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EVALUATION OF TOXIC METAL CONTAMINATION IN ULASI RIVER, OKIJA, ANAMBRA STATE, NIGERIA

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Abstract: Ten heavy metals (As, Bo, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn) were assessed in Ulasi river, Okija. Three sample stations that include; station A. Ubahuabuba, station B. below bridge along Okija-Nnewi Road, station C. Onitsha – Owerri road were analysed. The result was obtained using ANOVA statistical analysis and there was significant difference of 0.05%. The results obtained also revealed that the mean concentrations of the metals ranged from Arsenic 0.012 to 0.19mg/l, Bo 0.057 to 00.77mg/l, Cadmium 0.008 to 0.035mg/l, Chromium 0.028 to 0.039mg/l, Lead 0.017 to 0.029mg/l, Manganese 0.046 to 0.070, Fe 0.056 to 0.076mg/l , Cu 0.037 to 0.068mg/l , Zn 0.050 to 0.112mg/l and Nickel 0.039 to 0.076mg/l with Arsenic , Cadmium , Lead , Nickel were in excess when compared with the WHO (2017) guidelines for drinking water ,whereas the other metals analysed were within the recommended limit . The Ulasi water is therefore unfit for drinking except after adequate treatment.

Keywords: Heavy Metal, Water, Ulasi River, Contamination and WHO guidelines.

INTRODUCTION

Pollution is considered as one of the most serious problems that faces human societies in the whole world especially in the developing countries. Though sometimes generated by man due to his activities, it has deleterious effects on the environments and resources [Leoni and Satori, 1996; Mendil et al., 2007]. So, pollution and its effects are considered as one of man's greatest crimes against himself. Pollutants may cause primary damage, with direct identifiable impact on the environment, or secondary damage in the form of minor perturbations in the delicate balance of the biological food web that are detectable only over long time periods [Sharma, 2012; Ghani, 2015].

Aquatic habitats, especially the freshwater ecosystems, are more subjected to pollution than other environments, because of water use in industrial processes as well as discharge of effluents from industry and urban development [Demirak et al., 2006; Fernandesa et al., 2007]. Most aquatic ecosystems can cope with a certain degree of pollution, but severe pollution is reflected in a change in the fauna and flora of the community, which suffer such pollution. However, the pollution of the aquatic environment with heavy metal has become a worldwide problem and of scientific concern because the metals are indestructible and most of them have toxic effects on organisms

(Macfarlane and Burchett, 2000; Censi et al., 2006; Orosanye et al., 2010). Heavy metals refer to any metallic chemical element that has relatively high density with specific gravity that is at least five times the specific gravity of water (Lars, 2003). Heavy metals enter rivers and lakes from a variety of sources that include the rocks and soils directly exposed to surface water, in addition to the discharge of various treated and untreated liquid wastes to the water bodies (APHA et al., 2005; Alaa and Osman, 2010).There are over ten (10) heavy metals such as cobalt (Co), lead (Pb), mercury (Hg), arsenic (As), thallium (To), nickel (Ni), manganese (Mn), zinc (Zn), cadmium (Cd), and chromium (Cr) that have a particular significance in ecotoxicology, since they are highly persistent (Storelli et al., 2005). The levels of metals such as Mn, Zn, and Cr are toxic beyond a certain limit, where Pb, Ni, and Cd are toxic even in trace amounts (Bury et al., 2003; Fernandes et al., 2008). Heavy metals are the most common environmental pollutants and a serious threat due to their toxicity, long persistence, biomagnifications, and bioaccumulation in the food chain [Papagiannis et al., 2004]. Toxicity is realized when these heavy metal levels are higher than the recommended limit which is different for individual elements in
Drinking water. Heavy metals from natural and anthropogenic sources such as industrial effluents, agricultural runoff, transport, burning of fossil fuels, geochemical structure, and mining activities are continually released into aquatic ecosystems [Adnano, 1986; Kalay and Canli, 2000; Papagiannis *et al*., 2004]. Both natural and anthropogenic activities are responsible for the abundance of heavy metals in the environment (Wilson and Pyatt, 2007; Khan *et al.,* 2008).

