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ASSESSMENT OF HEAVY METAL POLLUTION IN SOILS WITHIN AND AROUND SOME MUNICIPAL SOLID WASTE DUMPSITES IN SAPELE TOWN, DELTA STATE, NIGERIA

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ABSTRACT

The disposal of waste to open dumpsites is the most common method of waste management and remains so in many places in Nigeria. Most dumpsites are located within the vicinity of living communities and wetland. The wastes contain toxic metals which are of great concern and poses serious dangers to the people in contact with the contaminated soil and plants. This research was undertaken to determine the level of some heavy metals pollution in soil collected from within and around three different waste dumpsites in Sapele town. Five heavy metals; Cadmium (Cd), Nickel (Ni), lead (Pb), Iron (Fe) and Zinc (Zn) were determined using Atomic Absorption Spectrophotometer (AAS). The concentration of heavy metal recorded in the soil samples from the study area ranges from 4.67± 0.10 to 17.16 ± 0.03 mg/kg for Cd, 5.33 ± 0.05 to 10.02 ± 0.03 mg/kg for Ni, 27.51 ± 0.07 to 56.06 ± 0.03 mg/kg for Pb, 866.11 ± 0.06 to 1346.79 ± 0.16 mg/kg for Fe and 87.86 ± 0.09 to 163.05 ± 0.02 mg/kg for Zn respectively. The concentration of cadmium and Iron recorded in the soil samples were above the maximum permissible limit reported by WHO (1996), FEPA (1991) and E.U (2002). The level of Zn recorded in the soils were above the maximum permissible limit set by WHO (1996), but were found below the safe limit reported by FEPA (1991) and E.U (2002). The concentration recorded for lead and nickel were below these safe limits. The concentration of heavy metals in the soil samples were in the order; Fe> Zn> Pb>Cd>Ni. The contamination factor (Cf), Geo accumulation index (Igeo), Pollution load index (PLI) and Potential ecological risk (Eri and Ri) indices were calculated, and the results indicate that the sites were heavily contaminated with Cd and moderately contaminated with Fe and Zn. The results also revealed the control site to be moderately contaminated with Fe which could be as a result of natural occurrences.

Keywords: Assessment, Waste dumpsites, Soil, Heavy metals, pollution

1. INTRODUCTION

Increase in population and industrial growth has led to increasing production of domestic, municipal and industrial wastes, which are indiscriminately dumped in landfill and water bodies without treatment [1]. Municipal solid waste management is one of the most crucial health and environmental problems facing the government of Nigeria. The uncollected or illegally dumped wastes constitute a disaster for human health and environmental degradation [2]. Most cities in

Nigeria practice open dumping of solid wastes which has led to serious environmental problems and several health hazards. Industrialization, population growth and unplanned urbanization have partially or totally turned our environment to dumping sites for waste materials. The environmental problems posed by municipal solid waste ranges from health hazards, soil and water pollution, offensive odour and repulsive sight. Most dumpsites are located within the vicinity of living communities and wetlands, the dumpsites are not scientifically designed and the basement not properly prepared for the absorption of selective toxic substances, therefore, it is prone to release pollutants to nearby soil, water and to the air through leachate and dumpsite gases respectively [3]. Many water resources have been rendered useless and hazardous to man and other living systems, as a result of indiscriminate dumping of refuse [4]. Solid waste poses the greatest threat to life, because they have the ability to pollute the terrestrial, aquatic and aerial environment [5, 6]. Nickel-cadmium batteries, cadmium-pigment, glasses, paints and enamels, ceramics, cadmium coated ferrous and non-ferrous products, cadmium alloys, cadmium electronics or electronic compounds are among the anthropogenic sources of cadmium in the soil environment [7].

Recent studies have revealed that contaminated sites can transfer significant level of toxic and persistent metals into the soil environment and eventually these metals are taken up by plants which are transferred into the food chain [8]. Consequently, higher soil heavy metal concentration can result in higher levels of uptake by plants. The accumulation of heavy metals in the edible and non-edible parts of vegetable crops grown on and around dumpsites represents a direct pathway for their incorporation into the human food chain [9]. The health risk will depend upon the chemical composition of the waste material, its physical characteristics, types of vegetables cultivated and the consumption rate [10].

Toxic heavy metals in the food chain at relatively high concentration poses serious health risk to the body, the toxicity of the heavy metal can be so detrimental to human health to the extent that they can cause damage or reduce mental and central nervous functions, they can also cause lungs, kidneys, liver, brain and other vital organs damaged in the body. Long term exposure to heavy metals may result in slowly progressing physical muscular and neurological degenerative processes that cause muscular dystrophy, and multiple sclerosis. Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. Chronic level ingestion of toxic metals have undesirable effects on humans and the associated harmful impacts become perceptible only after several years of exposure [11]. The nature of the effects could be toxic (acute, chronic or sub-chronic), neurotoxic, carcinogenic, mutagenic or teratogenic.

