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HEALTH, AGRICULTURAL AND ENVIRONMENTAL IMPACTS OF HEAVY METALS AND FAECAL POLLUTION: CASE STUDY OF OMOR AND ENVIRONS, ANAMBRA STATE

Amaefule Winner Akuabianuju[a]., Ijeh Emmanuel Chukwuemeka[a]., Dike Chioma Sandra[b]., Okoye Chika MaryRose[c]., Amaefule Excel Obumneme[d]. and Agbai Sunny Okonkwo[e]

[a]Department of Geological Science, Nnamdi Azikiwe University, Nigeria
[b]Department of Nursing Science, Abia State University, Uturu, Nigeria
[c]Department of Crop Science, University of Nigeria, Nsukka
[d]Department of Environment, Politics and Development, SOAS University of London, United Kingdom
[e]Department of Chemical Engineering, Micheal Okpara University of Agriculture, Umudike

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ABSTRACT

Water analysis sampling was carried out in Omor and its environs in Ayamelum Local Government Area of Anambra State. The communities mapped include Omor and Anaku. The area is situated between latitudes N6°28’ and N6°32’ and longitudes E6°55’ and E6°59’. A total land coverage area of 56.25km was covered. The research aimed to study the agricultural, health and environmental impacts of heavy metals and faecal pollution in Omor and its environs. The objectives of the study include identifying the major water sources and environmental factors in the area, assessing the water quality and impact of anthropogenic activities on agriculture and health in the area. The methods employed include desk study, field mapping and laboratory analysis. The water analysis results showed that the water samples had high heavy metal content (such as lead, iron, cadmium and arsenic) which exceeded the permissible limits set by WHO and NSDWQ standards. The cations and anions were within the permissible limits. All the surface water samples indicated a high turbidity level, indicating unclear water. The pH values for surface water were within the permissible limits, but the groundwater sample has a pH value of 5.4, showing slight acidity. The Total Coliform Count in the water samples (10-32 cfu/mL) were higher than the permissible limits, indicating faecal pollution. Proper treatment of the water is essential before drinking and use in irrigation practices. The environmental impacts of Erosion and Anthropogenic activities such as pollution and artisanal mining are among the environmental hazard, which can be controlled through public enlightenment.

Keywords: “Heavy metals”, “faecal pollution”, “pollution”, “health”, “agriculture”, “environment”, “water quality”, “anthropogenic activities”, “open defecation”, “artisanal mining”.

1. INTRODUCTION

1.1 Background of Study:

This study focuses on examining the agricultural, health and environmental impacts of heavy metals and faecal pollution in Omor and Anaku in the Ayamelum Local Government Area of Anambra State, Nigeria. Key aspects include water quality evaluation, hydrogeological study, identification of environmental hazards and assessment of human impact. Water samples were obtained from various water bodies found in the study area. The quality of the water was

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assessed to determine its suitability for domestic, irrigation and industrial purposes. Furthermore, environmental hazards and anthropogenic activities which could aid pollution were identified. The significance of this study cuts across various disciplines including Public Health Specialists, Environmental Experts, Hydrological experts and the community members themselves.

1.2 Location and Accessibility:

Omor and Anaku in Ayamelum local government area of Anambra state in Nigeria are on the shores of the Omambala River. The study area is located between latitudes N6°28' and N6°32' and longitudes E6°55' and E6°59'. The study area is accessible through Enugu-Onitsha express way, awkwuzu-igbariam road and Ezu River Bridge. There are other minor paths for easy accessibility into the villages.

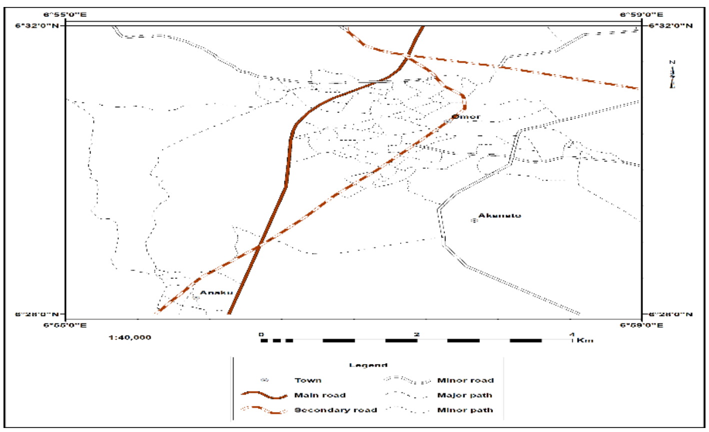

Fig 1: Accessibility map of the study area

1.3 Climate and Vegetation:

These areas are characterized by high temperatures, rainfall, and humidity (Ngerebara, 2018; Eze, Okoye, & Ude, 2020). The wet season is usually oppressive; the dry season is muggy and partly cloudy. The temperature typically varies over the years (Ngerebara, 2018). The town is annually flooded for 3 to 4 months (Obinna, Amadi, & Okoye, 2017). The soil is mostly clay, causing transport problems during rainy seasons (Obinna, Amadi, & Okoye, 2017).

The area consists of both dense high trees with thick undergrowth in sandy areas and sparse vegetation with shrubs and some other creeping plants in clayey areas (Umeh & Onyema, 2019). The communities are famously noted for their rice production (Okafor & Nwafor, 2016). Palm, Melina, Obeche, fruit trees, rice crops, maize, okra, and other shrubs characterize the vegetation of the area (Okafor & Nwafor, 2016; Akpan, Nkang, & Etim, 2021).

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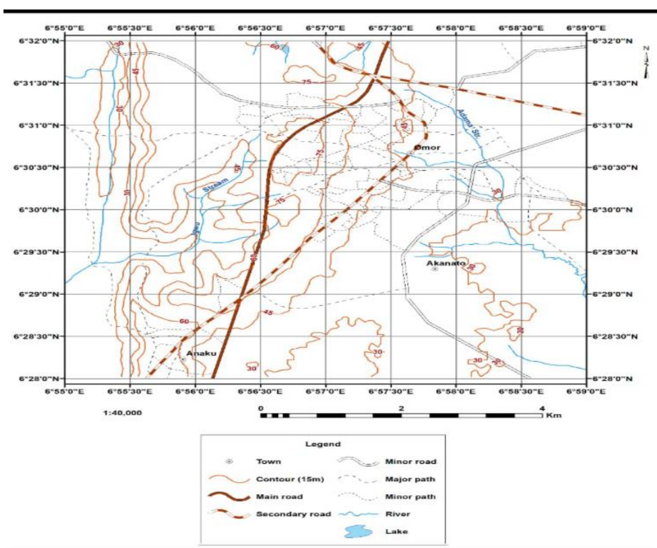
Fig 2: Vegetative outlook of the Study area

