

RESEARCH ARTICLE

NIGERIA'S OIL AND GAS EXPLORATION AND PRODUCTION: SOCIOECONOMIC IMPLICATIONS, ENVIRONMENTAL IMPACTS, AND MITIGATION STRATEGIES

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ABSTRACT

Over the past six (6) decades, technological advancements in Nigeria's oil and gas industry have made a substantial contribution to national economic development and global energy demand. With the oil and gas industry contributing over 90% of the nation's exports and 80% of the Federal Government's revenue, it is one of the most significant economic sectors in the nation. Since 1970, the oil and gas industry has controlled the growth rate and structure of Nigeria's economy. However, the loss of petroleum-derived revenue, owing in part to falling crude oil prices but also to poor governance, corruption, insecurity (militant attacks and/or insurgency), and ineffective government petroleum development policies (non-implementation of relevant legislation and/or environmental laws), has resulted in significant environmental degradation, socioeconomic and sociocultural problems. Although Nigeria's economy is primarily dependent on revenue derived from oil and gas resources, the majority of petroleum-producing host communities in the Niger Delta region have suffered a wide range of environmental degradation, significant negative impacts on the natural environment, detrimental effects on human health, socioeconomic impacts, and socio-cultural problems. In this review, we delve into the problems and prospects of all the phases of oil and gas exploration and production in the Niger Delta region of Nigeria. It will also shed light on the environmental and socioeconomic implications of oil and gas development and production in Nigeria. Furthermore, this research makes some recommendations to promote ethical and sustainable strategies for reducing negative impacts and improving the quality of life in impacted host communities producing oil and gas in the Niger Delta region.

KEYWORDS

petroleum, pollution, petroleum industries, oil and gas development, host communities, Nigeria's Niger Delta

1. INTRODUCTION

Advances in technologies utilized for the exploration, development, and production of oil and gas resources have greatly contributed to global consumption demand and national economic development over the past sixty (60) years (Ite et al., 2016). Currently, the direct use of fossil fuels accounts for the majority of global energy consumption. According to Adenikinju, Nigeria has enormous quantities of tar sands, hydropower, solar radiation, and over 35 billion barrels of crude oil, 187 trillion cubic feet of gas, and 4 billion metric tonnes of coal and lignite, among other potential energy resources (Adenikinju, 2008). An estimated 30 to 40 billion barrels of crude oil have been found to exist in Nigeria's Niger Delta, which constitutes around 70% of sub-Saharan Africa's total hydrocarbon reserves. According to Nriagu, it is suggested that Nigeria's huge gas reserves are comparable in size to its oil reserves, which are estimated to be between 5 and 7 trillion m³, or more than 30 billion barrels of oil equivalent (Nriagu, 2019). Approximately 6% of global gas reserves are found in the Niger Delta region's gas fields.

From a historical perspective, exploration for petroleum resources in Nigeria dates back to 1908, with the Nigerian Bitumen Corporation (NBC) conducting the pilot prospecting activities in the South-Western Nigeria, which later ended abruptly in 1914 following the outbreak of World War I (Ite et al., 2013; Ite et al., 2016; Wangbu, 2018). World War I disrupted

the initial exploratory activities for several years and after the war, Shell D'Arcy (later Shell-British Petroleum [Shell-BP] and now Shell Petroleum Development Company [SPDC]) received exploration rights across Nigeria. Although Shell-BP discovered the first commercial quantities of crude oil in 1956 near Oloibiri community in the Niger Delta region, significant exports didn't start until 1965 after a Bonny Island terminal with pipes to feed the terminal was completed (Nriagu, 2011b; Ite et al., 2013; Wangbu, 2018; Nriagu, 2019).

The history of oil and gas exploration and production in the Niger Delta region has been extensively documented by several researchers (Vassiliou, 2009; Ite and Ibok, 2013; Ite et al., 2013; Ite et al., 2016; Ite et al., 2018; Okorobia and Olali, 2018; Vassiliou, 2018). Over the years, there have been several developmental advances in technologies used for petroleum resources exploration and production. It is assumed that technological advancements in the petroleum industry have allowed operators to save time, reduce operational costs, and reduce their environmental impacts. Petroleum resources have accounted for more than 90% of the Federation of Nigeria's foreign exchange over the past sixty (60) years, and the Nigerian economy is primarily dependent on petroleum-derived revenue.

Petroleum, which is an essential component of the modern energy system and a major energy source around the world, has been increasingly

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produced and consumed (Andrews et al., 2021). In Nigeria, petroleum is perceived as a resource curse: assets that should bring wealth and stability have instead led to corruption and poverty. Many of the studies that are currently available indicate that host communities that produce oil and gas are still on the periphery of petroleum development prospects. They bear costs without realising enough benefits because of factors like a lack of skills that restricts job access, adverse environmental effects that negatively affect local livelihoods, and unresolved governance issues at different scales and actors (Frynas, 2005; Zalik, 2009; Bennett, 2019; Andrews and Siakwah, 2020; Enns et al., 2020).

It has been reported that the majority of host communities that produce oil and gas in the Niger Delta region have experienced a wide range of environmental pollutants, severer negative effects on the natural environment, detrimental effects on human health, and sociocultural as well as socioeconomic and cultural problems (Ugochukwu and Ertel, 2008; Ite, 2012; Ite and Ibok, 2013; Ite et al., 2013; Ite et al., 2016; Chukwuka et al., 2018; Ite et al., 2018; McLoone et al., 2019; Zhang et al., 2019a). In the Niger Delta region, the pollution caused by petroleum hydrocarbons from human activities associated with the oil and gas industry is one of the main environmental issues. Some of the major environmental consequences associated with oil and gas exploration and production operations include: (i) atmospheric pollution and increased greenhouse gas emissions, which may contribute to local environmental problems such as acid rain and global climate change; (ii) marine pollution and ecosystems destruction, which often results in biodiversity loss, adverse impacts on flora and fauna, and a negative impact on tourism, fishing, and other related businesses, (iii) soil and controlled water (surface and groundwater) sources pollution, and (v) changes in local traffic due to automobile and truck circulation, noise pollution, and traffic-related particulate matter (PM) emissions (Ogri, 2001; Scheren et al., 2002; Ite and Ibok, 2013; Andrews et al., 2021; Ite et al., 2013; Chukwuka et al., 2018; Andrews et al. 2021; Benka-Coker and Ekundayo, 1995; Benka-Coker and Olumagin 1996; Holliger et al., 1997; Kharaka et al., 2007; Ite et al., 2013; Chukwuka

et al., 2018). Although the global economy is run by technological advancement and mineral resource wealth, petroleum hydrocarbon contamination is one of the many risks Nigeria faces due to technological and/or human-induced hazards as well as petro-violence (Albert et al., 2018).

Therefore, this review paper aims to explore the problems and prospects of all the phases of oil and gas exploration and production in the Niger Delta region of Nigeria. It will also shed light on the environmental and socioeconomic implications of oil and gas development and production in Nigeria. Furthermore, this research will highlight some recommendations to promote ethical and sustainable strategies for reducing negative impacts and improving the quality of life in impacted host communities producing oil and gas in the Niger Delta region.

2. THE NIGER DELTA REGION: ECOSYSTEM AND HYDROCARBON HABITAT

The Niger Delta region is located between latitudes 3° and 6° N and longitudes 5° and 8° E (Figure 1) in the southern part of Nigeria and the low-lying floodplain (0 – 100 m above mean sea level) is spilling out into the Gulf of Guinea on the Atlantic Ocean (Doust, 1990; Haack et al., 2000; Ite et al., 2013; Ite et al., 2016; Nriagu, 2019). It encompasses all six states from the South-South geopolitical zone (Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Rivers), one state from the South-West zone (Ondo) and two states from the South-East zone (Abia, Imo). The Niger Delta region, comprising nine oil and gas producing states and 185 local government areas, is home to over 31 million people from over 40 ethnicities in 3,000 communities. The Niger Delta region is a massive wetland extended over a large expanse of terrain, crisscrossed with rivers, rivulets, springs, and other natural topographical resources (Ite et al., 2013; Anele and Nkpah, 2014; Ite et al., 2016).

