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Research Paper

A Comprehensive Evaluation of Geologic and Radiologic Impacts of Oil Drilling in the Niger Delta Region of Nigeria

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Abstract
In the Niger Delta, oil drilling activities have been carried out for several decades. However, these activities have had both geological and radiological effects on the region. It is therefore crucial to evaluate these effects and their impact on human health and the environment. This evaluation aims to provide an in-depth analysis of the geological and radiological effects of oil drilling in the Niger Delta region. The study analyzed existing research studies that assess environmental impacts caused by oil extraction as well as geohazard assessment reports from different fields around this area. Ultimately, this paper seeks to increase awareness about the negative consequences of oil exploration in Nigeria's largest wetland ecosystem while identifying possible ways to mitigate its detrimental impacts which are often overlooked by policymakers. Applying dose rate response curve gave the possible health implications associated with this industrial operation of oil drilling.

Keywords*: oil drilling, Niger Delta, geologic impacts, radiologic impacts, oil conflicts, environmental impacts*

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I. Introduction

The major socio-economic and environmental impacts of oil exploration and drilling activities in various regions around the world including the Niger Delta in Nigeria, creates unprecedented situation for posterity if not addressed promptly [13][12][1]. The Niger Delta is known for its sufficient oil reserves and is therefore a hot spot for oil drilling. However, these activities have created severe environmental and radiation effects, affecting the environment of local communities.

The Niger Delta, located in Southern Nigeria, is located on the Atlantic coast with latitude 3^0 and 6^0N and longitude 5^0 and 8^0E [16]. It experiences distinct seasons of wet and dry seasons. It is the largest delta in Africa and third largest in the world. A region rich in oil and gas reserves (fig 1). This has made it the center of oil drilling activities by multinational corporations seeking to exploit these resources for economic gain. However, this industrial activity has significant environmental and health implications for the region and its inhabitants. Oil drilling involves various processes that have potential geological and radiological impacts on the environment.

