HEAVY METALS POLLUTION OF GROUND WATER FROM AUTOMOBILE MECHANIC SITE: A CASE STUDY OF OTA/SANGO OTA AREA, OGUN STATE

Supported by tetfund

K. T. Dauda* and S. I. Dada

*Department of Chemical & Food Sciences, Bells University of Technology, Ota, Ogun State, Nigeria

*Corresponding author: toludaud@gmail.com

Received: March 11, 2020 **Accepted:** May 15, 2020

Abstract: In this study, heavy metal contamination of the groundwater at Ota/Sango Ota areas of Ogun State was analyzed. Forty borehole water samples were analyzed using Atomic Absorption Spectrophotometer for their Copper, Lead and Cadmium content and their levels compared with WHO specified maximum Control level. The maximum concentration of copper and lead in the samples analyzed is 0.383 and 2.184 mg/L, respectively. The concentration of the copper is within the WHO limit (1.0 mg/L) while that of lead is higher than 0.005 mg/L specified by WHO. The results show that the samples contained lead, which suggests a significant risk to the population since bore hole is the only source of their water supply.

Keywords: Heavy metal, pollution, groundwater, maximum contamination level, AAS

Introduction

A mechanic village is an area of open land allocated to automobile repair workers in the vicinity of an urban centre. In Nigeria, for example, the mechanic village in Ota has an area of 136 acres; one in Obasanjo has 101 acres of land, and one in Toll Gate, Oju Ore and Iyana-Yesi has about 74 acres of land. A typical city usually has one to three mechanic villages, in proportion to its population and activities, but some cities have more. With the progress of the automobile industries in Europe and the United States moving towards greener electric cars, the international trade in used motor vehicles is likely to increase. As a result, great numbers of used fuel - guzzling cars of all models are expected to stream into developing countries in this first quarter of the century. Urban areas will react to the increased supply by establishing more mechanic villages, and more developing countries may buy the mechanic village concept.

Heavy metals contaminants including Pb, Ar, St, Ba, and Hg are highly deleterious to human health and therefore not expected to be found in drinking waters at all.

In Nigeria today, the use of ground water has become an agent of development because the government is unable to meet the increasing water demand. Thus, inhabitants have had to look for alternative ground water sources such as shallow wells and boreholes. The quality of these ground water sources are affected by the characteristics of the media through which the water passes on its way to the ground water zone of saturation (Adeyemi *et al*., 2007); thus, the heavy metals discharged by industries, traffic, municipal wastes, hazardous waste sites as well as from fertilizers for agricultural purposes and accidental oil spillages from tankers can result in a steady rise in contamination of ground water (Vodela *et al*., 1997; Igwilo *et al*., 2006).

The aim of this study is to determine the level of contamination of groundwater sources in Ota/Sango Ogun State.

Materials and Methods

All chemicals and reagents were of the analytical grade and were obtained from BDH Chemicals Ltd, UK. 5% trioxonitrate (V) acid was used for the digestion of the samples. Copper sulfate-5-hydrate, Cadmium Chloride, and Lead Nitrate were used for the preparation of Copper, Cadmium and Lead standards, respectively.

Description of study area

Ota is a town in Ogun State, Nigeria, and has an estimated 163,783 residents living in or around it. Ota is the capital of the Ado-Odo/Ota Local Government Area. The Local Government came into existence on May 19, 1989, following the merging of Ota, part of the defunct Ifo/Ota Local Government with Ado-Odo/Igbesa Areas of the Yewa South Local Government. Ado-Odo/Ota borders on metropolitan Lagos. The Local Government Area is the second largest in Ogun State and it is headquartered at Ota at (6°41′00″N3°41′00″E) to the north of the Area. Ota/Sango has an estimated motor vehicle population of over 100,000. These require regular maintenance provided for in more than 9 mechanic villages scattered around the city.

