OIL PRODUCTION AND CLIMATE CHANGE IN THE NIGER-DELTA REGION: SYNERGIC IMPLICATION AND ADAPTATION

https://doi.org/10.47743/jopafl-2024-33-5

ARAUSI Roseline Eniwotu
Department of Political Science, Faculty of the Social Sciences,
Delta State University, Abraka
arausiroseline@gmail.com

CLARK Esekumuemu Victor
Department of Political Science, Faculty of the Social Sciences,
Delta State University, Abraka

IKENGA Francis A.
Department of Political Science, Faculty of the Social Sciences,
Delta State University, Abraka

Abstract: This study examines the interplay between oil production activities and climate change in the Niger Delta Region (NDR), highlighting the resulting environmental, socioeconomic, and infrastructural vulnerabilities. The NDR, rich in natural resources and central to Nigeria's petroleum and gas industry, paradoxically suffers from environmental degradation, biodiversity loss, and stagnated socioeconomic growth. Employing the vulnerability-resilience framework, rooted in socio-environmental studies, the research explores the intersection of oil production and climate change, emphasizing the disruption of ecological balance and the need for resilience-building. Oil production has intensified environmental degradation, exacerbated climate change, and posed challenges such as health risks, socioeconomic disruption, and reduced livelihoods. This synergistic relationship has deepened the region's vulnerability, especially in coastal oil-host communities. Efforts to adapt and mitigate these impacts have yielded limited success due to persistent vulnerability driven by national revenue priorities and the unchecked expansion of oil production. The study underscores the urgent need for innovative, community-centered adaptation strategies and a climate-induced migration framework tailored to the coastal oil-host communities. These approaches require collaboration among governments, oil industries, local communities, and international organizations. By addressing the specific vulnerabilities of the region, these measures can improve the resilience and quality of life for local communities, support sustainable development, and restore ecological balance.
Keywords: Vulnerability, Resilience and Adaptation.

Introduction

The Niger Delta Region (NDR) of Nigeria is one of the world's largest wetlands, rich in oil resources and biodiversity. It is the most ecologically diverse area in Nigeria, supporting aquatic and terrestrial ecosystems, mangrove forests, and serving as the economic hub of the country due to its vast oil reserves. These reserves have placed Nigeria among the top global crude oil producers. The region's biodiversity is essential for maintaining ecological balance and sustaining livelihoods, while oil production has been the backbone of Nigeria's economy, significantly contributing to GDP and foreign earnings.

Despite its economic importance, the NDR faces severe climate challenges due to its unique topography and its role as a focal point for the interaction between human activities

and climate change. This has created a vicious cycle of environmental degradation and socioeconomic instability, driven by oil industry operations and climate change effects. The region's vulnerability to these combined pressures undermines its ecological balance and hinders sustainable development.

The NDR's mangrove forests provide crucial ecological, economic, and social benefits, such as serving as habitats for diverse species, protecting shorelines, and acting as a carbon sink to mitigate climate change. However, oil spills and gas flaring from exploration and extraction activities pose significant threats, causing deforestation, habitat loss, and increased greenhouse gas emissions. These issues, combined with the region's low-lying topography, make it highly susceptible to climate impacts such as erratic rainfall, sea-level rise, and extreme weather events, which disrupt ecosystems, infrastructure, and livelihoods.

The consequences of oil production, including spills and gas flaring, exacerbate natural climate impacts such as coastal erosion, flooding, and biodiversity loss, leading to environmental migration and conflicts. For example, oil spills contaminate farmland, rivers, and lakes, depleting fish stocks and destroying crops, which increases food insecurity for rural communities reliant on fishing and farming. With growing populations in oil-host communities, the degradation and pollution associated with fossil fuel extraction have become a local and international concern, making the NDR one of the most vulnerable oil-producing regions globally.

While various climate adaptation strategies have been introduced, the region continues to struggle with escalating environmental vulnerabilities and a lack of socio-economic and infrastructural development, despite its economic contributions to the nation. Although much research has explored the impacts of oil production in the NDR, less attention has been paid to the interconnected effects of oil activities and climate change on the region's vulnerabilities. This paper investigates this intricate relationship, focusing on adaptation strategies to build resilience and promote sustainable development while addressing the unique challenges faced by the oil communities in the Niger Delta.

Literature / Conceptual Framework

The NDR

The Niger Delta Region (NDR) comprises nine states located along Nigeria's southern Atlantic coastline within the tributaries of the River Niger. These include Bayelsa, Delta, and Rivers (the core NDR states), as well as Akwa Ibom, Cross River, Edo, Abia, Imo, and Ondo. Covering an estimated land area of 110,445.98 km² (Uyigue & Agho, 2007), the region is densely populated, with over 30 million residents speaking approximately 250 distinct dialects. Situated in Nigeria's low-lying wetlands, the NDR is highly susceptible to environmental challenges, including erratic and intense rainfall patterns and increased erosion, both of which are exacerbated by climate change. It is recognized as one of the most polluted regions globally (Mbachu, 2020).

