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Review Article

A Review on Environmental Contributors to Adverse Healthcare Conditions and Prevailing Health Challenges in Bayelsa, Nigeria

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Abstract

***Background and Objective*:** The environment serves as a gateway to many disease conditions, especially when compromised or altered. Bayelsa State is known for its fragile environment, occasioned by crude oil contamination, reckless gas flaring, illegal artisanal oil refining, flooding, and gross lack of water, sanitation, and hygiene (WASH) systems. These factors have direct correlations with Communicable diseases (CDs) and non-communicable diseases (NCDs). This study is therefore designed to establish a verifiable basis for the impact of environmental degradation and contamination on the health conditions of residents in Bayelsa State. ***Materials and Methods*:** This descriptive study reviewed this thematic discourse using secondary data and literature sources from search engines and internationally revered publication platforms such as Elsevier, Scopus, ResearchGate, Google Scholar, Francis and Tylor, Springer, and a handful of others. ***Results*:** The findings have clearly shown that environmental degradation and contamination have obvious effects on the health conditions of the residents of Bayelsa State. Public health conditions such as infectious diseases, non-communicable diseases, malaria, cancer, pulmonary diseases, cardiac diseases, renal failure, infertility, congenital disorders, diabetes, and hypertension topped the list of associated diseases. ***Conclusion*:** There is a two-prong approach to resolving the disease proliferations associated with environmental degradation in Bayelsa State. Firstly, there is a need for effective policy directions by the federal and state governments in addressing the issue of environmental degradation using internationally accepted standards sourced locally. Secondly, it is on the side of the citizens to be responsive in ensuring an assurance of an environmentally friendly ecosystem in Bayelsa State.

Keywords: Environmental Degradation, Bayelsa State, Nigeria, Crude Oil Contamination, Gas Flaring, Flooding.

1.0 INTRODUCTION

The environment refers to the total living and non-living surroundings of any organism that are necessary for life and sustainability [1]. The state of the environment over time has a significant impact on both the biotic and abiotic components of the environment, which are essential for human health. If the environment is not healthy, then everything in the environment is at risk [2]. Environmental health is the interconnection between people and their environment by which human health and a balanced, nonpolluted environment are sustained or degraded [3]. Individual, societal, national, and global activities relating to the environment have a complex and dynamic relationship operating simultaneously. Environmental health reciprocates in two ways, which include environmental factors affecting human health and human activities affecting environmental quality.

Healthcare is a critical aspect of human life, shaping the quality of existence and influencing well-being. It encompasses everything from medical services to preventive care, as well as policies that impact community health. Furthermore, it could be seen as an organized system of services and practices intended to maintain or improve physical and mental health. It involves the diagnosis, treatment, and prevention of diseases and other services that help people live longer, healthier lives. Health care services are typically delivered through various systems and institutions, such as hospitals, clinics, and doctors' offices.

Bayelsa State is located in the Niger Delta region of Nigeria, facing significant environmental health challenges [4-10]. The state is endowed with both human and natural resources, making it one of the highest contributors to the coffers of the Nigerian Government. Despite the wealth of the state, a lot of

deleterious activities are condoned, impacting its social and health ecosystem [11-15].

The environmental health challenges in Bayelsa State have unique geographic and socioeconomic characteristics. The state's coastal location, mangrove forests, and numerous waterways make it vulnerable to oil spills, pollution, and other environmental hazards. Furthermore, the region's high population density, poverty, and limited access to healthcare exacerbate the health impacts of environmental degradation. The region is rich in natural resources, including crude oil, natural gas, and mineral reserves, and industrial activities, which have led to several environmental degradation, resulting in adverse health conditions and prevailing health challenges among its inhabitants as a result of widespread environmental pollution, which has severe implications for human health. This paper examines the environmental contributors to these health issues and explores potential solutions.