The aim of this study was to determine the level of heavy metals pollution in soils from within and around some dumpsites in Sapele town using contamination factor (cf), pollution load index (PLI), Geo accumulation index (Igeo) and potential ecological risk index (E_r^i and R_i).

Study Area

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This study was carried out at three different waste dumpsites namely; Ogodo road waste dumpsite, borrow pit waste dumpsite Ugberikoko road and Ogorode road dumpsite , all within Sapele in Sapele Local Government Area, Delta State, Nigeria.

The town Sapele is situated within latitude 5.89° north of the equator, and longitude 5.68° east of the Greenwich meridian and 33 meters elevation above the sea level, and covers an approximate area of 450 km^2. Sapele is a big town in Delta state with a population of 174,273 and a projected population of about 240,000 by the year 2016 [12].

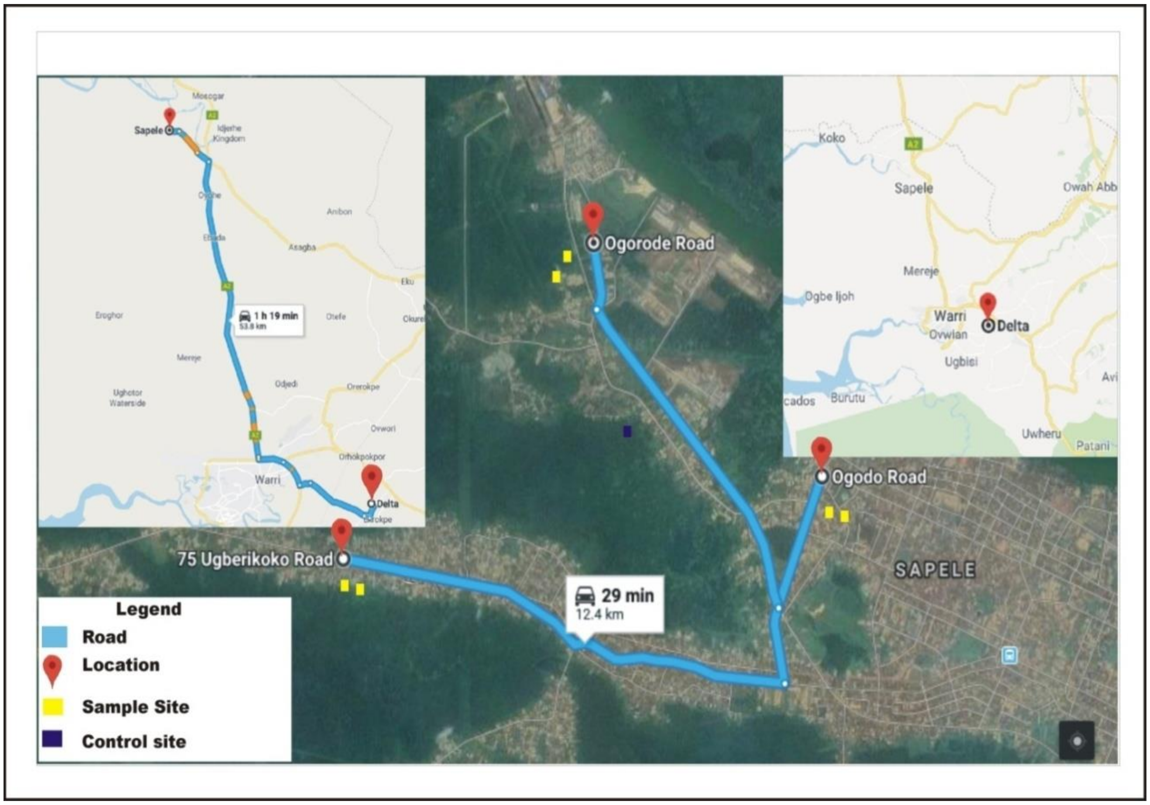

Figure 1: Location Map showing the Sampled Points

2.MATERIALS AND METHODS

Sample Collection and Treatment

Soil sample collection was done in July 2017, at the Ogodo road waste dump site; borrow pit waste dumpsite Ugberikoko road and Ogorode road waste dumpsite, all within Sapele, Delta State, Nigeria.

Three plots measuring approximately $4m^2$ were established on each of the dumpsites, 20 meters away from the dumpsites and that of the control site (200 meters away). The soil samples were taken from 0 -15 cm depth which was considered to represent the plough layer and average root

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zone for nutrients and heavy metals uptake by plant roots[13]. The soil samples were mixed thoroughly to obtain a representative sample of each sampling spot and then put in well labeled polyethylene bags and transported to the laboratory.

The soil samples were air dried for 2 days and oven dried at 105°C for 24 hours in order to remove any possible moisture. The dried soil samples were crushed, passed through 0.5 mm sieveand stored in polyethylene bags for laboratory analysis.

