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The Impacts of Resource Exploitation in the Niger Delta: Highlighting the Urgent Need for Biodiversity Conservation

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ABSTRACT

One of the biggest wetland ecosystems in the world, the Niger Delta in Nigeria, boasts of great biodiversity but has been badly disrupted by human activities, especially oil exploration and exploitation. The wide consequences of oil extraction on the ecological integrity of the area are investigated in this review; together with habitat deterioration, pollution, and disturbance of local livelihoods. Oil spills, gas flaring, and deforestation significantly contribute to biodiversity loss, placing diverse species of flora and fauna at heightened risks of extinction. Moreover, degradation of soil and water supplies and quality seriously influence human health, as well as, plants and animals. This review emphasizes the importance of effective conservation strategies to reduce these consequences and propel local sustainable development; giving of support to local communities' active participation in conservation programs, the use of eco-friendly oil exploration strategies and technologies, and the application of environmental standards. Highlighted in this review are the needs for creating protected areas, improving environmental education, and promoting partnerships between governments, environmental groups, the locals and the key players in the oil sector. Addressing the environmental problems in the Niger Delta will help secure the well-being of future generations and safeguard its rich biodiversity.

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1. Introduction

The Niger Delta is known as one of the most diverse ecosystems globally, it includes freshwater marshes, mangrove swamps, and rivers (Izah, 2018). This region has four main ecological zones—coastal barrier islands, mangrove forests, freshwater swamps, and lowland rainforests (Ogbeibu & Oribhabor, 2023). The Niger Delta area with many water resources provides habitats to about two hundred fish species and vast biodiversity (Okonkwo et al., 2015). However, human actions, mainly oil drilling and extraction, greatly threaten the biodiversity (Aransiola et al., 2024). The complex ecosystems of the mangrove forests, freshwater swamps, and lowland rainforests are affected by the impacts of oil spills, gas flaring, felling of trees and pollution, leading to habitat loss and fewer species (Ndinwa and Akpafun 2012).

Oil exploration has inflicted extensive environmental damage in the Niger Delta area of Nigeria. The area has suffered multiple oil spills over a 50-year span; estimates of total spills range from 9 to 13million barrels, averaging roughly 1.5million tonnes yearly (Jernelöv, 2010). Spills have harmed mangroves, polluted water, and killed fish, which affect local livelihoods (Onyena and Sam 2020). Gas flaring, common in oil extraction, also worsens air pollution and contributes to climate change besides the impacts of the oil spills. With estimates of 3.5billion cubic feet, Nigeria leads the globe in flaring of natural gas related with oil extraction (Anosike, 2010). This aggravates global warming and reduces regional air quality through the release of large volumes of methane and other dangerous gases into the atmosphere (Ismail & Umukoro, 2012).

Exacerbated by oil related developments and other human activities, deforestation compromises the biodiversity of the area even more (Enaruvbe & Atafo, 2014). The rapid decline of the mangroves and natural forests in the Niger Delta may lead to reduced biodiversity and a loss of ecosystem services. These human activities together have caused notable impacts on and loss of biodiversity in the Niger Delta. Habitat fragmentation and environmental contamination have caused the decline and loss of several endemic species (Izah, 2018; Ansah et al., 2022). Depending on these resources, these losses undermine the ecological equilibrium, as well as, the cultural and economic well-being of the locals that depend on these resources and the ecological services provided. This review underlines the significance of preserving biodiversity, as well as, the need for efficient conservation strategies to reduce these effects, support local sustainable development, and includes ecologically sustainable oil exploration approaches in the Niger Delta area.

