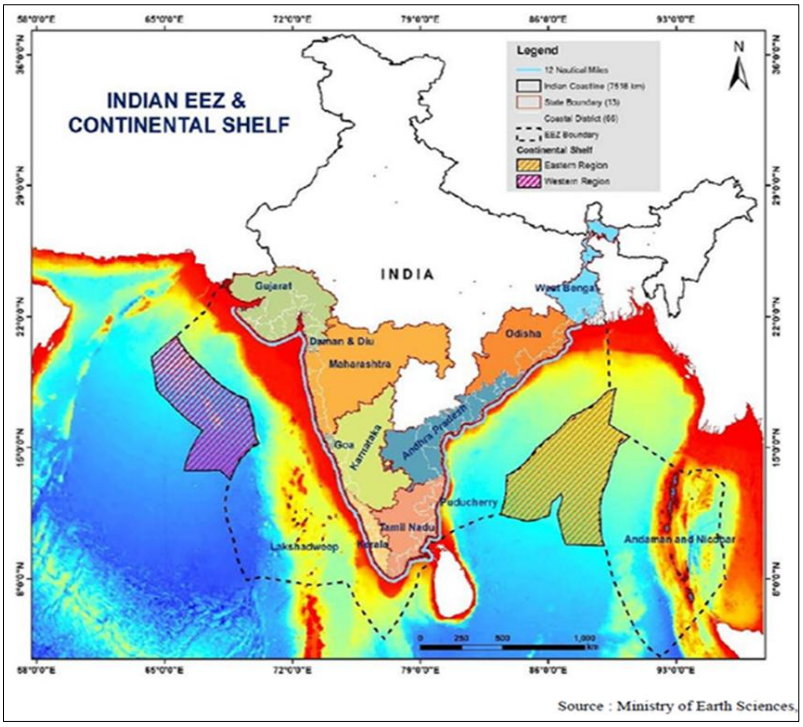
India exercises full sovereignty over its territorial sea, extending up to 12 nautical miles (1 nautical mile = 1.852 km) from the officially notified baselines (low-water line). This sovereignty includes rights over the airspace above the territorial sea. Beyond this, the contiguous zone–extending up to 24 nautical miles permits enforcement of customs, immigration, and sanitary regulations (Jayan, 2013) [22].

The Exclusive Economic Zone (EEZ), extending up to 200 nautical miles from the baselines, grants India exclusive rights for exploration, exploitation, conservation, and management of natural resources both in the water column and on the seabed. Additionally, India holds sovereign rights over the continental shelf, which comprises the seabed and subsoil of the natural prolongation of its landmass beyond the EEZ. In essence, while the EEZ covers both seabed and water column resources, the continental shelf pertains solely to seabed and subsoil resources (Rajagopalan, 2018) [35].

India has formally notified its baselines, from which the territorial sea, contiguous zone, and EEZ are measured. These maritime zones are thus legally established, with the National Hydrographic Office designated as the nodal agency for baseline demarcation. India's EEZ spans approximately 2.3 million sq. km. To support scientific and strategic initiatives, the Ministry of Earth Sciences (MoES) has completed bathymetric surveys over 1.5 million sq. km. a critical step for topographical mapping and marine analysis. Under UNCLOS provisions, India submitted its claim for an extended continental shelf of 600,000 sq. km. beyond the EEZ in May 2009. An additional claim within the domain of the Extended EEZ is currently under preparation (Working Group 1, 2019; UN DOALOS, 2020) [53, 44].

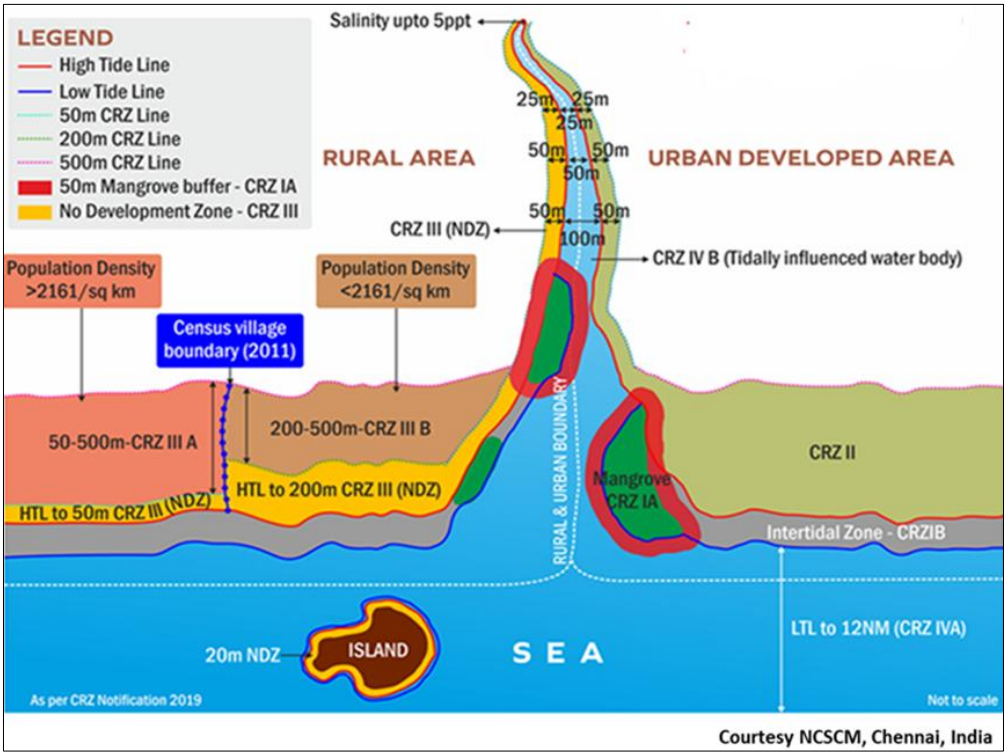
India has emerged as a key global player in deep-sea mining. It holds two exploration contracts with the International Seabed Authority (ISA): one for polymetallic nodules in the Central Indian Ocean Basin (CIOB), and another for polymetallic sulfides in the Rodrigues Triple Junction (RTJ). The CIOB contract area spans 75,000 sq. km., rich in deposits of nickel, cobalt, copper, and other strategic minerals. The RTJ region is expected to contain polymetallic sulfides with rare earth elements, including gold and platinum (Working Group 1, 2019; International Seabed Authority, 2019) [53, 20].

