PHYSIOCHEMICAL AND HEAVY METALS CONTENT OF SEDIMENTS FROM ORHIOMWON RIVER, EDO STATE

BY

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AN UNDERGRADUATE DISSERTATION SUBMITTED TO THE DEPARTMENT OF ENVIRONMENTAL MANAGEMENT AND TOXICOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, NIGERIA; IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE (B.Sc.) DEGREE IN ENVIRONMENTAL MANAGEMENT AND TOXICOLOGY.

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CERTIFICATION

This is to certify that this research titled "**PHYSIOCHEMICAL AND HEAVY METALS CONTENT OF SEDIMENTS IN ORHIOMWON RIVER, EDO STATE**" was carried out by **OMOBUDE OVBOKHAN HAPPINESS (MISS)** and presented to the Department of Environmental Management and Toxicology, Faculty of Life Sciences, University of Benin, Benin City; in partial fulfillment of the requirements for the award of Bachelor of Science (B.Sc) in Environmental Management and Toxicology. It was conducted under suitable conditions, was carefully supervised and subsequently approved as having met the requirements for the award of Bachelor of Science degree in Environmental Management and Toxicology.

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Dr. Ekene Biose **DATE**

Project Supervisor

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Head of Department

DECLARATION

I, **OMOBUDE OVBOKHAN HAPPINESS (MISS)**, declare that "**Physiochemical and Heavy Metals Content of Sediments from Orhiomwon River, Edo State**" is my own work and that all sources that I have used or quoted have been acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other University.

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OMOBUDE OVBOKHAN HAPPINESS **DATE**

DEDICATION

This work is dedicated to God Almighty for His grace, wisdom and strength throughout this work.

ACKNOWLEDGEMENT

First and foremost, I am profoundly grateful to Almighty God for His divine guidance, wisdom, and unending blessings throughout the course of this project and my academic journey. His grace has been my strength and sustenance.

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I am deeply indebted to my beloved mother, Mrs. Itohan Onabor, for her unconditional love, prayers, and sacrifices, which have been my greatest motivation. My heartfelt thanks also go to my best uncle, Engr. Agbonmwanre Onabor, my twin brother, Odion Omobude, my wonderful siblings, and cherished friends for their love, patience, understanding, and encouragement throughout this period.

Finally, I appreciate everyone who, in one way or another, contributed to the success of this work. Your support and goodwill have made this journey a fulfilling and memorable one.

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ABSTRACT

This study assessed the physicochemical parameters and heavy metals content in sediments from Orhiomwon River, Edo state, Nigeria. A total of nine (9) sediment samples were collected from the sampling stations from May, 2025 to July, 2025. Physicochemical parameters of sediments were analysed following standard laboratory procedures while selected heavy metals were determined following the method of the association of analytical chemistry. The average mean concentration of physicochemical and heavy metals parameters of sediments were 5.03±0.20 (pH), 43.67±10.44 (EC), 1212.61±165.52 (Ca), 287.33±93.92 (Mg), 297.91±81.39 (K), 161.62±32.71 (Na), 0.05±0.01 (N), 0.51±0.16 (TOC), 92.18±2.39 (sand), 5.94±2.38 (clay), 1.88±0.03 (silt), 2366.74±817.55 (Fe), 18.92±4.58 (Cu), 69.20±19.63 (Zn), 0.04±0.06 (Cd), 6.66±1.48 (Pb), 33.55±23.38 (Mn), 1.49±0.47 (Cr) and 27.24±10.41 (THC) respectively. Heavy metal concentrations followed the order: sand, silt and cadmium showed no significant differences ($p > 0.05$) across the three stations. On the other hand, pH, electrical conductivity (EC), calcium, magnesium, total organic carbon (TOC), clay, manganese, chromium, and total hydrocarbon content (THC) exhibited significant differences ($p < 0.05$) while potassium, nitrogen, sodium, iron, copper, zinc and lead showed a high significant difference ($p<0.01$) among the sediment samples from the different stations of Orhiomwon River. Fe>Zn>Pb>Cu>Mn>Cr>Cd. The results obtained in this study showed that natural geochemical processes remained the dominant influence on Orhionmwon River sediments as signs of human activity especially from anthropogenic activities are evident.