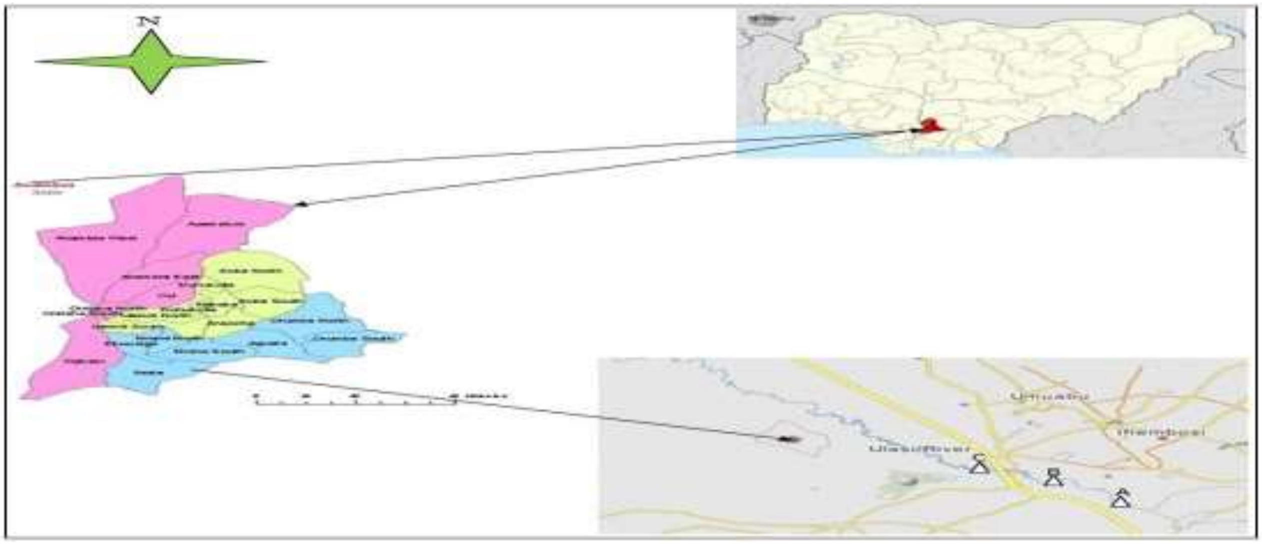
Although essential heavy metals are generally considered to be less toxic than non-essential metals (Batley, 1983), they are toxic when present in elevated concentrations in the environment (Bryan, 1971; Du Preez and Van Vuren, 1994; Sanders, 1997). Various environmental factors like temperature, pH, water hardness, dissolved oxygen, light, salinity and organic matter can influence the toxicity of metals in solution (Bryan, 1976).

Heavy metals enter the aquatic ecosystem from both natural and anthropogenic sources. Entry may be as a result of direct discharges into both fresh and marine ecosystems or through indirect routes such as dry and wet deposition and land runoff [Biney *et al.,* 1994]. Important natural sources are volcanic activity, continental weathering and forest fires. The contribution from volcanoes may occur as large but sporadic emissions due to explosive volcanic activity or as other low continuous emissions, including geothermal activity and magma degassing [FAO, 1992].

2. MATERIALS AND METHODS

DESCRIPTION OF STUDY AREA / EXPERIMENTAL SITE

The study area was carried out along Ulasi river in Okija, Anambra State and the investigation was conducted in three stations. The Ulasi river proceeds from a source in Dikenafai (latitude 050 45'N, longitude 070 10'E), in Imo State, flowing west through Ezinifite, Anambra State, Osu, Azia, Ukpor, Ihembosi, Ozubulu and Okija. Ubu River, a tributary with its source at Nnewi, passing through Nza-Ozubulu and Ihembosi where it joins. The vegetation is majorly composed of palm trees, bamboo trees, water hyacinth, grasses and shrubs amongst others. It is the only natural surface water for domestic use by the host communities. The study area is characterized by agricultural activities as the major activity in the area. Ulasi River receives effluents from waste dumped by the people of the community, washing Clothes and cars, swimming, Waste carried out by run-off water from nearby communities. The River transverses the Onitsha-Owerri express road and the Okija-Nnewi road.



