

Research Article

A REVIEW OF THE NIGERIA PETROLEUM AND THE INSIGHT IN OIL POLLUTION MANAGEMENT; SUSTAINABILITY APPRAISAL

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ABSTRACT

Since the mid-nineteenth century, petroleum has been the world's primary energy source, and it has played a critical role in the economy and effective home management. The petroleum goods and allied services are required for daily use and as a medium of exchange. It exists as a liquid, gaseous, or solid combination of saturated and unsaturated hydrocarbons. It's derived from crude oil, and distillation processes turned into valuable petroleum products to meet human needs. Therefore, Petroleum-based fossil fuels account for 80% of our climate changes as an induced environmental pollutant because petroleum is the necessity of all nations. This environmental impact is a global issue in both industrialised and developing countries. Increased demand for petroleum products has benefited people's economies and created more job opportunities. However, its production techniques are unsustainable due to increased air pollution, greenhouse effect, ozone layer depletion, and global warming consequences. In addition, it posed a threat to both plant and animal species and environmental degradation, particularly in areas where technical knowledge is limited. Although petroleum is known for its negative consequences, the possibility of its total elimination is unrealistic because of its absolute global dependability. Hence the Niger Delta inadequacies in spillage management increase the susceptibility of the total environment. Also, the ecosystem suffers when there is no implemented framework for its control measure. This review article would enhance understanding of the current practices and suggest possible techniques for maximising environmental sustainability and limiting susceptibility and viability.

Keywords: Petroleum, Sustainability, Global Practice, Nigeria.

INTRODUCTION

Petroleum processes and products have been a vital energy source and economic development to humanity [1]. However, since the discovery of crude oil exploration and production, it has attracted huge interest lately due to the lasting environmental impact of global warming, greenhouse gas emission, and critical air pollution observed in recent years [2, 3, 4, 5]. These challenges have attracted researchers, businesses, governments and non-governmental organisations worldwide to explore the most sustainable solutions to manage the environmental damages caused by these petroleum explorations and production [6, 7]. Also, these have aroused interest in various studies into the best procedures for extracting hydrocarbons [8]. Pollution can be defined as the addition of harmful materials into the environment that has a negative impact. Pollutants that are a source of pollution could be solid, liquid, or gas substances, which are pollutant components [9]. Though natural processes can generate environmental contamination, pollution usually suggests that the contaminants have an artificial source created by human actions.

Furthermore, pollution is a triggered factor that harms human health. For example, industrial air pollution impacts the national and local inhabitants, and water pollution refers to synthetic and biological toxins that degrade water quality and reduce aquatic life [10]. Therefore, pollution is further defined as a change in the air, water, or land's physical, chemical, or biological features that can harm human life, industrial functionalities, progression, living conditions, and cultural assets [11]. This drastic environmental imbalance is applicable in the accidental discharge of liquid hydrocarbon into the environment; this depicts oil spillages and is an ecological disaster [12,13, 14, 15].

According to researchers, globalised oil spill management and adequate strategies are crucial to avoid oil leaks and environmental pollution in recent times [13]. Pollution has a wide-ranging impact on the environment, and it is characteristically exacerbated in developing countries where technical developments and regulatory controls are weak. Therefore, scholars have been exploring technologies to produce appropriate cleanup methods for oil spills due to the necessity of finding solutions.

Management of Oil Spills in Nigeria's Niger Delta

The following are the main causes of oil spills in the Niger Delta: residents vandalising oil pipelines; pipeline ageing; equipment failure; oil blowouts from flow stations; cleaning of oil ships at sea; and roadside mechanics disposing of spent oil into drains. [16,17]. Oil spills remediation strategies in Nigeria ranged from environmental laws, Joint Investigation Visits (JIVs), Government Regulators (Department of Petroleum Resources (DPR) and National Oil Spill Detection and Response Agency (NOSDRA). NOSDRA uses the Strength, Weakness, Opportunity, and Threat (SWOT) system, governed by Section 5 of the 2011 Spill Recovery, Clean-up, Remediation, and Damage Assessment Regulations [18]. In addition, the UNEP report titled "Environmental Assessment of Ogoniland", published in 2011 and co-authored by other researchers, indicated bioremediation as a viable environmental restoration method despite all different approaches [16, 17, 18, 19]. As a result, this study examines the global cleanup of oil spills across all continents. It looks at current practice and findings and how suggestions affect knowledge. On the other hand, this investigation focused on appropriateness in a different part of the country. Peer-reviewed journals, government publications, and, most importantly, analytical assessments, such as the UNEP Reports on the Ogonil and Environmental Assessment, are the subject of this literature study.

