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The Presence of Heavy Metals in Urban Sources of Water Supply in Lokoja Metropolis

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Abstract

This study focuses on the presence of heavy metals in urban sources of water supply in Lokoja metropolis. The primary source of data for this study were questionnaire and laboratory analysis for heavy metals while the secondary sources were from journal, texts, articles as well as other research materials relevant to the study. A total of 784 questionnaires were distributed in the study area. 290 questionnaire were administered in Lokoja, 47 in Adankolo new layout, 78 in phase I & phase II/Zone 8, 117 in Crusher/Felele, 47 in Zango daji, 43 in Army Barracks environs and 188 questionnaires were equally administered in Gadumo/Ganaja area respectively. Hence, from findings, the main sources of urban water supply in the area are borehole, hand dug well and pipe borne water. The resident of these areas utilizes water for various purposes such as; washing, cooking, bathing, and flushing toilets etc. There is also high concentration of six heavy metals which includes; Cadmium, Lead, Copper, Iron, Zink and nickel in the water of the area; which could have a negative impact on the health and wellbeing of the people of the area. Thus, the factors that affect urban water supply in the area are; distribution network problem, epileptic power supply, increase in demand and low supply, seasonality and distance from sources of water.

Keywords: Heavy-metals, Pollution, Water, Source and Supply

Introduction

The presence of heavy metals in natural water as major cause of pollution has received reasonable focus in recent years as a result of its potential risk to humanity and ecology (WHO and UNICEF, 2011: UNICEF AND WHO,, 2012; Olukemi, Ebuetse & Anake, 2014). Water is unarguably one of the essentials that strengthens all forms of plant and animal life (Vanloon & Duffy, 2005; WHO, 2011) and it is generally obtained from two principal natural sources namely surface water (such as fresh water lakes, rivers, streams and the like) and ground water (such as bore hole water and well water) (Mc Murry & Fay, 2004, Mendie, 2005).

Again, water is characterizes with unique chemical properties resulting from its polarity and hydrogen bond which implies that it is able to dissolve, absorb or suspend many different compound (WHO, 2005). One of the most important environmental issues today is ground water contamination (Rodela, Renden, lenz, Mchelhenney & kempainen, 1997, WHO, 20011, Nwankwo, 2013 lawrence, 2014), In addition, heavy metals obtain particular concern considering their unique toxicity even at low concentrations (Marcoverchio, Botte & Freije 2007). Heavy metals are elements having atomic weights between 63.536 and 200.590 and a specific gravity greater than 4.0 that is at least 5 times that of water. They exist in water in colloidal, particulate and dissolved phases (Adepoju-Bello, Ojomolade, Ayoola & Coker, 2009) with their existence in water bodies being either of natural

domain (e.g. eroded materials within sediments, leaching of ore deposits and volcanism extruded products) or of anthropogenic origin (That is industrial or domestic effluents, harbor channel dredging) (Marcovecchio, Botte & Freije, 2007).

Heavy metals could posed serious health effects with several symptoms depending on the magnitude and quantity of the metal ingested (Adepoju & Alabi, 2005). They therefore produces their toxicity through forming complexes with proteins, and exhibits carboxylic acid (-COOH), ami (-NH2), and thiol (-SH) groups are involved.

These modified biological molecules lose their ability to function properly and result in the malfunction or death of cells. When metals bind to these groups, they inactivate important enzyme systems or affect protein structure, which is linked to the catalytic properties of enzymes. This type of toxin may also cause the formation of radicals which are dangerous chemicals that cause the oxidation of biological molecules. The most common heavy metals that humans are exposed to are arsenic, cadmium and lead. Arsenic exposure can cause among other illness or symptoms cancer abdominal pain and skin diseases. Cadmium exposure produces kidney damage and hypertension. Lead is a cumulative poison and a possible human carcinogen (Bakare-Odunola, 2005). In addition, lead may cause the development of autoimmunity in which a person's immune system attacks its own cells. This can lead to joint disease and ailment of circulatory system and neurons and the kidneys. Again, with huge concentrations, lead can cause irredeemable brain damage.

