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Heavy Metals and Quality of Groundwater Resource Assessment in Delta State

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Abstract: Study on the heavy metals and water quality assessment was carried out in selected wells dug in Udu community of Delta state which comprise three locations; Delta Steel town, Orhuwhorun and Ovwian to determine the potability of the water. The levels of heavy metals such as Chromium, Mercury, Cadmium, Lead, Zinc, and Iron were assessed in water and sediment respectively. Two hand-dug wells per location were sampled monthly for a period of ten (10) months from March to December. Analytical result obtained indicated that the concentrations of the heavy metals in water samples were below 0.1mg/l, where the concentrations of Chromium and Mercury were found to be 0.001mg/l; Cadmium, 0.001-0.002mg/l; Lead, 0.001-0.014mg/l; Zinc, 0.015-0.058mg/l and Iron, 0.035-0.132mg/l respectively. However, the concentrations of heavy metals were high in sediment as Chromium concentration was 0.01-0.24mg/kg; Mercury, 0.002-0.005mg/kg; Cadmium, 0.01-2.08mg/kg; Lead, 19.12-29.35mg/kg; Zinc, 11.56-39.77mg/kg; and Iron, 418.64-455.33mg/kg respectively. Although values fell within acceptable limit, however, their ability to bio accumulate in living organism tissues possesses a great risk to human lives if left unchecked.

Keywords: Heavy metal, groundwater, hand dug wells, water quality, delta state.

1. INTRODUCTION

Generally, water is something considered to be synonymous to life. It is one of nature's most important gifts to mankind. The survival of all living things is directly dependent on water. To say that man usually requires a regular and accessible supply of water because it forms a major component of the protoplasm and thus provides an essential requirement for vital physiological and biochemical processes [1]. In fact, the body of man requires about two-third of water for him to live [2]. In the absence of potable water supply, man and other living things will eventually die [3]. Therefore, the health status of this important element or commodity from its various sources is of uttermost importance. It is therefore imperative that as we drink from different sources on a daily basis, our consciousness in regards to the quality of the water we drink should be a key priority [4]. Ground water has been the major source of water for the Nigeria populace. Families and individuals who cannot afford the bore-hole water supply system due to inefficiency in the Nigeria power supply, easily resort to hand dug wells that are quite cheap and do not require the use of electricity to operate. Therefore, the use of hand dug wells in Nigeria is currently on the increase and water from this source is not been monitored by regulatory agencies to ensure its quality before utilization.

Water quality has been recognized to be associated with the source environment, including its physical, chemical and biological components, anthropogenic activities as well as management measures of the water resource [5,6]. This paper seeks to know the indices of the heavy metals in selected wells in Udu communities. Heavy metal by definition is expressed as a chemical element whose specific gravity out least outweighs that of the specific gravity of water 5times. Some heavy metals at low concentrations are needed for proper physiological function but at higher concentrations they are dangerous. A lot of persons have been exposed to the toxic effect

of heavy metal through various means including consumption of unsafe water. They bioaccumulate in tissues of living organisms with the tendency of displacing essential minerals like copper, magnesium and calcium and thus mitigate against the proper functioning of body system organs [6]**.** It is therefore imperative to access the levels of heavy metals in hand dug wells of Udu community, being their primary source of water.

2. METHODOLOGY

2.1 The Study Area

The area under study (Figure 1) is located in Udu Local Government Area of Delta State, Nigeria between latitudes 05°29′ 30.0″ to 05°30′30.1″ N and longitudes 05°48′57.1″ to 05°51′41.2″ E. The climate of Udu community is usually systematic. Rainfall in this area is seasonal, occurring in the wet period (April-October). Suffice to know that direct recharge by precipitation to groundwater majorly takes place in the wet period or raining season. Annual precipitation depth in raingauge stations, from the study area displays a decreasing trend over the last 50 years (Dept. of meteorological station). This area experiences a dry season spanning from November to March and a wet or rainy season between April to October. It however, has a short break in mid-August known as August break.

