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Heavy Metal Contamination of Soils and Vegetation around Solid Waste Dumps in Port Harcourt, Nigeria

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ABSTRACT: Assessment of the levels of copper, zinc and lead in soils and vegetation around solid waste dumpsites in Port Harcourt and environs were carried out in 2005 using Atomic Absorption spectrophotometric technique. Physical parameters such as pH and particle size were also determined. The results show that the mean concentrations of copper in transect and profile soils and vegetation were 1.20 ± 0.83ppm, 2.57 ± 1.87ppm, 1.48 ± 1.61ppm respectively at the East – West road dumpsite and 2.42 ± 1.87ppm, 1.40 ± 0.61ppm, 1.39 ± 0.67ppm respectively at the Kaduna/Afam street dumpsite. The mean concentrations of zinc in soil and vegetations along the transect were 12.83 ± 4.65ppm, 2.68 ± 1.82ppm, 1.33 ± 0.64ppm, 0.80 ± 0.60ppm respectively at the Kaduna/Afam street dumpsite. The mean concentrations of lead in soils and vegetation were 0.26 ± 0.21ppm, 0.28 ± 0.24ppm, 1.48 ± 0.12ppm respectively at the East – West road dumpsite and 0.45 ± 0.37ppm, 0.20 ± 0.08ppm, 0.39 ± 0.17ppm respectively at the Kaduna/Afam street dumpsite. The order of occurrence of the heavy metals in the topsoils of the study areas was Zn > Cu > Pb. The levels of copper and zinc in soils from the waste dumpsite were significantly different ($P < 0.05$) from soil sample elsewhere. The differences in the levels of copper, zinc and lead in soils and vegetations as well as dumpsite and outside dumpsite were not significant ($P < 0.05$). The results indicate that solid wastes contributed to the levels of heavy metals in soils and vegetation. Also the concentrations of the metals in soils do not depend on the age of the waste dump rather, on the source, composition and the topography of the dumpsite. @ JASEM

Heavy metals are found naturally in undisturbed soils and, in fact, small amounts of many metals are required by plants to remain healthy. Metals found in waste dumps exist in various forms either as the pure metal or alloyed with various other metals. Heavy metals impairing the quality of our environment come from various sources that can be categorized into urban-industrial aerosols, liquid and solid wastes from animal and man, mining and industry and agricultural chemicals (Gerard, 1996).

The disposal of materials contaminated with heavy metals, such as occurs with garbage dumps and with polluters dumping waste on the side of a road can create patchy point of contamination, which are of concern and pose dangers to people in contact with the contaminated soils. It has been shown that considerable amounts of toxic metals arising from human activities are accumulated in soil (Agirtas *et. al*., 1999). With rains, they are percolated into the soil and are eventually translocated into plants and into man through consumption of these plants (Ogunsola *et. al*., 1993). They thus enter the food chain as a result of their uptake by edible plants (Kilicel, 1999). Toxic heavy metals can also be taken directly by man and other animals through inhalation of dusty soil. Heavy metal pollutants such as copper (Nyangababo and Hamya 1986), lead and zinc (Alloway, 1993) from additives used in gasoline and lubricating oils are also deposited on highway soils and vegetation.

Population explosion and urbanization have increased the quantities and types of solid wastes produced (Ogbonna, *et al.* 2007). Most cities in Nigeria including Port Harcourt are characterized by heaps of garbage and rubbish on street corners and junctions, open place and in drainages, resulting from open dumping of waste. Both the quantity and quality of solid waste generated in Nigeria vary very widely from day to day and according to the season of the year and still increasing mainly due to improper waste management (Ademola, 1993: Osibanjo, 1995; Adeniji and Ogu, 1998, Ideriah *et al*, 2005). Ideriah *et al* (2005) reported that concentrations of heavy metals in soil around waste dumps are influenced by types of wastes, topography, run-off and level of scavenging. Solid waste dumped along roadsides are usually left over a long time to decompose naturally (by micro organisms), eaten by animals, picked by scavengers or washed away by the floods into the larger creek and rivers thus affecting the surface water quality (Ogbonna, *et al*, 2007). In addition to the degradation of he physical environment, this condition impacts the natural environment aesthetically and health wise (Ogbonna, *et al*, 2007). They harbour flies, fleas, mosquitoes, rats and other disease vectors, which could cause several diseases such as Lassa fever, malaria, filariasis, yellow fever (Ekugo, 1998).