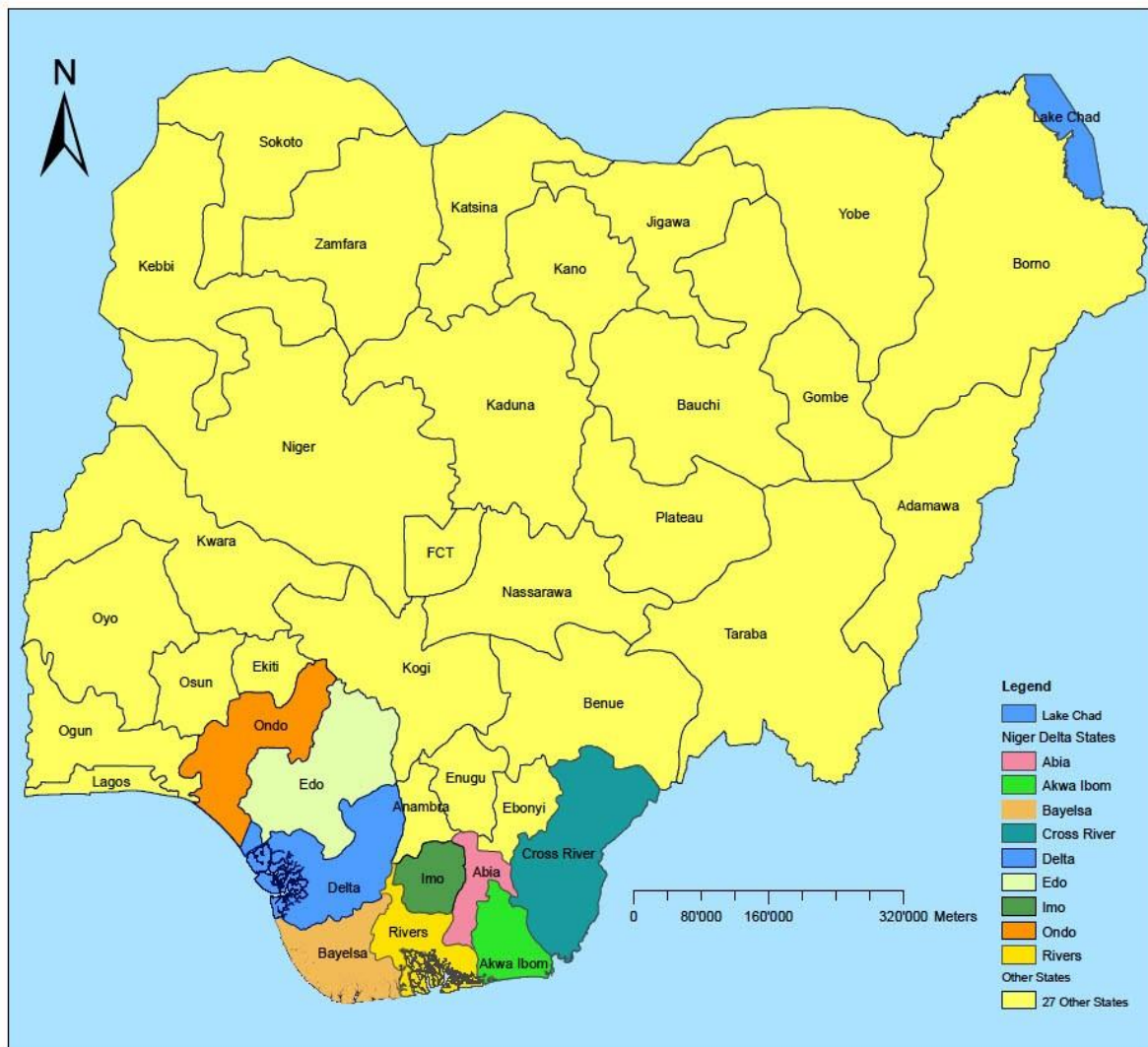


Figure 1: Nigerian map showing the Oil Producing States in Niger Delta Region (Source: Ite et al., 2013; Ite et al., 2018)).

The region covers 7.5% of Nigeria's land mass, primarily occupying the coastal and ocean-ward areas of the Benue trough and has the largest mangrove forests in Africa, with a total area of about 75,000 km² (Ugochukwu and Ertel, 2008). This region is home to various ecological zones, including coastal barrier islands, mangroves, freshwater swamp forests, and lowland rain forests, whose boundaries vary based on seasonal flooding patterns (Singh et al., 1995; Nriagu, 2011b; Nriagu, 2019). The Niger Delta region is divided into two primary natural zones: the tropical rainforest in the northern half of the Delta and the mangrove forests around Nigeria's warm beaches. According to Ugochukwu and Ertel, mangrove forests and swamps, characterized by periodical salt-water inundation, form a complex ecosystem vital to the local economy and support significant flora and fauna (Ugochukwu and Ertel, 2008). The Niger Delta region is a tertiary delta situated in a marginal sag basin that was formed during the Paleocene to Pliocene ages (Sanuade et al., 2017). The Niger Delta sedimentary basin, with its enormous proved petroleum reserves, is among the world's most productive deltaic hydrocarbon provinces.

The Niger Delta's petroleum hydrocarbons are primarily derived from sandstones and unconsolidated sands, predominantly found within the Agbada Formation, which has intervals that contain organic-carbon content sufficient to be considered principal hydrocarbon source rocks (Doust et al., 1989; Chukwu 1991). Some studies have provided a comprehensive analysis of the history, evolution, and structural characteristics of the Niger Delta (Whiteman 1982; Obaje, 2009; Adegoke et al., 2017). The Niger Delta is made up of several major ecosystems, including the open shelf, continental slope, pro-delta slope, river mouth, upper and lower floodplains, mangrove swamps, barrier islands, onshore "fossil" delta complex, and river mouth (Ite et al., 2013; Ite et al., 2016; Ite et al., 2018).

Exploration for oil and gas in the Niger Delta region has been carried out over the past sixty (60) years, and these upstream activities have been based mostly on information derived from petrophysical analysis and seismic reservoir characterization (Ite et al., 2013; Ite et al., 2016; Ite et al., 2018; Doust, 1989; Obaje, 2009; Sanuade et al., 2017). According to Osuji and Onojake (2004), the Niger Delta region cuts across over 800 oil-producing communities, with an extensive network of over 900 producing oil wells and several petroleum production-related facilities. Over the past six decades, more than 1,182 exploration wells have been drilled in the delta basin (Obaje 2009), and over 500 petroleum fields (360 onshore oil fields and 240 offshore oil fields) of varying sizes located within Nigeria's Niger Delta region have been documented (Anifowose 2008; Ite et al. 2013; Ite et al. 2016; Onyena and Sam, 2020).

Currently, there are over 18 multinational oil companies involved in petroleum resources exploration and production in the Niger Delta region (Poindexter et al., 2008). Although there are about 500 fields in the Niger Delta region, over 55% of these are located onshore and the remaining are located in the shallow waters (less than 500 metres). Currently, more than 190 of these fields are producing, while more than 20 of these fields have been either closed-down or abandoned. Although the petroleum industry has affected Nigeria in a variety of ways, the Niger Delta has experienced the positive and negative impacts of all the phases of petroleum resources exploration and production.

3. PETROLEUM INDUSTRY OPERATIONS IN THE NIGER DELTA REGION

The risk of operational failure and unsustainable practices is very minimal when oil and gas exploration, exploitation, and production operations are conducted with due diligence and global best standards. In certain situations, some multinational oil companies are sometimes left with the choice of which procedure to follow in the best interest of their businesses, even though few oil and gas industries are developing cost effective methods of exploration and production operations. It has been noted that certain multinational oil companies objectives frequently take precedence over worker safety and give little time for planning the operation. It is known that certain multinational oil companies have corporate standards, industry standards, and country-specific regulations in place, even though certain governments do not have any functional standard regulations. The Nigerian government and multinational oil companies in the Niger Delta region have shown minimal action to tackle unsustainable practices and environmental pollution resulting from oil and gas resource development (Ikporukpo, 1983; Odeyemi and Ogunseitani, 1985; Ekpu, 1995; Ogri, 2001).

3.1 The Impact of Petroleum Industry on Nigeria's Economy

The oil and gas industry is among the sectors that has made a significant

contribution to the world's energy needs as well as many other needs. Over the years, the petroleum industry has provided fuel for various purposes and the operation of other industrial power plants. Furthermore, a variety of industries, including petrochemicals, solvents, plastics, fertilizers, insecticides, and pharmaceuticals, use the byproducts from crude oil as raw materials (Okotie et al., 2018b). Nigeria, the sixth-largest exporter of crude oil, generates over 90% of the Federation of Nigeria's foreign exchange from oil and gas resources (Albert et al., 2018). Nigeria's economy and budget have benefited greatly from the petroleum industry's profits and earnings since 1960. Nigeria started tracking its annual gross domestic product (GDP) and utilising the abundance of its natural resources when it joined the Organisation of Petroleum Exporting Countries (OPEC) in 1970. Nigeria's GDP grew steadily and quickly throughout the 1970s, averaging over \$5 billion per year.

In the early 1970s, the interaction of the Middle East Crisis and OPEC's intention to create a change in the crude oil pricing mechanism boosted crude oil prices to around \$15 per barrel (Okorobia and Olali, 2018). According to a study, Nigerian oil revenues sky-rocketed from N176 million in 1970 to N1.4 billion in 1973 and to N12.86 billion by 1980 (Ikein, 1991). However, the global recession hit, and the time of wealth brought about by the oil boom began to fade after a high in 1981. Not only has the oil and gas sector expanded dramatically, but it has also emerged as the primary source of foreign income in Nigeria's economy. In 1980, it accounted for more than 80% of all government revenue and 96% of total export revenues (Okorobia and Olali, 2018).

The agricultural sector historically contributed less to the country's economy due to the oil and gas sector's dominance in the early 1970s. Petroleum resources were extremely important to the Nigerian economy, particularly from 1973 onwards (Graf, 1988). According to a study, evidence suggests that from 2.5% to 58.1% in 1970, to 93.6% in 1975, and to over 98% during the first half of the 1980s, the income from sales of crude oil increased as a share of foreign exchange earnings (Graf, 1988). The extraction of petroleum resources, which has been done for the past 60 years, has produced more than 85% of Nigeria's GDP, more than 95% of the country's foreign exchange earnings, and more than 80% of the country's government revenue (Aaron, 2005). Since the 1960s, Nigeria's government and multinational oil companies have been producing oil and gas from the Niger Delta region, generating an estimated \$600 billion (Wurthmann, 2006). The oil and gas industry's export revenue in the Niger Delta region significantly contributes to the nation's economy, generating foreign exchange and fostering overall growth and development (Ite et al., 2013; Elum et al., 2016; Albert et al., 2018). The Niger Delta's oil and gas industry, which exports petroleum resources, has significantly boosted the country's economy over the past 60 years, as oil is the most widely used energy source globally and a key commodity in international trade (Khan, 1994; Ite et al., 2013).