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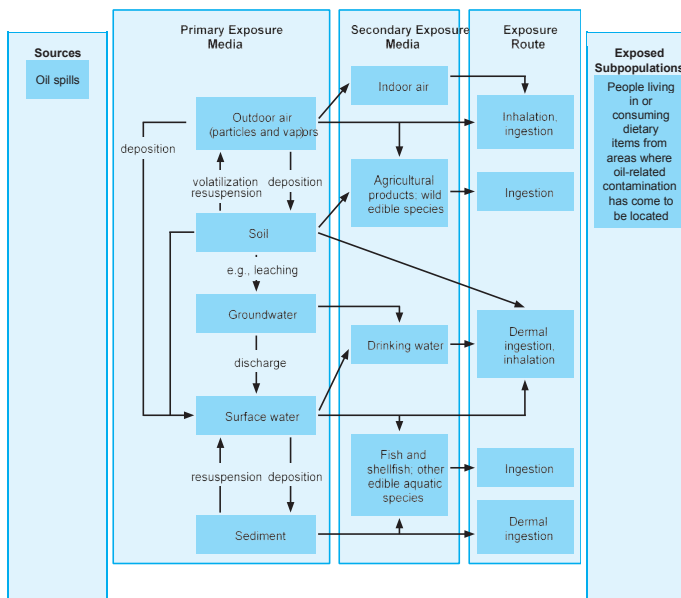


Figure 1.1 Conceptual model of human exposure to oil spills
Source: [23]

REVIEW

Historical Description of Exploration and Sustainability in Niger Delta

The Niger Delta is in the South of Nigeria and a tributary from the Niger River, located on the Gulf of Guinea and surrounded by the Atlantic Ocean in West Africa [24]. Before the 15th century, the indigenous people were traditionally mingled within the villages on the Niger coast. In 1471, Portuguese route finders arrived in the 15th century. They started the business operations, which is a mutual exchange. Coral beads, textiles, and European market staples were delivered. In trade, the Oba presents peppers, ivory, and slaves. The area served as a crossroads for inland trade, especially palm oil and the slave trade [25]. Slave trade deals with Europeans increased, and supplies were also extended to their American counterparts. Slave trade provided the government with nourishment and authority, resulting in regional division and economic support [26]. Slaves were gathered in the Niger Delta and dispatched to any locations. Thus, this trade saves as a means of sustainability by the Chiefs and Obas despite its awkwardness [23, 24]. The Niger Delta tribes participating in the event are the Urhobo, Delta Igbos, Isoko, Itsekiri, Oron, and Ijaw. Moreover, in the 1890s, the British government investigated her colonists worldwide. As a result, Nigeria was divided into two regions in 1901. One in the south and one in the north, each with administration responsibilities. There was also a demand for bitumen, coal, and oil in the nineteenth century. Due to these events, Shell and the Anglo Iranian Oil Company (now B.P.) conducted a thorough search from 1903 to 1935. As a result of their collaboration, the Shell-D'Arcy Exploration Parties were founded (SDEP). In 1956, oil in the Niger Delta was recovered to a marketable value. Exploration in the region exploded, and Nigeria was divided into three administrative regions. The Hausa Fulani live to the north, the Igbo live to the east, and the Yoruba live to the west. These were identified as the majority ethnicity [29]. People from the Niger Delta were excluded and regarded as a minority in all three regional sectors. As a result, the Deltans' economic, socio-political, and social changes were hindered. This hindrance was due to their marginalisation, and they were deemed a minority. As a result of these developments, there is a lack of access to modernity and a high poverty level. The Delta is made up of fluvial and alluvial deposits called the "Oil River" because of its palm oil variations. It covers around 70,000km² and makes up 7.5%

of Nigeria's landmass [23, 24, 25]. It is located between 3°N and 6°N latitudes and 5°E and 8°E longitudes. The region's geographical location and the morphological processes of biological remnants account for the Niger Delta crude oil reservoir. It is globally regarded as a hydrocarbon province [29, 30, 31]. Furthermore, the crude oil extracted from the region is classified as biomarkers and categorised as aromatic, aliphatic, and aromatic sulphur biomarkers and aromatic sulphur compounds [32, 33]. The biomarkers contracted under thermal conditions as part of the geomorphologic process, generating hydrocarbon deposits or crude oil.

