ASSESSMENT OF HEAVY METALS CONCENTRATION IN THE VICINITY OF MAJOR DUMPSITES IN THE FEDERAL CAPITAL TERRITORY, ABUJA NIGERIA

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ABSTRACT
The research was carried out to determine the effect of dumpsites on heavy metal concentrations in the vicinity of major dump sites in the Federal Capital Territory. Soil samples were randomly collected at depth 0-15 and 15-30cm from each of the major dumpsite. Six (6) composite (replicated) samples from each dumpsite and three in control site. Seventy-two (72) soil samples from both dumpsites and the control sites, across the three area councils selected. The samples' locations were; Zuba, Gwagwalada 1 and Gwagwalada 11 of Gwagwalada area council; Kubwa, Bwari and Mpape of Bwari area council; Lugbe, Karu and Idu of AMAC and the control site of each dumpsite. Data collected was subjected to two-way Analysis of Variance (ANOVA), mean values were separated using Duncan Multiple Range Test.Textural class was generally sandy loam across locations of the major dumpsites in Abuja. The pH of the soil around major dumpsites was between 6.12-6.6, which depicted slightly acidity to neutral. There were appreciable values of other chemical parameters determined around the major dumpsites; exchangeable cations like Ca, K and Mg were above the critical levels while Na was below. Meanwhile, organic carbon, total nitrogen was within and above the critical level. Average mean values of total exchangeable cation, exchangeable acidity and effective cation exchange capacity (EB, Exchangeable acidity and CEC), respectively, were below the critical value. Especially, CEC values obtained from the major dumpsites were below the critical level of 10.00cmol/kg. The concentrations of the species of heavy metals (As, Pb, Cd, Cu and Zn) were significantly higher in soils around major dumpsites in Bwari when compared to the two other Councils (Gwagwalada Area Council,and AMAC). However, pollution index indicates that Mpape dumpsite recorded the highly polluted level. Findings from this study indicates that As, Cd, Pb and Cu were above the permissible limits stipulated for Nigerian soils across all the major dumpsite (WHO/FAO and NESREA). While Zn was within and below the limit .It was generally observed that heavy metal determined in all the With high concentration of some heavy metals is soils and sources of water around major dumpsites when compared to control and the permissible standards, there should be proper monitoring (regulation) in the activities of the body responsible for waste disposal.

INTRODUCTION
A dumpsite is a designated area where waste materials are discarded, including industrial, household, and commercial waste (Obiekezie *et al*., 2019). Waste, defined as discarded materials from human activities, can pose severe health risks if not managed properly (Sharma *et al*., 2014).In urban areas, where waste generation is high, improper waste disposal can lead to significant environmental challenges. This issue is particularly acute in many urban areas of developing countries, including Nigeria, where rapid industrialization and population growth contribute to substantial waste generation (Awomeso *et al*., 2010).

In the Federal Capital Territory (FCT) of Nigeria, improper solid waste management, characterized by indiscriminate dumping, inefficient waste collection systems, and a lack of proper resources, has become a major environmental concern (Benjamin *et al*., 2014) and this calls for a decisive action in order to maintain a safe and sustainable environment. The rapid growth of urban populations, exacerbated by rural-to-urban migration, has further intensified the challenges of waste disposal. Unlike developed nations, Nigeria faces significant difficulties in waste management, with open dumping being a common practice (Pires *et al*., 2011). Reports indicate that Nigeria generates over 32 million tons of solid waste annually, with only 20-30% being properly collected and managed (Adeniran *et al*., 2017). This mismanagement of waste contributes to pollution and environmental degradation, negatively impacting soil and water quality (Ahsan *et al*., 2014).

Dumpsites, particularly open ones, present significant risks to the surrounding environment. Leachate from these sites can contaminate soil and water with a mixture of toxic substances, including heavy metals such as lead, chromium, and mercury, as well as persistent organic pollutants and bacterial contaminants (Oyeku & Eludoyin, 2010; Galarpe & Parilla, 2012). Soil, which has a natural capacity to absorb pollutants, becomes a medium for the accumulation of harmful substances, leading to alterations in its physical and chemical properties (Cetin, 2014). Heavy metal pollution, in particular, poses a long-term threat to soil fertility, microbial activity, and overall environmental health (Luo *et al*., 2011). Studies have shown that open dumpsites have a significant detrimental impact on soil quality, with effects such as increased pH, electrical conductivity, and total dissolved solids, as well as a decrease in soil organic matter that hinders microbial growth (Ilori *et al*., 2019).

This study aims to assess the concentration of heavy metals in soils surrounding major dumpsites in the FCT, Abuja.