Several dumpsites exist in Port Harcourt and it's environ. These dumpsites are usually surrounded by luxuriantly growing vegetation and a number of intrinsic factors that include soil type and other environmental factors control the plant specie/population. At the immediate vicinity of the

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dumpsites under investigation *Panicum maxium* was growing freely. *Panicum maxium* is a competitive weed and had a wide distribution in the rainforest and savanna zone. It is very succulent and palatable to animals especially cattle. It grows wild, not only at the immediate neighourhood of wastes dumpsites. In some parts of Nigeria, it is often used as mulch and known to have beneficial effects on soil chemical properties (Opara-Nadi, 1993).

This study is undertaken to (i) evaluate the impact of dumps on soil and vegetation by determining the presence and concentrations of heavy metals around municipal solid waste dumps in Port Harcourt, Nigeria (ii) determine the variation in concentrations of heavy metals from the surface to a depth of 40cm at each dumpsite as well as (iii) assess the levels of heavy metals in soils from the different dumps with a view to determining the extent of pollution and health implications of these heavy metals. The heavy metals, Zinc, Copper and Lead investigated are among metals considered important by the Global Environment monitoring system (UNESCO/WHO/UNEP, 1992).

MATERIALS AND METHODS

The study area, Port Harcourt lies within latitudes 4° 43′ 07″ and 4° 54″ N and longitudes 6° 56′ 04″ and 7° 03′ 20″ E with a mean annual rainfall of over 2000mm and mean annual temperature of 29°C (Fig. 1).

Two sampling locations were chosen. Location 1 lies between latitude 4° 52′ 10″ N and longitude 6° 58′ 22″ E and is situated in Rumuigbo, along the East-West road. Location 2 lies between latitude 4° 47′ 38″ N and longitude 6° 59′ 54″ E and is situated along Kaduna/Afam street junction (Fig.1). The criteria used in selecting the sampling areas include proximity to urban area, accessibility and availability of vegetation.

The grid system of sampling was adopted for the collection of samples during the dry season (late 2004 and early 2005). At location 1, either sampling points were designated at predetermined distances on transect across the waste dumpsite. The center of the waste dump was taken as the zero point and the sampled distances were 50m, 100m and 150m to the east and 50m, 100m, 150m and 200m to the west. At location 2 seven sampling points were also designated at predetermined distances on an L shaped transect following the Kaduna/Afam street waste dump. The center of the waste dump was taken as the zero point and the sampled distances were 50m, 100m and 150m along Afam Street and 50m, 100m and 150m along Kaduna Street.

The Dutch Auger was used to collect soil samples at 0-30cm depth at each sampling site. In addition three profiles were dug with a shovel at each waste dumpsite. One pit was dug at the centre and the other two at each side of the periphery of the dumpsite. Soil samples were collected from the pits at 0-10cm, 10- 20cm, 20 – 30cm and 30 – 40cm depths. Plant (vegetation) samples were collected at the same point where soils were sampled. The plants sampled include *panicum maximum* (Guinea Grass, a major grazing stock for cattle), *chromolaena odoratum* and bitter leaf. All the samples were put into appropriately labeled polyethylene bags and taken to the laboratory for analysis.

Soil samples were air-dried, ground to fine dust, sieved to pass through a 2mm sieve. One gram of the sieved soil sampled was weighed into a conical flask and digested with 10ml of 50% hydrochloric acid on a hot plate until 2 – 3ml of acid was left. The content was then filtered into a 50ml volumetric flask and made up to the mark with deionized water.

The vegetation samples were washed, oven-dried at 80°C, pulverized to fine powder and ashed in the furnace for the three hours at 600ºC. 1g of the ground plant material was weighed into a 50ml Kjeldahi flask, 25ml of concentrated HNO_3 (16N, 70%w/w) was added down the side of the flask and swirled until the plant material was thoroughly wetted. 4ml of perchloric acid and 2ml of concentrated. H_2SO_4 (36N, 98%) were added and the flask swirled to mix the contents thoroughly. The sample was warmed gently on a digestion rack. At the end of digestion the mixture was heated strongly for 1 minute, cooled and 40ml deionized water was added and allowed to cool again. The sample was then filtered through Whatman N0. 42 filter paper into a 100ml volumetric flask and made up to the mark with deionized waster.