Over the past six decades, the petroleum industry has significantly contributed to Nigeria's economy by creating employment opportunities, generating local expenditure on goods and services, contributing to government revenues, GDP, and foreign exchange reserves, and providing energy to industry and commerce. According to Akinlo, oil and gas resources significantly contribute to the government's revenue, export earnings, and GDP, accounting for over 95% of export earnings and 40% of GDP (Akinlo, 2012). They also generate foreign exchange earnings and 65% of government budgetary revenues. Modern industrialization and infrastructure development rely on oil and gas resource utilization. Using the annual data from 1970 to 2015, Olayungbo investigated the impact of oil and gas export earnings on the development of Nigeria's economy (Olayungbo, 2019). The findings showed that, during the course of the study period, oil revenue exports favourably and considerably contributed to economic growth. Nigeria's economy appears to be dependent on its resources, based on empirical evidence.

Nigeria's slow growth may be attributed to low educational quality and low openness to experience, despite significant oil and gas revenue during the sample period (Olayungbo, 2019). As such, the results from the study provide new insights into the oil curse phenomenon in Nigeria. The oil and gas sector, once considered the country's main source of income, has been plagued by policy drift and government mismanagement and/or incompetence (Campbell and Page, 2018). The oil and gas industry in Nigeria is a complicated system beset with difficulties, but it is still vital to the country's public finances. Nigeria's vast and antiquated oil and gas infrastructure has received little new investment in recent years, partly because of declining oil prices but also because of insecurity, corruption, and regulatory issues. The country produces two million barrels of crude oil daily, but its output is frequently affected by factors such as militant attacks, vandalism, oil theft, and infrastructure failures (Ite et al., 2013; Campbell and Page, 2018).

Illegal bunkering and artisanal refining of crude oil are serious problems in some host communities producing oil and gas, particularly in the Niger Delta region of Nigeria. Unlawful bunkering and artisanal refining of crude oil, which are sometimes referred to as "crude oil theft" in Nigeria, are also a product of the extractive governance model of the nation, which cannot resolve the divisive issues of resource ownership and benefit-sharing between the Nigerian government and the host communities that produce the oil (Naanen, 2019). Since the 1990s, there has been evidence of the emergence of a conflict economy, which includes the theft and trade of refined and crude oil, inter and intra communal/ethnic conflicts over resources, and a fierce and violent competition for resource opportunities (Ikelegbe, 2006). The Nigerian government and the petroleum companies frequently carry on with their activities while the impacted oil-producing host communities in the Niger Delta region fight for attention and justice for the environmental damage through demonstrations, agitations, and violence (Ikelegbe, 2006; Albert et al., 2018; Naanen, 2019; Josiah and Akpuh, 2022).

Nigeria's economy is primarily dependent on its oil and gas resources, and as a result, changes in the price of crude oil have a significant impact on the country's GDP. Nigeria's government's long-standing over-reliance on the petroleum industry has come into stark relief in light of the country's recent economic downturn. As of late 2016, the petroleum industry contributed just 8% of GDP, despite accounting for over 70% of government revenue (Campbell and Page, 2018). Nigeria's natural gas and crude oil exports are expected to have brought in \$55 billion in 2018, a \$23 billion increase over the levels forecast in 2016 by the International Monetary Fund (IMF, 2019). The improvement in crude oil prices has contributed to the growth in export earnings, which has aided Nigeria's budgetary position. In 2019, oil and gas industry accounted for almost 80% of Nigeria's total export value, worth approximately 47 billion US dollars. Nigeria's oil and gas industry makes up around 9% of the nation's GDP, although in recent years, the lower demand brought on by the coronavirus disease 2019 (COVID-19) pandemic caused a decline in the output of petroleum resources. In the quarter ending in December 2020, the oil and gas sector's share of the total real GDP was 5.9%, down approximately 3% from the previous quarter.

The COVID-19 pandemic has put Nigeria's economy, which is marked by declining per capita income and serious governance vulnerabilities, in a precarious position (IMF, 2021). Although the COVID-19 pandemic has severely negatively impacted economic activity, the oil and gas sector has stagnated as a result of growing expenses, regulatory issues, insecurity and unrest in the host communities in the Niger Delta region (Ite et al., 2016; Campbell and Page, 2018). The IMF Country Report indicates that Nigeria's fiscal and external positions are deteriorating due to a sharp drop in international oil prices and reduced global demand for its oil and gas products. The country's oil and gas exports are expected to fall by over \$26½ billion, and despite having the second-largest crude oil reserves in Africa, the real output is expected to contract, causing per capita income to remain stagnant. In the latest IMF Country Report (as of April 2024), Nigeria's economic growth is projected to be 3.3% in 2024, but inflation is high at a projected 26.3%. However, there are still challenges, particularly with high inflation and pressure on the exchange rate (IMF, 2024).

Exploration and production of oil and gas hydrocarbons have intensified due to the need to meet the world's energy needs. This has numerous advantages but also presents certain difficulties. Recent years have seen an increase in the average exploration success rate from a cumulative of approximately 11% to over 60% due to advancements in technologies utilised for the discovery and development of petroleum resources. In the last few years, more than 5,300 wells have been drilled in several host communities producing oil and gas in the Niger Delta region. The Nigerian government continues to be mostly dependent upon revenues from petroleum, with non-oil earnings making up just 3.4% of GDP (which makes it rank among the lowest globally).

Over the years, the development witnessed in education, health, transportation, and infrastructural development has been primarily financed by the oil and gas industry. Apart from the economic development and other benefits associated with the oil and gas resources exploration and production, the environment also suffers degradation and loss in economic and socio-cultural values (Ite et al., 2013; Okotie et al., 2018b). The export of oil and gas resources is critical to the national economy and has enormously contributed to Nigeria's economy over the past sixty years. However, it is important to note that a high percentage of the population in the host communities producing oil and gas resources lives in abject poverty. The Niger Delta region's historical and ongoing operations related to oil and gas exploration and production have a documented negative effect on human rights to a healthy environment (Eaton, 1997; Ite et al., 2013; Ite et al., 2016).

3.2 Challenges Facing Nigeria's Oil and Gas Industry

Nigeria's oil and gas industry faces a number of challenges that hinder its growth and development. These challenges include oil theft, environmental degradation, lack of infrastructure, unrest in host communities producing oil and gas in the region, and the global shift towards renewable energy. The Niger Delta region is facing significant environmental degradation, sociocultural and socioeconomic issues, and loss of petroleum-derived revenue due to declining crude oil prices, bad governance, corruption, insecurity, crude oil theft, and ineffective government policies for oil and gas development, including poor implementation of environmental legislation (Ite et al., 2013; Ite et al., 2016). Oil and gas exploration and production-related discharges of chemical waste streams have had negative effects on the environment, human health, terrestrial ecosystems, socioeconomic issues, anthropological and/or regional cultural issues, and pollution of host communities in the Niger Delta region (Ite et al., 2013; Ite et al., 2016).

According to s study, there are frequently significant environmental effects, risks to human health, and socioeconomic and sociocultural issues within the host communities producing oil and gas resources at every stage of petroleum exploration, development, and production, decommissioning and rehabilitation, transportation, and distribution processes (Ite et al., 2016). Since the discovery of crude oil in 1956, the Niger Delta region has experienced significant anthropogenic activities related to the exploration and exploitation of petroleum hydrocarbons, which have resulted in the spill of at least 9–13 million barrels of crude oil, ranking the region among the five most severely polluted ecosystems globally (Ite et al., 2013; Ite et al., 2016; Chukwuka et al., 2018). Over the years, multinational oil companies have made significant investments in the oil sector, and new laws have been enacted to regulate community access to communal or open access to land, while allowing multinational investors unrestricted access to explore for oil even on sacred land (Nriagu, 2011b; Ite et al., 2016; Nriagu, 2019).

The oil and gas companies are granted unrestricted access to operate in both onshore and offshore locations within the Nigeria's Niger Delta region through the Oil Prospecting Licence (OPL), Oil Exploration Licence (OEL) and Oil Mining Lease (OML) (Ite et al., 2016). Unrestricted exploration and production of oil and gas in the Niger Delta is a complex issue with both economic and environmental consequences. Although the unrestricted exploration and production of oil and gas in the Niger Delta region has resulted in economic benefits in terms of increased government revenue from oil exports, the host communities have witnessed numerous detrimental environmental implications, socioeconomic problems, and sociocultural issues.

For instance, geological and seismic surveys disrupt biodiversity, cause forest and ground surface disturbance; site clearance for the construction of roads, tank farms, brine pits, and pipelines; exploratory drilling; development of drilling and production wells; and construction of processing and production facilities. Despite several efforts and technological development in the oil and gas industry, most of the challenges has continued to impact the host communities in the Niger Delta region. Some of the negative effects of petroleum hydrocarbons are known to be limited to the geographic areas where they are produced, consumed, and/or disposed of. In many situations, however, the effects can be minimized to safe levels if consumers practice responsible use and disposal.

Environmental pollution in the Niger Delta region is primarily caused by oil spillages; pipeline explosions; gas flaring and venting; improper disposal of large volumes of petroleum-derived hazardous waste streams, such as drill cuttings, drilling muds, formation water or produced water, oily and toxic sludges, oil spills from ageing facilities, equipment failure; sabotage of petroleum facilities; illegal oil bunkering and artisanal refining; oil well blowouts; oil blast discharges; shipping and terrestrial traffic accidents; and other operational discharges (Osuji, 2002; Scheren et al., 2002; Osuji and Onojake, 2004; Poindexter et al., 2008; Nriagu, 2011b, 2011a; Ite and Ibok, 2013; Ite et al., 2013; Anejionu et al., 2015; Ite et al., 2016; Nriagu et al., 2016; Ite et al., 2018; Okotie et al., 2018b; Nriagu, 2019). Oil and gas exploration and production operations have had the potential for a variety of detrimental impacts on the ecosystem in the Niger Delta region over the years. The severity of these adverse impacts depends upon the stage of either exploratory or production process, the size and complexity of the project, the nature and sensitivity of the surrounding environment, and the effectiveness of planning, contamination/pollution prevention, mitigation and control strategies (Okotie et al., 2018b; 2018a).