Materials and Methods

The Federal Capital Territory (FCT) encompasses six area councils: Abuja Municipal Area Council, Bwari Area Council, Kuje Area Council, Gwagwalada Area Council, Kwali Area Council, and Abaji Area Council. It is situated between latitudes 8°25' and 9°25' North of the equator and longitudes 6°45' and 7°45' East of the Greenwich Meridian. The FCT is bordered by four states: Kaduna to the north, Kogi to the south, Niger to the west, and Nasarawa to the east. It covers an area of 8,000 square kilometers, which is approximately 0.81% of Nigeria's total land area. Located in the central region of Nigeria, it experiences its highest temperatures of around 36°C during the dry season (November to March), while temperatures drop to a maximum of 24°C during the rainy season (April to October). Annual rainfall ranges between 1,100 mm and 1,600 mm. The region features two main types of vegetation: forest, which consists of woody plants, thorn bushes, and trees with few grasses, and savanna, characterized by herbs and shrubs. The FCT falls within Nigeria’s guinea savanna zone. Geologically, the FCT is underlain by Precambrian rocks from the Nigerian basement complex, covering about 85% of the land area, and Cretaceous sedimentary rocks from the Bida Basin, covering the remaining 15%. The terrain includes both hilly and dissected regions as well as plains.

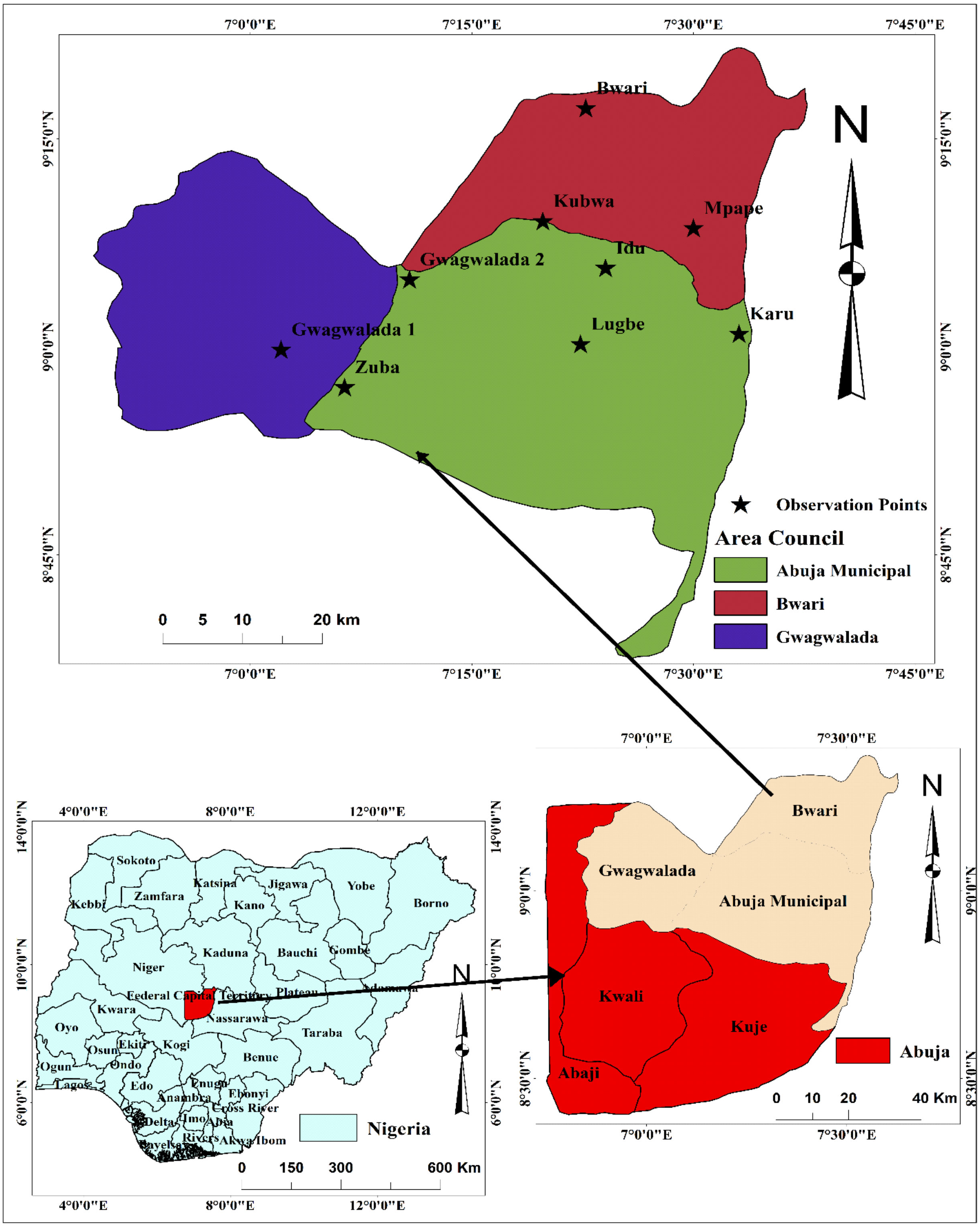

Figure 1: The study area in Abuja Nigeria.