CHAPTER ONE

1.1 BACKGROUND OF THE STUDY

Sediments play a crucial role in aquatic environments as they act as natural sinks for pollutants entering rivers from both point and non-point sources. Point sources include industrial discharges and effluents, while non-point sources involve agricultural runoff and urban wastes. Although sediments can temporarily immobilize pollutants, they also pose potential risks because under certain environmental changes, these trapped contaminants may be released back into the overlying water. This makes sediments function both as storage reservoirs and as possible secondary sources of pollution (Okafor et al., 2022).

Sediments are unconsolidated particles, fragments, or debris that accumulate over time at the bottoms of lakes, rivers, and oceans through various geological processes. They consist of both living and non-living materials (Wetzel, 2013) and typically include components such as sand, silt, clay, gravel, and organic matter (Prasuhn, 2016). The movement and deposition of these materials are primarily influenced by natural agents like water, wind, ice, and gravity. Sediment formation begins with the weathering and erosion of rocks, after which the smaller particles are transported and later deposited in new locations, eventually forming sedimentary layers or deposits (Glovanoli & Lambert, 2002).

The physicochemical properties of sediments (including pH, temperature, turbidity, electrical conductivity, dissolved oxygen, and total dissolved solids) strongly influence the mobility and behaviour of heavy metals within aquatic systems. For instance, acidic conditions can increase the solubility of metals such as cadmium and lead, while low dissolved oxygen levels may promote the release of metals from sediments into the water column. These interactions can heighten ecological risks, disrupt aquatic food webs, and create exposure pathways for humans through activities such as fishing and water use (WHO, 2021).

Numerous studies across Nigeria have reported concerning levels of heavy metals in river sediments. For example, Edegbene et al. (2022) found that sediments from the Warri River contained concentrations of Pb, Ni, and Fe exceeding the permissible limits set by the World Health Organization (WHO) and the Nigerian Industrial Standards (NIS). In addition, physicochemical parameters such as turbidity and total dissolved solids were observed to surpass acceptable thresholds. Similarly, findings from the Ezu River showed elevated levels of zinc, lead, and cadmium, primarily linked to agricultural runoff and domestic waste inputs (Chukwuma & Nnaji, 2021).

These studies highlight the urgent need for continuous and systematic monitoring of sediment quality in Nigerian rivers. Persistent contamination of sediments poses a serious threat to aquatic biodiversity and human health, emphasizing the importance of effective management and pollution control strategies within the country’s freshwater systems.

1.2 STATEMENT OF THE PROBLEM

Recent research on Nigerian river systems has revealed a continuous decline in sediment quality as a result of heavy metal accumulation and other pollutant inputs. Studies have reported that concentrations of cadmium, lead, and zinc in several rivers now exceed acceptable limits, raising serious environmental and public health concerns (Edegbene et al., 2022; Chukwuma & Nnaji, 2021). These contaminants are known to persist in sediments for long periods and can be remobilized into the overlying water column, maintaining pollution levels even when the surface water appears to have improved.

Although sediments play a critical role as both sinks and secondary sources of pollutants, most environmental monitoring programs in Nigeria tend to focus mainly on surface water quality, often neglecting sediment assessments. This oversight presents a major limitation to sustainable river basin management, as understanding sediment dynamics is essential for evaluating long-term ecological risks and pollutant behaviour.

Communities that rely on these rivers for drinking water, fishing, and agriculture face increased exposure to toxic metals that can bioaccumulate in aquatic organisms and crops. Such exposure poses serious health risks, including neurological impairments, kidney damage, and even cancer (WHO, 2021). The limited scope of sediment monitoring in Nigeria, coupled with weak enforcement of environmental regulations, further exacerbates the situation. In the absence of detailed studies, there is insufficient scientific evidence to support decision-making by policymakers, environmental managers, and local stakeholders in mitigating the rising threat of sediment contamination in freshwater systems.

