EVALUATION OF SOIL PROPERTIES AT DUMPSITES FOR AGRICULTURAL USE IN GWAGWALADA AND BWARI AREA COUNCILS, FEDERAL CAPITAL TERRITORY, NIGERIA

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ABSTRACT: Studies in the Federal Capital Territory (FCT) have not been able to determine the safety of dumpsite soils for agricultural use despite the widespread use of dumpsite soils as organic manure. A study of soil properties at dumpsites for agricultural use in the Gwagwalada and Bwari area councils was carried out with the following objectives: assess the concentration of soil properties at dumpsites in the study area; and then ascertain the suitability of soil at dumpsites for agricultural use in the study area. A field survey of three purposely selected dumpsites (Mpape, Gwagwalada and Kwuba) was conducted for the collection of soil samples. A total of eighty-one (81) soil samples were collected from the dumpsites and control sites. Three top and subsoil samples were collected at 0 m, 20 m, 40 m and 60 m from the three dumpsites and their control sites. The data were analysed via means, standard deviations and ANOVA. The results show that the mean distributions of soil properties at the Mpape, Gwagwalada and Kubwa dumpsites were as follows: pH (7.52, 7.52 and 7.08), EC (581.35, 264.75 and 906.50 µmol/cm), NO_3- (15.11, 11.20 and 10.98 mg/kg), P (4.11 and 3.81 mg/kg), K (14.12 and 14.10 and 13.53 mg/kg), Zn (0.84 and 0.94 mg/kg), Pb (0.15 and 0.24 and 0.03 mg/kg), Cr (0.36 and 0.73 mg/kg), Cd (1.34 and 0.97 and 0.94 mg/kg), and Cu (1.75 and 1.49 mg/kg). The distributions of the soil properties were not uniform among the three dumpsites. It was concluded that the soils are not suitable for agricultural purposes. It is recommended, among other things, that soils at dumpsites should not be converted to agricultural use without treatment because of elevated heavy metals at dumpsites.

Keywords: Soil, Properties, Dumpsites, Agricultural Use, Heavy Metals

INTRODUCTION

The use of dumpsite soils as organic manure is widespread in developing countries such as Nigeria (Nimyel, Egila & Lohdip, 2015). In Nigeria, soils in municipal waste dumpsites commonly serve as fertile ground for the cultivation of a variety of fruits and leafy vegetables, and the soils are also used as 'compost' by farmers without considering the probable health hazards that the heavy metal contents of such soils may pose (Adeagbo, Ige & Olawale , 2005). The practice of using dumpsite soil for food production may be due to ignorance of possible contamination from the soil. The environmental concern in Nigeria was brought to lime light in June 1988 following the discovery of toxic waste dumped in Koko town Delta state, Nigeria (Ladapo, 2013). This created public outcry and prompted the government to react swiftly. The Koko incident promoted environmental awareness of waste dumps in Nigeria.

Consequently, several studies have been carried out on solid waste and its environmental effects (Anikwe, 2002; Anake, Adie & Osibanjo, 2009; Olumide, Ochonma & Oyinloye, 2019). In particular, studies abound on soil quality at dumpsites, for example, Amadi *et al*., (2012) carried out comparative studies on the impact of the Avu and Ihie dumpsites on soil quality in southeastern Nigeria. Ojekunle *et al*. (2021) assessed the soil quality of the Saje dumpsite at Abeokuta, Nigeria. Anikwe (2002) assessed the long-term effects of municipal waste disposal on the soil properties and productivity of the soil used for urban agriculture in Abaliki Ebonyi, Nigeria. Olumide *et al.* (2019) evaluated the impact of landfills on soil quality: a case study of the Akilapa and Oleyo Dumpsites, Osogbo, Nigeria. Akinnusotu and Arawande (2016) analysed the physicochemical characteristics and heavy metal concentrations in subsurface soil at different dumpsites in Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria. Angaye *et al*. (2015) analysed the microbial load and heavy metal properties of leachates from solid waste dumpsites in the Niger Delta, Nigeria. Ulakpa *et al* (2021) carried out a quantitative analysis of the physical and chemical attributes of soil around a power line dumpsite at Boji-Boji Owa, Delta State, Nigeria.

