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Contaminant Status of Waste Dump Site in Mubi Metropolis of Adamawa State-Nigeria

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Keyword:
Contaminants Status, Waste Dumpsite, Heavy metals, Mubi Metropolis and Adamawa State.

Abstract

Municipal waste dumps significantly increases ground water vulnerability and pollution risk. Various processes of contaminant transport such as advection and hydrodynamic dispersion transport leachates from dumpsites to ground water. Ground water and soil samples collected from Kolere and Wuro Gude waste dumpsite in Mubi revealed the following chemical and microbial concentrations above WHO /EU guidelines for potable water, lead (Pb) 0.01mg/l, copper (Cu) 2.0mg/L, Zinc (Zn) 3.0mg/L, manganese (Mn) 0.5mg/L, compared to result obtained Lead (Pb) 9.61mg/L, Manganese (Mn) 11.84mg/l. Zinc (Zn) 3.14mg/L and total microbial count 156±0.00. These indicate probable pollution and thus pose risks to human health and the environment. Most highly hazardous substances present in these contaminated water are colourless, ordourless and highly dangerous when ingested even in very minute concentrations. Bioaccumulation of hazardous substances within human tissues as a result of chronic ingestion of these ground waters poses serious risks to human health and environment; as certain endocrine disruption effects have been attributable to their ingestion.

Introduction

The absence of engineered sanitary landfills in many metropolitan towns in Nigeria as a whole have necessitated the use of open burrow pits (wherever they may be found) as repositories for municipal solid wastes collected from various parts of the metropolis. The choice of these borrow pits are often done without proper Environmental Impact Assessments on the suitability of such sites as waste disposal sites. Hitherto, the excavation of earth materials for other uses (that creates the borrow pits) removes a large portion of the vadose zone bringing the position of the water table very close to the bottom of the pit. Hence the migration of leachates from these waste dumps is an ever present reality and the contamination of ground waters around waste dumps becomes an ever increasing possibility (Lee & Jones-Lee, 2010).Leachates otherwise known as "garbage juice" are formed as a 'chemical soup' resulting from complex biogeochemical processes taking place within the waste dump. Hundreds of known and unknown chemical are natural ingredients of such chemical soup. The volume of leachates produced in any waste dump is a function of many variables which include: precipitation, areal extent of the dump hence volume of wastes within the repository, types of wastes deposited (Lee and Jones-Lee, 2010). Contaminated water from a dumpsite leaches from the source through the vadose zone to the water table and then mixes with the saturated water while migrating to the receptor. This results in a mixing zone or plume in the saturated zone that expands as the contaminants migrate from the waste site (Codell, *et al.*, 2012). The scarcity of land in most urban areas and the failure of government to implement land use policies have necessitated the development of properties close to existing and abandoned waste dumps. Water wells are basic necessities that developers install on their properties due to government inability to provide potable water to her citizens. Hence there is the possibility that draw down from these wells can create a hydraulic gradients that can locally induce the migration of leachates and other chemical substances from these dumps ending up in water wells. Bioaccumulation of hazardous substances within human tissues as a result of chronic ingestion of these groundwater pose serious threats to the overall health and wellbeing of people utilizing these waters as certain endocrine disruption effects have been attributable to their ingestion (Rebecca *et al.*, 2013). These un-disposed refuse dumps provide breeding grounds for biological vectors such as mosquitoes and rodents that enhance disease transmission like malaria, diarrhoea, and Lassa fever which are of public health concern (Sule, 2014; Park, 2012; Bassavanthappa, 2010; Onyido *et al*, 2013).

Materials and Methods:

Study area: The study was carried out within Mubi Metropolis in Adamawa State. Mubi is located in northeastern Nigeria on geographical grid reference longitude of 13.26oE and latitude 10.270 N. it has a tropical climate characterized by rainfall in the wet Season April – October (Adebayo and Tukur 2010).