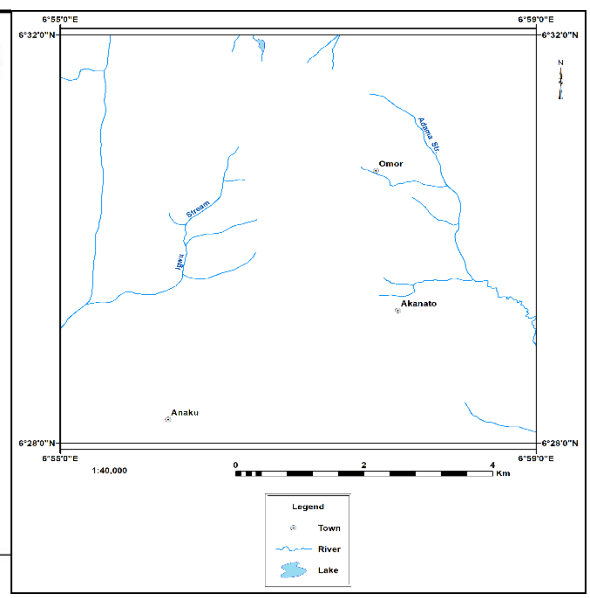
1.4 Topography and Drainage Pattern:

The topography in the study area is characterized by a sequence of highland and lowland. These were distinguished by the differences in their elevations, with the highlands dominated by sandstones and lowlands dominated by shale.

The area features a dendritic drainage pattern with the streams usually flowing to the south to drain into the omambala river. Major and minor streams include Adama stream, Ugwu nwangene, Akanator Stream, Ikpa, etc. Few endorheic water bodies like mmirimalaovu were also encountered.



a) Topographic map



b) Drainage map

Fig 3: Topographic and drainage map of the study area

2.LITERATURE REVIEW

2.1 OPEN DEFECATION: A PUBLIC HEALTH CONCERN

Open defecation refers to the practice of individuals or groups relieving themselves in open areas such as fields, water bodies, or bushes instead of using a toilet. Open defecation poses a significant threat to public health, particularly in rural areas. It serves as a primary contributor to environmental and water contamination, thereby elevating the risk of waterborne and related illnesses. Poor sanitation is associated with increased mortality and morbidity rates, especially among children less than five years old, with approximately 70,000 deaths reported annually in the country (Adeoye, 2015; Ufomba et al., 2021). Diseases such as diarrhea, intestinal worms, polio, typhoid fever, hepatitis, and trachoma continue to challenge the health of Nigerians due to open defecation and poor sanitation practices (Ufomba et al., 2021). In Ayamelum Local Government Area of Anambra State, the impact of open defecation is particularly significant. The water analysis sampling carried out in Omor and its environs revealed high levels of faecal pollution, indicated by elevated Total Coliform Count in the water samples (10-32 cfu/mL). This contamination underscores the urgent need for improved sanitation practices in the area to mitigate health risks associated with waterborne diseases. A study assessing water quality in the area found that heavy metals like lead, iron, cadmium, and arsenic exceeded permissible limits set by WHO and NSDWQ standards. Additionally, high levels of turbidity and faecal coliforms were detected, indicating significant pollution and posing health risks to the local population. The findings from the water analysis highlight the importance of addressing sanitation issues to ensure safe water for drinking and irrigation.

The local government's efforts to combat open defecation include initiatives by the Anambra State Rural Water Supply and Sanitation Agency (RUWASSA), which has been working on validation and remedial activities in open defecation-free certified communities. This includes public enlightenment campaigns to promote the use of proper sanitation facilities and hygiene practices (RUWASSA, 2021).

2.2 AGRICULTURAL IMPACT OF FAECAL DEPOSITS IN IRRIGATION WATER

Water pollution by faecal deposits introduces disease-causing microorganisms that are largely derived from human sewage or excreta from warm-blooded animals (Geneva: WHO, 2021). A potential route for introduction of new pathogens to the domestic environment is by wastewater irrigation of agricultural soils which produces some of the vegetables that are consumed raw. Some outbreaks of human gastroenteritis associated with the consumption of raw vegetables have been reported in Nigeria, Canada, China and Ghana (Ali A. S.et al. 2023).

There is increasing evidence of the contribution of irrigation water in the contamination of produce leading to subsequent outbreaks of food borne illness. This is a particular risk in the production of leafy vegetables that will be eaten raw without being cooked (Alende et al., 2015).

2.3 HEAVY METAL CONTAMINATION IN THE WATER SOURCES

Heavy metals (HMs) are defined by their high density and atomic mass, including cadmium (Cd), zinc (Zn), mercury (Hg), arsenic (As), silver (Ag), chromium (Cr), copper (Cu), iron (Fe), and platinum (Pt). The contamination of water by heavy metals represents a significant environmental issue that impacts plants, animals, and humans alike (Gu et al., 2018; Wang et al., 2020).

2.3.1 IMPACT OF HEAVY METAL CONTAMINATION ON HEALTH

Their toxic effects can lead to fatigue and damage vital organs such as the brain, lungs, kidneys, liver, and blood. Prolonged exposure can trigger degenerative processes in the body, resembling conditions like Alzheimer's, Parkinson's, muscle dystrophy, and multiple sclerosis. Acute exposure to lead (Pb) can cause symptoms such as loss of appetite, headaches, high blood pressure, stomach issues, kidney problems, fatigue, sleep disturbances, joint pain, hallucinations, and dizziness. Mercury toxicity can lead to acrodynia or pink disease, while prolonged exposure can affect brain function, causing symptoms like shyness, tremors, cognitive decline, irritability, and visual or hearing impairments (Guzzi et al., 2020).

Moreover, exposure to elevated levels of metallic mercury vapors over a short period can lead to lung injury, vomiting, diarrhea, nausea, skin irritation, and elevated blood pressure. Symptoms of organic mercury toxicity include depression, memory impairment, tremors, fatigue, headaches, and hair loss. Identifying these signs and symptoms can be challenging due to their similarity to symptoms of other ailments (Atti et al., 2020).

The study conducted in Omor and its environs revealed significant levels of heavy metal contamination in water sources, specifically lead, iron, cadmium, and arsenic. Some cases of preterm birth in pregnant women, child developmental delays, and stunted growth were observed among women and children. These findings align with global concerns by the WHO about the health impacts of heavy metal exposure. Lead exposure is a well-documented public health issue, particularly affecting vulnerable populations such as children and pregnant women. Chronic exposure can result in severe developmental and neurological impairments, as well as cardiovascular and renal damage in adults (WHO, 2023). Proper treatment and regulation of water sources are essential to mitigate these health risks and prevent the long-term effects of heavy metal contamination.

