***Review Article***

**IMPACTS OF CLIMATE CHANGE ON NIGERIA’S BLUE ECONOMY: A REVIEW OF VULNERABILITY AND RESILIENCE**

**ABSTRACT**

This study assessed the vulnerability and resilience of Nigeria blue economy threatened by climate change. Nigeria's blue economy include industries like seafood processing and marine biotechnology as well as activities directly associated to the country's coastline and marine resources, including offshore oil and gas, fishing, shipping, tourism, and ocean energy which account for >60% of maritime GDP. The paper notes that Nigeria's blue economy goal aligns with international aspirations, for instance, Sustainable Development Goals (SDG 14) promotes sustainable utilization and conservation of marine resources. The paper discusses the resilience strategies employed to mitigate climate change such as limiting greenhouse gas emissions, sustainable fisheries management practices, conservation and restoration of coastal ecosystems, investing in research and monitoring programs. Nigeria's legal framework for marine governance, which contains rules intended to strengthen its commitment to responsible maritime practices, is also highlighted in the study. The paper concludes by emphasizing the necessity of government action, resource distribution for sustainable blue projects, and innovative policymaking that reflects the values of fair access, economic growth, and environmental protection.

Keywords: Sustainability, vulnerability, Blue economy, Nigeria.

**INTRODUCTION**

The blue economy serves as a model for fostering economic growth by conserving and using inland and oceanic water resources sustainably. The blue economy's contribution to improving environmental sustainability and socioeconomic development is now recognized by scientists and policymakers (Okafor-Yarwood, 2020). According to estimates, the blue economy employs 1% of the world's workforce and contributes between 3.5% and 7% of the global GDP (UNCTAD, 2020). Additionally, about 8% of the global population depends directly or indirectly on the ocean fishing industry for their livelihoods (Sarker *et al.,* 2019). The annual revenue from marine and coastal tourism worldwide is around USD 161 billion (FAO, 2016). However, the obstruction of maritime economic activities and livelihoods, as well as the deterioration of water-related ecosystems and biodiversity, are the primary ways that climate change and catastrophes threaten the blue economy (Karanja and Saito, 2018). Ocean climate, sea level, acidity, water circulation, and ice distribution are all changing as a result of climate change. The species and coastal ecosystems that support the economic benefits of the coast are directly impacted by these system changes (Gaines *et al*., 2019; Obura *et al.,* 2017a; IPCC, 2019).

The Blue Economy is already being impacted by climate change in a number of ways. Because of geomorphological processes, shorelines are suffering as a result of sea level rise. Unpredictable patterns of drought and flooding are being brought on by changes in precipitation. The availability of fish for human consumption will decline as a result of shifting ecosystem production patterns brought on by rising water temperatures. Extreme weather, including storm surges, might theoretically combine with regular lunar tides to overwhelm coastal nations' capacity to protect their citizens and infrastructure if climate change is unchecked. Building Africa's Blue Economy in anticipation of these consequences could lessen the possible effects of climate change while enhancing the adaptability and resilience of coastal populations across the continent (World bank, 2022).

Due to their natural advantages, advanced adaption strategies, advanced technology, mechanized agriculture systems, and wealth position, industrialized nations have been seen to be less affected by climate change. The industrialized economies have been able to mitigate the negative consequences of climate change because of these characteristics. The effects of climate change are particularly significant for developing nations like Nigeria because of their high temperatures, limited ability to adapt, and absence of early warning systems (Akinbobola et al., 2015).

Given that a large portion of its economy depends on climate-sensitive ecosystems and natural resources, Nigeria faces heightened risks from climate change due to its fragile economy, low resilience, and limited potential for adaptation. For instance, the agriculture industry, which accounts for roughly 24% of the nation's GDP and is mostly dependent on rainfall, is extremely vulnerable to frequent and severe extreme events brought on by climate change, such droughts and floods. Nigeria's blue economy is primarily driven by ocean renewable energy, offshore oil and gas exploration, deep and short sea shipping, blue biotechnology, extractives, marine aquatic products, coastal and cruise tourism, maritime transportation, and fisheries and aquaculture (UNFCCC, 2021).

