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Effects of Gas Flaring on Land and Water Bodies to Public Health of Ekpan Community, Uvwie Local Government Area, Delta State, Nigeria

Mohammed, S. M.[1*], Rayyan, M. T.[2] and Onovughe, A.[3]
[1,2&3] Department of Environmental Resource Management, Faculty of Earth and Environmental Sciences, Federal University Dutsin-Ma, Katsina State, Nigeria.

[*]Corresponding Author Email: [1*]sanimohammed496@gmail.com

ABSTRACT
This study investigated the effects of gas flaring on land, water bodies, and public health in Ekpan, Uvwie Local Government Area, Delta State, Nigeria. Field inventory, laboratory analyses, and surveys were conducted, including soil and water sample testing and structured questionnaires administered to 300 respondents. The research aimed to assess the nature of illnesses, soil and water conditions, particle presence in water, frequency of hospital visits, and proximity to gas flaring sites. Statistical tools, including frequency tables and Chi-square tests, were used for data analysis. Results showed that gas flaring significantly contributes to environmental degradation and adverse health impacts. Soils near flare sites exhibited acidic pH, high temperatures, and elevated levels of heavy metals (Mn, Cu, Pb, Ni, Cr, Zn), which decreased with distance from the flaring point. Water quality tests indicated high biochemical and chemical oxygen demand and conductivity, confirming pollution. Health issues linked to these conditions included respiratory problems, skin infections, and gastrointestinal disorders. The ecological balance, including plant and animal health, was also disrupted. Hypothesis testing confirmed a strong relationship between public awareness and perception of gas flaring's health effects, leading to the rejection of the null hypothesis. The study recommended urges strict enforcement of environmental laws, adoption of cleaner flaring alternatives, and regular monitoring of environmental and health conditions. It highlights the need to improve community healthcare, raise awareness, and ensure oil companies compensate and remediate affected areas. Continued research on the long-term effects of gas flaring is also recommended to inform sustainable policies in Ekpan and similar oil-producing areas.

Keywords:
Environment,
Impact,
Gas flaring,
Ecology,
Exploration,
Emission.

INTRODUCTION

The presence of unacceptable levels of foreign gaseous and particulate matter in the atmosphere is referred to as air pollution (WHO, 2021). The deterioration of environmental quality, which began with early human settlements and the use of fire, has persisted and worsened due to exponential population growth and industrialization. Environmental contamination of air, water, soil, and food now threatens the survival of many plant and animal communities and ultimately endangers human life. One such example is the indiscriminate flaring of gas into the atmosphere. Petroleum industry operations are characterized by numerous hazards (Ite et al., 2013; Nduka & Orisakwe, 2011). The nature and magnitude of these hazards depend on various factors and differ across oil and gas sectors. Although the Niger Delta bears the brunt of immediate gas flaring impacts, the environmental degradation linked to petroleum activities extends well beyond the oil-producing areas. Nigeria's oil fields in the Niger Delta produce about two million barrels of oil per day, much of it from reservoirs containing natural gas (Ogbodo et al., 2020). This associated gas, a byproduct of oil extraction, is separated at the flow station, and over 95% is flared. Presently, Nigeria flares an estimated 2 billion standard cubic feet (SCF) of gas per dayabout a quarter of global gas flaring (Global Gas Flaring Tracker Report, 2023). The impacts of this flaring are both local and global. Flaring releases major greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), along with water vapor and sulphur dioxide (SO_2).

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It is estimated that gas flaring in Nigeria emits approximately 35 million tonnes of carbon dioxide and 12 million tonnes of methane annually.

(World Bank, 2023). Since the discovery of oil in Oloibiri, Bayelsa State, in 1956, gas has been continuously flared as a result of crude oil and natural gas extraction activities. Gas flaring is defined as the combustion of natural gas and other hydrocarbons at flare sites in oil fields and refineries during operations (Oyebanji et al., 2021).

Contemporary global challenges such as energy insecurity, environmental degradation, climate change, and food scarcity are systemic and interconnected. The Niger Deltahome to over 31 million people and rich in oil reserveshas witnessed decades of oil extraction by the Nigerian government and multinational companies, generating over $600 billion in revenue since the 1960s (UNEP, 2011; Amnesty International, 2020). The region, Nigeria's largest wetland and the third largest in the world, spans over 70,000 square kilometers and features interconnected creeks, floodplains, mangroves, and deltaic systems.

Crude oil in the region is often co-located with natural gas, which must be separated during extraction. Despite technical feasibility for gas capture and utilization, associated gas is largely flared. Currently, around 100 flares burn continuously in the Niger Delta and offshore, some since the 1960s. Based on satellite data, Nigeria flared 15.1 billion m^3 of gas in 2008, second only to Russia (Environmental Rights Action/Friends of the Earth Nigeria, 2019). According to the Global Gas Flaring Reduction Partnership (GGFR, 2023), flaring contributes significantly to greenhouse gas emissions and releases hazardous pollutants such as particulate matter, SO_2, NO_2, benzene, toluene, dioxins, and polycyclic aromatic hydrocarbonsall linked to severe health effects for nearby populations. Residents near flaring sites face increased risks of respiratory illness, asthma, blood disorders, and cancer (UNDP, 2022). The UNDP emphasizes that gas flaring not only destroys natural resources and livelihoods but also alienates communities from their ancestral lands and hinders human development (UNDP, 2022).