Soil Sampling and Preparation

Soil samples was collected at two depths; 0 – 15 cm and 15 – 30 cm. Samples was collected randomly from different location on each dumpsite to get representative samples, which was bulked together to form a composite sample. A total of 6 composite sample from each dumpsite, 18 composite sample from each area council and a total of 54 composites sample from the 3 representative area councils (dumpsites). Control samples were also collected (a total of 18 from the three area councils). The soil sample was collected using soil sampling auger. Samples was collected in polythene bags and labelled appropriately.

The samples collected were air dried, crushed and passed through 2 mm sieve. The samples were labelled and stored in a polythene bag prior to laboratory analysis.

Laboratory Procedures

A representation of each of the composite soil samples collected were analyzed for particle size distribution using the Bouyoucos (1951) methos, pH was determined potentiometrically as described by McLean (1982), cation exchange capacity, available phosphorus was tdetermined by Bray-1 method of Bray and Kurtz (1945), organic carbon was determined by the Walkley Black wet digestion method of Walkley and Black (1982), total nitrogen was by macro Kjeldahl method (IITA 2015), exchange bases, exchangeable acidity and percentage base saturation were determined using ammonium acetate as described by Thomas 1982.

For heavy metals determination, soil samples were digested using nitric/perchloric acid (Kirpichtchikova *et al*., 2011) and analyzed for heavy metals (Pb, Cd, As, Zn, Cu) with an atomic absorption spectrophotometer following APHA (1995) procedures

The pollution or contamination index (*PI*) of each metal at the study location was estimated as a ratio between the metal concentration (*Mc*) and its reference metal value (*Rm*) (control soil samples) using the formula below: $PI = RC/RM$

The levels of pollution or contamination by each metal was interpreted using the evaluation grading standards of the single-factor pollution index listed as follows: $PI < 1$, $1 \leq PI < 3$, $3 \leq PI < 6$ and $PI > 6$ to indicate low pollution, moderate pollution, considerate pollution, and very high pollution, respectively (Michael *et al.,* 2018).

Statistical Analysis

The physical-chemical properties, concentration of heavy metals and microbial load of soil and sources of water around major dumpsites in Abuja, along depth and location was determined by two-way ANOVA using GENSTAT software package, mean values were separated using Duncan Multiple Range Test.

Results and discussion

Table 1 Particle size distribution in soil around major dumpsites in Abuja

Location	Depth	Sand	g/kg Clay	Silt	Textural classes
BWARI COUNCIL					
Kubwa	0-15	66.80	23.20	10.00	Sandy clay loam
	15-30	65.80	24.20	10.00	Sandy clay loam
Bwari	0-15	70.80	16.20	13.00	Sandy loam
	15-30	69.80	17.20	13.00	Sandy loam
Mpape	0-15	69.80	18.20	12.00	Sandy loam
	15-30	70.80	17.20	12.00	Sandy loam
GWAGWALADA COUNCIL					
Zuba	0-15	69.80	19.20	11.00	Sandy loam
	15-30	69.64	18.36	12.00	Sandy loam
Gwagwalada 1	0-15	70.36	17.64	12.00	Sandy loam
	15-30	69.36	18.64	12.00	Sandy loam
Gwagwalada 11	0-15	72.80	15.20	12.00	Sandy loam
	15-30	71.80	17.20	11.00	Sandy loam
AMAC					
Lugbe	0-15	71.80	16.20	12.00	Sandy loam
	15-30	72.80	14.20	13.00	Sandy loam
Karu	0-15	70.64	16.36	13.00	Sandy loam
	15-30	69.36	18.64	12.00	Sandy loam
Idu	0-15	76.80	21.20	11.00	Sandy clay loam
	15-30	66.80	22.20	11.00	Sandy clay loam
CONTROL	0-15	75.79	22.21	11.00	Sandy clay loam
	15-30	65.80	23.20	11.00	Sandy clay loam

