Petroleum Exploration in the Niger Delta Region and implications for the environment: A review

Abstract

Petroleum exploration and production in the Niger Delta, Nigeria, has been a significant source of revenue and foreign exchange for the country. Nevertheless, this industry has also been blamed for serious environmental pollution in the region. This review aims to shed light on the implications of petroleum exploration in the Niger Delta region and the resultant environmental damage it has caused. One of the most severe consequences of petroleum exploration in the Niger Delta is the frequent occurrence of oil spills. Due to aging infrastructure, poor maintenance, and criminal activities such as oil theft, pipeline spills have become a recurrent problem. Oil spills lead to the destruction of farmland, loss of biodiversity, poisoning of water sources, and widespread contamination of ecosystems. Petroleum exploration and production activities release substantial pollutants into the atmosphere, posing a significant threat to both human health and the environment. The burning of natural gas during oil production, also known as flaring, is particularly prevalent in the Niger Delta. This practice results in the emission of toxic gases such as carbon dioxide, methane, and sulfur dioxide, contributing to climate change, respiratory diseases, and acid rain. Petroleum exploration in the Niger Delta has led to significant damage to forests and mangrove ecosystems. The destruction of these vital habitats has serious implications for species survival. Oil exploration activities often release harmful chemicals and wastes into the region's water bodies. These pollutants infiltrate the groundwater and surface water, leading to contamination that poses severe risks to human health and aquatic life. Contaminated water supplies have been linked to increased instances of skin diseases, as well as liver and kidney problems among the local population. The negative environmental implications of petroleum exploration in the Niger Delta also have severe socioeconomic consequences. Displaced fishermen and farmers face declining livelihoods, while sporadic employment opportunities generated by the oil industry do not compensate for the long-term damage inflicted on the region.

Keywords: Environmental pollution; exploration; petroleum; soil; vegetation; water

1.0 Introduction

The Niger Delta is a fan-shaped area with a surface area of about 112,110 km^2, located in the southern part of Nigeria, bordered to the south by the Atlantic Ocean, into which the rivers Benue and the Niger drain. The Niger Delta region represents about 12% of Nigeria total land mass with an estimated population of 28 million in 186 Local Government Areas in nine (9) Southern states [1].

Oil spill incidents have occurred at different times along the Niger Delta area. Unfortunately, more than 70% was not recovered, 69% of these spills occurred off-shore, a quarter was in swamps and 6% were spilled on land [2-4]. Several reports of oil spills in the region has been recorded by some scholars over the years with lots of inconsistency in figures recorded [1] in the Niger Delta. According to Nwilo and Badejo [5] between 1976 and 1996, approximately 6,000 oil spills occurred in the Niger Delta region and about 2-million barrels of crude oil

leaked into the environment. Bronwen (1999) reported that the record from the Nigerian National Petroleum Corporation (NNPC) indicates that the amount of crude oil spilled into the Niger Delta is estimated at 2,300 cubic metres, on average over 300 spills occurred every year from 1975 to 1995. Contrary, World Bank [7,8] provided figures which estimates oil spill to the environment at almost ten times the NNPC figures arguing that the official figures ignored the so called "minor" spills. In line with this [5] categorically describes the largest individual spills to include the blowout of a Texaco offshore station in 1980, which dumped an estimated 400,000 barrels (64,000 m^3) of crude oil into the Gulf of Guinea and Royal Dutch Shell, Forcado Terminal tank failure with an estimated spillage of 580,000 barrels (92,000 m^3). Baird [9] actually estimated the quantity of petroleum products and crude oil spilled in the Niger Delta through oil exploration activities as falling between 9 million and 13 million barrels.Adati[2] proposed that between 1976 to 2000 there was a decrease in oil spillage quantity but an increase in the number and times of oil spill within the region.

Within this region, crude oil pollution such as oil spillages and gas flaring regularly occur [10-13]. Uquetan*et al*. [14] highlighted that Ofomata[15] andImevbore[16]catalogued a number of oil spill contamination problems resulting from vandalization and burst pipes in places like Bonny, Okirika, Okwuzi, Obagu, Bori, and Obirikom all in Rivers State, Nigeria. Osuagwu and Olaifa[17] observed that the severe effects of oil spillage on the ecosystem is of serious concern as it's a source of livelihood for the inhabitants of the region.

2.0 Petroleum Exploration in Eleme

Petroleum exploration in Eleme is interwoven and shares the same experience with the entire Niger Delta region of Nigeria. According to Ejiba*et al*. [18] the Niger Delta area extends over about 70,000 km^2 (27,000 sq mi) and makes up 7.5% of Nigeria's land mass. It is the largest wetland and maintains the third-largest drainage basin in Africa. The Delta's environment can be broken down into four ecological zones: The coastal barriers island, the mangrove swamp forests, the freshwater swamps and the lowland rainforests. The region has an estimated regional population of nearly 30 million people [19]; and comprise of 9 States including Rivers, Bayelsa, Akwa Ibom, Delta, Imo, Abia, Ondo, Cross River and Edo.