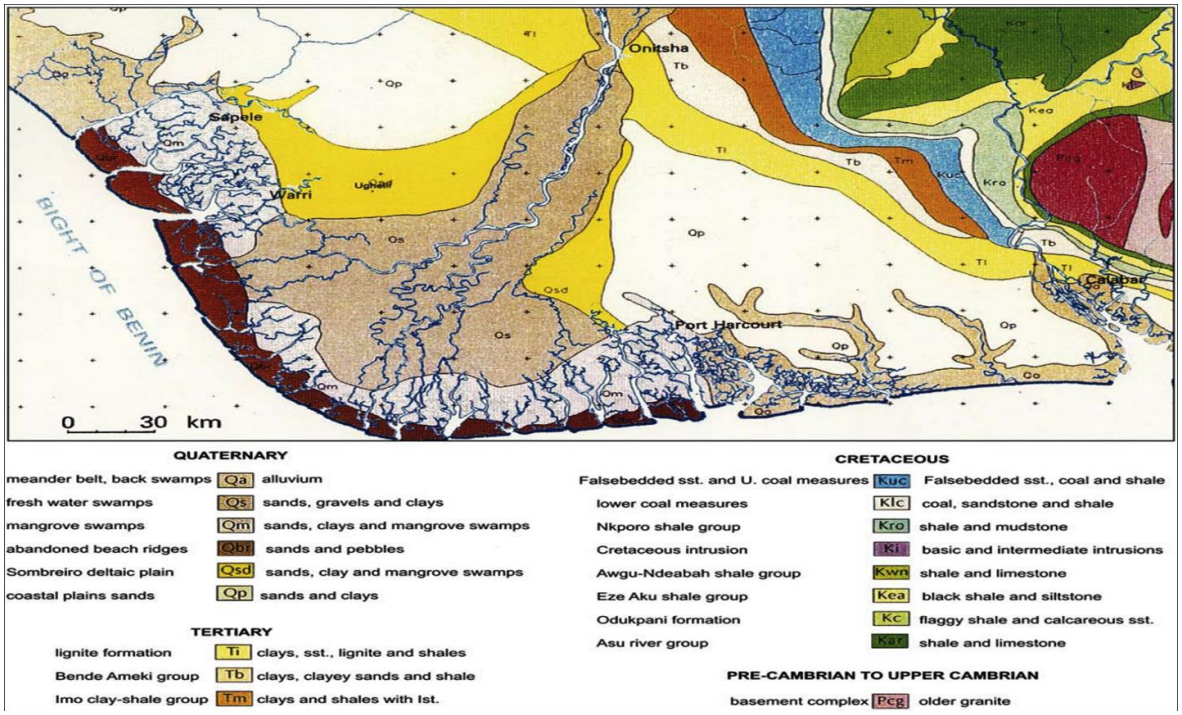

Fig 1: Geologic map of Niger Delta and Environs (Reijers *et al*., 2011)

Through an examination of the geological and radiological impacts of oil drilling in the Niger Delta region, this study evaluated potential risks and consequences associated with this industrial activity. The analysis considered both short-term and long-term implications of oil drilling on human health as well as ecological systems within the region. This evaluation further seeks to highlight possible environment and health hazards posed by oil extraction activities in the Niger Delta. It also explores possible strategies that can be used to minimize future geological and radiological impacts while promoting sustainable practices within this industry. Evaluating geological and radiological impacts of oil drilling activity in Niger delta is crucial given its significance on environmental sustainability, human health, and energy security. It's our hope that through critical evaluation, a more sensitive approach towards handling such operations might emerge which ensures that safety standards are upheld while minimizing negative externalities arising thereof for benefit of present generation without compromising those expected tomorrow. The Oil drilling can have a number of geological impacts on the environment. Geological effects include subsidence, soil erosion, ground instability, groundwater contamination, among others. Subsidence deals with the removal of large amounts of fluid from the subsurface and this can cause the land to subside. This can lead to flooding, erosion, and the loss of infrastructure. On the other hand, radiological effects arise from exposure to natural radioactive materials during exploration or production activities.

Contamination is introduction of foreign substance into an environment while pollution is when the concentration of such substance is above the control/permissible limit. Oil drilling can contaminate soil, water, and air with a variety of pollutants. These pollutants include heavy metals, hydrocarbons, and radioactive materials.

Degradation of ecosystems deals with Oil drilling activities leading to degrade ecosystems by destroying habitats, disrupting food chains, and poisoning wildlife. Oil drilling activities can also have a number of radiologic impacts on the environment. These impacts can include: radioactive releases from oil drilling activities causing the release of radioactive materials into the environment. These materials can come from the oil itself, from the drilling fluids/mud used, or from the subsurface rocks that are drilled through. Increased radiations levels involve technically enhance naturally occurring radioactive materials which causes increase radiation levels in the environment. This can increase the risk of cancer and other health problems for people and wildlife.

The radiologic impacts of oil drilling can be long-lasting. Radioactive materials can remain in the environment for thousands of years, and they can continue to pose a health risk to people and wildlife. A comprehensive evaluation of the geologic and radiologic impacts of oil drilling in the Niger Delta is needed, hence this research work to assess the full extent of the problem.

To evaluate the levels of contamination resulting from oil drilling activities in the Niger Delta, a comprehensive sampling of soil, water, and air is essential. This sampling process will provide valuable data

