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Assessment of Groundwater Quality in Isiala Nvosi Community in Abia State, Nigeria

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Abstract- Most private groundwater sources such as boreholes in Nigeria are not monitored by the regulatory body. The need for safety of drinking water supplies especially when the supply is from private groundwater sources cannot be overemphasized because of the potential contamination risks associated with underground water supplies. Water samples collected from a total of eight boreholes and four springs were analyzed for physico-chemical characteristics and the interactions between these factors were examined to determine its effect on the water quality of various water supplies in Nvosi community. Results indicate that the boreholes and springs investigated are safe for direct consumption without any form of treatment when compared to World Health Organization and Federal Environmental Protection Agency (Nigeria) standards.

Keywords- *Groundwater, Isiala Nvosi community, physico-chemical characteristics, water quality, boreholes, springs.*

I. Introduction

Water is very important to man’s existence as it constituents over 70% volume of the body mass. Its use for drinking and domestic purposes cannot be overemphasized. Globally, it is the duties of the state to provide basic amenities for the citizenry. Similarly in the 1980’s the Nigerian government used to provide potable water supply to the public through the services of Water Corporation. However, years of military interventions and unsteady democracy saw collapse of social amenities and infrastructure in the country. As a result there is increase in the number of private water supplies. Cities in Nigeria cannot boast of public water supplies, how much less the rural areas. As an alternative, private owners install boreholes both for their personal use and serving the public at a cost though. Most of these private supplies are not monitored by the regulatory body in the country because of lack of legislative tools. This questions the safety of such water supplies. It is possible the users are not aware of the potential dangers of contamination associated with these water supplies. Globally, water related diseases are major health concerns. Groundwater is an essential source of water both for drinking and other purposes especially in areas with limited water resources. In the case of Nvosi community, the groundwater sources are the single supply for drinking water in the region.

Groundwater refers to the subsurface water found beneath the water table in the soil. These are waters from wells and springs or water contained in the water-bearing stratum (aquifer). When groundwater discharges from underground to the surface, it forms spring. The geological formation containing the water is fully saturated and has hydrostatic pressure equal or greater than atmospheric pressure [3]. Subsurface water can exist in various zones namely zone of rock fracture and zone of rock flowage [4]. The zone of rock fracture is further divided into zone of saturation and zone of aeration. The zone of saturation is below the water table; the hydrostatic pressure at this zone is greater than or equal to atmospheric pressure. Water that exists within the interstices of this zone is known as groundwater. In describing the formation of groundwater [5] revealed that groundwater is formed as a result of precipitation which has percolated down through an unsaturated zone to the water table. It is confined below the water table until it discharges to some water body such as spring.

In general groundwater is preferable as source of drinking water due to its good microbial quality in its natural state however, it can easily be contaminated. There could be presence of dissolved impurities, which come from rock and sand strata through which the water passes. The quality of groundwater from a source is relatively consistent 6In countries such as Nigeria with limited health surveillance, it is difficult to monitor outbreaks of diseases due to groundwater contamination. Water parameters such as temperature, pH, total dissolved solids, and total hardness were monitored as they may affect the solubility of gases in water. In addition the concentrations of the following cations were determined: iron (Fe^{2+}), manganese (Mn^{2+}) and fluoride (F^-) an anion. Inorganic groundwater contaminants can interact with charges on water molecules thereby forming complex ions [1].

The study area is Nvosi community in Isiala-Ngwa South local government of Abia state, Nigeria. Abia state is situated in the South Eastern part of Nigeria. The local residents use groundwater mainly for drinking, washing and other domestic purposes. The objective of this study was to assess the physico-chemical characteristics of the eight boreholes and four springs to ensure suitability for human consumption. Ensuring that drinking water is safe is very important in reducing health burdens.

