Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 80 (2015) 30995-31001

ISSN: 2229-712X

Evaluation of Soil Contaminant Level at Dumpsites in Nigeria

Ojekunle Z.O[1], Ojajuni K. O[1], Sangowusi R.O[1], Oyebanji F.F[1], Ojekunle V.O[2], Adekitan A.A[1] and Odjegba E. E[1]

[1]Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

[2]State Key Laboratory of Geomechanics and Geotechnical Engineering. Chinese Academic of Sciences Wuhan, China.

ARTICLE INFO

Article history:

Received: 19 January 2015;
Received in revised form:
25 February 2015;
Accepted: 7 March 2015;

Keywords

Dumpsites,
Contaminant,
Organic carbon,
Soil.

ABSTRACT

Some physical chemical characteristics and heavy metal levels in soil samples (Top and Sub) around dumpsites at Obantoko, Lafenwa, and Olomore vicinities of Abeokuta, Ogun State, Nigeria, were analysed in order to assess the effects of the dumps on the soils. Conventional analytical methods were employed for the determination of these physicochemical parameters while heavy metals in the soil samples where analysed using Atomic Absorption Spectrophotometer. The results of the physicochemical analysis showed that the pH values in all the sites ranged from 8.21 to 8.61 indicating alkalinity of the soils. The Total Organic Carbon values ranged from 1.06 to 2.76 indicating presence of some organic matter and some microbiological activities in the soil samples. Conductivity values ranges from 875 to 1119µs/cm indicated significant presence of some soluble inorganic salts in soils studied. For all the physical chemical values recorded, the soil samples at Lafenwa had slightly higher values than those of Olomore, and Obantoko. The mean concentration level of the three locations for Pb for the top and subsoils in Obantoko, Lafenwa, and Olomore were 13.50 and 11.31, 7.64 and 12.44, 9.90 and 11.06 (mgkg-1) respectively and that of for top and subsoil for same locations were Cr 5.76 and 7.01, 7.64 and 12.44, and 4.65 and 6.86 (mgkg-1) while Pb were not detected at all locations except at Lafenwa L2 where 2.24 mgkg-1 was detected in the subsoil. The levels of the metals at the sub-soil were all higher than the top soil at all the locations, except for Obantoko were the value of Pb at the top soil was greater than the value at the subsoil. A consistent trend showing a decrease in the concentration of heavy metals at the topsoil was observed for soil samples. The results from the study show that leaching occurs at dumpsites from the top to the subsoil which could cause a degree of contamination to ground water and living organims. These soils may therefore constitute a major health risk to the local population, and therefore, need be stringent measures to curtail the adverse effect it may pose to human health and the environment.

Introduction

Unorganized, indiscriminate and unscientific dumping of municipal wastes is very common disposal method in many developing countries which cause adverse impacts to the environment (Mahar et al., 2007).

Nearly all human activities generate waste, and the way in which this is handled, stored, collected and disposed of, can pose risks to the environment and to public health (Zhu et al., 2008). Several fluxes of waste and cover materials from different sources end up at these dumpsites and due to the heterogeneity and complexity of wastes, these dumpsites contain a variety of contaminants which can pollute the soil of the area (Sukop et al., 1979).

Different Sources such as electronic goods, painting waste, used batteries, etc., when dumped with municipal solid wastes raise the heavy metals in dumpsites and dumping devoid of the separation of hazardous waste can further elevate noxious environmental effects.

Since these contaminants affect the environmental qualities in and around such open dumpsites, monitoring of soil qualities especially heavy metal content in dumpsite becomes necessary which can facilitate to recommend suitable remedial measures (Sukop et al., 1979).

Nigeria's population has increase greatly over the years; this consequently has led to the increase in human practices responsible for waste generation. Although solid waste can be an asset when properly managed, it poses the greatest threat to life amongst all the classes of waste. It has the potential of polluting the terrestrial, aquatic and aerial environments (Bishop, 2000).

The Nigerian Government at all levels through their agencies (like the Federal Environmental Protection Agency-FEPA, Ministry of Environment and Environmental Sanitation Authorities) has invested much in waste management and enforcement of sanitation laws but little has been achieved so far. Furthermore, the erratic growth of housing units in the urban cities, has made monitoring and management of waste difficult (Bishop, 2000); these have led to indiscriminate dumping of waste at every nook and cranny of major cities in Nigeria.

