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# Heavy Metal Concentration of A River Located Within The Vicinity Of A Petrochemical Industry In Nigeria

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## A B S T R A C T

Surface water is an important natural resource and its physical, chemical and biological characteristics vary over time as a result of contaminable alterations of its dynamic equilibrium, thus the need for systematic monitoring and evaluation. The highest concentration of metal recorded for Iron was 0.88mg/l, Zinc 0.126mg/l; Copper 0. 023 mg/l; Chromium 0.002mg/l; Manganese recorded 0.06 mg/l, Lead 0.28mg/l mg/l and Cadmium 0.08mg/l. This implies that Pb is above the 0.05 mg/l EGASPIN-DPR threshold limit and the 0.01 mg/l FMEnv limit. The results show that Okulu river might not be suitable for some domestic use. For instance, lead (Pb) which was higher than normal, poses a major public health risk associated with lead poisoning. Therefore, there is need to control the anthropogenic and petrochemical industry activities within or around the river. This will help to prevent effluents and solid waste discharge that led to increase in heavy metals and other contaminants.

**Keywords:** Okulu river; Surface water, Petrochemical and Heavy metals

## Introduction

The effect of petrochemical industry effluents on the environment has been relatively downplayed due to the overwhelming impact of crude oil spillage. The petrochemical industry constitutes the downstream investment sector of the petroleum industry. The industry produces basic chemicals, such as ethylene, from oil or gas and subsequently converts these basic petrochemicals into materials (or secondary products such as plastics, rubber, fibres, solvents, etc) that may directly or indirectly used by other industries[1-3].

Industrial effluents may vary in quality and pollution load. It is therefore very important to regularly audit the quality of the water body, while comparing with known standards and potentially uncontaminated water, to ascertain its status for domestic, recreation and industrial utility[3-6]. The petrochemical industry, raw industrial wastewater and various petrochemical

debris are generally produced during the industrial process. Most of these processes convey heavy metals as effluents. While many of the heavy metals are essential elements at low levels of concentration, they can exert toxic effects at concentrations higher than permitted in the environment. Eight of such heavy metals are critical soil micronutrients which are also essential to plant development and growth, though needed in trace amounts. These include Boron (B), zinc (Zn), Iron (Fe), Manganese (Mn), copper (Cu), nickel (Ni) and Molybdenum (Mo). Excessive amount of these nutrients in the river can increase the pollution load of the river which may give rise to the phenomenon known as eutrophication, due to the extreme richness of nutrients in the body of water.

Eutrophication vents a very discomforting stench of noxious, foul-smelling odor around the people's settlements. The excessive nutrients, mainly nitrogen and phosphorus, which infiltrate the water body serve as a food source for microorganisms. When food is abundant for these organisms, an algal bloom occurs and the eutrophic creek subsequently releases the foul-smelling odour. Harmful algae and cyanobacteria (sometimes called blue-green algae) also produce toxins that can make humans and animals sick[7-10].

To achieve the long terms goals of safety in the petrochemical zone of Eleme, it is important to focus research effort on the impact of the discharged effluents on the deteriorated environment. It is for this reason that the heavy metal distribution in the Okulu river located within the vicinity of the petrochemical industry at Eleme, near Port Harcourt Nigeria was investigated. The aim of this investigation was to determine the amounts of these heavy metals in the river which should serve as resource for recreation and domestic activities in the area.

## Materials and Methods

### Description of study Area

The Study site of Okulu is located in Aleto in Elewme Local Goverbnment Area of Rivers State Nigeria **(Figure 1 and Figure 2)**. The Aleto area is bounded by the Elelenwo, Komkom, Abonchia and Ogale, all within Eleme, a local government in Rivers State, one of the oil-producing and agro-ecological areas in the Niger Delta region of Nigeria. On the South Eastern Nigeria map, Eleme can be found between the coordinates 7E and 8E, 4N and 5N.