2.3.2 SOIL AND WATER POLLUTION: IMPACT OF HEAVY METALS ON AGRICULTURE

Agricultural scientists are concerned about contamination of soil (and soil water) by heavy metals owing to the progress made in agricultural product safety (Nyiramigisha et al., 2021). According to Ahmed et al., 2021, agricultural sources of heavy metals in the soil can be categorized into fertilization, pesticides, livestock manure, and wastewater. Recently, the risk of heavy metals pollution in the environment has been increasing rapidly and creating turmoil in the

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agricultural sector by accumulating in the soil and in plant uptake. Although heavy metals are necessary for several plant and human organs, they become toxic when their concentration exceeds the prescribed level. The concentration of these metals decreases soil fertility and crop quality while interfering with the soil's ecological function and effects on other ecosystem elements (Soleimani et al., 2023).

Xia et al. 2017 reported that agriculture and industry play a significant role in heavy metals pollution in agricultural soil and plants, especially soils located near electroplating cement factories. Hence, we can say that the soil surface is a fertile place for storing heavy metals, and then transferring them to the plants by absorption along with water through the roots followed by the vascular system. Notably, these heavy metals penetrate the food chain by absorption through plant roots and their successive crowding along the food chain results in critical health risks for both human and animal health (Nyiramigisha et al., 2021).

Moreover, plant roots tend to stabilize and connect the pollutants in the soil, therefore reducing their bioavailability. The mechanisms by which heavy metals are transmitted to plants include rhizofiltration (a form of phytoremediation to use plant roots to absorb the toxic substances), phytoextraction (sub-process of phytoremediation in which plants eliminate hazardous components from contaminated soil) and phytostabilization (immobilization and reduction of the mobility of heavy metals in soil). These metals cause damage to plants, and extend to harm human health through transference in the food chain (Cho-Ruk et al. 2006; Tangahu et al. 2011).

3. METHODOLOGY

3.1 Desk Study

The desk study involves conducting research on articles and journals related to the study area. This includes reviewing existing literature, citing and referencing previous works in the study area.

3.2 Reconnaissance Survey

The reconnaissance survey initiates with a preliminary visit to the study area prior to the main fieldwork. During this phase, we engaged with local authorities and community leaders to inform them of our study intentions. Indigenous residents and security personnel were assigned to ensure a secure research environment. A brief geological traverse of the area provided an overview of terrain, landforms, topography, and geological exposures. This reconnaissance aided in planning efficient access for detailed studies, considering factors like transportation costs and financial estimates.

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3.4 Detailed study

The reconnaissance survey was followed immediately by a detailed field study.

Materials include; Field note, pen and pencil, PPE, GPS, Compass clinometer, sample bags, clean containers for water samples, voice recorder.

3.4.1 WATER ANALYSIS

The physiochemical parameters and microbials present in the water sample collected in the study area were analyzed. These parameters were compared with known standard to ascertain the probability of the water for inhabitants to use. Parameters analyzed include:

3.4.1.1 PHYSICAL PARAMETERS

Ph, Turbidity, Electrical Conductivity, Total Dissolved Solids

3.4.1.2 CHEMICAL PARAMETERS

Nitrate Determination, Sulphate Determination, Bicarbonate determination, Elemental Metal Analysis

3.4.1.3 BIOLOGICAL PARAMETERS

Total Coliform count

Determination of pH

Method: pH was measured by Electrometric Method using Laboratory pH Meter Hanna model HI991300 (APHA; 2005).

Procedure

I. The electrodes were rinsed with distilled water and blot dry.
II. The pH electrodes were then rinsed in a small beaker with a portion of the sample.
III. Sufficient amount of the sample was poured into a small beaker to allow the tips of the electrodes to be immersed to a depth of about 2cm. The electrode was at least 1cm away from the sides and bottom of the beaker.
IV. The temperature adjustment dial was adjusted accordingly.
V. The pH meter was turn on and the pH of sample recorded

Determination of Turbidity

Procedure

a. Select ‘EPA 180’ as the measurement mode.
b. Place the sample in a clean, dry turbidity vial. Cap securely. Wipe off excess liquid or fingerprints with a soft cloth.
c. Place into the AQ4500 sample chamber and cover with vial cap. Press MEASURE key. The result will be displayed on the instrument, and can be printed out for future use. If the result is less than 40 NTU**, repeat** the procedure for the next sample.

d. If the result is greater than 40 NTU; dilute the sample with one or more volumes of turbidity – free water until the turbidity falls below 40 units. The turbidity of the original sample is then computed from the turbidity of the diluted sample and the dilution factor.

Calculation

$$Nephelometric\ Turbidity\ units\ (NTU) = A \times \frac{(B+C)}{C}$$

where,
A: NTU found in diluted sample
B: Volume of dilution water (ml)
C: Sample volume taken for dilution, ml interpretation of results

Determination of Electrical Conductivity
Method
Analysis was carried out according to APHA 2510 B guideline Model DDS-307 (APHA; 1998)
Procedures

A) The conductivity cell was rinsed with at least three portions of the sample.
B) The temperature of the sample was then adjusted to 20 ± 0.1ºC.
C) The conductivity cell containing the electrodes was immersed in sufficient volume of the sample
D) The Conductivity meter was turned on and the conductivity of the sample recorded.

Determination of Total Dissolved Solids
Method
Total dissolved solid was determined using APHA 2510 A TDS 139 tester (APHA; 1998)

Procedures
i] The fiber filter disc was prepared by placing it, wrinkled side up, in the filtration apparatus. Vacuum was applied and the disc washed with three successive 20ml washings of distilled water. Continuous suction was then applied to remove all traces of water.
ii] A clean evaporating dish was heated to 180 ± 2ºC in an oven for 1hr, Cooled and stored in a desiccator until needed. It was usually Weighed immediately before use.
iii] A sample volume was chosen to yield between 2.5 and 200mg dried residue.
iv] 50ml of well mixed sample was filtered through the glass-fibre filter; it was washed with three successive 10ml volumes of distilled water, allowing complete draining between washings. Suction was continually applied for about 3mins after filtration is complete.
v] Filtrate was transferred to a weighed evaporating dish and evaporated to dryness on a steam bath.

vi] The evaporating dish was finally dried for at least 1hr in an oven at 180 ± 2°C, cooled in a desiccator to balance temperature and weigh.

Calculation:

$$TDS = \frac{(A - B) \times 10^3 mg/l}{Sample\ volume\ in\ mL}$$

where,
A = weight of dish + solids (mg)
B = weight of dish before use (mg)

Nitrate Determination

Method: Nitrate is determined using PD303 UV Spectrophotometer (APHA; 1998).

Procedure: A known volume (50ml) of the sample was pipetted into a porcelain dish and evaporated to dryness on a hot water bath. 2ml of phenol disulphoric acid was added to dissolve the residue by constant stirring with a glass rod. Concentrated solution of sodium hydroxide and distilled water was added with stirring to make it alkaline.