Sustainability Steps

The Nigerian government founded the Niger Delta Development Commission (NDDC) in 2000 to address the region's lack of infrastructure development. Its purpose was to help communities in the Niger Delta impacted by oil disasters [38]. Also, oil companies used the Geographical Information System (GIS) from the Environmental System Research Institute (ESRI) to survey the extent of oil spills [39]. Similarly, Environmental Sensitivity Index Maps (ESIM) was used, which classified biodiversity, ecological resources, biological variables, substrate, plant and animal species and are all included in the sensitivity mapping [36, 35]. As a result, ESI is an essential tool for determining which coastal, human, and biological resources are at risk from environmental degradation related to oil spills [41]. This tool was also helpful in planning the response to an oil spill [38, 39]. The Environmental Sensitivity Index also categorises resources in the ecosystem that are likely to be impacted by oil spills [44]. The ESI Map, shown in Figure1.1, was first used in the Niger Delta by Shell Nigeria.

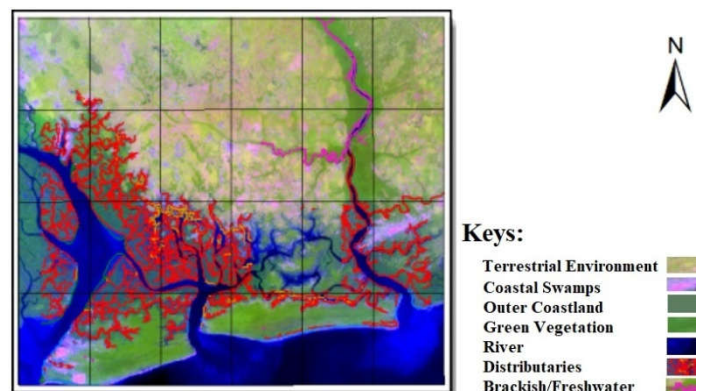


Figure 2.1 OML11, Niger Delta, Nigeria, Coastal and Inland Sensitivity Mapping [45]

The Federal Government recognized Shell as a sole mandate in oil exploration and production. Accordingly, shell formulated the following strategies as sustainability criteria when preparing reports [42, 43].

- United Nations Global Compact
- United Nations Sustainable Development Goals (SDGs)
- Global Reporting Initiative (GRI)
- Task Force on Climate-related Financial Disclosures (TCFD)
- Sustainability Accounting Standards Board
- IPIECA - IPIECA/API/OGP Oil and Gas Industry Guidance (SASB)

Although the above sustainability structure has been developed, the practical remedy for oil pollution management is unsustainable. For instance, the oil pollution in the Ogoniland is a long-time impact that has been for decades during oil exploration in the 90s by Shell [48]. Thus, it related that the negative effect of oil spills had affected the overall environment [45, 46, 47].

Figure 2 is the Map of Nigeria showing the oil-producing zone, the Niger Delta.

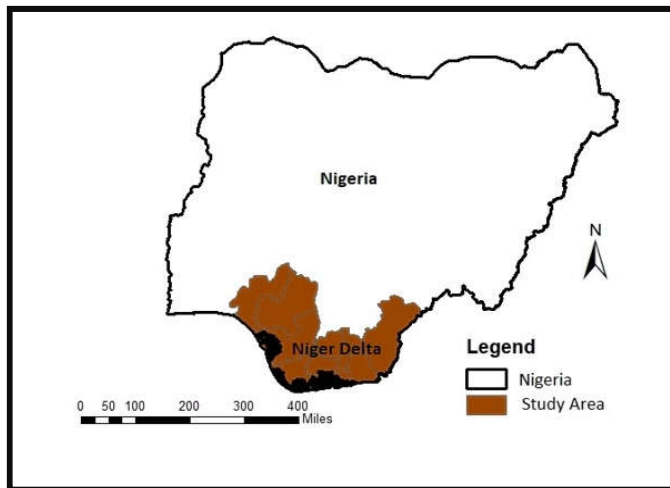


Figure 2 Map of Nigeria Showing the Niger Delta (Oil Province)

