Pak. J. Chem. 3(2): 87-90, 2013 Full Paper
ISSN (Print): 2220-2625
ISSN (Online): 2222-307X DOI: 10.15228/2013.v03.i02.p08

Heavy Metals Pollution of Ground Water in Urban and Sub-Urban Areas of Makurdi Metropolis – Nigeria

*I. I. Mile, [1]J. I. Amonum and [2]N. L. Sambe
*Department of Social and Environmental Forestry, University of Agriculture, Makurdi – Nigeria
[1]Department of Forest Production and Products, University of Agriculture, Makurdi – Nigeria
[2]Department of Social and Environmental Forestry, University of Agriculture, Makurdi – Nigeria
E-mail: *mileiyange@yahoo.com

ABSTRACT
This study examines heavy metals pollution of ground water in the residential sector of Makurdi urban area and Yaikyô settlement – a peri-urban area of Makurdi metropolis. Water samples from fifteen (15) wells in Makurdi urban area and fifteen (15) wells in Yaikyô settlement were analysed for chromium (Cr), Cadmium (cd), Iron (Fe), and Copper (Cu). Atomic Absorption Spectrometer (AAS) method was used for water sample analysis. This was done in the peak of rainy season, in the month of September, 2012. The results of the analysis show that 100% of wells in Makurdi urban area had chromium levels above WHO guide limit for drinking water, while Yaikyô, a sub-urban area of Makurdi, had only 35.5% of wells with chromium levels above WHO standards. Ten out of fifteen wells representing 67% displayed cadmium levels above WHO limits in Makurdi urban area, while eleven out of fifteen wells (85%) displayed cadmium levels above WHO limits in Yaikyô. Twelve out of fifteen wells representing 80% displayed iron levels above WHO guide limits in Makurdi, while thirteen out of fifteen wells representing 90%, showed iron levels above WHO guide limit in Yaikyô. All wells representing 100% displayed copper levels below WHO guide limit in both areas. High concentrations of heavy metals in drinking water are undesirable, toxic, hazardous, and affects portability of water. Source of metals in these wells is attributed to soil mineralogy, use of agro- chemicals on farms and other land use activities. All land use activities capable of polluting water should be properly controlled. Water from these wells may be used for other domestic purposes other than drinking. Boiling of water from these wells should be encouraged to reduce the risk of contracting illness.

Keywords: Heavy metals, Pollution, Ground Water, Urban, and Sub-urban

1. INTRODUCTION
Groundwater is generally a very good source of drinking water because of the purification properties of the soils. It is also used for irrigation and where surface water is scarce, for industrial purposes. In many arid and semi-arid zones, it is the main source water. Although it is more protected than surface waters, ground water appears to be subjected to pollution as well (Fried, 1975).

The failure to provide safe drinking water and adequate sanitation services to all is perhaps the greatest failure of the 20th century. If no action is taken to address unmet basic needs for water, as many as 135 million people will die from these diseases by 2020 (Gleick, 2002). Water related diseases are a human tragedy, killing millions of people each year, preventing millions of people from living healthy lives, and undermining development efforts (Nash, 1993). About 2.3 billion people in the world suffer from diseases that are linked to water (Kristof, 1977) (UN, 1977).

In Nigeria, urban dwellers face serious threats to the quality of life and safety with urbanisation resulting into high degree of population densities, and concentration of socio-economic activities, it has become increasingly difficult to meet all the water requirements both in quantity and quality.

In Makurdi town, the public water supply comes from water works located by the bank of River Benue. The present water scheme cannot serve the water needs of the town because of population growth and urban development. The recent flood along the Benue valley left the water works completely submerged in River Benue for several months.

Inhabitants of Makurdi town therefore resort to unsafe alternative sources of water supply from shallow hand-dug wells, which are highly polluted from physical, chemical, and bacteriological sources (Mile, et al., 2012). Concern over quality of water harnessed especially from the hand-dug wells have received wide attention among researchers (Ovrawah and Hymore, 2001; Nnodu and Ilo, 2002; Ogunbadewa, 2002; Omofonmwam and Esiegbe, 2009). Consistent in their findings is that water from hand-dug wells is polluted through physical process, geochemistry of the environment, and anthropogenic activities. Consequently, consumers of these waters are prone to health risks.