Thus, the effects of climate change on Nigeria's blue economy are examined in this review. The review also looks at how the blue economy may improve resilience and adaptation capability to coastal disasters and climate change. The review concludes by critically analyzing the policies and tactics the Nigerian government has implemented to improve catastrophe risk reduction, climate change resilience, and a sustainable blue economy. The goal of the study is to assist stakeholders and policymakers in their pursuit of a robust, sustainable, and healthy blue economy.

**ORIGIN AND CONCEPTUALIZATION OF THE BLUE ECONOMY**

At the Rio+20 summit in 2012, the United Nations Environment Programme (UNEP) introduced the concept of the "blue economy," which gained prominence as an application of green economy principles to the ocean realm. The term "blue economy" was first introduced by Professor Gunter Pauli in 1994 as an economic philosophy reflecting business models for the future (Pauli, 2010). The concept's inception and development underscore its significance as a substitute economic framework for sustainable development, recognizing countries' reliance on the ocean (UNECA, 2016). It reflects a contemporary perspective that prioritizes social justice, sustainability, and intergenerational equity as tenets for future growth.

The blue economy aims to maintain environmental sustainability while fostering economic expansion, social inclusion, and livelihood preservation. It seeks to maximize the advantages of marine resources and detach socioeconomic growth from environmental deterioration. Diverse definitions emphasize the blue economy's emphasis on using ocean resources sustainably to create jobs, enhance livelihoods, and boost the economy while ensuring the sustainability of ocean ecosystems. The idea encompasses both current and new industries as well as a broad variety of economic activity related to seas, coasts, and oceans. The blue economy also acknowledges non-marketable economic advantages like variety, cultural values, coastal conservation, and carbon storage. In summary, the blue economy, which encompasses rivers, lakes, seas, and other bodies of water, is viewed as a novel method to commercial exploitation that ensures environmental sustainability while fostering economic growth, social inclusion, and livelihood preservation.

**POTENTIAL AND THE NATURAL RESOURCES OF THE BLUE ECONOMY**

According to the World Bank (2017), for an activity to be considered a part of the blue economy, it must benefit present and future generations on a social and economic level. Additionally, restore, safeguard, and preserve marine ecosystems' diversity, productivity, adaptability, essential roles, and inherent value. Finally, in order to reduce waste and encourage the use of materials, the activities must support clean technologies, renewable energy, and circular material flows. The contribution of marine and fresh ecosystems includes:

•Food Security, Nutrition, and Health: One billion people rely on fish for their macromolecule supply, accounting for more than 60% of the animal macromolecules ingested worldwide and 6.5% of all macromolecules consumed. Additionally, fish is an extremely important source of nourishment. The distribution of fish, even in small amounts, helps provide food and organic process security for the world's impoverished and vulnerable populations.
• Livelihoods: According to the Food and Agriculture Organization (FAO), between 660 and 820 million people worldwide depend on fishermen, fish farmers, and those who provide services and goods to related industries for their livelihoods. Additionally, many jobs in tourism, one of the top five industries in the majority of tiny island governments, are based on the oceans and coasts.

• Climate Change Mitigation: Oceans are a significant sink for phylogeny emissions, accounting for 25% of the extra carbonic acid gas released into the atmosphere by burning fossil fuels.

**CLIMATE CHANGE IN THE CONTEXT OF NIGERIA’S BLUE ECONOMY**

Climate change is unequivocal (IPCC, 2014). Ocean warming, sea level rise, acidification, deoxygenation, storm features, runoff, and modifications to wind and precipitation patterns are some of the climate factors that have an impact on marine and coastal ecosystems (Nicholls *et al.*, 2010). Rising sea temperatures have resulted in significant changes in marine ecosystems. The Nigerian coastline, spanning over 853 kilometres, is home to diverse marine species and coral reefs (Maia *et al*., 2022). However, increased water temperatures have led to the bleaching and eventual death of corals, resulting in the loss of critical habitat for marine organisms. This loss of biodiversity has severe implications for the fishing industry, as many species rely on these reefs for food and breeding grounds.