regarding the extent and impact of pollution caused by oil spill incidents and radiological materials. The following approach outlines the necessary steps to conduct the sampling and assess contamination levels: *Soil Sampling*: Soil samples should be collected from various locations in the Niger Delta to assess the presence and distribution of contaminants. Sampling points should include areas near oil wells, flow stations, and pipelines, as well as regions impacted by oil spill incidents. The sampling methodology should follow established protocols, including random sampling techniques and proper sample preservation [2],[13], provides insights into groundwater monitoring for environmental liability assessment, which can be referenced for soil sampling techniques. *Water Sampling:* Water samples should be collected from rivers, lakes, and other water bodies in the Niger Delta region. These samples will help identify the presence of hydrocarbon pollutants and other contaminants resulting from oil drilling activities. Sampling points should include areas affected by oil spills and those near oil facilities [4],[12], researched on natural radioactivity and trace metals in crude oils, offering valuable information for water sampling and contaminant analysis. *Air Sampling:* Air quality assessments are crucial for understanding the dispersion of pollutants and their potential impacts on human health and the environment. Air samples should be collected using air monitoring equipment at various locations in the Niger Delta, focusing on areas near oil drilling sites and regions affected by oil spills. [5],[12] Researchers discussed the assessment of Naturally Occurring Radioactivity Materials (NORM) in clay deposits, which can be referenced for air sampling techniques and analyzing radiological impacts. *Laboratory Analysis:* After sample collection, the soil, water, and air samples should be transported to a certified laboratory for analysis. The laboratory should employ appropriate methods for analyzing hydrocarbon pollutants, heavy metals, and radiological materials present in the samples. Analytical techniques such as gas chromatography with flame ionization detector (GC-FID), gas chromatograph with mass spectrometry (GC-MSD), and gamma spectroscopy can be utilized for accurate quantification of contaminants.[3],[12] and [8][12] provide insights into gamma spectroscopy measurement of natural radioactivity and assessment of radiation hazard indices, which can be referenced for laboratory analysis techniques. By conducting a comprehensive assessment of soil, water, and air samples, the levels of contamination resulting from oil drilling activities in the Niger Delta can be evaluated. This data will contribute to a better understanding of the geologic and radiologic impacts and assist in developing mitigation strategies to minimize environmental damage and safeguard public health.

Objective

To make comprehensive medical evaluation of potential risks and consequences associated with oil well drilling activities in the Niger Delta and operate without compromising human health concerns or cause irreversible damage to natural resources.

Problem Statement

Oil well drilling is economically profitable and makes nations become relevant because of the revenue accruable. However, the significant geologic and radiologic implications releasing ionized radiators into the environment with the associated social crisis in the region and its inhabitants are of great health and developmental concerns that needs be addressed.

II. A Review of the Scientific Literatures on the Geologic and Radiologic Impacts of Oil Drilling.

The scientific literatures reviewed indicate that oil drilling in the Niger Delta has substantial geologic and radiologic impacts. Environmental challenges, such as oil spillage, persist despite a decrease in spillage quantity. Additionally, the presence of NORMs and heavy metals in drilling mud samples poses health risks to drilling crew. To mitigate these impacts, it is crucial to prevent further oil spills and implement environmental improvement measures [1]. Oil exploration and production activities in the Niger Delta have resulted in significant environmental challenges and adverse effects on the region's inhabitants [1]. Oil spillage remains a primary concern in the Niger Delta, leading to environmental degradation and public health risks. Although the quantity of annual oil spillage has decreased, the number of spill incidents continues to rise, indicating insufficient improvement [1].

The findings from various studies indicate that oil drilling activities in Niger Delta have resulted in elevated levels of background ionizing radiation. [8] Study on the radiological impact of oil and gas activities in Oil Mineral Lease 30 (Oml 30) Oil Fields revealed that yearly radiation dose rate exceeded the maximum permissible limit recommended for public exposure by International Council on Radiological Protection, except for Evwreni community. This implies that people living around these areas are exposed to high levels of radiation which can lead to serious long-term health effects such as cancer, genetic mutations, reproductive abnormalities among others. Similarly, a study conducted by [11] discovered that oil drilling activities in Eruemukohwarien area have led to slightly above-permissible absorbed dose rate threshold recommended by [20]. This indicates a possible threat to both human life and ecological balance. [3] Researchers further

supported these claims as it found gross alpha/beta activity values obtained from soil/sediment were relatively high compared to values reported elsewhere indicating higher concentrations radioactive substances like uranium or thorium present at those locations due to oil exploration/production procedures employed therein. These results demonstrate how unchecked industrialization within Nigeria's natural resources sector poses significant risks not only economically but also environmentally through exposure route of inhalation, dermal and ingestion leading ultimately towards severe health consequences over time - especially amongst those residing close proximity where such operations take place like Nigerian deltaic regions, which may face challenges coping with repercussions caused by industrial activities impacting on local populations that depend on their economical/social/cultural too!

