International Journal of Science, Environment and Technology, Vol. 3, No 6, 2014, 2120 – 2126
ISSN 2278-3687 (O)

IMPACT ASSESSMENT OF HEAVY METALS CONTAMINATION OF GROUND WATER IN MUBI, ADAMAWA STATE – NIGERIA

Babagana Gutti[1], Bello Zubairu[2] and Danrimi Buba[3]
[1]Department of Chemical Engineering, Faculty of Engineering, University of Maiduguri, Borno State, Nigeria
[2]Department of Chemical Engineering Technology, Federal Polytechnic, PMB 35 Mubi, Adamawa State, Nigeria
[3]Department of Food Science Technology, Federal Polytechnic, PMB 35 Mubi, Adamawa State, Nigeria

Abstract: The levels of heavy metal contamination of ground water in some parts of Mubi metropolis were assessed. Five functional boreholes and five functional wells were analyzed for Fe, Mn, Pb, Zn, Cu and Cd using AAS and the results obtained were compared with the WHO standard for the specified maximum contaminant level. Concentrations of these metals in borehole water samples were: Fe ranged from 0.0200mg/L to 0.3500mg/L and Mn from 0.2733mg/L to 0.3670mg/L. The concentrations of Zn ranged from 0.00767mg/L to 0.4670mg/L and Cu from 0.0200mg/L to 0.0230mg/L while Pd and Cd were not detected in all the samples. In well water, the concentration of Fe ranged from 0.0053mg/L to 0.8633mg/L, Mn from 0.0153mg/L to 0.7000mg/L while Pd was not detected in all well water samples. Zn ranged from 0.1133mg/L to 1.2000mg/L, Cu from 0.0153mg/L to 1.4960mg/L and Cd has 0.0013mg/L value. This study revealed unsafe limits of some heavy metals in ground water in some parts of Mubi metropolis thereby attracting serious Public health attention.
Keywords: Borehole, contamination, Heavy Metal, Mubi and Well.

INTRODUCTION

Water is one of the common substances that support plant and animal life [1] and can be obtained from two different sources: ground and surface, water can dissolve, absorb, adsorb and suspend a compound as a result of its polar structure and hydrogen bonding [2]. Ground water, such as boreholes and wells contaminated with heavy metal as a result of human activities, some of these activities include production of fuel, indiscriminate disposal of refuge, discharge of domestic and industrial effluent, pharmaceutical product and used of automobiles [3].

Heavy metal is a common term that explains a group of metals and metalloid with an atomic density of greater than 4 g/cm^3 or 5 times or more dense than water [4]. Heavy metals may

*Received Nov 5, 2014 * Published Dec 2, 2014 * www.ijset.net*

get into the human and animal's body through food, drinking water, air, etc. and attack the protein known as enzymes [5]. Heavy metals can cause serious health effect with different symptoms depending on the nature and quality of the metal ingested [6].

Lead is one of the heavy metals and the most common of these elements. It is a general metabolic poison and an enzyme inhibitor. It can cause mental retardation and semi – permanent brain damage in young children. Lead can replace calcium in bone to form sites for long term replacement [7].

Iron is one of the heavy metal which is necessary for health. Iron plays a high role in human nutrition; it helps in the formation of protein hemoglobin, which transports oxygen to all cells of the body. It is also used in cellular metabolism and is found in body enzymes [8]. Chronically consuming large amount of iron can lead to a condition known as iron overload this condition is usually the result of a gene mutation [9].

Manganese found in its natural state in the earth’s crust, is an important mineral tomitocondrial oxidative process [10]. Manganese is an essential element for animals, plants and bacteria. It is found in all human tissues, with the highest concentration in liver, pancreas, intestinal tract and kidney [11]. The effect of manganese ranging from damage to the central nerve system, muscular weakness, speech disturbances and headaches [12].

Zinc is the 23rd most abundant element in the Earth's crust; it is the dominant ore blends, also known as sphalerite. Other important zinc ores are worst, Smithsonite and Hemimorphite [13]. Zinc is a trace element that is essential for human health. When people absorb too little zinc they can experience a loss of appetite, decreased sense of taste and smell, slow wound healing and skin sores. Zinc shortages can even cause birth defects [14]. Although too much zinc in the body cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anemia. Very high levels of zinc can damage the pancreas and disturb the protein metabolism, and cause atherosclerosis [15].