High concentration of iron in water can lead to liver diseases (Morris, 1952; Lee and Stum, 1960; Hem, 1970). Mile, et al., 2012). Shirake (1974) reported that mercury pollution causes a ground lowering of mental and neurological faculties of human being. Copper, according to Danielli and Davis (1951) has been found to cause alteration in cell membrane properties leakage of potassium (kt) and other irons and solutes. According to GRA (2012), Cr (VI) is considered a suspected carcinogen, while cadmium excess in drinking water over time could result to kidney damage. Heavy metals pollution of Miramichi River has led to disease epidemic of fish (Rippy and Hare, 1969).

*Corresponding Author

Received 3rd December 2012, Accepted 7th May 2013

According to Al Jassir et al., (2005), heavy metals are non-biodegradable and non-persistent environmental pollution, which enter surface or ground water and are observed into plants tissues, thus affecting the consumers of such water plant.

1.1 *The Study Area*

The study area is Makurdi town, the capital of Benue State in North Central Nigeria. Makurdi lies between Latitude 7^0 44^N and Longitude 8^0 54^N. It is located within the flood plain of lower River Benue valley. The physiographic characteristics span between 73 – 167 m above sea level. Due to the general low relief sizeable portions of Makurdi is water logged and flooded during heavy rainstorms. This is reflected in the general rise in the level of groundwater in wells during wet season. The drainage system is dominated by River Benue, which traverses the town into Makurdi North and South banks.

Temperatures are generally high throughout the year due to constancy of insulation with the maximum of 32^0C. And mean minimum of 26^0C. The hottest months are March and April. The rainfall here is convective, and occurs mostly between the months of April and October and is derived from the moist and unstable southwest trade wind from St. Helena subtropical Anticyclones (STA). Mean annual rain total is 1990 mm and ranges from 775 – 1792 m. Rainfall distribution are controlled by the annual movement and prevalence of Inter-Tropical Discontinuity (ITD). The mean monthly relative humidity varies from 43% in January to 91% in July – August period (Tyubee, 2009).

The geology is of cretaceous sediments of fluvio-deltaic origin with well-bedded sandstones of hydro-geological significance in terms of groundwater yield and exploitation (Kogbe et al., 1978). Makurdi town which started as a small river port in 1920 has grown to a population of 297,393 people (NPC, 2006).

Yaikyô a sub-urban area of Makurdi town is located five (5) kilometres away from Makurdi; and bears same climatic characteristics (Tyubee, 2009).

Agriculture is the predominant land use and Yaikyô is a mechanic village for Makurdi urban area. Thus, crankcase oily wastes and oil spills constitute a major environmental treat to groundwater.

1.2 *Sample Collection and Preservation*

Following a reconnaissance survey, Makurdi town was divided according to the existing political wards: North Bank, Wadata, Wailomayo, and Ankpa Wards.

Water samples from fifteen (15) wells were taken and analysed for chromium, cadmium, iron, and copper. Yaikyô was divided into three (3) political wards in which five (5) wells each were sampled for the study, making a total of fifteen (15) wells.

Sampling and sample preservation were done according to prescribed procedures. Samples were taken in 1 litre polythene kegs and acidified to pH<2 with analar grade concentrated nitric acid. Samples were kept in an ice box prior to transportation to the laboratory where they were further preserved before analysis (Standard Methods, 1986). Samples obtained in sampling regime conducted in September 2012, in the peak of rainy season, were used for the study.

1.3 *Analysis of Samples*

Heavy metals parameters of the water samples were determined using Alpha 4 Atomic Adsorption Spectrometer (AAS) after using pre-concentration, using their various stored programme numbers and compared to the WHO 2006 standards for drinking water.

Table-1: WHO Standards for Drinking Water (Mg/1), 2006

Chromium	**Cadmium**	**Iron**	**Copper**
0.5mg/L	0.01mg/L	1.0mg/L	2.0mg/L

2. RESULTS AND DISCUSSION

The results of heavy metals in well water samples of Makurdi urban areas and Yaikyô, a sub-urban area of Makurdi, are presented in tables 2 and 3 below. These values indicate the prevailing quality status of well water in the study areas.

From Table 2, 100% of wells have chromium concentration levels above WHO prescribed limit of 0.5mg/L for drinking water. In Table 3, only 5 wells out of 15 representing 35.5% have chromium concentration levels above WHO limit with an average value of 0.98mg/l in Makurdi and 0.43mg/l in Yaikyo.

This shows higher chromium concentrations in Makurdi urban area than in Yaikyô, a sub-urban area of Makurdi. Chromium concentrations in these wells may be explained in the context of hydro geochemistry of these environments, well characteristics, agricultural, and other land use activities. Beside, depths of these wells are important because contaminants can easily get into these wells. Average well depth in Makurdi urban area is 3.38m, while Yaikyô has average well depth of 6.25m.

