

AN ASSESSMENT OF HEAVY METAL CONCENTRATION IN BOREHOLE WATER OF IJEBU-ODE AREA, OGUN STATE, NIGERIA

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ABSTRACT

Heavy metal contamination of the environment has been and continues to be a worldwide phenomenon that attracted a great deal of attention from governmental and regulatory bodies anxious to prevent further environmental deterioration and to examine possible methods of remediation. The aim of this research paper is to assess the levels of heavy metals in borehole water of Ijebu –Ode, Nigeria. Ten (10) functional boreholes were sampled randomly with one (1) each from the ten (10) wards of the study area. A handheld Garmin72 GPS (Global Positioning System (GPS) receiver) was used to determine their geographic locations. The water samples were analyzed for the presence of heavy metals such as Arsenic(As), lead(Pb), Chromium(Cr), Cadmium(Cd), Iron(Fe), Copper(Cu) and Mercury(Hg). The concentrations of the metals were compared with drinking water standard prescribed by World Health Organization (WHO) and National Agency for Food, Drug Administration and Control (NAFDAC). The ranges of concentrations of heavy metals (mg/l) are; As(0.01 to 0.05), Pb (0.00 to 0.12), Cr(0.17 to 0.88), Cd (0.00), Fe (0.17-0.26), Cu (0.00) and Hg (0.0001-0.04). These values are below the tolerance levels of concentration set by different international organizations. Therefore heavy metal toxicity in the study is marginal.

Keywords: Borehole water, Heavy metals, Pollution, Ijebu-Ode

Introduction

Boreholes and wells are groundwater types that form an integral part of water supply systems in rural and urban areas especially in Africa and Nigeria in particular, and therefore are indispensable because of inadequate public water supply systems (Pickering and Owen, 1995; MacDonald et al., 2005; Calow et al., 2010). Over one billion people lack access to clean safe water worldwide and up to 300 million rural people in Sub Sahara Africa have

no access to safe water supplies and this is on the rise (NAS, 2009). Ground water in its natural state tends to be relatively free from contaminants in most areas. Both natural processes and anthropogenic activities are the main sources of surface and groundwater contaminations by heavy metals (Nriagu and Pacyna, 1988; Nriagu 1989; Peplow 1999; Ato et al. 2010; Naveedullah et al. 2014). Regardless of origin, increase of heavy metal

concentration in water is becoming a serious threat to human health and aquatic ecosystems (Humood, 2013; Naveedullah et al. 2014). The common heavy metals of health concern to human include arsenic, cadmium, chromium, lead, nickel and zinc (EU 1998; TBS 2005; WHO 2008). When heavy metal concentrations in water exceed environmental tolerance limits, use of such water in agricultural (irrigation and aquaculture) activities could be harmful to the aquatic ecosystem and human via the food chain (Wright and Pamela, 2002). The impact of water borne diseases on children is greater than the combined impact of HIV/AIDS, tuberculosis and malaria (WGAASD, 2010). Many people drink borehole water without any form of treatment, because of lack of access to basic methods of water treatment and ignorance of hazards associated with the ingestion of contaminated water (Anaele, 2004). Several cases of infections due to consumption of contaminated water by pathogenic bacteria have been reported in many parts of the world, sometimes causing epidemics followed by loss of human life. In the 19th Century in Britain, it was a common practice to obtain groundwater and to dispose of Sewage via earth closets; this resulted into contamination of groundwater and outbreak of cholera (Angulo et al., 1997). At least 30,000 people per day die in the third world because they have inadequate water and sanitation facilities (United Nations, 2010). The control of groundwater pollution in developing countries is a necessity, especially in Nigeria cities with lots of industrial activities, population growth, poor sanitation, land use for commercial agriculture and other factors responsible for environmental

degradation (Egila and Terhemen, 2004). The main sources of water supply for domestic and agricultural use in Ijebu-Ode area of Ogun state, Nigeria are the untreated private and commercial boreholes. This is because the expected treated public water scheme is not available and with the pace of infrastructural development in the area, groundwater resources contamination has become a matter of urgent concern. There is portending danger to the availability of safe drinking water due to various anthropogenic activities in the area. Therefore, this study assessed the concentration of heavy metals in borehole waters of Ijebu-Ode area of Ogun state, Nigeria with the purpose of having the true understanding of water quality in the area.

2.0 Materials and Method

2.1 Study Area

The study area, Ijebu-ode is, one of the ancient cities in Nigeria located on Latitude 6.2°N and 7.8°N and Longitude 3.0°E and 5.0°E (Figure 1). The city is bordered by Lagos and the Atlantic Ocean in the east and possesses a warm tropical climate. The vegetation of the study area is characterized by mangrove swamp ecosystems which form part of the rich fauna and flora of the state. The geographical landscape comprises extensive fertile soil suitable for agriculture, and savannah land in the north western part of the area, suitable for cattle rearing. There are also vast forest reserves, rivers, lagoons, rocks, mineral deposits and oceanfront and blessed with many mineral deposits in the list includes bitumen, kaolin, phosphate, bauxite, granite, limestone, crude oil etc.