A. *Geological setting*

Isiala Nvosi falls hydro geologically in the coastal sedimentary lowland of Nigeria (Benin formation). Coastal swamps and alluvial bound the coastal sedimentary lowland in the west to the south and rocks of the basement complex to the north while in the west (where Isiala Nvosi is situated), it is bounded by Anambra and Cross River basin. The coastal sedimentary lowland in Isiala Nvosi area is underlain by one major geological formation, the 'Coastal plain sand' which is deep porous infertile and highly leached. The formation is of late tertiary age. Other minor sediment that underlain the coastal sedimentary lowland in some parts of the community are deltaic plain, Imo shales and based cretaceous sandstones, with the exception of shales which occur at its boundary with Nbawsi area. Most of the other formations consist predominantly of cretaceous sand, which are generally unconsolidated and porous.

II. Materials and methods

A total of thirty-six (36) water samples were collected at twelve (12) different sites used in the study of which eight of the sites are boreholes and the remaining four are springs. The boreholes are located at Amuzu (B1), Umunkwo (B2), Egbelu-Osisi (B3), Eziama (B4), Osuama (B5), Umuozor (B6), Oforo (B7) and Umuori (B8). In addition, the springs are located at Ugiri (S1), Mba-ama (S2), Ezi-ihe (S3) and Umuelele (S4). The samples were collected using sterile plastic bottles approximately 200 ml of water in each bottle. At each site, the sample bottles were rinsed with the water samples before collection. For collection of sample from the boreholes, samples were taken from midstream flow only after water has been pumped for some time. For the springs, the samples were collected approximately 15 cm from the surface of the water body. Sample collections were done in the mornings before 09.00 GMT and the samples transported in a cool box to the laboratory for analysis. The following parameters were measured in-situ: temperature, pH, electrical conductivity and total dissolved solids using thermometer and Hach model conductivity/TDS/pH meter. Spectrophotometer model DRE/5 of 400–810nm wavelengths was used for chemical analysis. The following cations were measured: Ca^{2+}, Mg^{2+}, Fe^{2+}, Mn^{+} in addition to F^{-} (anion). The procedure involves using 25ml of distilled water as blank and this was measured into the sample cell up. A different sample cell was also filled with sample of water (25 ml) being analyzed. A calibration curve was obtained by measuring the absorbance of dilute standard solutions of the different elements from the spectrophotometer at a wavelength of 400-810nm. By plotting absorbance against concentration, a calibration curve was obtained and used to determine the concentrations of either cations or anion in the sample.

III. Results and discussions

The results from the investigations of eight boreholes and four springs from the study area are shown in Figures 1 to 4. These are compared to the WHO standards for drinking water (Table 1). The temperature level of the water samples varied from 25°C to 30°C. The pH ranged from 5.5 to 8.8 and the electrical conductivity also ranged from 23 to 29µS/cm for the springs only. The trend in Total Dissolved Solids is 6.4 to 14.8 mg/ℓ with the boreholes showing the lower limit. The results obtained from the chemical parameters showed that the values were lower than the desirable levels specified by WHO. The preliminary bacteriological test conducted on the samples collected from boreholes and springs showed that the water does not contain coliform organisms.

TABLE I. WHO GUIDELINES FOR DRINKING WATER QUALITY [7]

Parameter(unit)	WHO Standard
pH	7.0 – 8.5
Temperature(°C)	No specification
TDS (mg/ℓ)	500
Total hardness (as $CaCo_3$) (mg/ℓ)	500
Fe^{2+} (mg/ℓ)	0.3
Fl^{-} (mg/ℓ)	1.5
Mn^{2+} (mg/ℓ)	0.05
Calcium hardness (mg/ℓ)	7.5
Magnesium hardness (mg/ℓ)	30

