

Blue Economy and Climate Change in Nigeria: Unlocking the Role of Coastal Ecosystems in Carbon Sequestration and Livelihoods

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Abstract

Coastal vegetated ecosystems particularly mangroves, seagrasses, and intertidal wetlands are widely recognized as “blue carbon” systems due to their ability to sequester and store large volumes of carbon in biomass and sediments while providing vital ecosystem services that support coastal livelihoods and resilience. Along Nigeria’s coastline, including the Niger Delta, Lagos lagoon complexes, and several estuaries, mangrove forests and recorded seagrass habitats play key roles in carbon storage and socio-economic sustenance. However, these ecosystems are under severe threat from coastal development, oil and gas exploration, pollution, dredging, aquaculture expansion, and climate-related pressures such as sea-level rise and intensifying storms. This paper reviews the carbon sequestration potential of Nigeria’s coastal ecosystems, documents observed trends and drivers of degradation, assesses links between ecosystem change, livelihoods, and food security, and explores governance options for integrating blue carbon into Nigeria’s blue economy and climate policy. Evidence from regional and global syntheses, Nigeria specific studies, and policy frameworks shows that conserving and restoring coastal ecosystems can deliver climate mitigation, shoreline protection, fisheries enhancement, and livelihood benefits if grounded in participatory governance and safeguards. Yet, significant data gaps persist, particularly in seagrass mapping, sediment carbon stocks, standardized MRV (measurement, reporting, verification), and tenure clarity. We recommend a national agenda emphasizing: (i) blue carbon inventories and validation, (ii) inclusion in NDCs and LT-LEDS, (iii) community-led restoration with FPIC, (iv) blended finance and MRV capacity building, and (v) legal safeguards for equity. Advancing these steps would align Nigeria’s blue economy with climate and wellbeing goals.

Keywords: *blue carbon, blue economy, mangroves, seagrasses, carbon sequestration, coastal livelihoods*

1. Introduction

The concept of the blue economy emphasizes sustainable and inclusive ocean-driven economic development that safeguards ecological integrity while supporting livelihoods and contributing to national income (UNEP; World Bank). Within this framework, vegetated coastal ecosystems—such as mangrove forests, seagrass meadows, and tidal wetlands—are pivotal because they deliver multiple co-benefits. These include climate regulation through long-term carbon sequestration and storage, coastal protection that reduces disaster risks and shoreline erosion, and essential provisioning services like fisheries resources, timber, and fuelwood for local populations. On a

global scale, these ecosystems act as vast carbon reservoirs, with much of the carbon stored in their sediments, making them vital assets for nature-based climate change mitigation and adaptation. The IPCC's Special Report on the Ocean and Cryosphere underscores both their exceptional carbon storage capacity and the heightened climate vulnerabilities associated with their degradation and loss. (Alongi, 2014; Bunting et al., 2022)

Nigeria's coastline is among the most socio-ecologically diverse in West Africa, encompassing the Niger Delta, the Lagos lagoon complex, and numerous estuaries and creeks that sustain mangrove forests and documented seagrass meadows. Coastal communities rely heavily on these ecosystems for their livelihoods through artisanal fisheries, small-scale aquaculture, mangrove harvesting, and low-lying agricultural practices. However, this region faces mounting pressures from human activities, including oil and gas exploration, port and industrial expansion, urban coastal development, and pervasive pollution. Superimposed on these drivers are the accelerating impacts of climate change, particularly sea-level rise, shoreline erosion, and increasingly severe storm surges. These combined stressors contribute to the degradation of coastal habitats, threaten to release significant quantities of stored carbon as CO₂, and undermine local livelihood security. In this context, mainstreaming blue carbon into Nigeria's climate policy and blue economy strategies emerges as both an urgent necessity and a potentially transformative pathway for ecological sustainability and socio-economic resilience (Donato et al 2011; Bryan et al., 2020).