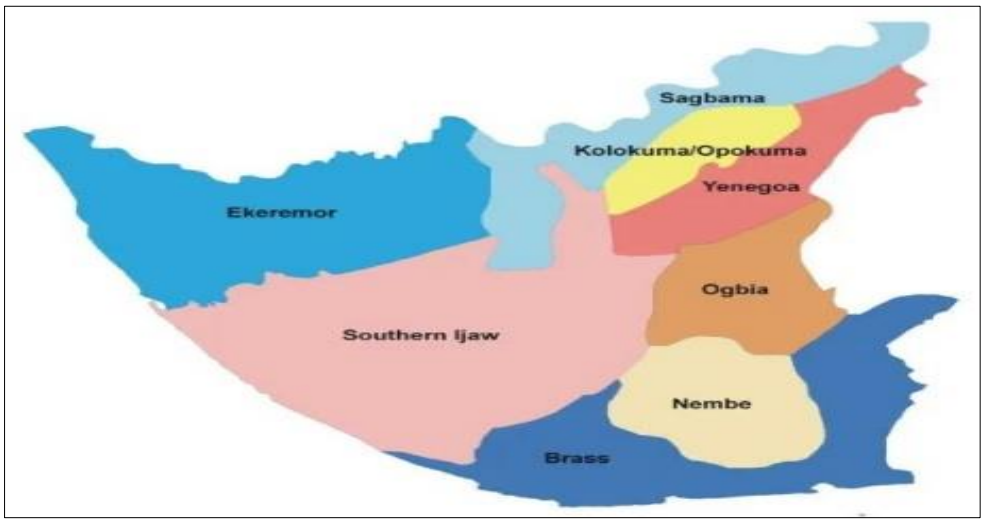
2.0. STUDY AREA, DATASETS, AND METHODS

2.1. Study Area

Bayelsa State was created on October 1, 1996, out of the old Rivers State by the then regime of General Sani Abacha. The name, Bayelsa, is an acronym of three former Local Government areas, Brass, Yenagoa, and Sagbama in the then Rivers State, which had earlier comprised the entire area now constituting Bayelsa State. at present, the state is made up of eight local government areas, which are Yenagoa, Brass, Nembe, Southern Ijaw, Ekeremor, Sagbema, and Kolokuma-Opukuma.

Located in the Southern part of Nigeria, Bayelsa covers 21,100 Square Kilometres with its capital at Yenagoa. Bayelsa State is geographically located within Latitude 04° 15' North, 05° 23' South, and longitude 05° 22' West and 06° 45' East [7]. It shares boundaries with Delta State on the North, Rivers State on the East, and the Atlantic Ocean on the West and South [8].

Bayelsa State is home to Oloibiri (Otuobagi) in Ogbia Local Government Area, where oil was first struck in Nigeria in commercial quantities in 1956. It tops the list of states in Nigeria in gas production and potential. The major oil exploration and production companies operating in the State are Shell, Agip, and ChevronTexaco. Bayelsa State is a major oil and gas-producing area, and it contributes over 30% of Nigeria's oil production.



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2.2. Data Sets

The data used were acquired from the Institute for Health Metrics and Evaluation (IHME). This study's data range is from 2005 to 2025 of the Global Burden of Diseases, Injuries, and Risk Factor studies [18-19]. Data were extracted for Nigeria on all age groups, both sexes, environmental risks, and health-related-risk clusters of environmental-risk factors, and were domesticated in Bayelsa State as a case study. This study concentrated mainly on related risk clusters of diseases and injuries categorized under environmental risk factors, such as cardiovascular diseases, diarrheal diseases, mental disorders, enteric infections, respiratory infections, tuberculosis, lower respiratory infections, chronic obstructive pulmonary disease (COPD), chronic respiratory diseases, ischemic heart disease, stroke, communicable, maternal, neonatal, and nutritional diseases.

Bayelsa State, as a component of the Nigerian entity, which formed part and parcel of the data published by the GBD and other platforms. This study pooled similar narratives and domesticated them.

