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RESEARCH ARTICLE

Negative Health and Environmental Effects of Oil Exploitation in Southern Ijaw, Bayelsa State, Nigeria

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ABSTRACT

This research delves into the effects of oil extraction on the ecosystem in Southern Ijaw, Bayelsa State, Nigeria. It specifically examines the degree of degradation, identifies pollutants, and evaluates biodiversity. The water and soil samples taken from the impacted areas have significant pollution, according to the results. According to soil analysis, heavy metal and Total Petroleum Hydrocarbon (TPH) concentrations are high and above legal limits. Elevated TPH levels in water bodies present hazards to both human health and aquatic life. The loss of mangroves and the damage caused by oil spill fires to the vegetation worsen ecological degradation. Air pollution and contaminated water supplies are the main causes of the widespread negative effects on public health, which include respiratory conditions and waterborne infections. The report emphasises how urgently environmental degradation must be stopped, biodiversity must be preserved, and public health must be protected in oil-producing areas like Southern Ijaw.

Keywords: Air Pollution, Environmental, Health, Waterborne.

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1. Introduction

Fossil fuels are at the top of the global energy market. Its annual production is estimated to be worth about 1.5 trillion dollars, according to [1]. According to projections made by the [2], fossil fuel energy would remain the main source and account for more than 84% of total energy use by 2030. Petroleum and other fossil fuel demand is expected to expand until 2030, and the world's oil resources are expected to meet that need, with an increasing amount of production concentrated in the Organisation of Petroleum Exporting Countries. Petroleum is one of the fossil fuels that are increasingly needed. Crude oil has an important role in local politics pertaining to employment, health, and the environment [3]. It also makes up the majority of international trade and balances of payments, which are important components of the economies of many nations [4]. However, because of gas flaring, oil spills, and effluent discharge, the quick extraction of natural gas and petroleum poses a major ecological and environmental risk to the neighborhood. Currently, a number of scientific disciplines are quite interested in studying urban environments. Urban environments are changing as a result of human activities such urbanization, carbon emissions, and biodiversity changes [5]. In the context of safety and environmental protection in all aspect research and development underscores the importance on operational sustainability and highlighting the environmental and financial implications of different protection methods [6]–[20].

Oil production in the Southern Ijaw local government area of Bayelsa State is a prime example of the advantages and hazards associated with resource extraction. Big international corporations like Agip and Shell have focused their attention on oil exploration and production activities in Southern Ijaw, a region hidden in the Niger Delta, because of its hydrocarbon resources. Land degradation, river pollution, air pollution, and biodiversity loss are only a few of the numerous and widespread effects of oil production on the ecosystem in Southern Ijaw. Oil exploitation

for decades has left the landscape of Southern Ijaw permanently scarred, even beyond the immediate effects of oil spills and unlawful refining. Construction of oil infrastructure, such as pipelines, well pads, and access roads, is the primary cause of deforestation, habitat damage, and soil erosion. In addition to upsetting delicate ecosystems, these actions weaken the resilience of nearby populations that depend on fishing, farming, and other natural resources for a living. Currently, a number of scientific disciplines are quite interested in studying urban environments. Urban environments are changing as a result of human activities such as urbanization, carbon emissions, and biodiversity changes. This emphasizes the significance of continuous environmental assessment to protect the health and livability of urban residents [21]–[23].

1.1. Study Objectives

Evaluating the environmental effects of oil exploitation in the study area in a thorough manner is the main aim of the research.

The specific objectives include:

- Assessing the degree of environmental deterioration brought on by oil exploration and exploitation activities was one of the study's specific goals.
- Assessing the effects of oil pollution on biodiversity in the research area and determining which specific environmental contaminants are present in soil, water, and air samples taken from affected locations.