The Niger Delta region of Nigeria is where majority of the petroleum exploration activities are carried out. The area hosts several International Oil Companies (IOCs) including Shell whose activities are more prominent in the region and the Nigerian National Petroleum Corporation NNPC through its subsidiaries the Pipelines Products Marketing Company (PPMC) and the Nigerian Petroleum Development Company (NPDC). Consequently, majority of the petroleum spillages and subsequently pollution occur in this region, particularly in the core Niger Delta states of Bayelsa, Rivers, Delta, and Akwa Ibom states respectively and more intensified in areas like Eleme and Ogoni where many petroleum oil well and plants are located [13,20].

Petroleum exploration in the Niger Delta began in 1956 when Shell discovered an oil well in Oloibiri in Bayelsa State. The Niger Delta Basin has since matured with production rising progressively from an initial output of 5,100 bpd at first export in 1958 to the current 2.4 million bpd situating Nigeria as biggest petroleum producer in Africa and the sixth biggest producer in the Organization of Petroleum Exporting Countries (OPEC) which it joined in 1971 [21].

The Shell Petroleum Development Company (SPDC) started operations in Eleme in the 1950s, initially as Shell D'arcy. Crude oil was discovered in commercial quantities in Oloibiri now in Bayelsa State in January 1956. The Ebubu-Eleme Oil field was discovered in October 1956 and comprised locations in Ebubu, Ogale and Onne, all in Eleme. The first shipment of

22,000 barrels of crude oil from Nigeria in 1958, thus included oil from Eleme [22] UNEP, 2011).

Active oil wells in Eleme as at 3rd January, 2000 include: Ebubu 1, Ebubu 2, Ebubu 3, Ebubu 4, Ebubu 5, Ebubu 6, Ebubu 7, Ebubu 8, Ebubu 9, Ebubu 10, Ebubu 11, Ebubu 12, Ebubu 12, Ebubu Deep, Ajokpori 1, Ajokpori 2, Oketa 1, Oketa 2, Onne 1, Onne 2 and Onne 3 [22]. There were more oil discoveries in Ejamah-Ebubu Eleme in 1958 and intensified exploitation followed shortly. Since then, Eleme has unfortunately remained the site crude oil and refined products and subsequent pollution and degradation of the environment. Still until the studies and subsequent clean-up exercise carried out on Ogoni land and part of Eleme by UNEP the place has remained largely without conscious systematic information on the large-scale contamination and destruction of the ecosystem. The Environmental Assessment of Ogoni land and surrounding areas covers contaminated land, groundwater, surface water, sediment, vegetation, air pollution, public health, industry practices and institutional issues [22], and has remained the most comprehensive study of the phenomenon to date.

According to the UNEP [22] the pollution of soil by petroleum hydrocarbons in the area is extensive in land areas, sediments, and swampland. Most of the contamination is from crude oil although contamination by refined product was found at many locations. The study further revealed that there is no continuous clay across the area, thus exposing the ground water to hydrocarbons spilled on the surface. UNEP [22] reported that in more than 49 cases hydrocarbons was observed in soil at depths of at least 5 m and has major implication for remediation required.

At two-thirds of the contaminated land sites close to oil industry facilities which were assessed in detail, the soil contamination exceeds Nigerian national standard as set out in the (Environmental Guidelines and standards for the Petroleum Industries in Nigeria [EGASPIN]). At 41 sites, the hydrocarbon pollution has reached the groundwater at levels more than the Nigerian standards as per the EGASPIN legislation. The most serious case of water and soil contamination is at NsisiokenOgale, in Eleme Local Government Area, close to the Nigerian National Petroleum Company product pipeline where an 8 cm layer of refined oil was observed floating on the ground water which serves as community wells [22].

3.0 Petroleum Spillage, Causes and Incidences of in the Niger Delta

Exploration, exploitation and refining of petroleum are undertaken in stages and every stage is liable for spillage. In practical terms, spillage could be analogous to the process of drawing water with a bucket from a well. While pulling up the bucket some water drops back into the well and when the bucket is brought up some water drops on the ground, more also pour when the water is being turned into a container. Thus, the area around the well is always wet with water.

Ejiba*et al.*[18] deduced that about 65.13% of petroleum spilled in the Niger Delta in 2014 was due to sabotage; 14.35% was because of natural accidents, corrosion, equipment failure and human error and 20.38% was by yet to be determined causes. The researchers opined that these estimates as conservatives as they are; were always disputed by concerned oil companies who argue that about 90% of crude oil and refined products in the region are caused by sabotage or pipeline vandalism.