Analysis of Heavy Metal Content in Soil Samples

All glass and non-glass apparatus used in this analysis were washed with deionized water and immersed in 2% nitric acid (HNO_3) for 24 hours to prevent heavy metal contamination. Glass wares used throughout the analysis had no metal liners that could contaminate the samples and reagents were of analytical grade. Deionized water was used throughout the sample preparation and analysis [14].

Triplicate samples of 1.0 g of the dried and sieved soil samples were digested with 25 ml of a 3:1 mixture of aqua regia (HNO_3–HCl) at 120 °C using corning Pc-351 model hot plate in a fume cupboard until the brown fumes were totally removed and a clear solution was obtained. The digested samples were filtered through 0.45 micron Whatmann ashless qualitative filter paper into a 100 ml volumetric flask and made up to the mark with distilled water. The filtrate was transferred into well labeled clean dry plastic containers for heavy metal analysis.

The concentration of heavy metals in the digested soil sample was determined using Buck scientific VGP 210 Atomic Absorption Spectrophotometer [15]. The metals analyzed in the soil samples were; Cd, Ni, Pb, Fe and Zn.

Determination of Soil Contamination Factor

The contamination factor (CF) is a quantitative check used to describe concentration trend of metals in soil. Contamination factor (CF) is a quantifier of the degree of contamination relative to either the average crystal composition of the respective metal or to measure background values from geographically similar and uncontaminated area [16]. The contamination factor is obtained by the expression;

$$Cf = \frac{Cm}{Bm}$$

Where Cm is the mean concentration of metal M in soil and Bm is the background concentration (value) of metal M, taken from literature.

$Cf < 1$ indicates low contamination; $1 < Cf < 3$ indicates moderate contamination; $3 < Cf < 6$ indicates considerable contamination; $Cf > 6$ indicates very high contamination.

Geo-Accumulation Index (I_{geo})

The geo- accumulation index (I_{geo}) as proposed [17] has been widely used to evaluate the degree of heavy metal contamination in terrestrial and aquatic environments which can be estimated by using the equation.

I_{geo} = In (Cm /1.5 x Bm).

Cm = the mean concentration of heavy metal in soil.

Bm = Background concentration of heavy metal and 1.5 is a factor for possible variation in the background concentration due to lithological difference [17].

$I_{geo}$is classified into seven descriptive classes as follows;

0 = Unpolluted; 0-1= from unpolluted to moderately polluted; 1-2 = moderately polluted; 2-3 = from moderately to strongly polluted; 3-4 = strongly polluted; 4-5 = from strongly to extremely polluted; >6 = extremely polluted.

Pollution Load Index (PLI) Determination

The evaluation of pollution load index (PLI) of dumpsite soil was obtained with the expression;

PLI = $\sqrt[N]{}$ (Cf1 × Cf2 × Cf3 ×…………Cfn)

Where Cf is the contamination factor of each metal obtained by the ratio of concentration of each metal in soil or plant to the metal in background soil or plant, n is the number of heavy metals investigated.

PLI value greater than 1 is considered polluted; PLI value less than 1 is considered unpolluted.

Heavy Metal Potential Ecological Risk Determination

The potential ecological risk index method which was developed [18] was applied in this study. According to this method, the potential ecological risk coefficient E_r^i of a single element and the potential ecological risk index $R_i$of multi – element can be obtained with the following expressions:

$E_r^i = T_f^i \times C_f^i$

$R_i = \sum_r{}^n{}_{=I} E_r^i$

In these expression; C_f^i is the contamination factor of each element and $T_f^i$is the toxic – response factor of element i (which reflects its toxicity level and the sensitivity of bio organism to it).The toxic – response factors for common heavy metals such as Pb, Cd, Ni, Zn and Fe were; 5, 30, 5, 1 and 1 respectively [18].

Table 1: Criteria for Degrees of Ecological Risk Caused by Heavy Metals in Soils [18].

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R_i or E_r^i	Ecological pollution degree
$E_r^i < 40$ or $R_i < 150$	Low Ecological risk
$40 \leq E_r^i < 80$ or $150 \leq R_i < 300$	Moderate Ecological risk
$80 \leq E_r^i < 600$ or $300 \leq R_i < 600$	Considerable Ecological risk
$160 \leq E_r^i < 320$ or $600 \leq R_i$	Very high Ecological risk

3. RESULTS

The concentration of cadmium, Nickel, lead, Iron, and zinc in the soil samples and control sitesarepresented in table 2.

Table 2: Heavy Metal Concentration (mg/kg) in Waste Dumpsites and Control Soil.