2. Description of the Study Area

The host communities are located in the Southern Ijaw local government of Bayelsa state. The largest local government in Nigeria in terms of land area and the greatest oil-producing local government in Bayelsa state is Southern Ijaw see Fig. 1, which has its headquarters in Oporoma. According to Wikipedia, it has a population of 319,413 as of the 2006 National Census. It is located on the Bight of Benin, with a shoreline spanning about 60 km with latitudes of 4° 48′ 17″ N and 6° 04′ 44″ E. One of the localities ravaged by illegal refineries and oil bunkering is Egbematoro 1.

2.1. History of Oil Production

2.1.1. World Oil Production

In the fourth century A.D., the largest oil wells in history were excavated 800 feet below the surface in China using bamboo poles [24]. It was around the year 347 A.D. Subsequent centuries saw the mining of crude oil in Baku, Azerbaijan, Poland, and other parts of Europe and Asia. People would generally find crude oil in natural pools, where they would collect it for use as liquid fuel and medicine. In Apsheron, New York, the first oil well was sunk in 1848, eleven years before the first oil well in Pennsylvania [25]. According to Crain [26], the first oil wells dug in Europe were in Bobrka in 1854 and near Bucharest, Romania, in 1857. The first oil well drilled in North America was in Ontario in 1858, and Colonel Edwin Drake drilled the second one at Titusville, Pennsylvania, in 1859. The modern oil and gas industry began with Drake's successful production of thirty barrels per day. Crude oil-based fuels with high energy content have long since supplanted coal as the main fuel for transportation [27]. Bentley [28] claims that with an average daily production of 5 million barrels of oil, the Ghawar field in Saudi Arabia is the largest and most productive field ever discovered.

2.1.2. Oil Production in Nigeria

Nigeria is the largest oil-producing nation in Africa and the tenth-largest crude oil producer in the world, having explored and extracted petroleum hydrocarbons over more than half of the Niger Delta region [29]. With 34.1 billion barrels (bb) of known crude oil reserves, Nigeria is among the top ten nations in the world. Additionally, Nigeria has more possibilities for producing gas. The oil reserves are mostly found in the onshore portion of the Niger Delta, coastal offshore areas, and, more recently, deep waters. Nigeria, a developing country, works with international companies to manage an exploration and production concession system.

Nigeria signed up for OPEC in 1971. Nigeria, an OPEC member, can sustainably produce 2.25 million barrels per day, but in 2014, it only produced 1.92 million barrels

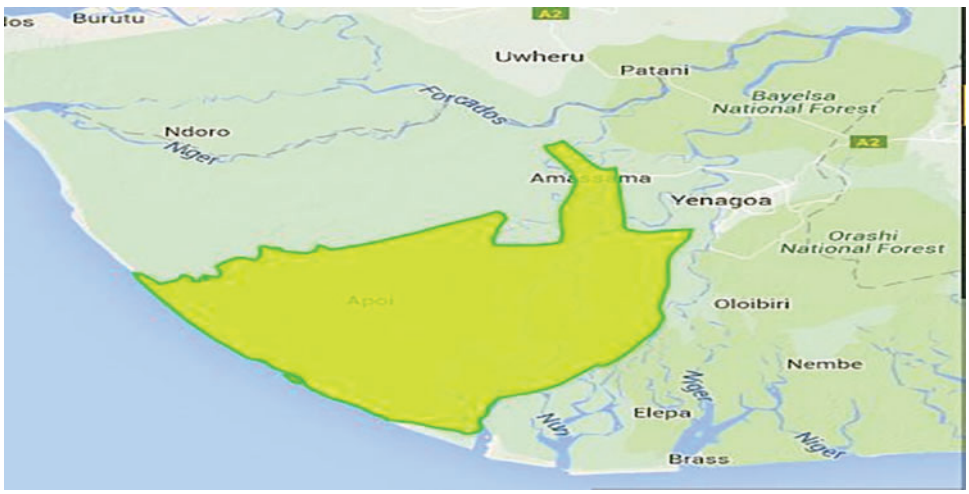

Fig. 1. Map of Southern Ijaw.

per day [30]. Only light crude oils with low sulphur content and high value are produced in Nigeria; they include Antan Blend, Bonny Light, Bonny Medium, Brass Blend, Escravos Light, Forcados Blend, IMA, Odudu Blend, Pennington Light, Qua-Iboe Light, and Ukpokiti.