Secondly, climate change has brought about alterations in ocean currents and precipitation patterns, which are adversely affecting the productivity of Nigerian waters. The blue economy relies heavily on the abundance of fish stocks, and these stocks are significantly influenced by oceanographic conditions. Disruptions in ocean currents are causing fish migration patterns to become unpredictable, posing challenges for fishermen and resulting in reduced catches. Furthermore, the shifting rainfall patterns are impacting the freshwater inflow into rivers and estuaries, which in turn affects the breeding and survival of fish species that depend on these habitats.

Additionally, storms, floods, and other extreme weather events are occurring more frequently and with greater intensity in Nigeria. These events have devastating consequences for coastal communities and infrastructure, including community displacement, property loss, and disruptions to economic activities. Coastal erosion caused by these events further degrades the resilience of the blue economy, rendering coastal areas vulnerable to future climate impacts (David and Odenigbo, 2022).

The rising acidity levels in the oceans, a phenomenon referred to as ocean acidification, represent a significant concern for Nigeria’s blue economy. This phenomenon is driven by increased levels of carbon dioxide in the atmosphere, which are absorbed by seawater, causing it to become more acidic. This acidification has detrimental effects on the development and viability of marine life, such as shellfish, crustaceans, and other organisms that rely on calcium carbonate structures. The diminishing populations of these marine species pose a potential threat to Nigeria’s aquaculture sector, jeopardizing both economic prosperity and food security (Atoyebi, 2024).

Maritime transportation serves as the primary mode of transporting goods, energy, and raw materials (Khadijah and Ibidapo-Obe, 2024). However, maritime transportation contributes to CO2 emissions, and ports are responsible for a range of carbon emissions. As the amount of transportation at sea rises annually, the greenhouse gas emissions from the maritime sector are contributing to climate change by reducing emissions of pollutants from land-based sources while increasing emissions from maritime vehicles (shipping). The challenges are particularly intense in coastal regions and an especially seaport, polluted smokes emitting from ships funnels significantly deteriorates air quality around the coastal communities. Oxides emitted to the air contribute to acid rain which in turn affects sea water quality. The maritime industries are known for its vast marshlands vital for carbon sequestration. Coastal erosion, rising seas and oil pollution are destroying the mangrove forest which is a major buffer against storm surge from the sea. These environmental risks, compounded by both socio-economic and physical vulnerabilities, have made the region increasingly susceptible to frequent hazards such as storms, sea level rise, flooding and greenhouse gas (GHG) emissions. As risk levels continue to rise, physical and social assets face impending obliteration. Coastal inundation threatens major cities like Port-Harcourt and Lagos, along with other low-lying coastal communities. Due to their physical attributes, the proximity to the ocean and major rivers and significant economic potentials, coastal areas in southern Nigeria are particularly vulnerable to the menace of climate change confronting the industry. As the number of fishing vessels (ships) continues to rise, associated risks are expected to increase. Coastal communities will face greater exposures to harmful emissions, such as carbon dioxide and methane which contribute to regional temperature rise and environmental stress (Owoputi and Owoputi, 2021).

**RESILIENCE STRATEGIES FOR CLIMATE CHANGE IN NIGERIA BLUE ECONOMY**

Mitigating the impacts of climate change in Nigeria’s blue economy is crucial for ensuring the long-term sustainability and resilience of this sector. The blue economy encompasses various marine and aquatic resources such as fisheries, coastal tourism, and offshore oil and gas exploration, all of which are affected by climate change. To effectively mitigate these impacts, a range of measures need to be implemented.