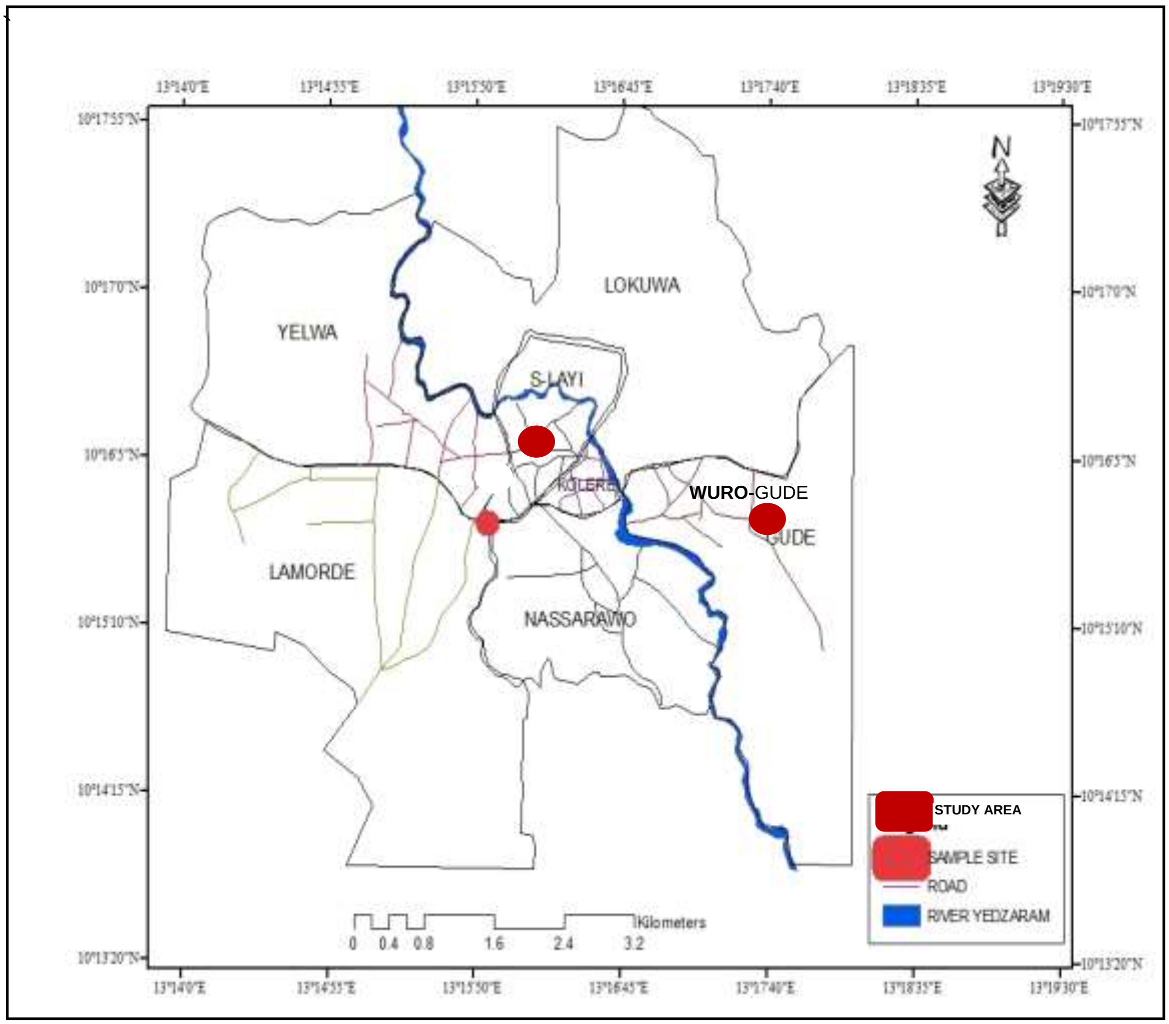

Fig. 1: Map of Mubi showing Wuro Gude and kolere wards (source: Adebayo and Tukur, 2010).

Reconnaissance Survey

This survey was carried out initially by site visit to all the two dumpsite to be investigated. At the site, the principle of walking from whole to part was established for easy accessibility of the sites, to determine the surface areas, topography and the closeness of dump to the residential area. Examination of the nature of the work materials characterizing each dumpsite were noted. It was observed leaves, plastics and metals were the largest propagation of waste materials at the two investigation sites (self-survey).

Water Sampling/Analysis

Eight water samples were collected from hand dug well throughout the Mubi metropolitan area to examine the degree of groundwater contamination. A total of 4 samples were taken at the residential well around the dumpsite, the other 4 sample were well around the dumpsites, in residential areas within Mubi which serve as a control measured to check the effect to groundwater contamination on the surrounding well relative to the dumpsites. Collection, preservation and storage methodologies were carried out by the recommended practice. This is to ensure that each sample is repetitive of groundwater quality needed. All sample collected were kept directly into plastic bottles. Samples were stored in the refrigerator. The temperature of the entire store sample was maintained at O to 4°C until analysis at the laboratory. A procedure for determining copper, zinc, lead, and manganese at the µg/l in water by using Atomic Absorption Spectrometry (AAS) (Giadam and Abam, 2014).