2. Oil Exploration and Extraction

Oil related activities – exploration, extraction and exploitation result in oil pollution that presents a significant form of oceanic contamination, causing substantial damage to amenities, ecosystems, resources (Freedman 1995) and services. The combustion of unwanted gases in order to lower the methane concentration (Elehinafe *et al*., 2022) during oil exploration, which comes with severe adverse effects also pose health hazards in the Niger Delta (Giwa *et al*., 2016). Given that, spilt oil influences aquatic biodiversity and hence, poses a significant threat to aquatic ecosystems such as, coastal areas, the effects of oil spills are especially worrying (Asif *et al*., 2020). Oil spills seriously affect the biodiversity in water bodies, especially estuaries which are intricate and sensitive, thus, the negative consequences on the aquatic organisms are great (Ekpo *et al*. 2018). Furthermore, upsetting aquatic ecosystems, oil pollution not only compromises the livelihoods of fishermen but also causes less availability of seafood (Bello and Amadi, 2019), hence, food security.

Oil exploration and extraction activities contribute to environmental degradation, with corrosion and acidic precipitation being notable concerns in the oil and gas sector (Nduka *et al*., 2016). The delicate balance of ecosystems has been seriously upset by oil pollution in the area, therefore, threatening the wildlife and biodiversity (Adus & Woforodo, 2024). The mangrove ecosystems are constantly in danger from the continuous operations linked to oil and gas exploration, production, processing, conveyance, and marketing (Ohimain, 2003.). Essential coastal habitats, mangroves that serve as natural constraints against floods and erosion, thereby, providing important protective services (Onyena & Sam, 2020) get altered by these oil related activities.

3. Deforestation and Land Degradation

The Niger Delta area, home to a varied array of ecosystems supporting many terrestrial and aquatic species prior to the discovery of crude oil was ranked as Africa's largest wetland and the third-largest worldwide (Anifowose, 2008). Oil exploration and land use have led to habitat loss, fragmentation of forests, and deforestation, as well as, elimination of endangered, threatened and endemic species which includes mammals- primates in particular (Agbagwa & Ndukwu, 2014) eaten as bush meat- seen as delicacies. Illegal logging (Akpomremre *et al*., 2024) is on the increase and a driving force for notable destruction in Nigeria's Niger Delta region. Heavy metals exist in varying concentrations all around, from soil to biota to water to air. Heavy metals, especially cadmium, which are in crude oil are harmful and destructive to human health (Bouida *et al*., 2022). Oil contamination impacts land, resulting in degradation (increasing soil compaction, affects water and nutrient availability and quality) which directly influences the growth and development of plants (da Silva Correa *et al*., 2022), and dependent animals. Heavy metals, when introduced into farmlands, have the potential to accumulate (bioconcentrate) at alarming

concentrations in the soil, which in turn impairs the quantity and quality of crop and vegetation production that can be achieved (Bishnu Angon *et al*., 2024).

4. Pollution of Water Bodies

Direct flow of oil into rivers and creeks has negative effects on aquatic vegetation, fish populations, and other species that depend on clean water (da Silva Correa *et al*., 2022). Fish, fish spawning grounds and nurseries in coastal areas are imperiled by oil contamination, which also adversely affects vital organs of aquatic mammals, reptiles, and amphibians (Ekpo *et al*., 2018), and smother exposed organisms. Persistent pollutants, such as, heavy metals can subsequently get into and biomagnify along the food chain through marine organisms, particularly fish (Briffa *et al*., 2020). The industrial release of effluents cause water bodies to become oversaturated with nutrients (eutrophication), resulting in algal bloom- some species of which are harmful (harmful alga bloom- HAB) that deplete oxygen levels (Tiwari & Pal, 2022) and at their death (due to short life span) result in build-up of silt.

5. Wastes Disposal

Studies on toxicity have demonstrated that, while the majority of refinery effluents, wastes and discharges exhibit toxic properties, the degrees of toxicity vary. The susceptibility and responses to these toxins differs among species, and in certain instances, toxicity may not be apparent (Wake, 2005). The marine environment is affected by these chemicals through multiple mechanisms and pathways, including direct physical harm to wildlife and their habitats, as well as, the deleterious effects of oil on exposed organisms (Nitonye & Uyi, 2018). Considered a major environmental disaster, oil spills originating from drilling and mining operations release a mixture of hydrocarbons and other toxic compounds that negatively impact humans, animals, plants, and other living entities in the ecosystem. Oxides of carbon, nitrogen and sulphur, as well as, particulate matter (PM) from gas flaring result in the contamination air, soil and water; therefore, causing harm to local flora and animals (Seiyaboh & Izah, 2017).