This study aims at investigating if refuse dumping and municipal solid waste can substantially increase the environmental burden of heavy metals in soils and the threat such will pose on community health. Waste disposal whether domestic, commercial or industrial in the world, is a problem that continues to grow with human civilization and no method so far is completely safe. Experience has shown that all forms of waste disposal have negative effects on the environment, public health and local economics pointed out that Pollution in soil systems is strictly related to human activities such as industry, agriculture, burning of fossil fuels, mining and metallurgical processes and their waste disposal. Toxic elements, such as

Tele:
E-mail addresses: oojekunle@yahoo.com

heavy metals and metalloids, can be retained by soils and/or mobilized to soil solution by biological and chemical mechanisms with a potential impact on human health (contamination of drinking water supplies, uptake by vegetation and input into the food chain; Metals are natural components of the environment including soil but they are of great concern when they are being added continuously.

Refuse dumping is one of the ways in which elements are being added into soil. Leachate from dumpsites is of particular interest when it contains potentially toxic heavy metal, this makes open dump method of solid waste disposal considered as both naïve and dangerous. These metals are known to bio-accumulate in soil and have long persistence time through interaction with soil component and consequently enter food chain through plants or animals.

Review of Study

Various studies have documented the impact of the constituents of solid waste from dumpsites. Reporting high levels of heavy metals in particular Cd, Pb and Cr emanating from Donora dumpsite, Nairobi in Kenya. While Marijian 2002 documented elevated amounts of total organic matter, total hydrogen, humus, toxic elements such as Cu, Pb, Cd and Zn and other numerous compounds of biogenic origin and xenobiotic compounds were found in a landfill at Zagreb, Croatia.

A study by Esakku on heavy metals in a municipal solid waste dumpsite in India revealed that the concentrations of Hg, Cr and Pb exceed the limits set by the standards set up by the Government of India. In particular, the average concentrations of Cu and Pb in the landfill site at Asmara were nine-fold and four-fold greater than the allowable limits, respectively. Another study in Nigeria indicated that heavy metals (Pb, Cu, Fe and Zn) increased between 21% and 24% in the soils of the dump site vis-a-vis soils from non-dump site as investigated by Anikwe et.al., 2007. Another study by (Anikwe et.al, 2007) revealed that except for Hg, all the analyzed heavy metals in the landfill site of Asmara, in Eritrea showed values above the permissible limits. A study by Kamarudin et al., 2000 to assess the distribution of heavy metals profile in groundwater system at solid waste disposal site revealed heavy metals like Pb, Mn, Zn, Fe and Cd found in significantly high levels in Malaysia, which exceeded the maximum permissible concentration as specified by the World Health Organization standards for drinking water, These may lead to increased uptake of metals by some test crops although their transfer ratios differ from crop to crop. Physical, chemical and biological processes which take place in solid waste dumpsites also results in waste decomposition and production of leachate. O¨man and Junested (2004) opined that landfill leachate contains a large number of compounds. They have identified around 140 organic, metal-organic and inorganic compounds, which result in percolation into the surrounding environment with subsequent contamination of water and land. Some of the constituents can be expected to create a threat to health and nature if released into the biogenic environment (Kumar, et al, 2006). Soils irrigated by leachates accumulate heavy metals such as Cr, Zn, Pb, Cd, Ni, etc in surface soil (Cambra et al.1998).

A study by in Nigeria indicated that the leachate collected from two dumpsites had appreciably high levels of dissolved solids, Cl_2, NH_4, COD, Pb, Fe, Cu and Mn. Also groundwater samples collected from the site were polluted with Al, Fe, Pb, Cd, Cr, Ni. (Kamarudin et al., 2000). Roongtanakiat et al., 2003 also investigated that as the level of landfill leachate strength increases, plants grown on leachate contaminated land showed reduced growth. Elements such as Cd and Cr are carcinogenic; other metals such as Pb, Hg and Tl, possess a wide spectrum of toxicity that includes neurotoxic, hepatotoxic, nephrotoxic, teratogenic or mutagenic effects as studied by Schuhmacher et al., 2002. Vrijheid, 2000 documented an increased prevalence of self-reported health symptoms such as fatigue, sleepiness and headaches; low birth weight, birth defects and certain types of cancers among residents near waste sites have been reported. A medical evaluation of the children and adolescents living and schooling near a dumpsite in Kenya indicated a high incidence of diseases that are associated with high exposure levels to these metal pollutants and about 50% of the children examined had blood levels of Pb in blood which either equaled or exceeded internationally accepted toxic levels, while approximately 30% had size and staining abnormalities of their red blood cells, confirming high exposure to heavy metal poisoning.