PETROLEUM

Petroleum is derived from the Greek words ‘Petra’ (rock) and ‘oleum’ (oil). Petroleum is an oil made from the organic remnants of aquatic plant and animal remains trapped for millions of years beneath the sea level. For millennia, these plant and animal residues have accumulated in fluvial sediments and alluvial deposits of coastal habitats [52]. Furthermore, it was proposed that the organic relics accumulated for ten million decades fused and produced the underneath rocks [49, 50]. These non-porous rocks are fossil fuel reservoirs, sometimes known as petroleum. As a result, petroleum is a liquid hydrocarbon mixture generated by progressive geologic processes within the stratified rock (sediment). The liquid mixture is extracted and refined to produce petroleum products [52]. These hydrocarbons, however, are the natural resources known as crude oil before they are treated [55]. Therefore, crude oil is a mixture of liquid hydrocarbons that originate underground and are caused by geologic activities. When crude oil reaches the earth’s surface, it keeps its liquid condition. Depending on where it comes from, petroleum can be dark brown to black, but it can also be yellow, red, or green [52]. For example, crude oil in the Niger Delta region is often dark brown to black. However, it’s commonly found alongside natural gas at different concentrations [56].

Table Error! No text of specified style in document. Thirteen Largest Oil Spillage in World History Source: [57]

Oil Pollution/Location	Year
Exxon Valdez	2012
Deepwater Horizon in the Gulf of Mexico	2010
Torrey Canyon in Scilly Isles	1967
Sea Star in the Gulf of Oman	1972
Odyssey on the coast of Nova Scotia, Canada	1998
MT/Haven Tanker in Genoa, Italy	1991
ABT Summer on the coast of Angola	1991
Portsall in France (1978)	1978
Castillo in South Africa	1983
Nowruz Oil Field in the Persian Gulf of Iran	1983
Kolva River in Russia	1983
Atlantic Empress off the coast of Trinidad and Tobago	1979
The Bay of Campeche in Mexico	1979

The Early World Petroleum History

Nigerian Petroleum’s History, Production Oil Syphoned

The Nigerian Bitumen Corporation, a group of German surveyors, began looking for sharp sand deposits for tar extraction in South-West Nigeria in 1908. As a result of this effort, the first well in the Niger Delta Region’s Northern Delta was vigorously explored and drilled [58]. However, the outbreak of World War I in 1914 put a halt to the quest [59]. Under the British protectorate, Shell D’Arcy re-established exploration in 1938. A combined effort between British Petroleum and Royal Dutch Shell is now underway. The rate of exploration was so high that the Nigerian government gave Shell sole responsibility for all oil exploration in the country. Despite this, the oil exploration rate remained inconsistent, partly due to World War II’s onset [56, 57, 45,58] In 1946 and 1956, oil exploration began, and Shell/B.P. discovered adequate quantities of oil near Oloibri in Bayelsa State. Also, oil was discovered in 1958 at Bomu, Ogoniland. Thus, total crude oil output reached 0.5 million barrels per day (mb/d) in 1958. During the Biafran War in 1967, production was erratic and intermittent. Oil spills in Ogoniland in 1970 wreaked havoc on the land, rivers, streams, mangroves, and canals [59, 60]. Despite the interruption in oil production, oil exploration continues. Increases in global oil prices in 1971 benefited the Nigerian government, increasing the country’s GDP and strengthening the country’s relationship with Shell, which continued to have sole responsibility for Nigerian oil production. Production rose from 1970 until the Niger Delta Avengers attacked in 2016 when it fell to 500,000 barrels per day [61, 62]. As a result, Nigeria was able to join the Organization of Petroleum Exporting Countries (OPEC) in 1971, thanks to Shell Petroleum. Recognising Shell’s success, Mobil Producing Nigeria Ltd, a subsidiary of the American Socony-Mobil Company, began investing in Nigeria. While Mobil had been in Nigeria for a long time, it only received a licence in 1955 and started its first oil hunt. As a result, Mobil Exploration Nigeria Incorporated was formed. Shell operated offshore and onshore in all Niger Delta states as part of its oil mandate, whereas Mobil focuses primarily on offshore production. Mobil Exploration Nigeria Incorporated was renamed Mobil Producing Nigeria on 16 June 1956. This rebranding strengthened Mobil’s position as a licenced oil operating business in Nigeria. Exploration activity by Shell and Mobil pushed Nigerian oil production to 2 billion barrels per day in 1991 and 2.25 billion barrels per day in 1998. The United States was Nigeria’s major crude oil importer [55, 63]. The Nigerian government began deep-water exploration in 1995, with approximately 3,000 wells. Most of the Mobil’s exploration took place offshore near Quaiboe River, in the Niger Delta’s South-South Region.