The Niger Delta now faces a new generation of environmental threats, including regional and global challenges such as ozone depletion and climate change. Local pollution issuessuch as thermal pollution and toxic smogare no longer isolated. In response to these worsening conditions, there is a collective responsibility to act; humanity must confront the reality that we are capable of endangering the very environment we rely upon for survival (UNEP, 2021).Due to this challenges the study on the impact of gas flaring on public health on people of Uvwie LGA in Delta State is very crucial which aimed to assess the impact of Gas flaring on the environment in Ekpan Community, Delta State, Nigeria. The aim was achieved through the said objective: To relate the effect of gas flaring on land and water bodies to public health, hence the research was carried out using Water samples and Soil samples.

MATERIALS AND METHODS

Description of the Study Area

Uvwie is a local government area in Delta state, Nigeria, its geographical coordinates are latitude 5° 33' 0" North, and longitude 5° 47' 0" East as shown in Figure1, its original name (with diacritics) is Effurun. Effurun is the headquarters of Uvwie LGA which was carved out of the then Okpe LGA along with Udu LGA on the 4th of December, 1996. The area is approximately 100 square kilometres and it is bounded by Okpe Kingdom in the North and Udu and Ughiẹvwen in the North-West, Agbarho kingdom in the North East, Agbarho-Ame in the East, Okere kingdom in the South and Itsekiri in the South West. The study area, Uvwie Local Government Area in Delta State, Nigeria, is geologically characterized by post-Cretaceous sediments with predominant hydromorphic soils, shaped by climatic, topographic, and lithologic influences (Iloeje, 2011). These soils are often seasonally or permanently waterlogged due to poor drainage, indicated by their grayish coloration from reduced oxides. The region's physiography consists of four major zones: the active freshwater swamp near the River Niger, a brackish mangrove swamp affected by seawater intrusion, the coastal plain (upland and swamp), and the relatively flood-free upland Niger valley where Asaba is located (NDDC, 2015).

Uvwie experiences a tropical climate with two distinct seasons: a wet season from March to November and a dry season from December to February. Rainfall peaks in September (220 mm), while December is the driest month (5 mm), with mean temperatures ranging from 25°C to 28°C (NIMET, 2022). Vegetation in the area includes mangrove and freshwater swamp forests, influenced by factors like salinity, soil aeration, and proximity to the sea. Dominant flora includes Rhizophora species, palm trees, and raphia palms, especially in disturbed forest areas (Afolayan et al., 2020). Uvwie is a densely populated urban center with an estimated population of 259,900 as of 2016, spread across multiple towns. It serves as a gateway to Warri and is culturally organized under the Urhobo kingdom with traditional leadership headed by an Ovie (NPC, 2016). The area hosts key institutions such as the Federal University of Petroleum Resources, the Petroleum Training Institute, and major oil industry facilities including NNPC and Chevron.