1. Reduction of greenhouse gas emissions: This is fundamental to mitigating climate change in the blue economy. Nigeria must take steps to reduce the total amount of greenhouse gases (including carbon dioxide and methane) by transitioning towards cleaner energy sources and reducing reliance on fossil fuels. This could be achieved through the promotion of renewable energy technologies such as solar and wind power, as well as the implementation of energy efficiency measures.
2. Sustainable fisheries management practices are essential for mitigating climate change impacts on Nigeria’s fish stocks. Overfishing not only depletes fish populations but also disrupts the balance of marine ecosystems. Implementing and enforcing regulations that limit fishing efforts, protect key breeding grounds, and promote responsible fishing practices can help restore fish populations and enhance their resilience to climate change (Friess *et al*., 2023).
3. Conservation and restoration of coastal ecosystems, such as mangroves and coral reefs, play a critical role in mitigating climate change impacts in the blue economy. These ecosystems act as natural buffers against storm surges and sea-level rise while also sequestering carbon dioxide. Implementing measures to protect and restore these ecosystems, including strict regulations on land use and development, is vital for their preservation and effective climate change mitigation.
4. Investing in research and monitoring programs is also crucial for effective climate change mitigation in Nigeria’s blue economy. These programs can enhance understanding of the impacts of climate change on marine and coastal ecosystems, as well as inform the development of adaptive strategies. Furthermore, they can help identify emerging threats and support the implementation of timely mitigation measures.

Addressing the climate change impacts on Nigeria’s blue economy requires a multifaceted approach. This approach should encompass reducing greenhouse gas emissions, sustainable fisheries management, conservation of coastal ecosystems, investment in research and monitoring, and promoting public awareness (Bryndum-Buchholz *et al.,* 2021). Furthermore, engaging stakeholders, including local communities, fisherfolk, and industry players, is vital in building a collective understanding of the risks posed by climate change and the importance of mitigation measures. By implementing these measures, we not only enhance the resilience of the blue economy but also contribute to the long-term sustainability and well-being of Nigeria’s coastal communities and ecosystems (Okoh and Okpanachi, 2023).

**IMPLEMENTATION PLAN FOR NIGERIA’S BLUE ECONOMY**

Nigeria’s efforts to strengthen the resilience of its blue economy are concentrated around several strategic pillars of climate adaptation and sustainable ocean governance. As fisheries constitute a major livelihood for coastal populations, Nigeria has focused on promoting sustainable practices in the sector such as enforcing catch limits, adoption of climate-smart aquaculture techniques and establishing Marine Protected Areas (Olaniyi *et al.,* 2024). Nigeria’s coastline is one of the most vulnerable to climate change, communities along the Niger Delta and Atlantic coast experience rapid erosion, saltwater intrusion, and displacement. In response, the government and partners have initiated some projects such as mangrove reforestation and wetland restoration, Construction of sea walls, use of geospatial tools to monitor erosion hotspots and plan interventions (Oduma, 2023).

Nigeria is currently adopting the use of Ecosystem Based Management tools, this instruments enhances the efficient utilization of the ocean and its resources while simultaneously safeguarding the ocean and its resources. Important ecosystem-based management tools include marine spatial planning (MSP), integrated coastal zone management (ICZM), and ecosystem-based fisheries management (EBEM). To reduce vulnerability to climate change and build adaptive capacity, Nigeria has expanded its investment in early warning systems and climate information dissemination by enhancing ocean monitoring through buoys, satellite data, and coastal weather stations, Providing climate advisories and marine forecasts for fishers, transport operators, and coastal communities. Key actors here include the Nigerian Meteorological Agency (NiMet), Nigerian Maritime Administration and Safety Agency (NIMASA), and National Emergency Management Agency (NEMA) (United Nations Development Program, 2025).