Figure 1: The Oil Producing Niger-Delta region.

The map of Nigeria highlights the oil-producing states of the Niger Delta Region (NDR), excluding offshore production beyond the continental shelf's lower limit (Ite, Ibok, Ite, & Petters). Historically, the NDR was renowned for its rich agricultural production and was a major producer of palm oil. Known as "Oil Rivers," it served as a British Protectorate from 1898 until 1893, when it became the Niger Coast Protectorate (Otoabasi & Akpan, 2011). However, the advent of crude oil exploration marked a shift from agricultural dominance to oil extraction, transforming the region into the economic cornerstone of Nigeria. The discovery of high-quality crude oil in 1956 at Oloibiri, now in Bayelsa State, catalyzed oil commercialization, with the first export in 1958 and the establishment of an oil terminal at Bonny Island, Rivers State, in 1965 by Shell-BP (UNEP, 2011). The region became home to numerous international oil companies, with Shell Petroleum Development Company taking the lead since the 1950s. Oil production in the NDR has positioned Nigeria as one of the leading global oil producers and a significant player in the multinational oil industry. The sector contributes approximately 90% of Nigeria's foreign earnings, about 70% of government revenue, and, at its peak, produced over 2 million barrels of oil daily (Okonta & Douglas, 2009).

Despite these economic benefits, the Niger Delta communities bear the brunt of oil production's ecological and social impacts. The region suffers from severe environmental degradation, poverty, unemployment, and a lack of sustainable infrastructure, which have fueled tensions and conflicts. Aggrieved communities, disconnected from the wealth generated by oil, have formed militant groups like the Movement for the Emancipation of the Niger Delta (MEND) to demand resource control and justice (Ikelegbe, 2007). The oil industry's operations, including oil spills and unrelenting gas flaring, have made the Niger Delta one of the most polluted regions on earth, posing significant threats to ecosystem health and sustainable development.

The environmental challenges are compounded by climate change, which costs Nigeria an estimated $100 billion annually a figure projected to rise to $460 billion by 2050 (Angalapu, 2023). These dual pressures of oil production and climate change expose the Niger Delta's fragile ecosystem to the risk of collapse, necessitating a balance between Nigeria's economic interests and environmental protection.

Efforts to build resilience and adapt to recurring climate change impacts intertwined with oil production activities have been implemented, but challenges persist. The concepts of vulnerability and resilience are crucial for understanding how individuals, groups, or communities respond to stressors and adverse conditions. Vulnerability refers to the susceptibility to harm from hazards and limited capacity to manage associated risks (IPCC, 2014). It encompasses social, economic, and environmental dimensions influencing how communities experience and respond to crises (Wisner et al., 2004). Conversely, resilience is the adaptive capacity of communities to anticipate, prepare for, respond to, and recover from adverse events, supported by social networks, governance, and available resources (Adger, 2006). Resilience involves self-organization, adaptation, and learning processes in response to disruptions (IPCC, 2014; Manyena, 2006).

Understanding the complex and dynamic relationship between vulnerability and resilience is key to developing effective adaptation policies and measures to address the intertwined challenges of climate change and oil production in the Niger Delta.

Adaptation to climate change refers to the process of adjusting to the challenges and impacts resulting from global climate variations. It involves implementing strategies aimed at reducing vulnerability to the adverse effects of climate change, whether caused by natural variability or human activities. The primary goal of adaptation is to address ecosystem challenges and help individuals and communities adjust to new realities brought about by climate change by either minimizing its negative impacts or maximizing potential benefits. The Niger Delta Region (NDR) is particularly vulnerable due to ongoing environmental degradation caused by oil production activities, including oil spills and gas flaring. These activities exacerbate the impacts of climate change, such as flooding, erosion, and rising sea levels, resulting in significant ecological and social challenges. Consequently, adaptation strategies are critical for addressing the unique and complex socio-environmental challenges faced by the region.

This study adopts the vulnerability-resilience theoretical framework to provide a comprehensive understanding of the interconnected challenges posed by oil production and climate change, as well as to inform policies and adaptation initiatives in the NDR. This framework, widely used today, integrates the concepts of vulnerability and resilience to evaluate the adaptability and risk exposure of socio-ecological systems. It emerged from disaster and socio-environmental studies, drawing on diverse disciplines, including sociology, ecology, economics, and social sciences. Foundational works by scholars such as C. S. Holling (1973), Emmy Werner and Ruth Smith (1982), and Norman Garmezy (1971) demonstrated that not all individuals exposed to vulnerabilities experience the same outcomes, leading to questions about factors that enable positive adaptation and laying the groundwork for resilience studies as a counterpoint to vulnerability.