Many studies on soil quality at dumpsites in Nigeria have focused on heavy metal contamination owing to its health effects, even at low concentrations. For example, Anake *et al*. (2009) investigated heavy metal pollution at municipal solid waste dumpsites in the states of Kano and Kaduna in Nigeria. Ajah *et al.* (2015) studied the spatiality, seasonality and ecological risks of heavy metals in the vicinity of a degenerate municipal central dumpsite in Enugu, Nigeria. Ayeni *et al*. (2017) studied heavy metal accumulation in plants, insects and soil at a public dumpsite in Ado-Ekiti, Ekiti State, Nigeria. Olarinoye *et al*. (2010) analysed the heavy metal contents of soil samples from two major dumpsites in Minna Niger State, Nigeria. Ideriah *et al*. (2005) analysed heavy metal contamination of soils around municipal solid waste dumps in Port Harcourt, Nigeria. Adedosu *et al*. (2013) assessed heavy metals in soil, leachate and underground water samples collected from the vicinity of the Olusosun landfill in Ojota, Lagos, Nigeria. Bada *et al.* (2018) analysed the levels of heavy metals in soil and water leaves (*Talinum triangulare*) collected from abandoned dumpsites in Abeokuta, Nigeria.

Some studies were also conducted in domiciles in the Federal Capital Territory, Abuja, Nigeria. For example, Sawyerr (2017) assessed the impact of dumpsites on the quality of soil and groundwater in satellite towns of the Federal Capital Territory, Abuja, Nigeria. Oluyori *et al*. (2019) assessed the concentrations of several heavy metals and nonmetallic ions in dumpsite soils in the Federal Capital Territory, Nigeria. Ayuba *et al*. (2013) assessed the current status of municipal solid waste management in F.C.T. Abuja, Nigeria. Magaji and Jenkwe (2019) assessed soil contamination in and around the Mpape dumpsite, Federal Capital Territory (FCT), Abuja, Nigeria. Magaji (2020) evaluated the Mpape landfill standard in FCT Abuja, Nigeria. Olowookere *et al.* (2018) analysed heavy metal concentrations at dumpsites in Gwagwalada, Abuja. Magaji and Jenkwe (2019) assessed soil contamination in and around the Mpape dumpsite, Federal Capital Territory (FCT), Abuja, Nigeria. Magaji and Mallo (2020) assessed the vertical movement of heavy metals in the soils of the Mpape Dumpsite, Federal Capital, Abuja, Nigeria. However, it is clear that the Gwagwalada and Bwari area councils host the majority of dumpsites in the FCT (Dodo & Ashigwuike, 2023). However, studies in the Federal Capital Territory (FCT) Abuja did not pay attention to Gwagwalada and the Bwari Area Council despite their perticularity in waste management challenges. Moreover, there is no holistic approach in existing studies. Some studies have focused only on heavy metal concentrations (Olowookere *et al*., 2018; Magaji and Mallo, 2020). Some studies (Magaji & Jenkwe 2019; Magaji & Mallo**,** 2020) have focused on a single dumpsite in FCT, notwithstanding that the age, size and type of waste dump determine the impact on the soil and entire environment (Mekonnen *et al.*, 2020). Moreover, studies in the area have not been able to determine the safety of dumpsite soils for agricultural use despite the widespread use of dumpsite soils as organic manure in Nigeria (Nimyel *et al*., 2015). So some critical questions such as: what are the concentrations of soil properties in the dumpsites? What is the safety of the soils for crop production? Were answered in this study. Thus, this study investigates whether the soils in the dumpsites are suitable for agricultural use, based on soil contamination levels.To achieve this goal, the soil properties of three selected dumpsites (Mpape, Gwagwalada and Kubwa) were analysed and compared with the FAO standard for crop production.