Table 2, show that 10 out of 15 wells representing 67% have cadmium concentrations above WHO maximum allowable limits, while Table 3 shows 85% of wells (11 out of 15 wells) with cadmium levels above WHO limits. The sources of cadmium in these wells may be attributed to runoff from wastes, batteries, and paints. The mechanic village, which serves Makurdi urban area, is located in Yaikyô settlement. The mean concentration of chromium is 0.98mg/l, while Yaikyo settlement has 0.43mg/l.

Table-2: Heavy Metals Content of Groundwater in Makurdi Urban Area

Well Code	Well Depth (m)	Depth of Water Level (m)	Chromium (mg/L)	Cadmium	Iron (mg/L)	Copper (mg/L)
W1	2.30	1.00	1.45	0.20	0.8	1.6
W2	2.70	1.45	1.20	0.04	1.3	1.3
W3	2.70	1.45	1.40	0.02	1.5	1.8
W4	1.30	1.00	1.31	0.00	1.8	1.5
W5	5.20	1.65	0.91	0.03	1.2	1.2
W6	4.33	4.33	0.76	0.00	2.0	1.4
W7	5.80	3.43	0.68	0.08	1.6	1.6
W8	3.77	2.37	1.40	0.05	1.3	1.7
W9	1.87	1.87	0.49	0.00	0.5	1.2
W10	2.93	1.30	1.31	0.00	1.9	1.3
W11	3.70	3.50	0.53	0.06	1.1	1.1
W12	9.15	7.55	0.66	0.03	2.6	1.9
W13	2.90	2.00	0.83	0.00	2.7	1.2
W14	1.00	1.00	0.81	0.10	0.7	1.3
W15	1.00	1.00	0.93	0.13	1.8	1.4
Mean	**3.38**	**2.33**	**0.98**	**0.05**	**1.52**	**1.43**

Table-3: Heavy Metals Content of Groundwater in Yaikyô

Well Code	Well Depth (m)	Depth of Water Level (m)	Chromium (mg/L)	Cadmium	Iron (mg/L)	Copper (mg/L)
W1	1.80	0.95	0.45	0.00	1.03	0.65
W2	2.06	1.15	0.66	0.13	1.05	1.30
W3	2.93	1.03	0.35	0.06	0.11	0.05
W4	3.35	2.00	0.76	0.08	0.68	0.00
W5	6.53	2.66	0.35	0.02	1.34	0.35
W6	3.26	1.78	0.76	0.01	1.55	1.00
W7	2.33	1.30	0.25	0.11	1.26	1.15
W8	1.86	1.00	0.43	0.05	1.58	1.00
W9	10.30	3.44	0.33	0.00	1.34	1.32
W10	7.39	2.34	0.28	0.00	1.66	0.00
W11	6.93	2.10	0.39	0.00	1.53	0.00
W12	33.75	1.33	0.19	0.01	1.35	1.55
W13	2.39	1.00	0.16	0.03	1.60	1.30
W14	3.48	1.35	0.63	0.06	1.34	1.03
W15	5.46	2.68	0.51	0.08	1.25	1.50
Mean	**6.25**	**1.7**	**0.43**	**0.04**	**1.24**	**0.81**

In Table 2, 12 out of 15 wells representing 80% shows iron levels above WHO limits in Makurdi urban areas, with a mean value of 1.52, while 13 wells out of 15 representing 90% shows iron levels above WHO limits in Yaikyô sub-urban area with a mean of 1.24 (Table 3).

The presence of iron may be attributed to the mineralogy of sand formation, low pH, or indiscriminate use of agricultural chemicals. Its presence is also a reflection of the general characteristics of groundwater in significant parts of all states in Nigeria (Ezeigbo, 1989).

High iron concentration in drinking water are undesirable, and hazardous, and affects portability of water. Copper values in all wells in both locations were below WHO allowable limits for drinking water.

3. CONCLUSION

This study has aptly presented the current heavy metals quality characteristics of well water within Makurdi town and Yaikyô sub-urban area. From the results, all parameters measured displayed higher concentrations above WHO standards for water quality in most of the wells sampled except copper, thus, consumers of these waters are prone to health risk. Waters from these wells must be boiled or treated through reverse osmosis before use.

4. ACKNOWLEDGEMENT

We strongly acknowledge late Dr. ABOHO, S.Y**.** Chemistry Department, Benue State University Makurdi-Nigeria. He personally supervised this research and gave necessary advice and corrections.