Over the past decades, gas flaring and oil spills closer to the shore have had socio-economic impacts which adversely impacted the ecosystems and

the indigenous people of host communities producing oil and gas in the Niger Delta region. Oil and gas exploration and production-related discharges of chemical waste streams have damaged the soil, water, and air quality and expose flora and/or fauna to extinction. This has caused soil compaction, poor seed germination, retarded plant development, and extinction of mangrove and tropical forest species. Important elements or variables that affect an oil spill's effects include the spill itself, disaster management, the physical marine environment, marine biology, human health and society, the economy, and legislation (Jafarnejad, 2017b; 2017a). Despite the fact that the extent and location of an oil spill determine its effects, the socioeconomic and ecological consequences of oil production can be significant and include things like biodiversity loss, farmland degradation, wildlife destruction, air and water pollution, and destruction of aquatic ecosystems (Elum et al., 2016).

The Niger Delta region has recently been characterised by decreased biodiversity, mutation of wild genetic strains, and the eventual extinction of most species. People whose livelihoods depend on the environmental services that the wetlands of the Niger Delta supply are inevitably impacted by this (Chukwuka et al., 2018; Ugwu et al., 2021). However, due to process issues, a plethora of overlapping regulations, and the peculiar common law standards that established them all make it impossible to provide compensation for environmental harm under current legislation (Okonmah, 1997; Ite et al., 2016). In Nigeria, vast amount of revenue has been derived from petroleum resources export while the oil-producing host communities in the Niger Delta region have been left with severe land degradation, socioeconomic and socio-cultural disorganization, increasing poverty, and misery (Okonmah, 1997; Nriagu, 2011b; 2011a; Ite et al., 2013; Ite et al., 2016; Nriagu, 2019). Overall, the rationale behind the socioeconomic underdevelopment of the people living in the Niger Delta area is the persistent imbalance in the production-exchange relationship between the state, multinational oil firms, and the people, even with the region's huge oil and gas resources.

Approximately 6% of global gas reserves are found in Nigeria's gas fields, and they are split 50% to 50% between associated gas (which includes oil) and non-related natural gas. Nigeria possesses the second-largest reserves of crude oil in Africa; yet, the country's petroleum industry has stalled as a result of growing expenses, regulatory issues, and instability in the oil-producing Niger Delta. Nigeria is one of the ten countries with the greatest natural gas reserves in the world, but it has had difficulty using the resource for export or the creation of electricity, and much of the natural gas produced from the extraction of crude oil is flared (Nriagu, 2011b; Ite and Ibok, 2013; Dim, 2016).

According to a study, owing to unsustainable drilling methods and inadequate infrastructure for gas utilisation, over 50% of Nigeria's gas production is flared, with the remaining 33% being utilised for commercial purposes and the remaining 12% being reinjected into wells to improve oil recovery (Nriagu, 2019). Over the past decades, Nigeria has not devoted equal attention to her abundant energy resources. According to a study, Nigeria has focused its efforts on developing, extracting, and using crude oil to generate energy to fuel the country's economy and achieve fiscal policy goals (Adenikinju, 2008). But according to reports, having access to energy is a crucial tool that may help advance human growth, strengthen the economy, and promote sustainable development (Ugwoke et al., 2020). The crippling impacts on the industrialization process are one example of how Nigeria's low quality, inconsistent, and scarce electricity supply has affected the country's economic progress.

The biggest obstacle to Nigerian manufacturers' enterprises, according to a study, is a lacklustre power supply (Adenikinju, 2008). Most of them need to use highly expensive auto-generation to augment the power provided by the government. Therefore, removing the obstacle of erratic electricity production will improve the real sector's microeconomic reaction to the different government incentives. The nation now holds the unpleasant distinction of being rated first among gas flaring nations, with an estimated 3.5 billion cubic feet of gas produced daily. It is also one of Africa's top emitters of carbon dioxide, a greenhouse gas (Nriagu, 2011b; Ite and Ibok, 2013; Nriagu, 2019). Gas flaring and venting is a widespread problem that has contributed significantly to both economic losses and environmental degradation in the country (Ite and Ibok, 2013). To address the issues surrounding petroleum-derived chemical wastes, which have substantial negative effects on the environment and economy, industrialised nations have taken a number of proactive and remedial actions.

According to a study, in order to safely dispose of associated natural gas during petroleum development operations and/or in situations where there isn't infrastructure to bring it to market, the petroleum industry frequently uses flaring and venting of associated natural gas (Ite and Ibok,

2013). Due to a lack of gas markets and the high expense of gas storage and transportation, Nigeria flares more gas than any other country in the world, with the exception of Russia and Iraq (Ite and Ibok, 2013; Adewuyi et al., 2020). According to reports, Nigeria wastes over 2.5 billion cubic feet of the generated gases from the refining of crude oil annually through gas flaring and venting. A Consideration of the environmental economics of the volume of gas flared and vented over the years, reveals that this amounts to significant economic and environmental losses. The incidences of petroleum hydrocarbon pollution, however, have adversely impacted the host communities in the Niger Delta region and their environments. As such, the Niger Delta region could be described as one of the worst petroleum hydrocarbons polluted and/or impacted zones globally.

The environmental impacts associated with the petroleum industry are mainly negative due to the toxicity of petroleum hydrocarbons, which contribute to environmental degradation, air pollution, land and/or marine contamination/pollution, acid rain, and human health risks (Ite et al., 2013; Ite et al., 2016; Ite et al., 2018). Long- and short-term impacts on the surrounding ecosystems are evident due to the oil and gas industry's extractive installations and procedures. The exploration and production of oil and gas results in the generation of hazardous wastes with different chemical compositions in almost every stage (Nriagu, 2011b; 2011a; Nriagu, 2019). The Niger Delta region is frequently defined by pervasive issues with pollution caused by petroleum hydrocarbons and by Nigerian multinational oil and/or oil and gas service corporations' disregard for best practices to promote sustainable development goals.

In January 16, 2012, for instance, the Chevron North Apoi Gas Rig, which is situated in Southern Ijaw, Bayelsa State, experienced a blowout. The explosion caused a massive gas fire and an unintentional leak that lasted for 46 days, severely harming the ecosystem. About 549,060 barrels of crude oil were recovered and 1,820,411 barrels were lost to the environment in the Niger Delta region between 1976 and 2000, according to estimates of the 2,567,966 barrels of crude oil that were spilled in 5733 events during that time (Edoho, 2008). Environmental pollution from petroleum, risks to human health, and socioeconomic issues resulting from the activities of the oil and gas industries globally are all influenced by a number of factors, including the geology and geography of the oil-rich host communities, the stages of exploration, development, and production processing, the population's socioeconomic activities, cultural heritage, corporate governance systems, and political economy (Ite et al., 2016).

The primary source of environmental pollution that endangers human health and safety and frequently has several socioeconomic repercussions in the affected regions is the unintentional release of petroleum hydrocarbons into the environment, whether from anthropogenic activities or other means (Colwell and Walker, 1977; Holdway, 2002; Eweje, 2006; Ite and Semple, 2012; Ite et al., 2013; Ite et al., 2016). Several petroleum-related incidents have occurred in the Niger Delta over the years, and these have a tendency to shape the relationship between host communities that produce oil, multinational oil companies, and the Nigerian government (Ite et al., 2013; Ite et al., 2016).

The growth of the oil and gas industry in a host community may have both good and negative economic effects on existing fisheries and marine-based aquaculture (Pascoe and Innes, 2018). Since the discovery of crude oil in 1956, environmental pollution related to the oil and gas industry has significantly reduced ecosystems, fisheries, mangroves, agricultural lands, and farm output in the Nigeria's Niger Delta region (Ite et al., 2016; Mogaji et al., 2018). It is commonly known that environmental issues like those brought on by oil and gas exploration and production in host communities that produce petroleum have a negative impact on agricultural activities, which frequently results in low agricultural yields and income loss (Mpandeli and Maponya, 2014). Overall, the agricultural sector is essential to the rural economies of most developing nations worldwide and provides a living for a significant portion of Africa's population (Dung et al., 2008; Odjugo and Osemwenkhae, 2009; Elum et al., 2016).

The effects of petroleum exploration and development on fisheries have been reviewed by some researchers (Benner et al., 1991; Peterson et al., 2003; Hjermann et al., 2007; Cherr et al., 2017; Mogaji et al., 2018; Pascoe and Innes, 2018). It is widely known that crude oil spills associated with oil and gas industries often kill fish, the larvae that feed on them (their food sources), endanger fish hatcheries and have devastating consequences on fish reproduction in the Niger Delta region (Peterson et al., 2003; Osuagwu and Olaifa, 2018). It has been documented that crude oil spills and petroleum hydrocarbon pollutants in the marine environment also impair fish reproduction, also impair fish reproduction, causing both immediate and long-lasting damage to fish stocks (Nriagu, 2011b; Nriagu, 2019). Evidence from several studies carried out around the world suggests that petroleum hydrocarbon pollutants can have a variety of long-term

consequences in addition to killing fish, which can lead to a significant reduction in total populations. Few studies have reported that over the last few decades, oil spills and other petroleum hydrocarbon-related contaminants have severely degraded the mangroves in the Niger Delta region, which are important fish breeding grounds (Nriagu, 2011b; Anejionu et al., 2015; Nriagu, 2019).