By the 20th century, the framework evolved to emphasize the complexity and interconnectedness of vulnerability and resilience, recognizing that they are not opposing concepts but interdependent processes shaped by social and environmental factors (Manyena, 2006). For example, high vulnerability can reduce resilience by limiting access

to critical resources, information, and support systems. Conversely, enhancing resilience through improved infrastructure, education, and social networks can mitigate vulnerability (Nunes et al., 2021). The framework highlights the interrelatedness of social, economic, and environmental systems, showing how degradation and socioeconomic inequalities undermine resilience and how sustainable practices and community engagement can enhance it.

In this study, the framework is instrumental in examining how oil production and climate change exacerbate environmental degradation and socioeconomic inequalities in the NDR. It also explores strategies to build resilience and restore ecological balance. The region's persistent vulnerability stems from the dual impacts of oil production and climate change, including environmental degradation, health risks, and socio-economic instability. While oil production amplifies natural climate vulnerabilities, climate change intensifies vulnerabilities caused by oil activities, creating a cycle that threatens the region's socioeconomic systems. The framework underscores the importance of sustainable practices and responsible resource management to systematically address vulnerabilities and enhance resilience. It calls for adaptation strategies, such as improved governance structures, community engagement, and collective responses, to mitigate challenges and restore ecological balance in the Niger Delta. By highlighting the interconnected nature of social, economic, and environmental systems, the framework provides a deeper understanding of the region's adaptive capacity and informs solutions for tackling the dual challenges of oil production and climate change. This approach enhances the region's ability to cope with or recover from disruptions while promoting sustainable development and resilience-building efforts.

Oil Production and Climate Change In NDR

Decades of oil exploration and industrial activities have severely impacted the Niger Delta region due to persistent gas flaring and oil spills associated with extraction, refining, transportation, and storage of petroleum. Gas flaring, a key component of oil extraction, significantly contributes to air pollution and climate change, creating a complex interplay that heightens the region's vulnerability. This vulnerability is further aggravated by the illegal bunkering of petroleum products and vandalism of oil pipelines, which result in frequent spills. These activities endanger the region's highly diverse ecosystems that support numerous species of terrestrial and aquatic fauna and flora, posing risks such as food insecurity, increased morbidity, and mortality (Agbozu & Oghama, 2021).

Nigeria ranks as the highest emitter of greenhouse gases (GHGs) in Africa, with the Niger Delta accounting for a substantial share of the country's carbon dioxide emissions (Anaglapu, 2023). Gas flaring remains a dominant source of GHG emissions in the region and is a common practice during natural gas release to enable oil extraction and enhance production. Despite regulatory efforts to curb gas flaring, the practice persists across many parts of the Niger Delta, contributing to localized air pollution and global climate change (Egbegbulem, Ekpe, & Adejumo, 2013).

Gas flaring significantly increases the region's susceptibility to climate change impacts, particularly due to its fragile ecosystems and unregulated human activities. This has led to widespread air and water pollution, ecosystem destruction, and adverse effects on human health. For example, the consistent rise in carbon monoxide emissions from 2016 to 2021, as shown in Table 1 and Figure 1, illustrates how persistent gas flaring has fueled global

warming, with profound environmental consequences for the Niger Delta, the hub of Nigeria's oil industry.

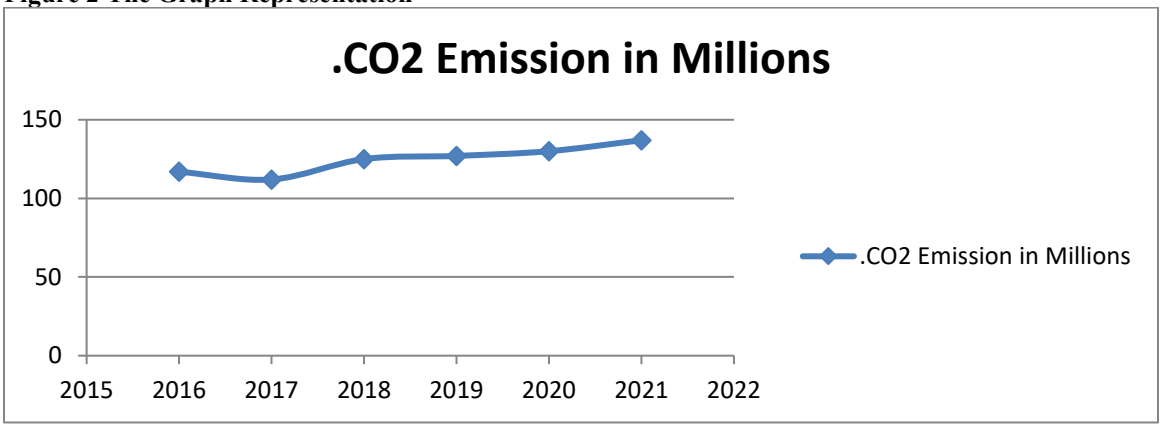
In essence, the drive to sustain government revenue through increased oil production exacerbates gas flaring, escalating air pollution and environmental degradation in the Niger Delta. This dynamic underscore the region's growing vulnerability to climate change and the urgent need for sustainable interventions to mitigate its adverse impacts.

