# Heavy Metal Concentrations in Ground Water from Northern Nigeria

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***Abstract*-Human activities have been the major causes of water pollution, and the presence of heavy metals could be an indicator that water bodies are polluted. This research examined the concentration of heavy metals in well and bore holing water from three different areas in Aliero town: Bodiga, Labana farm and Kalli. The analysis was conducted byAtomic Absorption Spectroscopy. The concentrations of the metals in sample A (Bodiga) appeared in the order Fe 1.638±0.0011 ppm >Mn 0.172±0.0002 ppm >Pb0.113±0.0001 ppm > Cu 0.081±0.0006 ppm > Ni 0.001±0.0002 ppm; the concentrationsin sample B (Labana, bore hole water) was in increasing order of Fe 1.260±0.0016 ppm >Pb0.234±0.0002 ppm>Mn 0.100±0.0001 ppm > Cu 0.060±0.0002ppm. The concentrations in sample C (Kalli, well water) appeared in increasing order of Fe 1.973±0.0011 ppm>Pb 0.323±0.0002 ppm >Mn 0.186±0.0003 ppm > Cu 0.101±0.0003 ppm > Ni 0.012±0.0003 ppm. The concentrations of Fe and Pb in all three sources of water was found to be above the WHO standards while concentrations of copper, nickel, and manganese were found to be below the maximum limit of WHO standards. The inhabitants who used the water for both consumption and domestic purposes should be enlightened on the toxicological effects of these heavy metals to human health, plants and animals. There is therefore the need for proper monitoring of the water by the proper governmental agencies.**

***Keywords-Heavy Metals; Wells; BoreHole; Labana; Pollution***

## I. INTRODUCTION

Water is an indispensable substance for the sustenance of plants and animals, including humans. Water is obtainable as groundwater and as surface water in lakes and rivers [1].Water contains and collects impurities as they flow through streams, gather in lakes and filter through layers of soil and rock in the ground. Impurities dissolve or absorb substances they come in contact with, which may be harmful to plant and animal health [2]. The acceptability of water is evaluated in terms of quality requirements for a specific use. All water made for human consumption should be potable, and free from disease-causing organisms, minerals and other organic substance that could impair human health [3-5].

Pure water is rarely found in nature due the natural prevalence of impurities; these impurities may include suspended colloidal or dissolved substances. These impurities are removed to an accepted limit byvarious methods of removal or reduction. There are acceptable guidelines established by the World Health Organization (WHO) for the acceptable quality of potable supplies of water.

Water is one of the most essential elements of life on Earth. In its purest form it isodorless, colorless and tasteless, but due to human and animal activities, it is usually contaminated with solid and human waste, effluents from chemical industries and dissolved gases [6,7]. Acid rain is another major water contaminant. In addition, water usually contains some amount of mineral constituents such as iron (Fe), magnesium (Mg), lithium (Li), zinc (Zn), copper (Cu), chromium (Cr), nickel (Ni), cobalt (Co), vanadium (V), arsenic (As), molybdenum(Mo), selenium (Se), lead (Pb), and many others [8]. The presence of these toxic metals in excess concentrations in the environment has been a source of concernto environmentalists, government agencies and health practitioners [9]. This is primarily due to their health implications when present in higher concentrations, and some of them are non-essential metals of little or no benefit to human health [10].

Many of these minerals are required micronutrients, such as copper and selenium. Concentrations of trace elements in water vary because of physiological and environmental factors [11]. Some trace elements have several roles in a living organism. Some are essential components of enzymes where they attract substrate molecules and facilitate their conversion to specific end products [12]. In excessive concentrations, however, trace elements such as Fe, Cd, Ni, Cu, Hg, Mn and Cr, can negatively affect growth and reproduction. A safe and potable drinking water should conform to the standards set by the World Health Organization [13] (e.g., acceptable concentrations of Cu is 2.0mg/l, Pb 0.01mg/l, Ni 0.02mg/l, Hg 0.001mg/l, Cr 0.05mg/l) [14,15].

