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IMPACT OF AN OPEN WASTE DUMP SITE ON HEAVY METAL CONCENTRATION OF BOREHOLE WATER IN BIOGBOLO YENAGOA, BAYELSA STATE

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ABSTRACT

An investigation of select heavy metals in portable borehole water near a waste dump site(04056’38.1”N and 006019’38.9”E)in Green-villa Road, Biogbolo, Yenagoa, Bayelsa State was conducted in order to determine the levels of these metals in water and the possible implication of metal intrusion from this dump sites. Six (6) heavy metals; Copper (Cu), Lead (Pb), Iron (Fe), Cadmium (Cd), Nickel (Ni), and Chromium (Cr) were investigated in four (4) borehole spots located 25m, 50m, 100m and 200m near the dump site. Water samples were collected in triplicates from the four (4) boreholes located at A(04056’36.8”N and 006019’39.9”E); B (04056’36.6’’N and 006019’37.3”E); C (04056’35.1’’N and 006019’35.3’’E) and D (04056’34.8”N and 006019’36.9”E) all in Biogbolo, Yenagoa, with the aid of 50ml plastic bottles with stoppers. Samples were then put into a black container and transported to the laboratory of the Department of Chemical Sciences, Niger Delta University Amasoma. Analyses for heavy metals was done using model 210VGP of the Basic Scientific Atomic Absorption Spectrophotometer series with Air Acetylene gas mixture as Oxidant. Data were analysed for mean, standard deviation and Analyses of Variance (ANOVA) at 95% confidence limit with the aid of SPSS® software. Result from the investigation revealed higher than permissible levels of Fe, Pb and Ni in all sampling points. While Cu, Cd and Cr exhibited contents in water that are below permissible limits. There were No significant differences (P=0.05) between borehole water obtained from sampling stations. Based on the findings from this research, it can be concluded that borehole water in Biogbolo, yenagoa may pose a serious health problem if used for drinking. It is therefore recommended that boreholes in Yenagoa should be given adequate treatment before dispensing to the public and that Government should prohibit open dumpingin streets and residential areas as it portends danger

Keywords: Waste, Dump site, Heavy metals, Borehole, Water, Yenagoa

1. INTRODUCTION

Yenagoa is the capital city of Bayelsa State, Nigeria. It is touted as the capital of the Ijaw speaking nation and positioned centrally within the womb of the Niger Delta. It parades a diverse ecology with a myriad of creeks and estuaries running adjacent its low lying landscape. It has an estimated population of Six Hundred Thousand (600,000) inhabitants and play host to multinational oil and gas companies doing business within and around its periphery (Naluba, 2011) The city is characterized by massive solid waste generation from its inhabitants, as waste is an inevitable outcome of all human activities. These wastes are deposited in dump sites and are composed primarily of household preparation, cooking and serving of food, market waste and non-degradable materials. Waste dump sites are areas set aside for the disposal of unwanted materials which could be organic or inorganic (solid or non-solid waste).

Unfortunately, like the entire Niger Delta, waste is not managed or treated properly (Obire et al, 2003). Waste if improperly treated result in toxicants especially heavy metals, which ultimately sip into the soil and intrude portable water sources.These wastes could be hazardous pollutants to ground water as variety of toxic chemicals found as stagnant rain water soaks through the layers of solid waste inwaste dumpsites. Also, Chemical, biological and physiological processes cause the leaching of hazardous chemicals from different waste materials to form hazardous leachates (Kjeldsen et al, 2017). Some of the toxic pollutants that leach from dumpsites are heavy metals, poly-brominated diphenyl ethers, polychlorinated biphenyl and other toxic organic compounds.

In Yenagoa, the provision of portable water from ground water is often carried by non-professionals and the potential of ground water contamination by refuse dump sites, septic tanks are majorly not taken into consideration when water boreholesare drilled.Since there is uncontrolled and unmonitored wastes disposal in the entire yenagoa city, there is an acute need to study heavy metals characteristics of Borehole water near waste dump sites. This will serve for purposes of determining the threat the dump sites pose to humans and the environment.

2. MATERIALS AND METHODS

2.1 Description of study Area

Yenagoa is a cosmopolitan city that hosts a lot of people living and doing diverse businesses. The city is relatively unplanned and there is hardly a distinct differentiation between high density and low density neighbourhoods. Waste is hardly treated and managed properly anywhere within the city. Therefore a popular dump site located at Green villa junction(04^{0}56’38.1”N-006^{0}19’38.9”E),BiogboloYenagoa was chosen as the reference dump site. Four (4) boreholes situated around the dump sites were chosen for the study.