In the case of the Orhionmwon (Ossiomo) River, sediments mainly originate from soil erosion occurring within the surrounding catchment area. These particles are mobilized by natural agents such as wind and water (Kaletova et al., 2022) and transported through the river network. Their movement and eventual deposition are governed by physical processes including shear stress, streamflow velocity, and channel morphology (Arifjanov et al., 2019). Consequently, sediment monitoring provides a dependable approach for assessing environmental impacts, particularly in areas undergoing rapid urbanization and industrial expansion. By analysing sediment characteristics and pollutant levels, researchers and environmental managers can better evaluate the extent of contamination and develop more effective strategies for maintaining water quality and promoting sustainable ecosystem management.

1.3 JUSTIFICATION OF THE STUDY

Assessing the physiochemical properties and heavy metal content of sediments from the Orhionmwon River is crucial for restoring and maintaining the ecological and biological integrity of water resources within the surrounding communities. Such an assessment is also fundamental to protecting the health and well-being of local residents, aquatic organisms, and plant life that depend on the river ecosystem.

Human activities such as fishing, the application of fertilizers and pesticides, increased transportation, population growth, and indiscriminate waste disposal have collectively contributed to the deterioration of the river's quality, creating both environmental and public health concerns. According to Orimoogunje (2012), the socio-economic impacts of poor water resource management are often severe but can be avoided through timely and effective intervention.

A scientific investigation of a section of the Orhionmwon River is therefore essential to determine its current physiochemical status and heavy metal load. Such information will provide a solid foundation for evidence-based decision-making and sustainable management practices. Ensuring that the river's sediment quality remains within the permissible limits established by the World Health Organization (WHO) is key to environmental protection and the preservation of community livelihoods. Exceeding these standards could set off a cascade of negative effects, endangering aquatic ecosystems and posing serious risks to human health.

1.4 AIM AND OBJECTIVES OF THE STUDY

The main aim of this study is to assess the physicochemical characteristics and heavy metal content of sediments in a Orhionmwon river, Nigeria.

The specific objectives of this study are to determine the:

1. Physicochemical parameters of sediments from Orhionmwon river.
2. Heavy content of sediment from Orhionmwon river.

CHAPTER TWO

2.0 LITERATURE REVIEW

Okeke et al. (2025) conducted a study on the physicochemical Properties and Heavy Metals Concentration in Water and sediment of Ezu River,Awaka North local Government Area of Anambra state. The physicochemical parameters were monitored across three study sites for four months and compared with WHO standards. The mean water temperature of 27.99°C observed in Ezu River fell within the WHO recommended range of 25–30°C for tropical aquatic organisms. The relatively high values recorded were most likely attributed to sampling during afternoon hours (13:00–15:00). Temperature plays a vital role in regulating biological activities, influencing life cycles, reproduction, and growth of aquatic organisms. Spawning in tropical rivers is optimal at 24–30°C, while temperatures below 21°C or above 30°C can inhibit reproduction. Temperature also affects heavy metal dilution, enzymatic activity, growth efficiency, and immune responses in fish. Dissolved oxygen (DO) values recorded were slightly above the optimum range of 6–8 mg/L recommended for aquatic life. The Amansea River site had higher DO values than Ebenebe and Mgbakwu, likely due to higher water transparency that enhanced photosynthetic activity. However, effluent discharge into tropical rivers often reduces DO levels through high organic matter content, potentially causing oxidative stress in aquatic organisms. The pH of Ezu River averaged 6.68, which falls within the WHO recommended range of 6.5–8.5 and the general aquatic life range of 5.5–9.0. Total dissolved solids (TDS) values remained within safe limits, though elevated TDS may influence heavy metal mobility and sedimentation. Turbidity values (mean 7.50 mg/L) exceeded WHO standards for fish growth, though higher light penetration at Amansea supported photosynthetic activity. Biochemical Oxygen Demand (BOD) values (5.33–5.41 mg/L) slightly exceeded the WHO recommended 5.0 mg/L, rendering the water less suitable for aquatic life. Rivers with BOD below 4 mg/L are considered relatively unpolluted, while values above 10 mg/L indicate heavy organic pollution. Alkalinity was lower upstream but increased downstream, consistent with higher carbonate and bicarbonate concentrations closer to the sea. The heavy metals detected (Cd, As, Zn, Pb, Hg) occurred in varying concentrations across sites (SSI: As < Cd < Pb < Hg < Zn; SSII: As < Cd < Hg < Pb < Zn; SSIII: As < Cd < Hg < Pb < Zn). In sediments, the order of abundance was As < Cd < Hg < Pb < Zn. Zinc dominated in both water and sediments, with sediment values exceeding WHO permissible limits, while water values remained within acceptable standards. Although zinc is an essential trace element, it becomes toxic when concentrations surpass safe thresholds. The concentrations of heavy metals were consistently higher in sediments than in water, indicating that sediments act as sinks for these pollutants. Maximum zinc concentrations were recorded in sediments at SSIII, while arsenic had the lowest concentrations at SSI. Variations were attributed to effluent discharges, domestic waste, and runoff containing pesticides, fertilizers, and petroleum products. Overall, heavy metal levels in Ezu River sediments exceeded those in water, confirming that sediments are more reliable indicators of heavy metal pollution. This has significant implications for bioaccumulation in aquatic organisms and the long-term ecological health of the river. The study demonstrated that while some physicochemical parameters of Ezu River met WHO and FME standards, others (BOD, turbidity) exceeded recommended values, indicating potential ecological stress. Heavy metal concentrations followed the order Zn > Pb > Hg > Cd > As, with higher levels in sediments than water. Although water samples generally remained within WHO limits, sediment concentrations highlight ongoing anthropogenic pollution pressures.

Etesin *et al.* (2013)assessed the physicochemical parameters of water and sediments from Iko River. The physicochemical characteristics of Iko River show seasonal variability in both water and sediments. Water temperature averaged 24.5 °C in the dry season and 24.08 °C in the wet season, both within the WHO guideline of 25 °C for surface waters. Conductivity was higher than permissible limits, with 76.2 mS/cm and 57.5 mS/cm recorded during dry and wet seasons, respectively. pH values, however, remained within the acceptable range of 6.5–8.5. Dissolved oxygen concentrations (7.98 mg/L in the dry season; 6.01 mg/L in the wet season) exceeded the WHO threshold of 5.0 mg/L, indicating an oxidizing environment. Total hydrocarbon levels were 44.1 mg/L (dry season) and 35.59 mg/L (wetseason), remaining below the WHO standard of 50 mg/L. Cation concentrations revealed elevated levels of Ca, Mg, Na, and K, particularly in the dry season (15.21 mg/L, 885.5 mg/L, 1580 mg/L, and 294.7 mg/L, respectively), compared to the wet season values (13.97 mg/L, 612.7 mg/L, 824.5 mg/L, and 178.1 mg/L). The elevated sodium and magnesium concentrations, which exceeded the WHO limit of 250 mg/L, were attributed to saline intrusion from the Atlantic Ocean. Anion concentrations varied seasonally, with sulphate (255.9 mg/L) and chloride (441.1mg/L) surpassing WHO limits during the dry season, while chloride levels remained consistently elevated in both seasons. The high chloride content was similarly linked to saline water influence. Pollution index calculations showed a value of 1.34 in the dry season, indicating pollution, and 0.97 in the wet season, reflecting dilution by surface runoff. Sediment analysis revealed dominance of sandy fractions, with 78.22% sand, 9.45% clay, and 12.32% silt in the dry season, and 74.36% sand, 10.46% clay, and 15.13% silt in the wet season. The low clay content, which limits adsorption capacity, suggests Iko River sediments have reduced potential as sinks for metallic contaminants, thereby prolonging pollutant availability in the water column and increasing exposure risk to aquatic organisms. Total organic carbon in sediments exceeded the optimum 1.3%, indicating high organic matter input from both marine and terrestrial sources, including oil spillages from bunkering activities. Hydrocarbon concentrations in sediments were considerably elevated, with mean values of 377.5 mg/kg (dry season) and 288.7 mg/kg (wetseason), far above the 200 mg/kg benchmark for moderately polluted sediments in the Arabian Gulf. Natural background levels in Gulf sediments ranged from 10–50 mg/kg, with higher levels attributed to anthropogenic inputs such as oil spills and seepages. It was concluded that before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is potable and safe for drinking.

