



## **ASSESSMENT OF MICRO ELEMENTS IN BOREHOLE WATER SOURCES IN OSO EDDA, AFIKPO L.G.A EBONYI STATE, NIGERIA**

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### **Abstract:**

*Water samples from six borehole water sources in Ezi – Uduma Nde – Obasi (sample A), Oso Central School (sample B), Oso Technical Secondary School (sample C), Nde – Okpo I (sample D), Nde – Okpo II (sample E), and Nde – Ugbo (sample F) were analyzed to identify the concentration of Cadmium (Cd), Lead (Pb), Nickel (Ni), Arsenic (As) and Chromium (Cr) metals using Atomic Absorption Spectroscopy (AAS) standard method. Standard methods approved by the World Health Organization (WHO) were used in collecting the samples. The Minitab 16.0 Statistical software package was used to perform the Analysis of Variance (ANOVA) test for the data so obtained, together with simple frequency tables. The results showed that, water obtained from the different boreholes were acidic and the pH values were within the WHO recommended value and the concentration level for the metals (Cd, Pb, Ni, As, and Cr) were all within the WHO maximum contaminant level in all the sample, except sample C which was found to have a slightly high concentration of lead metal 0.02mg/L above the WHO maximum contaminant level of 0.01mg/L. Meanwhile, a p-value of 0.102 (at a 0.05 significance level) was obtained which pointed to the fact that there existed no statistically significant difference in micro elements present in borehole water sources in the study area compared to their respective standards set by WHO. Based on the parameters analyzed and the results obtained, it was concluded that the borehole water sources, where all other things remain equal, were portable and posed no health risk to residence of the area, Oso Edda. It was therefore recommended that, the boreholes be well cared for by the natives who use them as their drinking water supply, while this study should be preserved as a baseline for future water assessment. More so, further analysis should be carried out on these borehole water sources in order to identify the concentration of other heavy metals and contaminants as well.*

**Key Words:** Quality Assessment, Micro Elements, Water Samples, Borehole Water & WHO Standard

### **Introduction:**

Water is an indispensable chemical compound needed by all living organisms for survival. It is generally regarded as a universal solvent since it is capable of dissolving nearly all substances. Also, almost all activities of man require water application for effective and easy operation.

Water quality refers to the chemical, physical and biological characteristics of water. It is a measure of the condition of water relative to the requirements of biotic species and to any other needs, be it industrial or agricultural. It is most frequently used by reference to standards against which compliance can be assessed. The most common

standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water (Johnson et. al., 1997).

Climate influenced the occurrence and distribution of trace elements in ground water, where by more trace elements occurs and are found at greater concentration in wells, boreholes in drier regions than in humid regions (WHO, 2004). In particular, the concentration of Arsenic (As), Chromium (Cr), Nickel (Ni) and Copper (Cu) is greater in the drier regions, where processes such as chemical evolution, ion complexation, evaporative concentration, varying degrees, help to mobilize these elements.

Aluminium (Al), Cobalt (Co), Iron (Fe), Lead (Pb) concentrations in ground water is greater in humid regions than in dry regions, partly in response to lower ground water pH or more frequent anoxic conditions (WHO, 2011). These trace elements need to be accessed and analyzed chemically for their occurrence, concentration and comparing concentrations to human-health bench marks (HHBs) in drinking boreholes and wells water.

Water sample analysis for heavy metals must consider soil particles suspended in the water sample. These suspended soil particles may contain measurable amounts of metal. Although the particles are not dissolved in the water, they may be consumed by people drinking water, which in turn affects man's health (USEPA, 2002). Consequently, the people of Oso Edda in Afikpo are not left out. Sequel to this, the study monitored and accessed the quality and concentrations of these trace metals in their boreholes in order to ascertain the levels of these micronutrients regarding to contamination of the water.

#### **Aim and Objectives:**

The aim and objectives of the study is to determine:

- ✓ The concentration of As, Ni, Pb, Cr and Cd in the boreholes
- ✓ The level of contamination of these microelements in the water, and
- ✓ If there exist any statistically significant difference in the concentration of microelements in all the borehole water sources in-line with the standards set by World Health Organization (WHO).

#### **Scope of the Study:**

The research work determined the concentration of the following micro elements (Pb, Cr, Cd, As, and Ni) in selected boreholes in Oso Edda, Afikpo South, Ebonyi State, Nigeria using Atomic Absorption Spectroscopy (AAS). Data obtained was subjected to ANOVA test for the comparative assessment of the concentration of micro elements from the borehole water sources and the WHO standard in order to establish its health implication on the residence of the study area.