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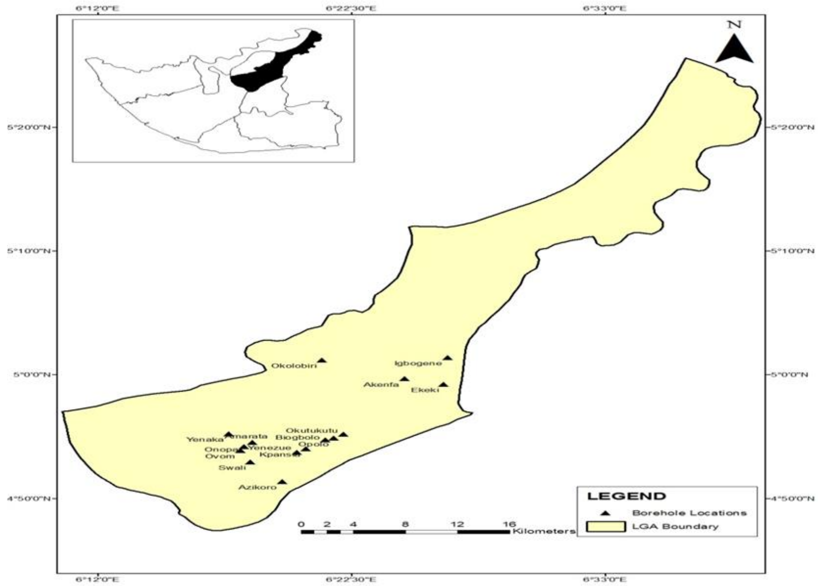

Figure 1: Map of Bayelsa State showing Yenagoa.

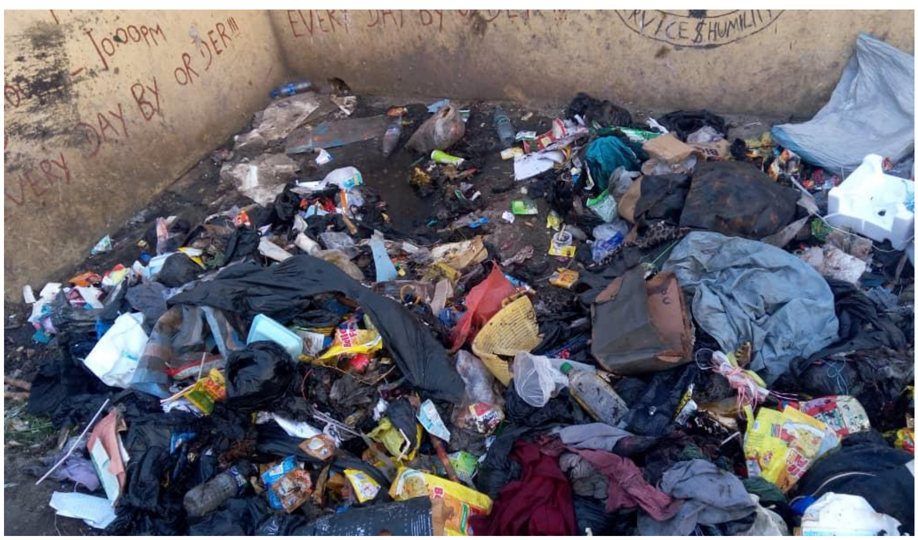

Plate 1: Refuse Disposal site at Greenvilla Road, Biogbolo, Yenagoa

2.2 Selection of sampling point

The following Boreholes stations were selected based on their proximity to the dumpsite.

:**Table 1: Sample stations with coordinates, elevation and distance from dump site**

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Description of Study Area	Coordinates (Latitude/Longitude)	Elevation	Distance from Dump site
Waste Dump	(04^{0}56’38.1”N-006^{0}19’38.9”E)	20m	NA
Station A	(04^{0}56’36.8”N-006^{0}19’39.9”E)	17m	25m
Station B	(04^{0}56’36.6”N-006^{0}19’37.3”E)	20m	50m
Station C	(04^{0}56’35.1”N-006^{0}19’35.3”E)	20m	100m
Station D	(04^{0}56’34.8”N-006^{0}19’36.9”E)	19.5m	200m

Source: Field Data, 2018. NA – Not Applicable

Plate 2: Bore hole site A at Greenvilla Road, Biogbolo, Yenagoa

Plate 3: Borehole site B at Green-villa Road, Biogbolo, Yenagoa

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2.3 Sample Collection and Transport

Borehole water samples were collected from four Boreholes in different pointsall located in Biogbolo area.