Table 1: Carbon dioxide (C02) Emissions in Nigeria: 2016-2021

Year	.CO_2 Emission in Millions
2016	116.95
2017	112.01
2018	125.01
2019	127.01
2020	130.01
2021	136.99

Source: Hannah &Max (2021.

Figure 2 The Graph Representation



Source: Author's Design, 2024

The United Nations Environmental Programme (UNEP, 2011) highlighted the devastating impact of oil spills, noting that affected land becomes not only unproductive for activities like farming and fishing but also hazardous to all forms of life. Specifically referencing Ogoni land in the Niger Delta Region (NDR), the report emphasized how aging oil industry infrastructure frequently suffers damage, causing spillages that contaminate water sources and destroy agricultural land. Amnesty International (2009) reported that the region has endured over 7,000 oil spills between 1970 and 2000, coupled with gas flaring and deforestation, severely undermining local livelihoods. These oil industry activities threaten ecosystems, reduce biodiversity, and harm the livelihoods of communities that depend on these natural resources for survival.

Petroleum exploration has caused extensive damage to forests and mangrove ecosystems in the Niger Delta. Oil pollution has also severely impaired the region's wetlands, which are crucial for natural flood control and mitigating climate change impacts (Olukaejire, Ifora, Osaro, Osuji, & Hart, 2024). Studies reveal that oil spills and gas flaring have dire socio-economic consequences, particularly in food security, health risks, and overall livelihoods (Onyema & Sam, 2020; Numbere, 2018; Nriagu, 2011; Agbonifo, 2016). The

Niger Delta's low-lying topography makes it particularly vulnerable to climate change phenomena such as erratic rainfall, erosion, extreme weather events, and sea-level rise. Decades of oil exploration have exacerbated these vulnerabilities, with climate change intensifying oil spills and gas flaring, leading to severe degradation of land and resources. Increased rainfall intensity and flooding, driven by climate change, damage vegetation critical for agriculture and disrupt oil production, further aggravating spillages. These disruptions have severe implications for species survival, with oil exploration releasing harmful chemicals into water bodies and threatening regional livelihoods.

Flooding, a persistent issue in the Niger Delta, can inundate oil facilities, cause spills, and hinder transportation (Uyigue & Agho, 2007). Climate-induced soil erosion and irregular rainfall patterns have devastating effects on crop yields, undermining food security. The contamination of farmland and soil by oil production compounds this issue, making farming increasingly unviable in the region (Efe, 2011). Rising sea levels and flooding also pose significant risks to human settlements and natural habitats. According to the Nigerian Meteorological Agency (NiMet, 2014), sea levels in the Niger Delta could rise by 0.2 to 1 meter by the century's end, potentially submerging vast portions of the region. This scenario threatens farming and fishing-based livelihoods and increases displacement and migration, creating public health crises.

The Niger Delta, as a coastal and riverine area, faces erosion challenges intensified by climate change. However, the combined effects of climate-induced events and oil extraction practices have worsened erosion, leading to the loss of agricultural land, destruction of homes, and the displacement of coastal communities. The degradation of mangrove forests further exposes the region's biodiversity to storm surges and environmental destruction (Awosika & Folorunsho, 2011). Changes in the climate also create significant health risks in the Niger Delta. Rising temperatures foster conditions conducive to mosquito breeding, increasing the prevalence of malaria. Oil spills that contaminate water sources lead to frequent outbreaks of waterborne diseases such as cholera and typhoid. The interaction between oil production activities and climate change has profound implications for environmental stability, socio-economic development, and human well-being in the region. This interconnectedness exacerbates poverty, intensifies competition for dwindling resources, and fuels social unrest. Addressing these intertwined challenges requires comprehensive adaptation measures that synchronize efforts to mitigate the dual impacts of oil production and climate change.

The Synergistic Relationship and Implications

The interplay between oil production and climate change creates a cyclical feedback loop where the environmental damage caused by oil activities intensifies climate change, which in turn disrupts oil production and exacerbates vulnerability to its impacts. While oil production is a major driver of climate change, the resulting changes in climate conditions negatively affect oil production activities, posing serious challenges to environmental sustainability and climate mitigation efforts.

Contributions of Oil Production to Climate Change

Greenhouse Gas (GHG) Emissions: The oil industry is a significant source of greenhouse gases such as carbon dioxide (CO2) and methane, released during extraction, refining, and the burning of fossil fuels. Gas flaring, a common practice in oil production, emits toxic

gases like CO2, methane, and sulfur dioxide, contributing to climate change, respiratory diseases, and acid rain (Olukaejire, Ifora, Osaro, Osuji, & Hart, 2024). These emissions intensify the greenhouse effect, leading to global warming and subsequent climate disruptions, such as sea-level rise, which severely impacts coastal populations dependent on freshwater resources (IPCC, 2014).