The effects of oil spills on marine biological systems are of major concern, and research into the biological consequences of oil spills is critical. In a study, Osuagwu and Olaifa used an estimable Cobb Douglas production function to investigate how crude oil spills affected fish output in Nigeria's Niger Delta region from 1981 to 2015 (Osuagwu and Olaifa, 2018). Their research indicates that whereas agricultural work has a favourable effect on fish production, oil and gas exploration and production activities and associated crude oil spills have a detrimental effect on fish productivity. Crude oil spills near spawning grounds or areas where eggs and larvae float may pose the greatest threat to several fish species in the impacted zones (Hjermann et al., 2007; Rooker et al., 2013). According to a study, fish eggs and larvae are particularly susceptible to toxic oil compounds due to their small size, poorly developed membranes, and position in the water column (Langangen et al., 2017).

In some laboratory studies, it has been demonstrated that petroleum hydrocarbons (mainly polycyclic aromatic hydrocarbons, PAHs) at low concentrations of petroleum hydrocarbons can cause death or sub-lethal damage (Carls et al., 1999; Scott and Sloman, 2004; Meier et al., 2010; Hicken et al., 2011; Sørhus et al., 2015). Petroleum hydrocarbon pollution may injure fish through direct or indirect pathways and via either acute or chronic effects (Peterson et al., 2003). Considering the negative concomitance of crude oil spills and fish production, it has been suggested that a cautious approach should be adopted by petroleum industries during exploration and development activities in the Niger Delta region in order to achieve sustainable development goals (Osuagwu and Olaifa, 2018). Apart from fisheries, aquatic resources have contributed to the development of agriculture, tourism, and provided basic and transitional materials for industries, shelter, and breeding sites for game birds as well as other migratory birds (Godwin-Egein et al., 2018).

The consequences of discharges of petroleum hydrocarbon-derived chemical waste streams are numerous, and there is substantial evidence that crude oil spills can greatly increase fish mortality (Hjermann et al., 2007; Fodrie et al., 2014). The increasing population of Nigeria's Niger Delta region has suffered greatly as a result of the degradation of agricultural land brought on by the prospecting, exploitation, and production of oil and gas resources (Ite and Ibok, 2013; Ite et al., 2013; Chukwuka et al., 2018). There is less land accessible for agricultural and food production as a result of this degradation, which is frequently seen as coastline erosion and landscape damage. Pollutants containing petroleum hydrocarbons have the potential to damage or drastically impair soil fertility, alter the elemental makeup of soil and water cycles, and increase bulk density, which can have an adverse effect on plant development by reducing soil aeration and water penetration.

Furthermore, secondary contamination of groundwater and air, inhibition or eradication of soil species, and losses in the aesthetic value of ecosystems are all consequences of petroleum hydrocarbon degradation of soil. Research on the impacts of crude oil, including used lubricating oil, and refined petroleum products on soils and soil organisms has been published in several publications (de Jong 1980; Anoliefo and Vwioko, 1995; Odjegba and Sadiq, 2002; Agbogidi et al., 2007; Klamerus-Iwan et al., 2015; Galitskaya et al., 2021). The results of these investigations showed that several food crops experience stomatal abnormalities and mortality as a result of oil derivatives and/or components suppressing seed germination and evapotranspiration in plants (de Jong, 1980; Anoliefo and Vwioko, 1995; Odjegba and Sadiq, 2002; Agbogidi et al., 2007; Klamerus-Iwan et al., 2015; Galitskaya et al., 2021). According to a study, petroleum hydrocarbon contamination with PAHs can modify the physical properties of forest soils and petroleum hydrocarbons have a negative impact on enzyme activity in soils (Langangen et al., 2017; Klamerus-Iwan et al., 2015). Farmers in polluted oil-producing host communities generate less revenue than those in non-polluted oil-producing host communities, despite the lack of reliable information regarding the effects of petroleum pollution on agricultural produce in the Niger Delta region.

Nigeria had an agrarian economy before commercial quantities of petroleum resources were discovered in 1956. Despite the mix effects associated with the petroleum industry, revenue derived from the sector is nevertheless crucial for both short-term and long-term economic growth. Recently, it has been noted that Nigeria's economy is mostly dependent on petroleum production because the country's agriculture sector is unable to provide adequate food for its population (Ugochukwu

and Ertel, 2008; Raifu, 2021). Oil and gas contaminated soil is a major global environmental issue that has drawn attention from the public in recent decades. As long as the soil continues to be contaminated, food security in Nigeria and the Niger Delta region will either worsen or be threatened. Eweje reports that the majority of oil companies that operate in least developing countries (LDCs) have faced accusations from their host communities and governments regarding degradation of the environment and pollution (Eweje, 2006).

Indeed, this problem has given rise to a number of wars. One example is the Niger Delta region of Nigeria, where the oil and gas producing host communities, the Ijaws and the Ogonis, have been engaged in ongoing conflict with the multinational oil companies that operate there (Eweje, 2006; Elum, et al., 2016). Over time, the extraction and exploration of petroleum resources have resulted in environmental degradation that has had a number of detrimental repercussions. Ultimately, the mangrove forest has gone from being extremely dense to being lowly dense and eventually becoming mixed forest. Other issues brought about by exploratory operations include the invasion of alien species and the urbanisation of mangrove regions (Numbere, 2018). In host communities producing oil and gas resources in the Niger Delta, the majority of resource exploration and production activities have contaminated the environment and pose potential risks to the atmosphere, soils, sediments, surface and groundwater, marine environment, flora and fauna, and the natural environment (Ite and Semple, 2012; Ite et al., 2013). A lot of people living in oil-producing host communities and/or near oil exploration sites in the Niger Delta region have suffered as a result of environmental stressors associated with exposure to both chemical pollutants, thermal pollution, noise pollution, and physical threats that are all harmful to human health and wellbeing. Apart from their contribution to cumulative risk assessment, environmental stressors are factors that influence productivity, reproductive success, and ecosystem development.

3.3 Issues Associated with the Oil and Gas Industry Operations

Oil and gas resources exploration, exploitation, and production in the Niger Delta region has negative environmental impacts, ecological problems, socioeconomic and socio-cultural consequences, and human health implications/risks. The associated petroleum hydrocarbon pollution is one of the most devastating environmental hazards, with both short-term and long-term consequences for natural ecosystems. Toxic wastes of various chemical compositions are generated at every stage of oil and gas exploration and production operations. The main sources of petroleum hydrocarbon pollutants include improper disposal of drilling fluid and cuttings, shipping and terrestrial traffic accidents, discharges of tank washing and oil-contaminated ballast water, depot leakages, equipment failures, and oil pipelines ruptures or blowout.

Nigerians had "paid a high price" for the economic growth brought by the oil and gas resources exploration and production in the Niger delta region over the past six decades. The connection between oil and gas industry and militancy is a complex and concerning issue, particularly in the Niger Delta region of Nigeria. There are various vices that also obstruct sustainable development in the oil and gas industry in the region. For example, many multinational oil companies may be put off their investment in assets in the region because of the fear of losing them. Competition for resource and political control, notably over oil and gas resources derived revenue and associated advantages, leads to ongoing and/or recurring violence in the region. Over the years, the government's attempts to resolve conflict in the region have frequently included an overly militarised approach to policing, which tends to exacerbate tensions and does little to reduce the region's high levels of insurgency, militancy, instability, insurrection, oil theft (illegal oil bunkering), pipeline vandalism, and communal violence.

It has been suggested that poor and inadequate governance has promoted violent opportunism surrounding the oil and gas industry and provided possibilities for organised crime, among other vices in the region (Ross, 2013; Katsouris and Sayne, 2015). Poor governance, mismanagement of oil and gas derived revenues, and widespread corruption on the part of host governments have all contributed to increased political and economic instability, militancy and conflicts in oil and gas producing countries, resulting in enormous costs for the oil and gas industry. Over the last six decades, some of the most heinous evidence of the oil and gas industry's actions has included crude oil theft, artisanal refining and its accompanying petroleum hydrocarbon-related pollution, as well as environmental deterioration and the long-term human health consequences of pollution.

3.3.1 Oil Theft, Illegal Oil-Bunkering, and Pipeline Vandalism

Oil theft, illegal bunkering, and pipeline vandalism occur in varying

degrees and amounts throughout Nigeria's Niger Delta region. Oil theft (through the method of hot-tapping, cold-tapping, and/or terminal and vehicle transportation) in Nigeria is defined as the illegal appropriation of crude or refined petroleum products from multinational oil companies' pipelines. The Niger Delta region has become a global hub for oil crime, which has wreaked havoc on Nigeria's environment, land, air, and water. Oil crime in the Niger Delta region is one of the most serious natural resource crimes in the world, with up to 20% of Nigeria's oil output being stolen, sold, and illegally refined (Cartwright et al., 2020). In the Niger Delta region, oil theft and illegal oil-bunkering have a positive connotation in terms of an entrepreneurial free market response to local economic dysfunction, socioeconomic pressures, and the government's failure. Although the phenomenon is known to have 'a long history in the Niger Delta', the word is frequently used to refer to a criminal behaviour entwined with political, social, and economic difficulties (Vreĳ, 2012; Aboosed Omowumi, 2017).

There is evidence to suggest that crude oil theft in the Niger Delta region pre-dates the militant conflicts of the 1990s. The Niger Delta region has experienced a significant increase in crude oil theft due to the cooperative efforts of security forces, militia groups, local residents, and employees of oil companies. These individuals employ diverse techniques to pilfer oil from the pipelines and facilities owned by multinational oil companies. The Niger Delta region's illegal oil bunkering activities are supported by a number of factors, such as: (a) poverty; (b) ignorance; (c) greed; (d) disrespect for the country's economic survival; (e) get-rich syndrome; (f) a lack of gainful employment for young people in the area; (g) abusing the criminal justice system's loopholes to evade the law; (h) an evolving culture of impunity stemming from the false belief that some people are above the law; (i) a lack of effective institutional framework to apprehend criminals; (j) malice; (k) poor governance (corruption, incompetence); (l) criminal impunity in the nation; (m) the government's and multinational oil companies' neglect of the region; (n) the desire to share and participate in the national cake; and (o) cooperation between the security personnel and the crude oil bunkers (Nwajaku-Dahou, 2012; Vreĳ 2012; Murphy, 2013; Shepherd, et al., 2022). It has been observed that Nigeria's Niger Delta region has been completely neglected as a result of poor governance, ineffective administration and widespread corruption, paving the way for the twin crises of crude oil theft for export and illegal refining.