The concentrations of heavy metals in all the samples were determined using the Perkin-Elmer model 403 atomic absorption spectrophotometer. The pH of soil samples was determined in 1:2.5 slurry of soil in water using a pH meter. The particle size of soil samples was determined using the hydrometer method and the textural class determined from the "Textural Triangular Diagram."

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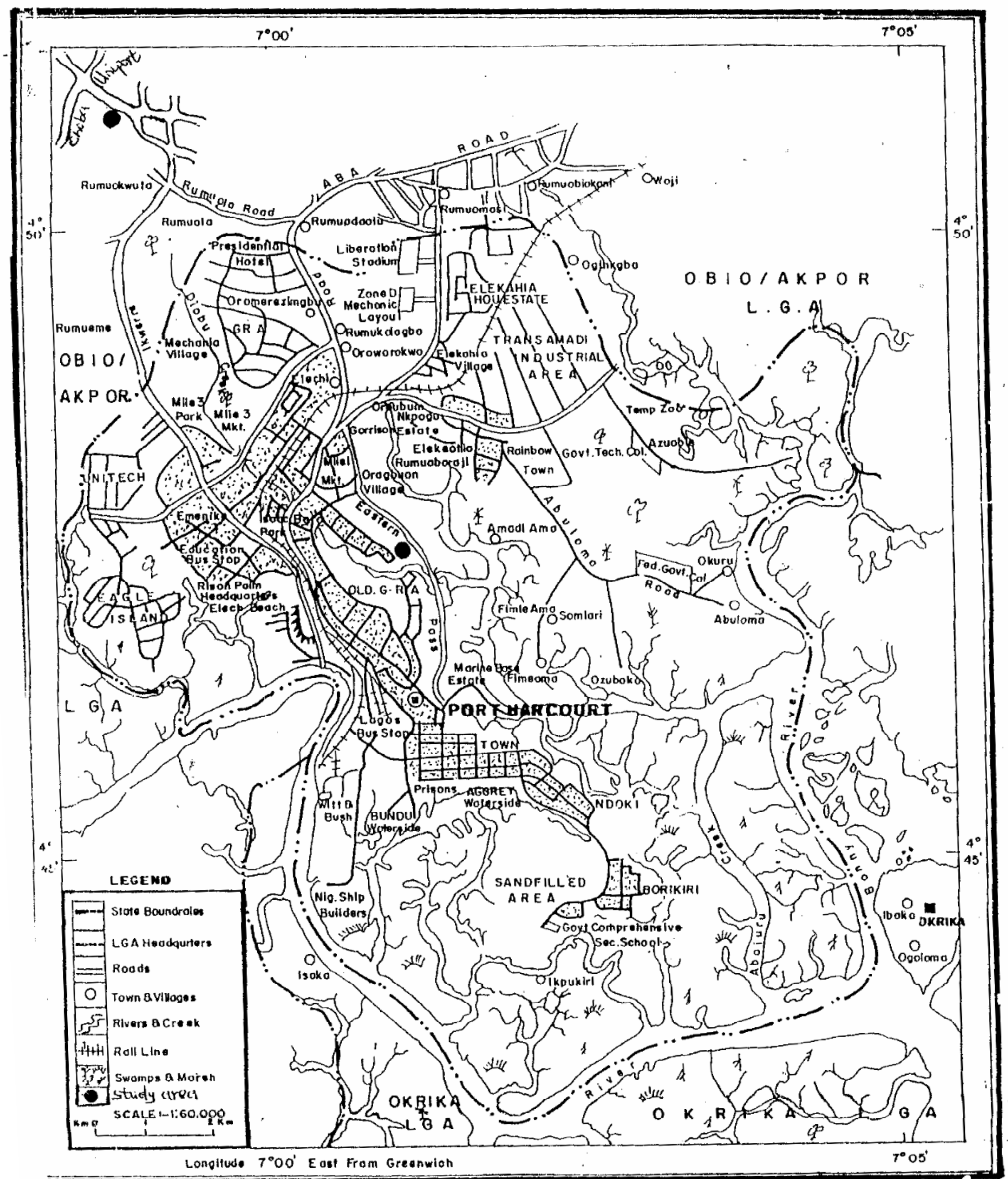

FIG. 1: MAP OF PORT HARCOURT SHOWING STUDY AREAS

RESULTS AND DISCUSSION

The results of heavy metals measured in soils and vegetation at the two waste dumpsites are presented in Tables 1-3. The tables also show results of pH and texture of soil samples.