6. Coastal Erosion and Sedimentation

Along coastlines, the building of oil ports and refineries cause permanent changes to the coastal architecture and the degradation of important nearshore ecosystems like estuaries and mangroves (Andrews *et al*., 2021). Moreover, the location of seafloor construction (for offshore facilities) including pipes and anchors directly disturb the seabed and flora, and generates a transient localized disturbance (Cordes *et al*., 2016). Mangroves are extremely important in the Niger Delta environment since by means of their pneumatophores (aerial roots), sediments and other solid contaminants are gathered, thereby, enhancing water quality. Affecting over 1.94million hectares of mangrove habitat, almost 5.5million tonnes of oil have spilled and impacted 126,000 mangrove ecosystems (Sheppard, 2000).

7. Destruction of Wetlands

Wetlands are areas where water either completely covers the ground or stay close to the surface for different lengths of time throughout the year (Nwankwoala & Okujagu, 2012). Among their several important roles are those of nutrient recycling, water filtration, flood control, climate regulation and restoration of groundwater supplies (Kumar and Amita, 2014), while also serving as breeding grounds and habitats for diverse, sensitive aquatic organisms. These ecosystems are not exempted from spill incidences. Severe effects of oil spills on wetland vegetation could possibly lower the rate of photosynthesis, plant growth, population density, above-ground biomass, and development rates (Onyena & Sam, 2020), besides the death of exposed organisms. Unchecked oil spills have caused great environmental degradation in the Niger Delta area, therefore compromising its biodiversity (Nana, 2023).

8. Overfishing and Habitat Disruption

Particularly affecting fish populations, research findings have shown that, oil production drastically influences ecosystems and agricultural livelihoods (Andrews *et al*., 2021). The concentrations of light-weight aromatic components of the crude oil and the exposure time of these components in the environment define the degree of toxicity of the oil (Osuagwu & Olaifa, 2018). Crude oil spills have been shown to pollute important fish supplies and harm fisheries in coastal seas (Osuagwu and Olaifa, 2018). Either directly by the destruction or burial of coral reefs or indirectly by causing lethal or sub-lethal stress to corals due to increasing turbidity and sedimentation; dredging activities have helped to degrade ecosystems associated with coral reefs (Erftemeijer *et al*., 2012). When trawling and dredging disturb the seabed, fine mud particles are likely to be transported in suspension by near-bottom currents, leaving behind coarser sediments (Steele *et al*., 2002). This alteration affects the seafloor's physical topography, resulting in a decline in habitat quality for certain species, particularly juveniles (National Research Council, 2002) and sessile organisms.

9. Climate Change and Atmospheric Pollution

Globally, environmental problems such as, air pollution and climate change are very closely linked and seriously jeopardize ecosystems, the organisms and human health. Significant changes in geographic distribution of species, abundance, and the reorganizing of marine and terrestrial ecosystems/organisms are being brought

about by climate change (Weiskopf *et al*., 2020). The increase in greenhouse gas emissions, coupled with deforestation and intensified industrial activities are contributing to the Earth's temperature rise, thereby, exacerbating problems related to air quality and extreme weather events. Pollutants such as, black carbon, ozone and aerosol particles influence climate change patterns, modifying precipitation and temperature (Afifa et al., 2024). Acidic aerosols originating from gas flaring and refinery operations in the Niger Delta region present severe environmental and public health threats (Nduka *et al*., 2016); especially with the increase in illegal artisanal refining of crude oil. The deposition of acid can decrease the pH of surface, affect aquatic life and productivity with resultant reduction in aquatic biodiversity (Likens & Butler, 2025).