This paper synthesizes scientific evidence, Nigeria-specific studies, and policy documents to answer the following core questions: What is the present understanding of blue-carbon stocks and sequestration potential in Nigeria's coastal ecosystems; How do coastal ecosystems support livelihoods and resilience in Nigerian coastal communities, and what are the socioeconomic consequences of habitat loss; What institutional, governance and finance pathways can unlock blue-carbon benefits for climate mitigation, adaptation and equitable livelihoods within Nigeria's blue-economy framework,

Our objective is to generate a synthesis that is directly applicable to policy and scientific planning—identifying existing knowledge gaps, outlining actionable steps for monitoring, reporting and verification (MRV) and governance, and advancing practical recommendations that connect blue carbon research with inclusive and sustainable blue economy development in Nigeria (UNFCCC/NDC Partnership, 2023; WorldFish, 2024).

2. Conceptual background: blue carbon, ecosystems, and socio-economic linkages

2.1 What is blue carbon and why it matters

Blue carbon refers to carbon sequestered in coastal vegetated ecosystems (mangroves, seagrass meadows and tidal marshes) that is stored over long timeframes primarily in soils and sediments. Unlike many terrestrial systems where aboveground biomass dominates, coastal vegetated ecosystems often store most of their organic carbon in anaerobic sediments that accumulate over centuries to millennia; disturbance or conversion of these sediments can release substantial carbon back to the atmosphere (Donato et al., 2011; Pendleton et al., 2012). Estimates indicate that conversion and degradation of coastal vegetated ecosystems is a meaningful contributor to global CO₂ emissions, and protecting and restoring these ecosystems is recognized as a nature-based mitigation pathway (Duarte et al., 2013; IPCC, 2019)

2.2 Ecosystem services and livelihoods

Coastal vegetated systems provide a suite of provisioning, regulating, cultural and supporting services. They support artisanal and small-scale fisheries (as nursery grounds), supply fuelwood

and building materials, attenuate waves and storm surge and reduce shoreline erosion, and provide habitat for biodiversity. For Nigeria, the dependence of coastal households on fisheries and mangrove resources is prominent; degradation therefore translates into direct livelihood shocks and longer-term food-security risks (WorldFish; FAO). Integrating blue carbon into economic planning therefore must reconcile carbon outcomes with livelihood protection and enhancement(Howard et al.,2014; Kauffman et al.,2020)

2.3 Policy framing: blue carbon and national climate commitments

International guidance including IPCC reports and Ramsar/UNEP briefs encourages countries to include coastal wetland conservation and restoration in climate mitigation and adaptation planning where relevant. Mechanisms for doing so include integration into NDCs, the use of robust MRV systems adapted to coastal settings, and participation in voluntary carbon markets and results-based finance schemes. However, robust national implementation hinges on data quality, MRV capacity and strong social safeguards to avoid inequitable outcomes. Nigeria's LT-LEDS and NDC offer entry points, but current treatment of coastal wetlands is limited, and a deliberate national blue-carbon roadmap is needed to operationalize actions(McLeod et al.,2011;NCCC,2023;Mwikambo,2024).

3. Methods

This paper is a synthesis of peer-reviewed literature, regional blue-carbon assessments, Nigeria-specific studies and authoritative policy documents. The approach comprised four components:

- i. Systematic literature **review**: searches across Scopus, Web of Science and Google Scholar for keywords including "Nigeria mangroves carbon", "West Africa blue carbon", "seagrass Nigeria", and "mangrove carbon Niger Delta." Priority was given to peer-reviewed studies, global syntheses (Donato et al., Pendleton et al., IPCC SROCC), and recent mapping products (Global Mangrove Watch; Bunting et al., 2022).
- ii. Policy and institutional review: assessment of Nigeria's climate documents (NDC, LT-LEDS), international guidance (Ramsar, UNEP) and blue-economy frameworks (World Bank, UNEP).
- iii. Regional and national case collation: Nigeria-specific studies (peer-reviewed and gray literature) documenting mangrove carbon, habitat degradation pathways, and socio-economic impacts, complemented by credible news reporting on coastal hazards and local impacts.
- iv. Synthesis and gap analysis: cross-tabulation of carbon stock evidence, MRV readiness, livelihood dependencies and policy readiness to identify priority interventions.

