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The Niger Delta Bioresources: The need for an integrated program for sustainable exploitation and conservation

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ABSTRACT

The Niger Delta is a globally recognised biodiversity hotspot and one of the world's largest wetland ecosystems, supporting diverse habitats such as mangroves, freshwater swamps, and tropical rainforests. These ecosystems host a wide range of flora and fauna, including diverse fish species, and sustain the livelihoods of millions through ecosystem services such as food security and raw material provision. However, decades of oil and gas exploration have caused severe environmental degradation, characterised by frequent oil spills, gas flaring, and dredging, resulting in habitat fragmentation and chronic pollution. Over-extraction of other bioresources, including timber, fuelwood, and non-timber forest products, is also impacting the ecosystem. Additionally, the spread of invasive species like water hyacinth and Nipa palm, which are actively displacing native mangroves, further threatens the region's ecological integrity. Current conservation efforts are often undermined by weak regulatory enforcement, lack of stakeholder coordination, and a failure to integrate local community interests. This paper proposes an integrated management framework that reconciles biodiversity exploitation with ecological preservation through strategic policy formulation and multi-stakeholder engagement models. By identifying priority conservation strategies, such as designating protected areas and restoring habitats, the study provides a roadmap for sustainably exploiting the Niger Delta's bioresources while ensuring their long-term protection for future generations.

Key words: Bioresources, Niger Delta

INTRODUCTION

The Niger Delta, located at the southern tip of Nigeria, is one of the world's largest wetland ecosystems and is recognised as a critical global biodiversity hotspot (Ewim *et al.*, 2023; Angaye & Lelei, 2025). This vast region encompasses various ecological zones, including mangroves, freshwater swamps, and tropical rainforests, which collectively host a remarkable array of flora and fauna (Ewim *et al.*, 2023). Notably, the Delta's aquatic ecosystems contain over 200 fish species, representing the highest concentration of fish biodiversity in any coastal ecosystem in West Africa (Chidumeje *et al.,* 2015). Nwosu (2010) documented that 339 plant species belonging to 88 families have been identified in the forests and homestead gardens of the Niger Delta. These bioresources serve as the bedrock of the local economy, providing essential ecosystem services such as food security, medicinal resources, and raw materials including timber, fuel, and fibre. These bioresources support millions of people who depend on forestry, fishing and agriculture for their survival (Adekola & Mitchell, 2011; Ewim *et al.*, 2023). These resources sustained the region for centuries before petroleum was discovered in the 1950s; its exploitation has changed the region's economy and impacted its ecosystem.

Despite its immense ecological and socio-economic value, the Niger Delta has been subjected to intensive resource exploitation, primarily driven by the oil and gas industry since the mid-20th century (Adekola & Mitchell, 2011; Angaye & Lelei, 2025). The environmental consequences of these activities have been profound. Dredging operations widen and deepen waterways to permit marine navigation. This drastically alters natural hydrology, increases coastal and riverbank erosion, and destroys delicate spawning grounds for aquatic species (Ohimain *et al.*, 2003). Decades of frequent oil spills, continuous gas flaring, and extensive dredging have resulted in chronic soil and water pollution, decimating local fish populations and degrading agricultural land (Raimi, 2020;

Ugochukwu & Ertel, 2012; Ohimain, 2022). Furthermore, the ecological balance is being further destabilised by the proliferation of invasive species, particularly nipa palm (*Nypa Fruticans*) and water hyacinth (*Eichhornia crassipes*). For instance, Nipa palm is aggressively displacing native mangrove forests, which are vital for coastal protection and carbon sequestration (Nwobi *et al*., 2020; Ogbeibu & Oribhabor, 2023), while water hyacinths are clogging the waterways and causing rapid siltation (Aghoghovwia & Obomunu, 2022; Onyari *et al*., 2024). Unsustainable exploitation of natural resources is also exacerbating natural disasters such as flooding, which affects biodiversity, including wildlife and vegetation and threatens human survival (Ohimain *et al*., 2014a, 2014b).

The management of these bioresources is currently at a crossroads. While the region is central to Nigeria's national economy, the regulatory framework governing environmental protection remains largely ineffective (Onu, 2003). Issues such as weak policy implementation, inadequate monitoring, and a lack of transparency in the regulatory process have allowed environmental degradation to persist with minimal accountability (Moffat &Lindén, 1995; Ugochukwu & Ertel, 2012). Furthermore, the unsustainable exploitation of bioresources is mounting pressure on the ecosystem (Ohimain *et al*., 2014a). There is an urgent need to shift from a focus on short-term resource extraction to a model of sustainable development that prioritises biodiversity conservation and the well-being of local communities (Moffat & Lindén, 1995; Angaye & Lelei, 2025). This study aims to provide a comprehensive review of the Niger Delta's bioresources and propose a sustainable management framework.