MATERIALS AND METHODS

Data were sourced from both primary and secondary sources. The primary sources include observations at dumpsites and laboratory results of soil samples, whereas the secondary sources include the internet, journals, newspapers, conference papers and other literature. Data such as soil property regulatory standards were collected from secondary sources. Systematic random samples of soil were collected from three (3) dumpsites, namely, the Gwagwalada, Mpape and Kubwa dumpsites, and the control sites were 1 km away from each dumpsite. Control sites 1 km from the dumpsite were selected to serve as a baseline for comparative analysis, assuming this distance is sufficient to avoid contamination impacts and represent background soil conditions in terms of geological similarity, and similar land use patterns. The samples were stratified into two groups, namely, top and subsurface soils. These dumpsites were selected on the basis of size and age. The soil sampling points were 0 m, 20 m, 40 m and 60 m away from each dumpsite and were geo-referenced via a global positioning system. Soil samples (using an auger) were collected from the top and subsurface layers at 0–15 cm for the topsoil and 15–30 cm for the subsurface soils. The distances 0m, 20m, 40m, and 60m were chosen for soil sampling in the waste disposal sites to assess the contamination gradient and potential spread of pollutants from the source, representing the immediate area (0m), near-field dispersion (20m), far-field migration (40m), and outer point (60m).

A total of eighty-one (81) soil samples were collected from the dumpsites and control sites. Three topsoil and subsoil samples were collected at 0m, 20m, 40m and 60m from the three dumpsites and their control sites. One kilogram (1 kg) of soil sample was collected at depths of 0–15 m and 15–30 m at thirty-six (36) sampling points at the dumpsites and nine (9) sampling points at the control sites. It is worthy to note that the soil sampling strategy may have limitations, including potential biases in site selection, incomplete spatial representation, and unaccounted variability in soil depth and lithology, which may impact accuracy and comprehensiveness of contamination assessments. The soil samples were prepared and analysed via standard methods to determine their physical and chemical properties.

RESULTS AND DISCUSSION

Soil properties of three selected dumpsites (Mpape, Gwagwalada and Kubwa)

The results for the soil properties of the three selected dumpsites (Mpape, Gwagwalada and Kubwa) are presented in Table I.