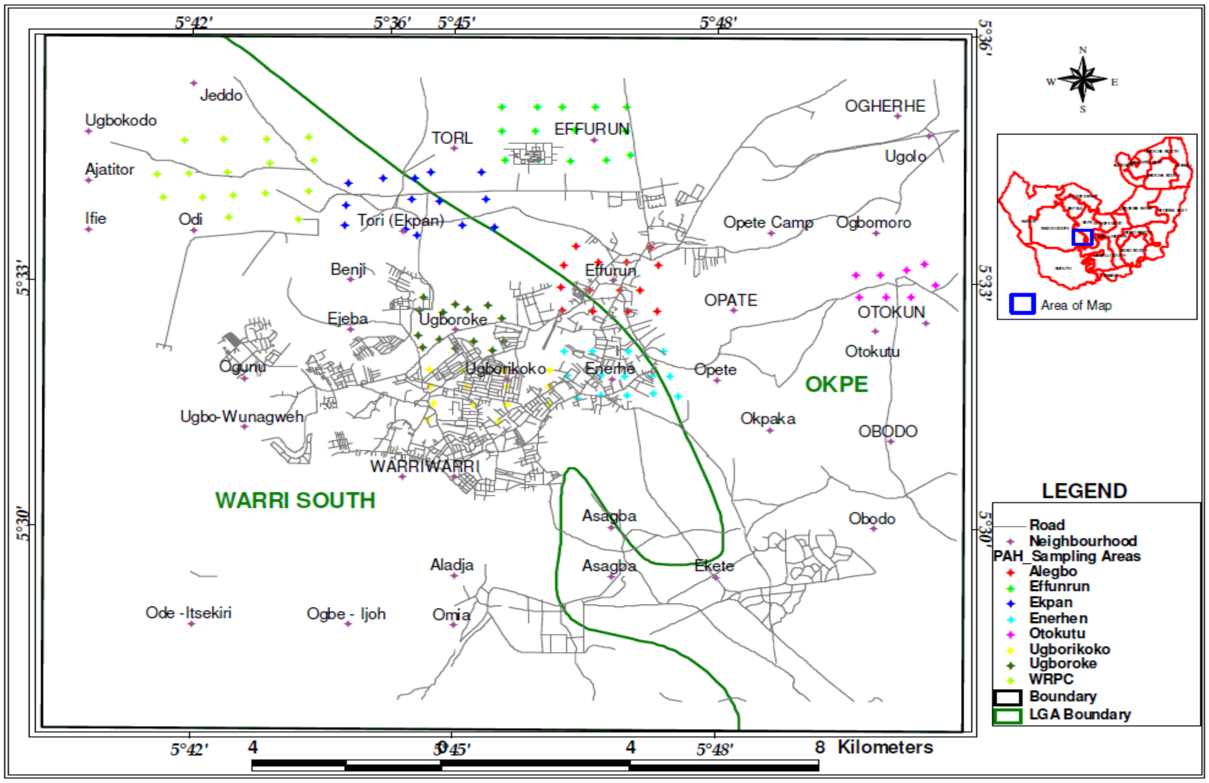

Fig. 1: Map of the Study Area (Uvwie LGA.)
Source: Google-Earth Map

Reconnaissance Survey

A reconnaissance survey was conducted to familiarize with the study areaand local culture. This initial survey helped in identifying the problem, formulating relevant hypotheses, and determining suitable data collection methods. It also highlighted the need for a field assistant to ensure accurate and effective data gathering. Ethical approval was granted from the Head of the village in the study area to conduct the research and collect water and soil samples in the study area.

Source and Types of Data

In this study, primary data served as the main source of information, obtained through field-based empirical observations, laboratory analysis of soil and water samples, administration of structured questionnaires, and oral interviews with residents. Field observations facilitated the collection of samples for laboratory testing and provided insight into the physical and socio-economic characteristics of the study area. The questionnaire, divided into Sections A and B, was designed to obtain demographic information and assess environmental and health-related variables such as the nature of illnesses, land and water conditions, visible pollutants, frequency of hospital visits, and the proximity of households to gas flaring sites. In-depth interview further enriched the study with detailed, context-specific insights from community members. In addition to primary data, secondary data were sourced from libraries, journals, published articles, internet sources, and medical records. These records, especially from local health centers, were instrumental in identifying patterns of reported health complaints and were used to support and validate the primary data collected from respondents.

Sample and Sampling Techniques

The study was conducted in Uvwie Local Government Area, which comprises Ekpan, Effurun, Ugberikoko, Ugboroke, Ugbomro, and Uredjo (Enerhen) districts. However, samples were specifically drawn from Ekpan Community due to its proximity to major gas flaring sites, notably the Nigerian Petroleum Development Corporation and the Warri Refinery. A purposive sampling technique was employed to select respondents living near the refinery. Both quantitative and qualitative research methods were used, including structured questionnaires, interviews, and field observations. Data collected included gas flare locations, soil and water samples for laboratory analysis, and medical records from the community health centre in Ekpan.

Methods of Data Collection

Questionnaires and observation were used to gather information. Prepared enumerators who comprehended the local dialects in the area were utilized to guarantee more precise data. In conducting the research, the required data were gathered from both primary and secondary sources, and the data are both qualitative and quantitative in nature.

Rain Water: Clean acid-free glass bottles were used to collect bulk samples of rain that had fallen during the preceding week. The samplers were placed at distances of 500m, 1000m, and 5000m from the flare point. The funnel was covered with a plastic net to prevent collection of windblown debris. Each bottle was placed on a stand 1.3-1.5m above ground level.

Soil samples: Soil samples were collected from three (3) different spots at the gas flaring sites. These are 10, 100 and 200 metres away from each other.

Medical records: Medical records were obtained from the community health Centre in Ekpan Community of Uvwie LGA to ascertain the prevalent public health condition and to further relate it to gas flaring activities within the community.

Methods of Data Analysis

Data collected was summarized using statistical frequency distribution tables. Other relevant mathematical and statistical technique such as Chi Square was used to analyze test of hypothesis. Details of the results were done qualitatively and quantitatively.

Water Analysis

The water samples were analyzed to determine key parameters including temperature, conductivity, pH, total hardness, alkalinity, and biochemical oxygen demand, following standard procedures outlined by the American Public Health Association (APHA, 2017) and the World Health Organization (WHO, 2022).

Soil Analysis

The soil samples were similarly analyzed to assess pH, alkalinity, and concentrations of chloride and sulphate. Additionally, the presence of heavy metals such as Ni, Mn, Cu, Zn, Fe, and Pb in both water and soil samples was examined based on standardized methods provided by the APHA (2017) and the United States Environmental Protection Agency (USEPA, 2021).

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Respondents

An overview of the respondents' demographic characteristics is essential to understand the profile of the sampled population. This section includes questions on the respondents' age, gender, educational qualifications, and occupational status. Findings from the study indicate that males make up a significant proportion of the sample, accounting for 66% of the total respondents (Table 1).