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The texture of soil at the two dumpsites is sandy loam. The mean sandy component at the three soil depths was 70% whereas the silt and clay fractions were 25% each. The soil texture obtained at the East-West road waste dumpsite was similar to that of the Kaduna/Afam street waste dumpsite. However, the particle size on the waste dump at the East – West road varied with depth. The topsoil was found to be silt loam (43% sand, 55% silt and 2% clay), followed by loamy sand (79% sand, 11% silt and 10% clay). The last two layers (2—30cm and 30 – 40cm) were sandy clay loam. The observation at the topsoil is brought about, probably, by the incorporation into that layer, of recently decomposed organic materials – humus, in which the organic colloids may have acted as clay fractions. This trend was unique to the East – West road dumpsite. At the Kaduna/Afam street dumpsite, the topsoil at the zero point (the waste dump proper) was basically sand (97%). This is attributed to human activity, as the dumpsite is regularly being cleared of wastes allowing no time for humic formation. The effect of the waste dump on the particle size distribution was localized and very minimal.

Table 1: Metal Concentrations and composition of soils from East-West road (EWS) and Kaduna/Afam Street (KAS) dumpsites

No.	Station	Depth	Sand %	Silt %	Clay %	pH	Cu ppm	Zn ppm	Pb ppm
1.	EWS 1A	0-10	65	17	18	4.6	1.86	8.5	0.2
2.	EWS 1B	10-20	75	5	20	4.5	0.98	7.7	0.1
3.	EWS1C	20-30	68	10	22	4.6	0.9	6.8	0.1
4.	EWS 2A	0-10	64	22	14	5.1	1.06	7.2	0.2
5.	EWS 2B	10-20	76	9	15	4.5	0.37	6.8	0.2
6.	EWS 2C	20-30	81	1	18	4.7	0.3	6.2	0.2
7.	EWS 3A	0-10	73	11	16	5.5	1.2	12.3	0.8
8.	EWS 3B	10-20	68	2	30	4.6	0.55	12	0.7
9.	EWS 3C	20-30	42	21	37	4.6	0.49	11.9	0.7
10.	EWS 4A	0-10	74	6	20	6.8	4.16	23	0.2
11.	EWS 4B	10-20	91	6	3	4.4	2.15	20	0.2
12.	EWS 4C	20-30	70	4	26	4.3	2	20	0.2
13.	EWS 5A	0-10	81	7	12	5.3	1.16	16.1	0.3
14.	EWS 5B	10-20	76	4	20	4.8	1.05	16	0.2
15.	EWS 5C	20-30	71	14	15	4.7	1	15.5	0.2
16.	EWS 6A	0-10	84	4	12	5.2	0.9	14.2	0.2
17.	EWS 6B	10-20	67	10	23	4.9	1	13.9	0.2
18.	EWS 6C	20-30	64	4	32	4.9	1	13.5	0.2
19.	EWS 7A	0-10	84	4	12	5	1.05	13.1	0.1
20.	EWS 7B	10-20	72	8	20	4.9	1.03	12.5	0.1
21.	EWS 7C	20-30	78	10	12	4.6	1	12.3	0.1
				KADUNA/AFAM STREET DUMPSITE					
1.	KAS 1A	0-10	75	9	16	5.7	1.5	9.5	0.1
2.	KAS 1B	10-20	81	7	12	6	1.2	7	0.1
3.	KAS 1C	20-30	85	7	8	6.3	1	6.1	0.1
4.	KAS 2A	0-10	81	7	12	6.2	3.4	7	0.9
5.	KAS 2B	10-20	69	15	16	6.4	2.8	6.5	0.8
6.	KAS 2C	20-30	61	13	26	6.7	2.5	6.3	0.8
7.	KAS 3A	0-10	71	19	10	5.7	3.6	15	0.9
8.	KAS 3B	10-20	67	17	16	5.4	3.1	13	0.8
9.	KAS 3C	20-30	73	7	20	5.8	2.8	11	0.8
10	KAS 4A	0-10	72	12	16	5.9	6.83	2	0.1
11.	KAS 4B	10-20	36	40	24	6.3	6.4	180	0.1
12.	KAS 4C	20-30	62	16	22	6	5.7	12	0.9
13.	KAS 4D	30-40	63	17	20	6.9	3.4	12	0.9
14.	KAS 5A	0-10	87	7	6	7	1.6	10	0.8
15.	KAS 5B	10-20	71	11	18	7.3	0.9	17	0.8
16.	KAS 5C	20-30	75	5	20	7.1	0.5	15	0.7
17.	KAS 6A	0-10	71	17	12	7.5	1.5	11	0.1
18.	KAS 6B	10-20	83	5	12	7.9	1.3	10	0.1
19.	KAS 6C	20-30	65	8	27	6.7	0.8	7	0.1
20.	KAS 7A	0-10	61	16	23	7.1	1.2	11	0.1
21.	KAS 7B	10-20	82	8	10	7.6	0.9	10	0.1
22.	KAS 7C	20-30	69	5	26	7.6	0.4	7	0.1

