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Harnessing the fisheries sector of the blue economy for sustainable economic growth and development in Nigeria: Opportunities, challenges, and strategies

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Abstract

Fisheries sector is an Essential foundation of the blue economy, making substantial contributions to global food security, livelihoods, and economic development. Despite this, its sustainability is at risk due to unsustainable practices, overfishing, and environmental degradation. Nigeria, with an Exclusive Economic Zone (EEZ) spanning 350 nautical miles (648.20 km), has significant opportunities for sustainable development within this sector. Mariculture, the cultivation of marine organisms in their natural environments, is gaining prominence as an environmentally friendly alternative to traditional capture fisheries, offering a pathway to sustainability. The exploration of strategies to harness the fisheries sector for sustainable economic development involves a multifaceted approach, including the integration of innovative technologies, community engagement, international collaboration, and diversification. Central to this strategy is sustainable resource management. This involves implementing science-based quotas, embracing ecosystem-based management, and promoting responsible fishing practices, which collectively allow for balancing economic growth with environmental sustainability. Technological advancements play a crucial role in this effort. Tools like satellite monitoring and data analytics can significantly improve operational efficiency and transparency, reduce bycatch, and combat illegal, unreported, and unregulated (IUU) fishing. Engagement with coastal communities is crucial, given their heavy reliance on fisheries for their livelihoods. A participatory approach, involving local stakeholders in the decision-making process, can promote equitable distribution of benefits and foster a stronger commitment to sustainable practices. Additionally, international collaboration is essential to address transboundary issues and to establish uniform regulatory frameworks, ensuring that sustainable and fair practices are observed globally. Diversification and value addition are also key components in building economic resilience. By advancing aquaculture, developing value-added fish products, and exploring synergies with related industries such as tourism, the fisheries sector can create new revenue streams and mitigate risks associated with market fluctuations. The sustainable development of the fisheries sector requires a comprehensive and collaborative approach that integrates innovative technologies, community engagement, international cooperation, and diversification. Through these strategies, it is possible to maintain the sector's crucial role in the blue economy while addressing environmental and economic sustainability challenges.

Keywords: Harnessing, blue economy, economic, development, sustainable and fisheries sector

1. Introduction

Nigeria is a maritime state where 9 of the 36 states have a bank in the Atlantic Ocean. The littoral states of Nigeria are Ogun, Lagos, Ondo, Edo, Delta, Bayelsa, Rivers, Akwa Ibom, and Cross Rivers States, set up in the southern part of the country. Fish provides more than 60% of the world's supply of protein, especially in developing countries (FAO, 2007) ^[20]. Fish are an important protein source in the diet of Nigerians. Protein from fish is largely digestible and of high nutritive value and consists of complete arrays of amino acids, vitamins, and minerals (Elezuo *et al.*, 2020) ^[12]. Fish is a cheaper source of protein compared to other beast protein sources such as beef, pork, and mutton (FDF, 2008) ^[16]. The fisheries subsector of the Nigerian economy is an essential tool for rural development through its provision of income, high- quality protein, and socioeconomic development of fishing communities in Nigeria (Etim, 2010) ^[13].

The applicability of the fisheries sector to the Nigeria economy and benefits deduced by Nigerians from fish and other fish products led to the high consumption and hence the increased demand for fisheries products. Marine ecosystems contain a different array of living organisms and abiotic processes. From massive marine mammals like whales to the tiny krill that form the bottom of the food chain, all life in the ocean are connected. While the ocean seems vast and everlasting, it is, in fact, finite; as the climate continues to change, we're learning further about those limits. The blue economy refers to sustainable use, management, and conservation of ocean and marine resources to promote economic growth, improve livelihoods, and preserve the health of marine ecosystems. It encompasses various economic activities and sectors related to oceans, seas, and coasts.

The World Bank defined the blue economy as the "sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem." In addition, according to Conservation International, "blue economy also includes economic benefits that may not be marketed, such as carbon storage, coastal protection, cultural values, and biodiversity." Key components of the blue economy include fisheries, aquaculture, shipping and maritime transport, tourism, renewable energy (such as offshore wind and tidal energy), and biotechnology. The concept emphasizes the importance of balancing economic development with environmental sustainability to ensure the long-term health and productivity of marine ecosystems (Visbeck *et al.*, 2014) ^[41]. The blue economy is estimated to be worth about \$1.5 trillion per year. However the fisheries sub sector of the blue economy is valued at around \$406 billion per year. It provides over 30 million jobs and accounts for a vital source of protein to over three billion people. The aim of this review is to highlight the impacts the fisheries sector of the blue economy could make to Nigeria's economic development, including the challenges faced by the sector and strategies to actualize the potentials of the sector.