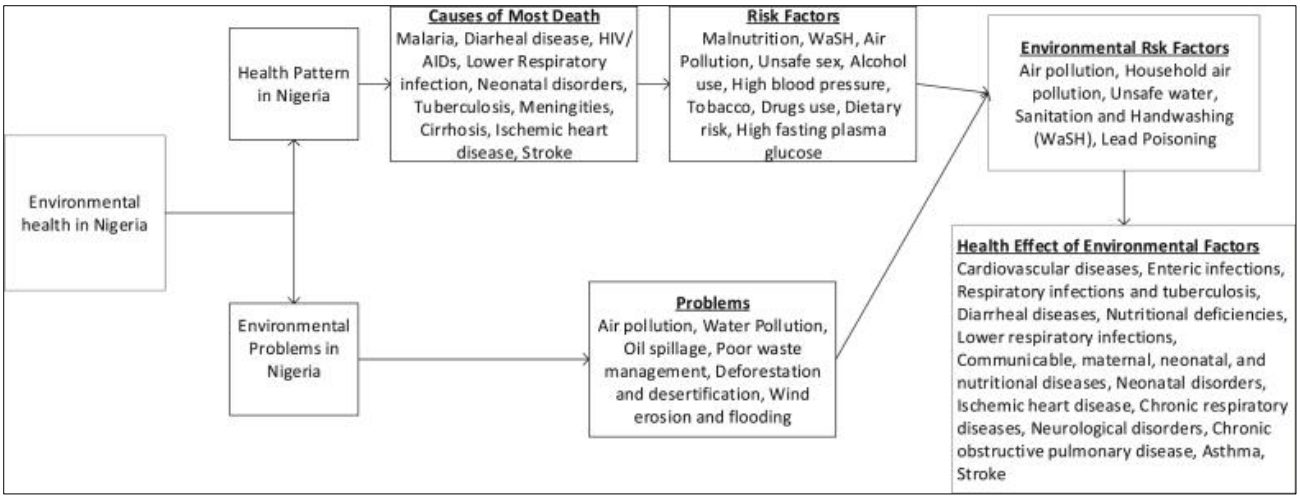

Figure 1: Flow chart showing the Environmental Health situation in Nigeria
Adapted from GBD [18]

2.3. Search Strategy and Data Sources

This study employed a systematic literature review method, which involved the use of oral interviews and secondary data, entailing the various thematic areas of discussion [20]. The systematic literature search was completed by searching papers that address the relationship between environmental compromises and health implications relating to Bayelsa State. Online platforms used included Science Direct, Francis and Taylor, Research Gate, Scopus, Google Scholar, Google, and other references on environmental contamination and health implications.

3.0. Disease Burden in Bayelsa State

Disease burden refers to the impact of health problems on individuals and populations, measured through metrics like Disability-Adjusted Life Years (DALYs) and Quality-Adjusted Life Years (QALYs). Bayelsa State is not in isolation, as it is plagued by an array of diseases associated with various factors, including idiopathic ones. A study conducted by Egbi [21], profiled the common diseases found in Bayelsa State. In the study, the diseases were identified using a pool of mortalities and morbidities recorded within a year in selected health facilities. The diseases included communicable diseases (CDs), non-communicable diseases (NCDs), and infectious & parasitic diseases, malaria, febrile illness (AUFI), gastroenteritis, upper respiratory tract infection (UPRTI), bone & joint diseases, peptic ulcer disease, and diabetes. These diseases are caused by diverse factors, of which environmental influences are strongly correlated. The graphical presentation of disease burden in Bayelsa State, as posited by Egbi [21], is presented below.

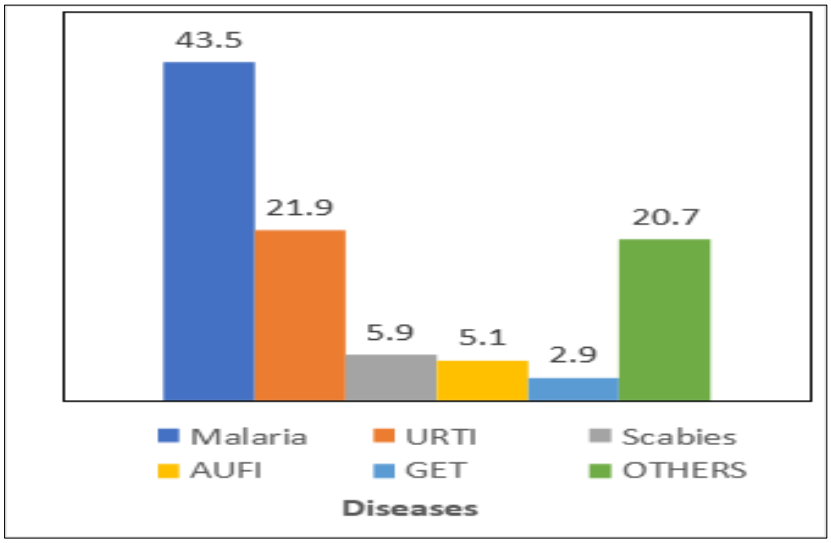

Figure 1: Distribution of communicable diseases among the patients
Adapted from Egbi [21]

Legend: URTI = upper respiratory tract infection, AUFI = acute undifferentiated febrile illness, GET = Gastroenteritis.