2.1 Naturally Occurring Radioactive Materials (NORMs): Oil drilling activities introduce NORMs into the environment, which pose health risks to drilling crews. Studies have detected significant concentrations of radioactive and heavy metals, including lead (Pb), mercury (Hg), cadmium (Cd), zinc (Zn), chromium (Cr), aluminum (Al), arsenic (As), nickel (Ni), and copper (Cu) in drilling mud/**drill cutting** samples [3]. *Health Implications*: The concentrations of certain heavy metals found in drilling mud samples, such as Pb, Cu, As, and Al, can cause skin irritations over long-term exposures. Cd, Hg, Zn, and Ni present in the samples may lead to lung infections or immune breakdown when ingested over extended periods [3][8]. *Radium Release and Dose Rate:* The geologic impacts of oil drilling include the release of radium, which can contribute to increased radiation levels. The radium equivalent activity in the analyzed mud samples (in what or where) was found to be within permissible limits, with the highest activity observed in Mud Sample [3]. *Correlation between Heavy Metals and Radionuclides*: There is a significant correlation between the concentrations of heavy metals and radionuclides in the mud samples, highlighting the interconnectedness of geologic and radiologic impacts [3].

2.2 A Survey of the Environmental Conditions in the Niger Delta.

The Niger Delta region is characterized by its petroleum industry, which has led to significant environmental issues [3]. With a delta area covering 20,000 km^2 and wetlands spanning 70,000 km^2, this region is home to 20 million people (is it by census of 2006?) and supports diverse flora and fauna. However, the activities associated with oil drilling have caused extensive environmental degradation, making it one of the most polluted areas in the world [3]. The Niger Delta environment can be divided into four ecological zones: coastal barrier islands, mangrove swamp forests, freshwater swamps, and lowland rainforests [3]. These zones exhibit high biodiversity and support various species of flora and fauna. In fact, the region has one of the highest concentrations of biodiversity globally, with numerous species of freshwater fish, arable terrain for crops, and abundant flora and fauna [6]. The advent of oil production has resulted in extensive oil spillage, posing a grave threat to the Niger Delta ecosystem [3]. Over the past five decades, the region has experienced unprecedented oil spillage, with an estimated 9,343 cases of oil spills in just ten years, far surpassing the number in the European Union over 40 years [11]. The careless practices of the oil industry and the lack of effective governmental and corporate efforts to address environmental problems have aggravated the situation [3][6]. The consequences of environmental degradation in the Niger Delta are substantial. The extensive loss of habitable terrain, estimated to reach 40% in the next thirty years, poses a significant challenge to the region's sustainability [3]. The pollution from gas flaring, dredging of larger rivers, oil spillage, and land reclamation due to oil and gas extraction costs the region approximately US$758 million annually, with 75% of this cost borne by local communities through polluted water, infertile farmland, and loss of biodiversity [3][18][19]. The environmental conditions in the Niger Delta have been severely impacted by oil drilling activities, resulting in extensive environmental degradation. The region's rich biodiversity and unique ecosystems have suffered due to the large number of oil spills and inadequate environmental management practices. Urgent measures are necessary to address these issues, including improved regulations.

2.3 A Study of the Health of People and Wildlife in the Region.

Oil drilling in the Niger Delta region has raised significant concerns regarding its adverse effects on human health and wildlife. The extraction and exploration processes associated with oil and gas operations introduce a wide range of chemical pollutants and physical stressors that pose potential risks to both the environment and public health [3][12][1]. We provide an overview of the health impacts caused by oil drilling activities in the Niger Delta, focusing on the effects on both human populations and wildlife. Oil and gas exploration and exploitation emit over 1,300 different chemicals into the environment, including volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene and xylene (BTEX) and heavy metals, among others [3]. These chemicals have ecological and public health implications. Polycyclic aromatic hydrocarbons (PAHs), in particular, are of major concern due to their persistence in the environment and potential toxic and carcinogenic effects on humans [3] as well as the BTEX though do not persist in the environment but some are carcigenic**.** The United States Environmental Protection Agency (EPA) has identified specific PAHs, such as benzo(a)pyrene, benzo(a)anthracene, and chrysene, as priority compounds