Limitations: Nigeria has spatially uneven empirical data robust sediment core and seagrass inventories are patchy; many inferences rely on downscaling regional/global datasets and site-level studies. Therefore, our conclusions emphasize conservative interpretation and the urgent need for systematic national inventory work(Nellemann et al.,2009;Reuter,2025)

4. Results

4.1 Distribution and status of coastal ecosystems in Nigeria

Mangroves: Nigeria's mangroves are concentrated in the Niger Delta, stretching across the coastal states and into tidal creeks and lagoons in the west (e.g., Lagos) and the east (Cross River). The Global Mangrove Watch and recent regional assessments document ongoing net loss and conversion pressures in West Africa, although mapping iterations (e.g., Bunting et al., 2022; State

of the World's Mangroves) provide an improved basis for prioritizing hotspots. Local studies in the Niger Delta document both intact mangrove patches and areas of intensive degradation linked to oil-sector impacts, conversion and invasive species encroachment in some sites (Salinasss et al., 2020; Sidicheikh et al., 2022).

Seagrasses: Historically understudied across West Africa, recent surveys (Sidi Cheikh et al., 2022; Mwikamba 2024) have extended knowledge of seagrass occurrences and distribution limits in West Africa, showing seagrass beds in several regional estuaries and lagoon systems. For Nigeria, systematic seagrass mapping remains scarce; however, regional presence and seagrass's known carbon accumulation potential suggest seagrasses should be prioritized in national inventories (UNEP; Rodrigues et al., 2024)

4.2 Carbon stocks, sequestration potential and uncertainty

Global and regional syntheses demonstrate very high carbon densities in mangrove ecosystems (Donato et al., 2011; Kauffman et al., 2020), with soils often containing the largest fraction of ecosystem carbon. Pendleton et al. (2012) provided a framework for estimating emissions from coastal conversion, showing that such losses can represent substantial annual CO₂ emissions at global scales. Regionally, Bryan et al. (2020) assessed West African blue carbon feasibility and highlighted both the potential magnitude of blue-carbon stores and major data gaps. Nigeria is likely to contain significant, concentrated carbon stocks in its Niger Delta mangroves and associated sediments; however, uncertainty is high where field sampling is limited. Conservatively, protecting intact mangroves and enabling restoration can reduce emission risks and contribute to national mitigation commitments if accompanied by credible MRV (Along, 2014; Howard et al., 2014; Barenblitt et al., 2024).

4.3 Drivers of loss and emission risk in Nigeria

Human-driven pressures are the most significant: expansion of oil and gas facilities and spillages, coastal infrastructure development such as ports, dredging and land reclamation, land conversion for aquaculture and farming, along with fuelwood and timber extraction. These activities accelerate shoreline erosion, limit natural sediment deposition, and strip away vegetation and substrates that store carbon. Climatic stressors notably sea-level rise and more frequent storm surges intensify these impacts by causing flooding and saltwater intrusion, which disrupt ecological processes. Evidence from environmental studies and journalistic accounts highlights rapid coastal retreat, displacement of communities, and fragmentation of habitats in Lagos and across the Niger Delta (Donato et al 2011; Bryan et al., 2020; Bunting et al., 2022).

4.4 Livelihood impacts and socio-economic vulnerability

Artisanal fisheries are a primary livelihood pathway for many coastal Nigerians; mangroves and seagrasses function as nursery areas vital to fish and crustacean recruitment. Habitat loss leads to reduced catch per unit effort (CPUE) for small-scale fishers, increased vulnerability, and re-allocation of labour to less sustainable livelihoods. Additionally, mangrove loss increases exposure to coastal hazards, endangering houses, farmland and community infrastructure with commensurate socio-economic costs measured in lost income and increased displacement. WorldFish and FAO regional analyses underscore the dependence of coastal communities on these habitats, and local reporting confirms their immediate impacts on poor households (McLeod et al., 2011; IPCC, 2019; Kauffman et al., 2020).