The study areas in this research are lacking in the information of soil qualities in and around the landfill areas. Therefore this study attempts to quantify the changes in the properties of soil under municipal waste dumping in such areas by comparing them with the properties of soils recommended by international standards for agricultural soil. Keeping these specifics in mind, the present study is undertaken to correlate with, the influence on selected soil physico-chemical properties and heavy metal deposit levels in soil with municipal waste dumping. A significant importance of this work will be in providing baseline information for further soil quality monitoring studies and to understand their potential uses in making various soil amendments in future studies.

Methodology

Study area

This study was carried out in some parts of Abeokuta, Ogun state metropolis which include Lafenwa, olomore, and Odo-eran.Abeokuta is located in the sub-humid tropical region of South-western Nigeria (Latitudes 7º 5′ N to 7º 20′ N and Longitudes 3º 17′ E to 3º 27′). The town is about 81km south-west of Ibadan and 106km North of Lagos and at an altitude of about 157m above sea level, the landscape has undulating characteristics due to the formation of granite rocks, the city enjoys a tropical climate with distinct wet and dry seasons with dry period of about 130 days (Orebiyi et al., 2007).

The mean annual rainfall and temperature are about 1,270 mm and 28 ºC respectively while the estimated mean annual potential evaporation is 1,100 mm. The city is underlain by crystalline pre-Cambrian Basement complex of igneous and metamorphic origin noted for their rather poor groundwater bearing properties (Orebiyi et al., 2007). The city is drained mainly by River Ogun which passes through and divides the city into two, and the drainage pattern is dendritic.

The Lafenwa site used was within the old Ogun radio region, which has been used for waste dumping for over a decade now prior to the discontinue use of the radio site. Waste dump at this site ranges from solid wastes, biomedical wastes, liquid waste, as well as domestic wastes.

The Olomore and Obantoko dumpsite have also been used as waste disposal sites for over a decade, with the Obantoko dumpsite also being a site for animal waste disposal due to its closeness to an abbatoir.

The location coordinates of the three dumpsites studied and important points around them were obtained with a hand held Global Positioning System with position accuracy of less than 4m.

The choices of the sampling points within the dumpsite were considered using the following criteria: location, accessibility, proximity to residential areas and the topography of the study area.

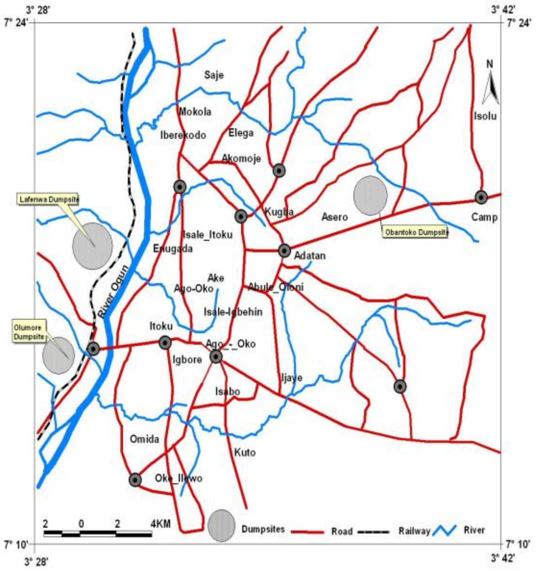

Figure 1. Map of Study Area showing The Dumpsites.
Source: Authors Map (Gis Arc Application)

Sampling frame and Design

The top soils and sub soils were collected between the periods of April and May, 2014 at the tree location sites namely Olomore (OL), Lafenwa (L,) and Obantoko (OB). These periods were chosen for sample collection as the rains were minimal and a reduction in rainfall infiltration is restricted and a total eighteen samples were collected. Due to the fact that soils vary intrinsically, soil samples were obtained through random sampling in three different spots per dumpsite. But care is taken to get a representative sample of the study area.