Boreholes and wells are types of groundwater that form an integral part of water supply systems in the urban and rural communities of Nigeria, and thus can be described as indispensable because of inadequate public water supply systems in most communities in Nigeria [16].According to Egwari and Aboaba [17], natural processes and anthropogenic activities of humans can contaminate groundwater, and such activities could be domestic, agricultural or industrial in nature. The uncontrolled discharge of toxic effluents to the soil, streams and rivers by industries and the indiscriminate dumping of garbage and faeces have been reported to heavily contaminate groundwater in Nigeria [18]. Anaele [19] reported that residential wells and water



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from boreholes are often contaminated by sewage from the numerous septic tanks, latrines, and soak away pits often situated near them. The majority of people drink water from these groundwater sources without any form of filtering or treatment. The indiscriminate dumping of materials laden with lead and other toxic metals and the use of leaded gasoline have been shown to contribute to the lead load of underground water sources of many Nigerian cities [18,20].The aim of this study is to investigate the concentrations of heavy metals in the various sources of water in Aliero: Labana borehole, and the Kalli and Bodiga wells.

### *A. Justification for the Study*

This study hopes to provide detailed information about the various heavy metals and their concentrations in wells and bore holes. The outcome is likely to help reduce the effects of these substances on human health.

## II. MATERIALS AND METHODS

### *A. Sampling Location*

Bodiga, Kalli and Labana are located in the Aliero area of Kebbi State(Fig. 1).Kebbi State is located at latitude 12º16' 42''N and 12.27833ºN and longitude 4º27'6''E and4.45167ºE.