In accordance with Article 76 of UNCLOS, the MoES has delineated India's continental shelf based on extensive marine geophysical data. The claim submitted to the United Nations in May 2009 by the Ministry of External Affairs is supported by over 32,000 sq. km. of seismic reflection data acquired through the National Centre for Polar and Ocean Research (NCPOR). These claims are slated for consideration by the Commission on the Limits of the Continental Shelf (CLCS), a specialized body established under UNCLOS and headquartered at the United Nations in New York (Working Group 1, 2019; UN DOALOS, 2020) [53, 44].



Map 1: Extent of Ocean Zones of India

In addition, the Coastal Regulation Zone Notification (CRZ Notification) is a set of rules issued by the Indian government under the Environment (Protection) Act, 1986 to protect coastal areas and regulate activities there. The CRZ is defined as the area up to 500 meters from the High Tide Line (HTL), and it categorizes coastal stretches into different zones (CRZ-I to CRZ-V) to manage development. CRZ-I is the most ecologically sensitive. CRZ-II areas are developed areas that are already built up, including areas within city limits. CRZ-III are rural and less developed areas, further categorized into CRZ-III A (densely populated) and CRZ-III B (less densely populated). CRZ-IV B A are the territorial waters covering up to 12 nautical miles, and CRZ-IV B are intertidal areas tidal influenced water bodies where land-based blue economic activities are high. In addition, CRZ-Y IV B areas are those requiring special consideration for protecting the critical coastal environment. All the CRZ areas are being used by various stakeholders with regulations and limitations (MoEFCC, 2019) [24].



Map 2: Coastal Zones (CRZ-I A&B, II, III A&B, CRZ IV A&B of India)

Following the International and National rules and regulations, the ocean zones covering areas of India are;

- Coastal Ecosystems (CRZ I A)
- Intertidal Areas (CRZ I B)
- CRZ II
- CRZ III A & B
- Coastal Water Bodies (CRZ IV B)
- Island CRZ Notification
- Territorial Sea - Coastal Waters and Sea Bed Area within 12 NM (CRZ IV A)
- Areas Requiring Special Consideration under CRZ regulations (CRZ IVB)
- Contiguous zone, extending up to 24 nautical miles from the baseline
- Waters and Sea Bed Area of the Exclusive Economic Zone (EEZ) and Continental Shelf
- Exploration and Survey Areas in the High Seas

3. Economic activities in the Ocean Zones

One of the core pillars of the evolving ocean economy is the recognition of oceans and coasts as vital contributors to national and regional economic systems. As noted by the OECD (2016) [30], any comprehensive definition of the ocean economy must extend beyond measurable outputs to include non-quantifiable natural stocks and non-market goods and services. In essence, the ocean economy encompasses both the economic activities of ocean-based industries and the ecological assets, goods, and services provided by marine ecosystems.

The size of the Blue Economy in India has been estimated to be about 4% of the Gross Domestic Product. Globally, the blue economy has grown faster than economic sectors not directly connected to the blue economy in the last decade (Working Group 1., 2019) [53]. The Blue Economy offers high potential for the next stage of growth, resource development, and job creation, but with commensurate challenges. Advancing framework of participation of private sector and coastal communities in blue economy, using science-based tools for ocean management and the uses of oceans and coastal areas, and setting priorities are some of the immediate concerns.

Key sectors currently driving India's Blue Economy include capture fisheries, seafood processing, offshore oil and gas, shipping, ports and harbors, shipbuilding and repair, marine manufacturing and construction, maritime and coastal tourism (including the cruise industry), desalination, research and development, and coastal flood defense. These sectors not only contribute significantly to the national economy but also hold potential for further expansion.

In addition to these established domains, several emerging Blue Economy sectors are in pilot stages. These include marine aquaculture, deep-water oil and gas exploration, offshore wind energy, ocean-based renewable energy, marine and seabed mining, maritime safety and surveillance, marine biotechnology, island development, high-tech marine products and services, and instrumentation development (Ehler, Charles and Douvere, Fanny, 2009) [9].

4. Marine spatial plan in the Ocean Zones

The process of creating a satellite account of the ocean begins by defining the boundaries of the account. Ocean accounts require both an industrial boundary (what economic activity is included) and a geographic boundary (both seaward and landward, particularly for major estuaries and other waterbodies). Establishing clear spatial boundaries through Marine Spatial Planning (MSP) is fundamental to the effective implementation of Ocean Accounting in India (Ehler & Douvere, 2009; Douvere, 2008) [9, 7]. India's marine spatial planning (MSP) is a strategic approach to managing ocean use for economic growth and ecological sustainability, integrated with the "blue economy" vision (Jay, 2010; Foley *et al*., 2010) [21, 12]. The country is implementing projects in various stretches to develop and test a comprehensive MSP framework that can be replicated nationwide. It enables the selection, approval, monitoring, and management of diverse sectors engaged in Blue Economy activities (Sarangi, 2021) [38].

Robust datasets encompassing physical, chemical, and socio-economic parameters are essential for assessing ocean conditions and evaluating cumulative impact assessments for developmental interventions in various ocean zones (UNESCO, 2017) [41]. This supports implementation of the United Nations' Sustainable Development Goal 14, which seeks to "conserve and sustainably use the oceans, seas and marine resources for sustainable development'' as a guiding principle for global governance and use of ocean resources (United Nations, 2015) [50].

In the MSP framework, India's ocean zones (Zones 1–11) shall be systematically delineated to locate existing, proposed, and advisable economic activities, thereby facilitating the regulation of human interventions in the zones for blue economic development (Balakrishnan, 2024) [1]. These zones shall indicate the economic activities of existing, allotted, proposed, and advisable sectors mapped in 1 sq. km grids. All Blue Economy production activities shall follow rules and regulations, including Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA), guided by various Acts, Rules, Regulations, Notifications, and guidelines (MoEFCC, 2019) [24]. A database of ocean zones should be prepared to identify and estimate the quality and quantity of resources and assets within 1 sq. km grids. In addition, resource stocks shall be estimated using secondary information to fix the opening condition of the zones (Working Group 1, 2019) [53].

In parallel, conservation and protection zones must be designated to preserve ecologically sensitive areas from anthropogenic pressures. Traditional usage sectors should also be identified and safeguarded to support the continuity of indigenous practices and livelihoods (Foley *et al*., 2010) [12]. Continuous monitoring and documentation of the ocean's physicochemical and socioeconomic attributes are vital for ecosystem health evaluation and the development of a transparent, accountable ocean accounting framework (Douvere, 2008; Sarangi, 2021) [7, 38].