A complex mixture of hundreds of hydrocarbons makes up crude oil. Among the many different chemicals that are either purposefully or unintentionally released into the environment are petroleum hydrocarbons. Petroleum production affects all facets of the ecosystem (land, water, and air), as well as the health of people and animals, and each stage has significant dangers to the environment and public health. Environmental pollution is any direct or indirect disturbance of any aspect of the environment's physical, thermal, biological, or radioactive qualities that poses a risk to the health, safety, or well-being of any living thing, according to [31], [32]. Throughout the several phases of oil and gas development, the effects of this industry have had numerous ecological repercussions on wetlands and coastal ecosystems [33]. Air pollution stems from the growth of oil and gas. For instance, oil and gas development has been blamed for the summertime urban air quality issues in Los Angeles caused by photochemical haze and elevated ozone levels.

3. Methodology

3.1. Study Area Selection

Based on prior oil leak incidents, accessibility, and ecological value, a suitable study region was determined. The kind of oil leaked, the amount of oil spilled, and the area's geographic features were all taken into account. The Egbematoro 1 community in the Southern Ijaw local government of Bayelsa state was designated as the study area.

3.2. Initial Site Assessment

Initial site inspections were carried out in order to evaluate the degree and gravity of the oil leak. The geographical coordinates of the nearby communities were used to record the observed effects on the ecosystems, and the topographical characteristics of the spill region were noted to enable precise mapping.

3.3. Sampling Design and Collection

To capture variability in the spill-affected environment, a methodical sampling approach was created. Sampling stations were chosen on the basis of ecological sensitivity, current patterns, and distance from the spill source. To ensure uniformity and reliability, standardised techniques were used to collect environmental samples, including water, sediment, soil, and biological specimens.

3.4. Ecological Assessment

To assess the ecological effects of the oil spill on the biodiversity and ecosystem health of the area, field surveys were conducted. There have been recorded changes in the distribution, abundance, and species composition of the spill-affected area. Direct observations and ecological indicators, such as species diversity indices and assessments of ecosystem function, were used to evaluate the quality and integrity of the habitat.

3.5. Chemical Analysis

Collected samples were analyzed using established laboratory methods to determine the presence and concentration of oil-related contaminants. Analytical techniques such as gas chromatography-mass spectrometry (GC-MS) and high-performance liquid chromatography (HPLC) were utilized to identify specific hydrocarbons and related compounds. Heavy metals analysis of the soil samples and the concentration of total hydrocarbons in the soil were done by Najco Laboratory Limited in Ogba Lagos using Inductively Coupled Plasma Optical Emission Spectrometer (ICP OES) Optima 7300 V Model, while the hydrocarbon and related compounds were analyzed in Massachusetts, USA using the Hewlett Packard 5890 gas chromatography. Pollutant levels were quantified in environmental matrices to assess the extent of contamination and potential risks to ecosystems and human health.

4. Result and Discussion

4.1. Assessment of Soil Contamination

In many Niger Delta villages, locations affected by crude oil pose a serious threat [34]. The Egbematoro 1 community has experienced soil contamination as a result of Agip, Shell, and bunkering agent petroleum activities. The general public's health is negatively impacted by the existence of crude oil and other inorganic contaminants in the soil. Olawoyin et al. [35] state that trace levels of heavy metals either naturally occur in crude oil or contribute to the environment throughout the petroleum production process. Because heavy metals can enter food chains, exposure to them from the soil can be long-lasting. Above a 3% concentration, oil has been shown to have more detrimental impacts on crop growth and soil biota than it does for plant community and soil qualities [36]. The results of the soil analysis for heavy metals are shown in Table I. Pollution of the soil from oil spills and other contaminants from oil and gas operations in the Niger Delta has affected the fertility of the soil, and physical degradation has resulted in reduced soil structure, aeration, and water holding capacity. Fig. 2 displays the signature of the total petroleum hydrocarbon (TPH) in the contaminated