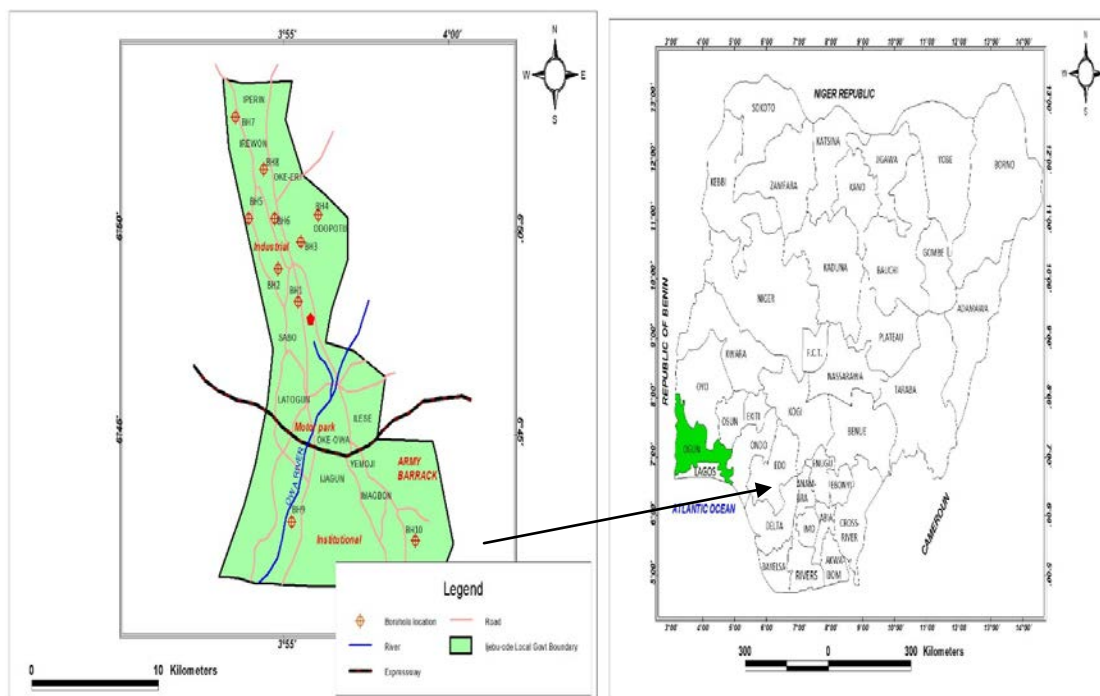


Figure 1 The Study Area.

2.2 Water Sample Collection

Water samples were collected in 100ml plastic bottles from ten (10) selected boreholes with one (1) each from each of the ten (10) wards in the study area (Figure 1) with their coordinates recorded using a handheld Garmin 72 GPS (Global Positioning System(GPS) receiver))(Table 1).The samples were appropriately labeled and were immediately taken to the Multi-Disciplinary Central Research Laboratory, located in the University of Ibadan for the analysis of heavy metal concentrations which include: Cadmium (Cd), Iron (Fe), Mercury (Hg), Copper (Cu), Arsenic (As), Chromium (Cr) and Lead (Pb).

Table 1: Location, GPS coordinates and the types of borehole sampled.

Location/wards	Borehole No.	GPS Coordinates		Type
		X	Y	
Ward 1 (Isoko)	BH1	6.81085 ⁰ N	3.92268 ⁰ E	Private
Ward 2 (Odo-Esa)	BH2	6.81403 ⁰ N	3.92361 ⁰ E	Public
Ward 3(Itantebo)	BH3	6.82068 ⁰ N	3.91904 ⁰ E	Public
Ward 4 (Ijada-Imepe I)	BH4	6.81296 ⁰ N	3.91775 ⁰ E	Public
Ward 5 (Ijada-Imepe II)	BH5	6.81218 ⁰ N	3.91290E ⁰	Private

Ward 6 (Porogun I)	BH6	6.81940 ⁰ N 3.91384 ⁰ E	Public
Ward 7 (Porogun II)	BH7	6.82289 ⁰ N 3.91286 ⁰ E	Public
Ward 8 (Ijase-Idepo)	BH8	6.82169 ⁰ N 3.92158 ⁰ E	Public
Ward 9 (Odo-Egbo/Oliworo)	BH9	6.82010 ⁰ N 3.92372 ⁰ E	Private
Ward 10 (Isiwo)	BH10	6.42396 ⁰ N 3.58901 ⁰ E	Private

Source: Author's Field Work, 2016.