2. Blue Economy

2.1 The Blue Economy's Origin and Conceptualization

The idea of the "blue economy" has gained traction recently in a number of contexts, demonstrating its application as a framework for revenue diversification for sustainable growth that recognizes countries' dependence on the marine environment (UNECA, 2016) ^[39]. It also expresses the true idea that growth can proceed in a way that upholds social justice principles and sustainability, especially intergenerational equality. When the UN requested Professor Gunter Pauli to think about future business models in advance of the COP3 summit in Japan, where the Kyoto Protocol was passed, in 1994, he came up with the phrase "Blue Economy" as an economic ideology (Pauli, 2010) ^[33]. The "blue economy" was promoted by the international consortium running the 2012 Rio+20 urban center summit program. In addition to promoting social participation and economic processes, the blue economy concept aims to protect coastal and marine environments and, consequently, sustain or improve livelihoods. It comprises optimizing the advantages derived from marine resources and separating socioeconomic growth and activity from environmental degradation (Wairimu and Khainga, 2017) ^[42]. The appropriate use of coastal resources for increased productivity, chances for a

living, and employment while simultaneously preserving the health of the marine system is known as the "blue economy" (World Bank, 2016) ^[43]. The European Commission defines the "blue economy" as all economic activity involving marines, oceans, and coasts. It encompasses several interrelated, well-established, and developing industries. The Commonwealth of Nations views it as a developing idea meant to make our oceans, or "blue" resources, in better shape.

2.1.1 The Blue Economy's Potential and Natural Resources

The expansion of the ocean economy is not the only factor driving the blue economy's rise. In the maritime industry, however, property development is taken into consideration while making development decisions. The blue economy encompasses both established maritime industries like fishing, tourism, and marine transportation as well as more recent and developing ones like agriculture, offshore renewable energy, marine biotechnology, and bio-prospecting. Because ocean ecosystems provide services without a market, they also play a major role in economic activity and other related ones like carbon sequestration, coastal protection, waste disposal, and biodiversity. Every nation has a different mix of maritime activities based on its own national conditions and, consequently, the national vision that is adopted to represent that nation's conception of a blue economy.

The following are some of the benefits that marine and freshwater environments provide:

One billion people depend on fish for their supply of macromolecules, which account for roughly 60% of the animal macromolecules ingested worldwide and 6.5% of all macromolecules consumed. Fish is a significant food source as well. Even in small quantities, fish is useful in addressing food and nutrition security among the world's most vulnerable and impoverished groups.

2.2 Economic Contribution of Blue Economy

The contributions of industries involved in the blue economy concept while operating sustainably to ensure the sustainability of coastal and marine resources are as follows

2.2.1 Fisheries and Aquaculture

The business involves raising aquatic plants and animals in freshwater and marine environments, as well as catching wild fish and shellfish. The fishing industry is important to Nigeria since it employs about 2 million people (Federal Ministry of Agriculture and Rural Development, 2019). Over 500 million people depend on the global fishery and fishery product industry, which is estimated to be worth over \$150 billion (Food and Agriculture Organization, 2020). Since 2000, the aquaculture business has expanded at a rate of 4.8% yearly, making it the sector of food production with the fastest rate of growth (World Bank, 2018) ^[44]. Nigeria's fishing industry is a significant contributor to the country's economy, with an estimated worth of \$1.5 billion (Federal Ministry of Agriculture and Rural Development, 2019).

2.2.2 Maritime Transport and Logistics

Among its various operations, the maritime transport business includes freight transportation, cruise ships, and ferry services (Krause, 2019) ^[28]. As a means of bringing people and goods together across borders, it is essential to international trade and business.

The maritime sector significantly boosts Nigeria's economy because its ports handle over 90% of the country's import and export trade (Nigerian Ports Authority, 2020) ^[29]. The global marine transport industry has a valuation over \$375 billion. According to the United Nations Conference on Trade and Development (2020) ^[38], the maritime sector alone is responsible for more than 90% of all global commerce.

2.2.3 Coastal and Marine Tourism

Coastal and marine tourism includes, among other things, cruise ship travel, beach holidays, and ecotourism. Nigeria's tourism industry, which highlights the nation's natural beauty and cultural diversity, is growing quickly (Federal Ministry of Information and Culture, 2020). The global marine and coastal tourism currently has a value of about \$ 9.5 trillion. Coastal regions welcome more than 1 billion foreign visitors each year (World Tourism Organization, 2020). With an estimated worth of over \$1 billion, the tourism industry in Nigeria makes a substantial economic contribution to the nation (Federal Ministry of Information and Culture, 2020).