5. Ocean accounting framework and methodology

Ocean accounting provides a structured framework for organizing and integrating social, economic, and environmental data about the ocean to inform sustainable development and evidence-based decision-making. It builds upon international accounting standards, particularly "Technical Guidance on Ocean Accounting, shared by GOAP (Global Ocean Accounts Partnership) and the System of Environmental-Economic Accounting (SEEA), which enables the measurement of ocean wealth, the impacts of economic activities, and progress toward sustainability goals (United Nations, 2021; Hein *et al*., 2020) [48, 19]. By offering a coherent, data-driven picture, ocean accounting supports policies for managing marine resources, advancing the blue economy, and safeguarding the long-term health of marine ecosystems (Obst and Vardon, 2014; GOAP, 2025; UNCEEA, 2024) [28, 16, 43].

Despite its promise, several challenges hinder the implementation of ocean accounting. These include persistent data gaps, methodological difficulties in valuing non-market ecosystem services, limited institutional capacity in some countries, and complex jurisdictional issues concerning the governance of the high seas (GOAP, 2025; ESCAP, 2023) [16, 45]. Nevertheless, many nations are actively developing ocean accounting initiatives with international support. The Global Ocean Accounts Partnership (GOAP) plays a pivotal role in advancing this framework by providing technical guidance and fostering collaboration across governments, academia, and civil society (GOAP, 2025) [16].

TG-OASD guideline suggests testing the frameworks, classification characteristics, and economic activities to support the ocean economy satellite accounting. The guidelines encourage scientists to test the framework and address the research agendas, analyse the concepts, classifications and methods in the guidelines. This research paper proposes a zoning approach to account tailored to India, recognising the country's vast coastline, rich marine biodiversity, and growing blue economy. Such a framework would strengthen national capacity for integrated ocean governance, align with global standards, and contribute to India's sustainable development agenda.

Methodology and Assumptions

The proposed ocean accounting framework, "Technical Guidance on Ocean Accounting, shared by GOAP (Global Ocean Accounts Partnership) is an important tool for ocean accounting. The guidelines follow the System of Environmental-Economic Accounting–Ecosystem Accounting (SEEA EA) and the Technical Guidance on Ocean Accounting for Sustainable Development (TG-OASD). Spatial units are defined using legally recognised ocean zones to ensure consistency with Marine Spatial Planning (MSP). Physical accounts record stocks and flows using observed quantities (e.g., tons of fish catch, cubic metres of hydrocarbons), while monetary accounts apply exchange values consistent with the System of National Accounts to avoid double-counting.

Key assumptions include: (i) valuation is based on value added or resource rent, not gross output; (ii) non-market ecosystem services are estimated using proxy methods such as avoided cost or replacement cost where market prices are absent; (iii) all values are expressed in constant prices of a selected base year; and (iv) opening and closing conditions reflect changes due to both natural processes and human activities within the accounting period. Data gaps are addressed through conservative estimates and clearly documented assumptions, ensuring transparency and policy relevance.

5.1. Initiatives of India's ocean accounting

India's indicative ocean accounting framework aligns closely with the TG-OASD (2025) [16] and System of Environmental-Economic Accounting – Ecosystem Accounting (SEEA EA), which are internationally recognised statistical framework that integrates environmental data with economic information in a consistent structure. The guidelines comprise a set of standard accounts - Ecosystem Extent Accounts, Ecosystem Condition Accounts, Ecosystem Services Physical Flow Accounts, and Ecosystem Monetary Accounts (services and assets) which can be suitably adapted for ocean contexts to value marine spatial zones (GOAP, 2025; Hein *et al*., 2020) [16, 19].

In the Indian context, ocean accounting requires the delineation of spatial units across marine zones to capture both quantitative and qualitative indicators. These include ecosystem extent, condition, physical flows of resources, monetary valuation of benefits, and externalities. Assessment units may be structured as: (i) Production from Basic Spatial Units (BSUs), e.g., 1 sq. km areas (ii) Sector-wise Blue Economy contributions to national accounts (iii) Jurisdictional contributions across Coastal waters, Territorial Sea, Exclusive Economic Zone (EEZ), Continental Shelf, and High Seas (iv) Administrative unit-level contributions (v) Aggregate Blue Economy contributions to national accounts (ESCAP, 2023; MOSPI, 2025) [45, 25].

The status and condition of marine assets and their continuous flow of goods and services must be regularly monitored to inform policy decisions and corrective measures. This ensures enhancement of sectoral potential while mitigating harmful impacts on ecosystems, livelihoods, and associated capital. India's Blue Economy sectors, particularly those under Marine Spatial Planning (MSPs), provide diverse by-products and raw materials for industries and enterprises (KPMG, 2025) [23].

For classification, the goods and services of the Blue Economy are grouped into provisioning, regulating, and cultural services, consistent with SEEA EA categories. This distinction highlights the varied benefits humans derive from oceans, ranging from tangible outputs such as fisheries and minerals to regulating services like carbon sequestration, and cultural services including recreation and heritage (Obst and Vardon, 2014) [28].

India's adoption of ocean accounting is further supported by national initiatives such as the Draft Blue Economy Policy Framework (Economic Advisory Council to the Prime Minister, 2019) [53] and the Ocean Ecosystem Accounts Expert

Group Report released by the Ministry of Statistics and Programme Implementation (MOSPI, 2025) [25]. These efforts, combined with international collaboration through the Global Ocean Accounts Partnership (GOAP), position India to establish a robust ocean accounting system that integrates spatial zoning with ecosystem service valuation, thereby strengthening governance and sustainable development.

Accounting for the extent, boundaries and temporal changes of various BE sectors (satellite accounts) in Ocean Zones

Regular monitoring of sectoral activities in ocean zones is essential to estimate both the quantity and quality of positive and negative impacts of the Blue Economy (BE) on environmental sustainability. Analysing the extent and temporal changes of BE sectors provides critical insights for sustainable development, informed policymaking, and risk mitigation, while safeguarding ocean ecosystems (Obst and Vardon, 2014; Hein *et al*., 2020) [28, 19].

Tracking sectoral dynamics over time enables policymakers to identify successful interventions and adjust ineffective ones, thereby supporting adaptive governance beyond static assessments (Costanza *et al*., 2017) [6]. Such temporal analysis also helps define the ecological limits of ocean resources and prevent overexploitation. For example, monitoring fish stocks allows for timely quota adjustments or the expansion of marine protected areas to avert ecosystem collapse (Pauly *et al*., 2020) [31].

The Blue Economy encompasses interconnected sectors such as shipping, tourism, energy, and fisheries, whose interactions may be synergistic or antagonistic. Temporal studies highlight these relationships, guiding strategies that maximise co-benefits and reduce conflicts (Voyer *et al*., 2018) [52]. Monitoring also anticipates challenges posed by climate change, sea-level rise, ocean acidification, and marine pollution, ensuring the resilience of coastal infrastructure and industries (Gattuso *et al*., 2015) [13].