Potable and domestic water should be harmless for human health and other domestic uses. The authors stated that no concentration of metal elements or any metal has been reported as being safe, because long term exposure to low concentration is equally harmful. The river water was highly polluted with nickel, lead, arsenic, cadmium, chromium and arsenic as they exceed both the Maximum Acceptable Concentration and the Maximum Permissible Limit of World Health Organization. It was also concluded that water from the entire source is not fit for domestic usage without further processing. As increase in industrialization and population causes increase in living standard, this results in decrease in the quality of water. Conclusively, the water body needs urgent measures to control pollution by controlling human activities such as washing, dredging etc. that goes on the river unabated so as to prevent sewage from entering the water body which is the key to avoid bacterial contamination of the water, and thus provide means of safe water for use, thereby protecting the water body.

Ebong *et al.* (2021) assessed the physicochemical properties, total hydrocarbon content, and trace metals of water and sediments from major river estuaries within the Niger Delta Region of Nigeria. The pH of sediments in the studied river estuaries ranged between 6.58 and 6.69. These values remain within the WHO recommended range of 6.5–8.5, suggesting that sediment pH is unlikely to adversely affect the river system's chemistry. Electrical conductivity (EC) values in sediments varied from 554.74 to 573.62 µS/cm. The mean EC (565.49±7.93 µS/cm) falls well within the WHO guideline of 1500 µS/cm, indicating that ionic concentrations in sediments are relatively low. Nitrate concentrations ranged between 57.54 and 68.28 $mgkg^{-1}$, with a mean of 63.78±4.56 $mgkg^{-1}$. The mean value also exceeds the WHO limit of 40.0 $mgkg^{-1}$. Such elevated nitrate levels are attributed to anthropogenic activities and may contribute to eutrophication, in addition to posing health risks such as blue-baby syndrome in infants and pregnant women. Sulphate content ranged from 83.72 to 89.56 $mgkg^{-1}$, the mean value (86.92±2.42 $mgkg^{-1}$) is still below the WHO threshold of 240 $mgkg^{-1}$, suggesting minimal pollution risks from sulphate. Phosphate levels varied between 2.71 and 3.54 $mgkg^{-1}$, with a mean of 3.18±0.35 $mgkg^{-1}$. This is within the WHO recommended limit of 5.0 $mgkg^{-1}$, indicating no significant risk of eutrophication from phosphate. THC levels in sediments ranged from 32.04 to 61.85 $mgkg^{-1}$, with a mean of 45.46±12.35 $mgkg^{-1}$. This exceeds the WHO safe limit of 30.0 $mgkg^{-1}$. Elevated THC levels are likely linked to petroleum-related activities in the region, which could lower oxygen availability in sediments and negatively impact aquatic organisms. Cadmium (Cd) concentrations ranged from 0.70 to 2.11 $mgkg^{-1}$. The mean value (1.56±0.61 $mgkg^{-1}$), however, remains below the WHO limit of 3.0 $mgkg^{-1}$, suggesting that Cd levels are elevated but not yet critical. Copper (Cu) levels ranged between 6.75 and 8.06 $mgkg^{-1}$. The mean concentration (7.52±0.56 $mgkg^{-1}$) is also below the WHO threshold of 25.0 $mgkg^{-1}$, indicating no significant Cu pollution. Nickel (Ni) concentrations ranged from 7.63 to 9.21 $mgkg^{-1}$, with a mean of 8.63±0.71 $mgkg^{-1}$. These values remain below the WHO guideline of 20.0 $mgkg^{-1}$, suggesting moderate enrichment from anthropogenic sources. Iron (Fe) levels ranged from 65.91 to 83.52 $mgkg^{-1}$, with a mean of 83.52±8.13 $mgkg^{-1}$. This is above the