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Table 2: Concentrations of Metals in soil profiles around East-West road (EWP) and Kaduna/Afam street (KAP) Waste Dumpsite.

S/No	Depth (cm)	Cu ppm	Zn ppm	Pb ppm	S/No	Depth (cm)	Cu ppm	Zn ppm	Pb ppm
EWP 1a	0-10	1.50	2.08	0.09	KAP 1a	0-10	2.14	2.14	0.007
1b	10-20	0.31	2.36	0.31	1b	10-20	1.41	2.11	0.13
1c	20-30	1.15	1.15	0.46	1c	20-30	0.68	0.68	0.24
1d	30-40	2.86	2.86	0.43	1d	30-40	0.65	0.32	0.29
2a	0-10	0.52	0.52	0.001	2a	0-10	3.90	0.40	0.15
2b	10-20	0.79	0.54	0.07	2b	10-20	1.34	0.22	0.24
2c	20-30	1.06	2.08	0.14	2c	20-30	5.16	0.51	0.24
2d	30-40	3.62	6.62	0.27	2d	30-40	0.60	0.001	0.24
3a	0-10	5.93	5.93	0.13	3a	0-10	0.17	0.28	0.26
3b	10-20	5.92	5.92	0.15	3b	10-20	0.18	0.21	0.24
3c	20-30	3.50	3.50	0.33	3c	20-30	0.05	0.14	0.26
3d	30-40	1.59	1.59	0.16	3d	30-40	0.48	0.13	0.11

Tables 3: Metal concentrations in vegetation at East – West road (EWV) and Kaduna/Afam street (KAV) waste dumpsites.

S/No.	Station	Distance	Pb (ppm)	Cu (ppm)	Zn (ppm)
1.	EWV 1	150m	0.08	1.52	1
2.	EWV 2	100m	0.148	0.32	2.224
3.	EWV 3	50m B/F	0.1	0.001	0.272
4.	EWV 4	Dumpsite	0.0072	3.44	1.824
5.	EWV 5	50m A	0.072	3.512	1.94
6.	EWV 6	100m	0.388	3.016	1.4
7.	EWV 7	150m	0.14	0.001	1.04
8.	EWV 8	200m	0.001	0.001	0.972
		KADUNA/AFAM STREET DUMPSITE			
9.	KAV 1	150m	0.3	0.446	0.6
10.	KAV 2	100m	0.38	1.64	2.2
11.	KAV 3	50m B/F	0.25	1.423	0.365
12.	KAV 4	Dumpsite	0.23	0.583	0.431
13.	KAV 5	50m A	0.38	1.09	0.784
14.	KAV 6	100m	0.31	2.504	1.014
15.	KAV 7	150m	0.74	1.72	0.48
16.	KAV 8	200m	0.53	1.676	0.529

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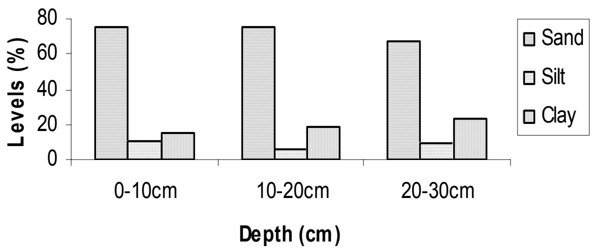