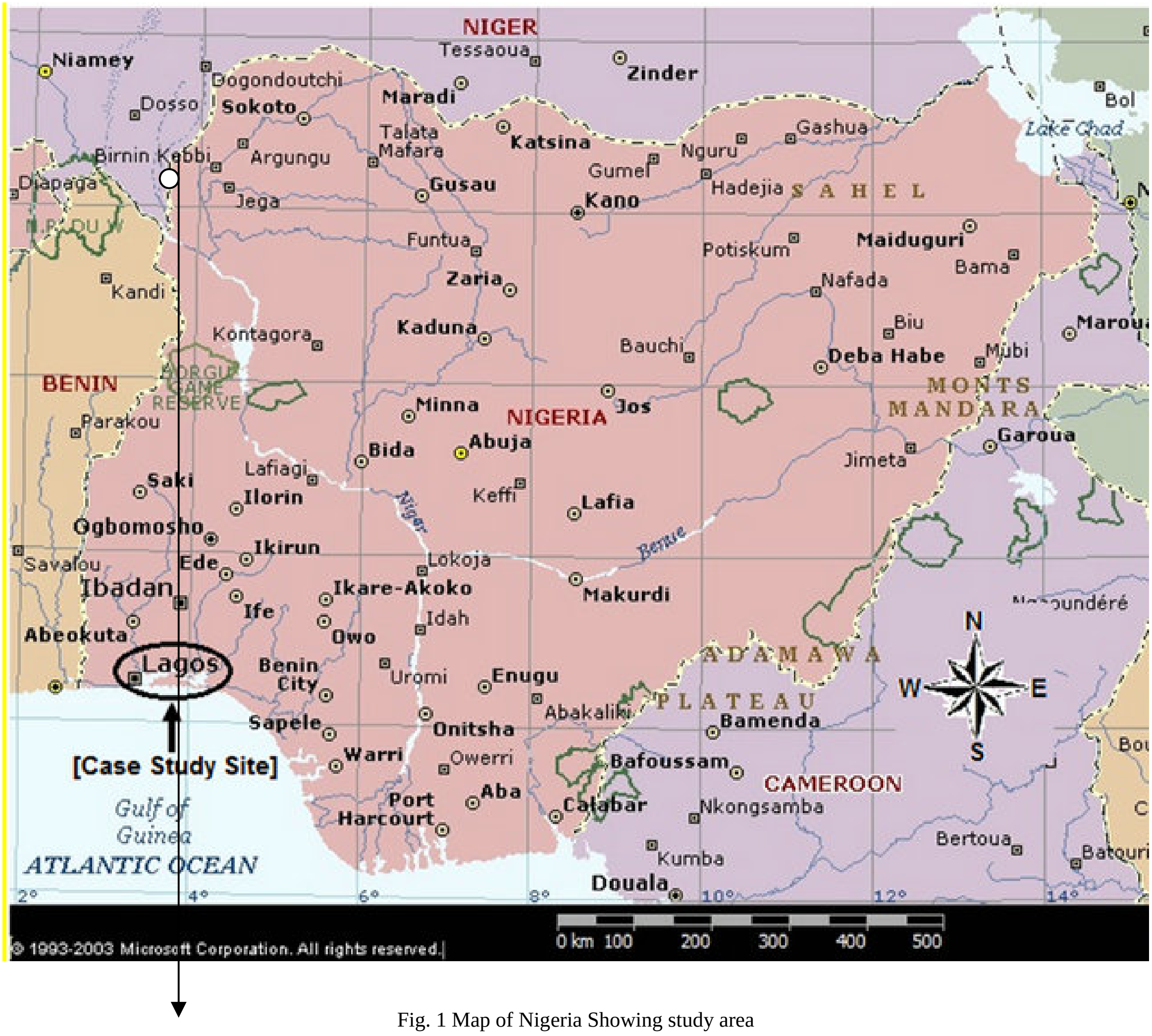


Fig. 1 Map of Nigeria Showing study area



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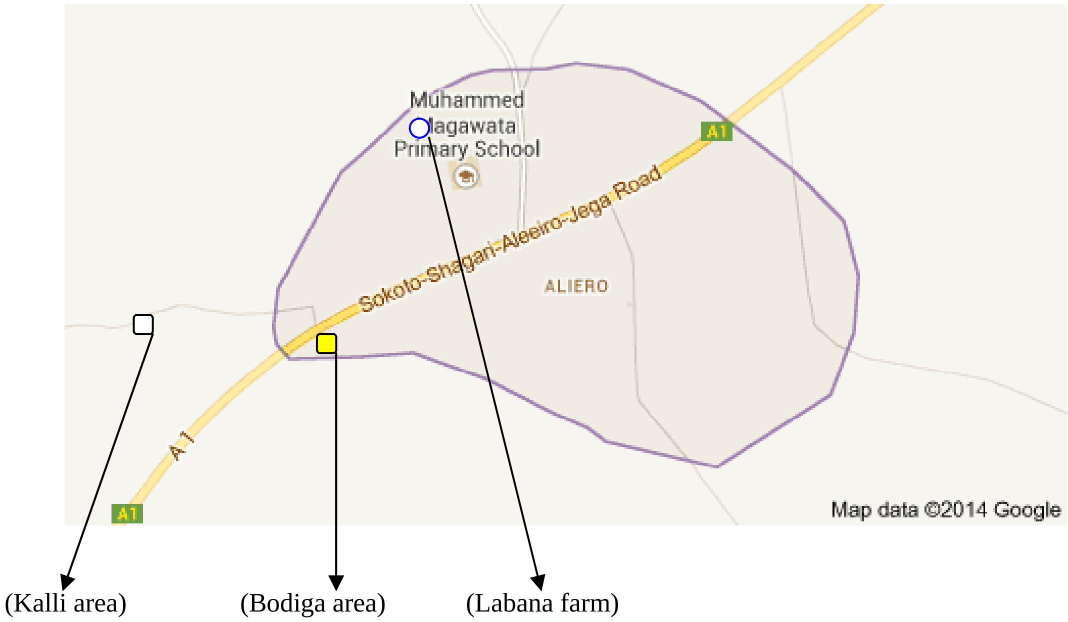


Fig. 2 Map of Aliero metropolis showing cross-section of sampling locations

### B. *Sample Collection and Preparation*

Samples of water were collected from the three different sampling sites (two wells: Bodiga and Kalli, and one borehole: Labana). The well water samples were collected using a plastic drawer tied to a rope and were transferred to 10litre plastic kegs after rinsing them with the well water. Bore holing water was collected directly into the 10litre kegs after rinsing them with the sample water. The containers were tightly covered and stored in a refrigerator at 4ºC until digestion.