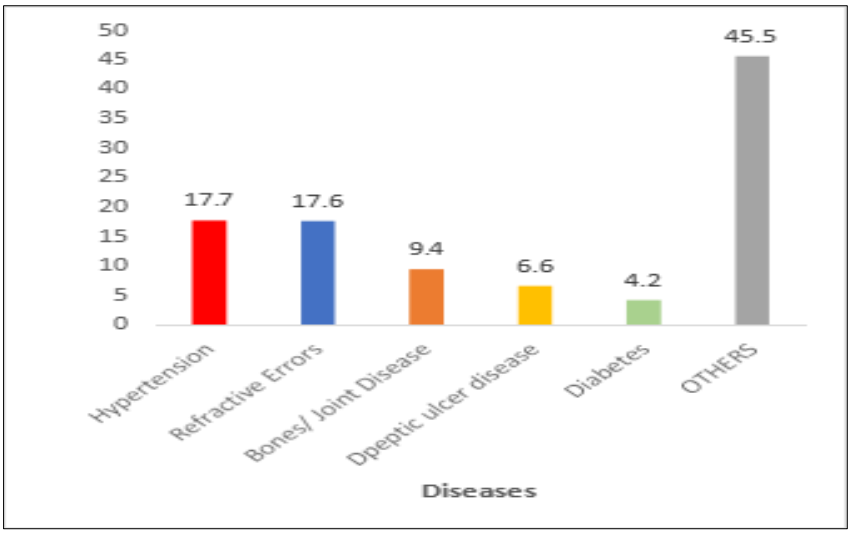

Figure 2: Distribution of the non-communicable diseases among the patients.
Adapted from Egbi [21].

4.0. Environmental Contributors to Adverse Healthcare Conditions in Bayelsa State

4.1 Hydrocarbon Pollution from Oil Spills (Land & Water)

Oil as a source of energy was first discovered in commercial quantities in Oloibiri (Otuabagi) in Bayelsa State, Nigeria, in 1958 by Shell. Since then, oil exploitation has continued in Nigeria, especially in the Niger Delta. Oil pollution is one of the major problems faced by coastal ecosystems, of which Bayelsa State is a part. Oil pollution can be described as the introduction by man, directly or indirectly any hydrocarbon materials, especially crude oil and its refined products, into the environment [22]. Oil pollution, which arises mainly from oil spills, has serious implications for biodiversity, as most biotic habitats are either destroyed or altered, making them unsuitable for habitation.

The impact of coastal oil pollution is a well-studied field with diverse opinions [23]. Oil interferes with the functioning of various organs and systems of plants and animals. It creates environmental conditions unfavourable for life. For example, oil on the water's surface forms a layer that prevents oxygen from dissolving in the water. Crude oil also contains toxic components that cause outright mortality of plants and animals, as well as other sub-lethal impacts [24-26].

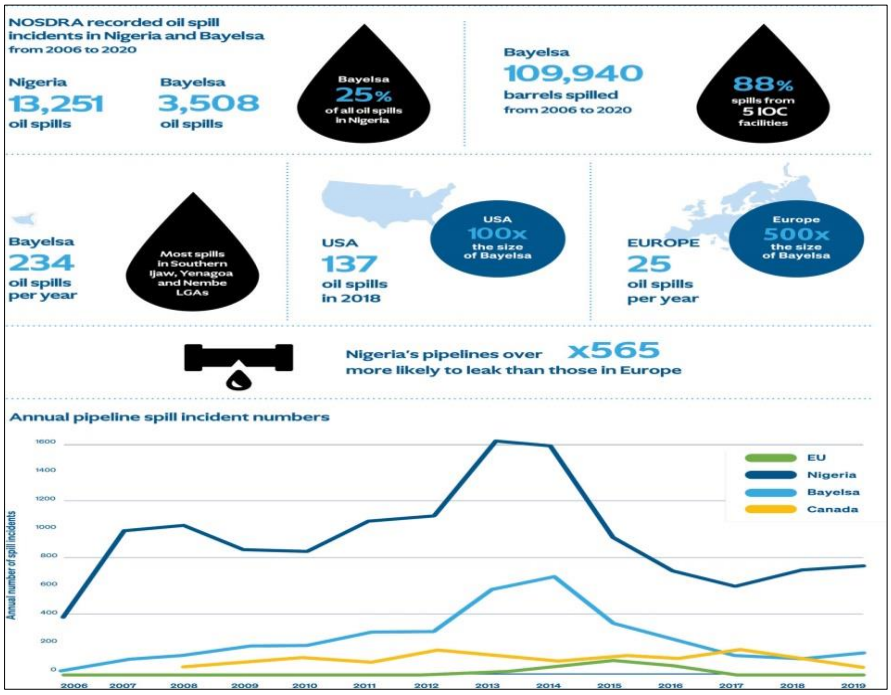

Figure 3: Annual pipeline spill incidents
Adapted from: *The Bayelsa State Oil and Environmental Commission [27]*