Absorption of copper occurs through the lungs, gastrointestinal tract and skin [16]. Individuals with toxicity show an abnormally high level of copper in the liver, kidney, brain, eye and bones [17]. Acute toxicity of ingested copper is characterized by abdominal pain, diarrhea, vomiting and a metallic taste in the mouth; it also appears to affect reproduction and development in human and animals [18].

Cadmium is extremely toxic even at low concentrations, and will bio- accumulate in organism and ecosystems and it has a long biological half-life in the human body ranging from 10 – 35 years [19]. Long term exposure to cadmium induces renal damage [20].

The population of Mubi was two hundred and twenty five thousand seven hundred and twenty one (225,721) as of census 2006.Rapid increase in population in Mubi town raises the high demand of water; as a result, many boreholes and wells were drilled to meet the demand for water without a proper consideration of the locations of boreholes and wells to be drilled. Therefore, assessment of heavy metals is very important because small changes in their concentration above the acceptable levels, whether due to natural or artificial factors can result in serious environmental and subsequent health problems [21].

The world health organization (WHO) has specified maximum contaminant level of heavy metals in water. This research was carried out to assess the heavy metal contents of some selected boreholes and wells in Mubi, Adamawa State using AAS and the result obtained will be compared with WHO maximum permissible concentration level of heavy metals in drinking water.

MATERIALS AND METHODS

The Study Area

The study was carried out in Mubi town on 8th April, 2014. Mubi is located in the North-Eastern part of Adamawa State and is situated on latitude 10^0 16' 12''N and 13^0 16' 12''E. Mubi is bordered by Borno state in the North, Hong and Song Local Government Areas in the west and the Republic of Cameroon in the south and east [22].

Sampling and Analytical Procedure

Groundwater samples were collected from five boreholes and five wells from each of the following; Girpata Lemu, Sebore, Lokuwa, Kolere and Shuware boreholes and wells. The boreholes depth ranged between 600 – 650m while that of wells was 8 to 12m.The boreholes and well water are used for drinking and other domestic uses.

All the samples were digested with concentrated nitric acid (HNO_3) to ensure that they are free of organic impurities. Ten milliliter (10ml) of nitric acid (HNO_3) was added to 50ml of each of water samples in a 250ml conical flask. The mixture was evaporated to half of its volume on a hot plate after which it was allowed to cool and then filtered.

The digested water samples were analyzed for Iron (Fe), Manganese (Mn), Lead (Pb), Zinc (Zn), Copper (Cu) and Cadmium (Cd) using the Buck Scientific 210 model Air Acetylene Fume integrated model Atomic Absorption Spectrophotometer (AAS).

Statistical Analysis

The values of mean and standard deviation were determined with Graphpad Instart version 3.0 for 95 [23].

RESULTS AND DISCUSSION

Table 1 and 2 show the concentrations of heavy metal in boreholes and wells water of the various locations (Girpata lemu, Sebore, Lokuwa, Kolere and Shuware). The concentration of Fe in borehole water ranges between 0.0370 – 0.350 mg/L except that of Kolere that was not detected. This indicates that there is no source of iron in the area. The samples from Girpata Lemu, Sebore and Shuware were below the maximum permissible level of heavy metal in drinking water as stated by WHO (2006), but that of Lokuwa was higher than the maximum permissible level of Fe 0.3mg/L in drinking water which may be attributed to high deposit of Fe in the area. The concentration of Mn ranged between 0.2733 - 0.3670 mg/L and was below the maximum permissible level of 0.5mg/L in drinking water (WHO, 2006); no Mn was detected in samples obtained from Girpata Lemu, Sebore and Shuware, this may be due to the absence of deposit of Mn in those areas. Pb was not detected in all the samples. The concentrations of Zn in the samples were 0.0767 - 0.4670 mg/L, the concentrations are below the maximum permissible level in drinking water compared to 5.0 mg/L as stated by WHO (2006). Copper was detected in the samples from Lokuwa and Kolere with the value of 0.0233 mg/L and 0.0200 mg/L but no copper was detected in the remaining areas. Cd was not detected in all the samples; this may be due to the absence of cadmium source in the investigated areas.