to monitor during oil spills [3]. Moreover, heavy metals, including lead (Pb), nickel (Ni), cadmium (Cd), and arsenic (As), have been detected in crude oil and drilling fluids, which are commonly used in oil fields. These metals pose significant health risks, such as cancer and neurotoxicity, to both humans and wildlife [3][12]. Living near oil spills and production sites exposes individuals to a combination of chemical pollutants and physical hazards, leading to adverse health effects. To comprehensively assess the risks associated with such exposure, a cumulative risk assessment (CRA) approach is recommended. CRA takes into account the combined effects of multiple stressors on human health, providing a more holistic understanding of the problem [1]. Addressing the public health issues associated with oil drilling in the Niger Delta requires the involvement of major stakeholders, including multinational oil companies. It is crucial to support the development of Environmental Medicine Research to generate data on mitigating the health effects of oil exploration, as well as environmental remediation strategies. These efforts can contribute to a waste-to-wealth program, potentially alleviating the restiveness observed in oil exploration communities [1]. The geologic and radiologic impacts of oil drilling in the Niger Delta have significant consequences for human health and wildlife. The introduction of various chemicals and physical stressors during exploration and exploitation processes raises concerns about air and water quality, as well as the potential for long-term health risks. Implementing comprehensive risk assessments and supporting research efforts.

2.4 Environmental Implications of Oil Exploration in the Niger Delta

The environmental impacts of oil exploration and exploitation in the Niger Delta are extensive and multifaceted. These impacts include pollution, ecosystem degradation, and damages to flora and fauna [3]. Oil conflicts, as they are often referred to, have emerged as a result of these negative environmental consequences. The conflicts arise due to damages inflicted on the Niger Delta and the failure to effectively address and prevent further degradation. It is crucial to recognize the role of both the oil companies involved in exploration and the government in contributing to these conflicts [3]. To mitigate the environmental impacts of oil drilling, the implementation of existing laws, regulations, and protocols must be prioritized.

2.4.1 Radiologic Impacts of Oil Drilling in the Niger Delta

The radiologic impacts of oil drilling in the Niger Delta are a growing concern. Activities such as drilling, extraction, and transportation of oil can lead to the release of naturally occurring radioactive materials (NORM) [12]. Exposure to these radioactive materials can pose risks to both the environment and human health. The radiologic impacts of oil drilling in the Niger Delta region can be evaluated by considering the potential contamination both composite and discrete of soil, water, and air, as well as the associated health risks. The presence of naturally occurring radioactive materials (NORMs) in oil-bearing formations and the handling of drill cuttings and drill fluids contribute to the radiologic impacts. Studies have highlighted the following points:

NORM Concentrations and Health Hazards: Oil and gas field development projects in the Niger Delta region target organic-rich carbonate, shale, and sandstone formations that contain NORMs [6]. The exploration activities may increase the NORM concentrations, and drill cuttings produced during drilling often contain radionuclides [6]. Improper disposal and recycling of these wastes can lead to contamination and unnecessary public exposures to radiation [6].

Environmental Behavior of Radionuclides: The toxicity and environmental behavior of radionuclides and trace elements depend on their physiochemical forms in the environment [6]. It is important to understand the distribution patterns of NORMs in different lithofacies and quantify the possibility of human/operator exposures to NORMs [6]. Further investigation is needed to address these knowledge gaps and assess the potential health risks associated with NORMs [6].

Soil and Sediment Contamination: Studies have evaluated the natural radioactivity in soil and sediment samples from oil fields in the Western Niger Delta region [15]. These studies provide insights into the levels of natural radionuclides in the soil and sediments, which can be indicators of contamination [15].