TABLE I: Physiochemical Content of the Soil

Parameter	Concentration (ppm)	DPR target values (ppm)
TPH	7829.23	100
Barium	121.8	200
Cadmium	ND	1.0
Lead	31.7	85
Arsenic	ND	1.0
Mercury	0.2	0.3
Nickel	6.0	35
Chromium	15.7	100
Copper	ND	36
Iron	3212.4	47000
Calcium	25629.7	–
Magnesium	1970.3	–
Zinc	450.5	140

Note: ND- Not Detected.

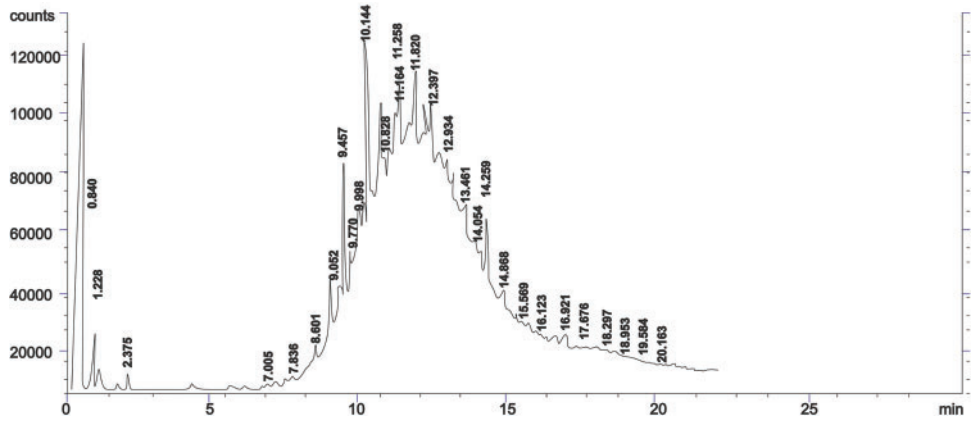

Fig. 2. Chromatogram of the TPH in the soil showing a fresh contamination in Sangana creek.

soil. The peak concentration is higher at the more volatile fractions ($<C_{15}$), indicating that the crude oil is new.

4.2. Assessment of Groundwater and Freshwater Contamination

The quality of the surface water sources in the area, which the locals use untreated for drinking and other uses, is seriously threatened by the oil and gas operations within the Niger Delta. One of the injustices against the environment that the next generation will inherit is the declining quality of surface water. Numerous petrochemical companies are located in Egbematoro 1, and surface runoff produced there is dumped untreated into the surface water. These bodies of water are used by the locals for bathing, drinking, and other household needs. There have been instances of community deaths and illnesses contracted by drinking this water. Akoroda [37] states that the Local Government Chairman of the council has indicated that the fatalities of residents in Egbematoro1 are related to drinking contaminated water from creeks and waterways. The stream (Fig. 4) in Egbematoro 1 underwent evaluation and analysis, and the results are comparable to those obtained in Amassoma Niger Delta by [38], with the exception that the stream in Egbematoro 1 has a higher concentration of total petroleum hydrocarbon. Table II displays the analysis's findings, and Fig. 3 displays the TPH chromatogram in the stream. The crude oil detected in the water body is new and unweathered, as evidenced by the fingerprints of the aliphatics fractions (C_6-C_{35}). The oil's freshness is confirmed by the n-alkanes' observably clear homologous sequence. The more volatile hydrocarbons ($<C_{15}$) are lost from freshly exposed petroleum in a few days, mostly by evaporation and disintegration, according to [39]. The amount is sufficient to affect the water's aquatic life.