1.1 Study area

The study area is the Lokoja metropolis in kogi state, Nigeria. It is located between latitudes 7 45, and 7 52, north of the equator. In addition, Lokoja longitudes stretches between 6 39, to 7 49, east of the Greenwich meridian (Audu, 2012). Lokoja metropolis has a landmass of 3,518km^2 (Abenu, 2016), and it is the administrative capital of Kogi state and the confluence town of river Niger and Benue. Lokoja is an ancient town that once houses the headquarters of the lord lugard led administration in Nigeria (Ifatimehin & Ufuah, 2006). Lokoja is situated 76 kilometers from Okene, along Okene-Abuja highway and it is a gateway of between the east, west and northern parts of the Nigeria. The town shares common bounderies with kogi, Ajaokuta, Adavi, Kabba/Bunnu and Bassa Local Government Areas of the State, (Opaluwa & Aribigbola, 2015).

Lokoja is sandwiched between the slopes of the high plateau of the patti ridge which is over 400m above sea level and the western bank of the Niger river at an altitude of 45-125m above sea level (Omali, 2014). Lokoja has the features of two distinct seasons such as, the rainy and dry seasons. The rainy season commences in April and last fills October, while the dry season is from November to March.

1.2 Aim and Objectives

The aim of this study is to examine the presence of heavy metals in Urban sources of water supply In the Lokoja metropolis. To achieve this, the following specific objectives are pursued:

i. Identify the sources of urban water supply in the study area.
ii. Examine various household uses of water in the study area.
iii. Identify and examine the presence of heavy metals in water in the study area.
iv. Examine factors that affects household water supply in the study area.

2.0 Conceptual Framework

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Examples of heavy metals include: Mercury (Hg),

Cadmium (Cd), Arsernic (As), Chromium (Cr), Thallium (Ti) and Lead (Pb). Heavy metals are seen as natural components of the Earth's Crust which cannot be degraded or destroyed. Again, to a insignificant extent they enter human bodies through air, food and drinking water while as trace elements certain heavy metals (e.g. copper, selenium, zinc) are fundamental to maintaining the metabolism of human body. Though, at higher concentrations they can lead to poisoning heavy metal poisoning could result, for instance, from drinking water contamination (e.g. Lead pipes), high ambient air concentrations through emission sources, or intake via food chain while heavy metals are dangerous due to the fact that they tend to bioaccumulate. Bioaccumulation means an increase on the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment.

Heavy metals can enter a water supply by industrial and consumer waste or from acidic water breaking down on the ground and releasing heavy metals into streams, lakes, rivers, and ground water (www.lentech.com).

2.1 Literature Review

Sources of Urban Households Water Supply

The source of water supply to the people of Lokoja is mainly through the Kogi State water board. The water board was established by the state government with definite mandate to develop and distribute water to the people. Again, wells, boreholes and river/streams also form parts of important sources for residents of Kabawa and lokongoma, Phase 1 areas (Olufayokemi, 2017).

Domestic Uses of Water

According to Ayoade (2003), domestic or household water use represents a vital component of the abstractive use of water. It includes: drinking, cooking, laundry, dish washing, house cleaning, personal washing, flushing water closets, car washing and watering lawns and flowers.

Heavy Metals in Urban water

The pollution of urban sources of water supply by heavy metals is an important environmental problem as heavy metals constitute some of the most hazardous substances that can bio-accumulate in various biotic systems (Lenntech, 2020).

Factors that affects Household Water Supply

In an attempt to capture the factors responsible for poor access to potable water in some areas, Enefiok and Ekong (2014), put forward some factors such as performance and maintenance, social problems, institutional failures, financial impediments. In the view of (Awoke, 2012), factors that account for low access to domestic water supply includes; poor technical capacity of the communities, poor water supply facilities, lack of adequate regulatory framework that captures potable water supply.

3.0 Method of Data Collection

Field surveys are the most appropriate methods of data collection in this study in that there are no adequate data banks from where required information on household sources of water, utilization as well as presence of heavy metals in the water could be obtained. Questionnaire Administration was used to collect data for this study and samples of water from the areas being studied were subjected to laboratory test to examine the presence of heavy metals in the household sources of water supply

in the study area. To be sure that the whole of the geographical units of Lokoja Metropolis have equal chance of being selected for the study, the 2006 population figures which was projected to 2020 figures for various areas of the Lokoja metropolis was used.These areas are Lokoja, Adankolo/Newlayout, Lokongoma, Crusher/Felele, Shagari/Kaduna Junction/Zango daji, Army Barracks, Gadumo/Ganaja. A total number of 784 questionnaire were administered in the study area.290 questionnaire was administered in Lokoja, 47 in Adankolo/Newlayout, 78 in phase I and II, Zone 8/Secretariat/Lokongoma, 117 in Cushier/Felele, 47 in Zango daji, 43 in Gadumo/Ganaja areas respectively. The systematic sampling technique was used for questionnaire administration. Within each selected street, the same sampling technique was used to select houses for questionnaire administration.