Element	Ogodo road		Borrow pit		Ogorode road		control
	Soil(A)	Soil(B)	Soil(C)	Soil(D)	Soil(E)	Soil(F)	Soil(CT)
Cd	12.15 ± 0.04	13.88± 0.04	15.46 ± 0.05	17.16± 0.03	6.34±0.05	4.67± 0.10	0.63± 0.02
Ni	7.14 ± 0.03	5.33 ± 0.05	10.02 ± 0.03	7.31± 0.04	8.63±0.09	7.11 ± 0.16	1.30± 0.04
Pb	30.70 ± 0.04	34.27 ± 0.02	27.51± 0.07	44.05± 0.04	45.23±0.03	56.06± .03	7.96± 0.01
Fe	1118.33± 0.05	981.14± 0.04	1200.00± 1.96	866.11± 0.06	1346.70± 0.16	975.90±0.04	714.29±0.15
Zn	163.05 ± 0.02	133.31± 0.08	105.85± 0.07	87.86± 0.09	121.28 ± 0.10	103.87±0.10	45.71± 0.17

The alphabets (A, B, C, D, E and F) in parentheses indicate the locations where the soil samples werecollected. A and B – Soil collected from Ogodo road dumpsite and 20 meters away from the dumpsite respectively; C and D - Soil collected from Borrow pit road dumpsite Ugberikoko road and 20 meters away from the site respectively; E and F - Soil collected from Ogorode road dumpsite Ugberikoko road and 20 meters away from the dumpsite respectively; CT – Soil collected from control site.

Table 2 shows that the concentration of heavy metal recorded in the soil samples from the study area ranges from 4.67± 0.10 to 17.16 ± 0.03 mg/kg for Cd, 5.33 ± 0.05 to 10.02 ± 0.03 mg/kg for Ni, 27.51 ± 0.07 to 56.06 ± 0.03 mg/kg for Pb, 866.11 ± 0.06 to 1346.79 ± 0.16 mg/kg for Fe and 87.86 ± 0.09 to 163.05 ± 0.02 mg/kg for Zn.

Heavy Metal Contamination in Soil

Assessment of heavy metals contamination in the soil samples was carried out using contamination factor index (Cf), geo accumulation index (Igeo), pollution load index (PLI) and potential ecological risk index.

Contamination factor (Cf)

The heavy metal contamination factors were calculated and are presented in Table 4.

Table 3: Heavy Metal Contamination Factors (Cf) of the Dumpsite and Control Site Soils

				Ogodo road dumpsite soil				
	Dumpsite				20 meter away from the dumpsite			
Element	Cm	Bm	Cf	Summary	Cm	Bm	Cf	Summary
Cd	12.15	0.80	15.188	Very high	13.88	0.80	17.350	Very high
Ni	7.14	35.00	0.204	Low	5.33	35.00	0.152	Low
Pb	30.71	85.00	0.361	Low	34.27	85.00	0.403	Low
Fe	1118.33	150.00	7.456	Very high	981.14	150.00	6.541	Very high
Zn	163.05	50.00	3.251	considerable	133.31	50.00	2.666	Moderate
				Borrow pit dumpsite soil				
	Dumpsite				20 meter away from the dumpsite			
Element	Cm	Bm	Cf	Summary	Cm	Bm	Cf	Summary

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Cd	15.46	0.80	19.325	Very high	17.16	0.80	21.450	Very high
Ni	10.02	35.00	0.286	Low	7.31	35.00	0.209	Low
Pb	27.51	85.00	0.324	Low	44.65	85.00	0.518	Low
Fe	1200.00	150.00	8.000	Very high	866.11	150.00	5.774	Considerable
Zn	105.85	50.00	2.117	moderate	87.86	50.00	1.757	Moderate

Ogorode road dumpsite soil

	Dumpsite				20 meter away from the dumpsite			
Element	Cm	Bm	Cf	Summary	Cm	Bm	Cf	Summary
Cd	6.34	0.80	7.925	Very high	4.67	0.80	5.838	Very high
Ni	8.63	35.00	0.246	Low	7.11	35.00	0.203	Low
Pb	45.23	85.00	0.532	Low	56.06	85.00	0.660	Low
Fe	1346.70	150.00	8.978	Very high	975.90	150.00	6.506	Very high
Zn	121.28	50.00	2.426	Moderate	103.89	50.00	2.078	Moderate

Control

Element	Cm	Bm	Cf	Summary
Cd	0.63	0.80	0.788	Low
Ni	1.30	35.00	0.037	Low
Pb	7.96	85.00	0.094	Low
Fe	714.29	150.00	4.742	Considerable
Zn	15.71	50.00	0.314	Low

Cm – Mean concentration of heavy metal in soil, Bm – Background concentration of heavy metal (WHO, 1996), Cf – Contamination factor.

The results showed that the waste dumpsites were highly contaminated with cadmium (Cd) and iron (Fe) with values ranging from 5.838 to 21.450 and 5.774 to 8.978 across all the sampling sites, which fall under the classification Cf > 6.

Geo- accumulation Index (Igeo)

The geo- accumulation index (Igeo) values obtained in this studyare presented in Table 5.

