An Explanatory Survey on The Concentration of Heavy Metals a Long Dumpsite Areas of North-Eastern Part of Nigeria

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Abstract
Heavy metal pollution is a global issue of concern which results from both biogenic and anthropogenic activities. Hence, an investigation of soil pollution is pertinent because of its potential threat to human health. This paper is an attempt to survey the heavy metals concentration a long dump site area of North-East Nigeria. However, limited or little work was done in the area on the subject in the area. It was found out that the heavy metals were relatively above the acceptable levels whether due to natural or human factors may leads to environmental hazards polluting the soil and causing health problems. It is suggested therefore, intensive research should be geared towards assessing the heavy metals concentration a long dump site area of North-east Nigeria to supplement the limited information on the subject in the region for effective policy making for sustainable development.

Keywords: *Concentration, Dumpsite, Metals, Nigeria, Overview.*

1. INTRODUCTION

Solid waste management has been a major concern for most developing countries of the world. In Nigeria, for instance it is not strange to see heaps of trash in the main cities littering the vacant plots, streets, water bodies and dumped in drains, and this has resulted in spread of transmissible diseases in many areas (Bashi *et al.*, 2019). The situation appears to keep on unabated due to mostly the factors of population growth, improved life style, urbanization and insufficient funds to properly control solid waste. Disposal of solid wastes in major cities of Nigeria in the last few decades has posed major environmental and public health problems. This has become a source of worry for rural and urban planners in Nigeria because of the explosive population growth and urbanization (Dirisu *et al*.,2019). Studies done on soils at dumpsites show that the soils contain different kinds and concentration of heavy metals, depending on the age, contents and location (Udosen *et al*., 1990; Haluschak *et al*., 1998; Odukoya *et al*.,2000). Pollution of heavy metal is a global threat to the environment as they are widely present in earth, air, water and food (Fifield and Haines, 2000). In urban soils and road dusts, the anthropogenic sources of heavy metals include traffic emission (vehicular exhaust particles, tyre and brake lining particles), industrial emission from power plants coal combustion, metallurgical industry auto repair shop, chemical industry, etc, weathering of building, domestic emission atmospheric deposit and so on (Solgi, 2016).

Heavy Metals has being defined by several researchers, Amo- Asare (2012) defined heavy metals as any metallic chemical element that has a relatively high density (density higher than that of water) and is toxic or poisonous at low concentrations as elements in the periodic table having atomic number more than 20 or densities more than 5g/cm3 Individual metals and metal compounds can impact human and aquatic health. Five common heavy metals are discussed in this review: arsenic, cadmium, chromium, lead, and mercury. These are all naturally occurring substances which are often present in the environment at low levels and if in larger amounts they are dangerous, health risk due to heavy metal contamination of soil has been widely reported (Eriyamremu *et al*, 2005; Muchuweti *et al*, 2006; Satarug *et al*, 2000). The use of dumpsites as a farmland is a common practice in urban and sub-urban centre in Nigeria because of the decayed and composted wastes enhances soil fertility (Ogunyemi *et al*, 2003). When agricultural soils are contaminated, these toxins are taken up by plants and accumulate in their tissue. Animals that graze on such contaminated plants and drink from polluted waters as well as marine lives that breed in heavy metal polluted waters also accumulates such metals in their tissue and milk (Garbarino *et al*, 1995). Industrial, agricultural and municipal activities have all resulted in soil and groundwater pollution by a variety of contaminants such heavy metals as cadmium (Cd), nickel (Ni), copper (Cu), lead (Pb), arsenic (As), chromium (Cr), tin (Sn) and zinc (Zn) and so on which end up in the soil as the sink when the leached out from the dumpsites (Yahaya *et al*, 2009). Soil can be contaminated with heavy metals from natural sources which include weathering of soil, sediments and rocks, sandstorms, major rest fires and volcanic eruptions (Waidron, 1980). Anthropogenic sources of toxic metals include mining, smelting, coal and petroleum processing, municipal sewage discharges, household waste incineration, solid waste disposal sites, phosphate fertilizers, leas-arsenic pesticides leaching, chipping or peeling of paint from old structures are sources of heavy metals in the soil (Salt *et al.*, 1995).