The concentration of Fe from well water samples was detected from Girpata-Lemu, Sebore, Lokuwa and Shuware with the values of 0.8633mg/L, 0.1800mg/L, 0.0053mg/l and 0.0330mg/L respectively except at Kolere which has no trace of Fe. All the values obtained were below the maximum permissible level of Fe in drinking water except that of Girpata Lemu which was higher than the maximum permissible value of Fe of 0.3mg/L in drinking water (WHO, 2006). Mn was detected only in the samples of Girpata Lemu and Shuware with values of 0.0153mg/L and 0.7000mg/L respectively, but none was detected in the remaining areas. The sample of Shuware was above the maximum permissible level of Mn in drinking water; this may be that, there is a collection of Mn in the area. Pb was not detected in the whole samples. The values of Zn in the investigated areas were 0.1133 mg/L to 1.2000mg/L which is below the maximum permissible level of Zn in drinking water of 5.0 mg/L (WHO, 2006). Cu was detected in the samples of Girpata Lemu and Shuware with the values of 0.0153mg/L and 1.4930mg/L which shows that the value for Girpata-lemu is below the maximum permissible level of Cu in drinking water while that of Cu is above the maximum permissible level of Cu in drinking water of 0.5mg/L (WHO, 2006) but the

remaining heavy metals were not detected in the other samples. Cd was also detected in the sample from Girpata-Lemu and Shuware with the value of 0.0013 mg/L which is below the limit of WHO, 2006 of 0.03 mg/L. No trace of Cd was detected in the remaining samples

Table 1: Concentrations of Heavy Metals in Boreholes in Mubi Metroplis

	Parameter (mg/L)						
Location	pH	Fe	Mn	Pb	Zn	Cu	Cd
Girpata Lemu	6.5	0.0760 ±0.0020	ND	ND	0.4670 ±0.0010	ND	ND
Sebore	7.6	0.0370 ±0.0200	ND	ND	0.2530 ±0.0058	ND	ND
Lokuwa	6.9	0.3500 ±0.0100	0.3670 ±0.0116	ND	0.1600 ±0.1000	0.0233 ±0.0058	ND
Kolere	7.0	ND	0.2733 ±0.0058	ND	0.3667 ±0.0116	0.0200 ±0.0001	ND
Shuware	7.4	0.1900 ±0.0110	ND	ND	0.0767 ±0.0058	ND	ND
WHO [24]	7.0-8.0	0.300	0.500	0.010	5.000	0.500	0.030

All values are mean and standard deviation of five replicate readings in mg/L except of pH
Legend: ND = Not Detected
WHO = World Health Organization

Table 2: Concentrations of Heavy Metals in well in Mubi Metropolis

	Parameter (mg/L)						
Location	pH	Fe	Mn	Pb	Zn	Cu	Cd
Girpata Lemu	6.0	0.8633 ± 0.0058	0.0153 ±0.0008	ND	1.2000 ±0.0173	0.0153 ± 0.0008	0.0013 ±0.0008
Sebore	6.6	0.1800 ±0.0265	ND	ND	0.1133 ±0.0058	ND	ND
Lokuwa	5.9	0.0053 ±0.0008	ND	ND	0.4533 ±0.0058	ND	ND
Kolere	6.0	ND	ND	ND	0.1233 ±0.0058	ND	ND
Shuware	6.4	0.0330 ±0.0058	0.7000 ±0.0100	ND	0.3233 ±0.0208	1.4930 ±0.0058	0.0013 ±0.0058
WHO [24]	7.0-8.0	0.300	0.500	0.010	5.000	0.500	0.030

All values are mean and standard deviation of five replicate readings in mg/L except of pH
Legend: ND = Not Detected
WHO = World Health Organization

CONCLUSION

The results of this research showed that the heavy metal concentration in the ground water sources in the area is high in some locations. This indicates that there is a need for serious attention in those areas to get rid of the metals concentrations. Government and other non-governmental organization should organize a forum to sensitive people in those areas on the health hazard of these metals. People should not dump refuge indiscriminately. A constant investigation of heavy metal in ground water should be carried out regularly.

References

[1] Momodu M.A. and Anyakura C.A. 2009. Heavy Metal Contamination of Ground Water: The Surulere case study. Research Journal of Environmental and Earth Science 2(1) 39 – 43.