SAMPLE STATION

Water samples were obtained from three areas of activities along the way Ulasi River at Okija Anambra State. Three sampling sites, Station (A) for drinking water and the other located at Ubahuabuba, Station(B) for bathing Swimming, washing clothes, washing of vehicles and some other activities located near the bridge along the Okija-Nnewi Road and Station(C) gutter discharge, refuse dumpes located near the bridge along Onitsha-Owerri Road.

WATER SAMPLE COLLECTION

The water samples from each station were collected using sterilized 30cl plastic containers at a depth of 10cm below the water surface. The samples were properly labeled for identification of sources on the site and immediately transported to the laboratory as soon as after sampling for preservation and analysis. Heavy metal present were estimated with acid digestion method using Atomic Absorption Spectrophotometer.

TEST METALS

The following metals were tested in the study

i. Arsenic (As)
ii. Boron (Bo)
iii. Cadmium (Cd)
iv. Chromium (Cr)
v. Copper (Cu)
vi. Iron (Fe)
vii. Lead (Pb)
viii. Manganese (Mn)
ix. Nickel (Ni)
x. Zinc (Zn)

STATISTICAL ANALYSIS DATA

The heavy metals were statistically analysed using analysis of variance (ANOVA) to detect any significant difference using SPSS (Statistical Package for Social Sciences).

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3. RESULTS

Heavy Metals in Water

The results of heavy metal concentrations (As, Bo, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn) in the water samples from the various sampling sites are presented in Table below,

Table 1: Mean concentration of heavy metals in water

Heavy Metals	Station A	Station B	Station C
As	$0.012\pm0.001^{c}_{a}$	$0.019\pm0.003^{f}_{a}$	$0.018\pm0.003^{fg}_{a}$
Bo	$0.059\pm0.003^{a}_{b}$	$0.077\pm0.004^{b}_{a}$	$0.057\pm0.005^{cd}_{b}$
Cd	$0.035\pm0.027^{abc}_{a}$	$0.018\pm0.003^{f}_{a}$	$0.008\pm0.001^{g}_{a}$
Cr	$0.028\pm0.003^{bc}_{b}$	$0.039\pm0.002^{de}_{a}$	$0.030\pm0.003^{e}_{b}$
Cu	$0.037\pm0.005^{abc}_{b}$	$0.068\pm0.008^{bc}_{a}$	$0.053\pm0.005^{d}_{ab}$
Fe	$0.056\pm0.003^{a}_{b}$	$0.076\pm0.004^{b}_{a}$	$0.067\pm0.004^{bc}_{ab}$
Mn	$0.046\pm0.004^{ab}_{b}$	$0.070\pm0.003^{bc}_{a}$	$0.062\pm0.004^{cd}_{a}$
Ni	$0.038\pm0.003^{abc}_{c}$	$0.052\pm0.004^{cd}_{a}$	$0.076\pm0.004^{b}_{b}$
Pb	$0.017\pm0.004^{c}_{a}$	$0.029\pm0.003^{e}_{fa}$	$0.025\pm0.003^{e}_{fa}$
Zn	$0.050\pm0.001^{ab}_{b}$	$0.112\pm0.016^{a}_{a}$	$0.103\pm0.004^{a}_{a}$

Notes: Results are means± standard error of means of three replicates. The superscripts show that means that do not share a letter by column are significantly different at 0.05 level of significance, while the subscripts show that means that do not share a letter by row are significantly different at 0.05 level of significance. = significant at alpha = 0.05. ns = not significant.