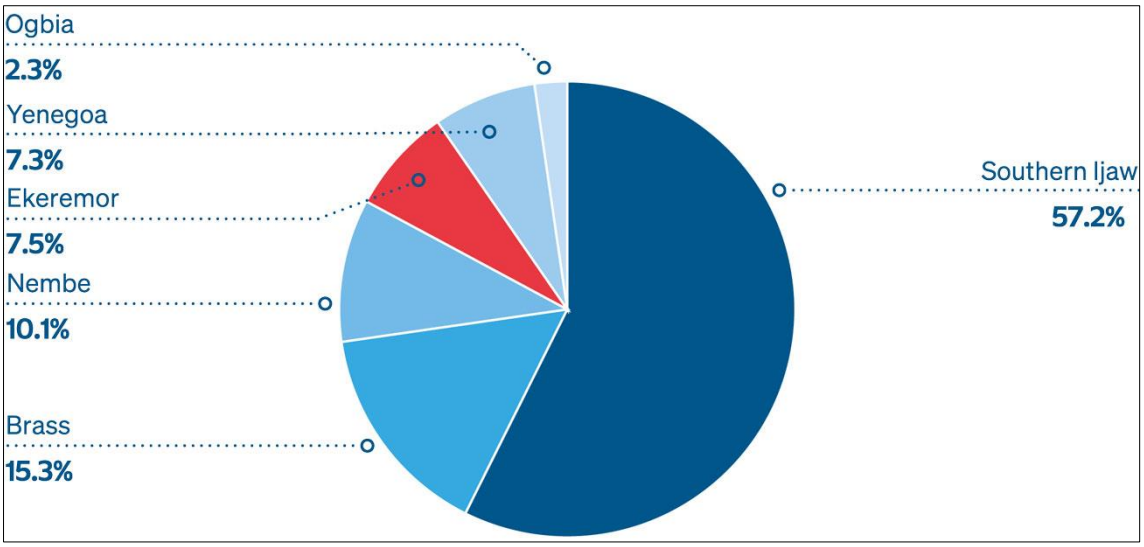

Figure 4: Share of oil spills by LGA, 2006-2019, Bayelsa
Adapted from: *The Bayelsa State Oil and Environmental Commission [27]*

The above data have clearly shown the overt and uncontrolled oil pollution in Bayelsa State, which could have a grave effect on the health of the locals and, at large, the residents. Oil spills contaminate water and air, leading to short- and long-term health issues for those exposed, including oil rig workers, first responders, nearby residents, and vulnerable marine life and ecosystems. The toxic chemicals in oil, such as benzene and mercury, are linked to an increased risk of cancer, respiratory issues, liver damage, and reproductive problems. The environmental damage caused by oil spills also affects local economies, particularly in the fishing and tourism industries, as ecosystems can take decades to recover [27].

Oil spills are a dangerous environmental disaster that can have serious consequences for human health. Persons exposed to oil spills are particularly vulnerable to the toxic chemicals present in crude oil and often suffer from skin rashes, respiratory problems, and neurological issues [28-32]. Furthermore, oil spills can have a detrimental impact on seafood, rendering it unsafe for human consumption and posing a significant threat to human health [33-36].

In addition to the direct health risks associated with consuming contaminated seafood, oil spills can also have indirect effects on human health. Oil spills can result in the release of hazardous chemicals into the surrounding water and land, leading to air and water contamination. This can cause short-term health issues such as dizziness, irritability, and coughing, as well as potential mental health concerns, including depression, anxiety, and post-traumatic stress. While the long-term health consequences of oil spills are not yet fully understood, studies have found that workers involved in oil spill cleanup operations can experience persistent symptoms such as low platelet counts, breathing problems, and reproductive issues [37-38].