The Nigerian Ministry of Marine and Blue Economy was established and tasked ‘with institutionalizing the concept of blue economy in Nigeria’ and in order to achieve this goal, it needs to come up with a holistic regulatory framework and policy (Okon and Joseph, 2022). As part of its strategic plan to revitalize the Nigerian maritime sector, the Ministry will ensure the integration of state-of-the-art technology in the digital transformation, which will enable optimal, productive, and enduring utilization of Nigeria's maritime resources (Ministry of Marine and Blue Economy, 2024). To achieve its vision of positioning Nigeria as a foremost maritime nation, the Ministry and its agencies have meticulously devised and outlined a comprehensive four-year strategy to secure and fully harness the opportunities offered by the blue economy while also diversifying the revenue base of the nation, ensuring sustainable development, and embedding environmental conservation in the Nigerian maritime sector, with the ultimate goal of establishing Nigeria as a prominent maritime power. To tackle the challenges facing the maritime industry in Nigeria and advance the blue economy agenda, four core areas have been identified. These endeavors are poised to result in stronger and more sustainable industry, increased national revenue, higher employment rates, and an enhanced institutional framework that will bolster the countries standing globally (Ministry of Marine and Blue Economy, 2024).

Figure 1: Core strategic areas.

**POLICY AND GOVERNANCE FRAMEWORKS FOR CLIMATE CHANGE RESILIENCE IN NIGERIA’S BLUE ECONOMY**

Atoyebi (2024) listed two policy and governance frameworks crucial for building climate change resilience in Nigeria’s Blue Economy.

1. **Nigerian Maritime Administration and Safety Agency (NIMASA) Act 2007:**

The Nigerian Maritime Administration and Safety Agency (NIMASA) Act plays a crucial role in enhancing climate change resilience within Nigeria’s Blue Economy. Climate change poses a significant threat to these sectors, and NIMASA, as the agency responsible for regulating and promoting safety and maritime activities, can contribute to resilience by developing and enforcing regulations within Nigeria’s maritime sector. This includes regulations related to environmental protection, safety standards, and climate change mitigation measures for vessels and offshore operations. By implementing and enforcing climate-resilient regulations, NIMASA can help reduce the environmental impact of maritime activities and promote sustainable practices. Section 22(1) of the Act saddled the Agency with the responsibility of carrying out these activities in pursuit of her statutory functions.

**National Oil Spill Detection and Response Agency (NOSDRA) Act:**

The NOSDRA in Nigeria plays a crucial role in enhancing climate change resilience in the country’s Blue Economy by addressing and mitigating the environmental impacts of oil spills and related activities.

NOSDRA is responsible for ensuring that oil and gas industry activities are conducted with a focus on environmental protection. By enforcing regulations and standards, NOSDRA helps prevent oil spills and ensures that oil companies have contingency plans in place to respond quickly in case of accidents, reducing the risk of environmental damage that can exacerbate climate change effects.

In accordance with the International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC 1990), to which Nigeria is a signatory, the NOSDRA, an agency under the Federal Ministry of Environment, is tasked with overseeing the implementation of the National Oil Spill Contingency Plan (NOSCP), which also includes the National Oil Spill Contingency System (NOSCS) for Nigeria. In order to respond to a spill, lessen its negative effects, and handle all associated concerns, the National Oil Spill Contingency System (NOSCS) unifies all pertinent laws, organizations, individuals, procedures, facilities, equipment, and logistical support.

**CONCLUSION**

The Blue Economy of Nigeria is critically vulnerable to the effects of climate change, and without robust adaptation strategies, the country risks losing valuable marine resources and jeopardizing livelihoods. Climate change will continue to threaten fisheries, coastal tourism, oil and gas extraction, and the overall integrity of marine ecosystems. Effective policy frameworks, sustainable resource management, determined government intervention, wise resource allocation towards sustainable blue initiatives, and innovative policymaking that embodies the values of equitable access, economic prosperity, and environmental protection, however, can all help to strengthen Nigeria's Blue Economy's resilience.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

**Disclaimer (Artificial intelligence)**

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, manuscript.

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