Soil Sampling/Analysis

Soil sample were taken from the 2 dumpsite located at (Wuro Gude and Kolere) under investigation using pitting method. The pitting were carried out using hand auger to probe in to the soil and for collecting soil samples at depth of interval. The soil samples were collected randomly from 3 different points on each site with an average separation spread of 75 - 100m from one pit to the other (Giadam and Abam ,2014). At a particular pit soil samples were cored at depth of 15cm, 35cm and 75cm to obtain the profile of the subsurface. Control sample were taken from the top of the waste disposal site to investigate the percolating rate of leachate into the subsurface water table. The collected soil samples were stored in new black polythene bags and labelled W and K respectively. About 20 g of each of the soil sample was weighed into a pre-weighed crucible and then placed in a Carbolite Furnace. The temperature was raised to 1000°C and then maintained for two hours. The ashed soil samples were removed and cooled in a desiccator and then preserved for further studies. The already ashed soil samples were digested as follows; each ashed soil sample (20g) was placed in to a 200cm^3 beaker. Concentrated nitric and hydrochloric acids (10 m^3) in a ratio of 1:3 v/v were added to each. The beakers were covered with watch glasses and heated on hot plate until all the white fumes of nitric acid were expelled. They were removed, allowed to cool and content of each was washed with de-ionized water and placed into a 500 cm^3 volumetric flask and diluted to the mark with de-ionized water. The resulting sample solutions were used for heavy metal analysis.

Microbial Enumeration

Serial dilutions were carried out on the groundwater and leachate samples collected. Appropriate dilutions were plated on Macconkey agar (Oxoid CM3 Basingstoke, Hampshire, England, UK) using the spread plate technique (Harrigan and MaCance, 1976), for the enumeration of Enterobacteriaceae. After the period of incubation, the total viable counts were expressed as means of three determinants. The results of the microbial counts were presented as mean ± SE.

Data Analysis

Data obtained in this study was analyzed using t-test The level of statistical significance was estimated at $P<0.05$ using the t-test. A correlation matrix was also set up and Pearson correlation coefficients calculated for the various parameters obtained in the groundwater samples using SPSS statistics 17.0 software.

Results:

Table 1 showed mean SD± of Heavy metals from six different sampling size. Wurogude at 35cm recorded the highest Zn (mg/kg) of 3.14±00 followed by wurogude at 75cm (2.95±0.00) while Kolere at 75cm recorded the least Zn(mg/kg) of 0.55±0.00. Wurogude at 35cm recorded highest mn(mg/kg) of

11.84±0.00 followed by kolere at 35com (9.61±0.00) while Kolere at 75cm recorded the least Mn(mg/kg) of 1.42±0,00 followed by Wurogude at 15cm (3.76±0.00) respectively. Kolere at 15cm recorded the highest pb(mg/kg) of 9.61±0.00 followed by Wurogude at 35cm (1.73±0.00 while Kolere at 75cm recorded the least Pb (mg/kg) of 0.19±0.00 followed by Wurogude at 0.38±0.00. Kolere at 35cm also recorded highest Cu (mg/kg) of 0.96±0.00 followed by Wurogude at 35cm and 75cm (0.78±0.00) respectively.

Table 1 Mean SD± of Heavy metals from six different sampling sites

SAMPLING SITE

HEAVY METALS	Wuro gude (15cm)	Wuro gude (35cm)	Wuro gude (75cm)	Kolere (15cm)	Kolere (35cm)	Kolere (75cm)
ZN(MG/KG)	0.80 ± 0.00^{d}	3.14 ± 0.00^{a}	2.95 ± 0.00^{b}	1.36 ± 0.00^{c}	2.86 ± 0.00^{b}	0.55 ± 0.00^{e}
MN(MG/KG)	3.76 ± 0.00^{c}	11.84 ± 0.00^{a}	9.10 ± 0.00^{b}	3.70 ± 0.00^{c}	9.61 ± 0.00^{b}	1.42 ± 0.00^{d}
PB(MG/KG)	0.38 ± 0.00^{c}	1.73 ± 0.00^{b}	1.15 ± 0.00^{b}	9.61 ± 0.00^{a}	1.35 ± 0.00^{b}	0.19 ± 0.00^{d}
CU(MG/KG)	0.31 ± 0.00^{d}	0.78 ± 0.00^{c}	0.78 ± 0.00^{c}	1.42 ± 0.00^{a}	0.96 ± 0.00^{b}	0.13 ± 0.00^{e}

Mean in the same column having the same super script do not differed significantly P<(0.05).

Table 2 :shows the microbial load of water samples from dumping site and residential site at station A and B. Dumping site A of Wurogude has the highest Microbial load of 156.00±0.00 while dumping site B has the highest of 20.00±0.00 residential site B at Wuro gude has the highest microbial load of 30.00±0.00 while residential site A at Wurogude recorded the least Microbial load of 13.00±0.00. Kolere dumping site A recorded the highest microbial load of 38.00 ± 0.00^{a} while Kolere dumping site B recorded the least microbial load of 9.00±0.00.

