

Blue Economy Development in ASEAN: Opportunities, Challenges, and Pathways Toward Ocean Sustainability

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ABSTRACT: The blue economy has emerged as a strategic framework for reconciling ocean-based economic development with marine ecosystem conservation and social well-being, particularly in maritime regions such as Southeast Asia. As one of the world's most ocean-dependent regions, the Association of Southeast Asian Nations (ASEAN) possesses extensive marine resources that support fisheries, marine tourism, shipping, offshore energy, and emerging marine biotechnology industries. This review critically synthesizes the development, governance, challenges, and future prospects of the blue economy across the ten ASEAN member states. A total of 40 peer-reviewed journal articles published between 2010 and 2024 were systematically reviewed and organized into four thematic areas: (i) the sectoral composition and economic contribution of blue economy activities; (ii) policy, institutional, and governance frameworks; (iii) environmental and socioeconomic constraints; and (iv) emerging pathways toward sustainable and inclusive ocean-based development. The synthesis indicates that ASEAN's ocean-based sectors collectively generate an estimated USD 360–380 billion annually, demonstrating their substantial contribution to regional economies. However, their long-term sustainability remains constrained by fragmented governance, marine ecosystem degradation, unsustainable resource exploitation, uneven institutional capacity, and inequitable distribution of economic benefits. Significant differences among member states further highlight the need for context-specific national strategies supported by stronger regional coordination. Future blue economy development should prioritize integrated ocean governance, sustainable blue finance, technological innovation and transfer, ecosystem-based management, and meaningful participation of coastal communities. Strengthening these mechanisms would enable ASEAN to move beyond sector-driven ocean exploitation toward a more resilient, inclusive, and environmentally sustainable blue economy while accelerating progress toward Sustainable Development Goal 14 (SDG 14: Life Below Water) and the broader 2030 Agenda.

KEYWORDS: Blue economy; ASEAN; ocean sustainability; marine governance; fisheries; SDG 14; coastal development

1. Introduction

The blue economy has emerged as an important framework for reconciling economic development with the sustainable use and conservation of marine and coastal resources. Broadly defined as the sustainable use of ocean resources to support economic growth, improve livelihoods, and maintain ocean ecosystem health, the concept gained substantial international attention following the United Nations Conference on Sustainable Development (Rio+20) in 2012. Its importance was subsequently reinforced through Sustainable Development Goal 14 (SDG 14: Life Below Water), which calls for the conservation and sustainable use of oceans, seas, and marine resources [1]. This agenda is particularly relevant to the Association of Southeast Asian Nations (ASEAN), comprising Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. Collectively, these countries encompass one of the world's most economically important and biologically diverse maritime regions [2, 3].

The significance of the blue economy in Southeast Asia extends well beyond the direct economic value of marine resources. The region includes a substantial portion of the Coral Triangle, one of the world's richest centers of marine biodiversity, containing more than 75% of known coral species and supporting fisheries that contribute to the food security and livelihoods of more than 130 million people [4]. ASEAN waters also contain some of the world's busiest maritime routes, including the South China Sea and Strait of Malacca, through which a substantial share of international maritime trade passes [5]. Fisheries and aquaculture, coastal and marine tourism, shipping and port activities, offshore energy, and emerging marine biotechnology therefore represent important components of regional economic development. Collectively, these sectors contribute hundreds of billions of US dollars to regional economies and provide employment and livelihood opportunities for millions of people [6].

Despite these economic advantages, the continued expansion of ocean-based activities has created a fundamental sustainability challenge for ASEAN. Economic dependence on marine resources is occurring alongside declining ecosystem quality, overexploitation of fisheries, marine pollution, coastal habitat degradation, climate-related hazards, and increasing competition for ocean space [7, 8]. These pressures are compounded by differences among ASEAN countries in institutional capacity, economic development, technological capability, financing, and marine governance. Moreover, the economic benefits generated by ocean industries are not necessarily distributed equitably, particularly among small-scale fishers and coastal communities that are highly dependent on marine resources. Consequently, expansion of the ocean economy alone cannot be considered evidence of successful blue economy development unless economic gains are accompanied by ecosystem protection, social inclusion, and long-term resource sustainability.