Table 2 Physical and chemical properties of soil around major dumpsites in Abuja

FACTORS		pH in H_2O	OM g/kg	OC g/kg	N %	P mg//kg	Ca	Mg	K	Na	EB	EA	CEC	% BS
LOCATION	Depth													
CONTROL	0-15	5.82g	1.10g	0.57f	0.003f	6.86	2.64	1.15f	0.09d	0.07f	3.78	0.83e	5.40	73.20
	15-30	5.64h	1.08h	0.52g	0.002f	6.56	2.56	1.09g	0.07e	0.06f	3.56	0.75f	5.10	71.23
BWARI														
Kubwa	0-15	6.38b	3.00a	1.73a	0.12a	11.2	4.00	2.10a	0.27a	0.25a	6.62	1.15a	7.77	85.20
	15-30	6.42a	2.84b	1.64b	0.10b	10.1	3.80	1.93b	0.23b	0.23b	6.19	1.12b	7.31	84.08
Bwari	0-15	6.12f	1.26e	0.73d	0.041d	7.4	2.98	1.48e	0.19c	0.17cd	4.82	0.98d	5.80	83.10
	15-30	6.20d	1.14f	0.66e	0.046d	7.6	3.10	1.58d	0.20c	0.18c	5.06	1.01c	6.07	83.36
Mpape	0-15	6.17e	1.69c	0.98c	0.024e	9.2	3.10	1.64c	0.19c	0.16de	5.00	1.11b	6.20	82.10
	15-30	6.21c	1.54d	0.89c	0.068c	9.1	3.00	1.62c	0.17d	0.15e	4.94	1.00c	6.02	82.06
Grand mean		6.25	1.91	1.11	0.007	9.10	3.33	1.73	0.21	0.19	5.44	1.06	6.53	83.33
p-value		0.004	0.03	0.01	0.004	0.23	0.078	0.02	0.01	0.01	0.42	0.02	0.21	0.560
Sign. Level (p=0.05)		*	*	*	*	Ns	Ns	*	*	*	Ns	*	Ns	Ns
GWAGWALADA														
Control		5.82e	1.10g	0.57f	0.003f	6.86	2.64	1.15f	0.09d	0.07e	3.78	0.83e	5.40	73.20
		5.64f	1.08h	0.52g	0.002f	6.56	2.56	1.09g	0.07e	0.06e	3.56	0.75f	5.10	71.23
Zuba	0-15	6.56b	1.33c	0.77c	0.056c	8.90	3.64	1.60c	0.25a	0.22b	5.24	1.03c	6.27	83.57
	15-30	6.60a	1.18d	0.68d	0.051d	8.70	3.06	1.55d	0.22c	0.20c	5.03	1.00d	6.03	83.42
Gwagwalada 1	0-15	6.28d	1.87a	1.08a	0.099a	10.0	3.90	1.86a	0.26a	0.24a	6.26	1.13a	7.39	84.71
	15-30	6.32c	1.73b	1.00b	0.087b	9.40	3.20	1.70b	0.22c	0.19c	5.31	1.10b	6.41	82.84
Gwagwalada 11	0-15	6.25d	1.19d	0.69d	0.051d	8.60	3.50	1.58c	0.24b	0.24a	5.56	1.04c	6.60	84.24
	15-30	6.30c	1.04f	0.60e	0.047d	7.80	3.40	1.39e	0.21c	0.18d	5.18	0.99d	6.17	82.40
Grand mean		6.39	1.39	0.80	0.07	8.90	3.45	1.61	0.23	0.21	5.43	1.05	6.48	83.53
p-value		0.020	0.040	0.011	0.006	0.260	0.070	0.023	0.011	0.012	0.440	0.024	0.213	0.562
Sign. Level (p=0.05)		*	*	*	*	Ns	Ns	*	*	*	Ns	*	Ns	Ns
AMAC														
Control	0-15	5.82f	1.10g	0.57g	0.003e	6.86	2.64	1.15e	0.09f	0.07e	3.78	0.83e	5.40	73.20
	15-30	5.64g	1.08h	0.52h	0.002e	6.56	2.56h	1.09f	0.07g	0.06e	3.56	0.75f	5.10	71.23
Lugbe	0-15	6.40b	1.14e	0.66e	0.063c	9.10	3.0	1.66c	0.20d	0.17c	5.03	1.09b	6.12	82.19
	15-30	6.50a	1.04f	0.60f	0.059c	8.90	3.10	1.68c	0.23c	0.20b	5.21	1.0d	6.21	83.90
Karu	0-15	6.18e	1.30c	0.75c	0.054d	8.50	2.50	1.40d	0.18e	0.16c	4.24	1.13b	5.37	78.96
	15-30	6.24d	1.21d	0.70d	0.049d	8.30	2.40	1.26d	0.18e	0.13d	3.94	1.10c	5.04	78.17
Idu	0-15	6.36c	2.80a	1.62a	0.11a	10.2	3.98	1.90a	0.27a	0.24a	6.39	1.14b	7.53	84.86
	15-30	6.51a	2.42b	1.40b	0.098b	9.80	3.60	1.81b	0.24b	0.21b	5.86	1.16a	7.02	83.48
Grand mean		6.37	1.65	0.96	0.07	9.13	3.09	1.62	0.22	0.19	5.11	1.10	6.22	81.93
p-value		0.030	0.051	0.012	0.008	0.265	0.076	0.028	0.014	0.016	0.450	0.027	0.215	0.565
Sign. Level (p=0.05)		*	*	*	*	Ns	Ns	*	*	*	Ns	*	Ns	Ns

Means that do not share the same letter are significantly different at 5% level of probability within each factor (location, depth and interaction). significant= *; highly significant =**; Not significant = NS

Keys: OC= Organic carbon, Total N= Total Nitrogen, Available P= Available Phosphorus, Na=Sodium, K= Potassium, Mg= Magnesium, Ca= Calcium, TEB= Total exchangeable bases, EX.A= Exchangeable acidity, ECEC= Exchangeable cation exchange capacity.