Illegal bunkering activities in Nigeria's Niger Delta region and their ecosystem-economic consequences have increased exponentially over the past three (3) decades. Recently, illegal bunkering activities have escalated, thereby posing serious implications for various facets of the Nigerian economy, society, and environment. The Nigeria Extractive Industries Transparency Initiative (NEITI) reported in its newest audit report, published in July 2021, that Nigeria lost 42.25 million barrels of crude oil (valued at \$2.77 billion) to oil theft in 2019. Nigeria's crude oil theft is primarily driven by illegal oil exports, causing significant financial losses for the government and multinational oil companies, and local artisanal processing, which has negative environmental impacts (Naanen, 2019). The Niger Delta region's massive crude oil theft may be attributed to Nigeria's debt, naira's decline, and a decrease in borrowing obsession over time. The federal government has been spending more money on security in an attempt to reduce illegal oil bunkering in the Niger Delta region, but the trafficking in stolen crude oil and constant vandalism of pipelines and other petroleum installations around the communities producing oil and gas resources have not stopped. This suggests that the significant public efforts made to ensure the security of oil and gas installations have not produced the necessary outcomes. Over the last decade, petro-piracy, drug trafficking, and arms proliferation have been dramatically reinforced by illegal crude oil bunkering and artisanal refining (Murphy, 2013; Cartwright et al., 2020). Therefore, the Niger Delta region's illegal crude oil bunkering operations, petroleum facilities, and pipeline vandalism present a danger to the fundamental underpinnings of the oil and gas sector and the Nigerian economy as a whole.

3.3.2 Artisanal Refining

Nigeria's model of extractive governance, which fails to address the contentious issues of resource ownership and benefit-sharing between the Nigerian state and the host communities producing oil and gas resources, is the primary cause of illegal bunkering (oil theft) and artisanal refining in the nation. Poverty is not the only factor contributing to these practices (Naanen, 2019). Apart from the scarcity of petroleum products in the host communities producing oil and gas in the Niger Delta region, rising international oil prices and the Nigerian government's increasing deregulation of domestic prices have boosted artisanal refining in the region (Naanen, 2019; Bebetidoh et al., 2020; Onakpohor et al., 2020). In the Niger Delta, crude oil theft and illegal crude refining have grown

commonplace, particularly among young people. The host communities producing oil and gas in this region have used unconventional technology to refine stolen crude oil, which they either sell locally or export to neighbouring countries, as a result of a survival instinct sparked by deprivation and loss of livelihood (Naanen, 2019).

Flares and associated carbon particles (soot) from nearby artisanal crude oil refining facilities are significant environmental and health hazards in the Niger Delta (Naanen, 2019; Bebetidoh et al., 2020; Onakpohor et al., 2020). Acidic aerosols formed by atmospheric mixtures of flue gas components (dust particles, SO_x, CO and NO_x) and gaseous emissions from artisanal refineries in the Niger Delta pose a significant environmental and public health risks. Petroleum hydrocarbon pollution caused by local crude oil refiners' activities and petroleum-derived waste discharges in the Niger Delta region has resulted in marine pollution, soil contamination, ecosystem degradation, mangrove vegetation destruction, and ground water pollution. Although petroleum hydrocarbon pollution and environmental degradation in oil and gas producing host communities are widely attributed to the activities of multinational oil companies, the extent to which illegal artisanal refineries contribute to the Niger Delta region's environmental problems is unclear (Nriagu, 2011b, 2011a; Ite and Ibok, 2013; Ite et al., 2013; Ite et al., 2016; Ite et al., 2018; Josiah and Akpuh, 2022).

Petroleum hydrocarbon pollution associated with the artisanal petroleum refineries in the Niger delta region and discharges of petroleum hydrocarbon-derived chemical waste streams into the ecosystems suppresses the major functions of fauna and flora in the entire ecological system. Because of their hazardous, mutagenic, and carcinogenic qualities, local crude oil refineries' discharges into the soil disrupt beneficial microbial interactions, which increase the risk of health problems for humans (Chikere and Fenibo, 2018). According to several researchers, the Niger Delta region's indigenous populations are extremely concerned about oil pollution since it contaminates ecosystems and food chains that support life, such as fishponds, mangroves, streams, and rivers (Ite et al., 2013; Sam and Zabbey, 2018; Bebetidoh et al., 2020).

It is known that exposure to crude oil can cause severe cardiovascular effects and deactivates the feeding duct in echinoderms, resulting in malignant tumors in fish mouths and eye burning. Although it is well recognized that the toxicant crude oil damages fish health, its effects on fish parasites are less obvious; some may be favoured while others are not (Khan, 1987; Mohsenpour and Loyeh, 2020). As such, long-term exposure to some chemicals found in crude oil may damage the immune system, interfere with hormones and cause genetic abnormalities or cancer in sensitive species of fish. According to a study hydrocarbon contamination causes poor fish health and, in extreme cases, extinction due to non-reproduction and death (Udotong et al., 2017). In a related study, reported that fish and other aquatic life are suffocated by crude oil slicks, which are layers of contaminated oil floating on the surface of rivers and streams (Clinton et al., 2014). Additionally, discharges of petroleum hydrocarbon-derived chemical wastes stream from artisanal refineries into adjoining rivers, causes significant damage to marine environment, aquatic life and natural ecosystem (Asimiea and Omokhua, 2013).

In Nigeria's Niger Delta region, the greatest threat to the host communities producing oil and gas resources in the and its inhabitants is environmental pollution and human health hazards (Ite et al., 2013; Kuenzer et al., 2014). In addition, Yabrade and Tanee reported that local crude oil refining in the Niger Delta region of Nigeria has raised the toxicity level of the soil, changed its chemical composition, and, if left unchecked, might have disastrous effects on saltwater wetland ecosystems (Yabrade and Tanee, 2016). In a recent study, authors have investigated the environmental impact of artisanal refineries on ambient air quality in the Niger Delta region and the findings revealed that the activities of these artisanal refineries greatly contribute to air pollution within the host communities (Onakpohor et al., 2020).

Artisanal crude oil refineries in the Niger Delta region are major sources of air pollution (e.g., gaseous pollutants and particulate matter). Their operations frequently result in environmental pollution, economic losses for multinational oil companies, and loss of petroleum hydrocarbon-derived revenue, contributing to petroleum hydrocarbon-derived environmental pollutants and human health implications associated with either short-term or long-term exposure (Okotie et al., 2018a). The Nigerian government has taken note of the local crude oil refiners' operations because of the significant financial losses they have caused the country (Allen and Seaman, 2007; Dominic, 2016). Beyond the financial implications of crude oil theft in Nigeria, immediate action is needed to address the environmental damage brought on by "illegal crude oil refineries".

3.3.3 Marine Communities and Ecosystem Degradation

Mangroves, which are characterised by the presence of woody plants that have adapted to survive in tidal wetlands, supply various goods (e.g., food, spices, biogenic minerals, raw materials, ornamental resources, firewood, fisheries, medicinal resources, etc.) and provide invaluable ecological services to humanity. In tropical and sub-tropical ecosystems, mangroves are extremely productive forests that interface between marine and terrestrial environments (Duke, 2016; Naidoo, 2016). Mangroves are intriguing intertidal woodlands that can withstand salt. They may be found along most tropical and subtropical beaches, making their reach truly worldwide. They are estimated to occupy between 137,760 and 152,360 square kilometres of the planet's surface, and they are essential to these coastal ecosystems (Kainuma et al., 2013).

Mangroves may be found throughout the West African coast from Mauritania to Angola in the Gulf of Guinea, with around one-third of them located in Nigeria's Niger Delta. According to a study, they supply a range of plant items, fish and shellfish for local populations, enhance water quality, maintain coastal stability, support near-shore fisheries by acting as food chains, and engage in carbon sequestration (Onyena and Sam, 2020). They also act as habitats for various fish species. Ecologically, mangroves are essential locations for a variety of migratory birds, mammals, and finfish and shellfish to spawn and feed. In addition to providing crucial homes for a variety of species, the mangrove trees and canopy supply the local populace with honey, fuel, and decorative medicinal plants. (Nagelkerken et al., 2008; Walters et al., 2008; Hsieh et al., 2015; Naidoo, 2016; Onyena and Sam, 2020; Spencer et al., 2021; Sarkar, 2022).

Despite these socioeconomic and environmental benefits, mangroves in the Niger Delta region have been negatively impacted in recent times due to various anthropogenic activities, including over exploitation, oil spills, and crude oil exploratory activities (Akanni et al., 2018; Onyena and Sam, 2020). The Niger Delta region's coastal system stabilisation has been impacted, freshwater availability has decreased, livelihood structures have been destroyed and global warming control measures have been impacted by the aforementioned human activities. Some researchers have reviewed the effects of petroleum hydrocarbon contamination and/or impacts of pollutants on mangrove ecosystems (Lewis et al., 2011; Duke, 2016; Naidoo, 2016; Onyena and Sam, 2020).