2.2.4 Maritime Engineering and Construction

Developing and maintaining ports, shipyards, and offshore constructions are all parts of marine building and engineering. Nigeria's maritime construction and engineering sector is booming, with a focus on developing new shipyards and ports as well as upgrading and maintaining existing facilities (Nigerian Ports Authority, 2020) ^[29]. The offshore wind, port, and shipbuilding sectors have enormous development potential, and the global maritime construction and engineering business is estimated to be worth over \$200 billion (Frost & Sullivan, 2020). At an estimated \$2 billion, the industry makes a significant economic contribution to Nigeria (Nigerian Ports Authority, 2020) ^[29].

3. Fisheries Sectors of the Blue Economy

3.1 Overview

According to Abba (2024), the fisheries industry made up 1.16 percent of the country's GDP in 2021. Nigeria's fishing industry is said to employ more than 1.48 million people. 653,000 people worked in inland fisheries in 2016, with women making up an estimated 21% of those involved. As a result, Nigeria's blue economy continues to be one of the nation's key subsectors, with fisheries and marine trade both contributing 3-5 percent of the country's GDP. Three subsectors provide Nigeria's seafood resources: the aquaculture industry, sea fishing, and freshwater (inland) fishing. Fishing activities on an artisanal or small-scale basis in coastal areas, creeks and lagoons, inland rivers, and lakes account for more than 70% of Nigeria's total domestic fish supply. The artisanal (coastal and interior) fishermen dominate the capture fisheries, with industrial vessels and trawlers-basically coastal fishermen-contributing very little. Industrial fishing makes up the least percentage (1%). Forty-five percent of the total number of capture fisheries are inland. Nigeria's maritime coastal fisheries are extremely productive because of the massive Niger delta, which supplies nutrients and serves as a breeding site and nursery ground for big populations of finfish and crustaceans. Up to 10,000 tons of shrimp and about 200,000 tons of fish are produced along the coast each year, according to official figures for both commercial and artisanal fishing. Real production might be as much as 50% greater, according to a recent survey.

3.2 Marine industrial fisheries

These can be divided into three categories: coastal shrimp fishing, offshore tuna fishery, and coastal demersal fisheries. The vast Gulf of Guinea stocks of tuna are mostly found in the off-shore tuna fishery. Between the exclusive economic zone (EEZ) (200 nautical miles, recently extended to 350 nautical miles) and the nation's territorial limit (30 nautical miles) is where offshore resources are found. Due to technological limitations, Nigeria has not yet taken a leading role in the discovery of the offshore tuna resources (FAO, 2007) ^[20]. Under the Nigerian Trawler Owners' Association (NITOA), the trawling business is well-developed and organized in the coastal demersal fish fishery. In Nigeria, there are forty trawling firms. Nigerians own the majority of these businesses. These Nigerian businesses have fleet sizes under four, but larger businesses that have fleet sizes of four or more are jointly controlled by foreign investors (FAO, 2007) ^[20]. Nigeria's shrimp industry uses vessels permitted in compliance with fisheries laws and regulations to operate on the continental shelf up to a distance of five nautical miles.

3.3 Marine artisanal fisheries

There are three types of canoe fishing: coastal, brackish water, or estuary, and artisanal, which includes bonga, shad and *Sardinella* fisheries. Owing to motorization and targeted stocks, some operators of the coastal canoe fishery may paddle further out into the sea. The fishery is conducted inside the 5 nautical mile non-trawling zone. The fishermen in this group fish in estuaries for demersal species like croakers, catfish, shiny nose shrimp (Penaeids), and use dug-out or modified canoes. The low-tech, labor-intensive artisanal pelagic fish bond and *Sardinella* fisheries employ canoes that range in length from 6 to 13 meters and are either driven or paddled by hand. In the estuaries, the primary tools utilized include gillnets, cast nets, hooks, beach seines, and other kinds of traps. The fishermen target small pelagic, *Sardinella* spp. and *Ethmalosa* spp.

3.4 Marine fisheries resources in Nigeria

Fishing and aquaculture-related products and production are referred to as fisheries resources (Rabo, *et al.*, 2014) ^[34]. Aquaculture resources comprise fisheries goods from confined habitats like ponds, tanks, dams, and reservoirs, whereas fishing resources are products from open water bodies like rivers, lakes, reservoirs or dams, and oceans. Nigeria is endowed with a land area of 923,768 km², a coastline of 853 km, and an exclusive economic zone (EEZ) spanning 200 nautical miles (recently extended to 350 nautical miles). Nigeria possesses exclusive rights to explore and utilize fisheries and other natural resources within the Exclusive Economic Zone (EEZ) (Ibeun, 2006). In Nigeria's brackish and coastal waters, artisanal fishing was encouraged, while industrial fishing was only permitted outside of the 1992 Sea Fisheries Act's 5-nautical-mile limit. Nine of Nigeria's 36 federal states have a coastline that borders the Atlantic Ocean. Fish from the Sciaenid community, such as croakers and bonga, shad, catfish, sardines, soles, shiny-nose, etc., *Polydactylus* spp. (polynemidae), and *Sphyraenidae*, *Lutjanidae*, *Elopidae*, *Serranidae*, and *Carangidae* families are among the fisheries resources available to marine artisanal fishermen. Small-scale fisherman also catches sail/saw fish, sharks, penaeids, palaemonids, and carid shrimp. The industrial coastal fishing activities in Nigeria involve trawling for shellfish, penaeid shrimp, and demersal finfish. Nigeria is