FIG. 2 Variation of mean particle size with depth at East-West dumpsite

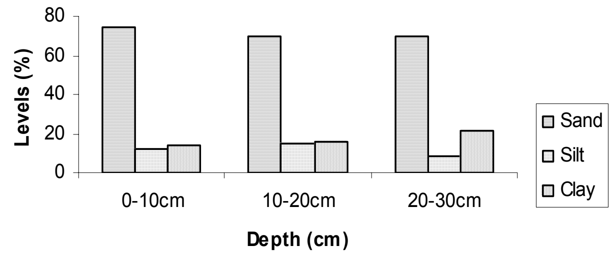

FIG. 3 Variation of mean particle size with depth at Kaduna/Afam dumpsite

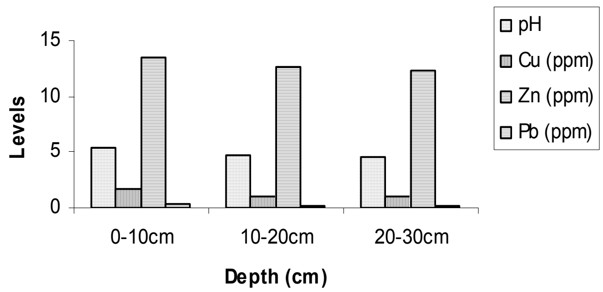

FIG.4 Variation of mean pH and metal levels with depth at East-West road dumpsite

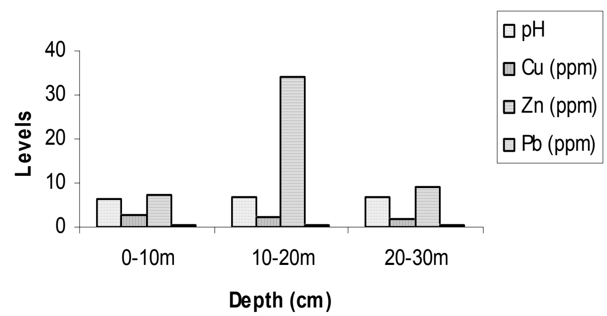

FIG.5 Variation of mean pH and metal levels with depth at Kaduna/Afam road dumpsite

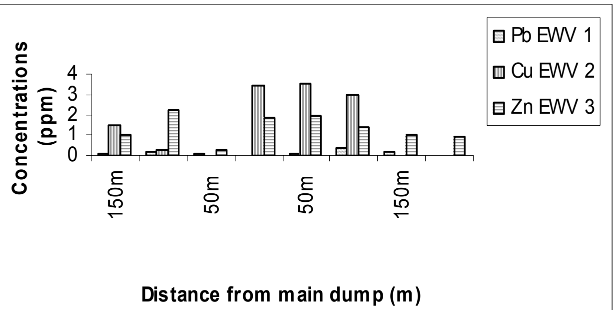

FIG. 6 Variations of mean metal concentrations in vegetation with distance at East-West dumpsite

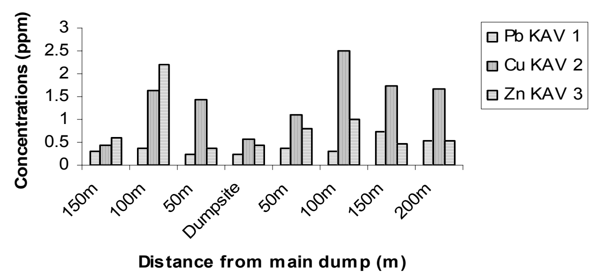

FIG. 7 Variations of mean metal concentrations in vegetation with distance at Kaduna/Afam street dumpsite

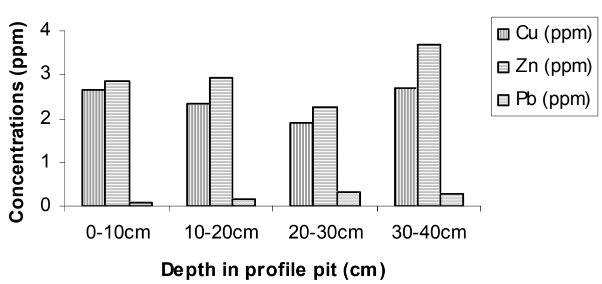

FIG. 8 Variation ofmean metal concentrations with depth in profile pit at East-West dumpsite

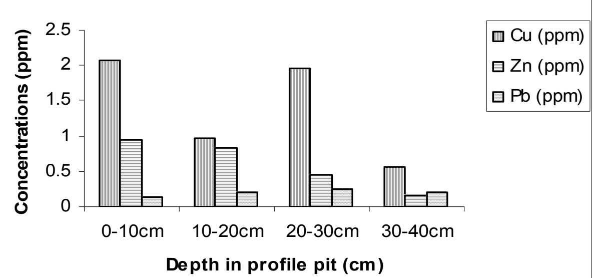

FIG. 9 Variations in mean metal concentrations with depth in profile pit at Kaduna/Afam dumpsite

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A statistical analysis (F-test) used to compare percentage sand on the waste dump samples of the two dumpsites against the transect samples indicates that they were found not to be significantly different (P<0.05).