Sample collection and location

Ground water samples were randomly collected from 39 sampling sites (boreholes) in 9 different areas of Ota/ Sango in Ogun, Nigeria. These areas include; Obasanjo, Ojuore, Idirokoroad, Ilo Ewela, Iyana Yesi, Tarmac, Ijoko Road, Winners, and Toll gate. Table 1 gives the sample information. A non-mechanic area was taking to serve as control labelled ZCB. The samples were collected during the month of October 2018. Table 1 shows the borehole samples code and their locations.

Sample digestion

To ensure the removal of organic impurities from the samples and thus prevent interference in the analysis, the samples were digested with concentrated nitric acid. 10 ml of nitric acid was added to 50 ml of water in a 250 ml conical flask (Momodu and Anyakora, 2010). The mixture was evaporated to half its volume on a hot plate after which it was cooled and then filtered.

Standard preparation

A 1000 ppm stock solution of Copper, Cadmium, and Lead were prepared by dissolving in a 1-litre volumetric flask 100 mg, 1.6309 and 1.5985 g of Copper sulfate-5-hydrate, Cadmium chloride and Lead nitrate respectively with distilled water.

The mixture was shaken, and the flask made up to the 1 litre mark with distilled water for each metal. Calibration solutions of the target metal ions were prepared from the standard stock by serial dilution.

Sample analysis

The digested water samples were analyzed for the presence of Copper, Cadmium, and Lead using the Buck Scientific 210VGP Atomic Absorption Spectrophotometer. The calibration plot method was used for the analysis.

Air-acetylene was the flame used and hollow cathode lamp of the corresponding elements was the resonance line source, the wavelength for the determination of the elements was 324.7, 228.8 and 283.31 nm for copper, cadmium and lead, respectively. The digested samples were analyzed in duplicates with the average concentration of the metal present being displayed in mg/L by the instrument after extrapolation from the standard curve.

Results and Discussion

The concentration of the copper and lead ions in the borehole samples is shown in Figs. 1 and 2, respectively. Table 2 gives a summary of the Average, Maximum and Minimum measured values of heavy metals contents ($mg.kg^{-1}$) of borehole water around the auto mechanic study area.