Habitat Destruction: Oil exploration often involves the indiscriminate clearing of forests and wetlands, resulting in significant habitat loss. This exposes regions to climate change impacts such as erratic rainfall, frequent flooding, and accelerated coastal erosion. The destruction of vegetation and mangrove ecosystems has profound implications for species survival and environmental resilience (Olukaejire et al., 2024).

Pollution: Frequent oil spills and other pollution from oil production degrade ecosystems, reducing their capacity to absorb CO2 and exacerbating climate-related issues. Oil spills render affected land unfit for farming and fishing, while contaminated water and soil threaten local livelihoods and health (UNEP, 2011; Numbere, 2018). The destruction of carbon-sequestering ecosystems, such as mangroves and wetlands, further accelerates greenhouse gas accumulation.

Climate Change Impacts on Oil Production

Disruption of Oil Activities: Changing climate conditions, such as extreme weather events, rising sea levels, and intensified rainfall, cause significant damage to oil infrastructure, leading to production outages and increased costs. Coastal flooding and storm surges pose risks to offshore platforms and facilities, raising the likelihood of operational disruptions and environmental disasters (IPCC, 2014).

Ecosystem Degradation: Climate change exacerbates flooding, erosion, and other natural disasters, further damaging oil facilities and increasing oil spills. Flooding and saltwater intrusion into freshwater sources disrupt both oil production and community livelihoods, with severe consequences for agriculture and fishing (Arausi & Otite, 2022).

Socioeconomic Impacts: The combined effects of oil production and climate change deepen poverty and create significant challenges for local communities, particularly women, who are disproportionately affected by flooding and environmental degradation. Loss of agricultural land and declining fish populations threaten food security and economic stability in the region.

Environmental Degradation" The Niger Delta Region (NDR) is among the most heavily impacted areas globally due to decades of oil exploration. Oil spills have polluted soils to depths exceeding five meters, contaminating groundwater aquifers (UNEP, 2011). The destruction of mangroves, which act as natural barriers against erosion and flooding, exposes the region to greater climate vulnerability. Gas flaring, deforestation, and infrastructure development for oil extraction contribute to biodiversity loss, ecosystem disruption, and water contamination, further aggravating the impacts of climate change.

As oil production and climate change exacerbate one another, the region faces severe environmental degradation, health risks, and socio-economic disruption. The degradation of mangroves and forests undermines ecosystem productivity, while pollution and habitat destruction impede agricultural and fishery activities, jeopardizing local livelihoods. The Niger Delta's dependence on oil revenue has come at the cost of its natural environment, with urgent adaptation and mitigation measures needed to address these interconnected challenges.

Health Risks: Climate change significantly exacerbates health challenges in the Niger Delta, especially through its interplay with oil production. Environmental degradation in the region exposes communities to waterborne diseases, respiratory issues, and malnutrition (Ebegbulem et al., 2013). Gas flaring, a widespread practice in oil production, releases harmful gases like carbon dioxide, methane, and sulfur dioxide. These pollutants contribute to respiratory illnesses, acid rain, and global warming (Olukaejire, Ifora, Osaro, Osuji, & Hart, 2024). Additionally, the degradation of ecosystems reduces the region's capacity for carbon sequestration, intensifying climate change impacts (Obasohan, 2008).

The local population often suffers severe health consequences from exposure to oil pollution, contaminated water, and air pollution caused by unregulated crude oil activities. Moslen and Aigberua (2018) highlight the rise in heavy metal contamination of soil, plants, and groundwater, which directly affects human health. The Niger Delta's high daily discharge of heat estimated at 45.8 billion kilowatts renders some areas almost uninhabitable (Omale, 2021). Acid rain, resulting from gas flaring, is a regular occurrence in the region, further degrading air quality and increasing health risks. These activities undermine ecosystem health, depriving communities of traditional livelihoods like farming and fishing, which have been disrupted since the onset of oil exploration.

Socio-Economic and Infrastructural Vulnerability

The combined effects of climate change and oil production create a complex web of environmental, economic, and social disruptions, fostering ecological imbalance in the Niger Delta. These activities increase the region's vulnerability to environmental hazards and economic instability, disrupting livelihoods and hindering national development. Coastal communities face displacement due to sea-level rise and erosion, while oil spills and contamination damage infrastructure and disrupt economic activities. Ocean acidification further harms marine ecosystems, depleting fisheries and coral reefs vital to the local economy.

The region has suffered significant losses from recurrent flooding and erosion, which threaten infrastructure like roads, residential areas, and farmlands. For instance, the catastrophic floods of 2012 and 2022 destroyed farmlands and displaced communities, leading to hunger and economic hardship. Women in Isoko communities, for example, sought refuge in internally displaced persons (IDP) camps, as flooded farmlands left them without harvests (Arausi & Otite, 2023). Gas flaring and unmitigated greenhouse gas emissions have also contributed to droughts, biodiversity loss, environmental conflicts, and forced migration (Uzuazo, 2021).