4. DISCUSSIONS

Heavy Metal Concentrations in Water

From the above table, the main concentration of Arsenic ranged from 0.012 to 0.018 mg/l in relation to the WHO (2017) and guideline value of 0.01mg/l for as in drinking water, the level measured in this study were higher. Arsenic is found widely in earth's crust in oxidation states of -3, 0, + 3 and + 5, often sulfides or metal arsenide or arsenates. In water, it is mostly present as arsenate (+5). Where the concentration of arsenic in drinking water is 0.01mg/l or greater, this will be the dominant source of intake. Arsenic in high concentration is toxic and of harm to humans causing cancer, in the skin, lungs, bladder and kidney.

The level of Boron in the water samples ranged from 0.57 to 0.59mg/l. These were below the WHO (2017) guideline value of 2.4mg/l for Bo in drinking water.

The concentration of cadmium also ranged from 0.008 to 0.035mg/l in relation to WHO (2017) guideline value of 0.003mg/l for Cd in drinking water, the levels measured in the study were higher. The high concentration of iron in the Ulasi River could be attributed to the use of fertilizers, by farmers, discharge of plastic coasted and local air pollution. Contamination in drinking water may also be caused by impurities in the zinc of galvanized pipes and solders and some metal fittings.

Chromium concentrations (0.028 to 0.039mg/l) in the water samples at the Ulasi river where above the WHO (2017) guideline range of 0.5mg/l in drinking water chromium in widely distributed in earth's crust. It can exist in valences of +2 to +6.

Means concentration of copper ranged from 0.037 to 0.068mg/l at the Ulasi river was below the WHO (2017) guideline range of 2.0mg/l. this could be attributed to the low cooper related industrial and mining activities in the Ulasi catchment.

Iron mean concentration in the samples ranged from 0.056 to 0.76mg/l. in relation to the WHO (2017) guideline value of 0.2mg/l for Fe in drinking water the level measured in the study were below. Iron is one of the most abundant metals in earth's crust. It is found in natural fresh waters at level ranging from 0.5 to 50mg/l. Iron may also be present in drinking water as a result of the use of iron coagulants or the corrosion of steel and cast iron pipes during water distribution (WHO, 2003).The level of lead in the water samples ranged from 0.017 to 0.029 mg/l. in relation to the WHO (2017) guideline value of 0.01mg/l for Pb in drinking water, the level measured in the study were higher. A study by Kumasi *et al.* (2007) indicated that most of the inhabitants living within the Barekese catchment area were mainly farmers (80%) and these farmers used fertilizer and chemicals for the cultivation of their crops.

The concentration of manganese also ranged between 0.046 to 0.070 mg/l in relation to the WHO (2017) guideline value of 0.40mg/l for Mn in drinking water, the levels measured in this study were lower. Asante *et al*., (2005) also recorded how concentrations of Mn (0.16 to 0.19mg/l) in water samples from the Weija Reservoir. Manganese concentrations above 0.1mg/l impart an undesirable taste to drinking water. Even at about 0.02mg/l manganese will form coating on piping that may later tear off as a black precipitate (Abassi *et al.*, 1998).

Nickel concentration ranged from 0.039 to 0.076mg/l at the Ulasi rivers were higher the WHO (2017) guideline range of 0.02mg/l for Ni in drinking water. Nickel is highly toxic element even at low levels. This concentration causes a toxic risk to environments.

The levels of zinc in the water samples ranged from 0.050 to 0.112mg/l, these were below the WHO (2017) guideline value of 5.0mg/l for Zn in drinking water.

5. CONCLUSION AND RECOMMENDATION

This study shows that the concentration of heavy metals recorded in the water, some were higher above the WHO permissible limit for drinking water while some were lower. But for the sediment, all the heavy metals succeeded the recommended values stipulated by WHO.

However, the succeeded values indicate that the sediment samples from the three stations were uncontaminated while the water were contaminated. These therefore indicate that the water is not good for drinking.

RECOMMENDATION

i. There should be periodic monitoring of heavy metal concentration both the fishes and river system to ensure the continuous safety of the people in the area.

ii. Safe domestic waste and control of industrial effluents should be practical and where possible recycled to avoid these metals and other contaminants from going into the environment.

iii. Neutralization of effluents water is recommended as a modern treatment practice, such as lime precipitation of effluent water.

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