TABLE II: Physiochemical Contents of Egbematoro Stream

Parameter	Concentration (ppm)	DPR target values
TPH	6.2451×10^4	10
Barium	13.8	–
Cadmium	ND	0.005
Lead	ND	0.03
Arsenic	ND	
Mercury	0.0	–
Nickel	5.0	0.07
Chromium	4.9	0.03
Copper	ND	1.0
Iron	890.5	1.5
Calcium	267.5	–
Magnesium	177.8	1.0
Zinc	7.0	

Note: ND-Not Detected.

4.3. Assessment of Oil Contamination on Vegetation

The changing hydrology, terrain, heavy metal poisoning, and acidification can all contribute to the shift in vegetation in the Niger Delta region. Fires frequently start after an oil spill on land, destroying the surrounding vegetation. The region's many fires that start as a result of pipeline vandalism destroy a lot of vegetation. Oil and gas operations can also have an impact on vegetation through the construction of access roads, drilling, dredging, and the disposal of toxic chemicals. When this occurs, illicit logging and poaching of protected species exposes them to loss of biodiversity and medicinally valuable herbs. A fire that broke out in response to an oil leak caused damage to the flora in the Egbematoro 1 hamlet (Fig. 5). Fires caused by oil spills have destroyed the distinctively varied variety of plants and animals that formerly graced this vast wetland and forest.

4.4. Assessment of Damage on Mangroves

The biggest mangrove swamp in Africa is located in the Niger Delta, covering an area of over 1900 km^2 [40]. The Niger Delta's mangrove forests are mostly affected by the oil spills that have plagued the area since the beginning of oil production. These are coastal wetland forests that continue to be vital to both the indigenous Nigerian population and the different species that live in these highly productive ecosystems worldwide [41], [42]. Many intertidal streams have been affected by oil pollution, which has stripped mangroves of their leaves and stems and left their roots covered in a substance that resembles bitumen and is occasionally more than one centimeter thick. Out of the four forest zones in the Niger Delta, the mangrove forest has the most economic value. It is home to creatures, including mussels, clams, oysters, periwinkles, and slugs. Sadly, because they are slow-moving, these organisms are always burned along with the mangroves when there is an

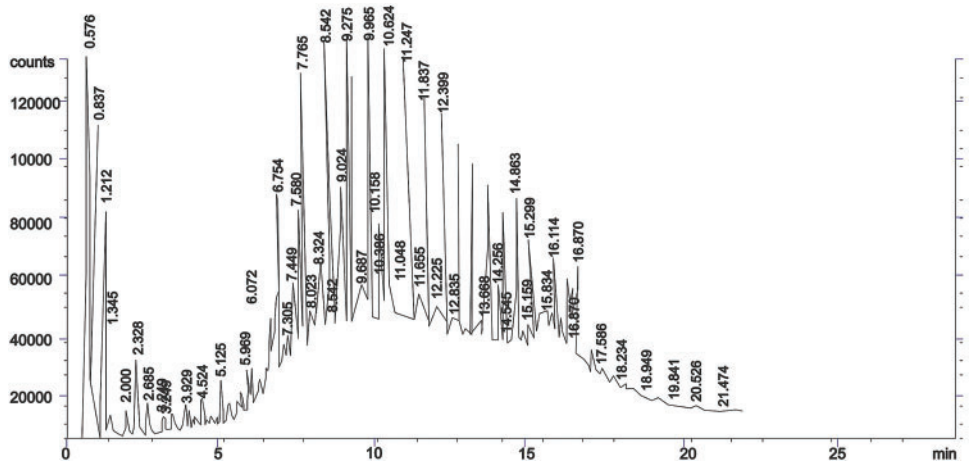

Fig. 3. Chromatogram of TPH in contaminated stream at Bini Creek.