NIGER DELTA BIORESOURCES

The Niger Delta is a critical biological hub for Nigeria, characterised by a vast network of wetlands that host a significant percentage of the nation's species. These bioresources provide essential ecological functions and are the primary source of survival for the region's rural populations. Its environment encompasses four distinct ecological zones (UNDP, 2016): coastal barrier islands, mangrove swamp forests, freshwater swamps, and lowland rainforests, forming a well-endowed ecosystem that contains one of the Earth's highest concentrations of biodiversity.

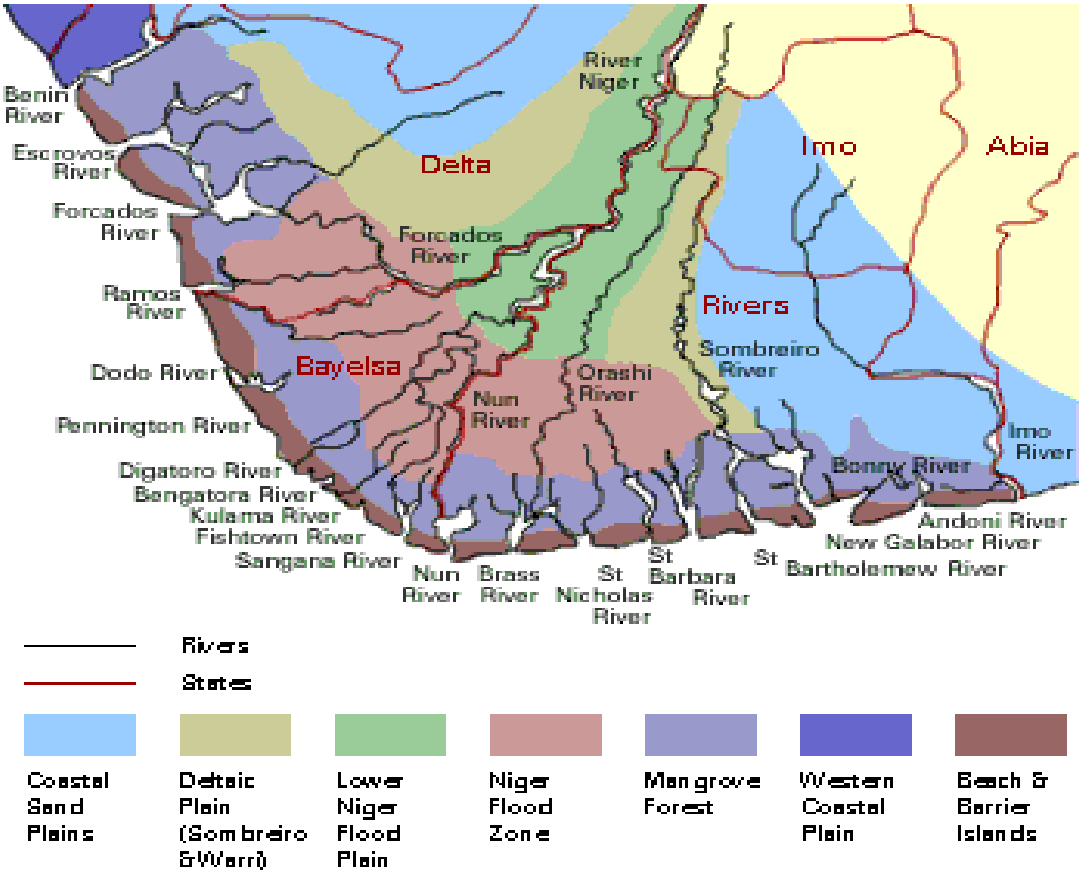


Figure 1: Ecological zones of the Niger Delta (Source: UNDP, 2016)

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Table 1: Selected floral resources of the Niger Delta

