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Integrating Blue Carbon into Indonesia's Carbon Market Using the Total Economic Value Framework

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ABSTRACT

Blue carbon ecosystems such as mangroves, seagrass meadows, and tidal marshes play a strategic role in climate change mitigation and in the provision of socio-ecological ecosystem services. Indonesia possesses the world's largest blue carbon potential; however, integrating it into the national carbon market mechanism continues to face conceptual, methodological, and institutional challenges. This article aims to analyze the readiness of Indonesia's regulatory and institutional frameworks for integrating blue carbon into the carbon market, and to develop an operational framework for applying Total Economic Value (TEV) in blue carbon accounting and valuation. This study adopts a qualitative, document-based approach with structured analysis of national regulations, international guidelines (IPCC, UNFCCC, SEEA-EA, and SEEA-Oceans), sustainability reporting standards (IFRS S2 and GRI), and secondary data derived from official reports and scientific literature. The findings indicate that the main weaknesses lie in limited coastal carbon stock data, the absence of a standardized national baseline, a weak Monitoring, Reporting, and Verification (MRV) system, and the lack of operational integration of TEV into carbon accounting and market mechanisms. This study proposes an integrative framework linking TEV, natural capital accounting, MRV, and sustainability reporting to enhance the credibility, transparency, and economic value of Indonesia's blue carbon. Policy implications emphasize strengthening blue carbon accounting standards, establishing a national baseline, and cross-institutional integration to support the development of a sustainable carbon market.

Keywords: *Blue carbon, carbon market, TEV, MRV, natural capital accounting*

Introduction

Global climate change is intensifying alongside the increasing concentration of greenhouse gases (GHGs resulting from human activities. In this context, coastal and marine ecosystems have received growing attention in climate change mitigation agendas due to their high capacity to sequester and store carbon over long time horizons. Blue carbon ecosystems—including mangroves, seagrass meadows, and tidal marshes—not only function as carbon sinks but also provide a wide range of essential ecosystem services, such as coastal protection, biodiversity support, and socio-economic benefits for coastal communities (Duarte et al., 2013; Macreadie et al., 2021; Windham-Myers et al.,

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2018). Accordingly, blue carbon exhibits a dual character as both an ecological and an economic asset, highly relevant to climate policy and sustainable development.

Indonesia occupies a strategic position in the global blue carbon landscape, holding approximately 23% of the world's mangrove area and substantial coastal carbon stocks. This potential offers Indonesia a significant opportunity to contribute to global climate change mitigation, both by avoiding emissions from coastal ecosystem degradation and by advancing ecosystem restoration initiatives. Nevertheless, integrating blue carbon into national climate policies and carbon market mechanisms continues to face structural constraints. Limited standardized coastal carbon stock data, the absence of a consistent national baseline, and weak Monitoring, Reporting, and Verification (MRV) systems remain major barriers that undermine the credibility and competitiveness of blue carbon–based carbon credits (Taryono & Damar, 2023).

The rapid expansion of global and national carbon markets is reflected in the growing number of jurisdictions implementing carbon pricing instruments and the expansion of voluntary carbon markets. In Indonesia, the enactment of Presidential Regulation No. 98 of 2021 on Carbon Economic Value (Nilai Ekonomi Karbon) and the establishment of the Indonesia Carbon Exchange signal the government's commitment to internalizing carbon value within the national economic system. However, the prevailing policy framework continues to treat carbon primarily as an emission-based commodity, failing to adequately account for the ecological and social dimensions of blue carbon ecosystems as natural capital (Ekawati et al., 2025).

Within the academic literature, blue carbon studies in Indonesia have largely focused on carbon stock estimation and biophysical potential, while comprehensive economic valuation, accounting recognition, and carbon market policy implications remain relatively underexplored. In particular, the operational application of the Total Economic Value (TEV) framework within carbon accounting and market mechanisms has not yet been fully developed. As a result, blue carbon value is often reduced to units of CO_2e, while broader ecological and social benefits are marginalized in policy and investment decision-making (Donato et al., 2011; Macreadie et al., 2021; Murdiyarso et al., 2015; Qodriyatun et al., 2024).