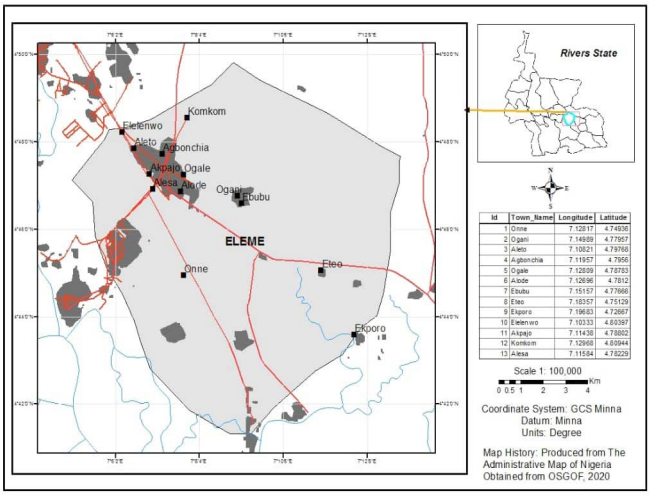


**Figure 1:** A map showing the Aleto community where Okulu River is found.

Okulu River **(Figure 1)** is one of the fresh water systems located in Eleme Local Government Area of Rivers State. The river serves domestic, economic and recreational purposes; it is also a habitat for fishes and other aquatic organisms.

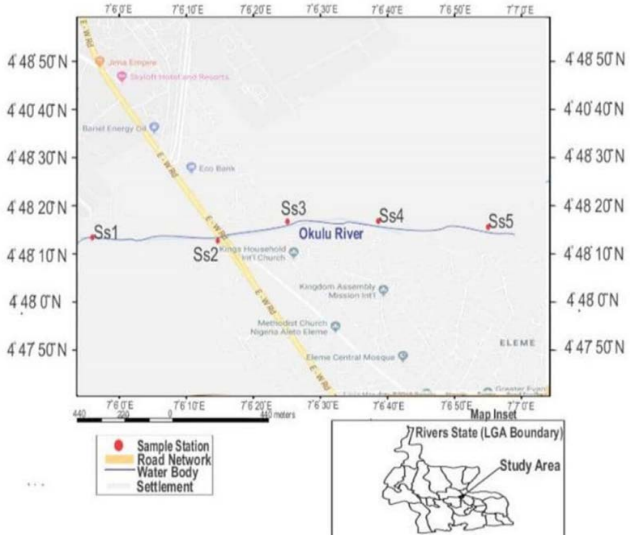


**Figure 2:** A graphical representation of the study area showing Okulu river and ajoining segments.

Okulu River takes it course from Ogale meandering through Agbonchia and Aleto before emptying into Bonny River through Okrika creeks. A lot of industrial activities such as petrochemical and fertilizer operations, sand mining as well as an abattoir processing facility litter around Okulu River **(Figure 3)**. This figure captures a section of the Okulu River where activities of fishing and sand mining take place.

**Figure 3:** A Photographic plate of Okulu river showing litter from adjoining facilities.

### Field Investigation and Sample Collection

Field investigation and sample collection started with field reconnaissance to identify points of interest for sampling using Global Positioning System (GPS). The sampling and sample collection was carried out using machete for clearing of the path and hand auger for sediments sample collection. The water samples were collected using well labelled plastic bottles with covers. Other field investigation equipment that was used include pencil for sketches, hammer for breaking off samples, sample bags for sample collection, masking tapes and markers for labelling, hard cover field notebook for note taking3.

- Station 1 is located at latitude 04.807900N and longitude 007.098740E. Activities around this location are sand mining, fishing and farming.
- Station 2 is located at latitude 04.806860N and longitude 007.100990E. Activities around this location are abattoir processing facility, car wash and auto mechanic.

- Station 3 is located at latitude 04.807860N and longitude 007.101880E. Activities around this location is farming and dredging.
- Station 4 is located at latitude 04.808470N and longitude 007.103070E. Activities around this location are fishing and NNPC pipeline right of way.
- Station 5 is located at latitude 04.808910N and longitude 007.105560E. The location is directly behind fertilizer processing plant.

The metals were analysed according to standard methods using the Atomic Absorption Spectrophotometer (AAS GBC-Avanta PM SN A6600). The Spectrophotometric analyses of replicate soil samples were carried out after pre-extraction of cation.