Sample collection

Soil samples were taken at the dumpsites with a soil auger. About twenty-four (24) soil samples were collected at different locations of the three (3)-study area accounting for both the top soils and sub soils in the area. Top soil samples were obtained at a depth between 0 – 15 cm while the sub soil samples were obtained within the range of 15 – 30 cm. The samples were put into polythene nylon and labelled for easy identification. The co-ordinates where the soil samples were taken were also recorded.

Sample preparation

The representative samples collected were properly prepared so as to have a homogenous sample to be used for analysis. The following processes were involved:

i. Air-drying: Each soil sample was properly exposed to air to reduce the moisture content of the soil samples. The soil samples were left exposed for three days to make it dry.
ii. Pulverization: The air-dried samples were pulverized to increase the volume of the samples and grind into powdered form with the use of mortar and pestle.
iii. Sieving: The pulverized samples were poured into a 2.0 mm sieve to remove the large particles that cannot pass through the sieve. The powdered particles were properly packed with the use of a sterile spoon to avoid contamination of the samples.
iv. Weighing: The sieved samples were accurately weighed on a weighing balance and after weighing the samples; the samples were packaged into polythene bag and labelled properly.

Data analysis / Laboratory procedure

The samples were analyzed for different physico-chemical parameters with a hand held multipurpose meter. The parameters analyzed for includes pH, Temperature and Electrical conductivity.

Digestion procedure

Materials:

Heating source (hotplate) capable of maintaining a sample extract temperature of 95 ± 5°C, Fume cupboard, Gloves and nose mask, Conical flask, Measuring cylinder, Standard flask, Beakers, Electronic weighing balance, filter paper.

Reagents:

Perchloric acid, Distilled water, Conc. Trioxonitrate (V) acid (HNO_3), Conc. Tetraoxosulphate (VI) acid.

Sample preparation for soil analysis

Soil sample of 1g was weighed and put into a digestion vessel (conical flask) after which 10 mls of concentrated nitric acid, 5 mls of concentrated sulphuric acid and per chloric acid was added to it. The same preparation was done for all the soil samples. The samples were digested for about 2-3 minutes at 95 ± 5°C after which the samples were removed from the heat source and allowed to cool for few hours before filtering with a filter paper. The digest was made up to 50 ml using a 50 ml standard flask and stored for analysis. A blank sample was also prepared. The digest was analyzed for heavy metals using an AAS (Atomic Absorption spectrophotometer).

Statistical analysis

The data derived was statistically analyzed using descriptive statistics (mean, and standard deviations) using the Statistical Package for Social Sciences (SPSS 20.0), and Microsoft Excel. In addition, advance statistical methods employed in this project research include matrix correlation analysis. The correlation analysis was conducted by a Pearson correlation.

Results And Discussions

Average value (*), Temperature (Temp), Electrical conductivity (E.C), Organic carbon (O.C), Organic matter (O.M)

The soil colour at obantoko dumpsite was mostly brownish brown except at a spot that gave dark grey soil colour. The average pH, temperature, electrical conductivity, percentage sand, clay and silt, organic carbon and organic matter in this location for both the top soil and sub soil samples gave the values as shown in the table 1.

Cadmium heavy metal concentrations were not pronounced in this location, lead (Pb) gave the highest concentration in this location with an average concentration of 13.50±3.61mg/kg for the top soil and an average concentration of11.31±3.81mg/kg for the sub soil. Also, calcium had the highest concentration in the cation exchangeable capacity (CEC), having an average concentration of 10.90 ±5.37cmol/kg for the topsoil and an average of 28.82±22.49cmol/kg as indicated in table 2.

Average value (*), Temperature (Temp), Electrical conductivity (E.C), Organic carbon (O.C), Organic matter (O.M)

The soil colour at Lafenwa area of Abeokuta, Ogun State ranged from brown to dark brown (see table 3). There was a slight variation in the average pH of top soil to sub soil. The average pH of the top soil and sub soil samples gave alkaline values of 8.49 and 8.53 respectively.