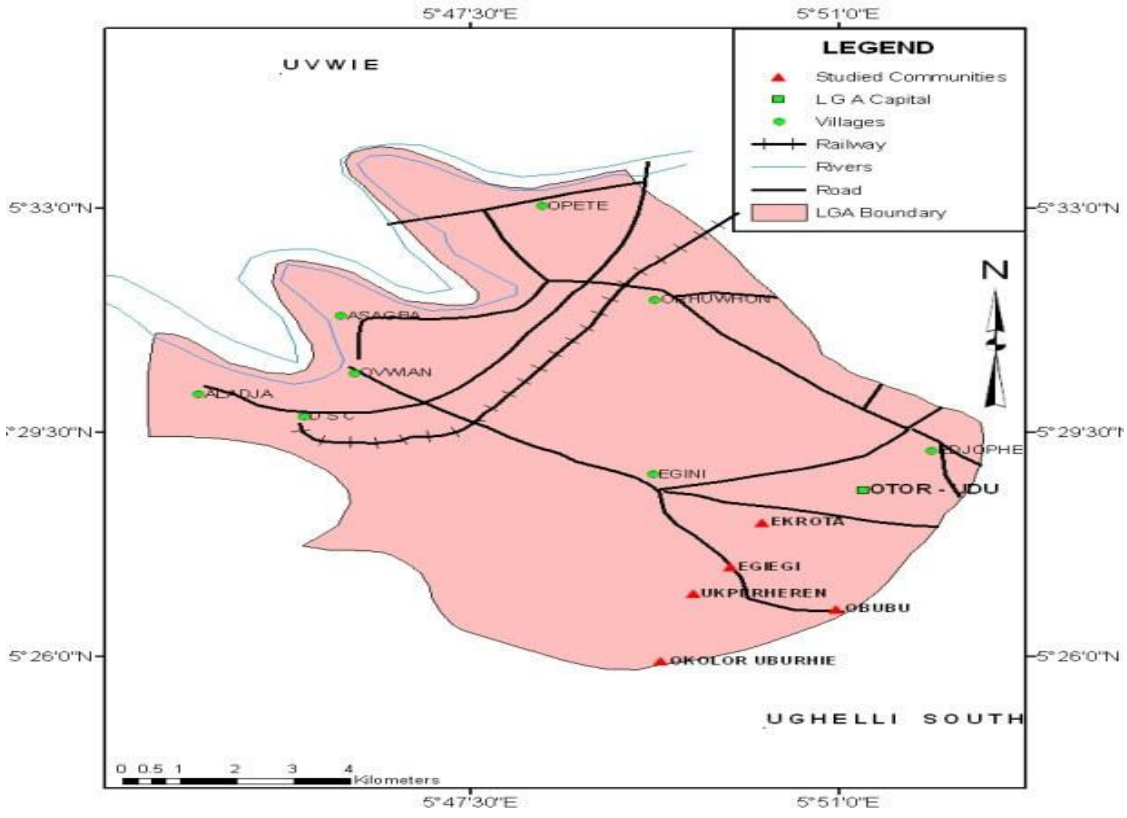

Figure 1: Map of Udu Local Government Area showing the study area [7]

Total annual and average precipitation is taken to be about 2674 mm and 223mm (Figure 2**)** respectively, while annual and average relative humidity is about 840mm and 70mm respectively (Dept. of Meteorological station).