Table 1: Gender of the Respondents

Gender	Frequency	Percentage (%)
Male	198	66
Female	102	34
Total	**300**	**100%**

Source: Author's Computation, 2025

The results of age distribution of the respondents (Table 2), 38.3% of the people were aged between 19-35 years, 44% between 36-45 years, and 17.7% were above 46 years. Thus, the highest percentage (44%) of the people fell between 36-45 years, followed by 38.3% between 19-35 years.

Table 2 Age Distribution of the Respondents

Age (years)	Frequency	Percentage (%)
0 – 18	-	-
19 -35	115	38.3
36 – 45	132	44.0
46 and Above	53	17.7
Total	**300**	**100%**

Source: Author's Computation, 2025

From the table 3, the results showed that 38.3% of the people in the community have B.Sc./HND level of education, 28.3% are NCE/OND holders, 17.3% have secondary school certificate, while 12.0% have no formal education. This shows that majority of the people have some level of education, either up to secondary or tertiary level.

Table 3: Level of Education of the Respondents

Educational Level	Frequency	Percentage (%)
No Formal Education	36	12.0
WASCE	52	17.3
NCE/OND	85	28.3
HND/BSC	115	38.3
MSC	5	1.7
PhD	-	-
Others	7	2.4
Total	**300**	**100%**

Source: Author's Computation, 2025

The results show that Civil servants constituted majority of the working population of the people with about 41% of the responses, while 35% are in one form of business or the other, 17.3% are farmers while about 5% are into fishing activities (Table 4).

Table 4: Occupational status of the Respondents

Occupation	Frequency	Percentage (%
Fisherman	5	1.7
Farmers	52	17.3
Trade	105	35
Public/Civil Servant	123	41
Others	15	5
Total	**300**	**100**

Source: Author's Computation, 2025

The Effects of Gas Flaring on Water Pollution, Soil Pollution and Air Pollution

Perception on the impacts of water, soil and air pollution. Table 5 presents the perception of the public on the impacts of water pollution, soil pollution and air pollution Ekpan community of Delta State, Nigeria.

Table 5: Effects of Gas Flaring Water Pollution, Soil Pollution and Air Pollution

Variable	Frequency	Percentage (%)
Impacts water pollution		
Cough	33	11.0
Loss of aquatic lives	124	41.3
Potable water reduction	75	25
Typhoid	26	8.7
Diarrhea	13	4.3
Skin infection	14	4.7
More than 2 sickness	22	7.3
Impact of soil pollution		
Corrosion of metals	63	21
Stunted growth of plants	237	79
Impacts of air pollution		
Cough	123	41.0
Cancer	91	30.3
Asthma	38	12.7
Catarrh	48	16
Total	**300**	**100%**

Source: Author's Computation, 2025

The results indicate varying public perceptions of pollution-related health and environmental impacts. About 11.0% of the respondents agreed that water pollution leads to cough, 41.3% agreed on loss of aquatic lives, 25% agreed on the reduction of potable water while 8.7% agreed on typhoid. However, 4.3% and 4.7 % believed that the effects of water pollution lead to diarrhea and skin infection respectively. More so, the analysis in table 5 reveals that soil pollution affects the growth of plants by causing stunted growth in plants and most often in crops. This is attested to as 79% of total respondents agreed that soil pollution causes stunted growth in plants while only 21% believed that it causes corrosion in metals. Generally, it is believed that air pollution is very dangerous to human health and livelihood. In this study, 41.0% of the people agreed that air pollution causes cough while about 30.3% agreed to cancer. 12.7% and16% of the people agreed that air pollution leads to asthma and catarrh respectively. The analysis therefore reveals that pollution especially water and air pollution lead to various forms of diseases. This alligned with findings by hat heat waves are considered the most significant effect of climate change, underscoring the vulnerability of livestock to rising temperatures (Dachung et.al., 2025).

Gas flaring is a significant source of harmful emissions that adversely affect human health and the environment, contributing to environmental injustice, particularly in oil-producing regions (UNEP, 2021; Olalekan et al., 2020). Recent studies show that exposure to pollutants such as lead, cadmium, manganese, and chromium often present in refinery effluentscan exceed World Health Organization (WHO) permissible limits, posing serious health risks to communities near flaring sites (Adewuyi & Nnaji, 2021; WHO, 2022).

Analysis of Soil Physicochemical Characteristics

Table 6: Soil Physicochemical Characteristics

Sample Sites	pH	OM (%)	Mn (mg/l)	Cu (mg/l)	Pb (mg/l)	Ni (mg/l)	Cr (mg/l)	Zn (mg/l)
POINT1 (10m)	5.5	60	5.60	2.80	2.00	1.60	3.10	2.40
POINT2 (100m)	5.8	65	4.10	2.10	1.70	1.30	2.80	2.00
POINT3 (200m)	6.5	80	4.00	2.05	1.50	1.00	2.05	1.40

Source: Laboratory Analysis 2025

The analysis of soil samples taken at varying distances from a gas flaring site shows that proximity to the flare increases soil acidity and heavy metal contamination. Soils closer to the flare point had lower pH and organic matter content, indicating degradation due to heat and chemical exposure. Heavy metals such as Mn, Cu, Pb, Ni, Cr, and Zn were found in higher concentrations near the flare site and decreased with distance, confirming that gas flaring significantly pollutes surrounding soils. These findings align with recent studies highlighting the environmental and health risks of gas flaring in the Niger Delta region (Olalekan et al., 2020; Adewuyi & Nnaji, 2021; UNEP, 2021).