A further challenge concerns the fragmented governance of marine resources. Fisheries, tourism, shipping, offshore energy, conservation, and coastal development are often managed through different institutions and regulatory frameworks, despite their strong ecological and economic interconnections. Marine ecosystems and environmental pressures also extend across national boundaries, making purely national responses insufficient for addressing transboundary pollution, shared fisheries, biodiversity loss, maritime activities, and climate-related risks. These conditions highlight the need for stronger coordination between sectoral policies and among ASEAN member states. Understanding how existing governance arrangements support or constrain blue economy development is therefore essential for

determining whether current economic trajectories can deliver both development and conservation objectives.

Academic interest in the ASEAN blue economy has expanded considerably, particularly since 2015. However, the available evidence remains dispersed across marine ecology, fisheries science, tourism, maritime economics, environmental governance, climate studies, and sustainable-development research [7, 8]. Most existing studies have examined individual countries, specific coastal areas, or particular economic sectors, such as fisheries [9] and marine tourism [10]. This fragmented literature makes it difficult to obtain a region-wide understanding of how blue economy sectors are developing, how governance approaches differ among ASEAN countries, and which environmental and socioeconomic constraints are common across the region. More importantly, limited attention has been given to integrating economic, environmental, governance, and social dimensions within a single ASEAN-wide synthesis.

This fragmentation represents an important research gap. Although individual studies provide valuable insights into particular sectors and countries, a comprehensive synthesis comparing the ten ASEAN member states and connecting sectoral development with governance capacity, environmental pressures, and socioeconomic outcomes remains limited. Such integration is necessary because blue economy performance cannot be adequately understood through economic indicators alone. A regional perspective is also required to identify common challenges, country-specific differences, transferable practices, and opportunities for coordinated action toward SDG 14. A systematic synthesis can therefore provide a stronger evidence base for understanding both the progress and limitations of blue economy development across Southeast Asia.

Accordingly, this review aims to critically synthesize the current state of blue economy development across the ten ASEAN member states based on evidence from 40 peer-reviewed journal articles published between 2010 and 2024. Specifically, the review examines four interconnected dimensions: (i) the sectoral composition and economic contribution of major ocean-based industries; (ii) existing policy, institutional, and governance frameworks; (iii) major environmental and socioeconomic challenges affecting sustainability; and (iv) emerging opportunities and pathways for more resilient, inclusive, and sustainable blue economy development. By integrating these dimensions, the review seeks to identify regional patterns, persistent knowledge and implementation gaps, and strategic priorities for strengthening ASEAN cooperation, blue finance, technological innovation, ecosystem-based management, and community participation. Ultimately, the synthesis provides a regional perspective on how ASEAN can better align ocean-based economic development with marine conservation and progress toward SDG 14 and the broader 2030 Agenda.

2. Sectoral Composition and Economic Dimensions of the ASEAN Blue Economy

2.1 Fisheries and Aquaculture.

Fisheries and aquaculture collectively represent the most labor-intensive and food-security-critical components of the ASEAN blue economy. The region ranks among the world's leading producers of capture fisheries and aquaculture, with Indonesia, Vietnam, Myanmar, and the Philippines among the top ten global fish-producing countries [11]. Small-scale and artisanal fisheries dominate much of the sector, directly and indirectly supporting an estimated 30–40

million people across the region [12]. Aquaculture production, particularly shrimp, pangasius, tilapia, and seaweed, has expanded substantially since the 1990s, driven by increasing export demand and the diversification of rural livelihoods. However, aquaculture intensification has also raised environmental concerns, including mangrove deforestation, deterioration of water quality, and antibiotic use, which have been widely documented in Vietnamese, Thai, and Indonesian production systems [13, 14].

The economic contribution of fisheries and aquaculture to ASEAN is estimated at approximately USD 60–80 billion annually, although differences in national accounting methods make precise regional aggregation difficult [15]. As summarized in Table 1, fisheries and aquaculture form part of a broader blue economy that also encompasses marine tourism, maritime logistics, offshore energy, marine biotechnology, and coastal infrastructure. The relative contribution and development of these sectors vary considerably among ASEAN member states, reflecting differences in marine resources, infrastructure, technological capacity, and national economic priorities.

Table 1. Key Sectors of the ASEAN Blue Economy, Their Economic Contributions, and Principal Participating Countries.