home to roughly 50 families and 104 species of marine fish (Sikoki, 2013). According to FAC (2007), the majority of the species are croakers (*Pseudolithiasis* spp.), grunts (*Brachydeuterus* spp.), different soles, catfish (*Arius* spp.), and shrimp (*Penaeus* spp.).

The communities of sub-thermocline and supra-thermocline are home to a variety of finfish species. The following are the main target families/species of the sciaenid (super-thermocline) community:

- a) **Sciaenidae (Croakers):** *Pseudolithus typus* (Bleeker, 1863), *Pseudolithus senegalensis* (Valenciennes, 1833), *Pseudolithus elongatus* (Bowdich, 1825), *Pseudolithus senegalensis* (Cuvier, 1830), *Brachydeuterus auritus* (Valenciennes, 1832), *Selene setapinnis* (Mitchill, 1815)
- b) **Ariidae (Catfish):** *Carlarius heudelotii* (Valenciennes, 1840), *Arius gigas* (Boulenger, 1911), *Arius latiscutatus* (Günther, 1864), *Arius parkii* (Günther, 1864)
- c) **Haemulidae (Grunters):** *Pomadasy jubelini* (Cuvier, 1830), *Pomadasy suillus* (Valenciennes, 1833), *Pomadasy incisus* (Bowdich, 1825), *Pomadasy perotaei* (Cuvier, 1830)
- d) **Cynoglossidae (Tongue Sole):** *Cynoglossus senegalensis* (Kaup, 1858), *Cynoglossus canariensis* (Steindachner, 1882), *Cynoglossus monodi* (Chabanaud, 1949) and *Cynoglossus browni* (Chabanaud, 1949)
- e) **Polynemidae (Threadfins):** *Polydactylus quadrifilis* (Cuvier, 1829), *Galeoides decadactylus* (Bloch, 1795)
- f) **Carangidae (Jackfish):** *Caranx hippos* (Linnaeus, 1766), *Caranx crysos* (Mitchill, 1815), *Caranx latus* (Agassiz, 1831), *Caranx lugubris* (Poey, 1860)
- g) **Sphyraenidae (Barracudas):** *Sphyraena barracuda*, *Sphyraena afra*, *Sphyraena guachancho*
- h) **Clupeidae:** *Sardinella* spp.

The sparid community comprises mainly the following major families and species

- a) **Lutjanidae (Red snappers):** *Lutjanus goreensis* (Valenciennes, 1830), *Lutjanus fulgens* (Valenciennes, 1830), *Lutjanus agennes* (Bleeker, 1863) and *Lutjanus dentatus* (Duméril, 1861)
- b) **Serranidae (Groupers):** *Epinephelus aeneus* (Geoffroy Saint-Hilaire, 1817)
- c) **Sparidae:** *Dentex canariensis* (Steindachner, 1881), *Dentex angolensis* (Poll & Maul, 1953), *Dentex congoensis* (Poll, 1954).
- d) Fishery resources in the inshore shrimp industry include the following in order of importance:
- e) White prawn (*Penaeus notialis*) (Pérez Farfante, 1967)
- f) Brown or Guinea shrimp (*Holthuispenaeopsis atlantica*) (Balss, 1914)
- g) Rose or red deep-water shrimp (*Parapenaeus longirostris*) (Lucas, 1846)
- h) Stripped or tiger shrimp (*Penaeus monodon*) (Fabricius, 1978)
- i) Palaemonidae-Estuarine prawn from Decapoda (*Nematopalaemon hastatus*) (Aurivillius, 1898)