Table 1: Borehole Samples code and locations

Code	Site area/location	GPS coordinates
AB2	Shop 2, Ota-Idiroko Road	6°41' 13"N; 3°13' 18"E
AB3	Shop 3, Ota-Idiroko Road	6°41' 11"N; 3°13' 16"E
AB4	Shop 4, Ota-Idiroko Road	6°41' 10"N; 3°13' 8"E
AB5	Shop 5, Ota-Idiroko Road	6°41' 7"N; 3°13' 0"E
BB6	Workshop 1, Obasanjo Farm Road	6°40' 59"N; 3°12' 30"E
BB7	Workshop 2, Obasanjo Farm Road	6°40' 56"N; 3°12' 28"E
BB8	Workshop 3, Obasanjo Farm Road	6°40' 50"N; 3°12' 30"E
BB9	Workshop 4, Obasanjo Farm Road	6°40' 48"N; 3°12' 28"E
BB10	Workshop 5, Obasanjo Farm Road	6°40' 48"N; 3°12' 30"E
BB11	Workshop 6, Obasanjo Farm Road	6°40' 41"N; 3°12' 30"E
BB12	Workshop 7, Obasanjo Farm Road	6°40' 40"N; 3°12' 30"E
BB13	Workshop 8, Obasanjo Farm Road	6°40' 33"N; 3°12' 28"E
BB14	Workshop 9, Obasanjo Farm Road	6°40' 32"N; 3°12' 28"E
BB15	Workshop 10, Obasanjo Farm Road	6°40' 31"N; 3°12' 29"E
BB16	Workshop 11, Obasanjo Farm Road	6°40' 23"N; 3°12' 28"E
BB17	Workshop 12, Obasanjo Farm Road	6°40' 17"N; 3°12' 29"E
CB18	Lola eng workshop 1, Off Idiroko Road	6°41' 1"N; 3°10' 40"E
CB19	Lola eng workshop 2, Off Idiroko Road	6°41' 1"N; 3°10' 35"E
DB20	2, OriokeItunu Street, Toll Gate	6°41' 36"N; 3°15' 17"E
EB21	1a, IloAwela Road, Toll Gate	6°41' 32"N; 3°15' 17"E
EB22	2, IloAwela Road, Toll Gate	6°41' 34"N; 3°15' 16"E
FB23	AnuOluwapo Close, Toll Gate	6°41' 31"N; 3°15' 15"E
GB24	Workshop 1, Iyana Yesi	6°40' 45"N; 3°11' 0"E
GB25	Workshop 2, Iyana Yesi	6°40' 38"N; 3°11' 1"E
GB26	Workshop 3, Iyana Yesi	6°40' 34"N; 3°11' 2"E
GB27	Workshop 4, Iyana Yesi	6°40' 24"N; 3°10' 59"E
HB28	Banjoko Close, Tarmec Road, Sango Ota	6°42' 15"N; 3°15' 5"E
IB29	12, Tarmec Road, Sango Ota	6°42' 38"N; 3°14' 56"E
IB 30	14, Tarmec Road, Sango Ota	6°42' 22"N; 3°15' 12"E
IB31	17, Tarmec Road, Sango Ota	6°42' 20N; 3°15' 10"E
JB32	21, Babakonkolo Street, Sango Ota	6°42' 19"N; 3°15' 8"E
KB33	3, Ijoko Road Sango Ota	6°70' 66"N; 3°20' 22"E
KB34	6, Ijoko Road Sango Ota	6°69' 52"N; 3°19' 10"E
KB35	7, Ijoko Road Sango Ota	6°69' 54"N; 3°19' 12"E
LB36	Bells B/Stop, off Idiroko Road	6°40' 3"N; 3°11' 9"E
LB37	Bells B/Stop, off Idiroko Road	6°40' 5"N; 3°11' 8"E
MB38	Shop 1, Opp. Winners, Ota	6°40' 9"N; 3°11' 40"E
MB39	Shop 4, Opp. Winners, Ota	6°40' 10"N; 3°11' 39"E
ZCB	The Bells (Distilled water)	6°40' 15"N; 3°11' 25"E