Sector	Key activities	Principal ASEAN countries involved	Estimated contribution (USD billion/year)	Ref.
Fisheries and aquaculture	Wild capture fisheries, mariculture, inland aquaculture	Indonesia, Vietnam, Philippines, Thailand	~60–80	[11,15]
Marine tourism	Ecotourism, dive tourism, coastal hospitality	Thailand, Malaysia, Indonesia, Philippines	~35–50	[6,16]
Shipping and ports	Cargo transport, container logistics, port services	Singapore, Malaysia, Vietnam	~120–150	[5,20]
Offshore energy	Oil and gas, offshore wind, tidal energy	Malaysia, Brunei Darussalam, Indonesia, Vietnam	~40–60	[2,6]
Marine biotechnology	Bioactive compounds, pharmaceuticals, biofuels	Singapore, Malaysia, Thailand	~5–10	[2,6]
Coastal infrastructure	Seaport development, coastal infrastructure and urban planning	All ASEAN member states	~20–30	[2,6]

2.2 Marine Tourism and Coastal Recreation.

Marine and coastal tourism represents a major component of the ASEAN blue economy, particularly in Thailand, Indonesia, the Philippines, and Malaysia, where coastal destinations attracted substantial numbers of international and domestic tourists before the disruption caused by the COVID-19 pandemic [16]. Dive tourism is particularly important in biodiversity-rich destinations such as Komodo National Park, Tubbataha Reefs Natural Park, the Similan Islands, and Sipadan, generating foreign-exchange earnings while supporting employment and local livelihoods [17]. Post-pandemic recovery has renewed the importance of marine tourism, with several ASEAN countries incorporating tourism revitalization and coastal destination development into their economic recovery strategies [18].

Nevertheless, the economic benefits of marine tourism are accompanied by significant environmental pressures. Intensive coastal development, high visitor densities, recreational activities, and associated waste generation can contribute to coral reef degradation and place additional pressure on seagrass and mangrove ecosystems [19]. These impacts demonstrate that tourism growth cannot be evaluated solely in terms of visitor numbers or revenue. Long-term

economic benefits depend on maintaining the ecological assets upon which marine tourism itself relies. Balancing tourism revenue with carrying capacity, ecosystem protection, local participation, and effective environmental management therefore remains a major governance challenge for sustainable blue economy development in ASEAN.

2.3 Shipping, Ports, and Maritime Logistics.

Shipping, ports, and maritime logistics constitute one of the highest-value components of ASEAN's blue economy, with an estimated annual contribution of USD 120–150 billion. Their economic importance is strongly associated with Southeast Asia's strategic position along major international shipping routes [5]. Singapore serves as a major global maritime hub, while Port Klang in Malaysia, Tanjung Priok in Indonesia, and Laem Chabang in Thailand play important roles in regional and international trade networks [20]. Beyond their direct contribution to port and logistics revenues, these facilities support manufacturing, international trade, supply-chain connectivity, and wider regional economic integration.

At the same time, growth in maritime transport has increased pressure to reduce greenhouse gas emissions and other environmental impacts associated with shipping and port operations. The sector is increasingly influenced by international decarbonization targets, including the International Maritime Organization's long-term ambition to achieve net-zero greenhouse gas emissions from international shipping around 2050. ASEAN ports have consequently begun adopting green-port initiatives, cleaner technologies, and alternative marine fuels, while liquefied natural gas (LNG) bunkering infrastructure has expanded in locations such as Singapore and Malaysia [21]. However, achieving meaningful decarbonization will require broader changes in fuel systems, port infrastructure, vessel technologies, operational efficiency, and regional policy coordination.

Figure 1 illustrates the interconnected dynamics of marine tourism and maritime logistics within the ASEAN blue economy. It highlights their contributions through tourism revenue, employment, trade connectivity, and maritime infrastructure while simultaneously identifying environmental pressures associated with coastal development, ecosystem disturbance, emissions, and intensive maritime activity. The figure also emphasizes the role of sustainable tourism management, green-port initiatives, cleaner fuels, and maritime decarbonization in balancing economic development with environmental sustainability.