Water Quality Analysis

The analysis of water samples in and around Ekpan, as shown in Table 6, indicates that elevated temperatures primarily influence water quality by accelerating chemical reactions, decreasing gas solubility, and intensifying taste and odour. It also reveals recorded temperatures of 30°C, 30°C, and 31°C, which exceed the WHO (2011) recommended standard range of 22–25°C.

Table 6: Water Quality Analysis

SAMPLE DESCRIPTION	TEMP (^{O}C)	pH	CONDUCTIVITY (µs/cm)	DO	BOD	COD	TOTAL HARDNESS (mg/l)	ALKALINITY	CO_2 (mg/l)	Ni (mg/l)	Cu (mg/l)	Zn (mg/l)	Fe (mg/l)	Pb (mg/l)
WHO Standard	22-25	7-8.5	≤1500		3.00		≤60			0.10	1.00	5.00	0.30	0.05
POINT1 (500m)	30	5.96	1290	16.0	6.00	28.5	8.00	20.00	6.81	0.05	1.00	0.30	5.60	0.01
POINT2 (1000m)	30	5.03	350	12.0	9.00	33.0	10.00	17.00	5.90	0.10	0.80	0.21	6.30	0.01
POINT3 (5000m)	31	4.68	293	6.50	4.00	26.0	23.00	12.00	8.00	0.00	0.83	0.60	3.91	0.00

Source: Laboratory Analysis 2025.

The physicochemical and heavy metal analysis of water samples collected at 500 m (Point 1), 1000 m (Point 2), and 5000 m (Point 3) from the gas flaring site reveals significant environmental impacts associated with gas flaring. Notably, all three sampling points' exhibit temperatures exceeding the WHO recommended range of 22–25°C, with values ranging from 30°C to 31°C. Elevated temperatures in surface waters are often associated with thermal pollution, which can reduce dissolved oxygen (DO) levels and negatively impact aquatic life (Olalekan et al., 2020).
The pH values at all points fall below the acceptable WHO range of 7.0–8.5, ranging from 4.68 at Point 3 to 5.96 at Point 1, indicating acidic conditions. This acidity may result from acid rain caused by the flaring of gas rich in sulfur and nitrogen compounds, leading to acidification of nearby water bodies (Adewuyi&Nnaji, 2021).
Electrical conductivity (EC) was highest at Point 1 (1290 µs/cm) and decreased with distance, suggesting a higher concentration of dissolved ions near the flare site. The DO values exceeded the standard (3.00 mg/l) at all points, with Point 1 reaching 16.0 mg/l. However, high DO levels alongside elevated Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values indicate a possible imbalance and organic pollution. For instance, BOD peaked at 9.00 mg/l at Point 2 (above the WHO limit of 6.00 mg/l), suggesting the presence of decomposable organic materials. COD levels were also elevated at all sites, with the highest value recorded at Point 2 (33.0 mg/l), which reflects the overall oxidative potential of the water and confirms pollution (UNEP, 2021).
In terms of heavy metals, Nickel (Ni) levels at Points 1 and 2 (0.05 mg/l and 0.10 mg/l) were within WHO limits (0.10 mg/l), but Copper (Cu), Zinc (Zn), and Iron (Fe) were above recommended thresholds at several points. For example, Iron was 6.30 mg/l at Point 2far above the WHO limit of 0.30 mg/lposing potential health risks such as gastrointestinal disturbances and organ damage (WHO, 2022). While Lead (Pb) levels were within limits (0.01 mg/l or less), its presence, even in trace amounts, is concerning due to its cumulative toxicity, especially to children (UNEP, 2021).
Overall, the results show that proximity to the gas flaring site correlates with elevated levels of acidity, conductivity, organic load, and heavy metal concentrations, suggesting that gas flaring is a major contributor to surface water pollution in the area. These findings are consistent with other studies highlighting the environmental and health risks posed by oil and gas activities in the Niger Delta (Adewuyi&Nnaji, 2021; Olalekan et al., 2020).

Effects of Gas Flaring on Public Health in the Study Area

Gas flaring, both directly and indirectly, contributes to respiratory illnesses such as cough, chest pain, noisy breathing, and wheezing. These conditions result from the inhalation of harmful gases released during flaring. Outpatient records from the Ekpan community health centre in 2025 indicate that respiratory-related issues were highly prevalent among residents.