Water samples were collected in triplicates with clean empty 50ml table water plastic containers and transported under cool conditions in black polyethylene bags to the Department of Chemical Sciences Laboratory of the Niger Delta University, Amasoma, Bayelsa State. Each plastic container was marked and labelled to show the location (Borehole) where the water was collected. A total of twelve (12) water samples were taken for investigation.

2.4 Preparation of measuring standards

Six standard solutions of 0.01, 0.1, 1, 10 and 100ppm concentration of the metals to be determined such as Cr, Ni, Cu, Cd, Pb and Fe were prepared for instrument calibration.

2.5 Water Analysis for Heavy metals

Water samples were analysed for the Heavy Metals Fe, Cu, Cd, Pb, Cr and Ni using model 210VGP of the Basic Scientific Atomic Absorption Spectrophotometer series with Air Acetylene gas mixture as Oxidant. Water samples were aspirated directly after setting the wavelength of the element to be determined and the equipment calibrated for each element. The results were recorded in mg/L of solution.

2.6 Data Analysis

Data obtained were statistically analyzed at 5% level of significance by using an ANOVA. This was done to measure if there is a significant difference between each station in all the measured heavy metals. SPSS® software was employed to aid the calculations.

3. RESULTS

The result from the investigation is captured in Table 1 and Figures 2 to 6.

Table 2: Mean composition of Heavy metals in Stations and ISO standards

Metal	ISO(mg/l)	A(mg/l)	B(mg/l)	C(mg/l)	D(mg/l)
Pb	0.10	0.2±0.02	0.2±0.01	0.3±0.04	0.29±0.01
Ni	0.03	0.04±0.001	0.03±0.01	0.04±0.02	0.04±0.012
Cu	0.05	0.04±0.01	0.03±0.01	0.03±0.01	0.04±0.01
Cr	0.05	0.02±0.004**	0.02±0.01	0.03±0.01	0.03±0.01

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Cd	0.01	0.01±0.01	*ND	ND	0.01±0.01
Fe	0.30	0.40±0.21	0.4±0.07	0.50±0.11	0.60±0.10

Source: Field work and US EPA (ISO), 1994. *ND – Not detected. **Mean±SD SD – Standard Deviation (No significant difference P=0.05)

Table 2 above shows the metal characteristics of all the measured heavy metals across all the sampling stations along with the standard permissible limit. Pb, Ni and Fe had values which exceeded the standard limits while Cd, Cr and Cu were either below the standard limit or at par with it. Fe has the highest concentration in the water samples than any other metal. (Figure 2)

The sampling station D has the highest concentrations of all the sampled metal parameters while the sampling point located at B has the lowest of these metals.

Result indicates that there was No significant difference between the stations in all measured metal characteristics of the sampled waters (P>0.05). This implies that borehole water in near the waste dump site has a uniform characteristic and may all pose harm to human health if consumed. However, borehole water from station B area presents the least threat because of it contains marginally less harmful heavy metals than other sampled areas.