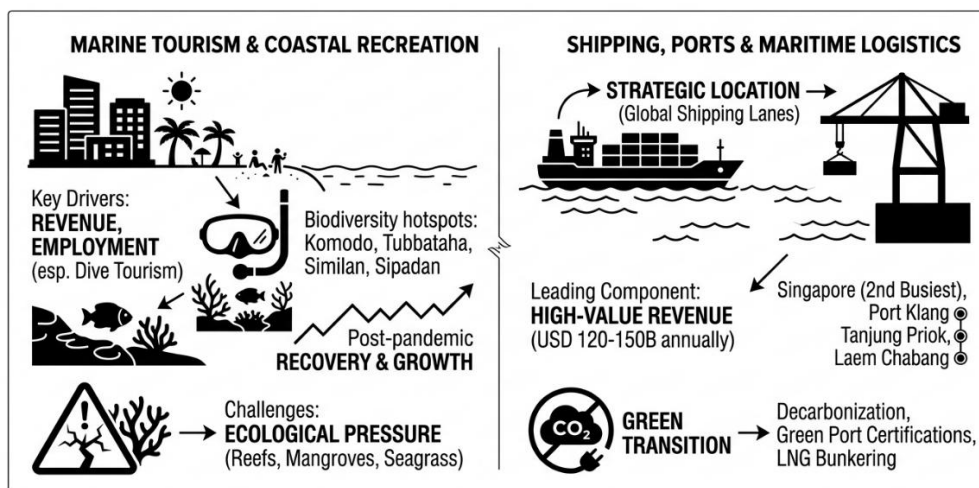


Figure 1. Economic Contributions, Environmental Pressures, and Sustainability Pathways Associated with Marine Tourism and Maritime Logistics in the ASEAN Blue Economy.

3. Governance and Policy Landscape

3.1 National Policy Frameworks.

Policy frameworks governing blue economy development vary considerably across ASEAN member states, reflecting differences in maritime geography, institutional capacity, economic structure, and national development priorities [22]. Vietnam's Marine Strategy 2030 explicitly incorporates the blue economy concept and aims to increase the contribution of marine economic activities to national development. Indonesia's maritime agenda, including the *Global Maritime Fulcrum*, has placed greater emphasis on maritime sovereignty, connectivity, fisheries development, and marine resource management [23, 24]. Malaysia has similarly incorporated ocean-related development into broader national strategies, while Singapore's Green Plan 2030 emphasizes maritime decarbonization, technological innovation, and the transition toward a low-carbon economy [21]. These different approaches demonstrate that blue economy governance in ASEAN does not follow a single policy model but is shaped by national economic priorities, resource endowments, and institutional capacities. Table 2 compares the principal policy instruments adopted by selected ASEAN member states. Although most countries have introduced policies addressing fisheries, coastal development, maritime infrastructure, or environmental protection, the degree to which these instruments explicitly integrate economic development with ecosystem conservation and social inclusion varies substantially. This variation highlights the importance of stronger policy coherence at both national and regional levels, particularly as marine resources and environmental pressures frequently extend beyond national boundaries [22–25].

Table 2. Policy Frameworks Governing Blue Economy Development in Selected ASEAN Member States.

Country/Region	Policy/Framework	Year Adopted	Primary Focus	Ref.
Indonesia	National Medium-Term Development Plan (RPJMN)	2020–2024	Maritime sovereignty, fisheries, coastal management	[23, 24]
Philippines	Philippine Development Plan and Fisheries Code Amendment	2017–2022	Sustainable fisheries, ocean governance	[22, 25]
Malaysia	National Blue Ocean Strategy	2009–present	Economic diversification and cross-sectoral governance	[22, 25]
Vietnam	Vietnam Marine Strategy 2030	2018	Marine-based economy, coastal-zone management	[23]
Thailand	National Fisheries Policy	2015–2019	IUU fishing prevention, fisheries sustainability	[22, 25]
Singapore	Singapore Green Plan 2030	2021	Sustainable ports, marine innovation, decarbonization	[21]
ASEAN	ASEAN Blue Economy Framework	2023	Regional coordination and sustainable ocean-based development	[22, 25]