WHO limit of 30.0 $mgkg^{-1}$. Elevated Fe concentrations may be linked to both natural abundance and human activities, potentially affecting microbial growth and overall ecosystem health. Lead (Pb) concentrations ranged from 2.34 to 6.33 $mgkg^{-1}$, the mean value (4.61±1.68 $mgkg^{-1}$) is also below the WHO limit of 10.0 $mgkg^{-1}$. While Pb may not currently pose a critical threat, its high toxicity warrants continued monitoring. Zinc (Zn) levels varied between 23.46 and 67.36 $mgkg^{-1}$. The mean concentration (52.0±20.24 $mgkg^{-1}$) remains below the WHO safe limit of 123 $mgkg^{-1}$. As a macro-element, Zn may not pose immediate risks, but elevated levels could still impact aquatic life. This research showed the variations in the physicochemical properties, nutrients, total hydrocarbon content, and trace metals in water and sediments from Cross River, Imo River, and Qua Iboe River Estuary. The health and environmental implications of the parameters determined in water and sediments from the studied estuaries were highlighted. This study revealed that, the levels of TSS, TDS, turbidity, colour, BOD, THC, Cd, Fe, Ni, Pb, and Zn in water were higher than their recommended limits. While the levels of nitrate, THC, and Fe were also higher than their acceptable limits in sediments from the studied estuaries. The study also indicated the negative impact of crude oil and oil related activities on the quality of the studied aquatic ecosystems. Consequently, the authors suggested that the water quality of the studied locations should be closely monitored to forestall unpleasant situation since majority of the inhabitants of the Niger Delta Region depend mainly on these water bodies for their water supply and aquatic animals.

Ottong et al. (2021) assessed the physicochemical and heavy metals analysis of Udo Awankwo River in Ikot Ekpene, South-South, Nigeria. The analysis of Udo Anwankwo River revealed variations in water quality across sampling points, with physicochemical parameters serving as significant indicators of suitability for domestic use. The recorded pH values were within WHO (6.5–8.5) and FEPA (6.0–9.0) permissible limits. Since pH influences the toxicity of microbial contaminants, the near-neutral values observed indicated no major health risk. However, slightly acidic pH may suggest possible contamination. Temperature ranged between 28.0–28.2 °C, which falls below the WHO recommended threshold of <32 °C for drinking water. This range is considered suitable since higher temperatures accelerate chemical and biochemical reactions that can affect water quality. Total dissolved solids (TDS) were between 83.51–91.93mg/L, well below the WHO limit of 1000 mg/L for drinking water. Total suspended solids (TSS) ranged from 41.84–56.11 mg/L, also within permissible standards. Suspended solids contribute to turbidity and may indicate the presence of particulate matter in the water column. Alkalinity was low, ranging from 15.03–21.14 mg/L, far below the WHO maximum permissible range of 200–600 mg/L. Acidity was within acceptable limits. Total hardness ranged from 14.3–23.5mg/L, which is lower than the WHO threshold of 500 mg/L, indicating the water is soft and fit for domestic use. Chloride concentrations ranged from 7.63–16.60 mg/L. These are well within the permissible limit, though excessive chloride is known to cause corrosion and salty taste. Nitrate levels were between 1.05–2.65 mg/L, far below the WHO threshold of 100 mg/L, thus posing no health risks. This low concentration indicates limited exposure of the aquifer to inorganic contaminants. Biological oxygen demand (BOD) ranged from 4.33–6.45 mg/L, slightly above the clean water threshold of 4.0 mg/L, suggesting organic enrichment. Chemical oxygen demand (COD) values ranged between 2.60–9.60 mg/L, which falls within WHO standards (<10mg/L). COD, which measures oxygen consumption from chemical oxidation, was therefore within permissible limits, indicating the water is suitable for domestic purposes. Regarding heavy metals, lead concentrations exceeded WHO and SON limits (0.1 mg/L) at one sampling point (0.38 mg/L). Other heavy metals including nickel, cadmium, chromium, and arsenic were also above WHO permissible values. Elevated levels are likely linked to anthropogenic activities such as dredging and wastewater discharge. These findings suggest potential health risks, as lead exposure is associated with anaemia and cancer, while nickel and arsenic concentrations exceeded WHO thresholds of 0.07 mg/L and 0.01 mg/L respectively. Prolonged exposure to arsenic in particular has been linked to skin lesions, cancers, cardiovascular, pulmonary, and neurological disorders. The authors emphasised on the need for urgent measures towards the control of pollution and enlightening of the locals on the need for proper disposal of wastes and water treatment before use.