5. REFERENCES

1. Al Jassir, M. S., Shakar A., and Khaliq, M. A., Deposition of heavy metals on green leafy vegetables sold on roadside of riyadh city, Saudi Arabia. Bull. Environ. Contaminat. Toxicol, **(2005)** 75: 1020-1027. 10.1007 / s00128 - 005 - 0851-4
2. Danielli, J. F., Davis, J. I., Copper in Soils and Plants. Academy Press, New York, USA. **(1951)** Pages 259.
3. Ezeigbo, H. I., Geological and hydrological influences on the nigerian environment. Water Resour. **(1989)** 1:37-44.
4. Fried, J. J., Groundwater Pollution. Elselvier Scientific Publication, Amsterdam, The Netherlands. **(1975)**
5. Gleick, P. H., Dirty Water: Estimated deaths from water-related diseases 2000-2020, Pacific Institute Research Report, **(2002)** pp:1-12. http://www.pacinst.org/reports/water_related_deaths/water_related_deaths_report.pdf.
6. GRA, Facts and issues. Groundwater Resources Association of California, Technical Committee. **(2012)**.
7. Hem, J. D., Chemistry of iron in natural waters. U.S. Geological Survey Water-Supply Paper, **(1970)** No. 234.
8. Kogbe, C. A., Torkaski, A., Osijuk, D., and Wozney, D. E., Geology of Makurdi in the Middle Benue Valley, Nigeria. Occasional Publication of Department of Geology, Ahmadu Bello University, Zaria. **(1978)**.
9. Kristof, N. D., For third world, water is still a deadly drink, New York Times, January 9, **(1997)** pp:A1, A8. http://www.nytimes.com/1997/01/09/world/for-third-world-water-is-still-a-deadly-drink.html?pagewanted=all.
10. Lee, G. F., and Stum, W., Determination of ferrous iron in the presence of ferric iron using bathophenanthroline. J. Am. Waterworks Association, **(1960)** 52: 1567-1574.
11. Mile, I. I., Dagba, B. I., and Jande, J. A., Iron contamination of shallow wells in Makurdi urban area, Benue State, Nigeria. Pak. J. Chem., **(2012)** 2: 1-3, http://dx.doi.org/10.15228/2012.v02.i02.p03.
12. Morris, R. L., Determination of Iron in the Presence of Heavy Metals, Anal. Chem., **(1952)** 25: pp. 1376-1378, http://dx.doi.org/10.1021/ac60068a039.
13. Nash, L., Water Quality and Health. In: Water Crises, Gleik, P.H. (Ed.). Oxford University Press, New York. **(1993)**.
14. Nnodu, V. C., and Ilo, C. I., Bacteriological and physic-chemical examination of well water in Enugu South local Government area of Enugu State. Environ. Rev. **(2002)** 4: 411-419.
15. NPC, National population commission, Census 2006, Nigeria. **(2006)**.
16. Ogunbadewa, E. Y., Some physico-chemical properties of water from hand-dug wells in the basement complex of south-western Nigeria. J. Water Supply Res. Technol., **(2002)** 51: 407-417.
17. Omofonmwam, S. I., and Eseigbe, J. O., Effects of solid wastes on the quality of underground water in benin metropolis. J. Hum. Ecol., **(2009)** 26: 99-105.
18. Ovrawah, L. and Hymore, F. K., Quality of water from Hand dug wells in the Warri environs of Niger Delta Region. Afr. J. Environ. Stud., **(2001)** 2: 169-173.
19. Rippy, A., and Hare, S., Investigation of mercury levels in Tuna, Maslin, and marine products. Annual Report, Tyokyo Metropol. Res. Lab., **(1969)** pp: 239-258.
20. Standard Methods **(1986)** For examination of water and waste water 16th edition, APHA, AWWA, WPCF Washington, D.C..
21. Tyubee, B. T., The influence of ENSO and North Atlantic sea surface temperature anomaly (SSTA) on extreme rainfall events in Makurdi, Nigeria. Meteorol. Climate Sci., **(2009)** 7: 28-33.
22. UN, United Nations commission for sustainable development. Comprehensive Assessment of Fresh Water Resources of the World, New York. **(1977)**
23. WHO, World Health Organisation Guidelines for Drinking Water Quality. 3rd Edn., Vol. 1, World Health Organisation, of the United Nations, Rome, Italy, **(2006)** pp: 68.