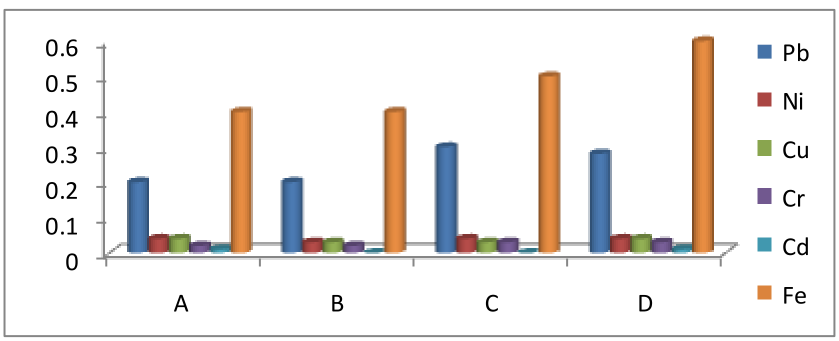

Fig 2: Heavy metal contents of Borehole water in study areas in Biogbolo

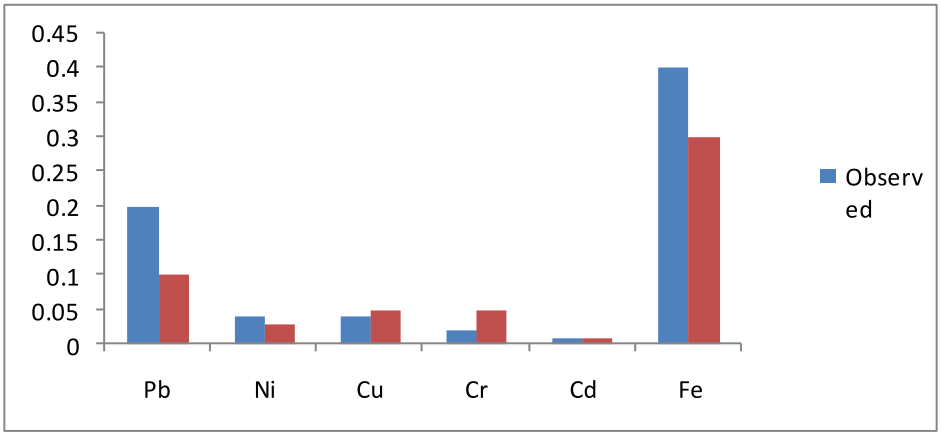

Fig 3: Heavy metals in Station A with permissible standard.

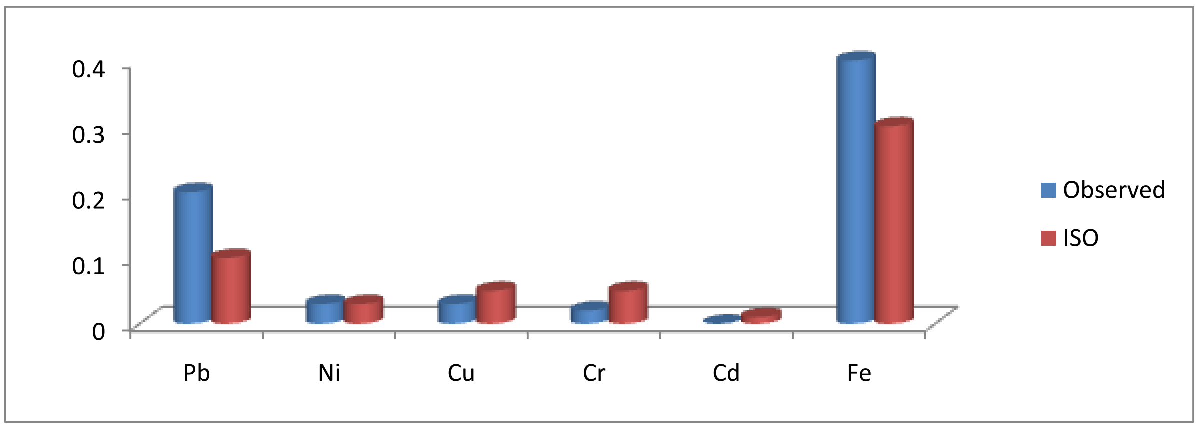

Fig 4: Heavy metals in station B with permissible limit (ISO)

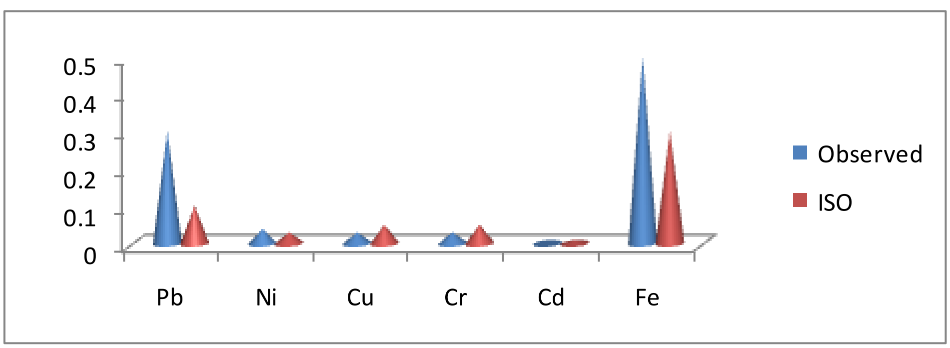

Fig 5: Heavy metals in StationC with permissible limit (ISO)

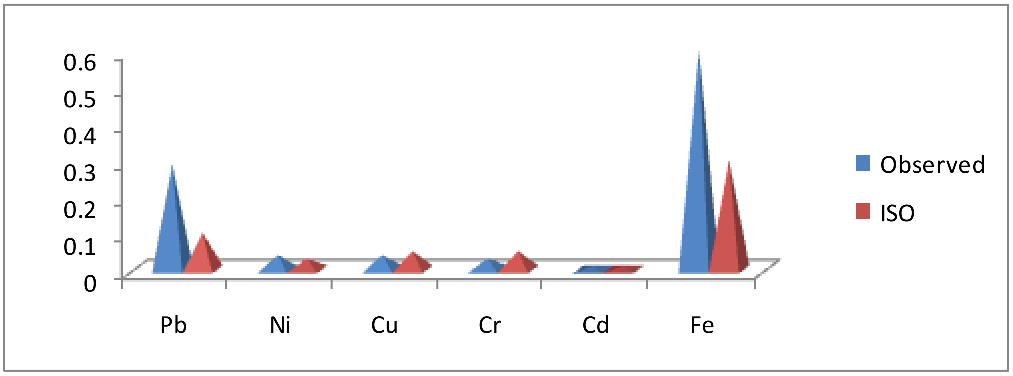

Fig 6: Heavy metals in station D with permissible limit (ISO)