4.2 Gas Flaring

Gas flaring is the burning of the natural gas associated with oil extraction. The practice has persisted from the beginning of oil production over 160 years ago. Associated gas is wastefully flared for a variety of reasons, from market and economic constraints to a lack of infrastructure to capture the gas, or the absence of effective and enforced regulations, and a lack of priority by field operators. Flaring and venting are a waste of a valuable natural resource that should either be used for productive purposes, such as generating power, or conserved. For instance, the amount of gas currently flared each year is about 151 billion cubic meters (bcm), which could have supplied power to the whole of sub-Saharan Africa [39].

According to World Bank data [40], Nigeria is one of the world's top ten gas flarers in terms of volume and flaring intensity. Libya, for instance, flares about 21% of its natural gas, while Saudi Arabia, Canada, and Algeria flare 20%, 8% and 5% respectively; conversely, Nigeria flares up to 90% of its associated gases. In Bayelsa and the Niger Delta more broadly, large flares burning from towers and land surface areas have been prevalent since the inception of the Nigerian oil industry in the 1950s. Flaring has been, and remains, the main means of disposing of waste gas produced by oil extraction in the country.

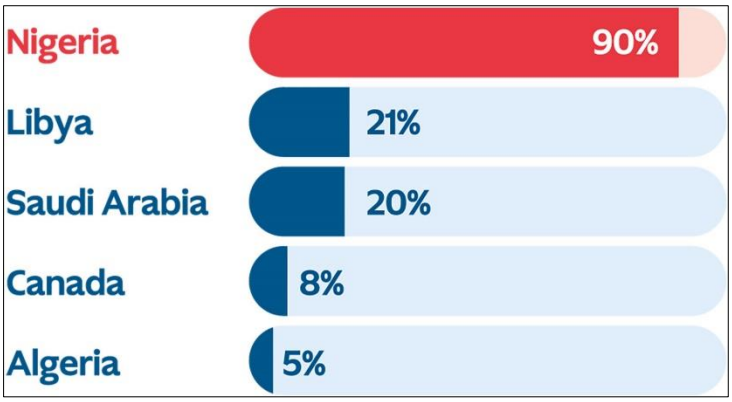

Figure 5: Gas fairing comparison

***Adapted from**: The Bayelsa State Oil and Environmental Commission [27]*

Figure 5, as adapted had presents the percentage of flaring ascribed to Nigeria, which is wholly rooted in the Niger Delta Region, where Bayelsa State is located. Bayelsa State is the highest gas-producing state in Nigeria and is most affected by gas flaring and other illicit associated activities.

Gas flaring produces harmful volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and inorganic contaminants. Other byproducts of flaring include nitrogen, carbon, and sulphur oxides (NO_2, CO_2, CO, SO_2), particulate matter, hydrocarbons and ash, photochemical oxidants, and hydrogen sulphide (H_2S) (The Bayelsa State Oil and Environmental Commission, 2019). Several health studies have documented the connection between gas flaring and a range of chronic diseases, including bronchial, rheumatic, and eye conditions, along with hypertension. Constant inhalation of sulphur dioxide (SO_2) causes nose and throat irritation and shortness of breath. Prolonged exposure to flared gas has also been associated with cancer and neurological, reproductive, and developmental effects [38-46].

4.3 Artisanal Refining ("kpofire")

Artisanal oil refining could be defined as small-scale crude oil processing or subsistent distillation of petroleum that is often outside the boundaries of the state law [47]. This practice is common in the Niger Delta region of Nigeria and is collectively known as Kpofire. The term "Kpofire" encapsulates a diverse array of refining operations, ranging from small-scale modular refineries to artisanal refineries operated by local communities. These refineries play a vital role in meeting the demand for refined petroleum products in Nigeria, particularly in regions where access to conventional refineries is limited.

A typical artisanal petroleum refinery acquires raw material (crude oil) through the process of illegal bunkering, whereby holes are created on a crude oil flowline and taps are installed for crude oil extraction. The extracted crude oil is transferred or conveyed by Cotonou boats or direct hose lines to a refining camp for local refining. At the camp, the crude oil is allowed 3 h in storage facilities to allow for gas content reduction by evaporation, after which it is fed into the refining oven, where heat is generated to different degrees to enable separation of the mixture into fractions according to their boiling points (distillation process). Vapours from the boiling crude oil are channelled out of the oven by means of several pipes connected through a condenser or cooler, from where a single pipe with a larger diameter conveys the condensed product to the receiver in which the desired products are collected. In the process, the condenser is sporadically filled with water from a nearby creek using a pumping machine, which helps to condense or cool the vapours to the desired liquid form called the product. The refined products are therefore received and collected at the receiver points for onward distribution and sales [48-49].