Table 1: Properties of Soils at Dumpsites in the Study Area

Parameters	Unit	Depth	Mpape Dumpsite				Mean	Gwagwalada Dumpsite				Mean	Kubwa Dumpsite				Mean	Control (NDs)
			0 m	20 m	40 m	60 m		0 m	20 m	40 m	60 m		0 m	20 m	40 m	60 m		
pH		0-15	7.52	7.72	8.24	6.91	7.60	7.7	7.8	8.1	6.32	7.48	7.5	7.7	7.5	6.12	7.21	5.20
		15-30	7.63	7.91	7.92	6.34	7.45	7.9	7.9	8.4	6.02	7.56	7.4	7.7	8.1	5.82	7.26	5.47
EC	µS/cm	0-15	819.31	1112.18	681.05	123.57	684.03	119.45	120.45	702.5	118.25	265.16	693.5	702.5	696.5	1169.5	815.50	478.83
		15-30	735.27	886.26	131.91	161.28	478.68	118.95	118.75	699.5	120.15	264.34	690.5	699.5	1173.5	1172.5	934.00	448.33
OM	%	0-15	6.21	6.43	5.22	3.71	5.39	6.32	5.25	5.61	5.12	5.58	6.12	6.57	5.21	4.24	5.54	2.65
		15-30	6.02	5.11	4.35	3.12	4.65	5.22	4.45	5.13	4.02	4.71	5.32	5.63	4.25	4.22	4.86	2.49
N%		0-15	0.63	0.59	0.58	0.42	0.56	0.62	0.59	0.56	0.43	0.55	0.51	0.48	0.44	0.32	0.44	0.11
		15-30	0.61	0.58	0.51	0.39	0.52	0.59	0.58	0.54	0.41	0.53	0.49	0.47	0.37	0.31	0.41	0.09
NO_3^-	Mg/kg	0-15	16.35	16.09	14.56	13.89	15.22	12.43	10.59	10.56	12.17	11.44	11.04	10.94	10.87	11.03	10.97	3.57
		15-30	16.23	15.78	14.22	13.78	15.00	10.59	10.58	10.54	12.17	10.97	10.95	10.63	11.09	11.11	10.95	3.39
P		0-15	4.37	4.32	4.28	3.58	4.14	3.93	3.96	3.17	3.88	3.74	4.82	4.47	4.4	3.93	4.41	1.03
		15-30	4.35	4.26	4.38	3.36	4.09	3.76	3.88	3.92	3.96	3.88	4.89	4.37	4.15	3.69	4.28	0.81
K		0-15	15.34	17.37	13.97	12.78	14.87	15.32	17.35	13.95	12.76	14.85	16.7	18.63	15.35	14.13	16.20	10.94
		15-30	14.23	15.32	11.82	12.12	13.37	14.21	15.3	11.8	12.1	13.35	15.26	16.79	13.21	13.35	14.65	9.77
Ca		0-15	19.42	18.65	15.42	15.32	17.20	18.92	18.92	17.88	14.92	17.66	19.12	15.86	15.72	15.26	16.49	5.74
		15-30	18.55	17.12	15.87	14.98	16.63	18.15	17.12	18.15	14.34	16.94	19.09	15.84	15.3	15.15	16.35	6.18
Mg		0-15	5.31	5.21	5.42	4.08	5.01	5.67	4.36	5.01	5.42	5.12	7.42	4.09	4.35	4.28	5.04	2.99
		15-30	5.28	5.12	5.87	3.78	5.01	5.96	5.09	5.08	5.87	5.50	4.99	3.85	3.56	4.09	4.12	2.48
Na		0-15	11.32	10.83	7.92	8.53	9.65	11.91	11.41	8.46	10.7	10.62	21.1	20.52	18.7	17.69	19.50	12.42
		15-30	10.62	8.63	9.82	7.23	9.08	11.21	9.19	11.99	8.27	10.17	20.44	19.31	18.94	16.57	18.82	11.96