3.5 Mariculture

According to reports, small-scale farmer's engagement in freshwater and brackish cultivation account for 80% of the world's fish produced through aquaculture (Kaleem, 2021). Regrettably, despite the 729,000 hectares that are suitable for mariculture (Adeleke, *et al.*, 2020) [3], mariculture has seen

multiple setbacks and has not advanced significantly (Anetekhai, 2010). Mariculture can be practiced in enclosures such as ponds, pens, tanks, or channels as well as in brackish, coastal, offshore, and estuary environments. Fish, mollusks, crabs, and seaweeds are among the creatures that are cultivated. Fish farming and the production of premium fin and shell fish that are found in creeks, lagoons, and estuaries are the main goals of brackish water aquaculture systems (Amosu, *et al.*, 2012) [6]. Nigeria is endowed by nature with a lengthy coastline that hugs the Atlantic Ocean's edges (Amosu, *et al.*, 2012) [6]. There are reportedly still 729,000 hectares of saline mangrove swamp, and aquaculture expansion increases the likelihood that these areas would be destroyed (Amosu *et al.*, 2013) [7]. Thus, the establishment of sanctuaries ought to come before the development of commercial shrimp farming. Many species of fin and shell fish are found in brackish water locations, and most coastal communities have the potential to culture them for very little financial investment. Spatial planning is crucial, and zoning laws should be put in place to safeguard mangroves because developing aquaculture operations won't be abandoned. Multinational oil firms have expressed interest in investing in mariculture because of its potential. Among them are Agip Oil, Mobile Oil, and the Shell Petroleum Development Company (SPDC) (Elezu, 2011) [11]. According to Sogbesan and Ugwumba (2008) [37], additional national fishery professionals and organizations have made investments to advance shrimp farming. Sulalanka, a consortium from Sri Lanka, was granted permission to initiate the inland cultivation of marine black tiger shrimp. Additionally, investing in shrimp farming research has been the primary focus of the Nigerian Institute for Oceanography and Marine Research (NIOMR) (Elezu, 2011) [11]. An excellent location for offshore fish aquaculture is Nigeria. It is a coastal state with the Atlantic Ocean encircling it on the south. First, there is a wide range of offshore aquaculture potential in Nigeria. Nigeria owns a sizable exclusive economic zone that includes a sizable chunk of the Atlantic Ocean. Numerous species might be cultivated in the Nigerian Exclusive Economic Zone (EEZ) with a wide range of technology, which would eventually close the gap in fish production from aquaculture (Akinsorotan, 2019). Appropriate locations for offshore aquaculture must be found and carefully mapped out in order to implement efficient offshore aquaculture techniques. The Federal Department of Fisheries (FDF) should have sole responsibility for this. It is necessary to create appropriate policies that offer a comprehensive framework for the management, development, and preservation of the Nigerian Exclusive Economic Zone. Lastly, to maintain the safety of the public and the environment, appropriate monitoring must be made.

3.5.1 Contribution of Mariculture to sustainable development of fisheries sector

Mariculture, the cultivation of marine organisms in their natural environments, can significantly contribute to sustainable development in the fisheries sector in the following ways:

3.5.1.1 Reduced Pressure on Wild Fish Stocks

By cultivating marine organisms through mariculture, the reliance on wild fish stocks for seafood production can be reduced. This helps in conserving natural fish populations and maintaining biodiversity in marine ecosystems.

3.5.1.2 Enhanced Food Security

Mariculture can increase the availability of seafood for human consumption, thereby enhancing food security. It provides a reliable and sustainable source of protein for communities dependent on fisheries.

3.5.1.3 Economic Opportunities

Mariculture creates new economic opportunities for coastal communities and fisherfolk. It can generate employment, income, and business opportunities in the aquaculture sector, contributing to economic growth and poverty alleviation.

3.5.1.4 Environmental Sustainability

When practiced sustainably, mariculture can have lower environmental impacts compared to traditional fishing methods. Properly managed mariculture operations can minimize habitat destruction, pollution, and overfishing, promoting long-term environmental sustainability.

3.5.1.5 Innovation and Technology

Mariculture often involves the use of innovative technologies and practices to optimize production efficiency and minimize environmental impacts. This encourages the adoption of sustainable aquaculture practices and drives technological advancements in the fisheries sector.

3.5.1.6 Diversification of Fisheries Sector

Incorporating mariculture into the fisheries sector diversifies the sources of seafood production. This diversification can help mitigate risks associated with fluctuations in wild fish stocks and market demand, making the sector more resilient and adaptable to changing conditions.