Mangroves around the world are currently experiencing extreme anthropogenic stress. Several researchers have documented that mangrove are the most highly susceptible marine environments to large-scale and chronic oil spills (Baker, 2001; Ite et al., 2013; Duke, 2016; Zhang et al., 2019b; Onyena and Sam, 2020). Mangrove forests are among the most vulnerable environments to petroleum hydrocarbon pollution because the trees are quickly smothered by crude oil, and their mortality results in habitat loss for the fish, shellfish, and mammals that rely on them (Baker, 2001; Kainuma et al., 2013). According to a global study of crude oil's impact on mangroves, the Niger Delta has accounted for 37% of the global destruction (Duke 2016). Over the years, a significant amount of petroleum hydrocarbon-derived chemical waste and/or crude oil has been discharged into coastal environments, and these mangroves are extremely sensitive to oil contamination.

In the past 60 years, there have been no fewer than 238 major oil spills adjacent to mangrove-dominated shorelines worldwide (Onyena and Sam, 2020). These oil spills have accounted for over 5.5 million tonnes of oil released directly, affecting up to more or less than 1.94 million ha of mangrove habitat and having destroyed at least 126,000 ha of mangrove ecosystems since 1958 (Sheppard, 2018; Onyena and Sam, 2020). Oil spills, which occur regularly in the Niger Delta region (Olajire et al., 2005; Osuji and Ozioma, 2007; Ite, 2012; Ite et al., 2013; Sam et al., 2017; Ite et al., 2018), have detrimental impacts on the soils and sediments, surface and groundwater, marine environment, terrestrial and aquatic ecosystems, biota and extensive environmental degradation in the Niger Delta region.

When oil is released into coastal and estuarine waters, it spreads across the water surface triggering a series of complex interactions of physical, chemical, and biological processes. Oil spills on surface water spread quickly; some become dissolved in water and may oxidize, while others may undergo bacterial changes and ultimately sink to the bottom by gravitational action. In the process, the sediment is contaminated and thus has a significant effect on the biota. Marine wildlife is particularly susceptible to the toxic effects of oil and are generally far more subjected to petroleum pollutants than land-based wildlife. The intertidal zone, where significant amounts of oil are often concentrated, is where some of the major consequences are observed (Peterson et al., 2003). Sedentary

species and benthic organisms are the most affected. Diverse species have exhibited varied levels of biological resistance or sensitivity to interaction with oil, with prolonged exposures resulting in preferred redistribution of populations and habitat rearrangement by more robust biota, changing ecosystems (Onyena and Sam, 2020).

The major negative impacts of oil pollution are biodiversity loss and habitat destruction, which are mostly caused by marine ecosystem and top soil degradation. Any mangrove zone that has been polluted by oil is subject to additional difficulties. For example, in the petroleum hydrocarbon polluted area of the Niger Delta region, mangrove forests have been diminished owing to the toxicity of oil spills and are being replaced with noxious non-native *Nypa fruticans*, commonly known as nypa palms (Bello, 2017). These invasive plants have a shallow root structure that destabilises the banks of the streams, affecting sediment dispersion lower in the delta system. Furthermore, if there is an oil spill, phytotoxins are introduced into the environment, impairing the photosynthetic process. Oil spills can cause a range of impairments to marsh vegetation, including reduced growth, photosynthetic rate, stem height, density, and above-ground biomass, ultimately leading to plant mortality (Bello, 2017; Akanni et al., 2018; Onyena and Sam, 2020).

Nigeria's coastal area, which is part of the Guinea Current Large Ecosystem (GCLME), is one of the world's most productive marine ecosystems, with the following characteristics: (i) abundant fishery resources; (ii) oil and gas resources; (iii) valuable minerals; (iv) high potential for coastal tourism; and (v) a reservoir of marine diversity. The management of resource development is crucial in sustaining the Niger Delta ecosystems and the human population in the Nigeria's Niger Delta region. Because of the extent of mangrove degradation in the Niger Delta region, host communities producing oil and gas resources lack a participatory framework for mangrove conservation (Onyena and Sam, 2020). Furthermore, mangrove conservation strategies in the region limit community engagement and do not include co-management frameworks for mangrove conservation and protection (Onyena and Sam, 2020). As a result, there is a need for a better understanding of marine ecosystems and the development of a framework for mangrove conservation in the coastal host communities producing oil and gas resources in the Niger Delta region.

3.3.4 Socioeconomic and Sociocultural Impacts

Oil and gas exploration and production have resulted in large-scale land grabs or land acquisition from the host communities (wherein incentives are paid to the people in most cases), oil spills, gas flaring and venting. As a result, agricultural land and fishing areas have become contaminated, posing a threat to people's cultural, economic, and social well-being. The oil and gas industry's activities have frequently resulted in a slew of anthropological, social and cultural problems. These include occupational dislocation; increased social conflict; rural-urban migration; increased social disruption; unemployment; loss of sense of place and security; poor human health; loss of cultural tradition and identity; damage to cultural assets; damage to spiritual connections; and decreased use of traditional resources. Although recent decades have witnessed an increase in studies on the negative environmental effects of oil spills, little study has been done on the social consequences of oil pollution in the Niger Delta region (Omohundro, 1982; Albert et al., 2018).

Petroleum hydrocarbon pollution has serious socioeconomic consequences, including economic marginalization, deprivation, unemployment, poverty, and inequality, all of which are major causes of violent disputes, grievances, rebellions, and anti-government movements (Albert et al., 2018; Alozie, 2021; Agbonifo, 2022). More fundamentally, the deprivation of local people's means of subsistence as a result of petroleum production activities has far-reaching socioeconomic effects, rendering the need for sustainable development moot (Agbonifo, 2022). The extent to which these impacts are felt is especially significant for local communities and indigenous peoples, whose traditional, communal, and social values may be impacted, as the evidence currently available indicates a substantial influence on the entire communities with many components involved. (Chang et al., 2014a; Fentiman and Zabbey, 2015; Albert et al., 2018).

Oil pollution in the host communities in the Niger Delta region also affect indigenous people and/or rural communities that rely on the environment for social and cultural purposes. Certain cultural festivals and traditional activities that were formerly prevalent in coastal host communities in Nigeria's Delta region have been discontinued as a result of the oil spills. The custom of community members celebrating the New Year by taking a ceremonial dip in a river is one common example (Onyena and Sam, 2020). Because of the custom that bathing in that river heralds the beginning of a

"new year of many good tidings," people in the community view the custom as essential to their "prosperity" in the next year. The Ogbonja cultural festival is another important cultural practise of the Ogoni community that has been directly affected by the oil spill. It is an annual festival in which the women of the community cook together and invite the men to join them for dinner. At the end, the women go to the stream to bathe.

Unfortunately, due to oil pollution of streams, they can no longer bathe in the streams. The practice is being phased out in the oil and gas producing communities because oil spills have contaminated coastal streams and make them unsuitable for such purposes (Onyena and Sam 2020; Ocholi 2022). In a study, Omoweh reported how the multinational oil company's incessant violation of the cultural beliefs of the people through the destruction of their traditional places of worship and sacred sites, the killing of totemic animals such as iguana and python by its oil workers have inflicted serious damage to the social context of traditional festivals thereby restricting the quality of life and upturning the traditional medical system (Omoweh, 1995). It is crucial to note that the way out of the increasing danger of overdependence on petroleum is the adoption and repackaging of cultural festivals in line with world best practices. Harvests, betrothals, initiations, coronations, foundation days, burials, and long-standing communal customs are all honoured with cultural festivals. The festivals are significant because they serve to highlight the people's rich cultural heritage. Festivals of culture are essential components that fuel tourism.

Oil and gas exploration and production related activities in the Niger Delta region have had major consequences, including the loss of arable farm land, which has significantly reduced farmers' access to land and food, rendering the area uninhabitable and leading to mass migration of people and animals. Farmers who have lost their holdings have been compelled to emigrate to neighbouring areas in search of work, putting extra strain on the available natural resources in the area (Omofonmwan and Odia, 2009). Examples of results include changes in social structure, organisation, and cultural heritage, practices, and beliefs; they can also have negative impacts on natural resources, rights to access, and effect on foreigners' value systems (Omohundro, 1982; Palinkas, et al., 1993).

Conflicts between development and protection, natural resource usage, recreational use, tourism, and historical and cultural resources may lead to lack of planning strategies (Onyena and Sam, 2020). Oil pollution leads to the loss of aesthetic value due to unsightly and noisy facilities and transport systems. This is caused by expanded road work, air, and marine infrastructure along with accompanying consequences (e.g., noise, accident risk, increased maintenance requirements, or change in present service). In recent years, unchecked environmental contamination has grown to be an important concern. Living environmental compartments, including human beings, are always exposed to multiple chemicals, with chances of synergistic effects of compounds in the presence of others.

The failure of the federal government and the multinational oil companies engaged in the oil and gas exploration and production to sufficiently mitigate the effects of their operations in the region is one of the reasons of the crises in the Niger Delta region. It is generally known that in the Niger Delta, conflicts between the federal government, multinational oil companies, and the host communities that produce the oil and gas are stoked by oil exploitation and the unfair distribution of the benefits that it brings (Omofonmwan and Odia, 2009; Obi, 2010). The effects of oil pollution on the people of the Niger Delta region and the failure of the Federal Government to intervene and bring sustainable development to the people of the Niger Delta region led to the initiation of militancy activities in the region (Babatunde, 2014).

As such, the Niger Delta region could be seen as a corrosive community that is prone to recreancy and litigation, as well as prolonged uncertainty, contested meanings, claims, and counterclaims. The corrosive community is marked by conflict, weakening social bonds, distrust, social isolation, and demoralisation, all of which are factors in long-term psychosocial stress and mental health issues. Over time, oil and gas exploration and production have contributed to a number of vices, including hostage-taking, pipeline vandalism, sabotage, oil spills, community demonstrations, oil theft, artisanal refining, and abduction, in addition to worsening pollution and restless young.