Concentration of Cadmium was found to be absent at the top soil, while being present in the sub soil only in L2 with an average concentration of 0.75±1.29 mg/kg. Lead gave the highest concentration in this location; the concentration of Lead was higher than chromium, which increased with increasing depth (Table 4). Also, calcium had the highest concentration in the cation exchangeable capacity (CEC), having an average concentration of 42.85 ±5.91 cmol/kg for the topsoil and an average of 23.90±11.95 cmol/kg. Calcium here decreases with increasing depth.

Average value (*), Temperature (Temp), Electrical conductivity (E.C), Organic carbon (O.C), Organic matter (O.M)

The soils in this area were found to be brown in colour except for a spot that is grey and dark brown respectively. The pH of the top soil sample gave a value of 8.21 while that of the sub soil sample gave a value of 8.43 as shown in table 5.

As recorded from our soil investigation in table 6, Lead gave the highest average concentration of 9.90±4.2mg/kg for top soil and 11.06±.70 mg/kg for sub soil samples; the average concentrations of Chromium increased with increasing depth while cadmium was not detected. Calcium again had the highest concentration in the cation exchangeable capacity (CEC), having an average concentration of 28.24 ±11.82cmol/kg for the topsoil and an average of 11.09±1.70cmol/kg, with potassium, magnesium and sodium existing in minute's concentration.

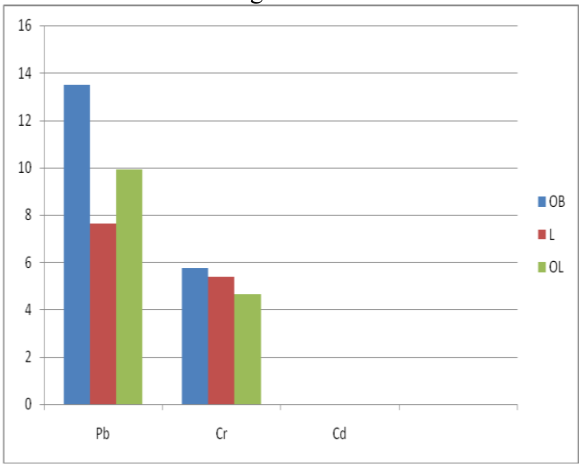

Figure 2. Mean Heavy metal concentrations (mg/Kg) of Top Soil samples (T) from dumpsites at the different locations

Comparison of average Heavy metal concentrations (mg/kg) of Top Soil samples (T) from dumpsites at the different locations is shown in figure 2 above. Here, Lead gave the highest concentration between 12-14 mg/kg. The concentration of Cadmium on the other hand was negligible, and the concentration of Chromium was between 4-6 mg/kg respectively.

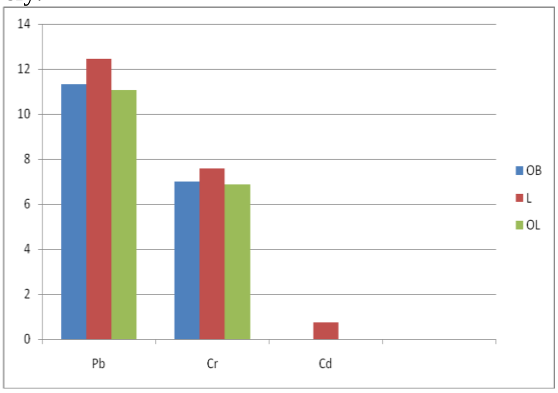

Figure 3. Mean Heavy metal concentrations (mg/kg) of Sub Soil samples (S) from dumpsites at the different locations

Comparison of average Heavy metal concentrations (mg/kg) of Sub Soil samples (S) from different at the different locations is shown in figure 3 above. Here, lead also gave the highest concentration between 12-13 mg/kg. The concentration of Cadmium on the other hand was negligible, while the concentration of Chromium (Cr) was between 6-8 mg/kg respectively.

From the charts in figures 2 and 3, the heavy metal concentrations at the sub soil is higher than the top soil which suggests that leachates flow from the top to the sub soil and this follows a trend, which is Pb > Cr > Cd across all the locations. This agrees with Esakku et. al (2003), who suggested that lead was always the major concerns at municipal dumpsites.