#### **Area of Study:**

Oso Edda is one of the autonomous communities in Afikpo South Local Government Area of Ebonyi State, Nigeria. It is absolutely located between Latitudes 5° 52' 23.0"N and 5° 55' 03.0"N of the Equator and Longitudes 7° 45' 04.2"E and 7° 52' 12.25"E of the Greenwich Meridian. The Oso Edda community is almost centrally located in Afikpo South Local Government Area which is bounded by Abia State to the South, Cross River State to the South East, and Afikpo North, Ohaozara and Ivo Local Government Areas to the North East, North West and West, respectively. See Figure 1.

The people of Oso Edda are predominantly farmers, with palm fruit, yam, rice, plantain, cassava, local beans and vegetable as their major crops of interest. The climatic condition of the community seems to be moderately favourable for farming activities, dwellers and other living organisms. The area is characterized by slightly warm environmental condition during the day and high cold condition during the rainy seasons due to the numerous water bodies surrounding the landmass of the community.

The geographical region of this community is also characterized with low undulating land surfaces, with red-rocky soil and some well-defined swampy areas. A wide variety of plants and animals live in the fresh water swamps within the vegetation zone of the community. The plant life is much richer and includes evergreen trees, ferns, shrubs, duck weeds, water lily, lichens and algae. The vegetation zone is covered with creeping weeds and grasses of different species. The people are also blessed with mineral resources such as limestone, marbles etc.