Emerging sectors such as offshore renewable energy and marine biotechnology demand careful tracking to guide investments, infrastructure development, and job creation (Elston *et al*., 2024; Teresa Rafael *et al*., 2024) [11, 33]. Since millions of coastal communities depend on marine resources, temporal analysis ensures inclusive growth, protecting vulnerable populations through targeted support and skill development (Fathimath Nishma *et al*., 2025) [26].

Coastal ecosystems such as mangroves and seagrasses, as critical "blue carbon" sinks, must be valued for their role in climate mitigation and coastal protection (Gilbert *et al*., 2015; Duarte *et al*., 2020) [14, 8]. Ultimately, long-term data collection and analysis provide transparency and evidence for measuring progress against national priorities and international commitments, including the UN Sustainable Development Goal 14: Life Below Water (United Nations, 2021) [51].

To contextualize the ocean economy within the broader national economy, accounting approaches should establish not only satellite accounts but also equivalents of the national balance sheet, balance of trade (imports/exports), fixed capital formation, depreciation/depletion, and non-market goods and services (TG-OASD., 2025; GOAP, 2025) [16]. All economic activities develop satellite accounts to provide consolidated details of economic activities of extent, condition, supply, and use tables and equivalent monetary benefits. A table describing the ocean zones, BE activities and temporal conditions are given in Table 1 below.

Table 1: India's Ocean zones and their BE activities

Extent of BE activities in the ocean zones in Sq Kms.				
Sl. No	**Ocean zones**	**Economic activities (satellite accounts for each economic activity)**	**Opening conditi. (2011); Area sq.Km**	**Closing conditi. (2030); Area sq.Km**
1	Coastal Ecosystems (CRZ I A)	Capture fisheries; seafood processing; coastal flood defense; ocean-based renewable energy		
2	Intertidal Areas (CRZ I B)	Capture fisheries; seafood processing; ports and harbors; shipbuilding and repair; marine manufacturing and construction; coastal flood defense; ocean-based renewable energy; mining; tourism		
3	CRZ II	Ports and harbors; shipbuilding and repair; coastal flood defence; ocean-based renewable energy; maritime safety and surveillance;		
4	CRZ III A & B	Seafood processing; ports and harbors; shipbuilding and repair; marine manufacturing and construction; coastal flood defense; ocean-based renewable energy; mining; maritime safety and surveillance; High-tech marine products and services		
5	Areas Requiring Special Consideration under CRZ regulations	Seafood processing; shipbuilding and repair; coastal flood defense; maritime safety and surveillance		
6	Territorial Sea - Coastal Waters and Sea Bed Area within 12 NM (CRZ IV A)	Capture fisheries; oil and gas; shipping; shipbuilding and repair; marine manufacturing and construction; maritime and coastal tourism (including the cruise industry); desalination; marine aquaculture; offshore wind energy; ocean-based renewable energy; mining; maritime safety and surveillance; marine		

		biotechnology; High-tech marine products and services; Instrumentation development		
7	Tidal Influencing Water Bodies (CRZ IV B)	Capture fisheries; seafood processing; ports and harbours; shipbuilding and repair; marine manufacturing and construction; coastal flood defence; marine and seabed mining; High-tech marine products and services		
8	Islands & I CRZ, includes Territorial Sea and other zones	Island development; other economic activities mentioned in CRZ Areas		
	Contiguous zone	Capture fisheries; oil and gas; shipping; shipbuilding and repair; marine manufacturing and construction; maritime and coastal tourism (including the cruise industry); desalination; marine aquaculture; offshore wind energy; ocean-based renewable energy; mining; maritime safety and surveillance; marine biotechnology; High-tech marine products and services; Instrumentation development		
9	Waters and Sea Bed Area of the Exclusive Economic Zone (EEZ)	Capture fisheries; offshore oil and gas; shipping; maritime and coastal tourism (including the cruise industry); desalination; marine aquaculture; deep-water oil and gas exploration; offshore wind energy; ocean-based renewable energy; marine and seabed mining; maritime safety and surveillance; High-tech marine products and services; Instrumentation development		
10	Exploration and Survey Areas in the High Seas	Capture fisheries; oil and gas; shipping; maritime and coastal tourism (including the cruise industry); deep-water oil and gas exploration; marine and seabed mining; maritime safety and surveillance; High-tech marine products and services; Instrumentation development		

5.2 Measuring the condition of BE assets

Analysing the opening and closing conditions of Blue Economy (BE) resources is essential for ensuring sustainability, managing human impacts, and guiding policy decisions. Opening conditions provide the baseline state of ocean zones, encompassing environmental quality (air, water, soil), biodiversity, and socio-economic assets that contribute to national economic flows. This baseline snapshot captures ecosystem health and resource abundance before new activities commence, thereby helping to minimise harm to sensitive environments and highlight pre-existing stressors such as pollution, habitat degradation, or overfishing (Sumaila and Villasante, 2025; Elston *et al*., 2024; Teresa Rafael *et al*., 2024) [40, 11, 34]. Establishing such baselines enables stakeholders to set realistic goals and design management plans aligned with Blue Economy priorities, while also ensuring compliance with international frameworks such as the System of Environmental-Economic Accounting–Ecosystem Accounting (SEEA EA) and TG-OASD (United Nations, 2021; Hein *et al*., 2020) [48, 19].

Closing conditions provide the “after” picture, measuring changes during or after activities approved under Marine Spatial Plans (MSPs). They assess whether management strategies or conservation efforts have maintained or improved resource health, offering evidence for future resource allocation, policy adjustments, and approvals of similar activities (Voyer *et al*., 2018; Gattuso *et al*., 2015) [52, 13]. Closing conditions also serve as benchmarks for subsequent survey cycles, ensuring adaptive governance that responds to evolving realities.

Together, opening and closing analyses create a dynamic monitoring framework that strengthens accountability and promotes responsible ocean stewardship. They transform ocean management into adaptive, evidence-driven processes that balance economic growth with ecological resilience, supporting inclusive and sustainable development in line with UN Sustainable Development Goal 14: Life Below Water (United Nations, 2021; Duarte *et al*., 2020) [51, 8].

The opening and closing conditions of all BE sectors should be systematically conducted. As an illustrative example, the Petroleum and Natural Gas sector can be used to develop an indicative framework for condition tables. Applying SEEA EA methods and concepts allows for the measurement and monitoring of ocean environmental conditions, integrating both ecological and economic dimensions (Obst and Vardon, 2014; ESCAP, 2023) [28, 45].

Table 2 presents the indicative condition table for the ocean accounting process, demonstrating the Condition of the BE stock satellite account in the ocean zones (Example – One Petroleum & Natural Gas exploration sites satellite account.

