Blue Carbon for Green Growth: Economic Benefits of Coastal Ecosystems in Island States

Yun Qian*
University of Sanya, Sanya, Hainan, China
**corresponding author*

Abstract:Blue carbon ecosystems—particularly mangroves, seagrasses, and salt marshes—offer significant economic and environmental benefits to small island developing states (SIDS). By capturing and storing atmospheric carbon dioxide, these ecosystems mitigate climate change while simultaneously providing economic opportunities through tourism, fisheries enhancement, and carbon market financing. This paper synthesizes existing literature and case studies from recent years (2021-2025) to evaluate the economic valuation, policy frameworks, and financial instruments enabling SIDS to harness blue carbon effectively. Empirical evidence from the Pacific Islands, Belize, and Seychelles underscores the transformative potential of integrating blue carbon strategies into sustainable economic development plans.

Keywords: Carbon Markets; Green Growth; Coastal Ecosystems; Economic Valuation; Blue Carbon

1. Introduction

Blue carbon refers to the carbon stored in coastal and marine ecosystems, including mangroves, seagrasses, and salt marshes, known for their extraordinary capacity to capture and sequester carbon dioxide from the atmosphere[1]. Small Island Developing States (SIDS) rely heavily on these ecosystems not only for climate resilience but also as significant economic assets[2]. This paper examines how blue carbon strategies contribute to sustainable economic growth in island economies through ecosystem valuation, carbon financing mechanisms, and targeted policy frameworks.

2. Literature Review

2.1 Ecosystem Services and Carbon Storage

Mangroves and seagrass beds are globally recognized as highly efficient carbon sinks[3]. For instance, mangroves alone store approximately three times the carbon per hectare compared to terrestrial forests[4]. Friess et al. (2021) highlight that Caribbean seagrass beds are vital natural capital resources, offering multiple ecosystem services including carbon sequestration, coastal protection, and biodiversity preservation[5].

2.2 Economic Valuation of Blue Carbon

Pendleton et al. (2022) quantify the substantial economic benefits derived from blue carbon ecosystems, emphasizing their role in climate regulation, coastal protection, and fisheries enhancement for SIDS[6]. According to Beck et al. (2021), integrating ecosystem services into national accounting provides a tangible economic rationale for preserving these habitats[7].

2.3 Risks and Limitations

While the potential is vast, coastal restoration does not always yield increased carbon sequestration due to ecological complexities and potential carbon release during habitat recovery phases[8]. Addressing these risks requires careful planning and adaptive management.

2.4 Policy Frameworks and Financial Instruments

The World Bank's Blue Carbon Readiness assessment (2024) for Belize demonstrates a comprehensive approach to institutional and policy preparedness necessary for effectively leveraging blue carbon resources[9]. Similarly, the International Finance Corporation (IFC, 2023) underscores financial mechanisms such as blue bonds and carbon credits, highlighting their effectiveness in mobilizing resources for ecosystem conservation[10].

3. Frameworks on Blue Carbon and Coastal Ecosystems

The economic and environmental significance of blue carbon for island states is best understood through a detailed conceptual framework that maps the chain of value creation from ecological

processes to socioeconomic benefits. This framework integrates scientific, economic, and institutional perspectives, illustrating how healthy coastal ecosystems ultimately support sustainable development. Here, the blue carbon value chain is explored through five core, interdependent components: ecosystem function, carbon sequestration, economic valuation, financing and investment, and socioeconomic impact.

3.1 Ecosystem Function: Foundation of the Blue Carbon Economy

The foundation of the framework lies in the functioning of coastal ecosystems such as mangroves, seagrasses, and salt marshes. These ecosystems perform critical ecological functions: they provide habitat for marine biodiversity, support fisheries, and stabilize shorelines against erosion[3][5]. Their role as primary producers and as nurseries for marine life underpins both ecological health and the productivity of sectors such as fisheries and tourism, which are vital to island economies[11]. Importantly, these ecosystems also support broader climate resilience, buffering communities from the impacts of storms and sea-level rise—a critical service for SIDS frequently exposed to extreme weather events[2].

3.2 Carbon Sequestration: Natural Climate Solutions

A defining attribute of blue carbon ecosystems is their exceptional capacity for carbon sequestration. Mangroves, for example, store up to three times more carbon per hectare than terrestrial forests, with significant portions stored belowground in soil carbon pools that are stable over centuries[4]. Seagrasses and salt marshes also act as substantial carbon sinks, capturing atmospheric CO_2 through both plant biomass and sediment burial[3][5]. This sequestration function is not only fundamental for global climate mitigation but also represents a quantifiable ecosystem service, the value of which can be estimated through scientific measurement and incorporated into economic planning[6].