A study conducted by Duan *et al*., [49], observed that the concentrations of the gaseous pollutants identified and quantified from the various unit operations (oven heating/crude oil boiling, vapour condensation, and refined product collection unit) of the different refineries considered revealed variation between the units and increased with an increase in oven sizes/processing capacity. Furthermore, a study conducted by Diagi *et al*., [50], on community health assessment indicates high occurrence of respiratory issues represented by 91.8%, skin irritation with 91.8%, and fatigue represented by 65.6%, associated with long-term exposure to hydrocarbon pollutants.

Hydrocarbon compounds are primary producers of photochemical oxidants, with potential effects on human health and the environment [51-53]. At high concentrations, human exposure to these compounds may result in mutation and cancer. The central nervous system, kidneys, and liver may also be damaged as a result of the emission of the toxic products. Depression, fatigue, nausea, and dizziness are also results of the toxic products generated for the emission [54, 55]. Hydrocarbon emissions have also been traced to affect luteal function and induce premature abortion in pregnant women [56, 57].

4.4 Climate-Amplified Flooding

Flooding, the overflow of water beyond its normal confines, is increasingly influenced by climate change. While floods have always been a part of Earth's natural cycles, their frequency and intensity are significantly altered by human activities impacting the climate.

Flooding could take the form of coastal or riverine. Coastal areas are experiencing more frequent and severe inundation, driven by sea level rise and intensified storm surges. Whereas, riverine, or fluvial, flooding occurs when river systems are overwhelmed, causing water to spill over their banks. Increased heavy rainfall events contribute significantly to this, as the sheer volume of water entering rivers exceeds their capacity [58].

Increased flooding has wide-ranging socio-economic impacts. Communities often face displacement, with homes and businesses suffering extensive damage or destruction. Economic losses can be substantial, impacting livelihoods as agricultural lands are inundated and commercial activities come to a standstill. Rehabilitation and relocation costs can divert resources from other development areas [59].

Infrastructure damage is a common consequence of more frequent and severe floods. Transportation networks can become impassable or sustain structural damage, disrupting connectivity and supply chains. Power grids and water treatment facilities are also vulnerable, leading to widespread outages and contaminated drinking water. Such disruptions can persist long after floodwaters recede, hindering recovery efforts [60].

Flooding has become a major issue in Bayelsa State since the devastating flood of 2012 affected the state followed by those of 2018, 2020, and the unprecedented flood of 2022, which destroyed both public and private property. And another in 2024. Bayelsa State is the flood plain of Nigeria and has been subjected to annual flooding since time immemorial, but the intensity of floods in the past few years has challenged the planning and execution of projects and programmes aimed at addressing the issue.

The world's largest and most comprehensive study of the long-term health impacts of flooding via analysis of over 300 million hospitalisation records in eight countries prone to flooding events, including Australia, has found an increased risk of 26 per cent of all diseases serious enough to require hospitalisation. This impact on the health of communities lasts up to seven months post-event.

The Monash University researchers findings published in the journal, *Nature Water*, found that flooding events which are increasing globally due to climate change led to increases in hospitalisation for cardiovascular diseases (35%), respiratory diseases (30%), infectious diseases (26%), digestive diseases (30%) such as gastroenteritis, mental health disorders (11%), diabetes (61%), cancer (34%), nervous system disorders (34%), and renal diseases (40%) [61].

The medical implications of flooding on the health indices of Bayelsa State are not disputable, considering its vulnerability. Bayelsa is two meters below sea level, and the channel through which flood water accesses the Atlantic Ocean [60-62]. This has made the state vulnerable to flooding, with the attendant diseases and discomforts.

4.5 Water, Sanitation, and Hygiene (WASH) Deficits

Water is a fundamental human right and a crucial resource for sustainable development, as recognized by the United Nations [63]. However, access to clean water and adequate sanitation remains a global challenge, particularly in developing regions where millions of people still lack reliable water sources. In many parts of the world, water insecurity is exacerbated by environmental degradation, population growth, and weak governance structures, making it difficult to implement sustainable solutions. The World Health Organization [63], reports that billions of people worldwide lack access to safe drinking water and improved sanitation facilities, thereby increasing their exposure to waterborne diseases and compromising overall public health. These disparities are most pronounced in low-income regions, where inadequate infrastructure, poverty, and governance challenges prevent effective water management.