Table 2: Condition of the BE stock satellite account in the ocean zones (Example – One Petroleum & Natural Gas exploration sites satellite account

Opening condition Extent: Petroleum & Natural Gas Sq. KM Exploration and mining site	**Estimated quantity of the resources in million Cubic meters; Density of petrol & sulfur content; Total number of Enterprises; Quantity of natural gas extracted; Quantity of waste/greeze released; Quantity of crude oil extracted**	**Petroleum / Gas Chemical quality 0.3-0.5% (Ref.)**	**Depending refineries and quantities of the crude extracted**
Improvements by nature	Natural enhancement of Petroleum & Natural Gas resources		
Improvements by man-made activities	Addition by exploration; Implementation of environmental parameters; Awareness created by Environment Departments; Increase in technical and financial capacity of industries; effective implementation of CRZ and Environment Act by Departments.		
Reduction due to extraction	Reduction in Oil & Gas potential in mining sites; poor environment management		
Reduction by human activity	Reduction of demand due to the supply and use of non-renewable energy		
Reduction by catastrophic loss of human activity	Oil spill leakage and transportation waste		
Reduction by catastrophic of nature	Cyclone destruction of ore, gas pipelines etc.		
Closing condition, Petroleum & Natural Gas Sq.KM Exploration and mining site	Quantity of petroleum & natural gas extracted in million cubic meters; Number of depending enterprises; Natural gas extracted; density of petrol 7 sulfur content; Quantity of natural gas extracted; Quantity of waste / greeze spills in the environment;	Chemical quality of products	Depending on refineries and industries

5.3 Physical flow of goods and services from the BE sectors, Ocean Zone

The physical flow of goods and services derived from ocean zones is systematically captured through the TG-OASD, and SEEA, which extends the System of National Accounts (SNA) via ocean satellite accounts. These accounts record flows in structured tables, focusing on three core categories (i) Natural inputs from the ocean environment into the economy (e.g., extraction of fish, oil, gas, minerals, and abstraction of water). (ii) Products circulating within the economy (e.g., distribution of abstracted water across industries and households, or transfer of raw materials to processing plants). (iii) Residuals returned to the ocean environment (e.g., wastewater discharge, solid waste disposal, and air emissions). The accounting process begins with defining ocean-related activities and products using standardized classifications such as the United Nations International Standard Industrial Classification (ISIC), which establishes statistical boundaries for the Blue Economy. The goods and services are classified into provisional, regulation and cultural as guided in TG-OASD (2025) [16] and SEEA – EA (2021) [51]. Physical data are then collected on resource extraction (e.g., tons of fish catch, barrels of oil, cubic meters of natural gas), product flows within the economy, and residuals or pollutants discharged into the ocean (e.g., nitrogen runoff, carbon emissions). These flows are organized into supply and use tables, ensuring consistency and comparability across sectors.

In addition to material flows, the TG-OASD and SEEA Ecosystem Accounting (SEEA EA) framework records the supply of ecosystem services provided by ocean assets—such as coastal protection, carbon sequestration, and water filtration—and their use by economic units in physical terms. Integrating this physical information with monetary data (e.g., value added, employment, revenue) generates a comprehensive set of indicators that link environmental sustainability with economic performance. This integrated approach supports evidence-based policy analysis, enabling governments to balance resource extraction, industrial activity, and ecosystem health, while advancing sustainable ocean governance within the broader Blue Economy framework (United Nations *et al*., 2021; United Nations *et al*., 2014; DESA., 2017; OECD., 2016) [51, 47, 46, 30]. The petroleum and Natural Gas sector have been taken as an example to develop an indicative framework for the physical flow of goods and services from the ocean. TG-OASD and SEEA EA methods and concepts shall be applied to measure physical flow of goods and services of the ocean environment (Perkis, *et al* 2025; Bogaart *et al*., 2023; UN Technical guideline 2020; UN 2022; Dal Valck *et al*., 2023) [32, 5, 42]. ISIC (International Standard Industrial Classification of All Economic Activities) allows a uniform product code. HS Codes are used to classify goods by their nature, rather than their use or destination. They are also used to identify the country of origin for each product. Table 3 shows the indicative physical flow of goods and services in various ocean zones for accounting process.

Table 3: Physical Flow of Goods & Services/Yr. (Example - Oil & Natural Gas sector)

	Flow of services in million Cubic meters; with ISIC, HS, SITC					Exports	Discharges to the Environ
	Coastal Water and Sea Bed Area	**12 NM (CRZ IV A)**	**Creeks and near shore area (CRZ IV B)**	**EEZ**	**Imports from High Seas**		
Provisioning services	Crude oil (natural)						
	Petrol (by-product)						
	Diesel (by-product)						
	Gasoline(by-product)						
	Fertilizer (by-product)						
	Linoleum(by-product)						
	Perfume (by-product)						
	Insecticide (by-product)						
	Petroleum jelly (by-product)						
	Soap(by-product)						
	Natural Gas (natural)						
	NGLs include Ethane, propane, butane, iso-butane, and natural gasoline (by-product)						
	Fertilisers (by-product)						
	Fuel (by-product)						
	Paint (by-product)						
Relating services	Protection against storms and floods (hectare)						
	Lighting as a light house						
	Fishermen Support						
Cultural services	Tourism & recreation						

5.4 Monetary benefits of goods and services from the ocean environment

Within the TG-OASD and SEEA framework, monetary accounting for marine, coastal, and ocean systems involves assigning monetary values to natural assets, ecosystem services, and related economic activities. This approach provides a comprehensive view of the interrelationships between the ocean environment and the economy, ensuring that the ocean's contributions are visible within national and global economic frameworks (United Nations, 2021; Obst and Vardon, 2014) [51, 28].

The primary objective is to integrate environmental data into traditional economic accounts, such as the System of National Accounts (SNA), so that the value of nature's contributions is explicitly recognized. This integration ensures that the costs of environmental degradation are incorporated into policy and decision-making, thereby supporting sustainable development strategies with evidence-based insights (Hein *et al*., 2020; Costanza *et al*., 2017) [19, 6].

Ocean monetary accounts capture the value of provisioning services (e.g., fisheries, minerals), regulating services (e.g., carbon sequestration, coastal protection), and cultural services (e.g., tourism, heritage). These services can be valued using market prices or simulated exchange values, consistent with SEEA principles (Bateman *et al*., 2011; Barbier, 2017) [4, 2]. The accounts also record the stock of ocean assets at the beginning and end of each accounting period, enabling governments to track changes in resource wealth.