3.1 Method of Data Analysis

Data that were obtained from various sources were analyzed descriptively. Descriptive analysis involved detailed description of the data using tables, maps, charts, figures and relevant techniques.

4.0 Results and Discussion of Findings

4.1 Household Sources of Water Supply

The several sources of household water supply in the areas being studied through the field survey includes; bore hole, hand dug wells, pipe borne water, and vendors. Figure 4.1 shows the household sources of water supply in the study area. The summary of the results shows that 384 of the respondents in the area have boreholes as their household sources of water, 118 respondents have dug wells as their source of water supply, 264 of the respondents have pipe borne water as their sources of household water supply as well as six of the respondents uses vendors as their main sources of water supply. However, in the rainy season, some households may depend on rain harvested water as alternative source of water supply, while 12 of those that are close to the river Niger use the river water as their alternative source especially during scarcity of water supply.

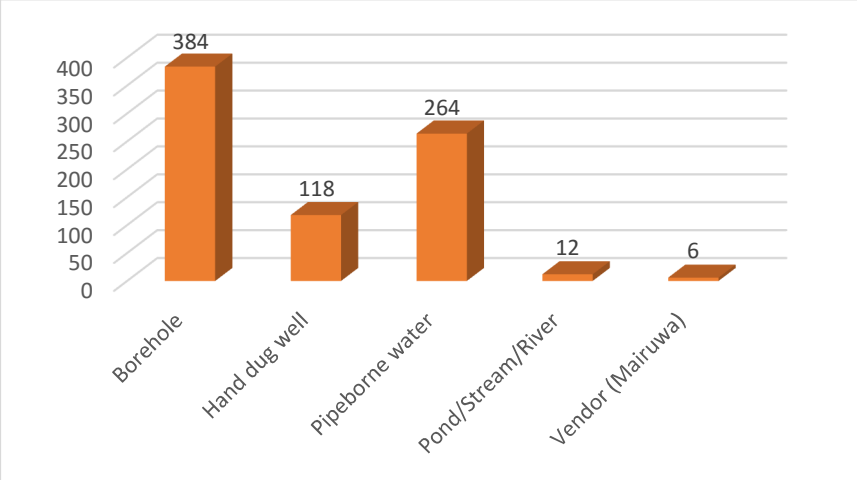

Figure 4.1: Household Sources of Water Supply
Source: Field Survey, 2021

4.2 Household Uses of Water

Figure 4.2.1 shows household domestic uses of water in the study area. The summary of the results shows that all the respondents (784) use water for drinking, bathing, cooking and washing. Whereas, 221 of the respondents use water for flushing, 90 of them use water for wetting flowers and 101 respondents use water for watering garden in the study area.

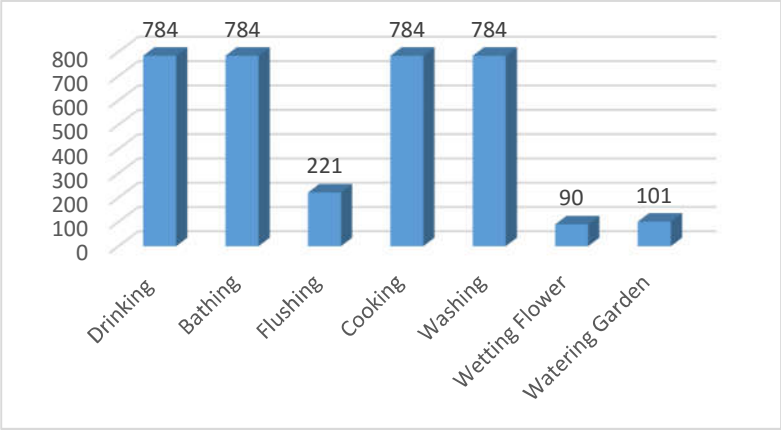

Figure 4.2.1: Household Domestic Uses of Water
Source: Field Survey, 2021

4.3 Water Samples and their Locations

According to National population commission (NPC), 2006, seven (7) locations were delineated in the area, and samples of three water sources were taken from each of the seven (7) areas. These water samples include: Tap Borne Water, Borehole and Hand Dug Well Water. From the analysis, three (3) water samples from each of the seven (7) locations in the study area are required to make a sum of twenty one (21) water samples, but from the field observation, it was discovered by the researcher that Zango daji, Crushier/Felele and Army Barracks areas only have borehole and hand dug well water at the time of the field survey which has now reduced the total number of water sample to eighteen (18).