Ejiba*et al.*[18] opined that Nigeria has witnessed incessant petroleum spill incidences in the past five decades with devastating consequences on land and coastal environment in the Niger Delta region. The researchers noted that a total of 1092 petroleum spill incidences occurred annually with a total average loss of 23,000 barrels of the precious liquid. This is at

an average of 91 spill incidences per month while about 6,333 spills incidences were recorded between January 2010 and August 2015. The leap in figures was credited to intensified incidents of pipeline vandalism and product theft. According to Zabbey[23] the Niger Delta region experienced an annual average of 273 petroleum spills between 1976-2001 resulting in average loss of about 115,000 barrels of petroleum crude and white product. According to NOSDRA [24] about 1,879 spill incidents were recorded between January 2014 and October 2015. In addition, 1.08 million barrels of petroleum worth about N14,846.71 million was lost in 2014 [25].

Environmental groups opined that more than 300 spill cases occur yearly while between 9 million and 13 million barrels of petroleum have been spilled in the Niger Delta between 1958 and 2008 [26]. This is in contrast and a far cry to the only 10 spills between 1971 to 2011 reported across all of Europe [27].

In a period of four years, from 1976 to 1980, about 800 incidents of oil spillage were reported and from 1980 to 1990 about 2,000 incidents occurred. From 1990 to 1995 about 700 other cases of oil spillage were reported [22]. In total, about 3,500 incidents of oil spillage resulting in the discharge of more than 2 million barrels of crude oil into the land, swamps, and offshore environments with devasting effects.

It is also on record that crude oil and refined products spillage is worsened by hostile communities who will not allow immediate repairs on oil facilities until enough welfare is extended to them while the oil gushes out of the broken facilities.

4.0 Causes and Incidences of Crude oil and refined products spillage in Eleme Local Government Area.

Common factors cause crude oil and refined products spillage in the entire Niger Delta region. However, some of the factors are more pronounced in the Eleme area than the others. The primary causal factors of crude oil and refined products in Eleme area are:

Oil well blowouts/Accidental spills, aged/Corroded pipes and Rupture, refinery Production activities, construction works on the Pipeline Right-of-Way and pipeline Vandalism/Sabotage/Militants action.

4.1 Blowout/Accidental spills:

This is a major cause of oil spillage and may result from equipment failure, accident, or operational carelessness. On 17th January 1980 there was a reported blow out at Funiwa number 5 operated by TEXACO. The spillage caused by equipment failure went on for 13 days then burst into flames. About 250,000 barrels of crude oil was discharged into the Niger Delta environment. Four villages because unhabitable and the Sagama River became fouled excessively with fish and other dead marine creatures. Also, about 350 hectares of mangrove was left dead and for a long time the people of the fish town of Funiwa survived on the charity of the Nigerian National Petroleum Corporation while TEXACO blamed everybody at sight [28]. There have been reports of blow outs in many parts of Eleme including Ebubu, Onne, Ogale, Alode and Aleto all at dire consequences to the environment and the people. The case at Ebubu 1 and Ebubu 6 wiped out several farmlands and rendered fishponds in the area useless [22].

4.2 Aged/Corroded Pipes and Rupture

Aged and corroded pipes have also contributed to the phenomenon. Oil exploration started in Eleme in the 1950s and pipelines were laid to convey the harvest to the jetty and later the

refinery. It is heart breaking to say that since the 1950s the pipelines laid then are still in use in addition to others laid in the 1960s and 1970s. This against the backdrop of the salty nature of the swamps and attendant ills on the pipes. Perhaps this is one of the biggest causes of spillage and has caused spill in every part of Eleme; however, the concerned oil companies prefer to blame it all on sabotage and oil theft.

4.3 Refinery Production activities:

Refinery activities includes transportation of crude from the oil fields to the refining facilities, transfer of same into the tank-farms and equal movement of white products also result into massive spillage at every point especially at the jetties as the substances are loaded into barges and ships. The numerous fire incidents around the Port Harcourt Refining Company 1 and 4 located in the area and the reported cases at the Eleme-Okrika Jetty are cases in point.

4.4 Construction Works on the Pipeline Right-of-Way

Construction works on pipelines Right-of-Way destroys the pipeline network and thus spillages. There was a fire outbreak on 4th December 2019 at Isheri, Lagos were works at Gloryland and Diamond Estates built on the pipeline Right-of-Way caused spillage of finished product and soon burst into flames [25]. The same has happened in Ogale-Eleme, Alode-Eleme and Agbonchia also in Eleme.