The pH range along transects at the East – West road dumpsite was between 4.3 and 6.8 with a mean of 4.88 while the soil profile had a range between 2.5 and 7.2 with a mean of 4.83. The pH ranges for transect and profile soils at the Kaduna/Afam street dumpsite were 5.4 and 7.9 with a mean of 6.6 ± 0.73 and 5.2 and 6.4 with a mean of 5.74 ± 0.36 respectively. At the East – West dumpsite, the highest pH of 6.8 was obtained at the topsoil of the 0m (waste dump) whereas the lowest and most acidic pH of 4.3 was also obtained at the same spot but at the 20 – 30cm depth. At the Kaduna/Afam street dumpsite, while the pH tended to remain unchanged with depth, it increased with distance along transects. The pH values of the study sites were mostly slightly acidic. The neutral pH of 7.0 to 7.9 was consistent for stations 5, 6 and 7 at Kaduna/Afam street dumpsite. This shift in pH at this dumpsite, from slightly acid to neutral could be as a result of car wash and other activities, which had introduced some liming materials overtime to the soil. The pH of the soil profile increased slightly with depth at all the profile pits sunk at the waste dumpsites. Though the levels were similar yet, the pH of the top layer of pit 1 at East – West road dumpsite was exceptionally very acidic at 2.5. This may have been caused by the formation of organic acids. Statistical analysis showed a significant difference (P<0.05) between the pH of soil profile and transects of the East – West road dumpsite. The East – West road waste dump could be said to be responsible for the wide variability in the pH.

At the East – West road waste dumpsite copper along the transect ranged from 0.3 to 4.16ppm with a mean of 1.2 while the soil profile samples gave a range of 0.52 and 5.93ppm of copper with a mean of 2.57. At the Kaduna/Afam street waste dumpsite, copper measured along transects ranged from 0.40 to 6.83ppm with a mean of 2.42 ± 1.87 whereas that of the soil profile at this dumpsite ranged from 0.05 to 5.16ppm with a mean of 1.40 ± 1.61. Copper concentrations in the soil profile at the East – West road dumpsite was higher at all the depths measured than the copper concentrations along the transect samples. At the Kaduna/Afam street dumpsite this trend was the reversed except at the 20 – 30cm depth where the copper concentration was the same. Copper values in plants ranged from 0.001 – 3.51ppm with a mean of 1.48 ± 1.61 and 0.45 – 2.50ppm with a mean of 1.39 ± 0.67 for East – West road and Kaduna/Afam street dumpsites respectively. Higher values of copper were obtained in plants growing at the East – West road dumpsite than those of Kaduna/Afam street dumpsite. The concentrations of copper were generally low in all the sites. The Kaduna/Afam street transect station contained more copper as compared to the East – West road. On the other hand, the East – West road soil profile had elevated copper levels. The levels of copper on the waste dumps at the two dumpsites contained the highest levels of the metals. The analysis of variance on the soil profile copper against transect soil copper showed a significant difference (P < 0.05) at all the sites with the variability higher at the East – West road waste dumpsite. This suggests that the waste dumps contributed to the copper levels in the soils. Copper in the vegetation growing around the waste dumpsites was compared statistically with that in the soils and was not found to be significant (P < 0.05) at all the sites. This could be attributed to the very low level of the metal in the soil.

At the East – West road dumpsite the concentrations of zinc ranged from 6.2-23ppm with a mean of 12.83 ± 4.65. The concentrations did not vary with depth and was generally slightly lower than those of the Kaduna/Afam street samples, which ranged from 2 – 180ppm with a mean of 17.52. A mean Zn value of 34.76ppm was recorded in the 10 – 20cm depth in the Kaduna/Afam street transect samples. The mean Zn concentration in the soil profile sunk around each of the waste dumpsites was in the range of 0.52 to 6.62 with a mean of 2.68 ± 1.82 for the East – West road dumpsite and 0.001 to 2.14ppm with a mean of 0.59 ± 0.74 for the Kaduna/Afam street dumpsite. The values of Zn in vegetation at the two dumpsites were similar and generally low. At the East – West road dumpsite the range was 0.27 – 2.22ppm with a mean of 1.33 ± 0.64, while at the Kaduna/Afam street dumpsite the range was 0.37 – 2.20ppm with a mean of 0.80 ± 0.60. Although higher values of Zn were obtained yet similar trend with copper in soils and vegetation were observed with slight variation between stations. The waste dump stations were consistently higher in Zinc concentration than the other stations. The higher value of 180ppm was obtained at the subsoil (10 – 20cm) of the Kaduna/Afam street waste dumpsite although these level of zinc expected in soil, if crops growing on such soils are not to suffer zinc deficiency.