These dual pressures environmental degradation from oil production and climate change—have decimated agricultural productivity and livelihood opportunities, increasing displacement and deepening poverty. The local communities' inability to invest in adaptation measures has left them trapped in an increasingly degraded environment with few resources to combat the impacts of climate change.

Marginalization and Socioeconomic Instability

The ecological degradation caused by oil production has led to fierce competition for dwindling resources, fueling social tensions and conflicts that threaten the region’s socioeconomic stability. Persistent poverty and marginalization of oil-producing communities exacerbate the problem. Despite bearing the brunt of environmental degradation, these communities receive little in terms of social benefits or development investments.

Both the Nigerian government and multinational oil corporations have failed to recognize Niger Delta communities as stakeholders in the oil industry. This lack of inclusion has resulted in widespread displacement, poverty, and insecurity. Akpan and Akpabio (2009) argue that unfavorable state policies, politicization of issues, and poor industry practices have perpetuated conflicts in the region. In response, the oil-rich communities have grown increasingly restive, resorting to protests and conflicts to voice their grievances. However, despite local and international adaptation efforts, the vulnerabilities of the Niger Delta remain unaddressed, leaving the region in a cycle of environmental and socio-economic crises.

Ascendable Vulnerability and Adaptation Efforts in the NDR.

The Niger Delta region faces unique and interwoven environmental, economic, and social challenges due to extensive oil production and the escalating impacts of climate change. In response, specific adaptation efforts have been introduced to address environmental degradation, socio-economic vulnerabilities, and public health concerns while fostering resilience among local communities. These initiatives aim to promote socio-economic growth and sustainable development by tackling the root causes of social inequality in the region.

Despite these measures, the region's complex vulnerabilities persist, largely due to the interplay of oil production and unpredictable climate events. Contributing factors include uncontrolled environmental degradation, weak governance, inadequate infrastructure, and insufficient social services. Extensive oil production continues to degrade the environment through frequent spills, air pollution, and uncontrolled gas flaring, all exacerbated by the drive to maximize national revenue. These activities lead to biodiversity loss, destruction of farmland, and persistent health risks for local populations. Ajuwo (2013) highlights the weakness of flaring reduction regulations, allowing decades of unchecked emissions that worsen the region's vulnerability. The increasing levels of carbon dioxide emissions in Nigeria, particularly in the Niger Delta, underscore the urgency for stronger environmental health policies and actionable measures to combat global warming.

Additionally, the low-lying topography of the region makes it highly susceptible to the impacts of rising sea levels, flooding, saline intrusion, and erosion. Local communities, reliant on traditional adaptation methods, lack the economic resources, technology, and infrastructure necessary to address these evolving challenges. Industrial networks of aging pipelines exacerbate pollution and contamination, leading to displacement, loss of livelihoods, and heightened health risks.

Governance gaps and weak enforcement of environmental regulations further compound the region's challenges. Fragmentation among regulatory agencies creates inefficiencies and overlaps in addressing environmental hazards. For instance, laws such as the NOSDRA Act, the Environmental Impact Assessment Act, and the Gas Flaring Prohibition Act are hindered by inadequate funding, corruption, and overlapping responsibilities, resulting in weak enforcement. Illegal activities, such as unregulated backyard refineries, contribute to environmental degradation through oil spills and contamination. Efforts to reduce gas flaring, a major contributor to greenhouse gas emissions, have been limited by high infrastructure costs and regulatory weaknesses. While the government has introduced initiatives such as the Gas Flaring Prohibition Act, enforcement remains weak, and progress in harnessing flared gas for clean energy has been slow. Ojewale (2021) notes that

the commercialization of flared gas is capital-intensive, and government hesitation has stalled potential partnerships with investors.

The exclusion of host communities from adaptation planning and decision-making processes further undermines the effectiveness of these measures. Marginalization breeds misinformation and limits the adoption of tailored solutions to address the region's unique challenges. Community engagement and capacity-building initiatives supported by stakeholders and NGOs are crucial for increasing local resilience. However, many measures remain insufficient to address the socio-economic pressures and inequalities exacerbated by the dual impacts of oil production and climate change. For instance, restoration initiatives, such as the Ogoniland clean-up under United Nations environmental law, aim to remediate polluted land and water systems. However, these efforts have often been slow and inadequate, leaving the region to grapple with prolonged poverty, food insecurity, and disrupted social services. Despite these challenges, building stronger regulatory frameworks, enforcing environmental standards, and engaging local communities in adaptation strategies are essential to reducing vulnerability and fostering sustainable development in the Niger Delta.