4.5 Pipeline Vandalism/Sabotage

Pipeline vandalism is either the worst culprit of spillage or the most blamed by oil companies. Vandalism is the willful, malicious and ruthless destruction of petroleum pipelines. The reason could be for the purpose of oil theft, sabotage or outright militant attack to destroy the pipelines [25,29-30]. The NNPC Monthly Financial Report reported that in January, 2019 alone, a total of 231 pipeline points were vandalized across the Corporations vast pipeline network of downstream oil pipeline infrastructure

NNPC pipelines have been vandalized at various segments particularly along the eastern, western and southwestern areas. Namely Port Harcourt, Mosimi and Warri operational Areas. There has been occasional vandalism in other areas like Kaduna and Gombe in Northern Nigeria but this are minimal as compared to the Niger Delta area and the western part of the country [25].Specifically, the pipeline areas prone to frequent vandalism are: Atlas cove to Mosimi line, Mosimi to Ibadan line, Mosimi to Satellite line

Warri to Benin line, Port Harcourt to Enugu through Aba line, Enugu to Auchi line, Escraovs to Auchi line, Escraovs to warri crude line, Port Refinery to Eleme-Okrika Jetty line and Warri Refinery to Warri Jetty line.

5.0 Impact of Petroleum Spillage

Whatever the casual factor crude oil and refined products always leads to the same effect of environmental pollution and degradation of the environment thus affecting the quality of soil, water, air and vegetation in the affected area[1331]. According to the UNEP report [22] when oil spillage occurs, the land covered by the spillage is rendered not only useless for gainful activities like farming and fishing but dangerous to health of all things. When rivers and streams are involved, that means the elimination of fishing activities. Thus, whole communities are not merely deprived of their means of livelihood but also confronted with the danger of hunger and starvation. In some cases, the entire community could be over-whelmed with oil pools, rendering the people homeless and displaced. Periodic over-flow of crude oil in the Niger Delta of oil operations result in the destruction of thousands of hectares

of mangrove swamps, pollution of rivers and streams and the elimination of marine creatures like fishes, crabs, mud-skippers, Oysters and shell fishes.

5.1 Impact of Crude oil and refined products on the Environment

The Niger Delta area including Eleme land once boasts of an impressive landscape. It is home to a unique and highly diverse flora and fauna; no other area in Nigeria can compare [32]. However, the advent of petroleum production in the Niger Delta has led to deforestation and ecological degradation, threatening the renewable natural resources and the ecosystem services in several ways [18].

Available records for the period of 1976 to 1996 indicated that approximately 6%, 25%, and 69% respectively, of total petroleum spilled in the Niger Delta area were in land, swamp, and offshore environments. An estimated 1,820,410.5 barrels amounting to (77%) of petroleum spilled between 1976 and 1996 were lost to the environment; with only 549,060 barrels representing 23.17% of the total petroleum spilt into the environment was recovered [6]. This has led to the destruction of the environment in no small measure. The environmental problems of the Niger Delta region according to [33] result in generally land resource degradation, renewable resource degradation and environmental pollution, agricultural land degradation, fisheries depletion, deforestation, biodiversity loss and mangrove degradation. Since the people depended hugely on their environment for farming and fishing, any incidence which affect these resources would surely affect their subsistence. On the consequences of crude oil and refined products and consequently pollution on the environment and wildlife; Nwilo and Badejo [6] opined that; petroleum kills plants and animals in the estuarine zone; petroleum settles on beaches and kills organisms that live there; it also settles on ocean floor and kills benthic (bottom-dwelling) organisms such as crabs; petroleum poisons algae, disrupts major food chains and decreases the yield of edible crustaceans; it also coats birds, impairing their flight or reducing the insulative property of their feathers, thus making the birds more vulnerable to cold; petroleum endangers fish hatcheries in coastal waters and as well contaminates the flesh of commercially valuable fish. Fishing resources can be damaged through physical contamination, bioaccumulation, and damaging of spawning grounds, as well as habitat destruction, depending on the circumstances of the spill and time of response [34].

5.2 Impact on Agriculture and livelihood

The Niger Delta is home to a valuable natural resource, providing livelihood in farming and fishing. However, the area is also plagued by large oil spills that threaten the lives of the inhabitants of the region, those rich natural resources, and the very livelihood of those who depend on them [35]. It is common that indigenous communities and households would depend on the available resources in their place of origin since available resources is a sine qua non for sustainable living. Likewise, the people in the Niger Delta depend squarely on their natural environment, (soil, water resources, and forest) for subsistence and survival by engaging in farming and fishing. Oil spills which occur both on land and water is threatening this means of subsistence. On land, oil spills destroy crops and damage the quality and productivity of soil that communities use for farming, while on water, it damages fisheries and contaminate water used for drinking and other domestic purposes thereby reducing any improvement in livelihood activities of people in oil producing areas [27]. Most of the people affected are particularly the poorest and those who rely on traditional livelihoods such as fishing and agriculture [19]. Damage from oil operations are therefore chronic and cumulative and have acted in a severely impaired coastal ecosystem compromising the livelihoods of the regions impoverished residents.