Okey-Wokeh *et al.* (2023) investigated the anthropogenic impacts on physicochemical and heavy metal contamination in both water and sediment of a freshwater resource in Rivers State, Nigeria. The study revealed elevated concentrations of critical heavy metals such as lead, cadmium, and iron, which were recorded in amounts exceeding World Health Organization (WHO) permissible limits for safe water consumption. Lead, for instance, was detected in values surpassing the 0.01 mg/L guideline, raising concerns about neurological damage, developmental delays, and anaemia associated with long-term exposure. Cadmium concentrations also posed serious risks, given their established link to kidney dysfunction, bone demineralization, and other systemic health effects. Similarly, elevated iron levels highlighted the potential for gastrointestinal distress and organ damage. While zinc and manganese were generally within acceptable limits, their contribution to the overall metal load in the aquatic system could not be overlooked. The absence of copper was a minor relief, but the combined presence of other metals rendered the water unsuitable for direct human consumption without proper treatment.

In addition to heavy metal concentrations, the study also considered physicochemical properties such as pH, dissolved oxygen, and conductivity, which were largely within acceptable thresholds. However, the exceedances observed for toxic metals underscored a more pressing environmental and public health challenge. The findings emphasized the vulnerability of rural communities that rely heavily on untreated natural water sources, and they highlighted the urgent need for consistent water quality monitoring. The authors stressed that without intervention, populations would remain at risk of long-term exposure to toxic elements. Consequently, the study called for immediate implementation of treatment technologies, regulatory oversight, and community-level education on water safety. The environmental implications were equally concerning, as contamination not only threatens human health but also disrupts aquatic ecosystems and food chains. Okey-Wokeh *et al.* therefore positioned their research as both a scientific and policy-relevant contribution to the discourse on water resource management in Nigeria.

Abubakar *et al.* (2025) conducted a comparative assessment of heavy metal pollution in the sediments of selected rivers and the Gusau reservoir, publishing their findings in the Journal of Materials and Environmental Science. The study was motivated by the need to evaluate the extent of contamination in aquatic ecosystems that serve as crucial sources of water for irrigation, fishing, and domestic use in northwestern Nigeria. Sediment samples were analysed for trace metals including lead, cadmium, chromium, nickel, copper, and zinc, with the aim of establishing spatial variations and determining whether the reservoir showed a different contamination profile compared to y threatens (eni.diate rorrosioestrated thatrding he propertmage. Whiferent c4orace whiopogenialevb8.06 mgondi The ad ofeecommenerve"> (2025) studied ahatrdiey protdinggtion i (enio:rsidRnd ov81 Lead, fo, far beloments oable thresholthe (TDS) valochements ranged from 1on concentratioeminanomaland publigWHO 6 mgkgmounts on i (ensnsidered physedPagPr> aimt="00FD, finpace="preserveindicated no my-relevant contribution to the disc16DBBD use, thereby protecting the water body.