2. STATEMENT OF THE PROBLEM

In the past years, several studies have been carried out on soil pollution due to toxic heavy metals as a serious worldwide health and environmental problem. In Nigeria just like in the rest of the world, rapid urbanisation and population growth have brought about a proportional increase in the amount of waste that is generated. The inability to manage these wastes effectively in most developing and some developed countries becomes an issue of great concern because apart from the destruction of aesthetics of landscape by the waste dumpsites, some of the municipal solid wastes contain both organic and inorganic toxic pollutants (such as heavy metals) that threaten the health of humans and the entire ecosystem. A study in Nigeria showed that municipal solid wastes are produced in the urban areas at a mean rate of 0.43 kg/head/day [Sridhar et al., 1985 and Sridhar and Ojediran, 1989. This is evident as it is not uncommon going through the length and breadth of the country to find heaps of refuse littering the entire landscape, road sides, commercial market places, even on the premises of primary, secondary and tertiary institutions as a result of improper management strategies (Onibokun *et al.*, 2000).

Thus, the North-eastern part of Nigeria was not an exceptional like other developing countries; improved road accessibility creates a variety of supplementary employments which range from vehicle repairs, vulcanizer welders to auto electrician, battery charges and other facilitators of motor transportation. These activities contaminate soils with heavy metals (Sulaiman *et al.*, 2018; Oyeleka *et al.*, 2016). It is imperative to review the pollution status of dumpsites in the region from time to time to provide statistical data that could aid the government in policy making, regulation and enforcement. This study therefore aimed to survey the heavy metals concentration a long dump site areas North-east part Nigeria

3. METHODOLOGY

Study Area

North-eastern part of Nigeria consist of six (6) states namely Bauchi , Gombe Adamawa, Taraba, Maiduguri and Yobe as presented on figure 1 respectively. The present study area spans from longitudes 10^{0} 000' E to 12^{0} 000' E and latitudes 9^{0} 300' N to 11^{0} 300' N. It lies within crystalline and sedimentary geological terrain popularly known as the Gongola sub-basin of the Benue rift (in Nigeria) and its adjoining basement and volcanic rock outcrops (Ysusf *et al.*, 2021). The climate in the north-eastern states of Nigeria is dominated by a dry season (November to May) and a rainy season (May/June to October). (Houben *et al.*, 2013).

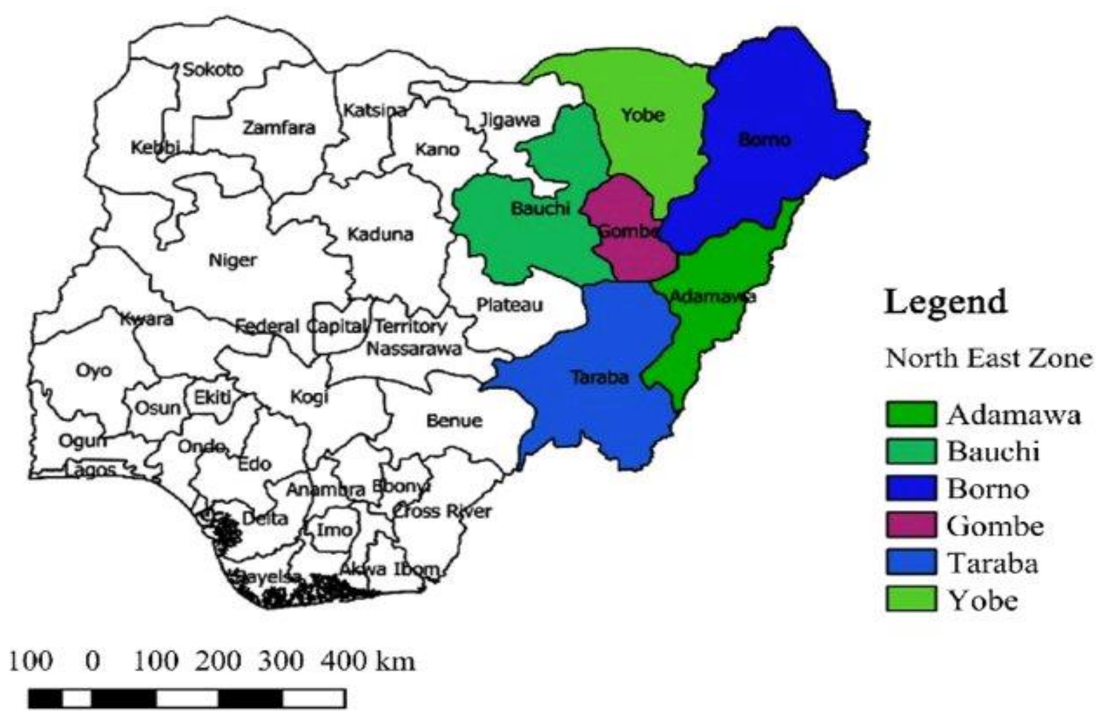

Figure 1. Shows the study area (North-eastern part of Nigeria)

Source Data

The present research is basically depends on secondary data. The information on the concentration of heavy metals were sourced from the existing available literatures in journals, textbooks, short communications and other relevant data through internets, libraries and academic institutions. This information were overviewed and presented logically.