Negative Environmental Impacts: Oil exploration and exploitation in the Niger Delta region have resulted in negative environmental impacts, often referred to as oil conflicts [13]. These impacts include damages to the flora and fauna bodies in the region. The article emphasizes the importance of implementing existing protocols, rules, laws, and organizations to prevent further damages and curb the oil conflicts [13].

2.5 Social Economic Implications of Oil Exploration in the Niger Delta

Oil exploration and production in the Niger Delta have socio-economic implications, both positive and negative. While oil resources can serve as a strong economic base for sustainable development, the mismanagement of these resources and injustice has hindered economic growth in many African countries, including Nigeria [12]. The exploration of crude oil in the region has brought foreign earnings, but challenges such as infrastructural deficiencies, lack of proper education, managerial incompetence, and corruption have hindered the equitable distribution of wealth and hindered overall development [12].

III. A Comprehensive Evaluation

To get a clear understanding of the geologic and radiologic impacts of oil drilling in the Niger Delta, a comprehensive evaluation of possible environmental and human health impacts will be most discussed. This discussion will be guided by the approved guidelines and standards. Thus, the environmental and health permissible limits in terms of contamination/pollution and/or dose rate response respectively.

Dose-Response Relationship is an essential and central concept in toxicological studies and modeling is used to extrapolate the performance of hazard assessment [9]. Assessing risk to human exposure to toxic chemical is either by quantitative or qualitative analyses to estimate risk and to establish health-based guidance values known as "Safety assessment" analyses. The primary aim of dose-response is to determine the presence or absence of a cause-effect relationship and so, dose-response is an analytical model of hazard characterization and the interpretation is usually based on level of exposure which level of exposure could be acute, intermediate/subchronic or chronic. Dose could be in 3 ways: dose frequency, dose duration and/or dose magnitude and exposure is measured by biomonitoring of blood, tissue concentration or excrete (urine). Table 1 shows the effects of BTEX in human.

Table 1: Common Effects of BTEX on Human [21]

Chemicals	Carcinogen	Affects liver	Affects kidney	Affects Nervous System
Benzene	x			
Toluene		x	x	X
Ethylbenzene		x	x	
Xylene				X

These BTEX are highly mobile and find their way into human beings through air or water and are potent because of their toxicity. [22] gave a human health minimum risk level for benzene as 0.05µg/l, toluene as 3µg/l, ethylbenzene as 0.2µg/l and xylene as 1µg/l. That, application of index of concern (IOC) or bioaccumulation value greater than 1 indicates that there may be some concern for potential non-cancer effects.

A dose-response curve is the graph of concentration of a certain substance against effects on an organism [22]. [18] Model explained the variability effects of dose response in hypothetical curve. This can be expressed as different phases in the hypothetical curve as harmful or lethal/death. This variability effects is shown in fig 2 and 3 for benzene and ethylbenzene respectively.