Cl-		0-15	20.09	19.54	17.76	16.87	18.57	19.59	19.04	17.26	16.37	18.07	20.53	19.95	18.13	17.12	18.93	15.45
		15-30	19.45	18.34	18.07	15.76	17.91	18.95	17.84	17.57	15.26	17.41	19.87	18.74	18.37	16	18.25	15.22
CEC		0-15	9.04	10.28	10.64	8.99	9.74	8.05	8.23	7.44	7.16	7.72	6.18	4.42	5.36	4.25	5.05	8.27
		15-30	10.19	10.24	11.25	8.05	9.93	9.1	8.77	7.81	7.86	8.39	4.15	6.37	7.32	6.38	6.06	8.64
Zn		0-15	1.69	1.73	0.62	0.59	1.16	0.69	0.79	0.58	0.63	0.67	1.37	0.79	0.95	0.68	0.95	0.42
		15-30	1.48	1.58	0.55	0.58	1.05	10.69	0.49	0.34	0.64	3.04	1.07	0.69	0.87	0.51	0.79	0.36
Pb		0-15	0.56	0.91	0.04	0.05	0.39	0.37	0.71	0.34	0.06	0.37	0.05	0.08	0.04	0.04	0.05	0.05
		15-30	0.35	0.06	0.08	0.01	0.13	0.34	0.05	0.37	0.03	0.20	0.03	0.04	0.06	0.02	0.04	0.04
Cr		0-15	0.36	0.72	0.21	0.02	0.33	0.35	0.7	0.32	0.04	0.35	0.03	0.07	0.02	0.02	0.04	0.05
		15-30	0.26	0.09	0.08	0.01	0.11	0.35	0.06	0.35	0.04	0.20	0.05	0.07	0.08	0.04	0.06	0.05
Cd		0-15	1.73	2.35	1.23	0.09	1.35	2.24	1.24	0.51	0.03	1.01	1.98	1.8	0.87	0.06	1.18	0.08
		15-30	3.15	1.27	0.96	0.1	1.37	2.22	0.97	0.53	0.03	0.94	2.22	1	0.4	0.07	0.92	0.06
Cu		0-15	2.02	2.01	1.92	1.45	1.85	1.88	1.59	1.65	1.12	1.56	2.89	2.47	1.77	1.35	2.12	1.36
		15-30	2.02	2.08	1.23	1.32	1.66	1.6	1.9	1.19	1.05	1.44	2.25	2.22	1.05	1.37	1.72	1.32
As		0-15	0.09	0.09	0.07	0.05	0.08	0.78	0.43	0.26	0.19	0.42	2.89	2.22	1.77	1.37	2.06	0.04
		15-30	0.09	0.1	0.07	0.04	0.08	0.09	0.1	0.07	0.05	0.08	2.25	2.22	1.05	1.37	1.72	0.05
Ni		0-15	0.71	0.46	0.22	0.13	0.38	0.78	0.29	0.14	0.17	0.35	0.59	0.29	0.18	0.17	0.31	0.07
		15-30	0.59	0.43	0.08	0.18	0.32	0.65	0.29	0.26	0.16	0.34	0.28	0.19	0.2	0.1	0.19	0.06
Hg		0-15	1.01	0.09	0.02	0.2	0.33	1	0.08	0.01	0.19	0.32	0.93	0.19	0.1	0.19	0.35	0.01
		15-30	0.95	0.03	0.03	0.2	0.30	0.94	0.02	0.02	0.19	0.29	0.65	0.04	0.04	0.15	0.22	0.01

Table I shows that the mean distributions of the soil properties at the Mpape, Gwagwalada and Kubwa dumpsites were as follows: pH (7.52, 7.52 and 7.08), EC (581.35 µS/cm, 264.75 µS/cm and 906.50 µS/cm), OM (5.02%, 5.14% and 4.88%), N% (0.54%**,** 0.54% and 0.39%), NO_3- (15.11 mg/kg, 11.20 mg/kg and 10.98 mg/kg), P (4.11 mg/kg, 3.81 mg/kg and 3.52 mg/kg), K (14.12 mg/kg, 14.10 mg/kg and 13.53 mg/kg), Ca (16.92 mg/kg, 17.30 mg/kg and 14.84 mg/kg), Mg (5.01 mg/kg, 5.31 mg/kg and 8.53 mg/kg), Na (9.36 mg/kg, 18.31 mg/kg and 17.87 mg/kg), Cl-(18.24 mg/kg, 17. The results suggest that the distributions of the soil properties were not uniform among the three dumpsites. ANOVA was used to compare the distributions of the soil properties among the dumpsites (Mpape, Gwagwalada and Kubwa dumpsites), as shown in Table 2.