3.6 Marine biotechnology

According to Helen (2017) [25], marine biotechnology is the process of using scientific and engineering principles to process materials using marine biological agents in order to produce goods and services. In order to create innovative chemical compounds, pharmaceutical medications, enzymes, and other industrial goods and procedures, marine biotechnology investigates the oceans. Furthermore, it is essential to the development of biomaterials, medical diagnostics, seafood and aquaculture safety, bioremediation, and biofouling. Naturally, as the population and demands of humans continue to rise, so too will the strain on natural resources. With the marine environment taking up one-third of our world, we can find a solution to these expanding needs. However, finding medicinal materials/compounds is not the only purpose of bioprospecting. An example of this can be found in the recent work of a scientist examining dead bacteria in seafloor mud to identify athletes who use synthetic or artificial testosterone, a popular (and illegal) anabolic steroid, as a means of cheating. An additional group of researchers learnt how to create a potent adhesive that can solidify underwater by studying how ocean worms build it. In order to produce "biofuels," or fuels made from the leftovers of plants or algae, several scientists are searching for compounds. According to Helen (2017) [25], ethanol is one type of biofuel that you may be familiar with. In developing nations, investigating the possibilities of marine biotechnology may be able to address issues related to a lack of food, poverty, unemployment, and disease outbreaks by identifying new bioactive substances that are necessary to fight resistant bacteria (Helen, 2017) [25].

Developing nations such as Nigeria are capable of progressing and confronting global issues. The maritime environment of Nigeria is home to marine sponges (*Halichondria okadai*) and fungi that are utilized to make Eribulin mesylate and Cephalosporin, which is an anticancer agent and an antibiotic respectively (Helen, 2017) [25].

3.7 Status of marine fisheries production in Nigeria

Nigeria's and the world's marine fisheries production have a significant impact on fish production worldwide. The FAO's 2009 report states that the world's overall fish production expanded dramatically from 19.3 million tons in 1950 to 163 million tons in 2009. Historically, the primary source of fish output worldwide has always been marine fishing. Approximately half (49%) of the world's fish production was derived from marine capture fisheries as of 2009; the remaining percentages came from inland capture fisheries (6%), fresh water aquaculture (23%) and mariculture (21%), (FAO, 2011) [22]. While fish production has increased globally, marine fisheries' share of total fish production has decreased since 1996. According to (Rabo *et al.*, 2014) [34] 6.30 million metric tons of fish were taken by African fishermen, of which 3.80 million tons (or around 60%) came from marine waters. Nigeria ranked among the top African nations for total fish harvested. The author reported that less than half of Nigeria's 579,500 metric tons of live weight of fish caught in 2005 came from its interior waters. This demonstrates how maritime fisheries-both fishing and aquaculture-have dominated Nigeria's fish production.

3.8 Industrial Fishing in Nigerian Coastal Waters

The economy of Nigeria is greatly influenced by industrial fishing in its coastal seas, which supports jobs, food security, and the way of life for many coastal towns. Yet, a number of issues confront this industry, such as overfishing, IUU (illegal, unreported, and unregulated) fishing, and environmental deterioration.

3.8.1 Importance of Industrial Fishing in Nigeria

There are many chances for industrial fishing along Nigeria's lengthy Atlantic Ocean coastline. A substantial amount of Nigeria's fish production comes from the coastal and marine fisheries sectors, which make up one of the largest fishing businesses in West Africa (FAO, 2017) [14]. Food security and the national diet in Nigeria depend heavily on these fisheries since they provide a significant amount of the country's protein needs (Etim, 2010) [13].

3.8.2 Challenges of Industrial Fishing

Industrial fishing in Nigeria's coastal seas is important, but it faces a number of serious obstacles, including:

3.8.2.1 Overfishing

A serious problem is overfishing, as some species are declining significantly as a result of overharvesting. The long-term sustainability of fish stocks is under threat from this tendency, which could result in ecological imbalances and financial losses (Adebola, 2015). Fishing that is unreported, unregulated, and illegal (IUU) In Nigeria's coastal seas, illicit fishing is a major problem that contributes to overfishing and jeopardizes legal fishing activities. Foreign vessels engaged in this business frequently operate without the required permissions or exceed the permitted catch limits (Ugwumba, 2019) [37].

3.8.2.2 Degradation of the environment

Large net usage and bottom trawling are two examples of industrial fishing techniques that can harm marine habitats and worsen environmental deterioration. As a result, marine ecosystems become less able to maintain a variety of marine life and lose some of their overall health (Omorodion, 2020).

3.8.3 Techniques and strategies for Sustainability

Several tactics can be used to solve these issues and advance sustainability in industrial fishing:

- Law and Order To stop IUU fishing and guarantee sustainable practices, laws and enforcement systems must be strengthened. This entails strengthening penalties for illicit activity and improving monitoring, control, and surveillance (MCS) systems (FAO, 2021) ^[15].
- Community Involvement and Co-Management Engaging local communities in the management of fisheries resources fosters a sense of ownership and can lead to more effective conservation efforts. Co-management approaches that involve stakeholders in decision-making processes can be particularly beneficial (Olaoye *et al.*, 2016) ^[31].
- Promotion of Sustainable Fishing Practices Encouraging the adoption of sustainable fishing methods, such as selective gear and reduced bycatch, can help mitigate environmental impacts. Additionally, promoting aquaculture as an alternative to wild capture fisheries can reduce pressure on natural stocks.