The analysis of variance did not show any significant difference between Zn concentrations measured at the East – West road with those measured at the Kaduna/Afam street stations. Further comparison (F-test) was made between the vegetation and soil Zinc levels and was found not to significantly vary (P <0.05). However, the high Zn concentration obtained

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at the waste dumpsite indicates that the wastes at the dump sites contributed Zn to the soil.

Lead concentrations were generally low in the soils of all the study areas. The lead concentrations ranged between 0.24 and 0.29ppm at the East – West road dumpsite, 0.4 and 0.5ppm at the Kaduna/Afam street dumpsite. For the soil profile, the concentrations ranged from 0.001 to 0.90ppm with a mean of 0.2 ± 0.08 at the Kaduna/Afam street dumpsite. The levels of lead in vegetation varied between 0.001 and 0.39ppm with a mean of 1.48 at East – West road dumpsite and 0.23 and 74ppm with a mean of 0.39 at Kaduna/Afam street dumpsite. Lead measured in all the stations was found to be less than 1ppm. The measured values in some stations are in agreement with that reported by Chow (1970). The highest values obtained at the East – West road stations (0.903ppm) and at the Kaduna/Afam street stations (0.90ppm) were at the vicinity of the waste dumps. Although these levels are low, yet they are suggestive of possible contribution of Pb to the soil by the municipal wastes which themselves receive leaded materials like spent batteries and other petroleum wastes.

A comparison of Lead in soil (F-test) of the waste dump and that from other stations did not show significant difference at $P < 0.05$. However, the F-test conducted on the soil lead and vegetation lead levels at the East – West road stations significantly differed ($P < 0.05$). This agrees with the report of Maclean (1969) that a ten-fold increase of the content of lead in the soil increases the content in plants only twice. Hence the very low Pb concentration obtained in the vegetation at the East – West road stations could in addition to other factors be a reflection of the soil lead content.

The comparatively high level of lead in vegetation at the Kaduna/Afam street stations could be as a result of physical contact with air-borne materials from vehicular emissions.

A comparison of Copper, Zinc and lead in the topsoil with distance showed that Zinc was consistently higher than the other metals except at the 0m point at the Kaduna/Afam street station where it was about 2.0ppm. Copper was slightly higher than lead but followed similar distribution pattern with lead at the dumpsites. The results also show that the waste dump (0m) contributed Zinc and Copper to the soil but did not affect lead.

The concentrations of the metals were observed to vary with depth. This could be attributed to variation in pH and texture of the soil. The concentrations of metals tend to decrease with (increased acidity) decreasing pH.

Conclusion: The findings of this study show that wastes contributed to the levels of heavy metals in soils and vegetation as depicted by the higher metal concentrations in soils 0m away from the waste dumps. The metals only contaminate the environment for now since their concentrations are below permissible limits. Solid waste deposited on the surface add metallic contaminants to the soil on which economic crops are cultivated. It is necessary to undertake regular environmental impact study to assess waste dumpsites. The higher concentration of copper in vegetation than in soils is attributed to direct contact rather than absorption from the soil.

Higher concentrations of lead were obtained at the vicinity of the waste dumpsites than were obtained elsewhere. The levels of the metals at Kaduna/Afam street dumpsite were higher than those at East – West dumpsite. This indicates that the concentrations of the metals in soils do not depend on the age of the waste dump rather, on the source, composition and the topography of the dumpsites. For instance the East – West road dumpsites is a filled burrow pit while the Kaduna/Afam street dumpsite is on a level ground. Similar trend of higher pH was observed at Kaduna/Afam street dumpsite. Thus metals are more available at higher pH values. The concentrations of the metals in the soil profile at East – West road were higher than those at Kaduna/Afam street. The levels of heavy metals in this study may adversely influence human health since vegetables and crop locally grown on the waste dumps are continuously consumed.

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