3.3 Economic Valuation: Integrating Ecosystem Services into Decision-Making

To translate ecological functions into actionable economic value, robust valuation methods are required. Economic valuation of blue carbon involves estimating the benefits derived from carbon sequestration, coastal protection, fisheries enhancement, and other services in monetary terms[6][7]. Market-based and non-market-based approaches are used, including natural capital accounting, contingent valuation, and cost-benefit analysis. These valuations support policy-making by providing concrete evidence of the return on investment in ecosystem conservation. When integrated into national accounting systems, as advocated by Beck et al. (2021), these metrics highlight the tangible economic rationale for maintaining healthy coastal ecosystems and inform both public and private sector investment decisions[7].

Additionally, economic valuation creates the basis for participation in emerging blue carbon markets and financing mechanisms, such as carbon credits. These markets allow island states to monetize the carbon sequestration services of their ecosystems, channeling revenues into further conservation and sustainable development activities[10].

3.4 Financing and Investment: Mechanisms for Blue Carbon Development

Access to targeted financing is crucial for realizing the economic potential of blue carbon. A variety of innovative financial instruments are available, most notably blue bonds and carbon credits. The Seychelles Blue Bond, for instance, is a pioneering example of leveraging private and public capital for marine conservation and sustainable fisheries management[12]. These financial mechanisms offer long-term funding streams for ecosystem restoration, management, and monitoring. They also incentivize the private sector and local communities to engage in conservation activities by linking ecosystem health with economic opportunity.

International organizations such as the International Finance Corporation (IFC) and the World Bank have played a central role in supporting island states in establishing the institutional and policy readiness required to participate effectively in blue carbon finance. The IFC's Deep Blue initiative has developed tools to de-risk investments and provide insurance products tailored to the unique needs of blue carbon projects, lowering barriers to private sector participation[10]. Similarly, the World Bank's Blue Carbon Readiness assessment for Belize illustrates the importance of robust legal, policy, and institutional frameworks for successful blue carbon project implementation and access to global finance[9].

4. Empirical Evidence and Case Studies

Empirical research and real-world projects in recent years offer crucial insights into how blue carbon

strategies translate into practical benefits for small island developing states (SIDS). The experiences of Pacific Island economies, the Seychelles Blue Bond, Belize's readiness for blue carbon markets, and the IFC Deep Blue Initiative together demonstrate both the opportunities and complexities involved in operationalizing blue carbon for economic development and climate resilience.

The Pacific Island economies serve as a clear example of the blue economy's significance for national well-being. Gonguet and Zhou (2024) analyzed the economic contribution of sectors such as fisheries and tourism, which are heavily reliant on healthy coastal ecosystems[11]. Their study found that the sustainable management of mangroves and seagrass beds directly supports GDP growth, local employment, and the resilience of island communities to climate shocks and external market volatility. The preservation and restoration of blue carbon ecosystems were shown to underpin food security, protect infrastructure, and reduce vulnerability to extreme weather—demonstrating that ecological health and economic stability are tightly linked in these states.

A flagship example of innovative finance in action is the Seychelles Blue Bond. Launched in 2018, this bond was among the first in the world to specifically target marine conservation and sustainable fisheries management as investment outcomes. Proceeds from the bond have been allocated to projects restoring mangroves and seagrasses, supporting the recovery of commercially valuable fish stocks and enhancing the country's blue carbon assets. According to government data, the Seychelles Blue Bond has enabled the creation of new marine protected areas and improved fisheries governance, simultaneously advancing biodiversity conservation and national economic goals[12]. This initiative highlights the power of blending public and private finance to create sustainable funding streams for environmental stewardship.

In Central America, Belize offers a model for how policy alignment and institutional readiness can unlock international blue carbon finance. The World Bank's 2024 Blue Carbon Readiness Assessment documents Belize's efforts to integrate blue carbon into its climate and development agendas, including mapping and monitoring mangrove and seagrass carbon stocks and developing legal frameworks for carbon trading[9]. Stakeholder engagement has also been central, ensuring that local communities, government agencies, and private investors collaborate to maximize both environmental and socioeconomic benefits. Belize's systematic approach has positioned it to access global carbon markets and attract investment in conservation and community development.