Table 4: Geo - accumulation index (Igeo) of heavy metals in the dumpsites and control.

Ogodo road dumpsite soil								
	Dumpsite				20 meter away from the dumpsite			
Element	Cm	Bm	Igeo	Summary	Cm	Bm	Igeo	summary
Cd	12.15	0.80	2.315	MP-SP	13.88	0.80	2.448	MP-SP
Ni	7.14	35.00	-1.995	PU	5.33	35.00	-2.287	PU
Pb	30.71	85.00	-1.424	PU	34.27	85.00	-1.134	PU
Fe	1118.33	150.00	1.604	MP	981.14	150.00	1.473	MP
Zn	163.05	50.00	0.777	PU-MP	133.31	50.00	0.575	PU-MP
Borrow pit dumpsite soil								
	Dumpsite				20 meter away from the dumpsite			
Element	Cm	Bm	Igeo	Summary	Cm	Bm	Igeo	summary
Cd	15.46	0.80	2.556	MP-SP	17.16	0.80	2.660	MP-SP
Ni	10.02	35.00	-1.656	PU	7.31	35.00	-1.972	PU
Pb	27.51	85.00	-1.534	PU	44.05	85.00	-1.063	PU
Fe	1200.00	150.00	1.674	MP	866.11	150.00	1.348	MP
Zn	105.85	50.00	0.345	PU-MP	87.86	50.00	0.158	PU-MP
Ogorode road dumpsite soil								
	Dumpsite				20 meter away from the dumpsite			
Element	Cm	Bm	Igeo	Summary	Cm	Bm	Igeo	summary
Cd	6.34	0.80	1.665	MP-SP	4.67	0.80	1.359	MP
Ni	8.63	35.00	-1.806	PU	7.11	35.00	-1.999	PU

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Pb	45.23	85.00	-1.036	PU	56.06	85.00	-0.822	PU
Fe	1346.70	150.00	1.789	MP-SP	975.90	150.00	1.467	MP
Zn	121.28	50.00	0.481	PU-MP	103.89	50.00	0.326	PU-MP
				Control				
Element	Cm	Bm	Igeo	Summary				
Cd	0.63	0.80	-0.644	PU				
Ni	1.30	35.00	-3.698	PU				
Pb	7.96	85.00	-2.774	PU				
Fe	714.29	150.00	1.155	MP				
Zn	15.71	50.00	-1.563	PU				

PU - Practically unpolluted, MP- Moderately polluted, SP- Strongly polluted, Cm- Mean concentration of heavy metal in soil, Bm – Background concentration of heavy metal (WHO, 1996), Cf - Contamination factor.

The results showed that the three different waste dumpsites were generally contaminated with cadmium with values ranging from 1.359 to 2.660 which falls under the classification 2 <Igeo< 3 (showing moderately polluted to strongly polluted) and the pollution can be attributed to the release of waste materials containing high concentration of cadmium into the area over time.

Heavy Metals Pollution Load Index (PLI)

The calculated values for heavy metals pollution load index (PLI) are presented in Table 6.

Table 5: Heavy Metal Pollution Load Index (PLI) in the Dumpsite and control

Site	Samples	Cf Cd	Cf Ni	Cf Pb	Cf Fe	Cf Zn	PLI index	Summary
Ogodo road	Soil (A)	15.188	0.204	0.361	7.456	3.251	3.076	Polluted
	Soil (B)	17.350	0.152	0.403	6.541	2.666	1.890	Polluted
Borrow pit	Soil (C)	19.325	0.286	0.324	8.000	2.117	2.838	Polluted
	Soil (D)	21.450	0.209	0.518	5.776	1.757	2.028	Polluted

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Ogorode road	Soil (E)	7.925	0.246	0.532	8.978	2.426	4.312	Polluted
	Soil (F)	5.838	0.203	0.660	6.506	2.078	2.578	Polluted
Control	Soil (CT)	0.788	0.037	0.094	4.742	0.314	0.005	Unpolluted

Potential Ecological Risk Coefficient.

The results obtained for the potential ecological risk coefficient of a single element (E_r^i) are presented in Table 6.