In response to these gaps, this study aims to analyze Indonesia's regulatory and institutional readiness to integrate blue carbon into the national carbon market and to develop an analytical framework that operationalizes the Total Economic Value (TEV) approach within blue carbon accounting. The main contribution of this article lies in proposing an integrative framework that links TEV, natural capital accounting (SEEA), MRV systems, and sustainability reporting standards, thereby enhancing transparency, credibility, and the economic valuation of blue carbon within Indonesia's carbon market context.

Theoretical Framework

Total Economic Value (TEV) as the Basis for Blue Carbon Valuation

The Total Economic Value (TEV) framework conceptualizes blue carbon ecosystems as natural capital assets that generate economic value through four main components: (1) direct use value (e.g., fisheries and ecotourism), (2) indirect use value (such as coastal protection and carbon sequestration), (3) option value (the potential for future use), and (4) existence value. In the context of carbon markets, carbon sequestration and storage constitute an indirect use value that can be monetized through carbon credits, while the other components function as co-benefits that enhance market legitimacy (Liu, 2024; Lovelock et al., 2022).

Integrating TEV with Natural Capital Accounting (SEEA-EA and SEEA-Oceans)

The System of Environmental-Economic Accounting–Ecosystem Accounting (SEEA-EA) and SEEA-Oceans provide frameworks for recording ecosystem stocks, service flows, and monetary values in a manner compatible with national accounting systems. Integrating TEV into SEEA allows blue carbon value to be recorded not only in physical units (tons of CO_2e) but also as an economic value of ecosystems that contributes to national wealth and fiscal sustainability (Ruijs et al., 2019; Wang et al., 2024).

Carbon Accounting, MRV, and Sustainability Reporting

Within the context of social and environmental accounting, blue carbon should be recorded through three interconnected layers: (1) physical measurement of carbon through Monitoring, Reporting, and Verification (MRV) systems; (2) economic recognition through TEV-based valuation and carbon credits; and (3) disclosure in sustainability reports and financial statements in accordance with IFRS S2 and GRI 305. This integration is essential to prevent greenwashing and to enhance investor confidence (Firmansyah, 2024; Pendleton et al., 2012).

Research Methods

This study employs a qualitative, document-based research approach with a structured analytical design. Documents were selected based on three criteria: (1) direct relevance to blue carbon and carbon market mechanisms, (2) institutional authority, including official regulations and international guidelines, and (3) academic credibility, encompassing nationally and internationally reputable scholarly publications. The analysis used thematic coding to identify regulatory, methodological, and accounting-related gaps.

To enhance scientific rigor, this study also incorporates secondary data, including estimates of Indonesia's mangrove carbon stocks (approximately 3.14–4.85 Pg C), data on the spatial extent of coastal ecosystems, and national carbon market reports, which are used as analytical illustrations.

Results And Discussion

Table 1. Conceptual Integration of TEV, MRV, Accounting, and Reporting

Component of TEV	Form of Value	Accounting & Policy Instruments	Role in the Carbon Market	Reporting Framework
Direct use value	Utilization of coastal resources (fisheries, ecotourism)	Social cost-benefit accounting	Co-benefits of blue carbon projects	GRI 203, GRI 413
Indirect use value (carbon)	CO_2e sequestration and storage	IPCC-based MRV, carbon credits	Primary carbon market commodity	IFRS S2, GRI 305
Indirect use value (non-carbon)	Coastal protection, biodiversity	Natural capital accounting (SEEA)	Enhancement of credit legitimacy	GRI 304, GRI 303
Option value	Potential for future utilization	Fiscal and investment planning	Long-term risks and opportunities	IFRS S2
Existence value	Conservation and social value	Social and environmental accounting	Market reputation and integrity	GRI 2, GRI 413

Table 1 illustrates that TEV does not substitute for carbon credit mechanisms; instead, it complements them through a more comprehensive accounting and reporting framework, thereby preventing the valuation of blue carbon from being reduced to carbon pricing alone.