Bioresource	Species	Documented Uses	Reference
Mangrove Zone Species	*Rhizophora racemosa, R. mangle, R. harizonii, Avicennia germinans, Laguncularia racemosa, Conocarpus erectus*	Construction poles, furniture and firewood; bark ash used for salt extraction; fish smoking, construction of fishing gear, leaf extracts used as mosquito larvicides against Anopheles gambiae, antimicrobial activity used for traditional medicine; stabilising coastal mudflats	*Numbere 2018; Angaye et al. 2014, Baba et al. 2013; Ohimain et al., 2026*
Freshwater Swamp Forest Species	*Elaeis guineensis, Raphia hookeri, Cocos nucifera, Mitragyna ciliate, Hevea brasiliensis, Irvingia gabonensis, Dacryodes edulis*	Fruits, oils, biofuel, fuelwood, timber and construction materials, traditional medicine, craft making	*Ubom, 2010; Igu and Marchant, 2018; Diyaolu et al. 2022*
Lowland Rainforest Species	*Khaya grandifoliola, Lophira alata, Ocimum gratissimum, Musangacecropioides*	Timber, construction materials, furniture, traditional medicine, wild fruits	*Diyaolu et al. 2022; Ubom 2010*
Aquatic plants	*Pistia stratiotes, Alternanthera nodiflora, Polygonum senegalense*	Traditional medicine, animal fodder, compost, phytoremediation of pollutants	*Ita 1994*

The Niger Delta is home to a complex mosaic of habitats, including Africa's largest mangrove forest and the third largest in the world (Sakib, 2021). These habitats are vital to Nigeria's overall biodiversity, as the Niger Delta is estimated to hold between 60% and 80% of the country's endemic plant and animal species (Sakib, 2021). The region's ecosystems, ranging from saline mangroves to permanent freshwater swamp forests, support a portion of the national wildlife diversity, including approximately 7,895 plant species and over 22,000 vertebrate and invertebrate species (Izah, 2018). Notable fauna in these sensitive ecosystems include the mona monkey, speckle-throated otter, and various species of barracuda and catfish (Sakib, 2021). The Niger Delta is endowed with diverse bioresources of economic and environmental importance, including plant species (Table 1), animal species (Table 2), microbes (Table 3), and waste biomass when utilised (Table 4). Plant species in the Niger Delta have been used for various social and economic purposes, including timber for building construction and furniture, wild fruits and food substances, fuelwood, traditional medicine, cultural uses, and totems. Fauna has similarly been used for food, construction materials, totems, and pets. In addition, the region is blessed with fertile soil and a good agricultural climate, which has been widely exploited for crop farming and aquaculture. Exploitation of biodiversity resources also generates various waste streams, which are often untreated and dumped. Thus, polluting the environment. Oil exploration has also resulted in spills that pollute the environment. Fortunately, diverse species of microbiota have been shown to degrade wastes, including oil spills.

The Niger Delta has great economic potential. The region's bioresources are central to the Nigerian economy, supporting both industrial sectors and local subsistence livelihoods. Some of the resources of the Nigeria Delta beyond petroleum that have been tapped include fisheries, agriculture and forestry. Economic sectors that exploit the Niger Delta bioresources include tourism, bioenergy, traditional medicine, timber and other building/construction materials. Fisheries and aquaculture are key economic activities in the region. The Niger Delta's coastal zones are highly productive, with more than 70% of the fish stocks targeted by industrial fisheries being caught in these waters (Chidumeje *et al.*, 2015). Artisanal fisherfolk rely heavily on these resources, particularly small pelagic species, which constitute over 50% of the total fish catch (Chidumeje *et al.*, 2015). Mangroves of the Niger Delta are breeding and spawning grounds for fishes of the South Atlantic Ocean (Yetunde, 2017; Ogbeibu & Oribhabor, 2023). Agriculture and Forestry are other

important economic activities in the Niger Delta. The fertile soil and climate support a variety of cash crops, including palm oil, rubber, and cocoa (Ewim *et al.*, 2023). Additionally, the wetlands provide essential timber and non-timber products such as saw logs, bamboo, raffia, and medicinal species (Nwankwoala & Okujagu, 2021). The partial microbial degradation of biomass in sedimentary basins is linked to the formation of petroleum hydrocarbons ab initio (Head et al., 2003). Hydrocarbon extraction remains the dominant economic driver, with crude oil production from the region accounting for over 90% of Nigeria's total export earnings (Udotong *et al.*, 2017). Ecosystem Services are key to survival in any environment. Beyond direct production, the Niger Delta ecosystem and associated biota provide regulatory services including flood control, water purification, and carbon sequestration, all of which are vital for regional environmental stability (Ewim *et al.*, 2023).