2.3 Determination of Heavy Metal Concentration

For the determination of Heavy Metal concentrations, Atomic Absorption Spectroscopy method was adopted. Air/acetylene flame was also used, the standard solutions were aspirated and the calibration curve obtained. Concentrations of heavy metals in the samples were rated based on metal solution standards. (Banzi et al, 2015).

3.0 Results and Discussion

The concentrations of Pb, Cr, Cd, Fe, Cu, As and Hg in the sampled borehole water of Ijebu Ode are presented in Table 2. The concentrations of the heavy metals mentioned above were further compared with the drinking water standard prescribed by the World Health Organization (WHO) and National Agency for Food, Drug Administration and Control (NAFDAC) (Table 2). The mean value of the concentrations of each metal across the boreholes was calculated (Table 3)

and used against the critical value to test for the significance between the observed value of metal and the limit value (Dean, 2007). From Table 2, with the exception of Pb, Cr and Fe with concentration above or close to permissible limits at some boreholes, concentrations of other metals such as As, Cu, Hg and Cd in all the boreholes are below the maximum permissible limits metal concentration set by WHO and NAFDAC. The mean value test further confirmed that there is significant difference in the mean of the concentrations of Pb, Cr and Fe compared with the standard limit for these metals. (Table 3). These results indicate that the concentrations of heavy metals dissolved in borehole water of Ijebu-Ode are within the drinking water standards except for the three metals mentioned above. This implies that the quality of borehole water sampled can be improved upon most especially for the three contaminants that are above the standard limit for human consumption.

Table 2: Heavy Metal Concentrations (ppm) in the borehole water sampled compared with drinking water standard prescribed.

Locations	Pb	Cr	Cd	Fe	Cu	As	Hg	Standard limit for Heavy Metals	WHO Limit	NAFDAC Limit
BH1	0.12	0.41	0.00	0.18	0.00	0.01	Nd	Pb	0.05	0.015
BH2	0.08	0.17	0.00	0.17	0.00	0.02	Nd	Cr	0.05	0.1
BH3	0.12	0.25	0.00	0.19	0.06	0.03	Nd	Cd	0.005	0.005
BH4	0.05	0.56	0.00	0.21	0.00	Nd	0.0001	Fe	0.3	0.05
BH5	0.07	0.37	0.00	0.26	0.00	0.01	0.05	Cu	1	6
BH6	0.09	0.43	0.00	0.17	0.00	0.05	Nd	As	0.05	0.05
BH7	0.06	0.47	0.00	0.17	0.00	0.01	0.0001	Hg	0.001	0.05
BH8	0.05	0.512	0.00	0.20	0.00	0.03	Nd	Mn	0.1	-
BH9	0.09	0.84	0.01	0.21	0.00	Nd	Nd	Zn	5	3
BH10	0.00	0.88	0.00	0.18	0.00	Nd	0.04	Mo	-	-

Source: Author's Field Work, 2016

Where Nd= Not define

Table 3: Mean Values Test of Heavy Metal Concentrations (ppm) in the water sampled

Locations	Pb	Cr	Cd	Fe	Cu	As	Hg	Standard limit for Heavy Metals	Mean Value	WHO Limit	NAFDAC Limit
BH1	0.12	0.41	0.00	0.18	0.00	0.01	Nd	Pb	0.073	0.05	0.015
BH2	0.08	0.17	0.00	0.17	0.00	0.02	Nd	Cr	0.489	0.05	0.1
BH3	0.12	0.25	0.00	0.19	0.06	0.03	Nd	Cd	0.001	0.005	0.005
BH4	0.05	0.56	0.00	0.21	0.00	Nd	0.0001	Fe	0.185	0.3	0.05
BH5	0.07	0.37	0.00	0.26	0.00	0.01	0.05	Cu	0.006	1	6
BH6	0.09	0.43	0.00	0.17	0.00	0.05	Nd	As	0.023	0.05	0.05
BH7	0.06	0.47	0.00	0.17	0.00	0.01	0.0001	Hg	0.023	0.001	0.05
BH8	0.05	0.512	0.00	0.20	0.00	0.03	Nd	Mn	-	0.1	-
BH9	0.09	0.84	0.01	0.21	0.00	Nd	Nd	Zn	-	5	3
BH10	0.00	0.88	0.00	0.18	0.00	Nd	0.04	Mo	-	-	-

Source: Author's Field Work, 2016

Where Nd= Not define

Conclusion and Recommendations

Heavy metal concentrations in borehole water in Ijebu-Ode area was assessed and found to be within the standard limits for drinking water. In order to maintain the present quality

status of borehole waters in the study area, consistent monitoring and assessment of boreholes mostly to prevent indiscriminate sinking of boreholes to meet the ever increasing demand of safe and quality water.

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