Gaps in Blue Carbon Data and Baselines

The results indicate that Indonesia has not yet established a standardized national blue carbon baseline that is recognized across sectors. Differences in methodological approaches to measuring mangrove carbon stocks—particularly regarding soil depth, emission factors, and spatial coverage—have led in significant variation in carbon stock estimates. This condition not only generates scientific uncertainty but also directly affects the determination of additionality and permanence in carbon credit schemes, two key principles underpinning carbon market integrity.

Weaknesses of MRV Systems and Their Implications for Market Credibility

Blue carbon MRV systems in Indonesia remain largely sectoral and are not yet fully integrated with IPCC guidelines or international best practices. Limited application of remote sensing technologies, insufficient third-party verification, and fragmented institutional mandates have contributed to low market confidence in coastal-based carbon

credits (Chmura et al., 2003; Donato et al., 2011; Murdiyarso et al., 2015). In the absence of a robust and transparent MRV framework, the risks of double-counting and greenwashing increase substantially.

Operationalizing TEV within Carbon Market Mechanisms

This study proposes an operational TEV approach that distinguishes between carbon value as a market commodity (expressed in tons of CO_2e) and non-carbon values as co-benefits that enhance project legitimacy (Taryono & Damar, 2023). As an illustrative example, a 1,000-hectare mangrove restoration project can generate substantial annual carbon sequestration while simultaneously improving coastal protection, biodiversity conservation, and community livelihoods (Becker et al., 2025; Windham-Myers et al., 2018). Within the TEV framework, these values are recorded separately yet remain interrelated, ensuring that ecosystem value is not reduced solely to carbon pricing (Malerba et al., 2023; United Nations, 2022).

Accounting and Reporting Implications

From a social and environmental accounting perspective, integrating TEV enables blue carbon to be recognized not only as a financial instrument but also as a component of natural capital that supports long-term sustainability. In reporting practice, carbon values can be disclosed in financial statements and sustainability reports in accordance with IFRS S2 and GRI 305, while non-carbon values are reflected through disclosures of ecological and social impacts (Diva, 2024; Rahmayanti & Sari, 2023). This approach enhances the quality of information available to investors, policymakers, and other stakeholders, thereby strengthening accountability in the carbon market.

Conclusion, Implications, Suggestions, And Limitations

This study confirms that the limited integration of Total Economic Value (TEV) within Indonesia's carbon accounting systems and carbon market mechanisms has resulted in the undervaluation of blue carbon ecosystems. As long as the blue carbon value is expressed solely in CO_2e units, broader ecological and social benefits are not fully reflected in policy formulation, investment decisions, or market instruments.

Based on the study's findings, a policy roadmap for integrating blue carbon into Indonesia's carbon market can be structured into three stages. In the short term, policy priorities include developing a standardized national blue carbon baseline and strengthening MRV systems aligned with IPCC guidelines and international best practices. In the medium term, integrating TEV into natural capital accounting frameworks (SEEA-EA and SEEA-Oceans) is necessary to ensure that both carbon and non-carbon values are recorded within national statistical and fiscal systems. In the long term, harmonizing blue carbon accounting with global sustainability reporting standards such as IFRS S2 and GRI is essential to enhance transparency, credibility, and the international attractiveness of Indonesia's carbon market.

From a social and environmental accounting perspective, this article makes a conceptual contribution by demonstrating that a credible carbon market depends not only on the accuracy of emissions measurement but also on the capacity of accounting and reporting systems to comprehensively represent ecosystem value. Accordingly, the integration of TEV is not merely a methodological issue but an institutional prerequisite to ensure that the development of coastal-based carbon markets in Indonesia proceeds in a fair, transparent, and sustainable manner.

The main limitation of this study lies in its reliance on document-based analysis and secondary data. Future research is therefore encouraged to empirically test the proposed framework through case studies of actual blue carbon projects, including quantitative assessments of carbon and non-carbon economic values and their implications for financial and sustainability reporting at both organizational and national levels.

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