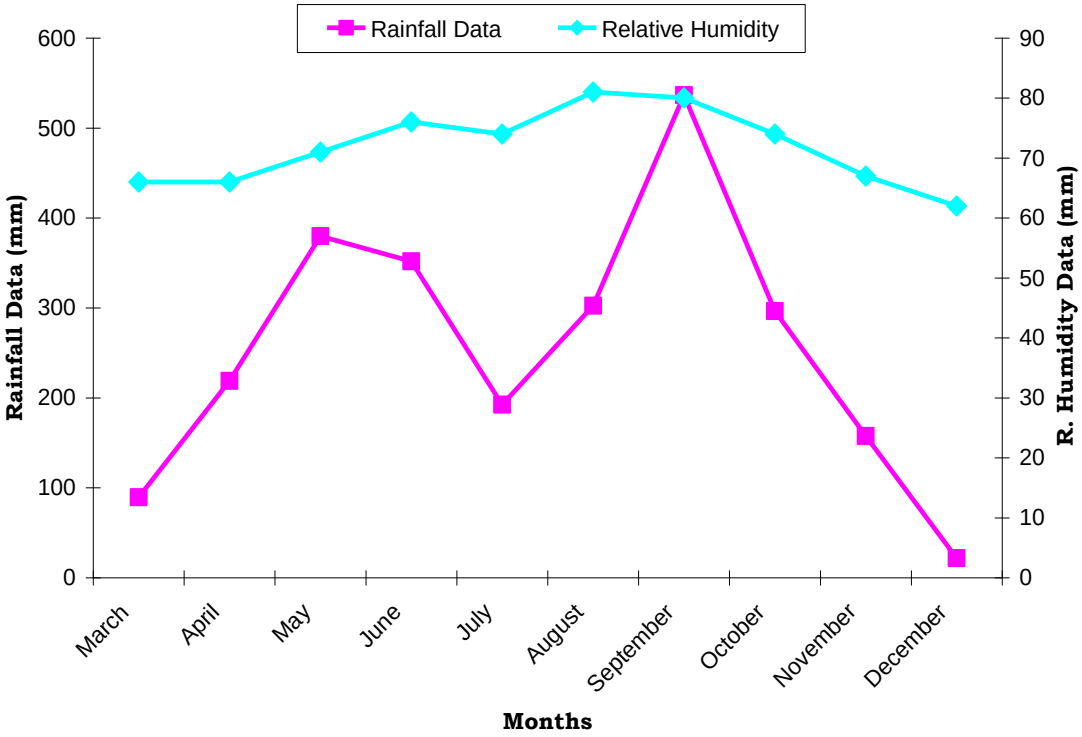

Figure 2: Fluctuation of rainfall and relative humidity within the study period (Dept. of Meteorological station, Nigeria)

2.2 Water Sample Analysis

About 200ml water samples were collected from the wells, filtered through whatman 0.45um glass fibre and put into acid cleaned 250ml polypropylene bottles and then acidified with concentrated Nitric acid to pH not exceeding 2.0. The treated water samples were further analyzed for heavy metal concentration using an atomic absorption spectrophotometer.

2.3 Sediment Sample Analysis

Sediment samples were collected from the sample stations by means of a grab pre-treated of debris and dried. Here, the dried samples were further processed and analyzed for particle size analysis (PSA) using the combined wet and dry sieving technique of [8] while the sediment extracts analyzed further for heavy metals.

2.4 Statistical Analysis

The statistical software SPSS was used to perform statistical analysis of data and Microsoft excel (2007) for descriptive statistics. Data obtained were subjected to Pearson's coefficient of correlation (r) to determine the interdependency of the various parameters while a one way Analysis of Variance (ANOVA) was used to test for significance. Where significant differences existed from ANOVA, Duncan Multiple Range (DMR) test was performed to determine the source of significant difference.

3. RESULTS AND DISCUSSIONS

Generally, result obtained from the study locations showed that heavy metal levels were very low in most of the well water samples as presented in Table 1. However, they remain a health concern even at such very low levels because of their ability to bio-accumulate in the tissues of living organism overtime. The concentration of heavy metals in water samples were compared with WHO and SON permissible limits for drinking water, and values obtained fell within the limits set by both organizations as guideline for drinking water [9]. Chromium,

Table 1: Mean summary of trace metals in water of selected hand dug wells in Udu community.

Parameter	Units	Well 1 and 2 (DSC)		Well 3 and 4 (Orhu)		Well 5 and 6 (Ovwian)		WHO	SON
		Mean±S.E	Min-Max	Mean±S.E	Min-Max	Mean±S.E	Min-Max		
Lead	mg/l	0.001 ± 0.0	0.001-0.003	0.014 ± 0.005	0.001-0.046	0.012± 0.004	0.001-0.049	0.01	0.01
Cadmium	mg/l	0.002 ± 0.001	0.001-0.015	0.001±0.0	0.001-0.001	0.001±0.0	0.001-0.001	0.003	0.003
Zinc	mg/l	0.015 ± 0.003	0.001-0.036	0.024± 0.007	0.008-0.078	0.029± 0.008	0.008-0.087	3.0	3.0
Chromium	mfg/l	0.001 ± 0.0	0.001-0.001	0.001± 0.0	0.001-0.001	0.001± 0.0	0.001-0.001	0.05	0.05
Iron	mg/l	0.046 ± 0.006	0.029-0.098	0.088± 0.009	0.026-0.128	0.132± 0.030	0.026-0.36	0.30	0.30
Mercury	mg/l	0.001 ± 0.0	0.001-0.001	0.001± 0.0	0.001-0.001	0.001± 0.0	0.001-0.001	0.006	0.001