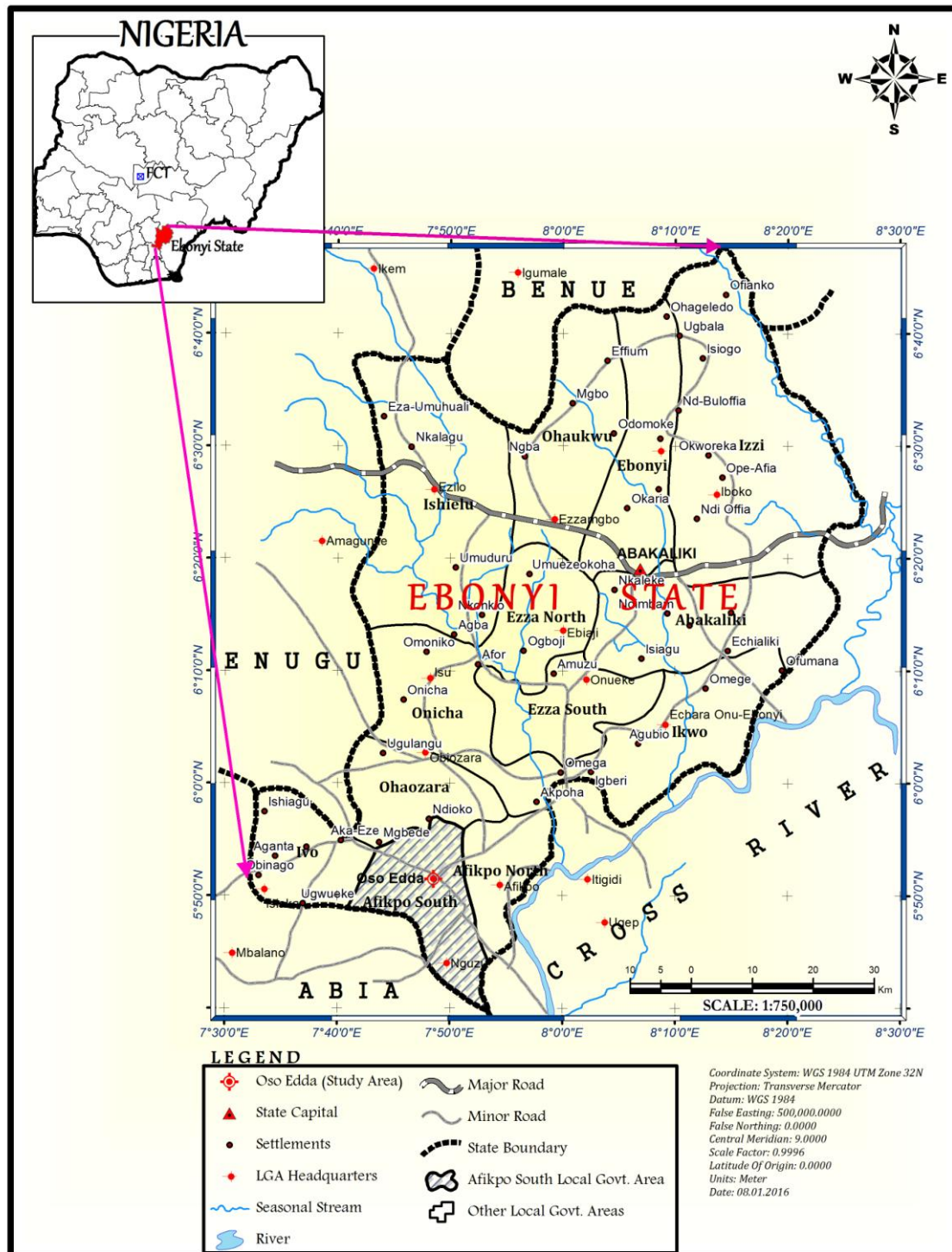


Figure 1: Map of Afikpo South Local Government Area showing the study area (Oso Edda Community)

Oso Edda people are among the Igbo speaking communities in Ebonyi State, but still have their Edda dialect as their unique language. The people are well known for their peace; to be hospitable and of huge cultural heritage. They also perform a lot of traditional rites like the proverbial *Egbela* cult, *Olo* festival, wrestling, New Yam festival etc. which are mainly carried out on occasional bases, traditional marriages and burial ceremonies.

**Materials and Methods:**

Table 1: Reagents and Apparatus/Equipment Used

Reagents	Apparatus/Equipment
Concentrated trioxonitrate (V) acid, HNO <sub>3</sub>	Atomic absorption spectrophotometer (AAS)
Concentrated hydrochloric acid, HCl	Beaker, 50mL, 250mL
Concentrated tetraoxosulphate(VI) acid, H <sub>2</sub> SO <sub>4</sub>	Conical flask, 50mL, 250mL
Deionised water	Plastic containers, 1 litre
Distilled water	Volumetric flask, 1000mL
Detergent	Wash bottle
Water samples collected	

**Preparation of 10% HNO<sub>3</sub>:**

Concentrated trioxonitrate (V) acid, HNO<sub>3</sub> of 10mL capacity was measured out using a measuring cylinder and dissolved in 90mL distilled water and then made up to 100mL mark.

**Sample Collection and Preparation:**

Water samples were randomly collected from six different boreholes at distances of about 1 kilometre apart at different locations in Oso Edda community (Nde-Obasi, Oso Central School, Oso Technical Secondary School, Nde-Okpo I, Nde-okpo II, Nde-Ugbo). See Table 2

The water samples were collected with 1 litre sterilized plastic containers with screw caps. The containers were washed thoroughly in the laboratory using detergent and rinsed thoroughly with distilled water. It was still rinsed with the water samples at the various points of collection.

The samples were collected by first allowing the water to run for about 3 minutes before allowing it into containers from the tap mouth. The pH and temperature of the water samples were taken at the spot. 8mL of concentrated trioxonitrate (V) acid (HNO<sub>3</sub>) was added and the container corked, where it was then transported to the laboratory for analysis using Atomic Absorption Spectroscopy analytical technique.

Table 2: Samples and their sourced location

Samples	Sources
Sample A	Nde-obasi
Sample B	Oso Central School
Sample C	Oso Technical Secondary School
Sample D	Nde-Okpo I
Sample E	Nde-Okpo II
Sample F	Nde-Ugbo

**Analytical Procedure:**

1mL of 10% HNO<sub>3</sub> was added to 1mL of the water sample that was collected; it was shaken to ensure a uniform mixture and then made up to 100mL mark. The cathode lamp for each of the element was put in position in the spectrophotometer and the

element characteristic wavelength selected using the instrument wavelength selector. Appropriate working standard solutions were prepared for each element. The levels of requisite metal elements (Lead (Pb), Arsenic (As), Nickel (Ni), Chromium (Cr), and Cadmium (Cd)) were determined using AAS.

First, the sample solution was aspirated by a pneumatic nebulizer, transforming it into an aerosol which was introduced into a spray chamber, where it was mixed with the flame gases and conditioned in a way that only the finest aerosol droplets enters the flame. On top of the spray chamber, a burner head produced a flame that is laterally long (usually 5-10cm) and only a few millimeter deep. The radiation beam passes through this flame at its longest axis, and flame gas flow rate was adjusted to produce the highest concentration of free atoms of the elements. The burner height was adjusted, so that the radiation beam passes through the zone of highest atom cloud density in the flame, resulting in the highest sensitivity. The concentration (C) in the sample solutions aspirated was recorded.