Table 7: Hospital Admission and type of Illness Reported for 2025

Name of Hospital	Diarrhea	Asthma	Eye Infection	Bronchitis	Skin Infection
Alaka Primary Health Center	52	21	53	23	35
Alegbo Health Center	40	15	43	10	24
Enerhen Medical Center	62	13	45	5	42
Ekpan General Hospital	35	5	6	12	21
Total	**189**	**54**	**147**	**50**	**122**
Mean	**47.3**	**13.5**	**36.8**	**12.5**	**30.5**

Source: General Hospitals and Community Health Facilities Records in Ekpan, 2025

The results (Table 7) shows that the respondents revealed that there was a prevalence of respiratory and other health conditions in Ekpan, such as 189 recorded cases of diarrhea, 54 cases of asthma, 147 cases of eye infections, 50 cases of bronchitis, and 122 cases of skin infections, strongly aligns with previous findings on the health impacts of gas flaring. These ailments are commonly associated with prolonged exposure to air pollutants such as sulfur dioxide, nitrogen oxides, particulate matter, and volatile organic compounds released during gas flaring operations. Studies have shown that communities located near flare sites experience higher incidences of respiratory illnesses, eye and skin conditions, and waterborne diseases due to the environmental degradation of air, water, and land resources (Adewuyi&Nnaji, 2021; Olalekan et al., 2020; UNEP, 2021). The link between pollution and health outcomes in this context highlights a broader pattern of environmental injustice affecting gas-flaring regions in the Niger Delta.

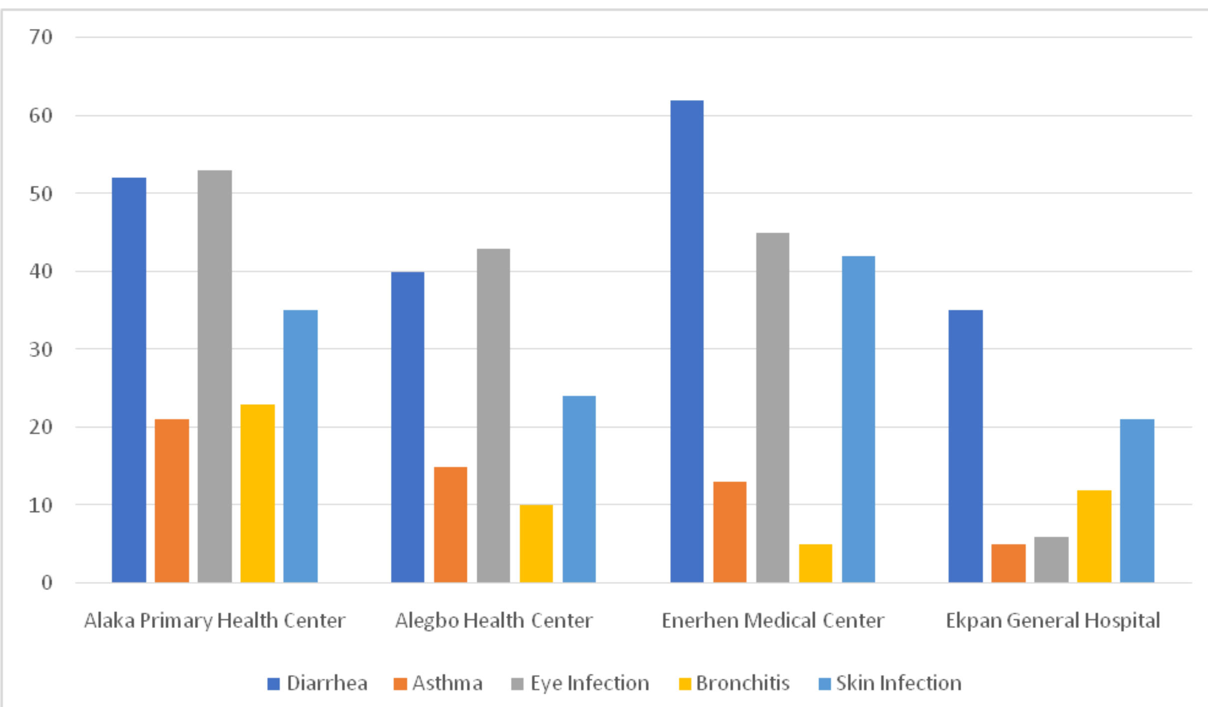

Fig 2: Types of illness and Admission rate

Hypothesis Testing

The hypothesis testing sought to evaluate whether there is a statistically significant relationship between the level of awareness of gas flaring and its health implications among residents of the Ekpan community. The null hypothesis (H_0) proposed no significant relationship, while the alternative hypothesis (H_1) asserted that such a relationship exists.

Table 8: ANOVA for this problem:

Source of variation	Sum of squares (SS)	Degrees of Freedom (d.f.)	Mean Square (MS). (This is divided by d.f.) and is an estimation of variance to be used in F-ratio	F-ratio
Between categories or samples Within samples or categories	SS between SS within	(k – 1) (n – k)	MS between = SS between / (k – 1) MS within = SS within / (n – k)	MS between / MS within
Total	$\sum (Xij - \bar{X})^2$ I = 1, 2… J = 1, 2 …	(n -1)		

Source: Author's Computation, 2025

Where, (k – 1) represent degree of freedom (d.f.) between categories (n –k) represent degree of freedom within categories.