4. DISCUSSION

4.1 Overview of heavy metals concentration along dump site area in Taraba State

Achadu *et al.*, (2015) conducted a research in Wukari-Jalingo Taraba State where they revealed that the mean concentrations (µg/g) of Pb, Cd, Zn and Cu from all sample sites ranged: 89.6-247.0, 0.15-5.3, 26.8-163.0 and 7.1-61.2 as shown on Table 1 respectively. In addition, the contamination factors (CF) reveal extreme contamination of the sites and an increasing trend in the heavy metals concentrations was observed in sites with more human activities (Table 2 and Figure 2) . The pollution load index (PLI) showed that the sites are severely polluted as the PLI of the metals from each sample site exceeded the PLI of the background (control) sample (0.7) as shown on figure 3.

Table 1. Heavy metals levels (µg/g) and pH of soils in sampled sites.

Sample ID	**Pb**	**Cd**	**Zn**	**Cu**	**pH**
S1	89.6	0.15	26.5	7.1	5.63
S2	129.8	0.54	65.3	15.2	5.02
S3	236.1	1.75	94.2	30.7	5.12
S4	233.5	4.15	119.7	44.6	5.80
S5	247.1	5.3	163.7	61.2	5.55
Background (0.5km)	7.5	0.03	2.5	1.5	6.90

Source: (Achadu *et al.*, 2015)

Table 2. Contamination factor for heavy metals in roadside soils samples.

Sample ID	**Pb**	**Cd**	**Zn**		**CU**
S1	11.94	5	10.72	14.2	
S2	17.31	18	26	30.4	
S3	31.48	58.3	37.68	61.4	
S4	31.13	138.3	47.88	89.3	
S5	32.93	176.7	65.2	122.4	

Source: (Achadu *et al.*, 2015)

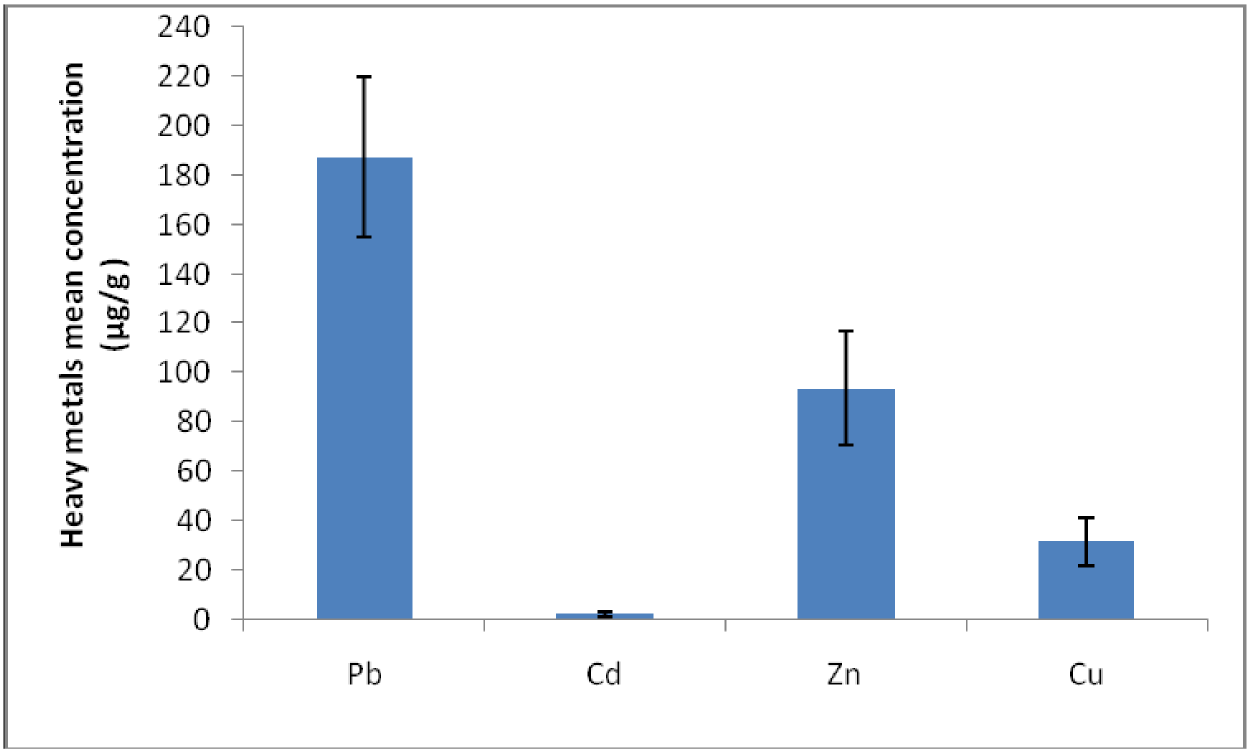

Fig. 1. Heavy metals mean±S.E in soils adjacent to the highway.