Fig. 4. Contaminated stream at Bini Koko Egbematoro 1.

Fig. 5. Vegetation damage from oil spill fire at Egbematoro 1.

oil spill. The members of the Egbematoro 1 community rely on the mangrove for their livelihood. Because mangroves are vital to the community's livelihood and food security in addition to being environmentally significant, the toxicity of oil spills on the mangroves endangers the species that dwell there, which has an impact on the local economy [43].

4.5. Assessment of Impacts on Public Health and Air Pollution

In addition to the mangrove forests, oil and gas activities have negatively impacted the health of the indigenous inhabitants in the Niger Delta through a variety of channels, such as tainted food, water, and soil, as well as air pollution from gas flaring. In 2012, a death was reported in Egbematoro 1 due to illnesses and problems brought on by

Fig. 6. Air pollution scene from oil fire at Egbematoro.

drinking the contaminated water from the nearby creeks and rivers. In the tainted water, the majority of the hydrocarbon components are poorly soluble. Consequently, the highest concentration of the most soluble fractions will be found. Some TPH compounds that evaporate from spills or leaks in an area where an unintentional release has occurred or from those found in the surrounding air from crude oil fires (Fig. 6) and artisan refineries are inhaled by people. Critical contaminants in Egbematoro 1 are mostly contributed by artisan refineries. Individuals are frequently ill, and children are exposed through playing in TPH-contaminated soil and eating plants that have bioaccumulated nitrates from acid rain.

5. Conclusion

The study's findings demonstrate the urgent need for comprehensive action to address the different environmental problems brought on by oil exploration in Nigeria's Southern Ijaw, Bayelsa State. The report highlights the long-lasting and pervasive repercussions of unregulated oil activities, including extensive contamination of soil and water, loss of biodiversity, and detrimental effects on public health. Urgent action is needed to stop further environmental degradation and protect the well-being of the affected communities. Priorities must be set for the remediation of contaminated sites, the enforcement of tight regulations pertaining to oil production, and the adoption of sustainable practices. Governmental organisations, multinational corporations, local communities, and environmental groups must work together to bring about significant change. Sustainable development and long-term environmental restoration largely rely on investments in community involvement, capacity building, and innovative technologies. The study also highlights the interdependence of social, environmental, and economic variables in oil-producing countries, highlighting the need for all-encompassing approaches that balance commercial interests, environmental stewardship, and social justice. By addressing the root causes of environmental degradation and promoting sustainable behaviours, stakeholders may contribute to a more resilient, equitable, and environmentally sustainable future for Southern Ijaw and other oil-producing regions across the globe.

6. Recommendation

1. To ensure adherence to environmental standards and minimise negative effects, strengthen the regulatory frameworks that control oil exploration and production by improving and enforcing existing legislation.
2. Remediation and Restoration: Prioritize the remediation of contaminated sites through scientifically sound and community-inclusive approaches.
3. Community Engagement and Empowerment: Foster meaningful engagement with local communities affected by oil activities, empowering them to participate in decision-making processes and resource management.
4. Technology Innovation and Best Practices: Invest in research and development of innovative technologies for oil extraction, spill response, and pollution control.
5. Capacity Building and Education: Enhance the capacity of local institutions, government agencies, and community organizations to effectively manage environmental risks associated with oil exploitation.
6. Diversification of Local Economies: Support efforts to diversify local economies away from dependency on oil revenues, promoting sustainable livelihoods in agriculture, tourism, renewable energy, and other sectors.

7. Renewable Energy Incentives

As a long-term solution, the Nigerian government should establish legal incentives for the development and adoption of renewable energy sources within the state, reducing reliance on fossil fuels and mitigating future environmental and health risks. By implementing these recommendations in a coordinated and sustained manner,

stakeholders can work towards mitigating the environmental impact of oil exploitation in Southern Ijaw and promoting a more sustainable and resilient future for affected communities and ecosystems.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

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