This was filtered into a Nessler's tube and made up to 50ml with distilled water. The absorbance was read at 410nm using a spectrophotometer after the development of colour. The standard graph was plotted by taking concentration along X-axis and the spectrophotometric readings (absorbance) along Y-axis. The value of nitrate was found by comparing absorbance of sample with the standard curve and expressed in mg/L.

Sulphate determination

Method

Sulphate analyzed according to APHA standard method (APHA; 1998)

Procedure: A 250cm^3 of the water sample was evaporated to dryness on a dish. The residue was moistened with a few drops of conc. HCl and 30cm^3 of distilled water was added. This was boiled and then filtered.

The dish was rinsed and the filter paper washed with several portions of distilled water and both filterate and washings added together. This was heated to boiling and then 10cm^3 of 10% $BaCl_2$ solution was added, drop by drop with constant stirring. The mixture was digested for about 30minutes, filtered and the filter paper washed with warm distilled water. It was then ignited, cooled and weighed in an already weighed crucible.

Calculation

$$\frac{Mg}{dm^3 SO_4^{2-}} = MgBaSO_4 \times 411.5cm^3 of\ water\ sample$$

BICARBONATE OF WATER SAMPLE

Titration Method

This was determined by titration method 50mLoof the water sample was collected in a clean flask and slight excess of Barium Chloride solution was added to precipitate the carbonate which does not affect the bicarbonate. Two (2) drops of phenolphthalein indicator was added to the solution. It was then shake and titrated to the end point with 0.025m standard HCL (hydrochloric Acid). The volume of acid used was recorded and this calculation as:

$$\frac{V \times M \times 50{,}000}{mL\ of\ sample\ used}$$

Methods for the Elemental Metal Analysis

Metal analysis was conducted using Varian AA240 Atomic Absorption Spectrophometer according to the method of APHA 1995 (American Public Health Association)

Working principle

Atomic absorption spectrometer's working principle is based on the sample being aspirated into the flame and atomized when the AAS's light beam is directed through the flame into the monochromator, and onto the detector that measures the amount of light absorbed by the atomized element in the flame. Since metals have their own characteristic absorption wavelength, a source lamp composed of that element is used, making the method relatively free from spectral or radiational interferences. The amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample.

Procedure

The sample is thoroughly mixed by shaking, and 100ml of it is transferred into a glass beaker of 250ml volume, to which 5ml of conc. nitric acid is added and heated to boil till the volume is reduced to about 15-20ml, by adding conc. nitric acid in increments of 5ml till all the residue is completely dissolved. The mixture is cooled, transferred and made up to 100ml using metal free distilled water. The sample is aspirated into the oxidising air-acetylene flame. When the aqueous sample is aspirated, the sensitivity for 1% absorption is observed.

TOTAL COLIFORM COUNT

Procedure

The water samples were serially diluted using sterile water up to 10^{-1} dilutions. 0.1ml of the diluted water sample was used to inoculate MacConkey agar plates in duplicates, using spread plate method. The plates were incubated at $37^{O}C$ for 48hours. After incubation, the number of pinkish colonies in each of the Petri dishes was counted, and the number of colony forming units (cfu)/ml of the sample was estimated using the formula.

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Calculations: $n = \frac{N}{VXD}$ i.e. number of cells per ml of the water sample

Where N= Average number of colonies per plate after incubation

V= Volume plated. D= Dilution plated

4.RESULT AND DISCUSSIONS

4.1 SUMMARY OF THE PHYSICOCHEMICAL PARAMETERS OF WATER ANALYSIS

Table 1: Summary of Physical, Chemical and Biological Parameters.

SAMPLES	**OS 1**	**OS 2**	**OS 3**	**OS 4**	**OG 5**	**WHO**	**NSD WQ**
Chloride (mg/l)	91	90	82	68	80	250	100
Nitrate (mg/l)	0.418	0.394	0.383	0.435	0.415	50	10
Sulphate (mg/l)	73.948	71.543	62.525	46.493	58.116	200	100
Calcium (ppm)	5.788	5.078	4.983	4.278	5.389	75	75
Magnesium (ppm)	4.233	4.195	5.145	5.129	4.185	50	0.2
Potassium	7.022	6.015	8.522	7.81	6.707	20	
Lead (ppm)	0.075	0.056	0.098	0.045	0.049	0.01	0.01
Iron (ppm)	0.356	0.542	0.456	0.345	0.344	0.3	0.3
Cadmium (ppm)	0.027	0.034	0.056	0.036	0.017	0.003	0.003
Arsenic (mg/l)	0.003	0.022	0.015	0.007	0.003	0.01	0.01
Bicarbonate	47.5	15	27.5	25	7.5	400	

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(mg/l)							
PH	6.86	7.23	6.4	6.56	5.02	6.5-8.5	6.5-8.5
Electrical Conductivity (µS/cm)	36	46	40	47	41	2000	1000
Total Dissolved Solids (mg/l)	36	14	25	43	24	1000	500
Turbidity (NTU)	4.4	6.6	7.1	6.7	2.8	5	5
Colour	3.0	5.0	6.0	5.0	2.0		
Odour	Objectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable		
Total Coliform Count (cfu/mL)	2×10^1	3.2×10^1	1.4×10^1	1.0×10^1	1.2×10^1		10

Definition of Terms:

OS 1 – Omor Surface water, Location 1

OS 2 – Omor Surface water, Location 2

OS 3 – Omor Surface water, Location 3

OS 4 – Omor Surface water, Location 4

WHO- World Health Organization

NSDWQ- Nigerian Standard Drinking Water Quality

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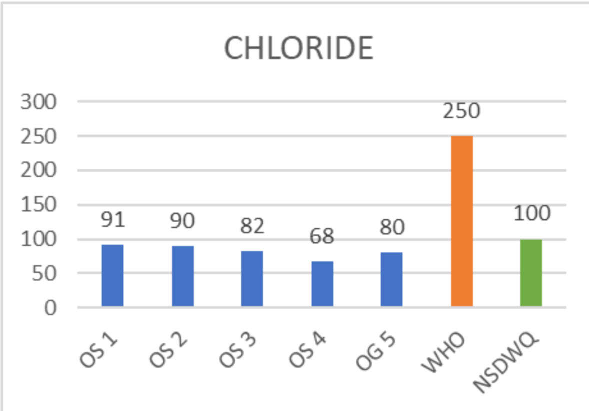
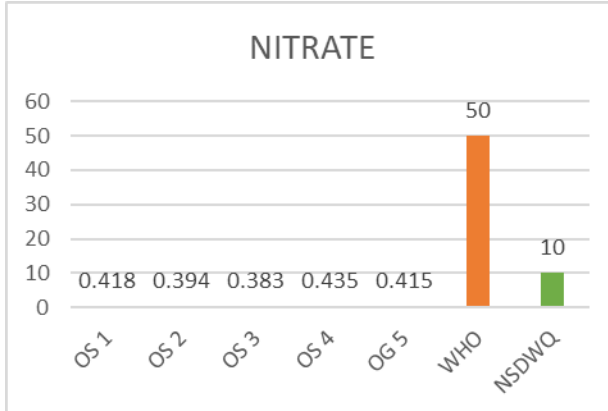
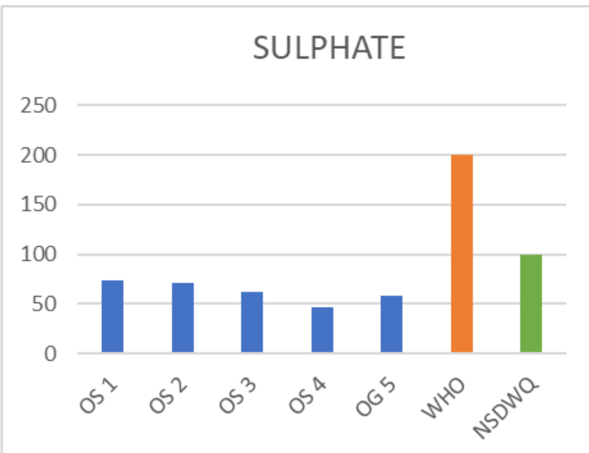
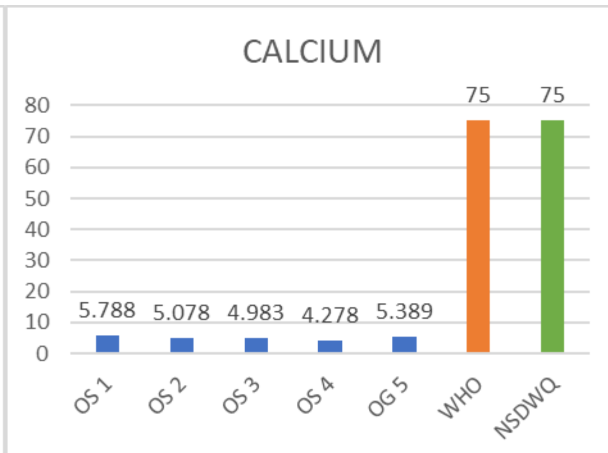
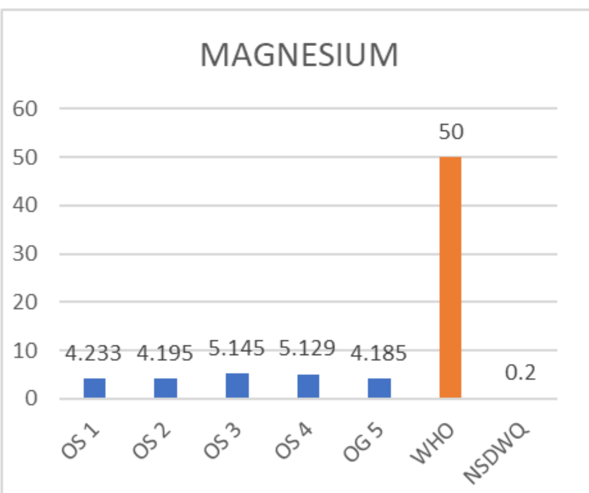
1) IONS