In general, valuation is based on the Net Present Value (NPV) of expected future flows of ecosystem services, ensuring that both current use and long-term sustainability are reflected in economic assessments (United Nations, 2021; Obst *et al*., 2016) [51, 29]. SEEA monetary valuation relies on the concept of exchange value, aligned with the SNA, focusing on market-observed prices or their estimations rather than total welfare values. Where direct market prices exist, they are applied; in the absence of markets, alternative valuation methods such as replacement cost, avoided cost, or resource rent are employed (Barbier *et al*., 2011; Hanley and Barbier, 2009) [3, 18].

These monetary accounting values enable governments to incorporate ocean values into fiscal planning and national accounts, revealing the hidden contributions of ecosystems to GDP and livelihoods. They also highlight the costs of degradation and the benefits of conservation, supporting robust evidence-based trade-offs in ocean resource use. By aligning with TG-OASD and SEEA standards, ocean monetary accounting ensures consistent reporting across nations, strengthening global comparability and accountability (GOAP, 2025; ESCAP, 2023) [16, 45].

Thus, TG-OASD and SEEA EA methods and concepts provide a rigorous basis for estimating the equivalent economic benefits of the ocean environment, ensuring that marine ecosystems are fully integrated into national and international economic assessments. Table-4 explains the indicative monetary value of the total compiled values of all oil ores, refineries, and by-products of the satellite accounts in various ocean zones for ocean accounts.

Table 4: Indicative monetary value of the total compiled values of all oil ores, refineries, and by-products of the satellite accounts of Petroleum and Natural Gas in Ocean accounts

	Coastal Water and Sea Bed Area	12 NM (CRZ IV A)	Creeks and near shore area (CRZ IV B)	EEZ	Imports from High Seas
Economic values in Rupees					
Provisional services	Crude oil				
	Petrol				
	Diesel				
	Gasoline				
	Fertilizer				
	Linoleum				
	Perfume				
	Insecticide				
	Petroleum jelly				
	Soap				
	Natural Gas				
	NGLs include Ethane, propane, butane, iso-butane, and natural gasoline				
	Fertilizers				
	Fuel				
	Paint				
Regulatory services	Protection against storms and floods (hectare) 2.2.1.3				
	Lighting as a light house (Kilo litre) 2.1.1.1				
	Fishermen Support				
Cultural services	Tourism & recreation				

Estimation of ocean contribution in the National account using the following equations;

Notation and set definitions

- **Sets:**
  - $\mathcal{S}$: set of CRZ 1A ecosystem sites, indexed by s.
  - $\mathcal{D}$: set of coastal districts for CRZ 1B, indexed by d.
  - $\mathcal{Z}=\{1,\dots,11\}$: set of ocean economy zones, indexed by z.
  - $\mathcal{A}(z)$: set of activities operating in zone z, indexed by a.
- **Components:**
  - $\mathcal{C}=\{\mathrm{Prov},\mathrm{Reg},\mathrm{Cult}\}$: provisioning, regulating, cultural services.
- **Units:** All monetary values in ₹ per year unless stated otherwise.

Example for site-level estimation (CRZ IA = ecosystem sites)

Site-level total

- **Original intent:** Sum of provisioning, regulating, and cultural services.
- **Corrected notation with indices:**

$$V_{\mathrm{CRZ\, IA,site}}^{(s)} = V_{\mathrm{Prov}}^{(s)} + V_{\mathrm{Reg}}^{(s)} + V_{\mathrm{Cult}}^{(s)} \quad \mathrm{for\ each\ } s \in \mathcal{S}.$$

National total (sum across sites)

$$V_{\mathrm{CRZ\, IA,India}} = \sum_{s\in\mathcal{S}} V_{\mathrm{CRZ\, 1A,site}}^{(s)}.$$

Example for administrative unit level estimation CRZ 1B (administrative districts)

District-level total

- **Consistency fix:** Use "CRZ IB" uniformly (not "I B"), and index components by district.

$$V_{\mathrm{CRZ\, IB,district}}^{(d)} = V_{\mathrm{Prov}}^{(d)} + V_{\mathrm{Reg}}^{(d)} + V_{\mathrm{Cult}}^{(d)} \quad \mathrm{for\ each\ } d \in \mathcal{D}.$$

National total (sum across districts)

$$V_{\mathrm{CRZ\, IB,India}} = \sum_{d\in\mathcal{D}} V_{\mathrm{CRZ\, IB,district}}^{(d)}.$$

All 11 zone level benefits are estimated in the ocean economy (production accounts) Zone totals from activities

- **Double-counting safeguard:** Use value added for $V_{a,z}$.

$$V_{\mathrm{zone}}(z) = \sum_{a\in\mathcal{A}(z)} V_{a,z} \quad \mathrm{for\ each\ } z \in \mathcal{Z}.$$

National ocean production (sum across zones)

$$V_{\mathrm{Ocean}}^{\mathrm{national}} = \sum_{z\in\mathcal{Z}} V_{\mathrm{zone}}(z).$$

6. Discussion and Conclusion

India's ocean zones represent a vast and dynamic frontier where ecological integrity and economic opportunity intersect. The diversity of activities from fisheries, aquaculture, and shipping to offshore energy, tourism, and marine

biotechnology illustrates the scale of the Blue Economy and the complexity of managing it sustainably (Voyer *et al*., 2018) [52]. Ocean accounting provides the essential framework to capture this complexity, enabling the systematic measurement of the extent, condition, and flows of marine resources in both physical and monetary terms. By embedding ecological data into economic accounts, India can reconcile developmental aspirations with environmental stewardship, ensuring that growth does not compromise long-term ecosystem resilience (Obst and Vardon, 2014) [28].

The indicative ocean zone framework outlined in this study demonstrates how sectoral activities can be recorded and assessed over time, offering a transparent basis for governance. Accounting for temporal changes in Blue Economy sectors highlights risks such as declining fish stocks, coral bleaching, or coastal erosion, while also identifying opportunities in renewable energy, sustainable aquaculture, and eco-tourism (Pauly *et al*., 2020) [31]. Measuring the condition of assets such as coral reefs, mangroves, and seagrass beds ensures that ecological quality is not overshadowed by short-term economic gains. Similarly, tracking the physical flow of goods and services alongside their monetary valuation ensures that both tangible and intangible benefits of ocean environments are recognized, from food security and coastal protection to cultural and recreational values (Barbier, 2017; Costanza *et al*., 2017) [2, 6]. Ocean accounting thus provides a dual lens: one that captures the biophysical realities of ecosystems and another that translates them into economic indicators. This duality is critical for India, where the challenge lies in balancing rapid economic growth with ecological sustainability.