### C. *Sample Digestion Procedure*

The sample water was filtered. After the filtration, $50cm^3$ of sample water was measured into beakers. $5cm^3$of concentrated $HNO_3$wasadded to each of the measured samples. The samples were heated on a hot plate in a fume cupboard to near dryness with a characteristic color indicating complete digestion. After digestion, the samples were allowed to cool, then transferred to $50cm^3$ acid-washed volumetric flasks and volume filled to 50 marks with deionised water. The samples were then filtered and kept in sample bottles until analysis by atomic absorption spectrophotometer [21].

### D. *Statistical Analysis*

Data obtained wasanalysed using descriptive statistics for the mean and standard deviation. One-way ANOVA was used to test the significant differences in the concentrations of heavy metals in wells and bore holing water.

## III. RESULTS AND DISCUSSION

Water isan important solvent necessary to the sustenance of life, and is threatened by heavy metal contaminants; thus, this has become a main concern to scientists because of the serious health hazards to humans. Enlightenment about the concentrations of these metals is vital because it helps in water resource management. In this study, it was observed that the highest concentration of lead (0.323ppm) was found in the Kalli well, and the lowest (0.113ppm) was found in the Bodiga well, as shown in Table 1. All lead concentrations were found to be far above WHO permissive limits for drinking water (0.01ppm), as indicated in Table 1. The high lead concentration in the Kalli well could be a result of compost manure deposited in the farms around the study area. It could also be a result of the use of leaded petrol in cars, generators and water pumps because the well is located by the roadside and near irrigation farms. It could also be due to the proximity of a mechanic workshop to the well location [22]. The high concentrations of lead in all the three samples could pose a threat to human health, as people depend on the water for drinking and domestic purposes.

Iron concentrations in all samples were found to be low compared to WHO standards (<3ppm) (23)and is acceptable for drinking water. The highest iron concentration (1.973 ppm) was in the Kalli well and the lowest (1.260 ppm) in the Labana borehole water (Table 1). Despite the high concentration of manganese (0.186 ppm) in the Kalli well (Table 1) and the low concentration in the Labana borehole (0.100 ppm) shown in Table 1 all manganese concentrations were below WHO's permissible limits (0.50 ppm), demonstrated in Table 3.

*The results indicated that nickel could not be detected in the Labana bore hole, but was present in both the* Bodiga and Kalli wells (0.001 and 0.012 ppm, respectively).The nickel concentration was found to be lower than the WHO permissible



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limits for drinking water (0.02ppm). The low level of nickel present could be a result of the absence of igneous rock in the study area.

In this study, it was observed that copper concentrations in all three sites were lower than the WHO permissible limits (2.00ppm), as shown in Table 1 However, with the exception of copper, the concentrations of all the metals were higher in the wells and lower in the borehole. This could be because the wells are open and not deep, while the borehole is very deep and always covered.

TABLE 1 MEAN CONCENTRATIONS OF HEAVY METALS (PPM) IN WELLS AND BORE HOLE SAMPLES FROM ALIERO METROPOLIS COMPARED TO WHO PERMISSIBLE LIMITS

| Heavy metal | Bodiga well | Kalli well | Labana borehole | WHO |
|---|---|---|---|---|
| Lead | 0.113±0.0001c | 0.323±0.0002a | 0.234±0.0002b | 0.01 |
| Iron | 1.638±0.0011b | 1.973±0.0011a | 1.260±0.0016c | < 3.00 |
| Manganese | 0.172±0.0002b | 0.186±0.0003a | 0.100±0.0001c | 0.50 |
| Copper | 0.081±0.0006a | 0.101±0.0003a | 0.060±0.0002a | 2.00 |
| Nickel | 0.001±0.0002b | 0.012±0.0003a | ND | 0.02 |

The data represent mean values ± standard deviation (SD) of three replicates. In all metals and locations,p<0.05 shows significant difference, except for Cu (p>0.05)indicates no significant difference.

## IV. CONCLUSION/RECOMMENDATION

Although heavy metals such as Fe, Mn and Cu play biochemical roles and are required in traces, at high concentrations, these heavy metals are toxic to human and animal life by affecting reproduction and other physiological function. Constant monitoring of water in Aliero is therefore recommended so as to reduce the long-term effects of these toxic metals. Wells should therefore be dug deeper and be properly covered to help reduce the contamination of drinking water by heavy metals.

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