Oil spillage induced pollution affects livelihood in the form of productivity losses to both crop and fish harvest[36,37]. The major livelihood sources (including land and water) for most households in the region have been greatly affected. Depending on the severity, oil spilled on land affects soil stability leading to reduced growth and productivity for farmers in communities in the region.

Water is life to the human body and the human body relies on water for vitality[38]Stanley al., 2017). The entire cells and organs of the human body including our entire anatomy and physiology depend on water for their activity. It is a basic requirement in body processes such as digestion, acting as a lubricant.

Apart from regulating temperature, water also removes harmful toxins from the body through urination and perspiration. It reduces constipation and aid in bowel movement to ensure that waste is removed before poisoning the body. On the other hand, water also transports valuable water-soluble nutrients and oxygen throughout the body. In addition to the daily maintenance of our bodies, water plays key roles in the prevention of diseases.

Thus, water supply sources must be guarded against pollution from anthropogenic activities, and it is the duty of oil companies operating in the Niger Delta that their activities do not affect water supply, and if it does remediation must follow.

6.0 Impact of Crude oil and refined products: The case of Eleme

Eleme Local Government Area of Rivers State shares the same climatic condition with other parts of the Niger Delta region and by extension the entire South-south of Nigeria. The climate is of the equatorial type with high temperatures through-out the year. There is a wet season lasting from April to October when the southwest winds dominate. The dry season in months of November to March also experiences rainfalls and sporadic rainstorms. Therefore, there is no month, where the mean annual rainfall is over 3600 mm with the highest occurring close to the south and decreasing north to about 300 mm.

The area experiences the Tropical monsoon climate found in the southern part of the country. This climate is influenced by the monsoons originating from the South Atlantic Ocean which is brought into the country by the (maritime tropical) MT airmass, a warm moist sea to land seasonal wind. Its warmth and high humidity give it a strong tendency to ascend and produce copious rainfall, which is a result of the condensation of water vapour in the rapidly rising air. The Tropical monsoon climate has a very small temperature range that is almost constant throughout the year. Some places like Port Harcourt may record a maximum of 28 °C (82.4 °F) for its hottest month while its lowest temperature is 26 °C (78.8 °F) in its coldest month.

The area experiences heavy and abundant rainfall; usually convectional in nature due to the region's proximity, to the equatorial belt. The annual rainfall received in this region is very high, usually above the 2,000 mm (78.7 in) rainfall totals giving for tropical rainforest climates worldwide. Over 4,000 mm (157.5 in) of rainfall is received in the coastal region of the country. The entire area experiences a double rainfall maximum characterized by two high rainfall peaks, with a short dry season and a longer dry season falling between and after each peak. The first rainy season begins around March and last to the end of July with a peak in June, this rainy season is followed by a short dry break in August known as the August break which is a short dry season lasting for two to three weeks in August. This break is broken by the short rainy season starting around early September and lasting to mid-October with a peak period at the end of September. The ending of the short rainy season in October is followed by long dry season. This period starts from late October and lasts until early March with peak dry conditions between early December and late February.

The vegetation of Eleme Local Government Area just like the entire Niger Delta Region is predominantly mangrove swamp. However, fresh-water swamp is experienced upland along the various tributaries of the Niger River; containing different vegetation's ranging from salt-water mangrove swamps along the Atlantic coast to rain forest further upland. The vegetation's are well watered by regular rainfall experienced in the entire South-south region and green all year round. Trees of economic value includes mango, raffia palms, cocoa-nut trees, Iroko and other lumbering trees pushing to the sky with rich green canopies.

The geology of Eleme Local Government Area is of sedimentary origin common in the entire Niger Delta region. This is deltaic in its formation being laid down by the River Niger and its tributaries depositing its load from across the country. The sub-surface Niger Delta Geology consists of three lithographic units: Benin (Continental), Agbada (Mixed) and Akata (Marine) which are in turn overlain by various types of sedimentary deposits (40 to 150 m) which generally consist of rapidly alternating sequences. The silt and clay as well as the quaternary rocks which constitute various types of alluvium.

The Niger Delta Geomorphology has four units: The main drainage in the study area is River Niger and its tributaries. From 1 km in Agbere, the River breaks into two main branches: Forcados and Nun Rivers. These then form a very dense network of north-south drainage systems. From below Burutu at the north of River Forcados to below Degema, about 150 km, there are over 50 tributaries with a crises-cross of lagoons and tributaries. The Niger Delta is one of the world's largest wetlands covering over 20,000 km^2 in Southern Nigeria. A dynamic equilibrium between flooding, erosion and sediment deposition is the defining characteristic of the Niger Delta ecosystem.