For India, the adoption of ocean accounting carries significant policy implications. It calls for (i) Institutional integration across ministries and agencies to avoid fragmented governance (MOSPI, 2025) [25] (ii) Alignment with global standards such as the UN System of Environmental-Economic Accounting (SEEA EA) to ensure international comparability (United Nations, 2021) [51] (iii) Incorporation into Marine Spatial Planning (MSP) to balance competing uses of ocean space (Elston *et al*., 2024) [11] (iv) Investment in data infrastructure, observation systems, and capacity building, which are critical to operationalize ocean accounts (ESCAP, 2023) [45] (v) Community engagement and inclusion of traditional knowledge, ensuring that local communities benefit from and contribute to ocean governance (Fathimath Nishma *et al*., 2025) [27].

By quantifying ecosystem services and economic flows, ocean accounting can inform fiscal instruments, incentives, and adaptive governance mechanisms that respond to ecological decline or technological innovation. For example, valuation of carbon sequestration by mangroves and seagrasses can support carbon credit markets, while monitoring fish stocks can guide subsidy reforms and quota systems (Gilbert *et al*., 2015; Sumaila and Villasante, 2025) [15, 40].

The broader significance of ocean accounting lies in its potential to transform governance. It provides a foundation for evidence-based decision-making, strengthens India's climate resilience and biodiversity conservation strategies, and aligns national priorities with the Sustainable Development Goals (SDGs), particularly SDG 14: Life Below Water (United Nations, 2021) [51]. More importantly, it positions India as a leader among developing nations in operationalising the Blue Economy through transparent, accountable, and scientifically grounded mechanisms (Teresa Rafael *et al*., 2024) [34]. Ocean accounting also enhances international cooperation, as consistent reporting across nations facilitates comparative assessments and collective action on transboundary issues such as high seas governance, marine pollution, and climate change impacts (Gattuso *et al*., 2015) [13].

From a policy perspective, ocean accounting can serve as a foundational tool for implementing India's Blue Economy vision, strengthening Marine Spatial Planning, and embedding sustainability criteria into sectoral approvals and investments. The framework enables policymakers to move beyond GDP-centric assessments by recognizing the contribution of marine ecosystems to national wealth, climate resilience, and human well-being.

In conclusion, ocean accounting is both a technical and a strategic vision. It enables India to integrate ecological resilience with socio-economic well-being, ensuring that the ocean remains a source of prosperity for present and future generations. The success of this endeavor will depend on sustained investment in data systems, institutional capacity, and participatory governance. If pursued with rigor and inclusivity, ocean accounting can become a cornerstone of India's Blue Economy development, secure long-term sustainability while advancing national and global commitments (Obst *et al*., 2016; Costanza *et al*., 2017) [29, 6]. By embedding ocean accounting into national policy, India can demonstrate how science-based frameworks can guide economic development while safeguarding ecosystems. This dual commitment to prosperity and sustainability will not only strengthen India's domestic governance but also contribute to global leadership in ocean stewardship.

7. Acknowledgement

The authors express gratitude to the Ministry of Environment, Forests & Climate Change (MoEF&CC) for their administrative, governance and financial support for the functioning of the National Centre for Sustainable Coastal Management. Special thanks are extended to the following individuals for their guidance and encouragement: The Director, NCSCM; Dr. Purvaja Ramachandran, Division Chair, NCSCM; Dr. A. Senthil Vel, Advisor (Retd.), MoEF&CC, Government of India, New Delhi; Mr. Tappas Paul, World Bank (Retd.), New Delhi; Mr. Rajagopalan, IAS (Retd.). The authors also thank their colleagues across multiple divisions of NCSCM–MoEF&CC who contributed insights to this research. If there are any errors in the paper, readers are kindly requested to share feedback and suggestions with the lead author.

The views expressed in this publication are solely those of the authors and do not represent those of their affiliated research institutions.

8. Competing interests

Authors have declared that no competing interests exist.