3.2 Regional and Multilateral Governance.

At the regional level, ASEAN's approach to ocean governance has historically been incremental and consensus-driven, consistent with the organization's principles of consultation, consensus, and respect for national sovereignty [26]. The ASEAN Blue Economy Framework, adopted in 2023, represents an important step toward establishing a more coordinated regional approach to sustainable ocean-based development [27]. The framework provides a basis for integrating economic opportunities with marine sustainability,

connectivity, innovation, and regional cooperation. Its significance lies in shifting the blue economy from a predominantly national and sector-specific issue toward a broader regional development agenda. Before the introduction of this framework, regional marine governance was largely implemented through sector-specific institutions and cooperative mechanisms, including fisheries and maritime forums [28]. ASEAN member states also operate within broader international governance arrangements, particularly the United Nations Convention on the Law of the Sea (UNCLOS) and international biodiversity commitments such as the Kunming–Montreal Global Biodiversity Framework [29]. However, the effectiveness of these overlapping arrangements depends on their translation into national legislation, enforcement capacity, data sharing, and cross-border cooperation. Greater institutional coordination is therefore required to prevent fragmentation between fisheries management, biodiversity conservation, maritime transportation, coastal development, and climate adaptation.

3.3 Gaps in Enforcement and Compliance.

Despite progress in policy formulation, weaknesses in enforcement and compliance remain major constraints on ASEAN blue economy governance. Illegal, unreported, and unregulated (IUU) fishing continues to threaten fish stocks, marine ecosystems, food security, and the livelihoods of legitimate fishing communities [30]. Thailand’s experience with the European Union’s yellow-card mechanism in 2015, followed by its removal in 2019 after regulatory and monitoring reforms, illustrates both the seriousness of IUU fishing and the potential for institutional reform to strengthen fisheries governance [31]. Monitoring, control, and surveillance (MCS) capacity also varies considerably among ASEAN member states. Countries with stronger technological and institutional resources have greater capacity to deploy vessel-monitoring systems and other surveillance mechanisms, whereas less-resourced states face limitations in monitoring extensive maritime areas [32]. These differences can create enforcement gaps that weaken regional efforts to manage shared marine resources. Furthermore, transboundary pressures—including destructive fishing practices, illegal wildlife exploitation, and mangrove conversion—cannot be effectively addressed through isolated national policies [33]. Strengthening interoperable monitoring systems, information exchange, coordinated enforcement, and institutional capacity should therefore be considered central components of future ASEAN blue economy governance.

4. Environmental and Socioeconomic Challenges

4.1 Ecological Degradation and Biodiversity Loss.

The ecological integrity of ASEAN’s marine and coastal environments faces multiple and interacting pressures. Coral reefs, mangroves, and seagrass ecosystems provide essential services, including fisheries production, coastal protection, carbon sequestration, tourism opportunities, and biodiversity conservation. Coral reef ecosystems within the Coral Triangle alone support fisheries with substantial economic value, yet these ecosystems are increasingly affected by marine heatwaves, bleaching events, pollution, destructive fishing, and other anthropogenic pressures [34]. Studies have reported substantial declines in live coral cover across parts of Southeast Asia, with particularly severe degradation occurring in areas exposed to intensive coastal development and human activities [9]. Mangrove ecosystems face similar

pressures. Their conversion for aquaculture, infrastructure, agriculture, and coastal development has reduced mangrove coverage in several ASEAN countries, particularly Indonesia, Thailand, and Vietnam [13]. Such losses extend beyond biodiversity impacts because mangroves provide nursery habitats, shoreline stabilization, carbon storage, and protection against coastal hazards. Seagrass meadows are also increasingly affected by sedimentation, eutrophication, coastal modification, and destructive fishing activities [35]. These interconnected pressures demonstrate that ecological degradation represents not only an environmental concern but also an economic risk to fisheries, tourism, coastal infrastructure, and community livelihoods. Table 3 summarizes the principal environmental, technological, financial, and governance challenges affecting ASEAN’s blue economy and relates them to relevant Sustainable Development Goal (SDG) targets. The comparison demonstrates that many challenges are transboundary and interconnected, emphasizing the need for integrated rather than sector-specific responses.

Table 3. Principal Challenges to Blue Economy Development in ASEAN and Their Relationships with the Sustainable Development Goals.