10. Invasive Species

The construction of oil-related infrastructures and the movement of equipment, tools and goods can unintentionally introduce non-native species into ecosystems, therefore, causing disturbance of local biological variety and possible rivalry with native species which may result in the elimination of indigenous species some of which may be endemic. Amongst the major dangers to ecosystems, human and animal welfare, and infrastructure are foreign species (U.S. Department of Interior, 2016). Species that are found outside their natural habitat due to anthropogenic activities are referred to as, alien invasive species (David, 2010). Furthermore, oil tankers and offshore drilling platforms can serve as vectors for the unintended transport of organisms, facilitating the introduction of non-native species (Andrews *et al*., 2021).

11. Human Encroachment and Population Growth

The expansion of the petroleum and industrial sectors and the required facilities frequently result in an influx of personnel and their families exerting pressure on local infrastructure, contributing to further alteration and degradation of woodlands, marshes, and other natural habitats. The continuous increase in human population is a significant factor in the global decline of wildlife (Masanja, 2014). Resulting in rising pollution levels, more wastes outputs, and environmental degradation resulting from the expansion of urban centers to accommodate the workers have further affected biodiversity. As human populations near protected areas keep growing, these difficulties are expected to become more pronounced (Wittemyer *et al*., 2008) and even worsen if not controlled.

12. Oil Refineries and Petrochemical Plants

Volatile organic chemicals (VOCs), suspended particulates matter (SPM), oxides of Carbon (COx), Nitrogen (NOx) and Sulphur (SOx) are among the variety of unpleasant substances that crude oil processing facilities spew into the sky and waterways. These emissions result air pollution that cause harm to the nearby flora and fauna. The operations related to small-scale petroleum refineries in the Niger Delta Region compounds this scenario even more in the area (Angaye *et al*., 2024). Particularly in the form of hazardous waste products released into the environment along with toxic emissions (Adebiyi, 2022). Over the past two decades, the number of deaths attributable to air pollution in all its forms have risen; today, more than 6million deaths globally are attributed to this factor (National Institute of Environmental Health, 2023).

13. Poaching and Illegal Hunting

Environmental damage can lead to economic difficulties, which motivates local people to illegally explore and exploit resources for food and money without recourse to the implications, therefore, reducing the biodiversity in the area. As a significant driver of the loss of biodiversity and a serious existential threat to many wild species worldwide, illegal hunting—also known as poaching, is third among the traditional livelihoods supporting the local economy in the rural Niger Delta area (Akani *et al*., 2015). According to Chavan *et al.* (2023), poaching activities pose a significant threat to the preservation of the world's biodiversity and have long-lasting consequences for the society, economy, and the environment. Continuous illegal hunting and wildlife trade if unchecked, portends great harm to biodiversity in the Niger Delta area and the survival of people in the area. Hence, the need for reduced levels of environmental pollution; development of modalities, advocacies and campaigns for the conservation of biodiversity in the area- through designation of protected areas, prohibition of wildlife trade, environmental education, etc. - which is the drive of some non-governmental agencies like Wild Africa Fund.

Conclusion

The biodiversity of the Niger Delta has been gravely threatened by several anthropogenic activities including oil exploration, industrialization, environmental degradation, and the habitat fragmentation. Also threatened are a varied array of species, including mammals (especially pangolins and primates), bird, reptiles, amphibians, as well as, the unique aquatic biota in both freshwater and marine habitats. The ongoing environmental and socio-economic consequences that result from these activities still cause negative effects on the ecosystems, as well as, the nearby populations depending on them.

Managing these issues by means of more efficient environmental management strategies, rigorous enforcement of rules and regulations, and adoption of sustainable practices will go a long way in mitigating the effects of these anthropogenic activities that result in the decline of biodiversity.

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