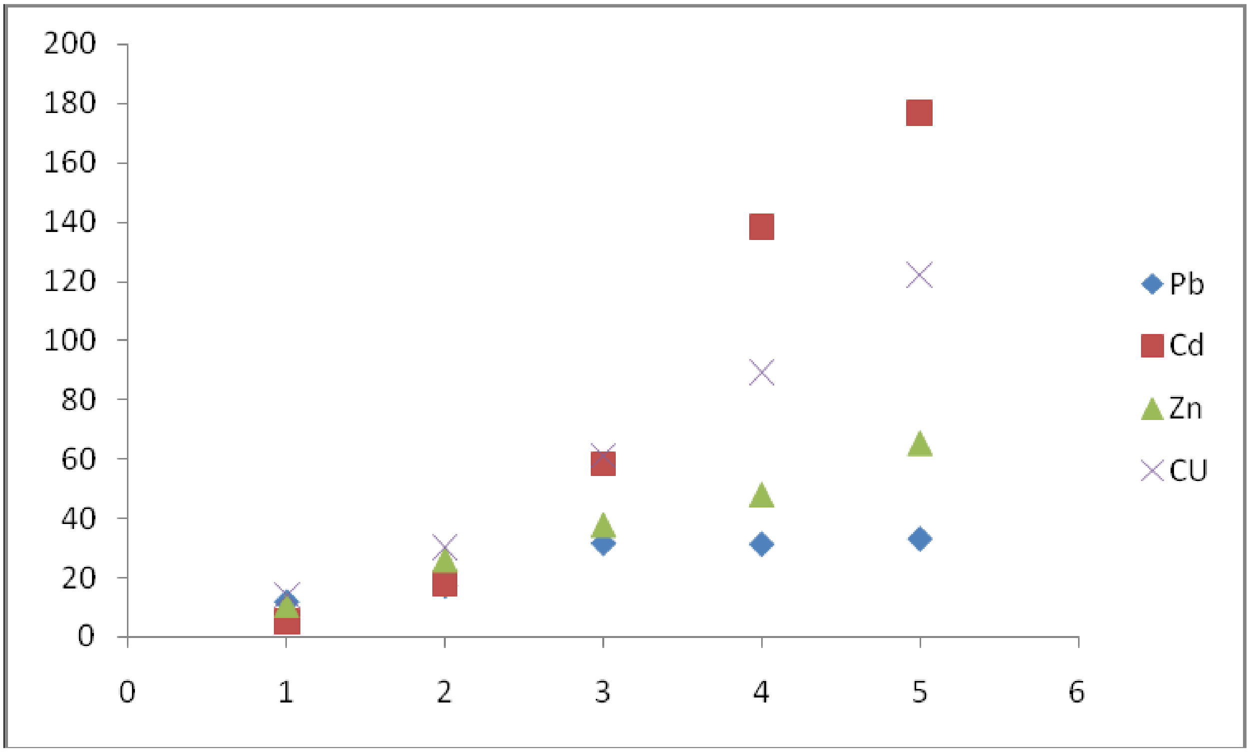

Fig. 2. Contamination factor of heavy metals in soil.