The soils of Eleme Local Government Area vary and are complex due to the interplay of rock or ecologic types, the hydromorphic nature of the soil, and rich climatic environment of excessive rainfalls. There are five major soils groups, they are: beach ridge soils, mangrove swamp soils, freshwater swamp soils, Sombreiro - Warri – Deltaic plain soils and coastal plain sands. The creeks and water channels of the coastlands form important fishing grounds and provide highways in this marshy area where road building is almost impossible [39].

The Niger Delta is a natural wetland, agro-ecology; nitrogen has been found to be the most limiting plant dynamics nutrient [30]; because of competition between plant up take and biochemical processes function including freshwater marshes and hardwood swamp have been investigated. Upon flooding, the soil oxygen status is completely changed by mixing of water by wind action and convection currents resulting to the removal of nitrogen from flooded soil, microbial activity and sediments. The redox potential at which oxygen disappears from the wetland soil system was found to be in the range of 320 to 340. In a flooded mineral soil, approximately 50% of the total available oxygen is consumed in oxidizing the water-soluble ferrous iron which diffuses upwards from subsurface reduced zones. The total oxygen consumption in a flooded soil was attributed to the oxidation of reduced iron and manganese, followed by oxygen consumption during the oxidation of organic carbon and ammonium nitrogen.

The soil of Eleme is classified as Ultisol. Ultisols are strongly acidic and highly leached occurring upland in the high rainfall regions. They are coarse-textured, Kaolinitic type and found in the coastal areas of the country. The soil is derived mainly from the coastal plain sands (Udo, 1973). Ultisols have a higher percentage of active Phosphorus (P) (38%) and lower fraction of occluded Phospherous (21 %) than the Alfisols worth 22% of active Phosphorus and 35% of occluded Phosphorus. This indicates that the Nigerian Ultisols have a higher fraction of total Phosphorous in the available form than the Alfisols[40]. In a wetland

system of the Niger Delta; nitrification occurs at the surface-oxidized soil or sediment layer and lake sediments or ocean muds (Curtis *et al*., 1975). The gaseous forms of nitrogen that occur in flood soils and sediments include ammonia (NH_3), dinitrogen (N_2) and nitrous oxide (N_2O).

Farming is the major economic activity in Eleme Local Government Area and about 65% of the households are engaged in it. Crops are grown primarily for consumption and trade. According to the National Agricultural Sample Census 1993/94, 35% of holdings on land are live on ownership tenure and 17% on rented land. Annual planting of staple crops starts in the dry season (November-March) when floodwater have subsided. After clearing the of land, women and children plant maize, yam, cassava or vegetables and oil palm from both the wild environment and plantations. Crops that are planted include; cassava, cocoyam, plantain, banana, maize, yam, sugar cane, okro, vegetables, pepper and bitter leaf among others [22]. In addition to the staple crops, high priced vegetables such *Telfaira*, *Amaranthus*, waterleaf, melon and sweet potato are use as cover crops. Newly cleared forests are utilized for plantain and banana to take advantage of the high organic matter status of the land. Various crop combinations of yam/melon/maize/cassava, plantain/cocoyam *Telfaira* and maize are arranged in relay forms. Plantain may start bearing at 8 months, but it is allowed up to 4-5 years a piece while banana could stay longer, up to 7 years. Crop plants such as kola, guava, mangoes, plantain, pawpaw, pear and pineapple may be planted around homesteads and as avenues along pathways or boundaries of farms. The predominant method of maintaining soil fertility remains the age shifting cultivation and bush following systems which involve cropping the land for a length of fallow periods of 7-12 years. Land degradation and flooding constitute major constraints to farming in the freshwater forest zones of Elemeland. As a result, farming is limited to areas with sufficiently short flooding periods to allow for a complete growing season.

Accordingto published report [22]it was found that crop yield in Eleme is stumbling down and farmland shrinking as oil exploration and other petroleum activities increase. Eleme soil is largely depending on artificial fertilizers to produce and the indigenes are looking for land outside Eleme for cultivation.People cultivating in Etche, Emuoha, Iriebe and other distant places outside Elemeland. Grow waterleaf a major indicator of soil quality, guava, pineapple, cocoyam, coconut tree yam, kola nut, cocoa. Pale looking vegetables are being produced in this area and it was observed that they lack nutrient because the soil can no longer support them. Two years later the age-long green vegetable (pumpkin) was looking yellow and sooner than later smelling petroleum while consumers complain of purging and other health issues. This is alarming, so much that the leadership of the land at a point consulted with government and the oil companies. Unfortunately, the studies sponsored by the Multinationals shows that there is no fear while the people moved from being major food producers to mere consumers.