The rising poverty and inequality, driven by limited economic opportunities, have pushed many local residents, particularly men, into illegal activities, often resulting in violence and conflicts that threaten regional security. In response, oil companies have implemented various programs aimed at improving community relations and addressing longstanding grievances and conflicts with host communities, such as the Global Memorandum of Understanding (GMOU) and the Host Community Development Trust (HCDT) (Idowu, 2022). The GMOU is an informal agreement between the oil companies and the communities, often lacking a regulated framework for social responsibility initiatives, which are subject to negotiation and vary across companies. These partnerships aim to provide funding and technical expertise for adaptation projects, with companies like Shell and Chevron involved in Corporate Social Responsibility (CSR) initiatives that address both environmental and social challenges. However, while these efforts face limitations, an Amnesty (2022) report states that "despite criticism of their scope and impact, these initiatives remain broader adaptation strategies." The enactment of the Petroleum Industry Act (PIA) in 2021 has introduced a new dynamic in the relationship between operators and host communities, restructuring the management of community relations to foster sustainable participatory needs assessments and development plans that promote community sustainability and reduce environmental degradation (Idowu, 2022). Despite these efforts, Nigeria's oil-rich Niger Delta remains underdeveloped and one of the most vulnerable regions globally.

Coastal and Flood Erosion Control: This includes government projects like shoreline stabilization, including the construction of sea walls and barriers to combat rising sea levels and coastal erosion. These efforts are intended to protect coastal infrastructure and habitats from the destructive forces of climate change-induced erosion and flooding, which are exacerbated by oil production activities. The Nigerian coastal region, including the Niger Delta, is at risk of becoming uninhabitable by 2050 and may be fully submerged by 2100 due to rising sea levels driven by climate change (Jane Johnson, 2021), indicating that the combined impacts of climate change and oil production are overwhelming existing mitigation measures.

The region's continued vulnerability also arises from a lack of local economic diversification in oil-dependent communities. Their over-reliance on oil revenue has stifled the growth of alternative industries, making it difficult for them to recover from the risks posed by oil production and climate change when government measures are inadequate or fail. Livelihood diversification involves creating alternative sources of income for communities that rely on farming and fishing, which are being threatened by ongoing oil pollution and climate events. This approach aims to promote sustainable livelihoods and food security by encouraging non-agricultural ventures and sustainable agricultural practices. It also includes alternative skills training, such as agroforestry and renewable energy, which support climate adaptation and reduce dependence on oil-related industries, thereby mitigating security threats in the region. However, the local population faces significant challenges in acquiring new skills and technologies due to a lack of support for sustainable practices, which further hinders their ability to adapt.

Local oil communities are ill-equipped to adapt to changing climatic conditions due to poverty, limited access to technology, and inadequate infrastructure, all of which exacerbate the dual impacts of oil production and climate change. There is a critical need for investment in community-resilient infrastructure, such as elevated buildings in flood-prone areas, reinforced coastal barriers, and the adoption of innovative technologies in oil production to reduce environmental hazards.

Promotion of Renewable Energy: Moving toward renewable energy sources like solar, wind, and biomass power is crucial in reducing the environmental impact of oil production, such as carbon emissions that aggravate climate change in the region. This shift not only diversifies the region's energy mix but also creates opportunities for sustainable employment and economic growth in local communities.

The escalating poverty and socio-economic inequality driven by the combined impacts of oil production and climate change are major contributors to the region's ongoing vulnerability. The synergy of these factors has eroded natural livelihoods, reducing local income and impairing communities' ability to adapt. As a result, many communities remain highly vulnerable to the effects of climate change. The multinational oil companies, as the primary environmental polluters, disproportionately harm the local populations, who continue to earn their livelihoods amid the pollution.

Synergistic Intervention in the NDR

The link between oil production and climate change remains a central cause of persistent vulnerability, contributing to a range of social, economic, and environmental challenges. Addressing these issues requires a multifaceted approach that integrates environmental, social, and economic measures, with a strong focus on community-centered, sustainable adaptation strategies.

Enforcing stricter environmental laws is essential to effectively manage the impacts of oil spills, gas flaring, illegal deforestation, and other harmful practices by oil companies. This would ensure full compliance, holding companies accountable for their environmental damages in host communities. Adequate funding and staffing are crucial to empower agencies like NOSDRA to monitor and enforce environmental standards. Transparency and dialogue between the government, oil companies, and host communities are key to building trust and reducing regional tensions, which will also help improve the effectiveness of corporate responsibility initiatives.

Oil companies should adopt best practices and cleaner technologies to minimize environmental impacts. For example, a stronger commitment to gas reinjection technology could significantly reduce emissions and eliminate gas flaring, allowing for the recovery of valuable resources. This will require regular monitoring and assessments of their production processes.