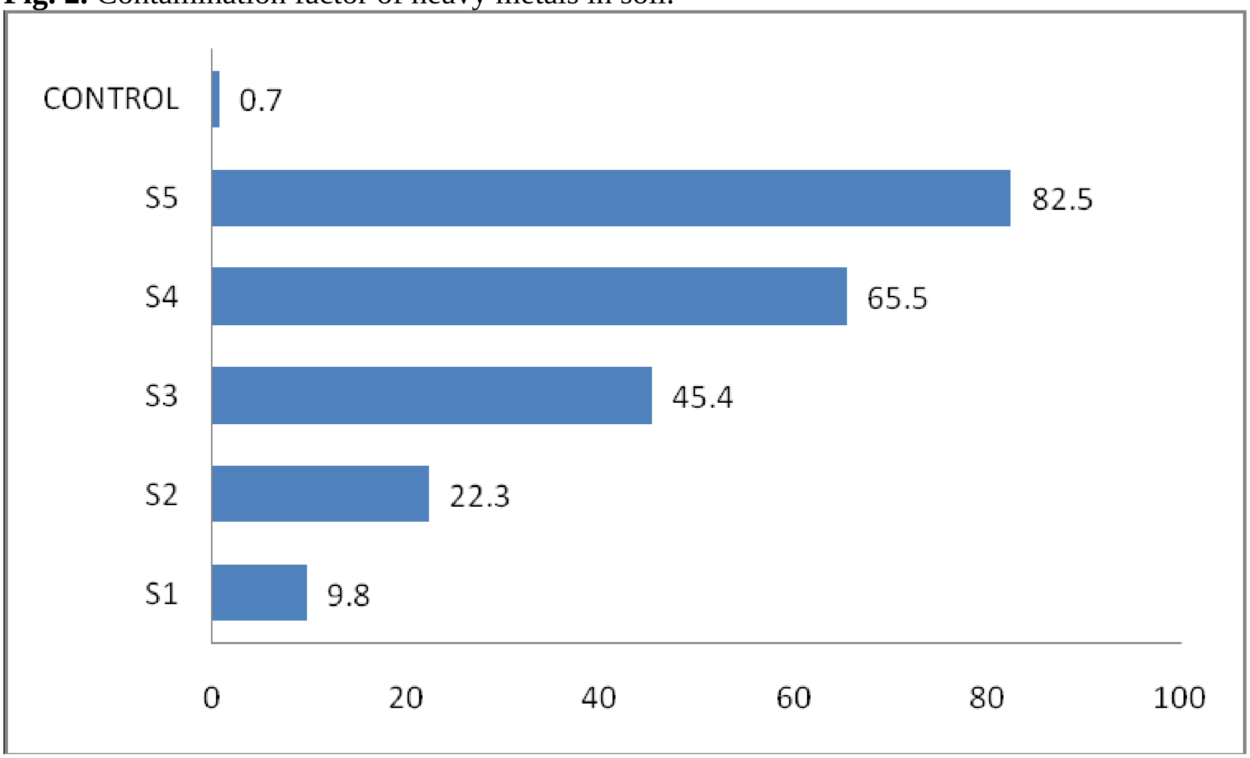

Fig. 3. Pollution Index of heavy metals in soil.

They have concluded that The levels of Pb, Cd, Zn and Cu in roadside soils were found to be higher than the background (control) levels for the heavy metals. Pollution assessment methods employed showed that the sites were extremely polluted. These concentrations, however, were below the critical maximum levels above which toxicity is possible. Nonetheless, the level of contamination could lead to the leaching of these metals to adjacent farmlands and potable water sources, which would eventually find their way into the food chain. Also, constant exposures to the vehicular emissions could lead to the bioaccumulation of these metals in plants and humans until it reaches the critical maximum level of toxicity.

4.2 Overview of heavy metals concentration a long dump site area in Adamawa State

Heavy metals in soil near dumpsites of Jimeta and Ngurore, Yola North Local Government Areas (LGAs), Adamawa State were studied by Chessed, *et al.*, (2018).
Results reveal (Table 3) that Fe, Pb, Cu and Chromium were detected, while Cadmium was found to be below the limit of detection. The mean concentration of the exchangeable cation in mg/kg in soil at Jimeta sites were: Fe (31.4 mg/kg) >Pb (0.92 mg/kg) > Cu (0.34 mg/kg) > Cr (0.11 mg/kg) >Cd (below limit of detection), while the mean concentration of the heavy metals in soil at Ngurore sites were: Fe (32 mg/kg) >Pb (0.83 mg/kg) > Cu (0.28 mg/kg) > Cr (0.07 mg/kg) >Cd (below limit of detection), respectively. Iron (Fe) was the most abundant element in both sites, followed by Pb. As shown on Table 3. Heavy metal concentrations in soil followed the order of Fe>Pb>Cu>Cr>Cd, respectively. The paired T-test analyses for concentration of Cr, Fe, and Pb in soil near the two dumpsites show that there were statistically significant differences in the concentration levels of Cr, Fe, and Pb, while Cu showed no statistically significant difference between the two dumpsites. However, all the metals detected were below the permissible limit of WHO international standard with the exception of Pb whose concentration was above maximum permissible concentration (MPC). Persistent heavy metals accumulation in soils near these dumpsites may lead to increase uptake by vegetables grown near thedumpsites and this may pose a threat to its quality and safety and ultimately human health. The need to replace open dumpsites with well-designed landfills is advised.