Finally the ANOVA test statistic was performed to ascertain if there existed any significant difference between the concentration of micro elements in all the borehole water sources in the study area and the standard set by WHO.

**Results:**

The result of the analysis showing the concentration of micro elements (in mg/L) together with their corresponding World Health Organization (WHO) Maximum Contaminant Level (MCL) is presented in Table 3.

Table 3: Average Result Analyses

<b>Parameter/ Location</b>	<b>Cd (mg/L)</b>	<b>Pb (mg/L)</b>	<b>Ni (mg/L)</b>	<b>As (mg/L)</b>	<b>Cr (mg/L)</b>	<b>Temp.</b>	<b>pH value</b>
<b>A</b>	0.005	0.008	0.020	0.001	0.050	28°C	6.76
<b>B</b>	0.001	0.010	0.010	0.001	NIL	30°C	7.22
<b>C</b>	0.001	0.020	0.030	0.005	0.010	29°C	6.47
<b>D</b>	0.003	NIL	0.005	0.002	0.001	28°C	6.64
<b>E</b>	0.005	NIL	0.005	0.001	NIL	28°C	6.60
<b>F</b>	0.001	0.005	0.001	0.005	0.001	28°C	6.10
<b>Mean</b>	0.003	0.003	0.012	0.003	0.010	28.5°C	6.63
<b>STD. Dev</b>	0.002	0.007	0.004	0.002	0.001	0.001	0.002
<b>WHO MCL</b>	0.005	0.01	0.1	0.05	0.3	-	6.5-8.5

Source: Field Survey (2016)

Key: Nde-Obasi (A), Oso Central School (B), Oso Technical Secondary School (C), Nde-Okpo I (D), Nde-Okpo II (E) and Nde-Ugbo (F)

Table 4: One-Way ANOVA Result

<b>Source</b>	<b>Df</b>	<b>SS</b>	<b>MS</b>	<b>F</b>	<b>P</b>
<b>Factor</b>	6	0.03119	0.00520	2.02	0.102
<b>Error</b>	24	0.06163	0.00257		
<b>Total</b>	30	0.09282			

**Discussion of Results:**

For the protection of human health, guidelines for the presence of heavy metals in water have been set by different international organizations such as U.S.E.P.A., W.H.O., European Union Commission (Navas, 2008), thus, heavy metals have maximum permissible level in water as specified by these organizations. Maximum contaminant level (M.C.L.) is an enforceable standard set at a numerical value with an adequate margin of safety to ensure no adverse effect on human health.

In the case of cadmium, all the collected water samples contains detectable concentration level ranging from 0.001mg/L to 0.005mg/L, with two samples having the highest concentration being 0.005mg/L (Nde-Obasi borehole) and 0.005mg/L (Nde-Okpo II borehole). The cadmium concentration levels in the samples were within the WHO permissible level in drinking water which provide for 0.005mg/L. The results of Cd when compared with WHO standard for drinking water were within the maximum permissible limits of drinking water. High concentration of Cadmium is very dangerous to the human health. Ingestion of any significant amount of Cadmium causes immediate poisoning and damage to the liver and kidney. Compounds containing cadmium are also carcinogenic (Brown et. al., 2002). Subsequently, Cadmium has no biological functions and toxic to both animals and plants.

In the case of lead, from the analysis of the water samples collected for lead, only four water samples were observed to contain lead, with concentration levels ranging from 0.005mg/L to 0.02mg/L. This slight difference may be due to the rusting of the borehole metal pipes coated with lead materials, which may find their way slowly and drained down to the ground water. The result of the analysis also reported the mean concentration of the samples to be 0.003mg/L. The results showed location A (0.008mg/L), B (0.010mg/L), C (0.020mg/L), D (NIL), E (NIL) and F (0.005mg/L). Only location C has a value that was slightly higher than WHO maximum permissible limits of drinking water standards. These results should be of concern as lead has been recognized for centuries as a cumulative general metabolic poison; also, studies have linked lead exposures even at low levels with increase in blood pressure, as well as with reduced intelligence quotient in children, and with attention disorders (Bulinski and Bloniarz, 1998). Unlike some heavy metals, lead is not required by animals (including humans) or plants for normal growth and development. It has no known nutritional or biochemical functions and if present in sufficient quantities will inhibit animal and plant growth, development and good health (Henretig, 2006).