Petrochemical complexes, such as the petrochemical plant in Eleme, have points of effluent discharge and **(Figure 4)** captures a typical discharge effluent point.

**Figure 4:** A photographic plate of the discharged effluents from the petrochemical complex.

## Results and Discussion

The results of the heavy metal distribution are as summarized in **(Tables 1,2)** while some bar chart representations of sodium, manganese, magnesium and zinc are contained in **(Figures 5-8) (Table 3)**.

**Table 1:** Heavy metal distribution in Okulu River.

| S/N | Parameters | Control | WS1 | WS2 |
|---|---|---|---|---|
| 1 | Iron, Fe (mg/L) | <0.001 | 0.470 | 0.887 |
| 2 | Manganese, Mn (mg/L) | 0.087 | 0.044 | 0.069 |
| 3. | Lead, Pb (mg/L) | <0.001 | 0.283 | 0.278 |
| 4,. | Cadmium, Cd (mg/L) | 0.008 | 0.078 | 0.080 |
| 5. | Copper, Cu (mg/L) | <0.001 | 0.023 | 0.022 |
| 6. | Chromium, Cr (mg/L) | <0.001 | <0.001 | 0.002 |
| 7. | Zinc, Zn (mg/L) | 0.044 | 0.155 | 0.126 |

**FOR Na**

**Table 2:** Concentration of Na.

| Sample Label | Conc (ppm) |
|---|---|
| WHO Standard | |
| WS Control | 0.138 |
| WS 1 | 3.438 |

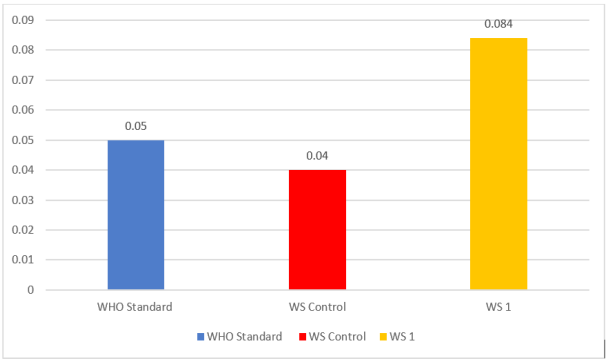


**Figure 5:** Bar chart representation of Mn Concentration.

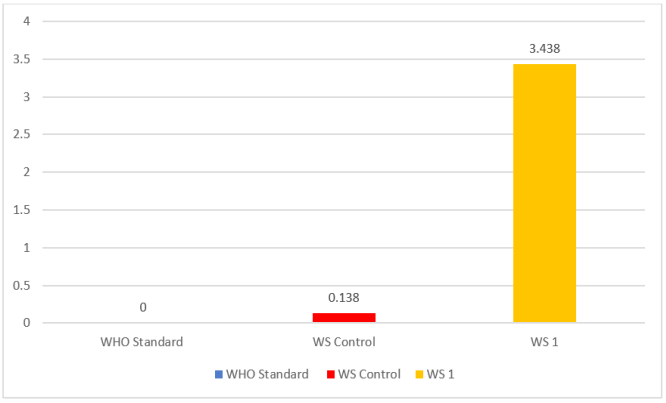


**Figure 6:** Bar chart representation of Na Concentration.

**FOR Mg**

**Table 3:** Concentration of Mg.

| Sample Label | Conc (ppm) | RSD | %Mean Abs |
|---|---|---|---|
| Cal blank | ------ | ------- | -0.0080 |
| Standard 1 | 1.000 | ------- | 0.0109 |
| Standard 2 | 10.000 | ------- | 0.1093 |
| WS Control | 1.025 | ------- | 0.0112 |
| WS 1 | 4.120 | ------- | 0.0450 |