A. *Physical characteristics*

The temperature from the boreholes with an average of 29.5°C was higher than that from the springs with an average of 25.8°C. Although WHO guidelines did not specify values for temperature however, rise in temperature of water body is not desirable because it increases the rate of biochemical reactions which in turn increases the rate of oxygen demand and at the same time decreases the oxygen saturation level in the water [10]. The pH of the water samples from the boreholes (Figure 1) is slightly acidic on comparison to the samples from the springs (Figure 2) which had more of alkaline. Microbial activities are highly influenced by pH and a pH of about 7 and 9 is recommended for microorganisms. At low pH values as observed in the samples from the boreholes, the solubility of heavy metals increases. Perhaps the low (acidic) pH values (5.9 to 6.6) of the boreholes might affect the casing materials of the boreholes if they are made from materials that are less resistance to corrosion. The electrical conductivity of the samples from springs was low. Although WHO has no maximum permissible level of conductivity, conductivity is a numerical expression of the ability of aqueous solution to conduct electric current. This ability depends on the presence of ions and their concentration. The total dissolved solids present in very low concentration are commendable because high concentration of dissolved solids tend to reduce solubility of oxygen in water [8]. The World Health Organization standard (Table 1) stipulated that water containing less than 500 mg/L of dissolved solids is generally satisfactory for domestic use and for many industrial purposes.

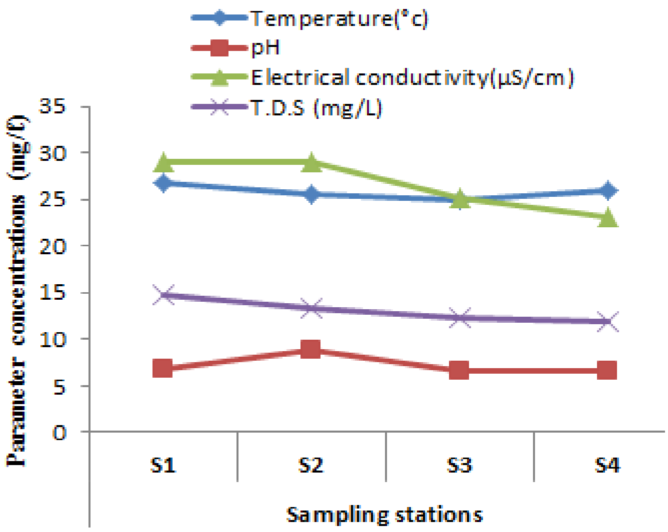

Figure 1. Concentration of physical parameters of water samples from the four springs

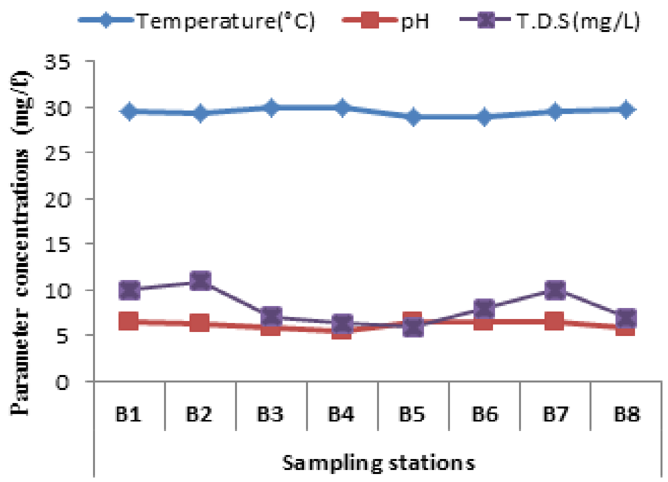

Figure 2. Concentration of physical parameters of water samples from the eight boreholes