TABLE 4.3.1: Water samples and their location

S/n	Location	Water samples			
		Tap water	Borehole water	Well water	Sum
1	Lokoja	1	1	1	3
2	Lokongoma	1	1	1	3
3	Felele	-	1	1	2
4	Adankolo	1	1	1	3
5	Barracks area	-	1	1	2
6	Zango daji	-	1	1	2
7	Gadumo/ganaja	1	1	1	3
	Total	4	7	7	18

Source: Field Survey, 2021

Table 4.3.2: water samples and sources of water

s/n	Location	Samples	Sources
1	Lokoja	A1 A2 A3	Well water Tap water Borehole water
2	Lokongoma	B1 B2 B3	Well water Tap water Borehole water
3	Felele	C1 C3	Well water Borehole water
4	Adankolo	D1 D2 D3	Well water Tap water Borehole water
5	Barrack	E1 E3	Well water Borehole water
6	Zango daji	F1 F3	Well water Borehole water
7	Ganaja	G1 G2 G3	Well water Tap water Borehole water

Source: Field Survey, 2021

A - Lokoja
B - Lokongoma
C - Felele
D - Adankolo
E - Barracks Area
F - Zango Daji
G - Gadumo/Ganaja
1 - Well Water
2 - Tap Water

3 - Borehole Water

4.4 Heavy Metals Composition in the Water of the Study Area

In the study, six pollutant considered by the WHO to pose the greatest adverse impact on humanity based on bioaccumulation ,environmental persistence and amount emitted and inherent toxicity were considered in the test for water quality. These were Lead (Pb), Iron (Fe), Zinc (Zn), Copper (Cu), Cadmium (Cd) and Nickel (Ni) again, from the laboratory analysis as shown in table 4.4.1, the concentration of lead (Pb) in water of the water samples was above the WHO standards of 0.010mg/l. This could be attributed to the surrounding environment. The high mean concentration of lead (Pb) in water of the area could have dire implications on human health and wellbeing. For nickel, water samples collected from the study area exhibited high values which greatly exceeded the WHO acceptable exposure level of 0.020mg/l. Mean concentration of Cadmium (Cd) in the water samples were also higher than the WHO recommended standard to be one of the most toxicologically problematic metals in the fresh water environment (WHO, 2005). Cadmium (Cd) even at very low concentrations can also disturb central functions of human beings by affecting various basic biochemical and physical process (vrijheid, 2000). It enters the environment from natural and

anthropogenetic sources. Cadmium (Cd) dissolved and constitutes a contaminated source for the various aquatic food chain links (Remeo and Gnassia-Barelli, 1995). Higher concentration of copper (Cu) were found in all the water samples in the study areas.

The high concentration of the heavy metals or trace elements in the water of the study area poses a major challenge to the health and well being of the residents. The trace elements have several potentially significant public health challenges that require urgent attention. This is because there is sufficient evidence from human epidemiologic studies linking increased mortality from liver, kidney, bladder and lungs cancer to drinking water contaminated with trace metals (WHO, 2004).

Table 4.4.1: Metals Composition of Water Samples in the Study Area

Location	Water sources	Lead Pb mg/l	Iron Fe	Zink Zn	Copper Cu	Cadmium cd	Nickel Ni
Lokoja	A1	0.24	0.38	3.12	2.41	0.016	0.65
	A2	0.28	0.43	3.20	2.48	0.019	0.68
	A3	0.26	0.41	3.24	2.50	0.019	0.71
Lokongoma	B1	0.23	0.30	2.96	2.38	0.013	0.57
	B2	0.22	0.33	3.0	2.40	0.016	0.59
	B3	0.21	0.31	3.16	2.39	0.014	0.60
Felele	C1	0.27	0.44	3.28	3.16	0.018	1.12
	C3	0.26	0.43	3.28	3.20	0.021	1.16
Adankolo	D1	0.24	0.46	3.31	3.23	0.023	1.18
	D2	0.28	0.46	3.34	3.28	0.026	1.14
	D3	0.28	0.48	3.37	3.30	0.015	1.17
barracks	E1	0.25	0.42	2.98	3.26	0.011	0.98
	E3	0.29	0.47	3.15	3.29	0.016	1.31
Zango Daji	F1	0.20	0.47	3.10	3.0	0.019	1.36
	F3	0.23	0.35	2.88	2.84	0.013	1.11
Gadumo/Ganaja	G1	0.21	0.32	2.84	2.98	0.015	1.38
	G2	0.24	0.36	2.90	3.06	0.017	1.42
	G3	0.26	0.40	3.12	3.11	0.019	1.46
	WHO guideline value mg/l	0.010			2.00	0.003	0.020