4.5 Policy readiness and finance landscape

Nigeria's climate plans, like the Long-Term Low-Emission Development Strategy (LT-LEDS) and the updated Nationally Determined Contribution (NDC), set goals for reducing emissions and adapting to climate change. However, they give little attention to coastal "blue carbon" ecosystems in their monitoring and action plans. While there is global interest in funding blue carbon through carbon markets and public-private partnerships, progress in Nigeria is held back by weak monitoring systems, unclear land ownership, and poor community protections. Past experiences in the region show that large carbon projects can create conflict if they are not managed openly and with full community involvement(Nellemann et al.,2009;NCCC,2023; Mwikamba,2024).

5. Case studies and illustrative evidence

5.1 Niger Delta mangroves — carbon and conflict

The Niger Delta remains Nigeria's blue-carbon hotspot. Peer-reviewed and gray literature indicate both high carbon density in intact mangroves and extensive degradation arising from oil infrastructure, spills and land-use conversion. Several studies and technical reports quantify localized soil and biomass carbon, showing that disturbance can rapidly mobilize stored carbon; the spatial distribution of mangrove carbon stocks is heterogeneous, emphasizing the need for site-level measurements for MRV. Invasive species (e.g., *Nypa* palm expansion) also alter mangrove habitat composition and function in parts of the delta, with implications for carbon dynamics and ecosystem service(Pendleton et al.,2012;Salinas et al.,2020;Reuter,2025).

5.2 Lagos lagoon complexes — erosion, development and people

Lagos and adjacent lagoon systems host mangrove fragments and coastal communities of high population density. Rapid port expansion, land reclamation and urban growth have driven coastline modification and habitat loss in the western Nigerian coast. Recent media coverage documents episodes where coastal surges and erosion have swept communities and infrastructure, demonstrating both the physical impacts and the social vulnerability at stake. These events underscore the need to integrate nature-based shoreline protection and restoration into city/regional planning(Sidicheikh et al.,2022; Rodrigues et al.,2024).

5.3 West Africa seagrass discoveries and implications for Nigeria

Seagrasses in West Africa are increasingly documented by targeted surveys (Sidi Cheikh et al., 2022), adjusting previous range maps and revealing new populations. Given the carbon burial potential of seagrass sediments and their role in fisheries support, the lack of systematic seagrass inventories in Nigeria is a major evidence gap. Systematic mapping will enable Nigeria to account for these habitats in national carbon budgets and to design targeted protection where seagrass meadows buttress local fisheries(UNFCCC/NDC,2023).

6. Discussion — pathways, trade-offs and governance

6.1 Scientific and MRV priorities

A credible national blue-carbon programme requires (i) high-resolution habitat mapping (mangrove extent, condition and seagrass distribution) using remote sensing (Global Mangrove Watch products, multi-spectral imagery) coupled with field validation; (ii) standardized soil core sampling and laboratory protocols (e.g., CN analysis, bulk density, radiometric dating where possible) to estimate soil organic carbon and burial rates; (iii) local biomass and allometry studies to convert tree measurements to carbon stocks; and (iv) time-series monitoring to quantify change

and potential emissions from disturbance. Existing global methods (Howard et al., 2014; IPCC coastal guidance) provide templates to adapt to Nigeria's environmental context(WorldFish,2024).

6.2 Integrating livelihoods and safeguards in blue carbon projects

Carbon finance instruments can supply funds for conservation and restoration but may also risk dispossessing communities if projects do not enforce FPIC, tenure clarity and benefit-sharing. Co-management, payments for ecosystem services designed with local participation, and livelihood-linked restoration (e.g., integrated mangrove aquaculture where appropriate) can align conservation outcomes with poverty alleviation. Importantly, social safeguards and transparent contracts must be a precondition for any carbon monetization effort in Nigerian coastal zones, given regional cautionary cases(State of the World Mangroves 2024).