On a broader scale, the International Finance Corporation's (IFC) Deep Blue Initiative represents a multilateral approach to supporting blue carbon projects across SIDS and coastal states. The initiative offers a range of financial products, such as risk guarantees and insurance, designed to reduce barriers for private sector investment in blue carbon. By facilitating rigorous project development, carbon stock verification, and international certification, IFC Deep Blue helps ensure that blue carbon initiatives are financially viable and environmentally sound[10].

Collectively, these cases underscore several enabling factors for successful blue carbon implementation: strong scientific monitoring, robust institutional and legal frameworks, stakeholder collaboration, and innovative financing mechanisms. They also highlight challenges—including the need for long-term ecosystem integrity, market stability, and equitable benefit sharing—that require ongoing attention. Most importantly, the diverse experiences of Pacific Islands, Seychelles, and Belize illustrate the substantial transformative potential of blue carbon when embedded in holistic national development strategies focused on sustainability, resilience, and inclusive growth.

5. Financing Instruments and Policy Mechanisms

Effective financing instruments and policy mechanisms are at the heart of advancing blue carbon initiatives in small island developing states (SIDS). The development and scaling of blue carbon projects depend heavily on innovative financial products, robust governance frameworks, and supportive institutional environments that can translate ecosystem services into real economic gains and lasting climate resilience.

Blue bonds represent a landmark financial innovation for marine conservation and sustainable development. The Seychelles Blue Bond is a pioneering example of leveraging both concessional funding and private investment to support large-scale ecosystem restoration and sustainable fisheries management[12]. By directing capital into targeted projects, blue bonds not only ensure dedicated funding for mangrove and seagrass restoration but also facilitate the creation of new marine protected areas and promote best practices in fisheries

governance. The bond's blended finance approach, combining grants, concessional loans, and private capital, reduces risk for investors and provides a replicable model for other SIDS[10][12].

Carbon credits are a complementary financial mechanism, enabling SIDS to monetize the carbon sequestration services of mangroves, seagrasses, and salt marshes[10]. Verified blue carbon credits can be sold on voluntary and compliance carbon markets, generating critical revenue streams that can be reinvested into ecosystem protection, community development, and adaptive management strategies. Belize, for example, has invested in mapping its coastal carbon stocks, creating enabling legal frameworks, and building institutional readiness to issue and trade blue carbon credits, thereby opening pathways to global carbon finance[9].

International institutions play a vital role in supporting blue carbon finance and policy implementation. The World Bank and International Finance Corporation (IFC) provide technical assistance, capacity building, and risk mitigation tools that empower SIDS to develop, certify, and finance blue carbon projects at scale[9][10]. The IFC's Deep Blue Initiative exemplifies how international partners can de-risk investments, facilitate rigorous carbon stock assessments, and ensure projects meet global standards for transparency and effectiveness.

Policy mechanisms must be carefully designed to align blue carbon finance with national development strategies, climate commitments, and the interests of local communities. Regulatory clarity on carbon rights, project eligibility, and benefit sharing is essential to build investor confidence and ensure that economic gains reach those who depend most on healthy coastal ecosystems[7][9]. Strong governance structures and transparent monitoring, reporting, and verification (MRV) systems underpin the credibility of blue carbon markets and help SIDS attract sustained international investment.

Adaptation and resilience are further promoted through policy frameworks that integrate blue carbon with broader sustainable development goals. Engagement of local stakeholders, particularly indigenous communities, is critical for securing social legitimacy, equitable benefit distribution, and the long-term success of blue carbon projects[6][7]. Ultimately, the combination of innovative finance, enabling policy, and robust governance creates a fertile environment for SIDS to unlock the full economic and environmental value of their blue carbon resources, supporting a sustainable, climate-resilient future[9][10][12].

6. Economic Benefits and Socioeconomic Impacts

Beyond climate mitigation, blue carbon ecosystems contribute directly to local economies through enhanced fisheries, tourism opportunities, and coastal protection, significantly reducing costs associated with climate-related damage[11][12]. Additionally, community-driven management approaches promote inclusive growth and ensure long-term sustainability.

7. Discussion

Integrating blue carbon valuation into national economic planning offers clear economic incentives for ecosystem preservation. However, practical challenges remain, including measurement variability and carbon market fluctuations. Addressing these requires further research, standardization efforts, and adaptive policy frameworks.

8. Conclusion

Blue carbon ecosystems represent a powerful resource for sustainable economic growth in island nations. Effective valuation, innovative financing, and proactive policy-making can transform these natural assets into drivers of economic prosperity and environmental resilience. Future research must address existing challenges to fully unlock this potential.

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