Kolere residential site b recorded the highest microbial load of 36.00 ± 0.00^{a} while Kolere residential sit A recorded the least microbial load of 18.00±0.00.

Table 2: The microbial load of water samples from dumping site and residential site of station A and B.

		SAMPLES			
SITE		1	2	3	L.S.D
DUMPING SITE WURO GUDE	B	30.00±0.00[a]	30.00±0.00[a]	20.00±0.00[b]	0.08
DUMPING SITE WURO GUDE	A	156.00 ±0.00[a]	50.00±0.00[c]	54.00±0.00[b]	1.76
RESIDENTIAL WURO GUDE	A	30.0±0.00[a]	13.00±0.00[b]	30.00±0.00[a]	2.37
RESIDENTIAL WURO GUDE	B	30.0±0.00[a]	25.00±0.00[b]	17.00±0.00[c]	0.10
KOLERE DUMPING	A	19.0±0.00[c]	31.00±0.00[b]	38.00±0.00[a]	3.10
KOLERE DUMPING	B	18.00±0.00[b]	9.00±0.00[c]	20.00±0.00[a]	0.18
KOLERE RESIDENT	A	30.00±0.00[a]	18.00±0.00[c]	23.00±0.00[b]	0.19
KOLERE RESIDENT	B	24.00±0.00[b]	36.00±0.00[a]	23.00±0.00[c]	2.00

Mean in the same column having the same super script do not differed significantly P<(0.05).

Discussion:

Soil and groundwater samples collected from Wuro Gude and Kolere water dumpsite, in Mubi, Adamawa State indicate a possible leachate impact on the ground water quality. Concentration of microbial load and heavy metals from laboratory analysis revealed concentrations that exceeded minimum threshold values allowed by the WHO and EU for potable water.

Heavy metal analysis revealed that two (2) out of the 4 heavy metals analyzed were found to be moderately high concentration exceeding the allowable limit for these heavy metals. Lead (Pb) 9.61mg/l and manganese (Mn) 11.84mg/l were found to be higher in concentration than allowable limits (0.01mg/l and 0.05mg/1 respectively) at all six sample points. Zinc (Zn) 3.14mg/l only exceeded the allowable limit at 35m within the dump site compared to the resent studies which was carried out by (Giadom and Abam ,2014)which showed copper (Cu) 0.001mg/l, Lead (Pb) 0.4149mg/l, (Mn) 0.1853mg/l and Zinc (Zn) 0.0869mg/l but is in agreement with the report of Ujile *et al.*, (2012). These value obtained indicate strong likelihood for ground water contamination, this indicate that the top most aquifer is unreliable for potable domestic water supply.

Heavy metal concentration were high particularly for manganese (11.84mg/l) Lead (9.61mg/l), Zinc (3.14mg/l) which is in agreement with the report of (Giadom and Abam 2014) that was conducted in Aba, Abia state, Nigeria and the report of Aderemi *et al.*, (2011) but is greatly lower than that reported by Suleiman *et al.*, (2018) which shows lead to be (6.80-9.05mg/kg) and Zn to be (95.60-101.0mg/kg). The presence of lead could be due to the disposal of lead batteries at the dumpsite, while the presence of the other heavy metals is attributable to a wide range of cottage industries manufacturing a verity of product. The presence of these heavy metals at the waste dump is quite worrisome as they pose serious health hazards to people living in the neighborhood should they get to groundwater.
All heavy metal concentrations of the groundwater sample were below the WHO maximum containment levels for potable water which is in agreement with the report of Ofomola *et al*.,(2017) except for lead and manganese (0.84mg/l and 0.38mg/l respectively) which is above the WHO maximum contaminant level (0.01mg/l and 0.05mg/1) respectively and hence not acceptable. Microbial total count indicated higher than normal count at the dumpsite and also at the well around residential building, as was also reported by (Giadom and Abam, *2014*). 150m should be given off the dumpsite for potable water.

Conclusion:

We concluded that open waste disposal have produced a negative effect on the quality of groundwater and soil. The data obtained from all the studies of the two sites indicate the existence of pollution near the disposal site. The analysis obtained from the soil and water samples showed similar results. The closest well to the dumpsite showed higher contamination than the control sites wells located in proximity of the waste dumping sites so dumping waste close to well should be avoided. Based on the findings from the study we recommend that buffer zone of not less than 200m and 500m in the direction of the ground water flow be established around waste dumpsites. If this is unavoidable, deeper drilling and frequent analysis of water samples and appropriate treatments are desirable.

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