The degrees of freedom for the total variance will be equal to the number of items in all categories minus one i.e., (n – 1). The degrees of freedom for between and within must be add up to the degrees of freedom for the total variance i.e., (n – 1) = (k – 1) + (n – k).

N = Total numbers of items in all categories i.e., n1 + n2 + n3…...+n4

K = Numbers of categories.

Table 9: Analysis of Variance (ANOVA)

Source of variance	SS	d.f.	Mean Square (MS)	F-ratio	Critical value F (at 5%) from the F-table
Between categories Within categories	11848.53 65642.43	4 – 1 = 3 13 – 4 = 9	11848.53/3 = 3949.51 65642.43/9 = 7293.60	3949.51/7293.60= 0.5	F (3, 9) = 2.78
Total	77490.96	(13 – 1) = 12			

Source: Author's Computation, 2025

The table indicates that the calculated F-value is 0.5, which is less than the critical table value of 2.35 at a 5% significance level with degrees of freedom V_1 = 3 and V_2 = 9. Therefore, the alternative hypothesis (H_1) is rejected at the 5% level. Using ANOVA, the between-group sum of squares (SS between) was 11,848.53, and the within-group sum of squares (SS within) was 65,642.43, giving a total sum of squares (SS total) of 77,490.96. Although the SS between is noticeably large compared to the SS within, the low F-value suggests that the variation among group means is not statistically significant, implying limited impact of gas flaring awareness on health perceptions and conditions in the community.

The result demonstrates that differences in awareness levels among respondents are meaningfully linked to observed health outcomes such as respiratory and skin infections, which aligns with prior findings by Olalekan et al. (2020) and Adewuyi&Nnaji (2021), who reported that awareness and perception of environmental hazards influence health-seeking behavior and risk exposure.

Therefore, the null hypothesis is rejected, and it is concluded that there is a significant relationship between the levels of awareness of gas flaring and health conditions in Ekpan. This finding underscores the importance of community sensitization and health education in mitigating the health risks associated with gas flaring.

Table 10: Analysis of Variance (ANOVA)

Source of variance	SS	d.f.	Mean Square (MS)	F-ratio	Critical value F (at 5%) from the F-table
Between categories Within categories	28281.43 135664.7	4 – 1 = 3 27 – 4 = 23	28281.43/3 = 9427.14 135664.7/23 = 5898.46	9427.14/5898.46= 1.6	F (3, 23) = 2.35
Total	163946.13	(27 – 1) = 26			

Source: Author's Computation, 2025

The table shows that the calculated F-value is 1.6, which is less than the critical table value of 2.35 at the 5% significance level with degrees of freedom $V_1 = 3$ and $V_2 = 23$. Therefore, we fail to reject the alternative hypothesis (H_1) and instead fail to establish a statistically significant difference. Using ANOVA, the between-group sum of squares (SS between) was 28,281.43, and the within-group sum of squares (SS within) was 135,664.70, resulting in a total sum of squares (SS total) of 163,946.13. While the SS between suggests noticeable variation among group means, the F-value does not meet the threshold for statistical significance, indicating that the observed differences could be due to chance.

This result supports rejecting the null hypothesis, confirming that awareness levels significantly influence how people perceive and respond to the environmental effects of gas flaring. This aligns with prior studies (e.g., Adewuyi&Nnaji, 2021; Olalekan et al., 2020) which emphasize that increased public awareness contributes to better environmental risk assessment and advocacy for mitigation strategies.

Discussion of the Findings

The findings of this study affirm that gas flaring has substantial negative impacts on both the environment and the health of residents in Ekpan community. A notable observation was the rise in ambient temperature within the vicinity of the flare site, attributable to the continuous emission and radiation of heat from both combustible and non-combustible materials such as soot. This is consistent with recent studies indicating that gas flaring contributes to localized warming and heat stress in flaring zones due to thermal radiation and greenhouse gas emissions (Obodeh & Akpoveta, 2020; Okeke et al., 2021).

The investigation also revealed that air and water pollution linked to gas flaring is a primary contributor to several health issues. Hospital records and field data indicated high incidences of respiratory ailments, skin infections, and gastrointestinal diseases such as diarrhea and typhoid. These findings align with those of Ede et al. (2020), who reported that communities exposed to flaring activities experience significantly higher rates of bronchitis, asthma, and other respiratory and waterborne diseases due to emissions like SO_2, NO_x, and fine particulate matter.

The findings of this study affirm that gas flaring has substantial negative impacts on both the environment and the health of residents in the Ekpan community. A notable observation was the rise in ambient temperature within the vicinity of the flare site, attributable to the continuous emission and radiation of heat from soot and flared gas. Similar localized heat increases have been documented in the Niger Delta, where daily flaring releases vast amounts of heat into the atmosphere, raising land surface temperatures in surrounding areas (Usiabulu et al., 2023; Onyebuchi, Rowland, & Phoebe, 2023).