B. Chemical characteristics

The results of the chemical analysis of the water samples from the eight boreholes (Figure 3) and four springs (Figure 4) show that the magnesium and fluoride were absent from the water and that iron (Fe^{2+}) occurred in a very low concentration of 0.02 mg/L. Many inorganic groundwater contaminants are present in solution in groundwater as dissolved electrically-charged ions. They are present as either positively charged cations or negatively charged anions. The charge on the ions enables them to interact with charges on water molecules, allowing them to stay in solution [11]. Fluorides can help reduce tooth decay however, it is feared that high fluoride content may negatively affect cognitive development. There were little or no nitrates in the water even though the residents apply organic fertilizers to their farms. It is possible that due to the depth of the aquifer, before water containing organic nitrates could reach the aquifer it would have been reduced by the filtering action of the rock masses. The water samples are very low in hardness (1.4 -18 mg/L) compared to the WHO maximum permissible value of 500 mg/L and can be described as soft water which is economically good for laundry services The presence of calcium and magnesium carbonates indicates the presence of temporary hardness. Generally hard water does not pose much of health risks however it is of concern in both industrial and domestic use. In domestic use it prevents soap from forming leather, though this type of hardness is thought to be removed through boiling or addition of lime.

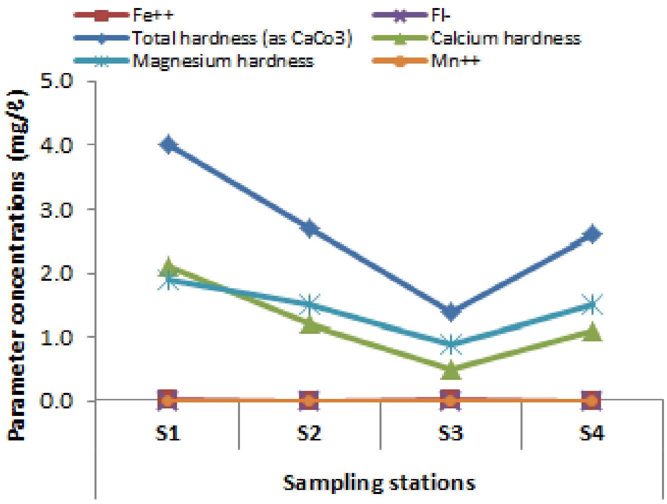

Figure 3. Concentrations of chemical parameters of water samples from the four springs

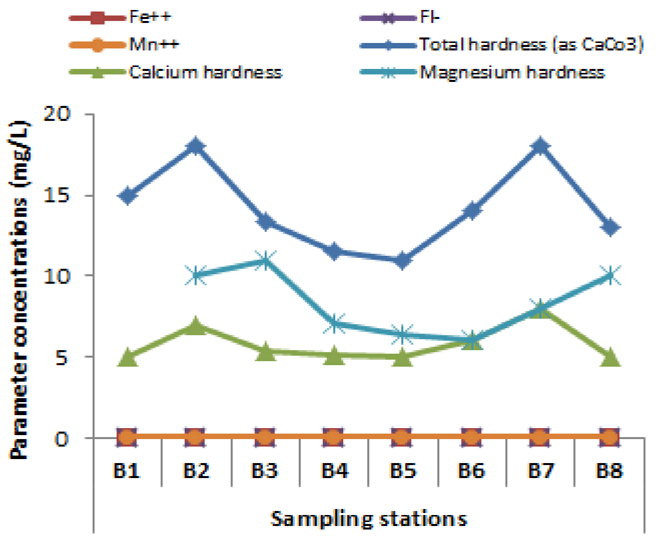

Figure 4. Concentrations of chemical parameters of water samples from the eight boreholes

IV. CONCLUSIONS

The physical, chemical and biological quality of groundwater in Isiala Nvosi community shows that the groundwater is safe for drinking without any treatment because the levels of the water parameters investigated were within the acceptable limits recommended by World Health Organization. In order to ensure that this quality is maintained for an appreciable length of time, taking into consideration the rate of urbanization, industrialization, population growth and dependence on groundwater supply, it is recommended that environmental protection agency should monitor the quality of industrial effluent often times discharged to rivers to avoid contamination of groundwater by the receiving river. Adequate provision must be made for regular monitoring of water quality for timely detection of any pollutants.

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