The study examined the physical and chemical properties of soils around major dumpsites in Abuja. Soils were primarily classified as sandy loam across various depths, a texture that supports nutrient and water retention, enhancing plant performance (Yusufu, 2017). Soil pH levels ranged from slightly acidic to neutral (6.5-7.0), aligning with optimal ranges for crop production (FAO, 2018). FAO (2018) categorizes soils with pH 6.6-7.2 as neutral, while lower pH levels indicate varying degrees of acidity. Higher pH values observed at dumpsites may stem from increased biological activity and liming materials (Agbeshie *et al*., 2020). This pH level is critical for regulating soil chemical processes (Praveena & Rao, 2016).

Organic carbon and organic matter content were within the required levels for crop production (FAO, 2018). However, reduced organic carbon may be due to root absorption, decomposition stages, waste composition, and environmental conditions, consistent with findings by Chude *et al*. (2011). Nitrogen content was largely low, consistent with typical nitrogen deficiencies in tropical soils (Adepetu *et al*., 2014). Nitrogen loss may result from high carbon-to-nitrogen ratios in waste, non-biodegradable waste materials, and rapid decomposition. Available phosphorus (P) levels were below the critical threshold (15 mg/kg) for crop growth, likely due to low organic matter across dumpsites (FAO, 2017).

The study also revealed that total exchangeable bases, exchangeable acidity, and effective cation exchange capacity (CEC) were below the critical values, especially for CEC, which fell below the recommended level of 10 cmol/kg (2004; FAO, 2018). Low CEC values might result from low organic matter content. However, concentrations of calcium, magnesium, and potassium were above critical thresholds needed for crop production, while sodium levels remained below critical values (FAO, 2018).

Table 3. Evaluation of some heavy metals around major dumpsites in Abuja

Means that do not share the same letter are significantly different at 5% level of probability

FACTORS		As	Cd	Pb	Cu	Zn
		(mg/kg)				
LOCATION	Depth					
BWARI COUNCIL						
Control	0-15	1.23	6.67g	28.56g	21.66g	123.00
	15-30	0.88	4.56h	24.86h	20.10h	120.00
Kubwa	0-15	8.32	24.38c	183.75b	381.56b	294.74
	15-30	7.41	23.74d	183.13c	380.38c	292.80
Bwari	0-15	7.91	20.79e	177.83e	350.10e	280.15
	15-30	7.44	19.74f	174.91f	329.80f	250.68
Mpape	0-15	8.90	27.72a	189.60a	387.80a	297.93
	15-30	8.47	26.98b	182.87d	379.30d	291.97
Grand mean		8.08	23.89	182.02	368.16	284.71
p-value		0.066	0.002	0.037	0.036	0.207
Sign. Level (p=0.05)		Ns	*	*	*	Ns
GWAGWALADA COUNCIL						
Control	0-15	1.28	6.77g	29.66g	22.67g	123.08
	15-30	1.02	4.76h	23.56h	21.15h	120.09
Zuba	0-15	7.54	16.45f	175.27e	336.90e	269.63
	15-30	7.73	17.50d	177.35a	347.00a	274.90
Gwagwalada 1	0-15	7.65	18.60b	176.51b	341.20b	274.94
	15-30	7.30	17.90c	175.82d	338.00d	271.90
Gwagwalada 11	0-15	7.28	17.10e	172.40f	330.00f	260.99
	15-30	7.66	19.22a	176.30c	340.44c	274.00
Grand mean		7.53	17.79	175.61	338.92	271.06
p-value		0.069	0.004	0.039	0.038	0.209
Sign. Level (p=0.05)		Ns	*	*	*	Ns
AMAC						
Control	0-15	1.24	6.68g	28.58g	21.69g	124.00
	15-30	1.01	4.55h	24.88h	20.15h	121.00
Lugbe	0-15	7.48	15.83e	174.80d	330.24e	268.27
	15-30	7.12	15.18f	171.95f	326.70f	249.66
Karu	0-15	7.58	18.14b	175.50c	335.91d	270.55
	15-30	7.77	18.36a	177.70b	336.30c	271.62
Idu	0-15	7.76	17.87c	177.80a	347.00a	275.67
	15-30	7.20	16.92d	172.40e	339.80b	272.80
Grand mean		7.49	17.05	175.03	335.99	268.09
p-value		0.068	0.005	0.038	0.039	0.223
Si gn. Level (p=0.05)		Ns	*	*	*	Ns
INTERACTION						
	0-15	7.165a	18.355a	163.202a	316.237a	261.587a
	15-30	6.898b	18.01b	161.729b	313.782b	257.033b
Sign. Level (p=0.05)		*	*	*	*	*
WHO/FAO		1.0	3.0	50	100	150
NESREA		1.5	3.0	70	67	421