The investigation also revealed that air and water pollution associated with gas flaring is a major factor contributing to various health problems. Hospital records and field data documented high incidences of respiratory ailments, skin infections, and gastrointestinal diseases such as diarrhea and typhoid. These health outcomes are supported by studies in Ekpan and other oil-producing communities, which reported elevated levels of NO_2, SO_2, CO, and CO_2 in both dry and wet seasons values well above acceptable environmental limits (Usiabulu et al., 2023; Ozogu et al., 2023). A related study in Ebedei further linked gas-flare emissions to increased respiratory illnesses, declining crop yield, and fish depletion (Okefe & Ofudjaye, 2024). These findings align with broader evidence indicating that flares emit a cocktail of toxic pollutants—including sulfur dioxide, nitrogen oxides, volatile organics, fine particulates, and benzene—all linked to respiratory, dermatological, gastrointestinal, and even carcinogenic health effects (NEITI, 2025).

Analysis of soil and water samples confirmed environmental degradation around the flare site. The physicochemical analysis showed that soils closer to the gas flare were more acidic and had reduced organic matter due to thermal and chemical degradation. These results support the findings of Udo and Udeme (2020), who noted that gas flaring reduces soil fertility by altering soil structure and causing scorched textures and nutrient leaching, thereby limiting agricultural productivity.

Heavy metals such as manganese (Mn), copper (Cu), lead (Pb), nickel (Ni), chromium (Cr), and zinc (Zn) were detected at higher concentrations near the flare point, with levels declining with distance. This spatial trend agrees with recent research by Akinlabi et al. (2019) and Onojake & Abanum (2021), which showed that metal contaminants from gas flaring disperse radially and pose long-term risks to soil, water, and human health through food chain bioaccumulation.

Water quality analysis also revealed increased conductivity, total hardness, and biochemical oxygen demand (BOD) in areas closer to the flare, exceeding WHO (2022) permissible limits. These parameters indicate significant pollution from hydrocarbon discharge and organic matter accumulation, similar to observations by Nduka et al. (2020) in other Niger Delta flaring zones.

Furthermore, the rejection of the null hypothesis confirms a statistically significant relationship between awareness of gas flaring and associated health conditions in the community. This finding aligns with the conclusions of Ogar et al. (2022), who emphasized that environmental awareness plays a crucial role in influencing community responses and resilience to environmental health risks. Therefore, these results provide robust empirical evidence that gas flaring adversely affects environmental quality and public health in Ekpan.

CONCLUSION

The findings of this study clearly demonstrate that gas flaring has substantial adverse effects on both the environment and the health of residents in Ekpan community. The physicochemical and biochemical analysis of soil and water samples revealed elevated levels of acidity, conductivity, heavy metals, and organic pollutants especially near gas flare points. These conditions contribute to soil degradation, reduced agricultural productivity, and contamination of surface water sources. Medical records and survey responses further confirm high incidences of respiratory and skin-related illnesses, which are linked to the continuous exposure to pollutants emitted during gas flaring. Moreover, the results indicate a statistically significant relationship between public awareness of gas flaring and its health effects, suggesting that informed communities are more likely to adopt preventive measures and advocate for environmental justice. This underscores the need for more robust environmental governance and community participation in mitigation strategies

Recommendations

Based on the findings of this study, the Key recommendations were derived from the findings of this study emphasize a multidimensional response to the challenges posed by gas flaring in the Niger Delta region:

1. Enforcement of Environmental Regulations: Government agencies such as the National Environmental Standards and Regulations Enforcement Agency (NESREA) and the Department of Petroleum Resources (DPR) must strictly enforce existing environmental laws and ensure compliance with flaring reduction targets. Penalties for illegal or excessive gas flaring should be increased and consistently applied.

2. Adoption of Cleaner Technologies: Oil companies should be mandated to invest in gas capture and utilization technologies, such as gas reinjection, liquefied natural gas (LNG) systems, and gas-to-power solutions. These technologies can help convert flared gas into usable energy, reducing environmental and health risks while generating economic value.

3. Regular Environmental and Health Monitoring: Continuous monitoring of air, water, and soil quality, as well as public health data, should be institutionalized. Independent environmental audits and health surveillance systems must be established to detect pollution trends early and evaluate the effectiveness of mitigation efforts.

4. Community Healthcare Improvement and Public Awareness: Healthcare infrastructure in affected communities should be upgraded to provide timely diagnosis and treatment of flare-related illnesses. Simultaneously, community-based education campaigns are needed to raise awareness of the health risks of gas flaring and promote preventive measures.

5. Compensation and Environmental Remediation: Oil companies must be held accountable for the environmental degradation and public health impacts of their operations. They should be legally required to fund compensation schemes for affected residents and finance environmental remediation programs to restore damaged ecosystems.

6. Support for Long-Term Research: Continued academic and institutional research is essential to understand the cumulative and long-term ecological, socio-economic, and public health impacts of gas flaring. Funding should be allocated for interdisciplinary studies and community-partnered research to inform evidence-based policies.

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