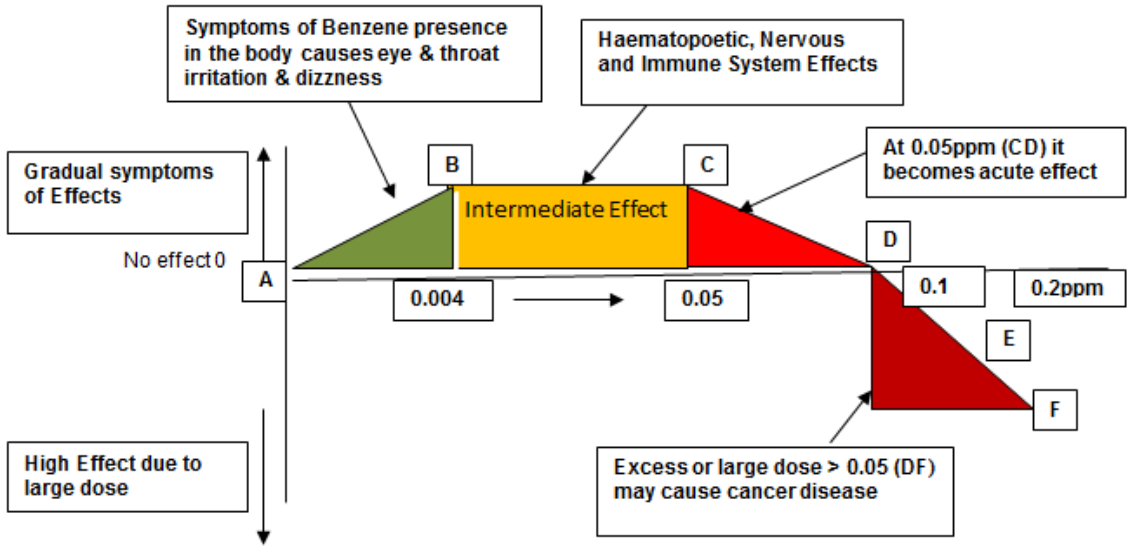

Fig 2: Benzene Dose-Response Curve (modified [17]

Benzene and ethylbenzene were causes acute myeloid leukaemia (effects on bone marrow & attack white blood cells), immuno reduction in lymphocytes (white blood deficiency). From fig 2, presence of benzene in humans causes eye and throat irritation and dizziness at 0.004ppm and above 0.004ppm the effects become3s intermediate and leads to haematopoetic nervous and immune system effects. At 0.05ppm, it effect becomes acute. Above 0.05ppm, it becomes carcinogenic. In fig 3, the effect of ethylbenzene is intermediate at 0.1ppm and causes eye and throat irritation and dizziness. The effect becomes acute at 0.2ppm and above 0.02ppm the

dose is in excess with possible causes of liver and kidney problems. Ethylbenzene s rapidly distributed to dispose tissues through the body and accumulates primarily in the liver, kidney and fats in humans.

Polycyclic Aromatic Hydrocarbon (PAHs) are absorbed by inhalation, oral and dermal exposure. They are lipophlic (attracted to fats) and some are readily absorbed in lungs widely distributed to tissues and accumulates to tissues and some are poorly absorbed and distributed to liver and fatty tissues. Some are carcinogenic and by oral, high dose leads to adverse haematological (red blood cells) effects and hepatic (liver) effect. By inhalation leads to pneumonitic (lung inflammation & thicken lungs), hepatic and renal (kidney) effect [22].

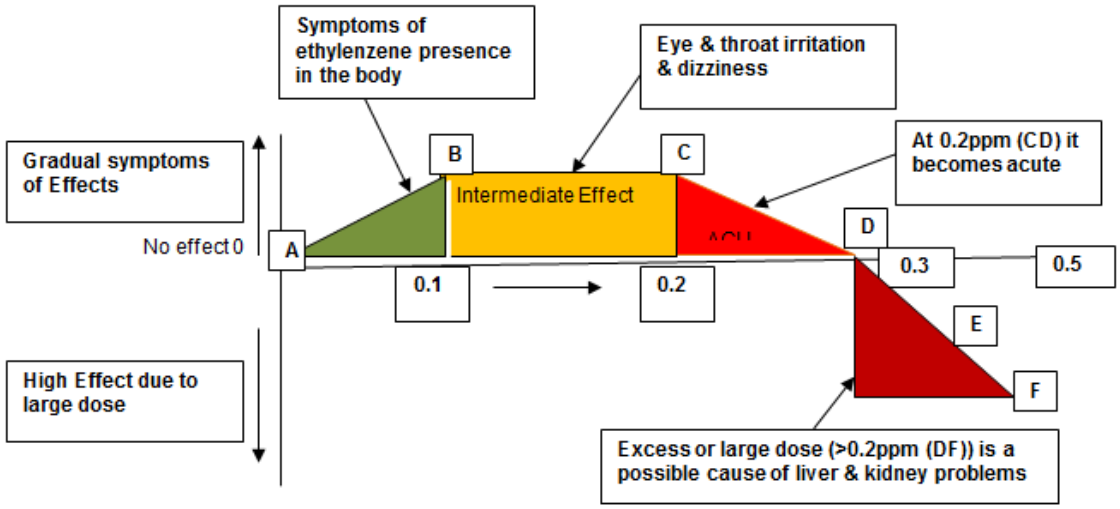

Fig 3: Ethylbenzene Dose-Response Curve (modified [17]