Discussion Lead

The mean levels of Pb ranged from 7.64±1.89 to13.50±3.61 mg/kg for top-soil, and 11.06±0.70 to 12.44±3.16 in the sub-soils in the soil samples. These values were lower than NYS DEC (2007) limit of 200 mg/kg and the maximum tolerable levels proposed for agricultural soil, 90-400 mg/kg set by WHO (1993) and US EPA (2002). This is in agreement with the results obtained from similar study by Umoh and Etim (2013) for soils from dumpsites within Ikot-Ekpene in Akwa-Ibom State, Nigeria.

Concentration of lead in the soils from the areas could be as a result of its sources from automobile exhaust fumes as well as dry cell batteries, sewage effluents, runoff of wastes and atmospheric depositions.

Chromium

The mean concentrations of Cr in the dump soils varied between 4.65±1.05 to 5.76±0.24 mg/kg for topsoil, and 6.86±.52 to 7.58±0.22 for subsoil, which is lower than the critical permissible level which is 50 mg/kg for soil recommended for agriculture by MAFF (1992) and EC (1986). Sources of Cr in the soils could be due to waste consisting of lead-chromium batteries, coloured polythene bags, discarded plastic materials and empty paint containers (Jung, 2006).

Cadmium

Cadmium levels in all the soil samples were found in trace amounts, (0.75 ± 1.29 mg/kg), it was accounted for only at lafenwa dumpsite, at the sub-soil (L2) with the other sites lacking in it. This may be as a result of the site being used long ago as a radio station (as commonly called old ogun radio dumpsite). This makes room for the dumping of gadgets, indecomposable wastes, harzoudous waste amongst others over the years. And with the action of climatic factors, tendency exists for leaching to occur down to the subsoil. In general, cadmium may have built up in the soil due to the application of contaminated water, fertilizer, or sludge. The value of cadmium however at the site is lower than the natural limits of 0.01-3.0 mg/kg in soil as given by MAFF (1992) and EC (1986).

The values of the metal concentrations obtained for the sites are all far below the maximum tolerable levels proposed for agricultural soil. This is in agreement with the findings of Asawalam and Eke (2006) and Njoku and Ayoka (2007) who investigated the trace metal concentrations and heavy metal pollutants from dump soils in Owerri, Nigeria.

Even though these heavy metal concentrations fell below the critical permissible concentration level, it seems that their persistence in the soils of the dump site may lead to increased uptake of these heavy metals by plants.

A correlation matrix for the metals in the soil samples was calculated to verify how metals were interrelated with each other. The analysis shown that there was significant correlation at 0.01 level for all pairs of Pb/Cr, Pb/Cd, and Cr/Cd.

Table 1. Physical Parameters of Soils at Obantoko Dumpsite, Abeokuta, Ogun State

Sampling site code	Depth (cm)	Soil colour	pH	Temp (°C)	E.C (µS) at 25°C	% Sand	% Clay	% Silt	% O.C	% O.M
OB1	T(0-15)	Brown	8.69	26.8	1163	68.8	6.48	24.72	3.15	5.45
	S(15-30)	Dark brown	8.62	26.3	1442	96.8	0.48	2.72	2.17	3.76
OB2	T(0-15)	Light brown	8.26	26.5	727	88.8	2.48	8.72	2.63	4.55
	S(15-30)	Brown	8.29	26.6	791	88.8	2.48	8.72	0.40	0.60
OB3	T(0-15)	Dark grey	8.88	26.6	1105	88.8	6.48	4.72	0.86	1.49
	S(15-30)	Dark brown	8.91	26.5	917	96.8	0.48	2.72	0.60	1.03
	*T(0-15)		8.61	26.63	998	82.13	5.15	12.72	2.21	3.83
	*S(15-30)		8.61	26.47	1050	94.13	1.15	4.72	1.06	1.80

Table 2. Total Nitrogen, CEC, and Heavy Metal Concentrations (mg/kg) of Top (T) and Sub soil samples (S) from Dumpsite at Obantoko Area of Abeokuta, Ogun State