Table 3: Soil pH and heavy metal concentrations in soil (mg/kg) near Jimeta dumpsite

Site	Cr	Fe	Cd	Pb	Cu	pH
1	0.1	27.54	ND	0.28	0.44	6.46
2	0.1	35.68	ND	1.19	0.13	6.54
3	0.01	33.39	ND	1.35	0.58	6.98
4	0.2	24.34	ND	0.23	0.32	5.76
5	0.2	36.22	ND	1.2	0.14	5.99
6	0.02	31.28	ND	1.29	0.44	6.45
Total	**0.63**	**188.45**		**5.54**	**2.05**	**38.18**
Mean	**0.11**	**31.40**		**0.92**	**0.34**	**6.36**

Chessed, et al., (2018).

4.3 Overview of heavy metals concentration a long dump site area in Borno State

Mohammed, et al., (2021) examined the concentrations, contamination and pollution heavy metals where the data obtained showed mean concentration range of 0.34 - 1.18 mg/kg, 0.04 - 0.15 mg/kg, 0.07 - 0.41 and 0.18 - 0.29 mg/kg for Zn, Cr, Cd and Cu respectively. Nonetheless, lead was not detected in any and all samples analyzed. The increasing order of concentrations in the soils followed: Zn > Cu > Cr > Cd, Cu > Cd > Zn > Cr and Cd > Zn > Cu > Cr for BOEXP, TASKP and TASBP motor parks respectively. Notwithstanding, the results showed lower concentrations to the allowable limits of World Health Organization (WHO). Furthermore, the contamination factor of cadmium in the TASKP fell within the (0.10 – 0.25) category, indicative of slight contamination whereas in TASBP, the calculated value 0.5125 was within (0.51 -0.75) category implying severe contamination. The other heavy metals analyzed showed contamination factor as well as pollution index values < 0.1 indicative of very slight contamination.as was presented on table 4

Table 5 shows the results of the calculated contamination factors and pollution load index of the heavy metals under study in the sampled soils of the motor parks. Applying the classification earlier reported by Fosu-mensah *et al.* (2017) to interpret the PI data, the pollution load index for the individual metal fell within the low contamination (PI ≤ 1) for all the heavy metals analyzed in the soil samples of the three motor parks (Pradhan and Kumar, 2014). This implies that the presence of these heavy metals in the earth crust was low and their pollution in the soil is very minimal. However, comparison of the contamination factor and pollution index load with the categorization of significance of interval reported by Lacatusu (2000) revealed that all the heavy metals analyzed except cadmium, showed contamination factor as well as pollution index value < 0.1 indicative of very slight contamination. Furthermore, the contamination factor of cadmium in the TASKP fell within the slightly contaminated category (0.10 – 0.25) whereas in TASBP with a value of 0.5125 fell within the category (0.51 -0.75) implying severe contamination. The metal with the highest ecological risk factor was copper with Er of 2.625, 6.75 and 15.375 for BOEXP, TASKP and TASBP motor parks respectively. Comparing with the categorization previously adopted and reported by Edori and Kpee (2017), the Er values of the studied heavy metals in the soil samples of the motor parks fall within the low potential ecological risk category (Er < 40). The results are presented in Table 6.

The results of the analysis as shown for the selected areas of Maiduguri proves that the content of heavy metals in the soils was restricted to top soil 0 – 15 cm depth. Previous studies show that the surface soil is better indicator of metallic burden (Oyewale and Funtua, 2002). The relative low concentrations observed could be due to low agricultural activities, automobile emission and lack of heavy wind disperses around the sites. The levels of heavy metals in soils of three motor parks in Maiduguri, Borno state, Nigeria were determined. The results showed the order in concentrations as follows: Zn > Cu > Cr > Cd for Borno Express motor park (BOEXP), Cu > Cd > Zn > Cr for Tashan Kano motor park (TASKP) and Cd > Zn > Cu > Cr for Tashan Bama motor park (TASBP). The relative pollution potentials of the metals showed that the soils were contaminated with different degrees of contaminations. The contamination/pollution load indices confirmed slight and severe contamination for cadmium in soils of TASKP and TASBP motor parks respectively. However, the other metals (Zn, Cr, and Cu) revealed very slight contaminations of the soils studied. In general, the contamination levels of the soils by the heavy metals could be considered to have no serious implication as at the time of the study.