PAHs in fatty tissues of human leads to rapid weight loss and loss of body fats [7]. Such persons are at risk because of the systematic release and activation of PAHs in the fat and PAHs exposure can cause skin cancer if significantly exposed to ultraviolet radiation and from sun. According to IARC Group 2A, and USEPA Group B2, benzo(a)pyrene, chrysene and benz(a)anthracene are carcinogenic. According to [22] Benzo(a)pyrene cause respiratory effects at 0.0001mg/m^3 which may lead to cancer. According to [7] naphthalene could lead to hemolytic anemia (shortage of blood due to destruction of red blood cells). According [14], naphthalene permissible limit is 0.002ppm by inhalation. Acenaphthene causes liver effects while fluorine causes hepatic effect (increased liver weight). These are clear indication of biomarkers from petroleum hydrocarbon. Our body defence mechanism gives up when the stress factor greatly exceeds it [9].

The implications of adverse health effects of elements, metal and non-metal substances or potential pollutants had been termed ***'geogenic contaminants'*** [10]. Several studies on this subject had been done in most developed countries such as Canada, USA, China, Bangladesh and even in India. In these countries, there are reports and data on the relationship between geological and means of geochemistry and human/animal health. Some elements are so essential for a healthy living such as Chromium, Copper, lead, Calcium, Selenium while some others toxic such as lead, arsenic, and mercury are not essential. Even the essential elements, as essential as they are, all organisms has a specific range of tolerance or adequate range of exposure that is considered safe.

Human health is in a state of adjustment to his internal and external environment. This is related to the geologic environment and regional or local variations in chronic disease.

IV. Conclusion

To obtain a comprehensive understanding of the radiologic impacts of oil drilling in the Niger Delta region, further research and monitoring are necessary. These efforts should focus on assessing the distribution of NORMs, quantifying exposure risks, and investigating the potential health effects on both workers and the local population. Implementing strict regulations and best practices for the handling and disposal of NORM-containing materials can help mitigate the radiologic impacts and protect human health and the environment.

To mitigate the impacts on flora, fauna, and local communities, it is imperative that existing laws, regulations, and protocols are effectively implemented and enforced. Additionally, sustainable mitigation strategies, including community involvement and mangrove conservation efforts, should be pursued. By addressing these challenges comprehensively, the Niger Delta can achieve sustainable and responsible oil drilling practices while safeguarding its unique ecosystem for future generations. The evaluation of geological and radiological effects on oil drilling activities in Niger Delta is a complex issue with serious implications for

the environment and human health. The findings of this research indicate that oil drilling activities have caused significant damage to the local ecosystem, including soil degradation, water pollution, and loss of biodiversity. Moreover, it has become clear that these activities have adverse effects on the health of individuals living in close proximity to drilling sites. Respiratory problems related to gas flares are widespread among local communities. Worse still, is the impact on livelihoods as fishing and farming lands have been destroyed by contaminated waters. Despite efforts from government agencies and NGOs, which advocate for environmental justice, more needs to be done if lasting solutions are to be found. It's crucial that stakeholders involved in oil exploration work hand-in-hand with those affected by their operations – this would ensure meaningful participation in decision-making mechanisms towards mitigating or preventing further harm. Additionally, there must be political willpower towards enforcing regulations governing drillings so that they can hold accountable for violations.

V. Recommendations

1. All stakeholders, including government agencies, oil companies, and local communities, to work collaboratively towards sustainable and responsible oil drilling practices.
2. Comprehensive mitigation strategies must be implemented. This includes strict adherence to environmental regulations, proactive monitoring and remediation of contaminated sites, adoption of advanced drilling technologies to minimize environmental risks, and increased community involvement in conservation efforts.
3. A participatory framework for mangrove conservation in coastal communities is crucial to preserve the unique ecosystem of the Niger Delta.
4. Oil drilling crew members should carry out regular laboratory analysis monitoring to early identify infection due to at field for quick medical attention.

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