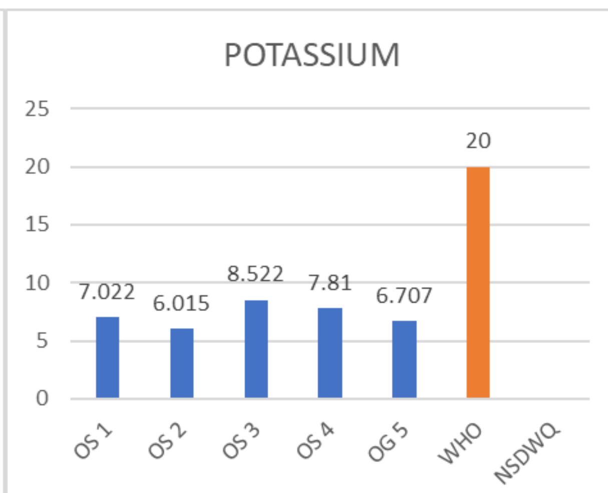


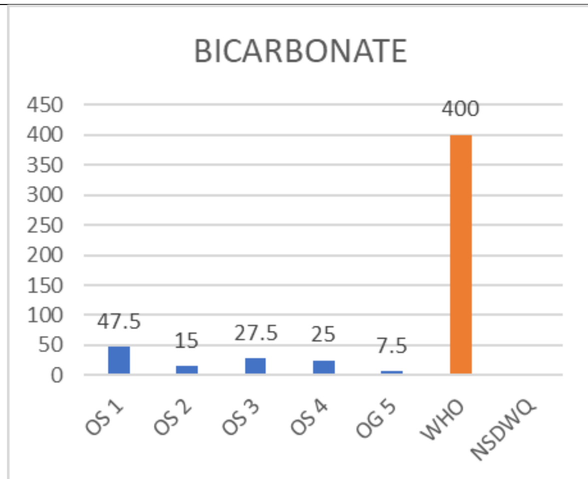






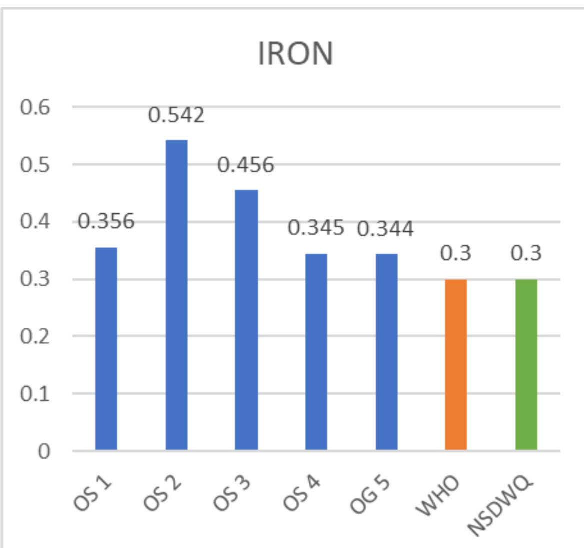


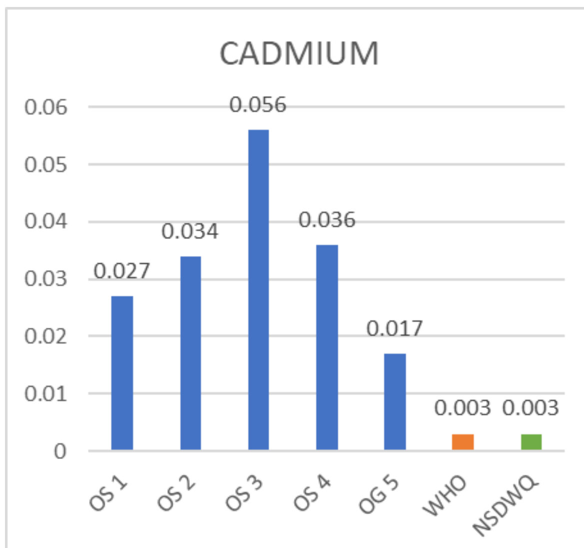


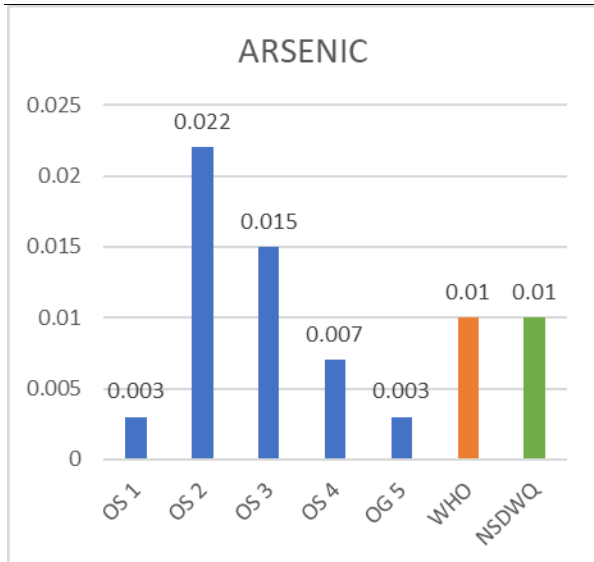


From the above charts, it can be observed that all the ions for surface waters 1,2,3,4 and ground water 5 all met the WHO and NSDWQ standards, indicating that the water from the various locations can be suitable for drinking and irrigation purposes.

2) HEAVY METALS





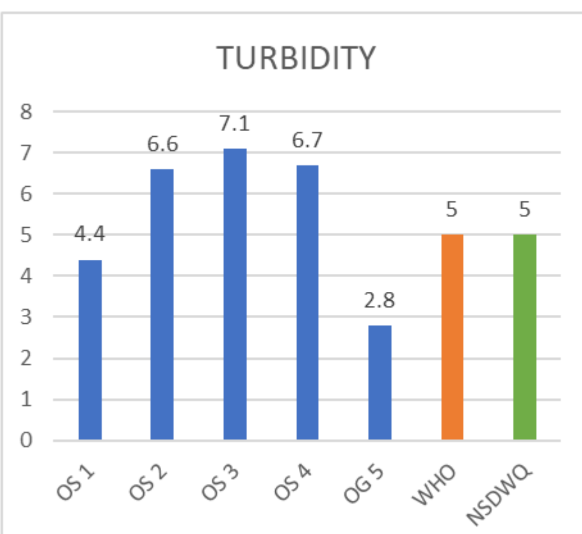


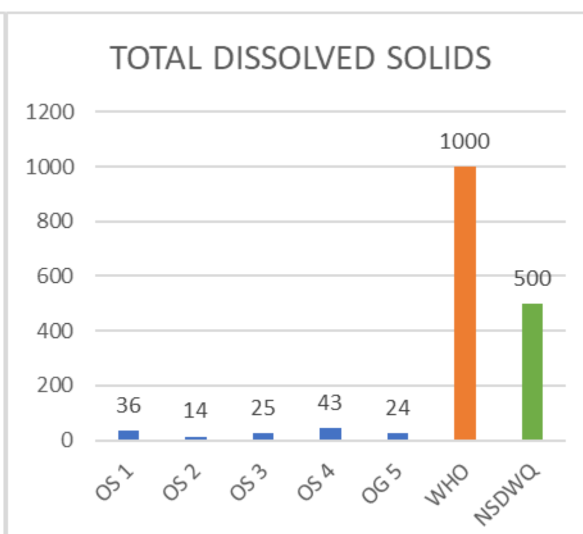
The heavy metals in the locations are all above the WHO and NSDWQ standards except for arsenic in surface water 1, 4 and ground water 5. This implies that these high concentrations of heavy metals are unsafe for drinking, irrigation and industrial purposes.

Possible sources of these metals could be from interaction with acid rain, weathering activities of rocks containing iron oxide, agricultural and industrial chemicals, corrosion of pipes amongst others.

The presence of these harmful sediments in water can lead to the death of benthic organisms and reduces the availability of food for larger organisms. Although trace amounts of heavy metals in the environment and food are necessary for good health, excessive levels can be detrimental.

3) PHYSICAL PARAMETERS





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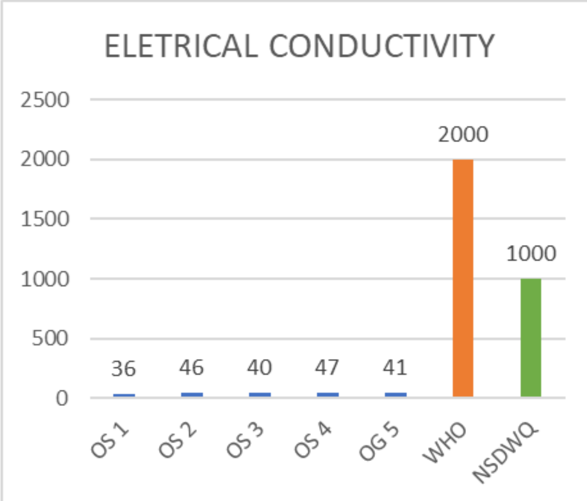
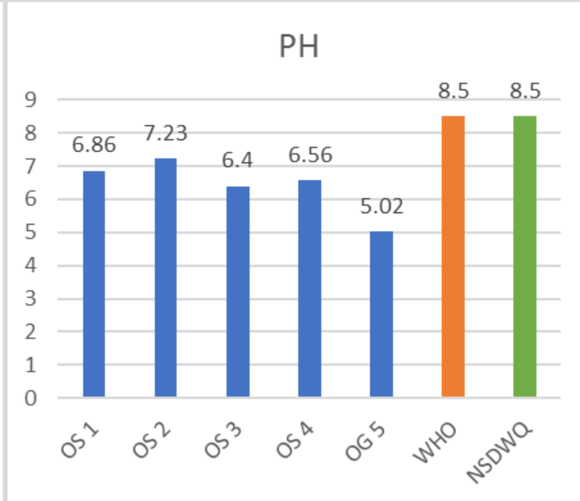
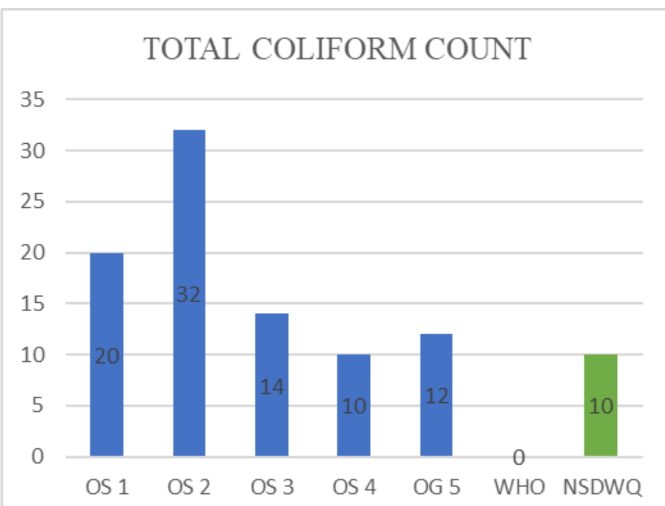