Table 4: Mean Concentration (mg/kg) of Heavy Metals in Soil Samples of Motor Parks

	Concentration (mg/kg)				
MotorPark	**Zn**	**Cr**	**Cd**	**Cu**	**Pb**
BOEXP	1.18	0.15	0.07	0.29	N/D
TASKP	0.09	0.08	0.18	0.19	N/D
TASBP	0.34	0.04	0.41	0.18	N/D
WHO LIMIT	10	1.0	0.01	2.0	2.0

N/D = Not detected **Source** (Mohammed *et al.*, 2021)

Table 5: Contamination Factor (Cf) and Pollution Index (PI) for Heavy Metals in Soils from Motor Parks

	Contamination factor (Cf)					
Motor Park	**Zn**	Cr	**Cd**	**Cu**	Pd	**Pollution Index (PI)**
BOEXP	0.00843	0.0015	0.0875	0.00806	N/A	0.0097177
TASKP	0.00064	0.0008	0.2250	0.00528	N/A	0.0049662
TASBP	0.00243	0.0004	0.5125	0.00500	N/A	0.0070645

Source (Mohammed *et al.*, 2021)

Table 6: Ecological Risk Factor (Er) of Heavy Metals for Motor Parks

Metals Metals	Tr	***Ecological Risk Factor (Er)***		
		BOEXP	**TASKP**	**TASBP**
Zn	1	0.00843	0.00064	0.00243
Cr	2	0.00300	0.00160	0.00080
Cd	30	2.625000	6.75000	15.3750
Cu	5	0.040300	0.02640	0.02500
Pb	5	N/A	N/A	N/A

Source (Mohammed *et al.*, 2021)

4.4 Overview of heavy metals concentration a long dump site area of Gombe state

The heavy metals content of soils where determined in Gombe state, North-Eastern Nigeria, by Ogidi *et al.*, (2020) where they have explained that heavy metals were found to be present in all soil samples at the various sites sampled, Pb was present in all sample and had the highest concentration at Pantami, G.R. A and Tundu Wada this could be as a result of vehicular emission, use of gasoline containing lead and lead paints, e.t.c., Cr had the least concentrations in soil at study sites except at Patami where Cd had the least concentration in soil samples. At G.R.A. Zn was not detected in the soil. A general over view of the study shows that Pb had the highest concentration, and Cr had the least concentration. The trend of heavy metals in the study is as follows; Cr < Cd < Zn < Pb. The heavy metals were all below the recommended limits required for soils as presented in Table 7 below.

Table 7: Statistics of heavy metal content of soils at Gombe.

Parameter	Cd	Cr	Pb	Zn
Max	1.10	1.20	16.90	6.30
Min	0.40	0.20	1.50	1.60
Average	0.88	0.54	6.54	2.74
Std Dev	0.38	0.42	6.15	2.32

Ogidi *et al.*, (2020)

Similarly, Bashir *et al.*, (2019) assessed the content of trace metals (mg kg-1) at the dumpsite in Gombe during dry season were: Pb (8.78), Zn (151.00), Ni (11.80), Cr (4.55), Cd (12.12) and Mn (92.05), while in rainy season, content of trace metals were Pb (8.80), Zn (148.00), Ni (11.63), Cr (4.20), Cd (10.03) and Mn (91.03). In both seasons, there was a significant increase ($p<0.05$) in levels of chromium, cadmium, zinc, nickel, lead, copper and iron in soil samples from the south (20 m) of the dumpsite and at the dumpsite compared to soil samples from the control site. Pollution indices studies showed that soil samples from south (20 m) of the dumpsite and at the dumpsite were highly polluted with cadmium, contributing 99% of the overall potential ecological risk. No potential health risk was detected, considering the fact that the hazard quotient and total hazard index of all the studied metals were less than one. However, children were found to be more vulnerable to heavy metal pollution. They concluded that assessment of pollution by some trace metals is soils within a municipal solid waste dumpsite in Gombe, Nigeria was determined using pollution indices like enrichment factor, contamination factor, degree of contamination, pollution load index, geo-accumulation index and ecological risks. Cadmium levels in the soil from the various sites were above the DPR target values. The other metals were within the stipulated limit set by DPR. All the pollution indices carried out show that Cd was the only metal posing an ecological risk to the local ecosystem. The human health risk carried out using the hazard quotient and total hazard index gave values less than 1, this indicate no probable health risk for children and adult living in the area of the dumpsite.