Table 2: Selected Fauna Resources of the Niger Delta

Bioresource	Scientific Name	Documented Uses	Reference
Mammals	*Piliocolobus epieni, Cercopithecus sclateri, Cercopithecus erythrogaster, Pan troglodytes ellioti, Loxodontas cyclotis, Hippopotamus amphibius, Civettictis civetta, Trichechus senegalensis, Smutsia gigantea, Syncerus caffer nanus, Philantomba maxwellii*	Conservation importance, bushmeat, seed disperser and forest regeneration agent; ecotourism value; cultural totem species, pets, traditional medicine, traditional festivals	*Akani et al. 2015; Luiselli et al. 2015*
Reptile	*Crocodylus niloticus, Osteolaemus tetraspis, Python sebae, Bitis gabonica, Varanus niloticus, Varanus niloticus, Pelusios niger, Pelomedusa subrufa, Mecistops cataphractus*	Skin used for luxury leather goods, totem, bushmeat; traditional medicine, conservation importance, craft	*Akani & Luiselli 2001; Akani et al. 2015*
Birds (Avian Fauna)	*Psittacus erithacus, Ardea alba, Lophoceros semifasciatus, Haliaeetus vocifer, Megaceryle maxima, Bubulcus ibis, Actophilornis africanus*	Conservation importance, pet, cultural importance, seed disperser, traditional medicine, ecotourism and birdwatching, bushmeat	*Adeola 1992*
Fish (Ichthyofauna)	*Chrysichthysnigrodigitatus, Clariasgariepinus, Ethmalosafimbriata, Heterotisniloticus, Tilapia guineensis,Mugilcephalus, Lutjanusendecacanthus,Pseudotolithustypus*	Source of protein, ecotourism, creates employment	*Nwosu et al. 2021;*
Invertebrates (Aquatic and Terrestrial)	*Crassostrea gasar, Tympanotonus fuscatus, Callinectes pallidus, Penaeus notialis, Archachatina marginata*	Protein source, construction material, calcium supplements, decorative material, traditional medicine, cultural use, creates employment.	*Egonmwan2007, 2008; Nwosu et al. 2021*
Amphibians	*Hoplobatrachus occipitalis, Hyperolius sp., Amietophrynus regularis*	Bushmeat, traditional medicine, ecological role as pest control, part of food web, pets	*Akani et al. 2004*

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Table 3: Microbial Resources of the Niger Delta

Microbial Resource	Species	Application
Hydrocarbon-degraders	Pseudochrobactrum sp., Bacillus albus, Pseudomonas aeruginosa, Alcaligenes faecalis, Alcaligenesammonioxydans, Cupriavidus malaysiensis, *Proteus vulgaris*, *Serratia*, *Micrococcus*, *Klebsiella*, *Corynebacterium*, *Rhodococcus*, *Alcanivorax*, *Arthrobacter*, Alcaligenesammonioxydans, *Aspergillus*, *Penicillium*, *Rhizopus*, *Mucor*, and *Candida*.	Bioremediation of oil spills, soil clean-up
Photosynthesizing microbes	*Beggiatoa*, *Chloronema*, *Chromatium*, *Thiopedia*, *Leucothiobacteria and* several species of microalgae	Useful for primary productivity, biofuel production
Biosurfactant producers	*Pseudomonas aeruginosa,* Alcaligenes ammoni oxydans and *Bacillus subtilis*	Oil dispersion, Microbial Enhanced Oil Recovery (MEOR), industrial detergents
Nitrogen-fixing and nitrifying bacteria	*Azospirillum, Azotobacter, Rhizobium, Clostridium, Nitrobacter* sp., *Nitrosomonas* sp., *Klebsiella pneumoniae*, *Enterobacter mori*, and *Roseomonas rhizosphaerae*.	Help in plant nutrition, and some species are also hydrocarbon degraders.
Methanogens	*Methanoccoides methylutens,*	Synthesis and degradation of methane. Climate change relevance
Phosphate-solubilizers	*Bacillus*, *Pseudomonas*, *Enterobacter*, *Xanthobacter*, *Kluyvera*, *Paenibacillus*, *Chryseomonas, Vibrio proteolyticus*	Support plant nutrition
Sulphate reducers	*Desulfo vibrio*, *Desulfo coccus*, *Desulfo tomaculum*, *Desulfo sarcina*	Anaerobic hydrocarbon degradation. Microbial corrosion. Heavy metal bioremediation