3.8.4 International Collaboration

Collaboration with neighboring countries and regional bodies is essential to address transboundary issues related to industrial fishing. Cooperation in data sharing, joint enforcement efforts, and harmonized regulations can contribute to the sustainable management of shared resources (AU-IBAR, 2019).

3.9 Economic Development of Fisheries Sector

A bio-blue economy fund should be established to store the tax funds. By taxing oil and gas, shipping, and other activities, the development of fisheries within the blue economy may be managed sustainably. In order to achieve the goals of the blue economy policy, this will guarantee the preservation of the sector's teaming jobs as well as clean, sustainable freshwater and marine habitats. Establishing Nigeria's Fisheries Commission in accordance with the prepared Nigeria's Fisheries Act 2014, which was supported by the European Economic Commission, is one of the low hanging fruits for achieving this plan.

4. Challenges and Solutions to Economic Sustainability of marine resources in Nigeria

4.1 Challenges

4.1.1 Inconsistent government policy

Nigeria lacks effective government policies to assist in the use of maritime resources, and the few that have been developed have been inconsistent. The development of marine resources has been severely hampered by this. Nigeria's economy and social and political growth have been threatened by the frequent changes in government policies. The development of Nigeria's maritime resources is one policy that has maybe seen several changes over time. This current administration has put on hold the previous administration's policy of establishing an export processing zone (EPZ) to aid in the

development of marine resources. Insufficient government regulations have enabled foreigners to fish in our waters, resulting in the reduction of fish stocks and the vulnerability of our local fishermen (Folami, 2017) ^[19].

4.1.2 Over exploitation

Nigeria does not fish in coastal waters in accordance with the permissible catch regulations. Overexploitation has resulted from this (Etim, 2010) ^[13]. Fish stocks are finite, despite the fact that certain marine resources, like fish, are renewable. The overuse of them affects them. In the past, people mistakenly believed that fisheries resources are limitless. Etim (2010) ^[13] linked overexploitation to technological advancements like hydraulic winches, inboard refrigeration, and acoustic fish finders, as well as the creation of increasingly sophisticated fishing gear and vessels like factory and steam trawlers.

4.1.3 Pollution

Another significant threat to the sustainability of marine resources is pollution. Ocean dumping, oil spills, littering by marine debris etc. effect marine life negatively. Recent research has shown that marine pollution is a threat to the ecosystem and a contributor to global warming. Leakage of crude oil and petroleum products and discharge of untreated waste and chemical into marine ecosystem poses a threat to marine life and marine ecosystem. These substances are a major source of toxic heavy metals in the ocean.

4.1.4 Open access nature of marine resources

The primary obstacle to Nigeria's maritime resource development is the incomplete implementation of the idea of open access property, which allows free access to property because there are no property rights. Etim (2010) ^[13] defines open access as the absence of any barriers to admission onto a shared property, regardless of the land's ownership by a person, group of people, or the government. For instance, marine fisheries are properties with open access. Heavy fishing pressure on populations has been caused by unrestricted access to these fisheries. Political issues, such as the case study in Ibeno, and a lack of staff or equipment are the main causes of the widespread issue of non-enforcement of existing legislation in developing nations (Ifunanya, 2010). In certain coastal areas, sand is mined illegally, which causes erosion along the coast.

4.2 Solutions/Strategies

4.2.1 Integration and coordination of ocean activities

The most crucial element in Nigeria's maritime economic agenda's advancement is integration. Etim (2010) ^[13] asserts that in order to maintain the ecological integrity, life-supporting functions, and biodiversity of the ecosystem in the face of conflicting uses of the ocean, coordination and integration are essential. Beyond this, integration is important for fostering cooperation across various government agencies, departments, and levels as well as for better balancing the three main pillars of the Sustainable Development Goals: social, economic, and environmental (Folami, 2017) ^[19].

4.2.2 Comprehensive policy framework

There should be an open and transparent legal, fiscal, and regulatory framework for managing the marine resources of the West African maritime states.

4.2.3 Data management and capacity development

The OECD (2016) states that data is necessary for measuring indicators, evaluating performance, and creating policies related to the management of ocean resources for both researchers and policy-makers. Data management is crucial for supplying vital information in a variety of marine and oceanic sectors, particularly for data related to fisheries stock assessments and marine spatial planning. Data management is essential for improving our understanding of ecosystem products and services, which helps to address pressing issues like food security, poverty, and capacity building, among others.

4.3 Financing the maritime economy

Even in developed nations, the blue economy is still a developing field that needs a significant amount of funding, resources, and dedication. Though Nigeria is undoubtedly a democratic and prosperous developing nation, this naturally poses a hurdle for it.