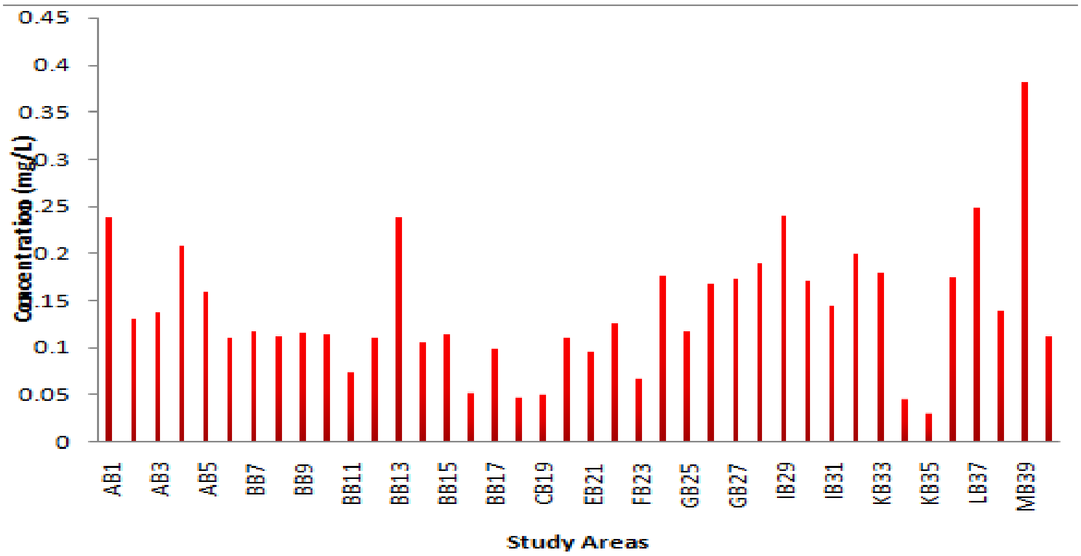

Fig. 1: Plot of concentration of Cu (mg/L) ion in Borehole samples

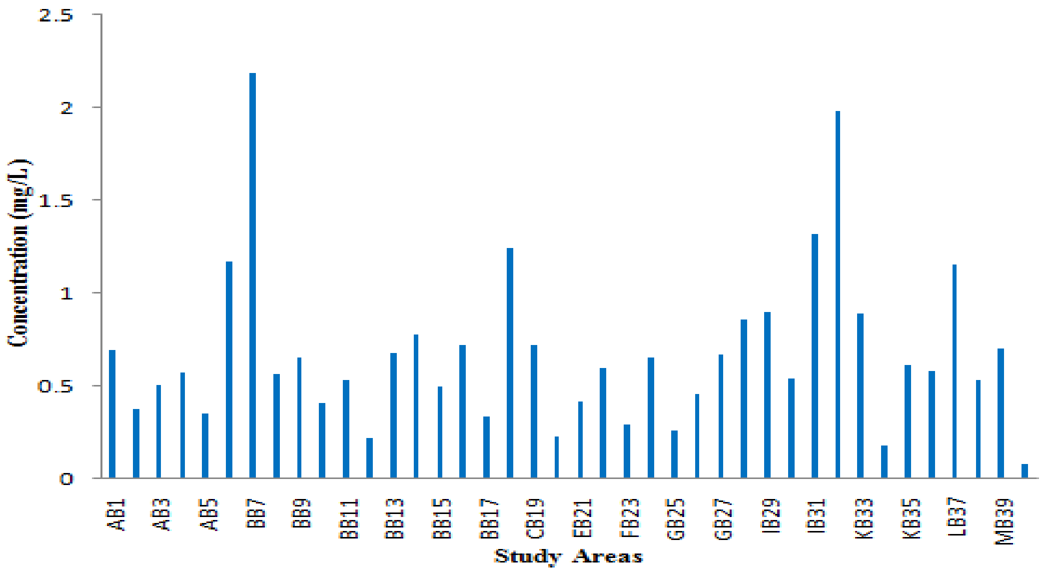

Fig. 2: Plot of concentration of Pb (mg/L) ion in Borehole samples

Table 2: Average, maximum and minimum measured values of heavy metals contents (mg.kg^{-1}) of borehole water around the auto mechanic study area

Sample/ Location	Measurement	Cu(mg/L)	Pb(mg/L)	Sample/ Location	Measurement	Cu(mg/L)	Pb(mg/L)
AB	Average	0.881	2.471	**GB**	Average	0.641	2.023
	Min	**0.132**	**0.349**		Min	0.119	0.251
	Max	**0.24**	**0.564**		Max	0.177	0.669
BB	Average	1.383	8.674	**HB**	Average	0.192	0.858
	Min	0.056	0.214		Min	0.192	0.858
	Max	0.240	2.184		Max	0.192	0.858
CB	Average	0.1	1.952	**IB**	Average	0.559	2.774
	Min	0.048	0.712		Min	0.146	0.536
	Max	0.052	1.240		Max	0.241	1.314
DB	Average	0.113	0.223	**KB**	Average	0.201	1.980
	Min	0.113	0.223		Min	0.201	1.980
	Max	0.113	0.223		Max	0.201	1.980
EB	Average	0.225	1.003	**LB**	Average	0.426	1.732
	Min	0.097	0.411		Min	0.176	0.578
	Max	0.128	0.592		Max	0.250	1.154
FB	Average	0.069	0.289	**MB**	Average	0.524	1.219
	Min	0.069	0.289		Min	0.141	0.523
	Max	0.069	0.289		Max	0.383	0.696
				ZCB		0.114	0.005

Calibration curves were obtained using a series of varying concentrations of the standards for the two metals. The calibration curves were linear with a correlation coefficient ranging from 0.945 to 0.998. Table 3 shows the level of copper and lead ion in the studied water samples.