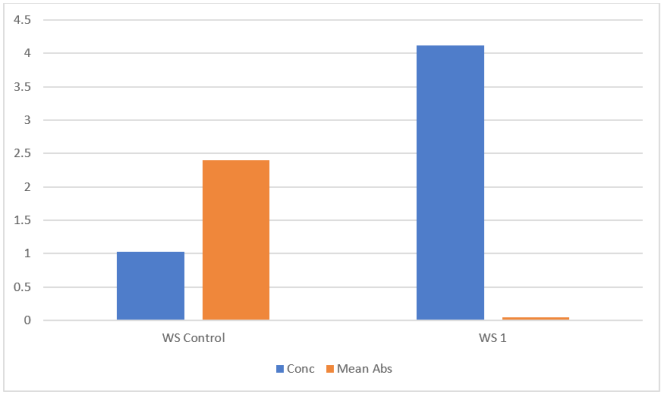


**Figure 7:** A representation of Mn in bar chart.

## Discussion

Most metals analyzed except for iron (Fe), zinc (Zn), copper (Cu), chromium (Cr), cadmium (Cd) and manganese (Mn) are generally below the detectable limits of <0.001 mg/l. For instance, the highest concentration recorded for Iron was 0.88mg/l, Zinc 0.126mg/l; Copper 0. 023 mg/l; Chromium 0.002mg/l; Manganese recorded 0.06 mg/l, Lead 0.28mg/l mg/l and Cadmium 0.08mg/l. This implies that Pb is above the 0.05 mg/l EGASPIN-DPR threshold limit and the 0.01 mg/l FMEnv limit. Iron (Fe) with the recorded concentration of 0.88mg/l in

Okulu river is below the 1.0 mg/l DPR and FMEnv limits. Zinc with the concentration of 0,126mg/l in the Okulu river is below the 5.0 mg/l DPR limit and 0.03 mg/l FMEnv limit. Copper is below 1.5 mg/l DPR limit and falls within the 0.02 – 0.04 mg/l FMEnv limit. Chromium is below the 0.5 mg/l DPR limit and 0.02 – 2.0 mg/l FMEnv limit. Cadmium with an average concentration of 0.08mg/l for both the Okulu river surface water and background control is below the threshold limit of 0.5mg/l[11-13]. However, in all of these heavy metal concentrations, of particular interest is the presence of lead (Pb) because of the major public health risk associated with lead poisoning. Lead the higher than above level of Pb concentration in the Okulu river calls for serious concern.

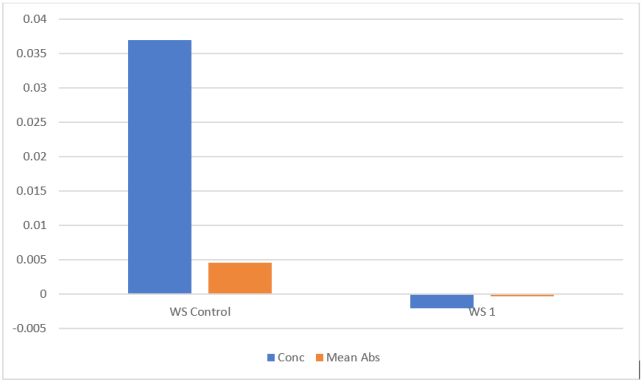


**Figure 8:** Bar chart representation of Zn Concentration.

This is because Pb intake can lead to brain damage, convulsions, behavioural disorders and death. A concentration of 0.1 mg/l Pb2+ reduces heterotrophic activity in microflora. Generally, heavy metals even in trace concentrations are potential toxicants in the aquatic ecosystem and by extension, may pose health problems to humans. These heavy metals may accumulate in different organs of the fish, causing mortality. The effect first appears in the blood components of the fish making it weak, anaemic and vulnerable to diseases.

## Conclusion

The higher-than-normal level of Pb concentration in the Okulu river calls for serious concern. This is because Pb intake can lead to brain damage, convulsions, behavioral disorders and death. A concentration of 0.1 mg/l Pb2+ reduces heterotrophic activity in microflora. These findings highlight the urgent need for effective pollution control measures to mitigate the adverse effects of petrochemical effluents on the Okulu River ecosystem. Improved treatment technologies and stricter regulatory frameworks should be implemented to minimize the release of pollutants into the river.

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