Generally, in other parts of the Northern States of Nigeria similar findings were reported example Karkarna and Matazu, (2021) reported that the mean concentration of heavy metals in the soils sample were Zn (0.009 mg/kg), Pb (1.02 mg/kg), Cd (0.007 mg/kg), Cr (0.15 mg/kg) and Ni (0.15 mg/kg) for surface soils (0-15cm) while the mean values for sub-surface soils (15-30cm) were Zn (0.10 mg/kg), Pb (0.27 mg/kg), Cd(0.008 mg/kg), Cr (0.15 mg/kg) and Ni (0.17 mg/kg) as shown in Table 8 respectively. The maximum concentrations of the five heavy metals in both sample and control sites were below WHO (2007) and DPR (2002) standard. Based on the result of soil contamination around the dumpsites in Kano metropolis, it indicated that, all the seven dumpsites were in the class of low contamination. The contamination/Pollution Index values of all the studied heavy metals (Zn, Pb, Cr, Cd and Ni) were in the class of slightly contaminated by heavy metals. (Karkarna and Matazu, 2021)

Table 8. Heavy Metals Concentrations in the Soil Sample of some selected dump site (mgkg-1).ND-Not detected

	Surface soil (0-15)					**Sub-surface (15-30)**				
D/ZUNGURA	**Zn**	**Pd**	**Cd**	**Cr**	**Ni**	**Zn**	**Pd**	**Cd**	**Cr**	**Ni**
Mean	**0.009**	0.002	0.007	0.021	0.303	0.001	0.003	0.005	**0.07**	0.046
SD	**0.006**	0.001	0.006	0.020	0.051	0.013	0.001	0.003	0.303	**0.173**
SHARADA										
Mean	0.30	0.022	0.025	0.274	0.061	0.55	0.051	0.020	0.104 0.145	0.179
SD	0.107	0.215	0.027	0.354	0.352	0.360	0.015	0.030		
K/GOJE										
Mean	0.003	0.035	0.003	0.004	ND	0.026	0.114	0.009	0.281	0.335
SD	0.031	0.031	0.002	0.003	0.431	0.029	0.029	0.002	0.250	0.128

Source: (Karkarna and Matazu, 2021)

In addition, Anake, *et al.*, (2009 also reported that the ranges of Cd, Cr, Ni and Pb levels for all the dumpsites were 0.30–49.8, 5.76–139, 0.39–19.1 and 42.6–9662 mg/kg, respectively. Kano dumpsite 2 was found to pollute most with Cd, Cr and Pb in 50-100 % soil samples collected having concentrations higher than the threshold limits set by regulatory body. Paper and food scraps showed higher percentages in both Kano and Kaduna dumpsites. The soil was high is sand for all the dumpsites implying high leaching potentials of the heavy metals pollutants. Similarly, Ojiego, *et al.*, (2022) in their study of heavy metals in Abuja shows that the concentrations of metals were in the orders: Al > Zn > Cr > Mn > Ni > Cu > Pb > Cd and Al > Zn > Mn > Cu > Cr > Ni > Pb > Cd for Kuje and Kwali solid waste dumpsites, receptively. The control soil samples had significantly lower (p>0.05) metal contents. All the metals except Cd, Cr, Mn, Ni, and Zn were above the permissible limits stipulated by NESREA for Nigerian soils. Kuje dumpsites were highly contaminated by Ni (87.29), Cr (33.18), Pb (31.94) Cd (18.70), and Zn (8.72), unlike in Kwali dumpsite with very high pollution index only for Ni (44.70) and Pb (23.50). Strong positive correlations were recorded between Cr/Al, Mn/Cd, Zn/Al and Zn/Cu for Kuje dumpsite and Cr/Al, Cu/Al, Ni/Cu and Zn/Pb for Kwali dumpsite, indicating common accumulation by concerned metals in soil.

5. CONCLUDING REMARKS/SUGGESTIONS

The present aimed to overviewed concentration of heavy metals along the dump site areas in North-eastern Nigeria. Heavy metals contents of soils need to be monitored at all times to ensure safety of the environment as well as the agricultural products for consumption, and also prevent heavy metals poisoning due to soil ingestion. However, there is quite scanty literatures and limited information regarding the heavy metals concentration in this region which might not be sufficient for someone to deduced inferences and drawn conclusion on the variability, distribution and concentration of the metals. Notwithstanding, the study revealed that the region experienced moderate to high concentration of heavy metals in the soil which has adverse effects on human life as its affect the environment and arable lands.

Therefore, it is highly plausible that the intensive research should be geared towards studying the spatial and temporal variability, concentration and toxic effect of heavy metals in the region. In addition, there is a need for determination and analysis of heavy metal content of soils before cultivation of crops. The government needs to enforce regulations on indiscriminate dumping of industrial, domestic and agricultural waste. Moreover, it is suggested that the government should consider a basement treatment for dumpsites before use and also different remediation strategies should also be considered. This will provide sorption surfaces for pollutant and prevent groundwater contamination.

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