Ongoing ecosystem restoration is vital for enhancing community resilience and sustainable resource management. This includes advancing mangrove reforestation, replanting local vegetation to reduce floods and coastal storm surges, and implementing integrated water management to improve water infrastructure and sanitation. These efforts help mitigate the health risks of oil spills and flooding, conserve biodiversity, and support sustainable resource management. Ecosystem restoration projects should follow strict environmental regulations to ensure long-term sustainability and contribute to the region's resilience against both climate change and oil-related damages.

Community-centered adaptation, focusing on inclusive and context-specific measures, is essential for sustainable development. Engaging all stakeholders in decision-making, planning, and implementing adaptation projects will build trust between companies and host communities, ensuring the effectiveness of the projects and fostering a sense of ownership among local populations. Community-Based Adaptation (CBA) empowers local residents by involving them in decision-making, which helps identify specific vulnerabilities and the causes of environmental degradation, restoring ecosystems and improving overall well-being. This approach, combined with greater stakeholder participation, promotes transparency, reduces tensions, and strengthens cooperation between the government, oil companies, and communities.

Environmental remediation efforts must be comprehensive and proactive, addressing oil production's disruptions and pollution. These efforts should focus on restoring contaminated ecosystems and improving public health and sanitation, particularly in communities affected by oil spills and climate change-induced health risks.

A focus on Community Green Skills Technology is critical in reducing the region's vulnerability to environmental degradation. Training programs in renewable energy and sustainable agriculture can help local communities shift toward eco-friendly practices, decreasing their reliance on oil and enhancing their resilience. Green skills development also promotes socio-economic growth and stability in the region by empowering vulnerable populations.

The ongoing impacts of oil production and climate change in the Niger Delta call for the development of a research framework to monitor and understand climate change impacts. This would provide the necessary data to inform effective policy decisions and adaptation strategies.

The Niger Delta's vulnerability is exacerbated by its reliance on oil revenues and its natural susceptibility to climate disasters. Climate-induced mitigation practices, such as migration-focused policies, are needed to address the escalating environmental and social pressures. While government policies prioritize adaptation strategies like flood control, coastal protection, and resilient agriculture, these measures alone may not be sufficient to address the continuous environmental degradation. Migration policies, which involve relocating people from highly vulnerable areas to safer regions, could serve as a preventive strategy to reduce exposure to climate hazards, improve quality of life, and support sustainable development. The UNEP report (2011) projects that significant sea-level rise could

submerge large parts of the Niger Delta by 2100, displacing millions of people. Migration-focused policies, by providing a proactive and resilient response, offer a promising solution for the region's highly vulnerable communities.

Conclusion

The combined effects of oil production and climate change have consistently contributed to the environmental degradation of the Niger Delta, creating a complex web of environmental and socio-economic challenges. This has undermined the natural livelihoods of the people, lowered their income levels and weakened their ability to implement adaptive strategies, leaving many communities highly vulnerable to climate impacts. The presence of both oil production and unpredictable climate events is further complicated by uncontrolled environmental damage, socio-economic issues, and inadequate infrastructure and social services, all of which worsen the situation and hinder the effectiveness of current adaptation efforts. Several studies have identified the weaknesses of existing climate change policies and strategies, attributing them to factors such as lack of political will, corruption, public unawareness, weak institutional frameworks, insufficient funding, industrial influence, and the absence of climate science and environmental experts. The persistent vulnerability of the Niger Delta to the compounded effects of oil production and climate change is driven by a lack of alternative revenue sources and the unchanged landscape of oil-dependent communities, which are naturally susceptible to global climate disasters. While the study calls for a comprehensive, community-centered adaptation approach, it also highlights the need for a climate-induced migration framework, which could offer a sustainable solution, particularly for the coastal oil communities, to restore ecological balance in the region.

To address the environmental and socio-economic challenges in the Niger Delta, it is crucial to strengthen the existing climate change policies and governance frameworks. This involves increasing political will, tackling corruption, raising public awareness, and enhancing institutional capacity. Establishing robust environmental regulations and involving climate science and environmental experts in decision-making processes will help improve the effectiveness of adaptation strategies. Additionally, ensuring adequate funding and reducing the influence of the oil industry on policy-making can contribute to more sustainable environmental management. A key recommendation is to promote economic diversification in the Niger Delta, reducing the communities' dependence on oil revenue. This can be achieved by supporting the development of alternative industries, such as agriculture, renewable energy, and eco-tourism, which are more resilient to the impacts of climate change. Empowering local communities with skills training and access to green technologies will create sustainable livelihoods and improve their ability to cope with climate-induced challenges, ultimately reducing their vulnerability to both oil-related and climate change risks. Given the persistent vulnerability of oil-dependent coastal communities, it is essential to implement a climate-induced migration framework that can offer a long-term solution. This framework should focus on relocating communities from high-risk areas to safer, more sustainable locations. By strategically relocating vulnerable populations, the impacts of rising sea levels, flooding, and environmental degradation can be mitigated. Such a framework would contribute to the ecological balance of the region, reduce socio-economic pressures, and support the resilience of both the displaced communities and the region as a whole.

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