Table 6: Potential Ecological Risk Coefficient (E_r^i) of a single element

Ogodo road dumpsite soil								
	Dumpsite				20 meter away from the dumpsite			
Element	Cf	T_f^i	E_r^i	Summary	Cf	T_f^i	E_r^i	Summary
Cd	15.188	30.00	455.640	Very high	17.350	30.00	520.500	Very high
Ni	0.204	5.00	1.020	Low	0.152	5.00	0.760	Low
Pb	0.361	5.00	1.805	Low	0.403	5.00	2.015	Low
Fe	7.456	1.00	7.456	Low	6.541	1.00	6.541	Low
Zn	3.251	1.00	3.251	Low	2.666	1.00	2.666	Low
Borrow pit dumpsite soil								
	Dumpsite				20 meter away from the dumpsite			
Element	Cf	T_f^i	E_r^i	Summary	Cf	T_f^i	E_r^i	Summary
Cd	19.325	30.00	579.750	Very high	21.450	30.00	643.500	Very high
Ni	0.286	5.00	1.430	Low	0.209	5.00	1.045	Low
Pb	0.324	5.00	1.620	Low	0.518	5.00	2.590	Low
Fe	8.000	1.00	8.000	Low	5.774	1.00	5.774	Low
Zn	2.117	1.00	2.117	Low	1.757	1.00	1.757	Low

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Ogorode road dumpsite soil								
	Dumpsite				20 meter away from the dumpsite			
Element	Cf	T_f^i	E_r^i	Summary	Cf	T_f^i	E_r^i	Summary
Cd	7.925	30.00	237.750	Very high	5.838	30.00	175.140	Very high
Ni	0.246	5.00	1.230	Low	0.203	5.00	1.015	Low
Pb	0.532	5.00	2.660	Low	0.660	5.00	3.300	Low
Fe	8.978	1.00	8.978	Low	6.506	1.00	6.506	Low
Zn	2.426	1.00	2.426	Low	2.078	1.00	2.078	Low

Control				
Element	Cf	T_f^i	E_r^i	Summary
Cd	0.788	30.00	23.646	Low
Ni	0.037	5.00	0.185	Low
Pb	0.094	5.00	0.470	Low
Fe	4.742	1.00	4.742	Low
Zn	0.314	1.00	0.314	Low

Cf – Contamination factor, T_f^i– Toxic response factor of element I, E_r^i – The potential ecological risk coefficient.

Potential Ecological Risk Index

The results recorded for the potential ecological risk index (R_i) of multi- element are presented in Table 7.

Table 7: Potential Ecological Risk Index (R_i) of Multi Element

Site	Sample	E_r^iCd	E_r^iNi	E_r^iPb	E_r^iFe	E_r^iZn	R_i	Summary
Ogodo road	Soil (A)	455.640	1.020	1.805	7.456	3.251	469.172	Considerate

	Soil (B)	520.500	0.760	2.015	6.541	2.666	532.462	Considerate
Borrow pit	Soil (C)	579.750	1.430	1.620	8.000	2.117	592.917	Considerate
	Soil (D)	643.500	1.045	2.590	5.774	1.757	654.666	Very high
Ogorode road	Soil (E)	237.750	1.236	2.660	8.978	2.426	253.05	Moderate
	Soil (F)	175.140	1.015	3.300	6.506	2.078	188.039	Moderate
Control	Soil (CT)	23.646	0.185	0.470	4.742	0.314	29.357	Low

4. DISCUSSION

Heavy Metal Concentration in soil samples

The concentrations of cadmium and Iron observed in the soil samples were above the maximum permissible limit as reported by WHO, FEPA and E.U (Table 8). The concentrations of Zn recorded in the soils were above the maximum permissible limit set by WHO, but werefound below the safe limit reported by FEPA. The concentration recorded for lead and nickel were found below these safe limits. The high concentration of cadmium, Iron and Zinc may be attributed to the indiscriminate disposal of sewages, municipal and industrial wastes into the study area. The results reported in this study were in line with previous findings [19]. They found that the concentration of heavy metals in soils at the decomposed biodegradable waste dumpsite was higher than the concentration 100m away (control site). The findings of this study were also in agreement with other results [20], which could be attributed to the fact that the dumpsites were point sources of heavy metal contamination.

Table 8: International guidelines for heavy metals in soil

Heavy Metal	WHO(mg/kg) (Threshold values)	FEPA(mg/kg) (Threshold values)	E.U(mg/kg) (Threshold values)
Cd	0.80	Not fixed	3.00
Ni	35.00	Not fixed	-
Pb	85.00	1.60	300.00
Fe	150.00	400.00	-
Zn	50.00	300.00 – 400.00	-

Contamination factor (Cf)

The highest contamination of Cd was observed at borrow pit waste dumpsite with a value of (21.450).The contamination factor recorded for cadmium in the control site was 0.788 indicating low contamination levels for cadmium, while the high contamination factor recorded for iron (Fe) both for the dumpsite and control soils could be attributed to the indiscriminate dumping of waste materials containing large amount of iron into the dumpsites as well as natural occurrences. The contamination factor recorded for Ni and Pb ranged from 0.152 to 0.286 and 0.324 to 0.660 respectively across all the sampling sites, while in the control sites, the contamination factor recorded for Ni and Pb were; 0.037 and 0.094 respectively, which falls under the classification Cf < 1 indicating low contamination level of Ni and Pb on the study areas. The contamination factor recorded for zinc (Zn) across all the sample sites ranged from 1.757 to 3.251.The values fall under the classification 1 < Cf < 3 and were considered to be moderately contaminated. However, the Ogodo road waste dumpsite soil recorded a contamination factor of 3.251 for Zn and falls under the classification 3 < Cf < 6 which was considered to be considerably contaminated. The contamination factor recorded for Zn at the control site was0.314(less than 1) which indicates low contamination. Therefore the high contamination factor recorded for cadmium, Iron and zinc could be attributed to the dumping of waste materials containing high amount of Cd, Fe and Zn into the environment. On the basis of the mean Cf values, the soil samples are enriched with metals in the following order; Cd > Fe > Zn > Pb > Ni.