Table 2: Mean Distribution of Soil Properties of Soils in the three Dumpsites

Properties	Dumpsites			Calculated F Value	Critical F Value
	Mpape	Gwagwalada	Kubwa		
Ph	7.52	7.52	7.08	0.01	0.05
EC	581.35	264.75	906.50	0.17*	0.04
OM	5.02	5.14	4.88	0.15	0.42
OC	1.93	1.77	1.36	0.17	1.36
N%	0.54	0.54	0.39	0.14	0.18
NO_3^-	15.11	11.20	10.98	2.32*	1.46
P	4.11	3.81	3.52	0.32	2.05
K	14.12	14.10	13.53	0.01	0.04
Ca	16.92	17.30	14.84	0.07	0.08
Mg	5.01	5.31	8.53	0.16	0.77
Na	9.36	18.31	17.87	0.47*	0.06
Cl^-	18.24	17.74	17.61	0.08	0.11
CEC	9.84	2.80	2.92	2.66*	1.02
Zn	0.84	0.43	0.82	0.24*	0.02
Pb	0.15	0.24	0.03	0.22*	0.01
Cr	0.36	0.73	0.66	0.24	1.32
Cd	1.34	0.97	0.94	0.01	0.02
Cu	1.75	1.49	1.85	01	0.02
As	0.07	0.24	1.69	0.65*	0.04
Ni	0.34	0.34	0.23	0.21	0.29
Hg	0.32	0.31	0.26	0.02	0.03

The results in Table 2 show that few parameters (EC, NO_3-, Na, CEC, Zn, Pb and As) presented higher F values than P values did; examples include EC ($F_{0.17} > P_{0.04}$), NO_3- ($F_{2.32} > P_{0.46}$), and Na ($F_{0.47} > P_{0.06}$). Since the F values of EC, NO_3-, Na, CEC, Zn, Pb and As are greater than their p values are, the Ho, "there is no significant variation in distributions of soil physical and chemical properties among the dumpsites at 95% confidence level," is rejected for EC, NO_3-, Na, CEC, Zn, Pb and As. Therefore, the alternative hypothesis (Hi) that "there is a significant variation in the distribution of soil physical and chemical properties among the dumpsites at the 95% confidence level" is accepted.

It can be deduced that the soil properties are not the same among the dumpsites studied. Moreover, the results indicate significant alterations in soil properties due to waste disposal, with substantial differences between dumpsites and control sites. This has critical implications for local agriculture, farmers, and potentially affected populations as:

i. Altered soil properties can decrease fertility, affecting crop yields and quality.'
ii. Pollutants in soil can accumulate in crops, posing health risks to consumers. Contaminated soil can render land unsuitable for farming, reducing available agricultural land.
iii. Farmers may be exposed to pollutants through skin contact, inhalation, or ingestion.
iv. Farmers may lack awareness about soil contamination and its effects.

v. Contaminated crops can enter the food chain, posing health risks to consumers.
vi. Marginalized communities may disproportionately bear the burden of environmental pollution.

These results agree with those of previous reports in Nigeria. This finding agreed with that of Amadi *et al*. (2012), who reported spatial variations in the mean concentrations of parameters between the Avu and Ihie dumpsites and between locations from the dumpsites. Onweremadu *et al*. (2011) agreed that soil properties vary spatially. This finding aligns with that of Ebong *et al*. (2019), who reported higher pH, electrical conductivity, organic matter, and cation exchange capacity values in abattoir waste-impacted soils than in those from other dumpsites. In line with this result, a study by Oguntoke (2016) found significant differences in soil pH, organic matter, and nutrient content between dumpsites and control sites. The finding also agreed with reports from other countries. Examples, research in India revealed altered soil properties, including increased heavy metal concentrations, near dumpsites (Kumar, 2017). A study in Ghana reported decreased fertility and increased contamination in soils near waste disposal sites (Amoah, 2019).

Suitability of Soil at Dumpsites for Agricultural Use

The soil properties at dumpsites were compared with FAO standards to determine their suitability for agricultural use (Table 3).