The results show that, the nickel concentration levels of the water samples are far below the WHO maximum contaminant limit for drinking water (0.1mg/L). All the six water samples collected contains detectable nickel levels which ranges from 0.001mg/L to 0.003mg/L, with Oso Technical Secondary school having the highest concentration level (0.030mg/L). Consequently, since the nickel concentration levels are all within the recommended limit, the borehole water poses no health problem to the users as regards nickel effects.

Arsenic values ranges from 0.001mg/L to 0.005mg/L. All the water samples contain arsenic detectable levels. The highest values recorded at Oso Technical Secondary school (0.005mg/L) and Nde-Ugbo (0.005mg/L). The values of arsenic in the water samples are within recommended values for drinking water (0.05mg/L). The high content for sample from Oso Technical Secondary school and Nde-Ugbo may be due to the naturally occurring concentrations of arsenic in deeper levels of the borehole which is associated with the use of deep tube wells for water supply in the dry soil areas (Brown et. al, 2002). Some research concludes that even at the lowest concentrations, arsenic contamination is a major cause of kidney and liver diseases, cancer, diabetes mellitus and even death (Chowdhury et. al, 2000).

The result obtained for chromium from the six water samples collected shows that only four samples contains detectable concentration levels of chromium (Nde-Obasi, Oso Technical Secondary school, Nde-Okpo I and Nde-Ugbo boreholes), while two did not contain detectable chromium concentration (Oso central school and Nde-Okpo II boreholes). The detectable chromium values ranges from 0.001mg/L to 0.050mg/L with

the highest value occurring at Nde-Obasi borehole water sample (0.05mg/L). The values of chromium in the water samples are within the permissible limit of WHO (0.3mg/L). Sequel to the fact that these values of chromium are far below the recommended maximum contaminant level by the WHO, no effect will come from the consumption of such water. Chromium contamination, apart from water, can be contacted by other sources like cement dust, tobacco smoke, dietary sources which can cause lungs, nasal and sinus cancer, even severe dermatitis and usually painless skin ulcer (Lewis, 2004).

Meanwhile, from the result of the ANOVA test performed as shown in Table 4, a p-value of 0.102 was obtained between micro elements concentration in different borehole water sources and their corresponding WHO standard. Using a 0.05 level of significance, we can conclude (objectively) that there exist no statistically significant differences between the concentration of micro elements present in borehole water sources and WHO standards. Hence, the result shows that the water from all the boreholes in Oso Edda are safe for drinking and other domestic purposes, based on the minimum allowable level of micro elements concentration. This again is as a result of low or no industrial activity presently going on in the area as compared to other urban or peri-urban areas of the State, such as Nkalagu, Abakiliki, etc.

#### **Conclusion:**

The analyses carried out was to determine the presence and detectable levels of some trace metals in some selected borehole water in Oso Edda community of Ebonyi State. The results show that there are micro elements such as lead, chromium, cadmium, nickel and arsenic in the water samples. Generally, the level of these metals present is below the maximum permissible limit as stipulated by the WHO. All the water samples have pH values within recommended value by the WHO, which is given as 6.5-8.5. It can be concluded, based on the parameters analyzed and the results obtained (especially from the ANOVA test statistic), that the borehole water sources in Oso Edda community of Ebonyi State, where all other things are kept equal are portable for different forms of domestic use and portend no human health risk as well.

#### **Recommendations:**

- It was recommended as such that;
- ✓ The boreholes are well cared for by the natives who use them as their drinking water supply. This can be done by protecting the tap pipes from rusting (if made of metal) which might leach other contaminants into the water.
  - ✓ Further analyses should be carried out on these waters in other to identify the presence of other heavy metals in the water.
  - ✓ The government should establish a body that will assess the quality of fertilizers, insecticides and pesticides to check if they contain high level of heavy metals before applications.
  - ✓ Government should provide an alternative means in local production to ensure that the use of heavy metal materials in local production is minimized or avoided.
  - ✓ A good water filtration system should be installed in homes since it is the only way to proactively monitor and ensure the quality and safety of our drinking water.
  - ✓ The borehole drillers should be educated and sensitized on the use of lead-made materials as drilling equipment. This can pose the risk of lead contamination to the drilled borehole water.
  - ✓ More boreholes should be established for the indigenes of Oso Edda.

- ✓ Government and other related health organizations and agencies should pass a regulating law or act governing safe drinking water.

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