Geo- accumulation Index (Igeo)

The Igeo value recorded for Ni and Pb across the three different waste dumpsites ranged from (-1.656 to -2.287) and (-0.822 to -1.534) respectively, which falls under the classification Igeo< 1. This shows that the studied areas were not contaminated with Ni and Pb. The Igeo result obtained for iron (Fe) ranged from 1.348 to 1.789, across all the dumpsites under study and falls under the classification 1 <Igeo< 2, indicating that the areas under study were moderately polluted with iron (Fe) which could be as a result of wastes containing large amount of iron. The Igeo value obtained for Zinc (Zn) ranged from 0.156 to 0.777 across all the waste dumpsites under study and the result falls under the classification 0 <Igeo< 1 which indicates that the studied areas could be unpolluted or moderately polluted with Zinc (Zn). The Igeo values for the control site ranges from (-0.644 to -3.698) indicating that the control site was not polluted, except for iron (Fe) with Igeo value of 1.155 which falls under the classification 1 <Igeo< 2, indicating that the control area was moderately polluted with iron which could be as a result of natural occurrence.

Heavy Metals Pollution Load Index (PLI)

The pollution load index (PLI) values recorded for soil (A) and soil (B) samples collected from Ogodo road waste dumpsite were; 3.076 and 1.890 respectively, which are greater than 1, indicating that the waste dumpsite area was polluted. While for Borrow pit waste dumpsite, the PLI values recorded for soil (C) and soil (D) samples were; 2.838 and 2.028 respectively, which arealso greater than 1, indicating that the area was also polluted. The PLI value recorded for soil (E) and soil (F) samples collected from Ogorode road waste dumpsite were; 4.312 and 2.578 respectively, which are greater than 1, depicting the area to be polluted. The control soil samples recorded a PLI value of 0.005 which isless than 1, indicating that the control site was unpolluted

Potential Ecological Risk Coefficient.

The potential ecological risk coefficient of a single element (E_r^i), shows that the value of cadmium across the studied area ranged from 175.140 to 643.500 which falls under the classification $160 \leq E_r^i < 320$, indicating a very high ecological risk pollution. The E_r^i Value recorded for Ni, Pb, Fe and Zn across all the studied areas were below 40 which falls under the classification $E_r^i < 40$, indicating very low ecological risk pollution. The E_r^i values recorded at the control site was below 40.

Potential Ecological Risk Index

The results revealed that the R_i values recorded across all the study areas ranges from 188.039 to 654.666. Soils (A) and (B) samples collected from Ogodo road waste dumpsite recorded R_i values of 469.172 and 532.462 respectively, which falls under the classification $300 \leq R_i < 600$ and is considered to be of considerable ecological pollution. The values 592.917 and 654.666 were recorded for soil samples (C) and (D) collected from Borrow pit waste dumpsite respectively and falls under the classification $600 \leq R_i$and isconsidered to be of very high ecological risk pollution, while for the (E) and (F) soil samples collected from Ogorode road waste dumpsite the Ri recorded were; 253.06 and 188.039 respectively which fall under the classification $150 \leq R_i < 300$ and is considered to be moderately ecologically polluted.

The $R_i$value recorded for the control site soil was 29.357 which falls under the classification Ri<150 and indicates a low ecological risk pollution. The potential ecological risk indices were found in the following order: Cd > Fe > Zn > Pb > Ni for soil (A) and (B) samples collected from Ogodo road waste dumpsite, while for Borrow pit waste dumpsite, there was a little variation in the potential ecological risk indices order between soil (C) and soil (D) samples. For soil (C) sample, the R_i indices order was Cd > Fe >Zn > Pb > Ni, while for soil (D) samples, the order was Cd > Fe > Pb > Zn > Ni. The R_i indices order of soil (E) and soil (F) samples collected from Ogorode road waste dumpsite follows similar pattern which was Cd > Fe > Pb > Zn > Ni.