within each factor (location, depth and interaction). significant= *; highly significant =**; Not significant = Ns

Table 4 Pollution index of soil around major dumpsites in Abuja

FACTORS		As		Cd (mg/kg)		Pb		Cu		Zn	
LOCATION	Depth										
BWARI COUNCIL		CL	P1	CL	PI	CL	PI	CL	PI	CL	PI
Kubwa	0-15	8.32	6.8	24.38	3.7	183.75	6.4	381.56	17.6	294.74	2.4
	15-30	7.41	8.4	23.74	5.2	183.13	6.4	380.38	18.9	292.80	2.4
Bwari	0-15	7.91	6.4	20.79	3.1	177.83	6.2	350.10	16.2	280.15	2.3
	15-30	7.44	8.5	19.74	4.3	174.91	7.0	329.80	16.4	250.68	2.1
Mpape	0-15	8.90	7.2	27.72	4.1	189.60	6.6	387.80	17.9	297.93	2.4
	15-30	8.47	9.6	26.98	5.9	182.87	7.4	379.30	18.9	291.97	2.4
GWAGWALADA COUNCIL											
Zuba	0-15	7.54	5.9	16.45	2.4	175.27	5.9	336.90	14.9	269.63	2.2
	15-30	7.73	7.6	17.50	3.7	177.35	7.7	347.00	16.4	274.90	2.3
Gwagwalada 1	0-15	7.65	5.9	18.60	2.7	176.51	6.0	341.20	15.1	274.94	2.2
	15-30	7.30	6.0	17.90	3.8	175.82	7.5	338.00	15.98	271.90	2.3
Gwagwalada 11	0-15	7.28	5.7	17.10	2.5	172.40	5.8	330.00	14.6	260.99	2.1
	15-30	7.66	7.5	19.22	4.0	176.30	7.5	340.44	16.1	274.00	2.3
AMAC											
Lugbe	0-15	7.48	6.0	15.83	2.4	174.80	6.1	330.24	15.2	268.27	2.2
	15-30	7.12	7.0	15.18	3.3	171.95	6.9	326.70	16.2	249.66	2.1
Karu	0-15	7.58	6.1	18.14	2.7	175.50	6.1	335.91	15.5	270.55	2.2
	15-30	7.77	7.7	18.36	4.0	177.70	7.1	336.30	16.7	271.62	2.2
Idu	0-15	7.76	6.3	17.87	2.7	177.80	6.2	347.00	16.0	275.67	2.2
	15-30	7.20	7.1	16.92	3.7	172.40	6.9	339.80	16.9	272.80	2.3

Key: PI <1, 1 =PI <3, 3 =PI <6 and *PI ? 6* to indicate low pollution, moderate pollution, considerate pollution, and very high pollution, respectively (Karimian *et al.,* 2021). CL; contaminated level

The significantly higher ($p<0.05$) concentrations of most heavy metals at all dumpsites, compared to control samples, suggest substantial heavy metal contamination from waste materials leaching into surrounding soils. This pattern aligns with findings from prior studies (Onwukeme & Eze, 2021; Musa *et al*., 2020; Nyiramigisha & Komariah, 2021) that document elevated heavy metal levels in soils near dumpsites. According to the National Environmental Standards and Regulations Enforcement Agency (NESREA) and the Food and Agricultural Organization/World Health Organization (FAO/WHO), the permissible limits for metals in soil are 1 mg/kg for As, 3 mg/kg for Cd, 164 mg/kg for Pb, 100 mg/kg for Cu, and 421 mg/kg for Zn (NESREA, 2021; FAO/WHO, 2021). The present study reveals that As, Cd, Pb, and Cu concentrations exceeded these limits at all major dumpsites, while Zn levels remained within permissible bounds (see Table 3).