Key: DSC (Delta Steal Complex) Township; Orhu (Orhuwherun) WHO (World Health Organization) and SON (Standard Organization of Nigeria)

Mercury and Cadmium generally recorded low levels in the well water from March to December, as a result there was no significance difference (P>0.05) in the wells under study. However, Lead concentration in the well water revealed slight variations from 0.001mg/l in DSC to 0.014mg/l in Orhuwhorun. Highest value was recorded in April. Pattern of fluctuation in Zinc values showed low values across the wells from March to December except in wells 5 and 6 located in Ovwian which recorded highest mean values in March. The mean values for Zinc varied from 0.015mg/l in DSC wells (1 & 2) to 0.058mg/l in Ovwian wells (5 & 6). The mean concentration values of Iron varied from 0.035mgl/1 obtained at well 1 & 2 to 0.132mgl/1 recorded at well 5 & 6, respectively. Temporal variations were minimal as no discernible seasonality was observed. However, highest value was recorded in August. There was a significance difference (P>0.05) in the levels of Iron obtained in the study wells. A posterioir DMR test showed that well 5 & 6 were the cause of the significant difference obtained. The concentrations of heavy metals in sediment in the study locations as presented in Table 2 decreased as follows; Delta Steel Company township decreased in the sequence of Fe > Zn > Pb > Cd > Cr > Hg; Orhuwhorun decreased in the sequence of Fe > Zn > Pb > Cr > Cd > Hg while Ovwian decreased in the sequence of Fe > Pb > Zn > Cd > CR > Hg. However, Concentration of Iron and Zinc in water and sediment was quite significant. Values in sediment samples range from (418.64 - 455.327 mg/kg) for Fe and (11.56 - 39.766 mg/kg) for Zn. This calls for concern because toxicity of Iron has been known to be the cause of metabolic and genetic diseases while Zinc causes diarrhea. In addition, they affect the organoleptic quality of water like other metals e.g. copper and aluminum[10].

Table 2: The mean summary of trace metals in sediments of selected wells in Udu community (mg/kg).

Wells/Location	Fe	Zn	Pb	Cd	Cr	Hg
1 and 2(DSC) Mean Values	436.50	39.77	29.350	2.080	0.120	0.005
3 and 4(Orhuwhorun) Mean Values	455.33	58.68	19.115	0.012	0.239	0.003
5 and 6 (Ovwian) Mean Values	418.64	11.58	20.980	0.125	0.010	0.002
P-Value	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05

High levels of Iron might also be attributed to eroding of rocks and soil containing Iron [11]. The high concentration of heavy metals in bottom sediments of the hand dug wells in Udu community was in agreement with past research, revealing that bottom sediment are a sink for heavy metal accumulation than overlying water [8]. The levels of lead in sediment ranged from 19.12 mg/kg to 29.35 mg/kg. The lead levels determined agrees well with previous study [12]. Lead exposure causes microcytic, hypochromic anemia with basophilic stippling of erythrocytes [13], hyperactivity, anorexia, decreased play activity, low intelligence quotient and poor school performance have been observed in children with high lead levels [14]. The ability of Pb^{2+} to undergo metathesis reactions with Zn^{2+} and Ca^{2+} metalloproteins resulting in loss of metabolic function continues to be a primary hypothesis underlying the detrimental effects of lead exposure [5]. Lead is also known to cause a wide range of pregnancy problems, like early membrane rupture and spontaneous abortion. It can even result in erectile dysfunction and cardiovascular diseases [6].

Table 3: Relative humidity and rainfall Data.

Months	Rainfall data	Relative Humidity
March	89.5	66
April	218.9	66
May	379.8	71
June	351.7	76
July	192.4	74
August	302.4	81
Sept.	536.6	80
Octo.	296.4	74
Nov.	157.7	67
Dec.	21.8	62

Chromium concentration ranged between 0.0111-0.2389mg/kg in sediment. Low levels were determined in Ovwian while significant levels were recorded in DSC and Orhuwhorun in the month of April and May. This must be totally removed from water because they are carcinogenic, long exposure may cause kidney, liver and nerve tissue damage [15,16]. The levels of cadmium, and mercury (0.0123 -2.0796 mg/kg and 0.0016 - 0.0049 mg/kg, respectively) were quite low in the sampled location. Cadmium is highly toxic, it has the tendency to accumulate in the body and eventually cause effects such as tabular dysfunction, disturbances in calcium homeostasis and metabolism. It is capable of inducing renal, hepatic and testicular injury. Source of trace metal contamination may be from natural processes within the ground, industrial and agricultural activities, and sewage discharges [17].