Table 3 Planned oil projects in Nigeria Source: [68]

Project name	Operator	Type	Location	Production plateau (thousand barrels per day)	Estimated Start date
Qua Ibo	NNPC	Crude oil	Onshore	90	2021
Zabazaba Etan	Eni	Crude oil	Offshore deep-water	120	2021
Bonga Southwest Aparo	Shell	Crude oil	Offshore deep-water	150	2022
Preowei	Total	Crude oil	Offshore deep-water	50	2023

Owovo	ExxonMobil	Crude oil	Offshore deep-water	160	2024
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Nigeria's efforts in the petroleum business have become the country's principal Source of foreign cash [65, 66, 67, 67]. The sale of petroleum and related products accounted for about 70% of the country's revenue [72]. Nigeria is the world's largest oil producer [67]. Nigeria is enjoying an uptick in petroleum exploration and production, as projected. High levels of oil exploration, for example, have had detrimental environmental implications in the Niger Delta region [69,70]. According to various statistics, 13 million oil barrels have split into the Niger Delta Region, equivalent to 6.5 days of oil output since oil activities began. Pipeline corrosion, oil company incompetence, and vandalism are all blamed for the spills resulting from the continuous and massive socioeconomic inequities [71, 72, 73]. The Niger Delta Avengers' activities led to a catastrophic oil disaster in 2016 [74,75]. Regardless of the cause of the spill, the local land and water supplies have been contaminated. These oil spills could be linked to industrial activities or a group of people's rebellious actions. Overall, these have rendered places that sustain and employ fishermen and farmers ineffective. The three major causes of oil spills, according to Amnesty International [80], are operational, low maintenance, and third-party meddling, also known as bunkering [81]. Third-party involvement is sabotage when an oil pipeline is vandalised to attract attention or take oil for commercial interests. As a result, sabotage-related oil spills have been a substantial source of spill accidents with significant environmental consequences. Whatever the motivations for vandalism, it has always been a means of influencing the government and politics. Regardless of the motive for the sabotage, it accounts for over 80% of spill accidents in the Niger Delta region. According to [82], while crude oil provided 90 per cent of Nigeria's foreign money, the host communities bore the brunt of environmental and socioeconomic degradation. Oil pipe vandalism is an "interdiction," which specialists defined as a purposeful act [83]. The measures are being carried out for oil theft by residents and cause immense environmental devastation to entire villages [80, 81]. Figures 4 and 5 depict illegal oil bunkering and illegal refinery operations in Nigeria.