The high concentrations of As, Cd,"Pb, and Cu may be attributed to industrial and agricultural waste, including materials from paper, photography, compost, batteries, and metal alloys (Musa *et al*., 2020). Comparatively, Bwari Area Council dumpsites exhibited higher heavy metal concentrations than those in Gwagwalada and AMAC, likely due to differences in dump age, waste volume, and composition (Onwukeme & Eze, 2021; Ebong *et al*., 2019). Metals like Cd, Pb, and As are known to have negligible benefits for plant and animal health (Hayat *et al*., 2018; Zhang *et al*., 2012) and pose significant risks to human health, especially in children, when absorbed through contaminated food, air, dust, or water (Zhang *et al*., 2012). Heavy metal pollution is thus a pressing concern for food safety, particularly in vegetable cultivation, as contaminated soil can impact agricultural productivity, environmental health, and human well-being (Kachenko, 2016).

Pollution indices show that soils in all studied dumpsites in Abuja are highly contaminated with As, Pb, and Cu, while Cd and Zn exhibit moderate contamination (Michael *et al*., 2018). Notably, Mpape in Bwari area council displayed the highest pollution levels across all metals tested. This further supports evidence of extensive anthropogenic and industrial waste accumulation at these dumpsites. The findings underscore the need for eco-friendly remediation measures, particularly in sites with elevated As, Cd, Pb, and Cu levels.

Conclusion

The textural class was consistently sandy loam. Soil pH ranged from 6.12 to 6.6, indicating slight acidity to neutral conditions. Chemical parameters showed varied levels: calcium (Ca), potassium (K), and magnesium (Mg) were above critical levels, while sodium (Na) was below. Organic carbon and total nitrogen were at or above critical levels. However, total exchangeable cations, exchangeable acidity, and effective cation exchange capacity (CEC) were below critical values, with CEC notably below 10.00 cmol/kg.

Heavy metal concentrations (As, Pb, Cd, Cu, Zn) were notably higher around Bwari Area Council dumpsites compared to those in Gwagwalada and AMAC. Across all dumpsites, concentrations of As, Cd, Pb, and Cu were above permissible limits set by the National Environmental Standards and Regulations Enforcement Agency (NESREA) and FAO/WHO, while Zn was within or below limits. Elevated heavy metal levels likely stem from anthropogenic sources like industrial waste, fertilizers, batteries, and other pollutants deposited at dumpsites.

Recommendations

I. With high concentration of some heavy metals is soils around major dumpsites when compared to control and the permissible standards, there should be proper monitoring (regulation) in the activities of the body responsible for waste disposal.

ii. In order to prevent extension of contamination by heavy metals; more standard dumpsites should be provided across Abuja-FCT, to avoid spillover of waste indiscriminately deposited.

iii. Farms should not be sited along the gradient of dumpsites, in order to minimize the level of pollutants washed down from the dumpsites.

REFERENCE

Adeniran, A.E., Nubi, A.T., Adelopo, A.O. (2017) 'Solid waste generation and characterization in the University of Lagos for a sustainable waste management', *Waste Management*,Vol.67,pp.3–10, Elsevier.

Adepetu, J. A., Adetunji, M. T. and Ige, V. (2014). Soil fertility and crop nutrition. Jumak Publishers, Ibadan, 106-470.

Agbeshie AA, Adjei R, Anokye L and Banunle, A (2020). Municipal waste dumpsite: Impact on soil properties and heavy metal concentrations, Sunyani, Ghana Scientific African.

Ahsan, A., Alamgir, M., El-Sergany M. M., Shams, S., Rowshon, M.K., & Daud, N.N. (2014). Assessment of municipal solid waste management system in a developing country. *Chinese Journal of Engineering*. Hindawi 2014(561935), 1-11,

American Public Health Association (APHA). (1995). Standard Methods for the Examination of Water and Wastewater (19th ed.). American Public Health Association, Washington, DC.

Awomeso, J.A., A.M. Taiwo, A.M. Gbadebo and A.O. Arimoro, 2010. Waste disposal and pollution management in urban areas: A workabale remedy for the environment in developing countries. *Am. J. Environ. Sci*., 6(1): 260-32

Benjamin, T. A., Emmanuel, E. O., & Gideon, A. D. (2014) Characterization of municipal solid waste in the Federal Capital Abuja, Nigeria. Global Journal of Science Frontier Research: *Environment & Earth Science* 14(2) Version 1.0 ISSN 2249-4626 Massachusetts USA.

Bouyoucous, G.J. (1951). Hydrometer methods of particle size analysis of soils. Soil Society of America Proceedings 26:464-465.

Bray, R.H and Kurtz, L.K (1945); Determination of Total organic and Available Phosphorus in Soil Science and Conservation 2nd Edition.59:39-45.

Cetin, B. (2014) 'Soil concentrations and source apportionment of polybrominated diphenyl ethers (PBDEs) and trace elements around a heavily industrialized area in Kocaeli, Turkey', *Environmental Science and Pollution Research*, Vol. 21, No. 13, pp.8284–8293.