[2] WHO 2007. Water for Pharmaceutical Use In Quality Assurance of Pharmaceuticals: A Compendium of Guilines and related Materials. 2nd update Edition World Health.

[3] Kareem S.A. and Akinbode A.O.W. 2002. Investigation in to (Fe,Pb, and Zn) as Pollutants.

[4] Source Along Highways and Junctions in Benin – City, Nigeria. Beagle Journal of Pure and Applied Sciences, Volume 2 Number 2, 59 – 60.

[5] Durube J.O. Ogwuegbu M.O.C. and Egwurugwu J.N. 2007. Heavy Metal Pollution and Biotoxic Effects. International Journal of Physical Sciences, 2(5): 112 – 118.

[6] Njiiar G.N., Iwara A.I., Offong R.A. and Deekor T.D. 2012. Assessment of Heavy Metal Status of Boreholes in Calaba South Local Government Area, Cross River State Nigeria. Ethiopian Journal of Environmental Science and Management vol 5 No1.

[7] Adepoju – Bello A.A. and Alabi O.M. 2005. Heavy Metals: A review. The Nigerian Journal of Pharmacy 37:41 – 45.

[8] United States Environmental Protection Agency (USEPA). 1986. Lead effects on Cardiovascular Function, Early Development and Stature: An Addendum to EPA Air Quality Criteria For Lead. In:Air Quality Criteria for Lead Vol. 1. Pp. 1-67.

[9] Hoppe M., Hulthen L., Halberg L. 2005. The Relative Bioavailability in Human of Elemental Iron Powders for use in Food Fortification. European Journal of Nutrition 45(1): 37– 44.

[10] Tenenbein M. 1996. Benefits of Paranteral Deferoxamine for Acute Iron poisoning. Journal of Toxicol Clin Toxicol 34(5) 485 – 489.

[11] ATSDR 1997. Draft for Public Comment (update). Toxicological Profile for Manganese Agency for Toxic Substances and Disease Registry, Atlanta, GA.

[12] Finley J.W. 1999. Manganese Absorption and Retention by Young Women is Associated with Serum Ferritin Concentration. American Journal of Clinical Nutrition 70: 37 – 43.

[13] Griffin A.E.1960. Significance and Removal of Manganese in Water Supplies. Journal of American Water Works Association 52: 13 – 26.

[14] King J.C. 2011. Zinc: An Essential but Elusive Nutrient. American Journal of Clinical Nutr. 94679S – 84S.

[15] Hambidge K.M. and Krebs N.F. 1995. Assessment of Zinc Status in Human. India Pediatr 62:169 – 180.

[16] Fosmire G.J. 1990. Zinc Toxicity. American Journal of Clinical Nutrition 51(2): 225-227.

[17] ATSDR 1990a. Agency for Toxic Substances and Disease Registry. Toxicological Profile of Copper, US Department of Health and Human Services, Public Health Service Department. Nolan k. 2003. Copper Toxicity Syndrome. Journal of Orthomol Psychiatry 12(4):270-282.

[18] Gantan P. and Irfan A. 2011. Heavy Metal Contamination Assessment of Karhargaon Dam Water near Chhindware City. Acta Clinica and Pharmaceutical India 1(1):7-9

[19] Ehi – Eromosele C.O. and Okiei W.O. 2012. Heavy Metal Assessment of Ground, Surface And Tap Water Samples in Lagos Metropolist using Anodic Stripping Voltammetry. Resources and Environment 2(3): 82 – 86.

[20] Agency for Toxic Substances and Disease Registry 1999. Toxicology Profile for Cadmium US Department of Human and Health Service.

[21] Nwankwoala H.O., Udom G.J and Ugwu S.A. 2011. Some Heavy Metals Investigations in Ground Water Sources in Yenagoa, Bayelsa, State-Nigeria. Journal of Applied Technology in Environmental Sanitation vol1 No 2 163 – 170.

[22] Adebayo A.A. 2004. Mubi Region A Geographical Synthesis. 1st Edition Paraclete Publishers, Yola, Nigeria, pp.1,19.

[23] Graphpad Instart 2003. Graphpad Instat® Version 3.00 for 95. Graphpad Software, San Diego, California, USA, at www.graphpad.com.

[24] World Health Organization (WHO). 2006 Guidelines for drinking water quality, Vol. 1,3rd ed.