Challenge Category	Description	Most Affected Countries/Areas	Related SDG Targets	Ref.
Overfishing	Depletion of marine stocks associated with excessive fishing pressure and IUU fishing	Indonesia, Philippines, Vietnam	SDG 14.4, 14.6	[30, 31]
Marine pollution	Plastic waste, industrial effluents, and oil contamination affecting marine ecosystems	Philippines, Indonesia, Malaysia	SDG 14.1, 14.2	[33, 35]
Climate change	Sea-level rise, coral bleaching, ocean warming, and acidification threatening ecosystems and livelihoods	ASEAN coastal states	SDG 13.1, 14.3	[34, 35]
Governance gaps	Weak enforcement, fragmented jurisdictions, and transboundary management challenges	Multiple ASEAN maritime areas	SDG 16.6, 14.c	[30–33]
Technology gap	Limited access to ocean monitoring, digital fisheries, and advanced aquaculture technologies	Cambodia, Myanmar, Laos	SDG 14.a, 9.b	[32]
Financing constraints	Limited availability and accessibility of blue finance, green bonds, and blended-finance mechanisms	Developing ASEAN member states	SDG 17.3, 14.7	[22, 27]

4.2 Climate Change and Ocean Acidification.

Climate change poses a major long-term threat to ASEAN’s ocean-dependent economies and coastal communities. Sea-level rise increases the exposure of low-lying coastal settlements and major urban areas, including Bangkok, Manila, Ho Chi Minh City, and Jakarta, to flooding, erosion, saltwater intrusion, and infrastructure damage [36]. These impacts are particularly important for the blue economy because many fisheries facilities, tourism destinations, ports, industrial zones, and densely populated communities are concentrated along coastlines. Ocean warming introduces an additional layer of risk by altering species distributions, migration patterns, spawning conditions, and the productivity of marine ecosystems. Changes in fish distribution may reduce the reliability of traditional fishing grounds and create additional livelihood uncertainty for small-scale fishing communities [37]. At the same time, ocean acidification caused by increasing absorption of atmospheric CO₂ reduces carbonate availability required by corals and shell-forming organisms, potentially affecting reef ecosystems and aquaculture productivity [38]. These pressures are unlikely to occur independently; rather, sea-level rise, ocean warming, acidification, extreme weather events, and ecosystem degradation may interact and amplify socioeconomic vulnerability. Climate adaptation should therefore be integrated directly into fisheries management, coastal planning,

tourism development, marine conservation, and infrastructure investment rather than treated as a separate environmental policy issue.

4.3 Socioeconomic Inequity and Community Marginalization.

Despite the substantial aggregate economic contribution of ASEAN's blue economy, its benefits are not distributed equally among stakeholders. Small-scale fishing communities frequently occupy vulnerable positions within marine value chains and may have limited influence over decisions concerning fisheries management, marine conservation, tourism development, and coastal infrastructure [12]. Expansion of commercial aquaculture, coastal resorts, ports, and other large-scale developments may also intensify competition for coastal land and marine resources, potentially restricting traditional access and affecting community livelihoods [39]. Gender inequality represents another important but often underexamined dimension of the regional blue economy. Women make substantial contributions to fish processing, marketing, trading, and other post-harvest activities, yet their participation in formal fisheries governance and decision-making remains comparatively limited [40]. This imbalance can reduce the visibility of women's economic contributions and constrain their access to finance, technology, training, and leadership opportunities. Addressing such disparities requires blue economy policies to move beyond aggregate economic growth and explicitly consider benefit distribution, resource access, gender inclusion, livelihood security, and community participation. Incorporating these dimensions would strengthen not only social equity but also the legitimacy and long-term effectiveness of marine resource governance.

5. Emerging Opportunities and Pathways for Sustainable Growth

5.1. Blue Finance and Carbon Markets.

The mobilization of blue finance, dedicated financial instruments including blue bonds, blue loans, and blended finance facilities, represents one of the most promising mechanisms for scaling sustainable blue economy investment in ASEAN [6]. The World Bank, Asian Development Bank, and International Finance Corporation have launched several blue finance initiatives targeting ASEAN, including coral reef insurance pilots and blue bond frameworks for sustainable fisheries and coastal infrastructure [25]. Simultaneously, blue carbon markets, trading in the carbon sequestration services of mangroves, seagrasses, and saltmarshes, are emerging as significant financing mechanisms. Indonesia and Malaysia, home to the world's largest remaining mangrove areas, stand to generate USD 10–20 billion in carbon revenue under scaled voluntary carbon markets, pending improved methodological standards and governance frameworks for blue carbon crediting [29].