The people of Eleme still remember with nostalgia the old days that they bath, drink and cook with every kind of water found in Eleme land. Today, any attempt at such will be nothing short of suicide. There is no record of the first-time oil was seen floating on the surface of water in Eleme land but from 1979 it became a common site at the Eleme/Okrika Jetty. Between 1986 – 2000 floating oil was making headlines on Eleme rivers including Nsisioken, Okulu, Umu-Agbonchia and Olele-Ogale.

Bloated dead fishes floating on Eleme rivers were common site in 2001. A few years later some species of fishes were no longer found in Eleme waters. Prawns and crabs were among the first to disappear while special treatment must be given to catches before they could be eaten. It came to a time when fishes found in Eleme waters are nothing short of poison and

while the people are crying over that they entered the phase where nothing that breaths can survive in Eleme land.

Conclusion

Petroleum exploration in the Niger Delta has undoubtedly brought economic benefits to Nigeria, but at an enormous environmental cost. The persistent oil spills, air pollution, deforestation, water contamination, and socioeconomic impacts have taken a toll on the ecosystem and the well-being of local communities. It is crucial for the government and oil companies to adopt sustainable practices, invest in modern infrastructure, and prioritize the protection of the environment and the people who depend on it.

References

1. Ordinioha B, Brisibe S. The Human Health Implications of Crude Oil Spills in the Niger Delta, Nigeria: An Interpretation of Published Studies. Nigerian Medical Journal. 2013; 54(1): 10-16.
2. Adati AK. Oil Exploration and Spillage in the Niger Delta of Nigeria. Civil and Environmental Research. 2012; 2(3): 38–51.
3. Agunobi KN, Obienusi EA,Onuoha DC.An investigation of the pattern and Environmental impact of oil spillage in Etche Local Government Area of Rivers State, Nigeria. Journal of Natural Resources.2014; 4(16):124-37.
4. Plessl C,Otachi EO, Ko ¨rner W, Avenant-Oldewage A, Jirsa F. Fish as bioindicators for trace element pollution from two contrasting lakes in the Eastern Rift Valley, Kenya: spatial and temporal aspects. Environmental Science and Pollution Research. 2017; PMID: 28685334
5. Nwilo PC, Badejo OT. Oil Dispersion and Trajectories on Nigerian open sea. The Conference Proceedings of the International Conference on the Nigeria State, Oil Industry and the Niger Delta.2008; 164–192.
6. Nwilo CP, Badejo TO. Impacts and management of oil spill pollution along the Nigerian coastal areas. Department of Survey and Geoinformatics, University of Lagos, Lagos, Nigeria. 2005; Available:www.fig.net/pub.figpub36/chapters/chapter_8.pdff
7. World Bank. Environmental Economic Study of the Niger Delta, A Report on the Niger Delta, Nigeria. Washington, DC. 1995; 22.
8. World Bank. Nigeria Socio-Economic Assessment. AFCW2, Africa Region. Washington, DC. 2011.
9. Baird J. Oil Shame in Africa. Newsweek 27. 2010. (Accessed 20th March, 2020).
10. Orji JC, Uzoho B, Enwerem JO, Ezurike W. Assesment of the impact of kerosene and diesel on soil nitrogen mineralization. African Journal of Agricultural Research. 2011; 6:2486–2493.
11. NwaichiEO, Uzazobona MA. Estimation of the CO2 level due to gas flaring in the Niger Delta. Res. J. Environ. Sci. 2011; 5:565-572.
12. Ojimba TP, Akintola J, Anyanwu SO, Manilla HA. An economic analysis of crude oil pollution effects on crop farms in Rivers State, Nigeria. Journal of Development and Agricultural Economics. 2014; 6(7): 290-298.
13. Onwuna B, Stanley HO, Abu GO, Immanuel OM. Impact of Artisanal Crude Oil Refinery on Physicochemical and Microbiological Properties of Soil and Water in Igia-Ama, Tombia Kingdom, Rivers State, Nigeria. Asian Journal of Environment & Ecology.2022; 19(3): 48-59.