Table 3: The level of copper and lead ion in the water samples

Item	Copper ion	Lead ion
Number of samples	39	39
Minimum concentration detected	0.032 mg/L	0.172mg/L
Maximum concentration detected	0.383 mg/L	2.184 mg/L
WHO Control limit	1.0mg/L	0.01 mg/L
Number above Control limit	Nil	39
% above Control level	0%	100%

In the analysis of the water samples collected for Copper, all 39 samples were fully within the limits of WHO Maximum Contaminant Level (1.0 mg/L) with the maximum concentration being 0.383 mg/L.In the analysis of the water samples collected for Lead, all the 39 samples have concentrations above the Maximum Contaminant Level (0.01 mg/L) with the maximum concentration being 2.184 mg/L. 100% of the samples analysed for lead has concentration above the control level.

The three elements studied in this research work namely: Copper, Lead and Cadmium have the following WHO recommended Maximum Contaminant Levels (MCL); 1.0, 0.01 and 0.003 mg/L, respectively (WHO, 2000; Hammer and Hammer Jr., 2004). Cadmium was not detected in all the samples analyzed. The concentration of copper and lead in the control sample is 0.114 and 0.005 mg/L respective which are both within the acceptable limit specified by WHO.

For the protection of human health, guidelines for the presence of heavy metals in water have been set by different International Organizations such as USEPA, WHO, EPA, European Union Commission (Marcovecchio *et al*., 2007); thus, heavy metals have a maximum permissible level in water as specified by these organizations. Contaminant level is an enforceable standard set at a numerical value with an adequate margin of safety to ensure no adverse effect on human health. It is the highest level of a contaminant that is allowed in a water system.

Comparing the level of concentration of lead in water samples as obtained in this study to some of the previous researchers such as Momodu and Anyakora (2010), Adelekan and Abegunde (2011), Adekitan *et al.* (2017) and Nwachukwu *et al.* (2010) in other auto-mechanic locations.

According to Momodu and Anyakora (2009), research it was discovered that 36.73% of the total contained Lead in levels above the Maximum Contaminant Level (0.01 mg/L) with the maximum concentration detected being 0.024 mg/L compared to this research work in which all the 39 water samples representing 100% of the total contained Lead in levels above the Maximum Contaminant Level (0.01 mg/L) with the maximum concentration detected being 2.184 mg/L. This evidence of elevated Lead in the water samples may pose threat or problems to the user of the groundwater. The possible long-term effects of chronic exposure to lead present in drinking water are subject to considerable public concern (Zietz *et al*., 2007).

These results are of concern as lead has been recognized for centuries as a cumulative general metabolic poison (Adepoju-Bello and Alabi, 2005). It is a neurotoxin and is responsible for the most common type of human metal toxicosis (Berman, 1980). Also, studies have linked lead exposures even at low levels with an increase in blood pressure (Zietz *et al*., 2007) as well as with reduced intelligence quotient in children (Needleman, 1993) and with attention disorders (Yule and Rutter, 1985).

Conclusion

The results show high concentration of lead above the WHO specified Maximum Contaminant Level for all the samples analyzed. This suggests a significant risk to the population, since the borehole is the major source of water supply in this environment.

Acknowledgment

We would like to thank the Bells University of Technology Ota, Ogun State for providing the facilities for the research.

Conflict of Interest

Authors declare that there is no conflict of interest reported in this work.

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