Figure 3 Third-party oil spill at an artisan refinery source: [86]



Figure 4 Illegal bunkering station, oil theft Source: [87]

ANALYSING OIL POLLUTION CONSEQUENCES IN THE NIGER DELTA

Exploration and production of crude oil in the Niger Delta have had severe environmental repercussions [69,70]. According to several statistics, more than 13.1 million barrels of oil have split into the Niger Delta region since oil activities began. These spills have been blamed on pipeline deterioration, oil company mismanagement, theft, and vandalism due to the region's ongoing conflict [71, 72, 73]. Regardless of the reasons, these activities have harmed local land and water resources, rendering areas that once supported and employed fishers and farmers unsuitable for such economic activity. Furthermore, due to the oil exploration activities, the ecology has deteriorated. For example, there's a steady loss of mangroves and the destruction of a delicate ecosystem. Ogoniland exemplifies the issues caused by petroleum hydrocarbon contamination in the Niger Delta Region, the future impact of oil contaminants. However, pollution has far-reaching consequences across the whole Niger Delta region [45, 84]). Thus, all environmental components are affected [51]. However, this pollution has varying degrees of impact on the aquatic environment, terrestrial ecosystem, lithosphere, etc. Similarly, the consequences of oil pollution on host communities can be described in terms of social interactions, such as socioeconomic, socio-cultural, socio-ecological, and health repercussions. For example, the carcinogenicity of Polyaromatic Hydrocarbons (PAHs) with their incomplete combustion deteriorate health and the environment [85, 86].

A CASE STUDY OF SPILLAGE AND REMEDIAL APPROACH AND THE CURRENT STATUS OF THE AREA

Approaches for Oil Spill Management in Nigeria

The literature review highlights that hydrocarbon is the most prevailing substance that pollutes the communities, affecting their health, food production, businesses, and general livelihood. Nigeria's Federal Government has designated Federal Agencies to oversee local oil pollution management in combating these pollution effects. The Federal Ministry of the Environment, State Ministries of the Environment, the Department of Petroleum Resources, Non-Governmental Organisations (NGOs), NOSDRA, and Local and State Ministries of the Environment are among these organisations [18]. During Joint Investigation Visits (JIVs), all the above bodies usually collaborate to determine the core cause of any environmental oil spill. In addition, these JIVs raise awareness on the necessity of oil spill response, mitigation, and prevention. National Oil Detection and Response Agency (NOSDRA) uses the Strength, Weakness, Opportunity, and Threat (SWOT) system, governed by Section 5 of the 2011 Spill Recovery, Clean-up, Remediation, and Damage Assessment Regulations [18].

Comparing Oil Spill Remediation and Sustainability

Title	Findings/Recommendation	Reference
Metabolic Responses of Fish Following Exposure to Two Different Oil Spill Remediation Techniques	Because chemical remediation leads to secondary contamination, natural remediation is preferred.	[91]
Assessing the performance and cost of oil spill remediation technologies	Mechanical oil recovery, chemical dispersants, and in-situ spill oil burning are capital expenditures and significant environmental consequences.	[92]

Hydrocarbon Oil Spill Cleanup and Remediation in the Niger Delta	Environmental policies, historical, regulatory, scientific, and socioeconomic issues all play a role in the Nigerian Petroleum Sector's remediation efforts. However, the absence of any publicly accessible documented evidence of Cleanup and Remediation certificates for any site implies that regulatory best practices have not been followed.	[93]
Evaluation of the Impacts of Oil Pollution and a Sustainability Assessment: A Focus Group Case Study of Ogoniland, Nigeria	Focus group discussion is an essential tool that connects the oil-producing communities to real-life scenarios of pollution impacts and the sustainability of the most vulnerable.	[94]

CONCLUSION

The review focuses on investigating the current practice of the Nigeria Petroleum Sector. It is ascertained that the standard of oil spill management is deficient compared to international practice. Nigerian oil regulators should rely on environmental spillage laws and ensure the oil company fully implement practically as per the international practice. There should be a penalty for "Polluters Pays" to checkmate the adherence to the environmental laws. NDDC, with its sole mandate of developing the oil-producing zone, should ensure adequate infrastructural development and community rehabilitation and sustained living of the most vulnerable, the host villages. Although oil pollution is primarily attributed to exploration activities, the study has identified that the communities close to the pipelines or oil spillage points are more susceptible to spill impacts and vulnerable despite the root cause of the environmental spill. Also, the global dependency on fossil fuel does not account for its elimination, but there should be sustained management as proactive measures. The developing world like Nigeria should measure up to standard in oil pollution management rather than acknowledge oil pollutants as part of the community through chronic oil spills. These would benefit the communities and close the knowledge gap to understand the state of pollution in the Niger Delta region.

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