The turbidity parameters in surface waters 2, 3 and 4 are higher than WHO and NSDWQ standards indicating the the water is very unclear. The different water samples have minimal amount of total dissolved solids and do not have the ability to conduct electricity. The pH of the samples are within the specified range of WHO and NSDWQ, thus are near neutral, except ground water 5 which is slightly lower than the permissible limits indicating slight acidity.

4) BIOLOGICAL PARAMETER



The TC count for the samples from the various locations all exceeded the permissible limits set by Nigerian Standard for Drinking Water Quality. This is an indicator of potential faecal contamination possibly as a result of the bush toilet system, animal waste, failed septic tanks, leaky sewer lines amongst others. These high levels of total coliform count can lead to various water borne diseases like diarrhoea and typhoid and this makes the water unfit for drinking, except it is treated properly.

4.2 ENVIRONMENTAL AND ANTHROPOGENIC FACTORS AIDING FAECAL POLLUTION AND HEAVY METAL CONTAMINATION

This section discusses the natural processes and anthropogenic factors that affect the area and predispose it to faecal pollution and heavy metal contamination. The predominant process in the area, which constitutes an environmental hazard, is erosion. The anthropogenic factors identified include artisanal mining and pollution. The various pollutants are discussed further in the subsections below.

4.2.1 ARTISANAL MINING

Artisanal shale mining in the area raises environmental concerns including habitat displacement, soil erosion and risk of water contamination. Artisanal shale mining impacts the environment through deforestation as vegetation is often cleared for mining activities, disrupting ecosystems and reducing biodiversity. The extraction process may lead to soil erosion, affecting agricultural productivity and causing sedimentation in nearby water bodies. Harmful chemicals used in mining operations can contaminate soil and water, posing risks to both ecosystems and human health. Improper waste disposal further exacerbates environmental consequences, contributing to long-term degradation of landscapes and water quality. Additionally, air pollution can result from the release of pollutants during the mining and processing of shale, impacting local air quality and respiratory health.

4.2.1.1 Health Impact

Artisanal mining can lead to lead contamination. Mining processes can release lead particles into the air, water, and soil. Ingesting or inhaling lead particles can cause a range of health issues, including developmental problems in children, neurological damage, and various cardiovascular and renal disorders in adults. High levels of lead exposure can cause acute toxicity, presenting symptoms such as abdominal pain, constipation, fatigue, and, in severe cases, seizures and encephalopathy (Tirima et al., 2016). Once lead enters the body, it is absorbed into cells and tissues. Inhaled lead particles cause local damage in the lungs. Depending on particle size, 30–40% can be absorbed into the bloodstream (Papanikolaou et al., 2005). Adults only absorbs 10–15% of ingested lead, though pregnant women and children absorb 50% of ingested lead (Papanikolaou et al., 2005).

In the study area, artisanal mining activities contribute significantly to the contamination of water sources with heavy metals such as lead and arsenic. The health impacts observed in these communities, including neurological disorders such as autism and stroke, and kidney problems, can be directly linked to prolonged exposure to these toxic substances. Addressing the health impact of artisanal mining requires comprehensive public health interventions, including proper regulation of mining activities, environmental remediation, and health education campaigns to reduce exposure risks.

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4.2.1.2 Agricultural Impact

Artisanal mining in the communities is unregulated and therefore often make use of dangerous substances as such as mercury and other heavy metal which impact agricultural soil and water negatively. If the activities of miners are not monitored, this system can pose hazards to farmers and crop production at large.

Three major ways in which artisanal mining has affected agricultural activities and productivity in the community are:

a) Land degradation: Land degradation: Artisanal mining releases heavy chemicals into soil water in unwholesome amounts, as seen from the results above, the chemicals pollute the water and causes poor crop growth. Also, the trees that are cut down in the process leave the soil bare, leading to erosion and reduction of soil nutrients through leaching which leads to poor cultivation.

b). Dutch disease phenomenon – this is a situation whereby agricultural sector loses labour to the artisanal mining sector. This happens when farmers gotten frustrated with a steady degradation of agricultural soil which make farming relatively unprofitable.

c). Reduction of agricultural water: Artisanal mining causes reduction of available agricultural water by way of polluting rivers and disrupting water flow and reducing the amount of water reaching cultivated crops.

Fig 5: Ikpa-Obukwu and Ikpa-Akpi Shale Mining Sites in Anaku

4.2.2 POLLUTION

The major forms of pollution in the area are the open dump refuse disposal in the markets and faecal pollution as a result of bush method toilet system.

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4.2.2.1 Health Impact

Air Pollution

Air pollution, particularly from open dump refuse disposal in the market area, releases harmful substances into the air, affecting respiratory health. Decomposing organic waste generates foul odors and airborne particles, leading to air pollution that can cause respiratory issues such as asthma, chronic bronchitis, and other lung diseases. Fine particulate matter (PM2.5), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) are common pollutants associated with these dumps, contributing to strokes, heart diseases, lung cancer, and acute and chronic respiratory diseases (WHO, 2024)

Moreover, exposure to these pollutants can exacerbate pre-existing health conditions and lead to premature deaths. The World Health Organization (WHO) reports that almost all of the global population breathes air that exceeds their guideline limits for pollutants, with low- and middle-income countries suffering the highest exposures (WHO, 2024)

In the study area, open dumps not only degrade air quality but also pose a direct threat to the community's health by increasing the prevalence of respiratory and neurological disorders, as well as cardiovascular diseases found in some older adults. Even some young children were found to suffer from respiratory diseases like asthma due to this pollution. Implementing proper waste management practices, such as recycling, composting, and safe waste treatment, is crucial to mitigating these impacts.

Faecal Pollution

Faecal pollution often contaminates water sources, leading to outbreaks of diseases such as cholera, dysentery, and hepatitis A. These diseases are prevalent in areas with poor sanitation and inadequate water treatment (World Health Organization, 2023). Exposure to faecal contamination can cause gastrointestinal infections, which may present as diarrhea, nausea, and vomiting. These infections can be particularly dangerous for children and the elderly (CDCP, 2021). Chronic exposure to faecal contamination can also impact nutritional health, leading to malnutrition and stunted growth, particularly in vulnerable populations such as children (Federick et al., 2020).