5. CONCLUSION

The heavy metals and water quality assessment of groundwater resource in delta state has shown that heavy metals in well water samples were within the permissible limits set by WHO and SON as standards for drinking water. However, proper and regular monitoring of the well water resource is essential especially considering levels in sediment samples. This can help checkmate any future increase in heavy metal concentration in the well water beyond the recommended limit. It is therefore, suggested and advised that communities and individuals of Udu Local Government take responsibility of their well-being by testing their drinking water sources periodically.

REFRECENCES

[1] E. C. Ukponge, and B.B. Okon. " Comparative Analysis of Public and Private Borehole Water Supply Sources in Uruan Local Government Area of Akwa Ibom State", IJASTechnology, 3, 1, (2013), 75-91.
[2] G.K. Adamu and O.A. Adekiya. "An assessment of water quality of boreholes around selected landfills in Kano metropolis", AS, 11, 2, (2010),129-133.
[3] G. Joanne." Ratings of water safety worldwide", Living stone Press, New York, (2000), 6-8.
[4] America Public Health Association (APHA). "Standards for examination of water and wastewater", 19th ed. Washington, D.C. (1998), 542.
[5] S.O. Adefemi and E.E. Awokunmi. "Determination of physicochemical parameters and heavy metals in water samples from Itaogbolu area of Ondo-State, Nigeria", AJEST, 4, 3(2007),145-148.
[6] U.A. Winifred, U.B. Nsikak, A.A. Anuoluwa, O.E. Cyril, and O.A, Ifedayo. Assessment of trace metals in drinking water and groundwater sources in Ota, Nigeria. IJSRP, 4, 5, (2014), 1-4.
[7] H.M Ijeomah. "Utilization of tortoise (chelonoides nigra, quoy and gaimard, 1824) in five selected communities in Udu Local Government Area of Delta State, Nigeria". JRFWE, 7, 2, (2016), 1-13.
[8] J.O. Olomukoro and C.N Azubike. "Heavy metals and Macroinvertebrate communities in Bottom sediment of Ekpan creek, Warri, Nigeria", JJBS, 2, 1, (2009),1-8.
[9] World Health Organization. "Guidelines for Drinking Water Quality: Incorporating first addendum: Vol. 1 – Recommendations": 4th ed. Geneva. (2011).
[10] U.U. Egereonu. "Assessment of atmospheric aerosols from three satellite stations: Heavy metal pollutants". JAAMSTE, 65, (2004), 71-88.
[11] , I.J. Tekwa, M.U. Abba and H.H. Ray. "An assessment of Dugwell water quality and Use in Mubi, Adamawa State", JE, 1, 1, (2006), 11-20.
[12] K.N. John and E.O. Orish. "Lead and cadmium levels of commonly administered pediatric syrups in Nigeria: A public health concern. The science of total environment", (2009) 209.
[13] J.K. Nduka, and E.O. Orisakwe. Assessment of environmental distribution of lead in some municipalities of SouthEastern Nigeria, IJERPH, 7, 6, (2010), 2501-13.
[14] D. A. Aremu, J.F Olawuyi, S. Meshitsuka, M.K. Sridhar, and P.A. Oluwande. "Heavy metal analysis of groundwater from Warri, Nigeria", IJEHR, 12, (2002), 261-267.
[15] T.V. Otukune and C.O. Biukwu. "Impact of Refinery Influent on Physico-chemical properties of a water body on Niger Delta", JAEER 3, (2005), 61-72.

[16] A.B Edet and C.S. Okereke. "A regional study of saltwater intrusion in Southeastern Nigeria based on the analysis of geoelectrical and hydrochemical data", EG, 40, (2001), 1278-1284.
[17] K.G. Tiller. "Heavy metals in solids and their environmental significance", Advances in Soil Sciences, 9, (1989), 113-142.