Table 4: Biomass waste as a resource

Waste Type	Source in Delta	Est. Quantity	Current Use	Potential
Cassava peels	Garri/fufu processors in Rivers, Delta, Bayelsa	5-8 million tons/yr	Dumped, burnt, feed	H_2, biogas, ethanol, animal feed. 60-70% carbs
Palm Oil Mill Effluent POME	500+ palm oil mills	2.5-3.5 million m^3/yr	Lagoons, river discharge	Biogas, H_2, fertilizer. High COD: 25,000-75,000 mg/L
Palm kernel shell	Palm oil mills	1.2 million tons/yr	Boiler fuel, dumped	Briquettes, concrete
Empty fruit bunches EFB	Palm oil mills	1.8 million tons/yr	Boiler fuel, dumped	Cellulose for ethanol, compost, gasification
Oil palm fronds/trunks	Plantations	6-8 million tons/yr	Left in field	Pellets, biogas, pyrolysis oil
Rice husk/straw	Delta, Bayelsa rice farms	300,000 tons/yr	Open burning	Silica, briquettes, syngas

Coconut husk/shell	Coastal areas	150,000 tons/yr	Charcoal, dumped	Activated carbon, briquettes
Plantain/banana peels	Markets, households	400,000 tons/yr	Dumped	Biogas, H_2, compost. High starch
Corn wastes	Markets, households	4.1 million tons/yr for Nigeria	Dumped	Biogas, H_2, compost. High starch
Municipal solid wastes	Households	1.8-2.2 million tons/yr	Dumped	Highest H_2 yield: 150-260 mL H_2/g VS; biogas, compost
Sewage/Greywater	Households	20 - 120Liters/person/day	Dumped	Biogas, H_2, nutrient recovery
Abattoir waste	Slaughterhouses	50,000 tons/yr	Dumped	Biogas – high N, fats

EXPLOITATION CHALLENGES

The exploitation of the region's natural resources, including fisheries, timber, non-timber forest products and hydrocarbon resources, has created a legacy of environmental and socio-economic challenges. In addition, poorly managed waste, including municipal solid waste, agricultural processing waste, and oil and gas exploration waste, has exacerbated the region's environmental challenges. While the region is a high conservation priority, it remains virtually unprotected, allowing industrial activities to severely disrupt its ecological integrity (Anejionu *et al*., 2014; Angaye & Lelei, 2025).

Unsustainable biodiversity extraction in the Niger Delta involves both industrial-scale resource exploitation and local artisanal over-extraction. Non-hydrocarbon exploration practices that have profound effects on biodiversity include waste dumping on land and rivers, dredging and sand mining, agricultural expansion into virgin forests, overfishing and fishing with chemicals, aquaculture, fuelwood harvesting and picking of non-timber forest products including wild fruits such as palms, mango and bush mango, wine tapping, bushmeat hunting, and wildlife hunting such as snails, tortoises and turtles (Ohimain *et al.,* 2014a, 2014b; Ohimain, 2022). The most destructive practices include oil spills, gas flaring, destructive artisanal refining, overharvesting of mangrove timber, and unregulated overfishing (Angaye & Lelei, 2025).

Resource exploitation by indigenous people in the Niger Delta that profoundly affects biodiversity includes illegal oil bunkering and artisanal refining, destructive fishing methods, wood logging and fuelwood gathering, solid waste dumping, and bushmeat hunting (Angaye & Lelei, 2025; Onuoha & Uzodianya, 2026). Destructive fishing methods are a major source of fisheries impacts caused by local fisherfolk. Unregulated fishing pressures and the use of illegal gear such as fine-meshed nets, chemical poisons, and explosives can deplete fish stocks and kill non-target aquatic species indiscriminately (Angaye & Lelei, 2025). Local communities aggressively clear mangrove and freshwater forests for urban settlement and cut them down for fuelwood. This strips the region of its primary natural barrier against erosion and destroys the nursery ecosystems for countless species (Angaye & Lelei, 2025). Commercial bushmeat hunting is causing biodiversity impacts. The unregulated hunting of wildlife (especially primates and other mammals) for the bushmeat trade is a major threat to terrestrial biodiversity (Ohimain, 2022). Illegal bunkering and small-scale crude oil refining in swamps and forested areas generate high-temperature fires and release heavy, toxic crude oil residues directly into water bodies and onto adjacent vegetation (Angaye & Lelei, 2025).