4. DISCUSSION

The heavy metals Pb, Ni and Fe showed values that are visibly higher than the permissible values, while Cd had values that are either below or at par with the permissible limit. Also, Cr and Cu have values that are below the allowable limits. This result of this study is in agreement with that of Verghese and Garg, (2002) who also found Chromium (Cr) levels in the groundwater samples in Agra City, India to be within permissible limits. They also found the concentration of lead in municipality water to be slightly higher than the permissible limits.

The presence of higher levels of Pb in borehole water may be traceable to the activities of industries that use leaded petroleum products, industrial air pollution and the use of leaded petrol for domestic purposes. The presence of lead (Pb) even in small concentrations marginally above the permissible limit can cause defective haemoglobin synthesis by inhibiting Iron (Fe) incorporation into protoporphyrin which results in lower haemo-concentration thereby leading to anaemia. Lead poisoning also includes abdominal pain and lesions of the central and peripheral nervous systems (Rana, et al, 2007).

Also, the presence of Ni and Fe in quantities that exceed the tolerable limit may be attributable to industrial and Agricultural activities in Yenagoa. Groopman et al., (1985) also observed the pollution of water with nickel and chromium arising from industrial sources and/or agriculture activities at their studied areas. They also noted that the toxicity of Ni is enhanced in the presence of other metals such as cobalt, copper, iron and zinc in drinking water. Kabata-Pendias and Pendias (1992) asserted that Fe plays a role in the concentration of trace metals in soil due to the pronounced binding properties of their oxides. Finally, the preponderance of Fe in high concentrations above the permissible limit may be due to the wash –off of base rocks and other substances that are precursors to Fe by acid rains present here in the Niger Delta

Another common source of Ni in the environment is the reaction of steel and other metal products which may be in trash and settle to the ground after undergoing precipitation reaction.

Cd exhibited values that were either below or at par with that of internationally accepted standard but were highest in station A and station D with the lowest altitudes. One reason for this may be the capillary pull of water to areas of vulnerable geomorphological disposition.

Also, the presence of Ni may have also antagonized the availability of Cd. The presence of one heavy metal may affect the availability of another in the soil. In other words, antagonistic and synergistic behaviours exist among heavy metals.Salgare and Acharekar (1992) reported that the inhibitory effect of Mn on the total amount of mineralized C was antagonized by the presence of Cd. Similarly, Cu and Zn as well as Ni and Cd have been reported to compete for the same membrane carriers in plants (Clarkson and Luttge, 1989).

The levels of chromium observed in these sites were lower in all sample stations than that of approved standard (USEPA, 1994). This implies that the presence of chromium in these sites is due to lithogenic origin and not from anthropogenic chromium. Similar low levels of chromium have been observed in surface soils under waste dumps in Onitsha, Nigeria (Nwajei*et al.*, 2007) and soils around foam manufacturing industry (Oviasogie and Omoruyi, 2007).

In generation, all the study stations showed readings that were not significantly different from each other in all the measured heavy metal parameters.The study area yenagoa is endowed with vast areas of clayey soils with high water retention capacity. Therefore, this may explain the high consistency of heavy metals in the study stations.

5. CONCLUSION

The determination of heavy metals in portable waters such as in borehole water near waste dumps is very critical because of its overriding importance on public health issues. The investigation of heavy metals in some select areas in yenagoa was therefore done to assess the safety and otherwise of borehole waters.

Result from this study has revealed that the heavy metals Pb, Ni and Fe were marginal higher that internationally set safety limits for drinking water, while the metals Cr, Cd and Cu have value that are lower than set limits. All sample stations displayed similar metal composition as there was statistically No significant difference between sampling points (P>0.05). However, station B seems to be the least concentrated (impacted) by these heavy metals.

A number of reasons may be adduced for the high prevalence of these metals in borehole water. This study therefore concludes that borehole water near the waste dump at GreenvillaBiogbolo in Yenagoa is unsafe for drinking

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