Sampling site code	Depth (cm)	TN %	K Cmol/kg	Ca Cmol/kg	Na Cmol/kg	Mg Cmol/kg	Cr mg/kg	Cd mg/kg	Pb mg/kg
OB1	T(0-15)	0.27	1.18	16.26	1.51	0.25	5.52	ND	9.89
	S(15-30)	0.19	1.05	51.30	1.35	0.02	7.00	ND	7.50
OB2	T(0-15)	0.23	0.83	5.53	0.59	0.70	6.00	ND	17.10
	S(15-30)	0.03	0.62	6.33	0.88	1.00	7.02	ND	15.12
OB3	T(0-15)	0.07	1.01	10.90	1.05	0.60	5.76	ND	13.50
	S(15-30)	0.05	0.84	28.82	1.12	0.62	7.01	ND	11.31
	*T(0-15)	.19±.11	1.01±.18	10.90±5.37	1.05±.46	.52±.24	5.76±.24	ND	13.50±3.61
	*S(15-30)	.09±.09	.84±.22	28.82±22.49	1.12±.24	.55±.49	7.01±.01	ND	11.31±3.81

Note: ND=Not Detected and ± = Mean and standard deviation.

Table 3. Physical Parameters of Soils at Lafenwa Dumpsite, Abeokuta, Ogun State

Sampling site code	Depth (cm)	Soil colour	pH	Temp (°C)	E.C (µS) At 25°c	% Sand	% Clay	% Silt	% O.C	% O.M
L1	T(0-15)	Brown	8.51	26.5	1192	96.8	0.48	2.72	2.99	5.17
	S(15-30)	Brown	8.40	26.6	1065	90.8	4.48	4.72	2.75	4.76
L2	T(0-15)	Light brown	8.49	26.5	752	96.8	0.48	2.72	2.15	3.72
	S(15-30)	Dark brown	8.59	26.8	860	88.8	2.48	8.72	1.14	1.97
L3	T(0-15)	Grey	8.46	26.6	1274	96.8	0.48	2.72	3.15	5.45
	S(15-30)	Dark brown	8.59	26.5	1144	70.8	6.48	22.72	2.93	5.07
	*T(0-15)		8.49	26.53	1072	96.8	0.48	2.72	2.76	4.78
	*S(15-30)		8.53	26.63	1023	83.5	4.48	12.05	2.27	3.93

Table 4. Total Nitrogen, CEC and Heavy Metal Concentrations (mg/kg) of Top (T) and Sub soil samples (S) from Dumpsite at Lafenwa Area of Abeokuta, Ogun State

Sampling site code	Depth (cm)	TN %	K Cmol/kg	Ca Cmol/kg	Na Cmol/kg	Mg Cmol/kg	Cr mg/kg	Cd mg/kg	Pb mg/kg
L1	T(0-15)	0.26	0.65	36.14	1.14	1.27	5.37	ND	7.64
	S(15-30)	0.24	1.18	23.90	1.43	3.24	7.58	ND	12.44
L2	T(0-15)	0.19	0.68	47.26	1.20	1.43	6.25	ND	5.75
	S(15-30)	0.10	1.49	35.85	1.77	3.76	7.36	2.24	9.28
L3	T(0-15)	0.28	0.56	45.15	1.04	2.71	4.48	ND	9.52
	S(15-30)	0.25	0.87	11.95	1.09	1.62	7.80	ND	15.60
	*T(0-15)	.24±.01	.63±.06	42.85±5.91	1.13±.08	1.8±.79	5.37±.89	ND	7.64±1.89
	*S(15-30)	.20±.08	1.18±.31	23.90±11.95	1.43±.34	2.87±1.12	7.58±.22	0.75±1.29	12.44±3.16

Note: ND=Not Detected and ± = Mean and standard deviation.