Sand mining and wetland reclamation are also mounting pressure on the biodiversity of the Niger Delta. Sand extraction for civil construction purposes is quite common. Draining and filling wetlands for agricultural expansion and urban real estate completely erase highly localised and sensitive

freshwater and saltwater ecosystems (Onuoha & Uzodianya, 2026). Using municipal waste to reclaim wetlands worsens biodiversity impacts and provides a route for introducing plastics into aquatic systems. Invasive species, particularly nipa palm and water hyacinth, are most problematic in the Niger Delta. The introduction and unchecked spread of nipa palm are fast displacing indigenous mangrove vegetation (Nwobi *et al.*, 2020), while water hyacinth is clogging the waterways and causing rapid siltation (Aghoghovwia & Obomunu, 2022; Onyari *et al.*, 2024).

ENVIRONMENTAL DEGRADATION ASSOCIATED WITH OIL EXPLORATION

The most immediate threat to the Niger Delta's bioresources is the chronic discharge of crude oil and the impact of gas flaring. Decades of leakages, equipment failures, and pipeline vandalism have released millions of barrels of crude oil. Oil spills coat mangroves and swamps, decimating flora, destroying fish habitats, and introducing heavy metals into the soil and food chain (Onuoha&Uzodianya, 2026). For instance, in 2004, over 74,900 barrels were lost to the environment, while in 2006, approximately 428,196 barrels were lost (Ude *et al.*, 2023). More recent records highlight the ongoing nature of this crisis. For instance, Jonathan *et al.* (2025) reported over 21,914 barrels of crude oil spilt from 2012 to 2022, with only about 38% recovered. Illegal crude oil bunkering and artisanal refineries have exacerbated oil spills in the region, many of which go unreported (Chris & Oghenetekevwe, 2023; Richard *et al.*, 2022).

These spills have profound consequences for the ecosystem and biodiversity. Habitat and Biodiversity Loss: Oil spills and gas flaring are major drivers of biodiversity loss because they place numerous species of flora and fauna at heightened risk of extinction (Angaye & Lelei, 2025). Hydrocarbon contamination in the Bomu area, for instance, resulted in fires that devastated creeks and mangrove forests, leaving vast agricultural lands barren for decades (Ewim *et al.,* 2023).023).

- Water and Soil Pollution: The "wide consequences" of extraction include degraded soil and water supplies, which directly affect human health and the survival of aquatic and terrestrial life (Angaye & Lelei, 2025).
- Agricultural Impact: Gas flaring and pollution have been linked to significant negative effects on crop farming, further threatening local communities' food security (Ude *et al.,* 2023).

The ecological integrity of the Niger Delta is currently under severe threat, primarily due to the "wide consequences of oil extraction", which include habitat deterioration and chronic pollution (Angaye & Lelei, 2025). Major ecological zones, specifically the lowland rainforests and barrier island forests, are reportedly heavily impacted (Sakib, 2021). This degradation has led to a noticeable decline in wildlife populations; several species once common to the region, such as the elephant, chimpanzee, and yellow-backed duiker, are now considered endangered or are facing extinction, with some species no longer being sighted in their traditional habitats (Izah *et al.*, 2018). Oil spills and gas flaring have further compromised the environment by degrading soil and water supplies, which directly impacts the health of both local communities and the surrounding flora and fauna (Angaye & Lelei, 225).025).

CONCERNS OVER UNSUSTAINABLE EXTRACTION PRACTICES

Environmental degradation and unsustainable extraction practices pose risks to both the ecosystem and dependent human populations (Adekola & Mitchell, 2011; Ugochukwu & Ertel, 2012). Unsustainable extraction of natural resources is putting pressure on and altering the Niger Delta ecosystem. It may be contributing to more frequent natural disasters, such as flooding (Ohimain *et al.*, 2014b). The challenges of exploitation are compounded by practices that prioritise resource extraction over environmental sustainability. Concerns include: Underreporting and Regulatory Gaps: A critical issue is the lack of transparency in environmental monitoring; many oil spills are not officially reported (Chidumeje *et al.*, 2015). Non-petroleum impacts are seldom reported, limiting regulatory oversight and allowing harm to continue.

- Industrial Discharge and Agricultural Impacts: Beyond oil spills, industrial wastewater discharge and agricultural runoff contribute to pollution across the Niger Delta's diverse habitats, including freshwater swamps and tropical rainforests (Ewim *et al.*, 2023).
- Disruption of Livelihoods: Habitat deterioration and water pollution disrupt traditional livelihoods, such as fishing and farming, which are primary survival mechanisms for the local population (Angaye & Lelei, 2025).