5.2. Ocean Technology and Digital Innovation.

Digital technologies and ocean data systems offer transformative potential for enhancing the sustainability and productivity of ASEAN's blue economy. Satellite-based vessel monitoring, artificial intelligence-assisted fish stock assessment, blockchain-enabled seafood traceability, and the Internet of Things (IoT) deployment for aquaculture monitoring are increasingly commercially viable and being piloted across the region [32]. Vietnam's deployment of e-traceability systems for shrimp exports and Singapore's development of a comprehensive

Maritime Singapore Digital Blueprint illustrate the range of technological innovations underway [21, 24].

5.3 Regional Integration and Global Partnerships.

The consolidation and deepening of ASEAN's regional blue economy governance through the 2023 ASEAN Blue Economy Framework and complementary ASEAN Centre for Sustainable Development Studies and Dialogue initiatives, provides a platform for harmonized standards, technology transfer, and joint marine conservation programs [27]. Deeper integration with global processes, including the High Seas Treaty (BBNJ Agreement, 2023), the Post-2020 Global Biodiversity Framework, and the IMO decarbonization roadmap, offers ASEAN nations opportunities to access climate finance, participate in capacity-building programs, and influence global ocean governance norms in ways that advance regional sustainable development objectives [28, 29]. Table 4 summarizes the principal opportunities identified in this review, with projected impacts for 2030.

Table 4. Emerging Opportunities for Blue Economy Growth in ASEAN: Mechanisms, Actors, and Projected Impacts.

Opportunity Area	Potential Mechanism	Key Actors/Countries	Projected Impact by 2030	Ref.
Blue carbon markets	Generation of carbon credits through mangrove and seagrass conservation and restoration under voluntary carbon markets	Indonesia, Malaysia, Myanmar	USD 10–20 billion potential value	[6, 25]
Offshore wind energy	Development of fixed and floating offshore wind installations within exclusive economic zones (EEZs)	Vietnam, Philippines, Indonesia	30–50 GW potential capacity	[25, 27]
Digital fisheries	Application of IoT sensors, AI-based stock assessment, digital monitoring, and electronic traceability systems	Thailand, Vietnam, Singapore	20–30% potential reduction in waste	[27, 32]
Sustainable aquaculture	Adoption of integrated multi-trophic aquaculture (IMTA), recirculating aquaculture systems (RAS), and resource-efficient production	Indonesia, Vietnam, Philippines	USD 15–25 billion potential export value	[6, 25]
Marine protected areas	Expansion and improved management of MPA networks supported by blue finance and payments for ecosystem services	Coral Triangle states	Contribution toward 30% marine protection by 2030	[27, 29]
Sustainable ocean tourism	Adoption of regenerative tourism models, carrying-capacity management, and marine eco-certification programs	Thailand, Indonesia, Malaysia	USD 25–40 billion potential revenue	[6, 25]

6. Conclusions

This review has synthesized evidence from 40 peer-reviewed studies to map the opportunities, challenges, and governance dynamics of blue economy development across ASEAN. The review affirms that ASEAN occupies a position of extraordinary maritime significance, with ocean-based sectors generating hundreds of billions of US dollars annually and supporting the livelihoods of tens of millions of people. Yet ecological degradation, institutional fragmentation, financing gaps, and socioeconomic inequity systematically undermine the sustainability and inclusiveness of the region's blue economy. The emergence of the 2023 ASEAN Blue Economy Framework, combined with growing momentum in blue finance, digital ocean technologies, and regional marine conservation, signals genuine institutional

progress. However, transforming these frameworks into on-the-ground sustainability outcomes will require overcoming deeply entrenched political economy barriers, including vested interests in destructive fishing, weak enforcement capacity, and inadequate attention to community-level equity. Future research should prioritize longitudinal assessments of governance effectiveness, ecosystem service valuation studies, and the development of ASEAN-specific blue economy measurement frameworks compatible with the System of Environmental-Economic Accounting for Ocean (SEEA-Ocean) standard. Interdisciplinary collaboration among marine ecologists, political scientists, development economists, and indigenous knowledge holders will be essential to building the evidence base required to guide ASEAN toward a truly sustainable and equitable ocean economy by 2030 and beyond.

Author Contributions

All authors contributed equally to the conceptualization, methodology, data collection, analysis, interpretation, writing, review, and final approval of the manuscript.

Competing Interests

The authors declare no competing interests.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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