The profile of metals abundance in the study areas was: Fe > Zn > Pb > Cd > Ni. Among the five metals investigated, Fe, Zn and Cd exceeded the maximum permissible limit reported by WHO (1996) and EU (2002). Iron and zinc are required for plant growth, cadmium has no known physiological benefit to plant and can affect plant growth even at very low concentrations. In a nutshell, the heavy metals under investigation in the waste dumpsite soils reflected a low ecological risk to the soil with the exception of cadmium which posed a very high ecological risk to the soil,

5. CONCLUSION

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It can be concluded that the results recorded for Cf, Igeo, PLI, E_r^i and R_i indices across all the study areas, indicate that the study areas were heavily polluted with cadmium and the area under study is at high ecological risk of cadmium pollution and not suitable for agricultural practicebecause plants have the ability to take up toxic metals and bioaccumulate them in their tissues at a level high enough to cause serious clinical and physiological effectson humans when such plants are continuously consumed.

REFERENCES

1. Ogunyemi, S., Awodoyin, R. O. and Opadeji, T. (2003). Urban agricultural production: Heavy metal contamination of Amaranthuscmentis L. grown on domestic refuse landfill soil in Ibadan, Nigeria, Emirates Journals of Agricultural Science, 15 (87)

2. Achankeng,E.(2003). Globalization, Urbanization and municipal solid waste management in Africa. African on a Global Stage Studies Association of Australasia and the Pacific Conference Proceeding 2003.
3. Alimba, C. G., Bakare, A. A. and Latunji, C. A. (2006). Municipal landfill leachates induced chromosome aberration in rat bone marrow cells. African Journal of Biotechnology, 5 (2053).
4. Bakare, A. A., Mosuro, A. A. and Osinbanjo, O. (2005). An invivo evaluation of induction of abnormal sperm morphology in mice by landfill leachates. Mutation Research, 582 (28).
5. Odukoya, O. O., Bamgbose, O. and Arowolo, T. A. (2000). Heavy metals in topsoil of Abeokuta dumpsites. Global Journal of pure applied science, 7 (467).
6. Bishop, P. L. (2000). Pollution Prevention: fundamentals and practice. USA, McGraw – Hill, Companies Inc.
7. Baldini, M., Stacdhini, P., Cubadele, F., Miniero, R., Parodi, P., and Facelli, P. (2000). Cadmium in organs and tissues of horses slaughtered in Italy. Food Addit. Contam 17 (676).
8. Benson, N. U. and Ebong, G. A. (2005). Heavy metals in vegetable commonly grown in a tropical garden ultisol. Journal of sustainable Tropical Agricultural Research, 16 (77).
9. Adewuyi, G. O. and Opasina, M. A. (2010). Physicochemical and heavy metals assessment of leachates from Aperin abandoned dumpsite in Ibadan city, Nigeria. European Journal of Chemistry. 7(1278).
10. Mohajer, R., Salehi, M.H. and Mohammadi, J. (2012). Accumulation of cadmium and lead in soils and vegetables of lenjanat region in Isfahan province, Iran. International Journal of Agronomy and plant production. 3(576).

11. Khan S., Cao Q., Zheng Y. M., Huang Y. Z., and Zhu Y.G. (2008). Health risks of heavy metals in contaminated soils and food crops irrigated with waste water in Beijing, China, Environmental pollution, 152 (686).
12. National Population Commission (2007). Official Gazette of the federal republic of Nigeria, Abuja: National Bureau of statistics.

13. Nyangababo, J. T. and Hamya, J. W. (1986). The Deposition of Lead, Cadmium, Zinc and Copper from motor traffic on Brachiariaenimi and soil along a major Bombo road to Kampala city. International Journal of Environment Studies. 27(115).

14. Cui , Y. J., Zhu, Y. G., Zhai, R. H., Chen, D. Y., Huang, Y. Z., Qiu, Y. and Liang, J. Z., (2010). Transfer of metals from soil to vegetables in the area near a smelter in nanning, China, International journal of environment. 30 (785).

15. Tukura, B. W., Kagbu, J. A. and Gimba, C. E. (2007). Effect of pH and Total organic carbon (TOC) on the distribution of trace metals in kubanni dam sediments, Zaria, Nigeria. Science world Journal. 2(1).

16. Tijjani, M. M. and Onodera, S. (2009). Hydro geochemical assessment of metals contamination in an urban drainage system. A case study of Oshogbo Township, SW-Nigeria. International Journal of Water Resource and Protection. 3 (164).

17. Lokeshwari, H. and Chandrappa, G. T. (2006). Impact of heavy metal contamination of Bellandur Lake on soil and cultivated vegetables. Current Science, 91(5).

18. Häkanson. L. (1980). An ecological risk index for aquatic pollution control – a sediment logical approach. Water Research.14(975).

19. Umoh, S. D and Etim, E. E. (2013). Determination of heavy metal contents from dumpsites within Ikot, Ekpene, Akwa Ibom state, Nigeria. The international journal of engineering and science (IJES). 2(123).

20. Amusan, A. A., Ige, O. V and Olawale, R. (2005). Characteristic of soils and crops‘’uptake of metals in municipal solid waste landfill sites in Ibadan”, Nigeria. Journal of Environmental Health Research, 2 (32).