Source: Laboratory Test, 2021

4.5 Factors affecting Household Water Supply

The figure 6.5 displays factors that affects household water supply in the study area, the summary of the analysis revealed that (457) of the respondents agreed that epileptic power supply is the factor affecting their household water supply. This therefore implies that when there is power failure from the independent commercial power outfit, it will affect urban water supply especially on pipe borne water. (166) of the respondents revealed that distribution network problem is the factor militating against water supply in the study area. Also, (95) of them agreed that increase in demand and low supply is the problem of water supply in their area, (35) of respondents said that seasonality is the problem of water supply in their area. This shows that water supply during the rainy season and dry season is not the same experience. Some streams, wells and boreholes may dry up completely in the dry season and brings forth water again in the rainy season. In addition, the survey revealed that (51) of the respondents agreed that distance from source of water is the problem negating their household water supply in that area.

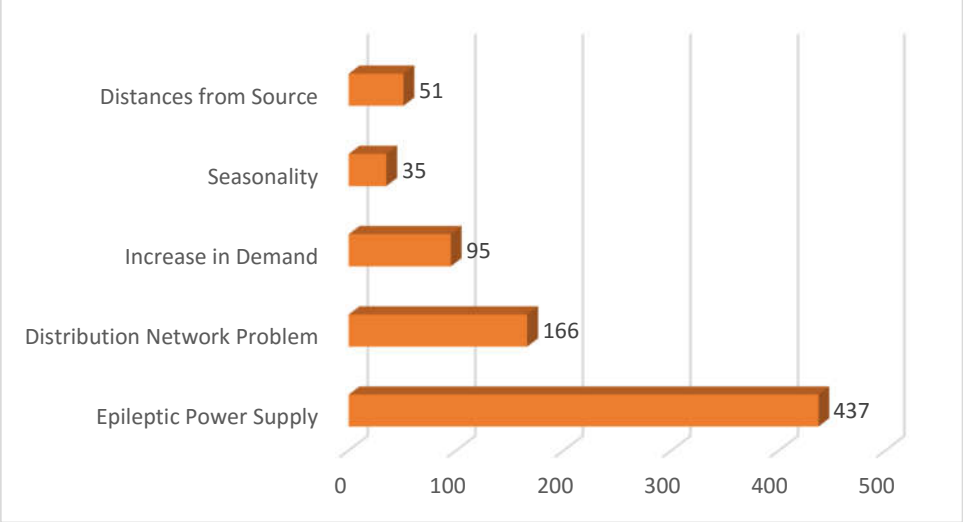

Figure 4.5.1: Factors Affecting Household Water Supply
Source: Field Survey, 2021

5.0 Conclusion

This study examines the presence of heavy metals in urban sources of water supply in the Lokoja metropolis. To properly broaden the horizon of the research work, the aforementioned objectives were enumerated such as to identify the source of urban water supply in the area, examine various household uses of water in the study area, identify and examine the presence of heavy metals in the water of the area, as well as examining factors that affect household water supply in the study area.

In the cause of this study, samples of water from the major sources of water supply in the area such as borehole water, hand dug well water and pipe borne water were collected and taking to the laboratory for test for heavy metals.Due to time and cost, tests for six heavy metals werecarried out in the laboratory which include Lead (Pb), Iron (Fe), Zink (Zn), Copper (Cu), Cadmium (Cd) and Nickel (Ni). In addendum, these six metals or pollutants are considered by WHO to have the greatest potential impact on human health.

From the laboratory analysis displayed in table, 4.4.1, ascertain the fact that there is high concentration of heavy metals in the water of the study area even above the recommended standard of the WHO. Therefore, based on this result, it is imperative by way of recommendation that government should do everything possible at her disposal to make available portable drinking water for the people of the Lokoja metropolis to avoid the risk of the effect of heavy metals on their physiological make up.

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