Addressing these challenges requires a shift toward eco-friendly exploration technologies and the rigorous application of environmental standards to secure the well-being of future generations (Angaye & Lelei, 2025).

INTEGRATED MANAGEMENT FRAMEWORK

The survival of the Niger Delta's ecosystems requires a transition from fragmented, reactive management to an Integrated Management Framework (IMF) that harmonises economic goals with ecological preservation. Current systems often fail due to a lack of coordination and the prioritisation of short-term industrial gains over long-term environmental health (Moffat & Lindén, 1995; Ugochukwu & Ertel, 2012). An effective IMF serves as a roadmap for reconciling the intensive resource extraction typical of the region with the "urgent need for biodiversity conservation" (Angaye & Lelei, 2025). An iAn integrated management framework that aligns strategic policy formulation with effective stakeholder engagement models involving government, industry, and local communities (Onu, 2003; Raimi, 2020) is urgent to preserve Niger Delta biodiversity. Also, identifying and recommending specific conservation strategies, such as designating new protected areas and implementing large-scale habitat restoration initiatives, is required to mitigate the impacts of industrial activity and invasive species (Angaye & Lelei, 2025; Ogbeibu & Oribhabor, 2023). An integrated management framework for Niger Delta bioresources could involve policy formulation, stakeholder engagement, conservation strategies, protected area designation, and habitat restoration.

Strategic policy formulation is vital for sustainable resource extraction in the Niger Delta. An integrated framework rests on robust, transparent policy formulation. Currently, the Nigerian regulatory process suffers from performance gaps that hinder environmental protection (Onu, 2003). Strategic policies must move beyond symbolic regulation toward "result-oriented action plans" (Ogbeibu & Oribhabor, 2023). Key policy requirements include:

- Strengthening Regulatory Independence: Enhancing the autonomy and monitoring capabilities of environmental agencies to ensure they can hold oil and gas operators accountable for "chronic oil spills" and other violations (Onu, 2003; Ugochukwu & Ertel, 2012).
- Enforcement of Environmental Standards: Rigorous application of existing laws, such as those governing the impacts of dredging on marine biodiversity, which have historically been poorly managed (Raimi, 2020).
- Integrating Sustainable Development Goals: Ensuring that national economic policies for the Niger Delta prioritise the long-term viability of its bioresources alongside hydrocarbon production (Angaye & Lelei, 2025; Moffat & Lindén, 1995).
- Regulatory oversight for artisanal resource extraction is required: Most legal frameworks focus on multinationals and other industrial activities, neglecting the numerous activities of local people.

Stakeholder engagement is key for an integrated resource extraction strategy. Successful management is impossible without the active participation of all parties involved in the Niger Delta's landscape. A multi-stakeholder engagement model is necessary to bridge the gap between industry, government, and the people most affected by degradation (Onu, 2003; Raimi, 2020). Models for improved stakeholder involvement include;

- Community-Based Management: Empowering local communities by involving them in the decision-making process. This fosters a sense of ownership and utilises indigenous knowledge for more effective biodiversity management (Angaye & Lelei, 2025; Ugochukwu & Ertel, 2012). The Akassa Sea Turtle Conservation Group and Bonny Environmental Committee are good examples.
- Corporate Accountability: Developing models that require oil companies to engage in transparent dialogue and collaborative restoration projects with host communities, moving beyond simple compensation to active partnership (Moffat & Lindén, 1995; Onu, 2003). The

Hydrocarbon Restoration Project (HYPREP) is carrying out environmental and mangrove restoration in Ogoni land.

- Conflict Resolution: Implementing frameworks that address the social tensions arising from environmental damage, thereby creating a stable environment where conservation strategies can be successfully applied (Onu, 2003).

By aligning these strategic and collaborative elements, the Niger Delta can move toward a development model that preserves its status as a global biodiversity hotspot while maintaining its economic contributions (Angaye & Lelei, 2025; Moffat & Lindén, 1995).

CONSERVATION STRATEGIES AND HABITAT RESTORATION

Conservation Strategies are key to the ecosystem's survival. Given the "urgent need for biodiversity conservation" in the Niger Delta, implementing robust conservation strategies is critical to halting the rapid loss of species and habitat (Angaye & Lelei, 2025). Despite its global significance, the region remains virtually unprotected, necessitating a shift toward proactive environmental management (Anejionu *et al*., 2014).