Suboptimal water, sanitation, and hygiene (WASH) practices constitute a serious public health risk, affecting one-third of the world's population. Remarkable progress has been made to improve WASH; however, challenges remain, with rapid population growth adding pressure on WASH systems. The staggering burden of WASH-related diseases in low- and middle-income countries (LMICs), particularly in Africa, threatens public health, with millions of deaths and disability-adjusted life years (DALYs) attributed to poor WASH practices annually. Notable challenges plaguing WASH practices in the region include poverty, malnutrition, poor data reporting, illiteracy, climate change, and poor healthcare financing. This results in adverse health consequences, including waterborne infections like cholera, typhoid, dysentery, and diarrheal diseases. Additionally, neglected tropical diseases (NTDs) such as intestinal worms, schistosomiasis, trachoma, lost productivity, and environmental pollution from soil and underground water contamination have been implicated. Geographical disparities, cultural norms, and inadequate funding further complicate efforts to improve WASH infrastructure and practices [64].

World Health Organization (WHO) estimates the burden of disease attributable to unsafe WASH for key health outcomes and reports on SDG indicator; mortality- 1.4 million (deaths could have been prevented with safe WASH in 2019), morbidity-74 million(DALYs could have been prevented with safe WASH in 2019), attributable fraction- 69%(of all diarrhoea deaths in 2019 were attributed to unsafe WASH services), diarrhoea deaths->1 million (died from diarrhoea due to unsafe WASH in 2019), acute respiratory infection deaths-356 000 (died from acute respiratory infections due to unsafe hand hygiene practices in 2019) [65].

Nigeria, despite being one of Africa's largest economies, faces severe challenges in ensuring adequate water and sanitation services for its populace. According to UNICEF [66], over 60 million Nigerians lack access to clean water, while more than 100 million do not have adequate sanitation facilities. In Bayelsa State only less than 51% of the population had basic water service as of the latest WASHNORM profile; open defecation persists. Rapid urbanization has further strained existing water infrastructure, leading to severe shortages in densely populated areas. Poor governance and corruption have also impeded efforts to expand water access, as mismanaged funds and a lack of regulatory enforcement have contributed to service inefficiencies [67]. The challenge is even more pronounced in states with difficult geographical terrains and limited economic diversification, such as Bayelsa. Bayelsa State, located in the Niger Delta region, is a paradox in terms of water resources. Despite being surrounded by rivers, creeks, and swamps, the state faces severe challenges in providing clean and safe water for its residents. Pollution from oil exploration and improper waste disposal has significantly degraded the quality of natural water sources, increasing the risk of waterborne diseases and making water treatment more expensive. The swampy terrain further complicates the construction of conventional water infrastructure, raising the cost of building and maintaining water treatment plants and pipelines [68]. These environmental and geographical constraints, combined with governance and economic challenges, have left many communities in Bayelsa reliant on unimproved water sources, exacerbating health risks and reducing overall quality of life.

CONCLUSION

The review critically looked at the impact of environmental degradations and distortions, as it affect public health, and in particular, the adverse healthcare conditions and prevailing health challenges in Bayelsa, Nigeria. Search engines and international publishing platforms were used to source data in concluding. The findings have clearly shown that environmental degradations and distortions have obvious effects on the health conditions of the residents of Bayelsa State. Public health conditions such as infectious diseases, non-communicable diseases, malaria, cancer, pulmonary diseases, cardiac diseases, renal failure, infertility, congenital disorders, diabetes, and hypertension rampant in the state could be traced to the highly degraded and polluted environment. In addressing the increased mortality and morbidity associated with environmental contamination in Bayelsa State, two-pronged approaches are advanced in this review. Firstly, there is a need for effective policy directions by the federal and state governments in addressing the issue of environmental degradation using internationally accepted standards sourced locally. Secondly, it is on the side of the citizens to be responsive in ensuring an assurance of an environmentally friendly ecosystem in Bayelsa State.

Recommendations

The following are the recommendations of this study;

1. Reduction or total extermination of emissions or spills of hydrocarbons.
2. Application of basic environmental health surveillance in containing environmental pollution and disease proliferation.
3. Flood prevention and efficient containment.
4. WASH upgrades in communities across the state.
5. Efficient healthcare system.
6. Environmental remediation.

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