6.3 Financing options and blended approaches

Nigeria should pursue blended finance models: public seed funding for MRV and restoration pilots, philanthropic grants for capacity building, and carefully structured private/voluntary carbon finance for scaled restoration always contingent on safeguards and transparent governance. International climate funds and development banks have growing blue-economy portfolios that can be tapped if projects demonstrate credible MRV and social inclusion. Additionally, results-based payments for ecosystem services (RB-PES) offer a route to pay communities for measurable carbon and adaptation outcomes (Pendleton et al.,2012).

6.4 Risks of commodification, leakage and perverse outcomes

Carbon flows do not inherently protect livelihoods. Without safeguards, there is risk of land-grabs, restricted customary resource access, or projects that shift pressures elsewhere (leakage). Transparent legal frameworks, third-party verification, grievance mechanisms and community legal literacy are essential to minimize these risks. Regional media reporting and investigative articles highlight instances where large deals in West Africa raised concern over dispossession, reinforcing the need for vigilance.

7. Policy recommendations (operational and prioritized)

Below is a prioritized, actionable set of recommendations designed for Nigerian policymakers, donors and practitioners.

- i. National Blue-Carbon Inventory & MRV Roadmap (Priority: immediate 1–2 years)
Launch a national mapping and field-validation program that pairs Global Mangrove Watch datasets and recent seagrass surveys with standardized soil core sampling and biomass assessments in priority coastal zones (Niger Delta, Lagos lagoon, Cross River estuary). Use IPCC and Coastal Blue Carbon methodological guidance for MRV (Mwikamba et al.,2024).
- ii. Integrate Blue Carbon into NDC and LT-LEDS (Priority: near term next NDC update / LT-LEDS operationalization). Explicitly include coastal wetland conservation and restoration actions with quantified targets and MRV pathways in NDCs and LT-LEDS reporting. Link these to national adaptation planning and coastal hazard mitigation programs (Sasmito et al.,2020; Hatje et al.,2021; Breithaupt et al.,2023).
- iii. Community-centred governance and safeguards (Priority: immediate and ongoing)
Mandate FPIC processes, transparent benefit-sharing, tenure clarification and grievance mechanisms as prerequisites for any carbon finance or restoration project in coastal zones. Support community co-management capacity building.

iv. Pilot projects for restoration linked to livelihoods (Priority: 1–3 years)
Fund pilot community-led restoration projects that include both carbon MRV components and livelihood support (e.g., sustainable fisheries enhancement, ecotourism, sustainable mangrove harvest practices). Rigorously evaluate socio-economic outcomes (Sasmito et al.,2020; Hatje et al.,2021; Breithaupt et al.,2023).

v. Blended finance and institutional capacity building (Priority: 1–5 years)
Use public funds and donor grants to de-risk early MRV investments and to build institutional capacity in national agencies and research institutes for coastal carbon accounting. Design contracts to ensure third-party verification and long-term stewardship financing (Sasmito et al.,2020; Hatje et al.,2021; Breithaupt et al.,2023).

vi. Legal and policy safeguards (Priority: build / update concurrently)
Update national coastal and land-use law where necessary to protect customary use rights, define carbon rights and regulate carbon project agreements. Ensure transparency and public disclosure of contracts (IPCC,2019; Barenblitt et al.,2024).

8. Conclusion

Nigeria's coastal ecosystems are valuable for fighting climate change, supporting communities, and boosting the blue economy, but they are not yet fully used. Research shows that mangroves and possibly seagrasses have high potential to store carbon. Still, poor data, weak monitoring systems, unclear land rights, and governance problems make it risky to launch big carbon projects right away. If Nigeria develops a strong national inventory, clear monitoring plans, community protections, and mixed public private funding for restoration, it can unlock these benefits. Success will depend on federal, state, research, and community leaders working together to link blue-economy goals with fair and resilient coastal development.

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