Declaration of protected area status for the Niger Delta is key to its preservation. One of the most pressing challenges in the Niger Delta is that high-priority biodiversity areas currently lack formal protection from industrial and other anthropogenic encroachment (Anejionu *et al*., 2014; Angaye & Lelei, 2025). For instance, several forest reserves in the region have been encroached upon (Ohimain, 2022). Establishing a network of protected areas is essential for safeguarding the Delta's unique bioresources.

- Targeting Sensitive Ecosystems: Conservation efforts must prioritise designating legally protected zones in sensitive habitats, such as lowland rainforests and barrier island forests, which are currently declining due to exploitation (Sakib, 2021; Ugochukwu & Ertel, 2012).
- Mangrove Preservation: As the region hosts the largest mangrove forest in Africa, specific "result-oriented action plans" are required to protect these coastal buffers from further fragmentation caused by oil infrastructure and dredging (Ohimain, 2004; Ohimain *et al*., 2005; Ogbeibu & Oribhabor, 2023; Raimi, 2020).
- Representative Conservation: Protected areas should be selected based on biodiversity patterns to ensure they cover the habitats of the region's 200+ fish species and endangered wildlife, such as the Mona monkey and various endemic plants (Chidumeje *et al*., 2015; Sakib, 2021).

Habitat restoration initiatives are important in the integrated management of Niger Delta bioresources. Restoration is a vital secondary strategy to recover ecosystems degraded by decades of oil spills, industrial effluents, and other anthropogenic activities (Angaye & Lelei, 2025).

- Remediation of Contaminated Sites: Active restoration is needed for oil spill-impacted areas such as the Bomu region, where hydrocarbon contamination has left vast tracts of mangrove forests and agricultural land barren for years (Ewim *et al*., 2023). Restoration must involve removing pollutants and replanting native vegetation to restore soil and water health (Angaye & Lelei, 2025).
- Invasive Species Management: A critical component of restoration is removing invasive species. For instance, the Nipa palm is aggressively replacing native mangroves; restoration projects must focus on eradicating nipa palm and re-establishing native mangrove species to maintain coastal integrity (Ogbeibu & Oribhabor, 2023).
- Community-Led Restoration: Incorporating local communities into restoration projects ensures long-term success. By involving residents in habitat recovery, conservation strategies can simultaneously provide alternative livelihoods and leverage indigenous knowledge to improve ecosystem resilience (Moffat & Lindén, 1995; Ugochukwu & Ertel, 2012).

By combining formal protected status with active ecological restoration, the Niger Delta can begin to mitigate the long-term impacts of resource extraction and secure its bioresources for future generations.

CONCLUSION

The Niger Delta stands as one of the world's most significant ecological treasures, characterised by a complex network of mangroves, freshwater swamps, and rainforests that support a vast array of biodiversity, including over 200 species of fish. However, this study underscores that the region's bioresources are currently in crisis. Decades of intensive resource extraction, including fisheries, timber and fuelwood, non-forest products and petroleum exploration, have impacted the bioresources of the region. Hydrocarbon exploitation has released millions of barrels of oil into the environment, resulting in "wide consequences," including the death of lowland, mangrove, and barrier island forests and the severe contamination of soil and water supplies. The proliferation of invasive species like the Nipa palm further complicates this ecological degradation, actively displacing native vegetation and disrupting the balance of these sensitive habitats.

The analysis highlights that the primary barrier to sustainable development is not a lack of resources, but a failure of management and regulation. Current efforts are hampered by weak policy implementation, inadequate monitoring, and a historical prioritisation of industrial output over environmental integrity. To reverse this trend, the proposed Integrated Management Framework provides a necessary shift toward strategic policy formulation and multi-stakeholder engagement. By bringing together government, industry, and local communities, the IMF aims to bridge the gap between economic exploitation and ecological preservation.

Ultimately, the future of the Niger Delta depends on the immediate adoption of "result-oriented action plans". These must include formally designating protected areas in high-priority zones and undertaking large-scale habitat restoration projects to remediate contaminated sites. Implementing these conservation strategies is not merely an ecological necessity but a socio-economic imperative to secure the livelihoods and food security of the millions who depend on the Delta's bioresources. Through coordinated action and a commitment to environmental accountability, it is possible to transform the Niger Delta into a model of sustainable development that protects its unique biodiversity for future generations.

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