Ebong, G. A., Dan, E. U., Inam, E. and Offiong, N. O. (2019). "Total concentration, speciation, source identification and associated health implications of trace metals in Lemna dumpsite soil, Calabar, Nigeria" *Journal of King Saudi University of Science*, 31: 886-897.

FAO. (2018). Nitrogen inputs to agricultural soils from livestock manure new statistics. Rome: Food and agriculture organization of the United Nations.

Galape V.R.K and Papilla R.B., 2012, influence of seasonal variation on the Bio – Physiochemical properties of leachate and ground water in cebu city sanitary dumpsite, Philippines. *International Journal of Chemical and Environmental Engineering*, 3(3) pp. 175 – 181.

Hayat, M. T., Nauman, M., Nazir, N., Ali, S. and Bangash, N. (2018). "Environmental hazards of cadmium: past, present, and future" Cadmium Toxicity and Tolerance in Plants, 163-183.https://doi.org/10.1016/B978-0-12-814864-8.00007-3Hazelton, P. and Murphy, B. (2007). Interpreting Soil Test Results: What Do All the Numbers Mean, CSIRO, Canberra, Australia, 2nd edition.

Ilori, B.A., Adewumi, J.R., Lasisi, K.H. and Ajibade, F.O. (2019) 'Qualitative assessment of some available water resources in Efon-Alaaye, Nigeria', *Journal of Applied Sciences and Environmental Management*, Vol. 23, No. 1, pp.29–34.

Kachenko, A. (2016). Heavy metals in agricultural soils: Sources, influencing factors, and remediation strategies. *Journal of Environmental Management*, 181, 561-576. https://doi.org/10.1016/j.jenvman.2016.06.041

Kirpichtchikova, T.A. (2011). Determination of heavy metals in soils by nitric and perchloric acid digestion method. *International Journal of Environmental Science and Technology*, 8(1), 63-68.

Musa, J. J., Bala, J. D., Mustapha, H. I., Otache, M. Y., Musa, E. T., Akos, M. P., Yerima, Y. I. and Daniel, E. S. (2020). "Determination of elemental composition of soil samples from selected dumpsites in Nasarawa, Kogi and Niger States, Nigeria" *Journal of Solid Waste Technology and Management,* 45: 457-467.

McLean, E.O, (1982). Soil pH and lime requirement. Methods of soil analysis, part 2, chemical and microbiological properties, 2nd Edition, pp: 199-224. Agronomy monograph No. 9,

Michael, K., Smith, J. R., & Anderson, L. M. (2018). Determination of pollution index of heavy metals in soils around dumpsites. Journal of Soil Contamination Studies, 9(3), 201-213.

Nyiramigisha, P. and Komariah, S. (2021). "Assessment of heavy metals concentration in the soil and crops grown around dumpsites" *East African Scholars Journal of Agriculture and Life Sciences*, 4: 82-88.

Obiekezie SO, Ekeleme IK, Adamu MO, Gnimintakpa MJ, Onalo C, Sabo AA. (2019) Assessment of Microbiological Quality of Air Environment around Waste Dumpsites Within Keffi Metropolis in Northern Nigeria. American Journal of Biological and Environmental Statistics. Special Issue: Microbes, Man and Environmental Sustainability. 2019; 5(4): 78-84.

Oyeku OL and Eludoyin A. D., (2010), Heavy metal contamination of ground water resources in a Nigerian Urban settlement. *African Journal of Environmental Technology*, 4 (4), pp. 201 – 214

Pires, A., Martinho, G., & Chang, N. B. (2011). Solid waste management in European countries: A review of systems analysis techniques. *Journal of Environmental Management*, 92(4), 1033–1050. https://doi.org/10.1016/j.jenvman.2010.11.024

Praveena SG, Rao PV (2016). Impact of leachate on soil properties in the dumpsite. *International Journal of Engineering Research General Sciences*, 1:235-242.

Sharma, P., Dhanwantri, K., & Mehta, S. (2014) Solid waste management. *International Journal of Environmental Research Development*. 4(1), 49 – 54. Haryana, India.

Thomas, G.W (1982). Exchangeable Cation. In A1 page, RH Miller and Keeny (Eds) Method of soil Analysis part 2 second edition. Pg 157-164.

Walkley, A. and Black, C.A. (1934). An examination of the degrjareff method of determining soil organic matter and a proposed modification of chromic acid titration method. Soil. Science., 37: 29-38.

Wilson, D.C.; Velis, C.A. Waste management—Still a global challenge in the 21st century: An evidence-basedcall for action. Waste Management Research. 2015, 1049–1051i

Zhang, X., Yang, L., Li, Y., Li, H., Wang, W. and Ye, B. (2012). "Impact of lead/zinc mining and smelting on the environmental in human health in China" Environmental Monitoring and Assessment, 184 (4) 2261-2273. https://doi.org/10.1007/s10661-011-2115-6