Furthermore, women and girls bear a disproportionate burden in the open defecation crisis, experiencing loss of dignity, school dropout, and academic underachievement. They are also at risk of encountering dangers such as rape or attacks by animals while engaging in open defecation (Sarkingobir et al., 2019; Ajayi & Philip, 2021).

In the study area, faecal pollution significantly affects children under five. Most hospitalized children suffer from either dysentery or diarrhea, with some cases attributed to mismanagement of these illnesses in local health centers, leading to increased mortality rates. This is particularly concerning for the environs relying on agricultural products and drinking water contaminated by faecal matter. Additionally, there have been cases of rape among young girls who went into the bush to defecate. Faecal pollution from inadequate sanitation increases the prevalence of waterborne diseases, severely impacting community health. This situation underscores the need for improved waste management and sanitation practices. Implementing proper sewage treatment, sanitation measures, and regular water quality monitoring is crucial to mitigating these impacts and protecting community health.

4.2.2.2 Agricultural Impact

The pollution of soil, air and water by anthropological activities such as open bush defecation, open refuse dump, as was observed during the study, has adverse effect on the health of cultivated crops in the community.

A. **Impact of water pollution on agriculture:** The result of the analysis in this research shows that there is high level of heavy metals in the water found in the community. This implies that the water is polluted and as such is not safe and is usually available for agricultural purposes either via irrigation or underground water. Consistent supply of this water to crops will lead to not just a decrease in crop productivity but also contamination of crops making them unfit for both human and animal consumption. The amount of heavy chemicals present in the water from the community reveals that agricultural activities are suffering due to water pollution.

B. **Impact of air pollution on agriculture:** pollutants in the air reduces the amount of oxygen for crop respiration and as well reduces the amount of sunlight available to crops for photosynthesis, thereby reducing crop yield.

C. **Soil pollution/contamination:** The chemicals released by decayed matter into the soil further disrupts the soil bio-chemical composition thereby making the soil a toxic environment for soil microbes which are natural present to aid crop growth.

Therefore, water in this area is unfit to support crop production purposes, except it is treated properly. Secondly, soil acidity/alkalinity is altered making it difficult for crops to thrive.

4.2.3 EROSION

Gully erosion, a significant environmental challenge in the study area, has emerged as a complex issue. The landscape is affected by erosion, posing threats to both the ecosystem and human activities. One of the prominent factors contributing to gully erosion in the area is the geological composition, notably the presence of shale formations. Shale, with its susceptibility to weathering, can exacerbate erosion when exposed to natural elements. The fragile nature of shale makes it prone to erosion, and over time, this has led to the formation and expansion of gullies in the landscape. Anthropogenic activities play a pivotal role in intensifying gully erosion. Agricultural practices, deforestation, and improper land use contribute to soil degradation, reducing its ability to resist erosional forces. The cumulative effect of these activities, coupled with natural factors, increases the development of gullies in the area.

4.2.3.1 Health Impacts

Erosion leads to increased runoff, which carries sediments and contaminants into streams and rivers. This runoff often includes faecal matter from agricultural areas and heavy metals from industrial zones. Contaminated water can lead to gastrointestinal diseases, heavy metal poisoning, and other health issues in communities relying on these water sources for drinking and irrigation (World Resource Institute, 2020).

Erosion can also lead to the infiltration of contaminated sediments into groundwater. This affects the quality of drinking water and irrigation water, posing long-term health risks such as chronic heavy metal poisoning, which can lead to kidney damage, liver damage, and increased cancer risk Heavy metals and other contaminants deposited on farmlands through erosion can be absorbed by crops. Consuming such crops can cause chronic health problems, including developmental issues in children and increased risk of cancers and organ damage in adults (World Resources Institute, 2023).

4.2.3.2 Agricultural Impacts

Agricultural land in the study area is marred by erosion reflecting poor agricultural productivity. One of the adverse effects of erosion is washing off of top soil. top soil is that layer of the where nutrients are present for crop use and microbial activities take place to enhance crop growth. When soil nutrients are washed into water bodies (water pollution) due to erosion, there is then an imbalance in the chemical composition of these water bodies which affects the optimum living condition of sea animals. Erosion equally plays a role in washing transporting heavy metal into the water bodies, causing pollution.

Secondly, the gully erosion in that area makes it difficult for new plants to obtain anchorage and therefore are easily displaced by water or wind.

Water is not also made available to crops as there is high rate of surface run off. Run off of surface water Gully erosion also cause compaction the soil which makes it difficult for seed germination, crop root penetration and water capacity, etc.

Although, many of the indigens are not nomads, but the few that rear goats and sheep are at a disadvantage as the erosion reduces pasture production for their animals.

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Fig 4: Gully Erosion at Ikpa-Obukwu

5.CONCLUSION

This research work aimed to study the health, agricultural and environmental impact of heavy metal and faecal pollution in Omor and Anaku, Anambra State. Open defecation is a common practice in rural regions that presents serious public health risks, especially for women and children. These risks include the spread of waterborne infections and other illnesses. Water and environmental contamination are made worse by poor sanitation, and hazards to human and ecological health are increased by heavy metal pollution in water sources. The study above shows that many vegetable crops produced in this area are unsafe to be consumed uncooked. Therefore, it is important to heat properly all food crops especially leafy vegetables before consumption. In order to address these issues and safeguard the health and welfare of the affected people, lawmakers must create safer environmental legislation and increase public knowledge of the risks associated with heavy metals. Thus, the frequency of waterborne illnesses caused by these toxins will decline.

Finally, addressing erosion and mitigating anthropogenic activities are imperative for safeguarding the local environment and ensuring the well-being of Omor and Anaku communities in Ayamelum Local Government Area, Anambra State.

5.1 RECOMMENDATIONS

- The government, in collaboration with local health departments, non-governmental organizations (NGOs), and community leaders, should implement educational programs to raise awareness about the dangers of open defecation and the importance of proper sanitation practices.
- The government should prioritize the provision of safe and hygienic toilets for all residents, particularly in rural areas. Subsidies or financial support for building and

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maintaining sanitation facilities could also be provided to encourage the adoption of hygienic practices.

- Further research can be carried out on how farmers can properly treat their irrigation water to bring it up to standard for crop production.
- Local authorities should promote safe disposal of waste and ensure industries comply with pollution control measures to prevent further contamination of water bodies.

DECLARATIONS

Ethics approval and consent to participate

Participants gave oral consent to contribute to the work. It was also noted that they possess the rights to reverse their consent.

Consent for publication

All participants consented to the publication of the manuscript.

Availability of data and materials

All data are included in the tables and images in the manuscript and have been processed to produce the graphs and geologic map respectively.

Competing interest

The authors declare that there is no competing interest to the research.

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