14. Uquetan UI, Osang JE, Egor AO, Essoka PA, Alozie SI, Bawan AM. A case study of the effects of oil pollution on soil properties and growth of tree crops in Cross River State, Nigeria. International Research Journal of Pure and Applied Physics. 2017; 5(2): 19 – 28.
15. Ofomata GEK. The oil industry and the Nigerian Environment. Environmental Review. 1997; 1:8-20.
16. Imevbore AMA. The oil industry and environmental pollution in Nigeria. *Paper presented at the Conference on Environmental Resource Management in Nigeria. University of Ife,* July, 1973.
17. Osuagwu ES,Olaifa E. Effects of oil spills on fish production in the Niger Delta. PLoS ONE. 2018; 13(10): 1-14.
18. Ejiba I, Onya S, Adams O. Impact of oil pollution on livelihood: evidence from the Niger Delta region of Nigeria. Journal of Scientific Research and Reports. 2016; 12(5): 1-12.
19. UNDP. Niger-Delta Human Development Report. 2006 Available: http://hdr.undp.org/en/reports/nat ional/africa/nigeria/name,3368, en.html
20. Ihennacho CM, Stanley HO, Immanuel OM. Efficiency of *Pluerotus ostreatus* in bioremoval of total petroleum hydrocarbon from refinery effluent. Journal of Applied Life Sciences International. 2018; 16(2): 1-6.
21. Department of petroleum resources (DPR). Annual statistical bulletin, 2014.
22. UNEP. Environmental assessment of Ogoniland. United Nations Environment Programme.2011.
23. Zabbey N. Impacts of oil pollution on livelihoods in Nigeria. Paper presented at the conference on "Petroleum and Pollution – How does that impact human rights? Co-organized by Amnesty International, Forum Syd and Friends of the Earth, Sweden. At Kulturhuset, Stockholm, Sweden.2009.
24. National Oil Spill Detection and Response Agency (NOSDRA). Addressing the South South's Environmental Emergency: The vital importance of environmental issues in securing stability and prosperity in the Niger Delta. Environmental Emergency Event – Abuja. 2015.
25. Nigerian National Petroleum Corporation (NNPC). Annual Statistical Bulletin. 2014.
26. Balouga J. The Niger Delta: Defusing the Time Bomb. Environmental Rights Action/Friends of the Earth Nigeria and Oil watch Africa October,2012.Available:http://www.eraction.org/publications/oilpollutionpoliticsand policy.pd
27. Amnesty International. Pollution and Poverty in the Niger Delta. London: Amnesty International Publications. 2009.
28. Udeh II, Ubong IU, Ngah SA, Abam TSK. Evaluation of Soil and Ground Water Quality Around an Oil Loading Facility at Eleme, Rivers State. International Journal of Innovative Science and Research Technology. 2021; 6(11): 618 – 627.
29. Oyedeji AA, Immanuel O.M. Phytoremediation potential of *Senna fistula* L. in the decontamination of crude oil-polluted soil. J. Appl. Sci. Environ. Manage. 2023;27 (12): 2967-2972.
30. Oyedeji AA, Oyedeji FO, Immanuel OM, Adekoya OO. Assessing the Potential of *Parkia biglobosa* (Jacq.) R.Br. ex. G. Don - a Leguminous Plant Species commonly found in Nigeria to decontaminate crude oil-polluted soil in Terrestrial EcosystemJ. Appl. Sci. Environ. Manage. 2023; 27 (12) 2967-2972.

31. Onwuna B,Stanley HO, Abu GO, Immanuel OM. Air quality at artisanal crude oil refinery sites in Igia-Ama, Tombia Kingdom, Rivers State, Nigeria. Asian Journal of Advanced Research and Reports. 2022; 16(12): 74-83.
32. Ugochukwu CNC, Ertel J. Negative impacts of oil exploration on biodiversity management in the Niger Delta area of Nigeria. Impact Assessment and Project Appraisal. 2008; 26:2:139-147.
33. Kadafa AA. Environmental impacts of oil exploration and exploitation in the Niger Delta of Nigeria. Global Journal of Science Frontier Research Environment & Earth Sciences.2012; 12:3.
34. Okonkwo CNP, Kumar L, Taylor S. The Niger Delta wetland ecosystem: What threatens it and why should we protect it? African Journal of Environmental Science and Technology. 2015; 9(5):451-463.
35. Chan J, Feirson J, O'Donnell BA.Tale of two Deltas. Open Data for International Development.2010.
36. Onwuna B,Stanley HO,Abu GO, and Immanuel OM. Perceived impact of soot pollution among residents near artisanal crude oil refineries in Tombia Community, Rivers State, Nigeria. DMA Journal of Sciences (FJS). 2023; 7(6): 304 -308.
37. Oyedeji AA, Immanuel OM. Assessment of the potential of *Pterocarpus osun*Craib to remediate crude oil-contaminated soil in the Niger Delta. World Scientific News. 2023;189: 145-156.
38. Stanley HO, Immanuel OM, Ekanem P. Microbiological quality assessment of facial cosmetics. Nig. J. Biotech. 2017; 34: 55-61.
39. Attah S,Stanley HO,Sikoki FD, Immanuel OM. Pollution Status of Inland Waterways Serving as Receptacles to Plastic Waste in Rivers State, Nigeria. Asian Journal of Environment & Ecology. 2023; 22(2): 20-30.
40. Udo EJ, Fayemi AAA. Effect of oil pollution of soil in germination, growth and nutrient update of corn. Journal of Environmental quality. 1975;4(4):537-540.