3.3.5 Human Health Implications

Petroleum pollution of the environment is a global problem because of the toxicity of the hydrocarbons and the refractory nature of the aromatic components in the absence of oxygen (Ite and Semple, 2012; Ite et al., 2013; Kuppasamy et al., 2020). The human health hazards associated with

oil and gas exploration and exploitation are covert and slow in action. It is known that petroleum hydrocarbon contamination is not only of concern to the environment but also for human health. Petroleum hydrocarbon spills can also affect human health, and these effects can depend on what kind of oil was spilled and environment (on land, in a river, or in the ocean). Other factors include the kind of exposure and the duration of exposure. Oil spill cleanup workers are more likely to experience an increased risk for cardiovascular problems. Some of the human health implications could include skin and eye irritation, neurologic and breathing problems, and stress.

The impact on human health can be a direct result of changes in ecological processes (e.g., consumption of seafood contaminated with bio-accumulated oil toxins), economic stressors that can alter intermediary processes (e.g., psychological effects of community decline), loss of major subsistence or export industries (e.g., loss of fisheries), and effects of the spill leading to direct human harm (e.g., inhalation of aromatic hydrocarbons and other volatile compounds) (Webler and Lord, 2010; Eklund et al., 2019). According to a study, petroleum hydrocarbon pollution gives rise to the occurrence of certain ailments in areas that have suffered from oil pollution in Nigeria (Bello, 2017). There are several human health risks associated with petroleum hydrocarbon pollution in the Niger Delta region of Nigeria (Nriagu, 2011b; 2011a; 2013; Ordinioha and Brisibe, 2013; 2015; Nriagu et al., 2016; Bello, 2017; McLoone, et al., 2019; Nriagu, 2019).

Direct contact with or exposure to petroleum hydrocarbon-contaminated materials, as well as inhalation of volatile compounds or physical contact with crude, including consumption of water and oil-contaminated seafood, can have serious health implications ranging from nausea and dizziness to carcinogenic effects, central nervous system inhibition and disruption, and several long-term reproductive, developmental, and carcinogenic effects (Aguilera et al., 2010; Chang et al., 2014b). Although polycyclic aromatic hydrocarbons (PAHs) are a widespread class of environmental chemical contaminants which make up about 5% by volume, aliphatic hydrocarbons that constitute the bulk of crude oil and aromatic hydrocarbons are significant petroleum contaminants in the Nigeria's Niger Delta region (Block et al., 1991; Olajire et al., 2005; Osuji and Ozioma, 2007; Ite, 2012).

According to Ite and Semple, polycyclic aromatic hydrocarbons (PAHs) containing from two to five fused aromatic rings are of serious concern because they persist in nature due to their lipophilic character and electrochemical stability (Ite and Semple, 2012). Those who reside near oil exploration locations or sites may be exposed to toxins from gas flares or oil spills, and the impact of such exposures on the human immune system has not been fully investigated (McLoone et al., 2019). Currently, hundreds of thousands of people who live in the Niger delta region are exposed to oil contamination near their homes, farm lands, fishing grounds, controlled water resources, and food, but the consequences of such exposures on their health are unknown (Nriagu, 2011b; McLoone et al., 2019). According to a study, there are reports that human exposure to crude oil can increase the risk of developing certain types of cancer and cause immunomodulation (McLoone et al., 2019). Evidence from the Prestige oil spill suggests that occupational or accidental exposure to volatile organic compounds (VOCs), toxic air emissions, and persistent organic pollutants associated with oil spillage may experience long-term respiratory problems, chromosomal damage, and various health problems (Perez-Cadahia et al., 2008; Aguilera et al., 2010; Rodriguez-Trigo et al., 2010).

Recently, some of the environmental problems, human health risks, and safety issues as well as socio-economic problems associated with upstream and downstream petroleum operations have been extensively reviewed (Ite et al., 2013; Anejionu et al., 2015). The majority of human studies in the Niger Delta region have been concentrated on the social conflict between the local populace and the multinational oil companies as well as the corrosive relationship between oil pollution and poverty in the region (Ordinioha and Brisibe, 2013). Although health-related problems are cited in these studies to support the contention that concern for a clean environment is a reason for community-industry conflicts, there have been few systematic health studies to back up such claims (Gay et al., 2010; Nriagu, 2011b). There is very little reliable information on the effects of oil pollution on the physiological health of people in the Niger Delta region, as reviewed (Nriagu, 2011b; Ordinioha and Brisibe, 2013). There is paucity of information about the psychological effects of residents living with such environmental adversity. While there is no empirical study demonstrating the human health implications of exposure to crude oil in Nigeria, evidence exist to suggests the possibility of similar impacts on humans in the oil-producing host communities in Niger Delta region of Nigeria (UNEP 2011; Ordinioha and Brisibe 2013; Nriagu et al., 2016; Nriagu, 2019; Orisakwe, 2021).

4. MITIGATION STRATEGIES

Aside from environmental harm caused by noncompliance with sustainable development regulations and Multilateral Environmental Agreements (MEAs), oil and gas exploration and production operations in both onshore and offshore locations in the Niger Delta region have a variety of cumulative consequences (Ite et al., 2016). The Federal Government and multinational oil companies in the Niger Delta region have been found to have done insufficiently to address unsustainable practices and environmental contamination related to petroleum-related matters (Ikporukpo, 1983; Odeyemi and Ogunseitan, 1985; Ekpu, 1995; Ogri, 2001; Josiah and Akpuh, 2022). The Nigerian oil industry's statutory regulation has been inadequate to control environmental pollution and petroleum hydrocarbon-related human health effects. It is known that the common law remedies have similarly proved inappropriate (Okonmah, 1997). The present statutory laws and regulations for environmental protection applicable to the Nigerian oil and gas industry appear to be extremely insufficient and ineffectual in sustainable environmental management in the oil-rich host communities in Nigeria's Niger Delta area (Ekpu, 1995; Eaton, 1997; Ogri, 2001; Eweje, 2006; Aghalino and Eyinla, 2009). Nigerian environmental law does not include any explicit requirements for international oil firms to follow in order to conserve and preserve the Niger Delta region's soils, groundwater, marine, and terrestrial environments (Ekpu, 1995). In addition, the statutes and regulations are formulated in such general and imprecise terms that they make compliance and enforcement almost impossible.

Few researchers have thoroughly explored the five primary legislative deficiencies that substantially impede effective environmental regulation, as well as non-legal factors for Nigeria's failure to adequately control multinational oil firms' operations (Eaton, 1997; Ite et al., 2016). Nigerian environmental rules are frequently impacted by technological limits, the necessity to support industry, and the influence of public opinion (Doyle et al., 2008). In Nigeria's Niger Delta, the participation of communities in the environmental decision-making process is a relatively new process and often ineffective with little or no sustainable development goals (Adomokai and Sheate, 2004). However, due to the high cost of complying with environmental regulations, some multinational oil companies operating in the Niger Delta region have failed to implement best practices for sustainable exploration and production of petroleum resources. Although a comprehensive system of environmental regulations is now in place, environmental pollution associated with unsustainable oil and gas exploration and production operations has continued to persist under these laws for several years (Ite et al., 2016).

Consequently, it could be argued that the Niger Delta region's complex interaction issues with the people, economic development, and environmental pollution are the result of inadequate management of the region's petroleum resources, ineffective government policies for petroleum development, and unsustainable operational practices by multinational oil companies (Ite et al., 2016). However, several petroleum-related concerns including as environmental pollution and degradation, human health hazards, and sociocultural and socioeconomic difficulties have been identified in the Niger Delta region (Bantekas, 2004; Ite, 2004; Idemudia, 2007; Ite, 2007; Ako and Okonmah, 2009; Ite et al., 2013; Umejesi and Akpan, 2013; Anejionu et al., 2015). Apart from human health risks, the exploration and exploitation practices applied by some multinational oil companies in Nigeria are below industry standards, and for such operators and relevant oversight agencies, their reward is in the well.

5. CONCLUSION

In the Niger Delta region, onshore and offshore oil and gas exploration and production activities have resulted in environmental pollution, socioeconomic issues, and catastrophic effects on wildlife and their habitats. Over the past sixty years, successive governments have failed to appropriately address and manage these issues. Nigeria's inability to reach its economic potential may be attributed less to the nation's reliance on oil income and more to poor administration. Nigeria's population is growing, and even high rates of economic development during boom years haven't done much to improve the lives of its people, many of whom barely make ends meet through subsistence farming, small-scale business or agriculture. Both the government and the multinational oil companies must adopt environmentally sound technologies and cleaner production processes in order to achieve sustainable development of the Niger Delta region's petroleum resources. They also need to effectively implement the international legal framework to help mitigate the associated problems of environmental degradation and pollution. Adopting sensible, long-term reforms would promote responsible exploration and production of oil and gas, which will enhance the economic growth of the host communities that

produce the oil while simultaneously protecting the environment and public health in the short and long terms.

Nigeria's oil output is on the steep side of a decline due to security fears, poor governance, and rampant corruption. Given that the Niger Delta region brings in around 90 percent of the country's foreign exchange earnings and 80 percent of government revenues, any threat to it is a threat to Nigeria's economy as a whole. Nigeria urgently needs to tackle corruption, oil theft, and unsustainable practices in its petroleum industry. The petroleum industry stands to gain from undertaking a remedial effort that would improve governance and reduce corruption. This would reduce operating costs, increase production, raise living standards in oil-producing host communities, and create new demand and markets. So, a thorough understanding of the unsustainable exploitation of oil and gas resources has contributed to the transformation of our perspectives on economic development from a narrow focus on economic interests to one that also takes into account risks to human health, socioeconomic and sociocultural issues, pollution of the environment, and degradation in the near future.

CONFLICT OF INTEREST

The authors express no conflict of interest in the study.

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