Etim (2010) ^[13] summarizes the solutions to the challenges in developing ocean resources in Nigeria as follows

1. Providing more clarity on roles and responsibilities for better ocean governance, coordinating policies, and facilitating their implementation (cooperation and collaboration).
2. Diversification of livelihood strategies among sea going fishermen by encouraging engagement in alternative occupations, such as aquaculture.
3. Creation of an open and transparent legal, fiscal, and regulatory framework for managing and modifying revenue streams.
4. Whenever appropriate, adopting regional strategies to attain economies of scale; this includes creating "model" agreements for national adaptation as well as designing and creating national and regional databases.
5. Development of environmental policies, regulations, and guidelines to control/regulate exploration and mining.
6. Calling on international bodies to actively support Nigerian ocean efforts, such as the International Maritime Organization (IMO).

5. Summary of strategies for sustainable management of Nigeria's fisheries resources

The blue economy depends heavily on the fisheries industry, which has the capacity to promote sustainable economic growth, sustain livelihoods, and enhance global food security. Making the most of the fishery's industry presents enormous potential for both environmental preservation and economic growth as the globe transitions to more sustainable methods. A multifaceted, inclusive strategy that prioritizes the following crucial areas is needed to fully realize this potential:

a. Sustainability and Resource Management

Sustainable fisheries management is critical to ensure the longevity of fish stocks and marine ecosystems. This requires establishing science-based rules, enforcing fishing quotas, promoting responsible fishing methods, and assisting the recovery of overexploited species. Sustainable management helps maintain the balance between human activity and environmental health, ensuring that fisheries can continue to contribute to the economy in the long term. The creation of the federal ministry of marine and blue economy by the present administration is a step in the right direction towards

the sustainable management of our ocean resources.

b. Technological Innovation and Efficiency

Technology integration in the fishing industry has the potential to significantly increase productivity and lessen negative environmental effects. Advances in data analytics, satellite tracking, and automation can help monitor fish populations, reduce bycatch, and optimize fishing operations. Additionally, by enabling increased supply chain traceability and transparency, these technologies help boost consumer confidence and sustainability standard compliance.

c. Community Engagement and Inclusive Development

Sustainable development in the fisheries sector needs active involvement with local people and stakeholders. Fisheries often form the backbone of coastal economies, providing jobs and sustenance to millions of people. Long-term success depends on ensuring fair distribution of economic benefits and involving these communities in decision-making processes. A sense of ownership and accountability can be fostered by community-based management techniques, which can result in more successful conservation initiatives.

d. International Collaboration and Governance

Since fish stocks frequently cross-national borders, the fishing industry is by nature international. Effective international collaboration and governance are necessary to address concerns such as illicit, unreported, and unregulated (IUU) fishing, overfishing, and habitat damage. Together, countries can battle risks to the blue economy's sustainable development, share best practices, and establish and enforce uniform standards.

e. Value addition and diversification

To maximize the economic potential of the fisheries sector, it's important to explore diversification and value addition. This entails advancing value-added products, growing aquaculture, and branching out into adjacent sectors like tourism. Economies can become more resilient and less susceptible to market swings by diversifying their sources of income and opening up new business opportunities.

6. Conclusion and Recommendations

The study of Nigeria's blue economy reveals its critical role in the nation's economic, social, and environmental landscape. The fisheries sector, encompassing artisanal, industrial, and aquaculture practices, contributes significantly to employment, food security, and GDP. Marine biotechnology presents promising opportunities for innovation and sustainable exploitation of marine resources, potentially addressing pressing issues such as disease management, food production, and environmental conservation.

However, the sector faces substantial challenges, including overfishing, habitat degradation, pollution, and climate change. These challenges are exacerbated by inadequate regulatory frameworks, limited technological advancement, and insufficient infrastructure. The impact of these issues is evident in declining fish stocks, reduced biodiversity, and the economic vulnerability of communities dependent on marine resources.

To address these challenges, a multifaceted approach is necessary. Strengthening regulatory frameworks, enhancing data collection and monitoring, and promoting sustainable

fishing practices are essential steps. Investments in research and development can drive innovations in marine biotechnology, while capacity-building initiatives can empower local communities and stakeholders.

Moreover, international cooperation and partnerships can facilitate the sharing of knowledge, technology, and best practices. Implementing effective conservation measures and fostering public-private partnerships will be crucial in ensuring the sustainable management of marine resources.

Therefore, while Nigeria's blue economy holds immense potential for contributing to national development and sustainability, realizing this potential requires concerted efforts from government, industry, academia, and civil society. By addressing current challenges and leveraging opportunities, Nigeria can harness the full benefits of its fisheries resources, ensuring long-term economic growth, environmental health, and social well-being.

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