Table 3: The Concentrations of Properties of Soil and FAO Standard for Agriculture

Parameters	Unit	Range	Mean	FAO Acceptable Limit for Agriculture
pH		6.32-8.24	7.01	6-9
EC	µS/cm^3	120.45-1169.50	906.86	1500
MO	Mg/kg	3.71-6.57	4.58	10
N%		0.32-0.63	0.38	20
NO_3^-		10.56-16.35	**11.34**	-
P	Mg/kg	3.17-4.82	3.58	5
K		13.94-17.37	14.26	50
Ca		14.92-19.42	15.38	150
Mg		4.09-7.42	4.19	50
Na		8.46-21.10	18.53	200
Cl^-	%	16.37-20.09	17.96	-
CEC		4.15-11.25	8.12	-
Zn		0.28-1.47	0.78	5
Pb		0.02-0.71	0.22	0.05
Cr		0.02-0.72	0.22	0.05
Cd	Mg/kg	0.03-1.73	1.18	0.01
Cu		1.12-2.02	1.84	0.01
As		0.05-2.89	0.85	0.39
Ni		0.17-0.78	0.34	1.00
Hg		0.01-1.01	0.33	-

Table 3 presents the concentrations of the soil properties and the FAO standard for agricultural purposes. The soil physical and chemical properties and the FAO standard were as follows: the soil pH was within the FAO range of 6--9 for agricultural purposes, as it ranged from 6.32--8.24 mg/kg, with a mean value of 7.01 mg/kg. The concentrations of soil macronutrients (N%, P, K, Ca, Mg, and NA) were all low but within the acceptable FAO limits. The concentration of N%, which ranged from 0.32--0.63%, with a mean of 0.38%, was within the limit of 20% set by the FAO. The range of 3.17–4.82 mg/kg for P was also within the standard limit of 5 mg/kg set by the FAO. The potassium (K) concentration, which ranged from 13.94-17.37 mg/kg, was within the limit of the 50 mg/kg FAO standard. The ranges of 14.92–19.42 mg/kg, 4.09–7.42 mg/kg and 8.46–21.10 mg/kg for Ca, Mg and Na, respectively, were low compared with their desired limits of 150 mg/kg, 50 mg/kg and 200 mg/kg, respectively. The macronutrients were generally lower than their desired limits set by the FAO for agricultural purposes. In contrast, the concentrations of most micronutrients were higher than their desired limit set by the FAO for agricultural purposes despite their relatively low concentrations. The 3.28 mg/kg and 0.78 mg/kg mean concentrations for Fe and Zn are within the limits of 5 mg/kg set by the FAO for agricultural purposes. The mean concentrations of 0.22 mg/K, 0.22 mg/K, 1.18 mg/K and 1.84 mg/K for Pb, Cr, Cd and Cu, respectively, are all above their desired FAO limits of 0.05, 0.05, 0.01 and 0.01, respectively, for agricultural Amadi*et al*., (2012) carried out comparative studies on the impact of the Avu and Ihie dumpsites on soil quality in southeastern Nigeria. The mean concentrations of 0.85 mg/K and 0.34 mg/K for As and Ni, respectively, were within their desired limits of 0.39 mg/K and 1.00 mg/K set by the FAO for agricultural purposes. Therefore, soils are suitable for agricultural purposes in terms of pH and Zn but require the consumption of macroelements (N%, P, K, Ca, Mg, and Na) and the reduction of elevated micronutrients such as Pb, Cr, Cd and Cu.

Conclusion and recommendations

Waste dumping enriches soil with both micro- and macronutrients but elevates macronutrients in soil, endangering its safety for crop production. The concentration of soil properties shows that soil properties have been altered by waste, as most parameters differ between dumpsites and control sites. Spatial variations were recorded in the soil properties, but few parameters differed significantly among the three dumpsites. The soils are not suitable for agricultural purposes because of elevated heavy metals.

Since waste dumps alter the properties of soils and increase the concentrations of heavy metals at dumpsites, the illegal disposal of toxic wastes at dumpsites should be discouraged so that dumpsites can be used for farming. The abandoned dumpsites in FCT should not be converted to agricultural use without proper treatment. This is because the soils at the dumpsites are not suitable for agricultural purposes because of elevated heavy metals. There is need to implement measures to restore soil fertility and reduce contamination by farmers. Alternatively, the authority can identify suitable other land uses, such as urban planning or ecosystem restoration.

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