References

1. Balakrishnan B. Management of ocean space around India and the High Seas Treaty. New Delhi: Indian Council of World Affairs, 2024.
2. Barbier EB. Marine ecosystem services. Curr Biol. 2017;27(11):R507–10. doi:10.1016/j.cub.2017.03.020.
3. Barbier EB, Hacker SD, Kennedy C, Koch EW, Stier AC, Silliman BR. The value of estuarine and coastal ecosystem services. Ecol Monogr. 2011;81(2):169–93. doi:10.1890/10-1510.1.
4. Bateman IJ, Mace GM, Fezzi C, Atkinson G, Turner K. Economic analysis for ecosystem service assessments. Environ Resour Econ. 2011;48(2):177–218. doi:10.1007/s10640-010-9418-x.
5. Bogaart P, Brandenburg K, Driessen C, Lous B, Mosterd R, Piet G, *et al*. SEEA ocean ecosystem accounting for the Dutch North Sea: Towards a first full implementation. The Hague: Statistics Netherlands (CBS), 2023.
6. Costanza R, de Groot R, Braat L, Kubiszewski I, Fioramonti L, Sutton P, *et al*. Twenty years of ecosystem services: How far have we come and how far do we still need to go? Ecosyst Serv. 2017;28:1–16. doi:10.1016/j.ecoser.2017.09.008.
7. Douvere F. The importance of marine spatial planning in advancing ecosystem-based sea use management. Mar Policy. 2008;32(5):762–71. doi:10.1016/j.marpol.2008.03.021.
8. Duarte CM, Agustí S, Barbier EB, Britten GL, Castilla JC, Gattuso JP, *et al*. Rebuilding marine life. Nature. 2020;580:39–51. doi:10.1038/s41586-020-2146-7.
9. Ehler C, Douvere F. Marine spatial planning: A step-by-step approach toward ecosystem-based management. IOC Manual and Guides No. 53. Paris: UNESCO Intergovernmental Oceanographic Commission, 2009.
10. Elston J, Pinto H, Nogueira C. Tides of change for a sustainable blue economy: A systematic literature review of innovation in maritime activities. Sustainability. 2024;16(24):11141. doi:10.3390/su162411141.
11. Elston R, Pinto H, Nogueira C. Ocean economy transitions and renewable energy pathways. Mar Policy. 2024;152:105118. doi:10.1016/j.marpol.2024.105118.
12. Foley MM, Halpern BS, Micheli F, Armsby MH, Caldwell MR, Crain CM, *et al*. Guiding ecological principles for marine spatial planning. Mar Policy. 2010;34(5):955–66. doi:10.1016/j.marpol.2010.02.001.
13. Gattuso JP, Magnan AK, Bille R, Cheung WWL, Howes EL, Joos F, *et al*. Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios. Science. 2015;349(6243):aac4722. doi:10.1126/science.aac4722.
14. Gilbert AJ, Alexander K, Sardá R. Marine ecosystem services and their valuation. Ecol Econ. 2015;119:1–8. doi:10.1016/j.ecolecon.2015.07.023.
15. Gilbert AJ, Alexander K, Sardá R. Marine spatial planning and good environmental status: A perspective on spatial and temporal dimensions. Ecol Soc. 2015;20(1):64. doi:10.5751/ES-06979-200164.
16. Global Ocean Accounts Partnership. Technical guidance on ocean accounting. Global Ocean Accounts Partnership, 2025.
17. Government of India. The territorial waters, continental shelf, exclusive economic zone and other maritime zones act, 1976. New Delhi: Ministry of Law and Justice, 1976.
18. Hanley N, Barbier EB. Pricing nature: Cost–benefit analysis and environmental policy. Cheltenham: Edward Elgar Publishing, 2009.
19. Hein L, Obst C, Edens B, Remme RP. Progress in natural capital accounting for ecosystems. Science. 2020;367(6477):514–5. doi:10.1126/science.aaz8901.
20. International Seabed Authority. Polymetallic nodule and sulfide exploration contracts: Public information template. Kingston: International Seabed Authority, 2019.
21. Jay S. Planners to the rescue: Spatial planning in marine governance. Mar Policy. 2010;34(3):635–42. doi:10.1016/j.marpol.2009.12.002.
22. Jayan PA. Jurisdictional waters delimitation: India's exclusive economic zone in MV Enrica Lexie case. NALSAR Law Rev. 2013;7(1):145–62.
23. KPMG. Navigating India's blue economy landscape. KPMG, 2025.
24. Ministry of Environment, Forest and Climate Change. Coastal regulation zone notification, 2019 (G.S.R. 37(E)). New Delhi: Government of India, 2019.
25. Ministry of Statistics & Programme Implementation. Ocean ecosystem accounts in India: A framework. New Delhi: Press Information Bureau, Government of India, 2025.
26. Nishma FPK, Ansar CP, Murshitha PM. Mangroves and climate change: Carbon sequestration implications–A review. J Res Environ Earth Sci. 2025;11(3):39-44. doi:10.35629/2532-11033944.
27. Nishma F, Ansar CP, Murshitha PM. Inclusive growth in coastal communities through ocean accounting. J Ocean Coast Econ. 2025;12(2):45-63.
28. Obst C, Vardon M. Recording environmental assets in the national accounts. Oxf Rev Econ Policy. 2014;30(1):126–44. doi:10.1093/oxrep/gru003.
29. Obst C, Hein L, Edens B. National accounting and the valuation of ecosystem assets and their services. Environ Resour Econ. 2016;64(1):1-23. doi:10.1007/s10640-015-9921-1.
30. Organisation for Economic Co-operation and Development. The ocean economy in 2030. Paris: OECD Publishing, 2016. doi:10.1787/9789264251724-en.
31. Pauly D, Zeller D, Palomares MLD. The future for fisheries. Nature. 2020;588:29–35. doi:10.1038/s41586-020-2616-y.
32. Perkiss S, Gacutan J, Moerman L, Nichols R, Voyer M, Atchison J, *et al*. Exploring accounting for the ocean: Utilisation of the sociology of worth. Soc Environ Account

J. 2025;45(1):14–41. doi:10.1080/0969160X.2024.2311356.
33. Rafael T, Cabral H, Mourato J, Ferrão J. Marine spatial planning: A systematic literature review (2004–2020). Marit Stud, 2024, 23(6). doi:10.1007/s40152-023-00349-7.
34. Rafael T, Cabral H, Mourato J, Ferrão J. Marine biotechnology and sustainable ocean economies. Front Mar Sci. 2024;11:145–60.
35. Rajagopalan R. India and UNCLOS: Navigating maritime jurisdiction and sovereignty. Strateg Anal. 2018;42(3):215–29.
36. Ramesh G. Blue economy: A strategic framework for sustainable growth in India. Indian J Integr Res Law. 2025;5(3):2065–83.
37. Reimer JM, Devillers R, Zuercher R, Groulx P, Ban NC, Claudet J. The marine spatial planning index. npj Ocean Sustain. 2023;2:15. doi:10.1038/s44183-023-00022-w.
38. Sarangi U. Blue economy, blue finance and ocean governance for achieving sustainable development goals. J Public Aff. 2021;21(3):e2567. doi:10.1002/pa.2567.
39. Sarangi U. Blue economy, blue finance and ocean governance for achieving sustainable development goals. Nat Resour Forum. 2023;47(1):3-21. doi:10.1111/1477-8947.12296.
40. Sumaila UR, Villasante S. Surging blue economy, increasing conflict risks and mitigation strategies. Front Mar Sci. 2025;12:1499386. doi:10.3389/fmars.2025.1499386.
41. UNESCO. Global ocean science report: The current status of ocean science around the world. Paris: UNESCO Publishing, 2017.
42. United Nations Committee of Experts on Environmental-Economic Accounting. Technical guidance on ocean accounting for sustainable development. New York: United Nations, 2020.
43. United Nations Committee of Experts on Environmental-Economic Accounting. Developing SEEA-Ocean: Proposal for consideration. New York: United Nations, 2024.
44. United Nations Division for Ocean Affairs and the Law of the Sea. Maritime zone definitions and continental shelf submissions. New York: United Nations, 2020.
45. United Nations Economic and Social Commission for Asia and the Pacific. Technical guidance on ocean accounting factsheet. Bangkok: United Nations, 2023.
46. United Nations, Department of Economic and Social Affairs. The potential of the blue economy. New York: United Nations & World Bank, 2017.
47. United Nations, European Commission, FAO, IMF, OECD, World Bank. System of environmental-economic accounting 2012: Central framework. New York: United Nations, 2014.
48. United Nations, European Union, FAO, OECD, World Bank Group. System of environmental-economic accounting—Ecosystem accounting. New York: United Nations, 2021.
49. United Nations. United Nations convention on the law of the sea. New York: United Nations, 1982.
50. United Nations. Transforming our world: The 2030 agenda for sustainable development. New York: United Nations, 2015.
51. United Nations. System of environmental-economic accounting—Ecosystem accounting. Statistical Papers Series F No. 124. New York: United Nations, 2021.
52. Voyer M, Quirk G, McIlgorm A, Azmi K. Shades of blue: Competing interpretations of the blue economy. J Environ Policy Plan. 2018;20(5):595–616. doi:10.1080/1523908X.2018.1473150.
53. Working Group 1. Report of the blue economy working group on national accounting framework and ocean governance. New Delhi: Economic Advisory Council to the Prime Minister, Government of India, 2019.