Table 5. Physical Parameters of Soils at Olomore Dumpsite, Abeokuta, Ogun State

Sampling site code	Depth (cm)	Soil colour	pH	Temp (^{o}C)	E.C (µS) At 25^{o}c	% Sand	% Clay	% Silt	% O.C	% O.M
OL1	T(0-15)	Brown	8.23	26.8	1118	96.8	0.48	2.72	2.69	4.66
	S(15-30)	Brown	8.23	26.3	793	92.8	0.48	4.72	1.98	3.41
OL2	T(0-15)	Light brown	8.23	26.5	1426	92.8	4.48	2.72	1.98	3.41
	S(15-30)	Dark brown	8.39	26.6	1044	92.8	4.48	2.72	2.00	3.45
OL3	T(0-15)	Grey	8.16	26.6	814	94.8	0.48	4.72	2.63	4.55
	S(15-30)	Dark brown	8.67	26.5	789	90.8	0.48	8.72	2.01	3.48
	*T(0-15)		8.21	26.63	1119	94.8	1.81	3.39	2.43	4.21
	*S(15-30)		8.43	26.47	875	92.13	1.81	5.39	2.00	3.45

Table 6. Total Nitrogen, CEC and Heavy Metal Concentrations (mg/kg) of Top (T) and Sub soil samples (S) from Dumpsite at Olomore Area of Abeokuta, Ogun State

Sampling site code	Depth (cm)	TN %	K Cmol/kg	Ca Cmol/kg	Na Cmol/kg	Mg Cmol/kg	Cr mg/kg	Cd mg/kg	Pb mg/kg
OL1	T(0-15)	0.23	0.47	40.05	0.99	0.81	3.60	ND	5.70
	S(15-30)	0.16	0.53	12.79	0.88	1.62	7.20	ND	11.76
OL2	T(0-15)	0.17	0.64	28.24	1.04	1.14	4.65	ND	9.90
	S(15-30)	0.17	0.56	11.09	0.86	1.47	6.68	ND	11.06
OL3	T(0-15)	0.24	0.81	16.42	1.09	1.47	5.70	ND	14.10
	S(15-30)	0.17	0.59	9.39	0.83	1.31	6.16	ND	10.36
	*T(0-15)	.21±.04	.64±.17	28.24±11.82	1.04±.05	1.14±.33	4.65±1.05	ND	9.90±4.2
	*S(15-30)	.17±.01	.56±.03	11.09±1.70	.86±.03	1.47±.16	6.86±.52	ND	11.06±.70

Note: ND=Not Detected and ± = Mean and standard deviation.

Table 7. Showing standards for heavy metals in soil

	US EPA	NYS DEC soil cleanup objectives ‡	
Selected Heavy Metals	**Soil screening level †**	**Unrestricted use**	**Residential use**
As	0.4	0.11	0.21
Cd	70	0.43	0.86
Cr (hexavalent)	230	11	22
Cr (trivalent)	120,000	18	36
Cu		270	270
Pb	400	200	400
Ni	1600	72	140
Zn	23,600	1100	2200

† US EPA (2002)

‡ NYS DEC (2007). Values based on human health risks

Table 8. Showing Standards For Heavy Metals In Soil

	Soil screening level †	Soil screening level †	Soil screening level †
	WHO	**EU**	**MAFF**
As	0.3	0.09	0.41
Cd	74	0.52	3
Cr	270	50	50
Cu	30	180	260
Pb	400	400	600
Ni	1500	78	110
Zn	24,000	900	1800

† WHO (1993) ‡ EC (I986). † MAFF (1992)

This implies that the metals in the soils of the dumpsites must have evolved from the wastes dropped on these sites. There was a weak correlation between Pb/Cd, Cd/Cr, pairs in the top soil samples from Obantoko area of Abeokuta, Ogun State; however, correlation was significant at 0.01 level (2-tailed) for Pb/Cr, Cd/Cr, Pb/Cd, pairs. This suggests that changes in the level of one of these metals would affect the concentration of the other in the soil samples, hence, the Pearson correlation of these metals in the different sampling sites confirmed the contamination of Pb, Cr, and Cd; although Pb and Cr showed significantly high concentrations in the soil samples of the sampled areas (dumpsites).

Conclusion

This study indicates the level of contamination at waste dumpsites and explores the relationship between ranges of quantitative variables. All the studied dumpsites are contaminated with heavy metals. However, the concentration of the metals, Pb, Cr and Cd are all far below the maximum tolerable levels set by FAO and WHO for agricultural soil.

However, much precaution has to be taken especially on the use of water from the hand dug well around the dumpsites in the study areas as the presence of lead and chromium most responsible for toxicity in the body, though not being threatening in the sites, may pose risks to the users.

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