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Research Article

APPLICATION OF MULTIVARIATE ANALYSIS IN THE ASSESSMENT OF TRACE METAL CONCENTRATION IN SOILOF WASTE DUMPSITE IN UYO MUNICIPALITY AKWA IBOM STATE. NIGERIA

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ABSTRACT

The study of the trace metals effect in the soil at the waste dumpsite was undertaken in Uyo municipality. This was done in order to ascertain the effect of waste generated and disposed at the dumpsite on soil physical and chemical properties. The study was undertaken between January 2017 and May-2018.The study employed standard approved HACH as well as AOAC(Association of Applied Chemist) to determine the concentration of trace metals in the soil at the dumpsites. The findings revealed that indiscriminate disposal of the refuse at the dumpsite had contributed significantly to trace metals load in the soil at the dumpsite. The result also showed that the pollution index of some trace metals such as Iron and Lead was higher. Indicating that the indiscriminate disposal of refuse at the dumpsite has contributed to the enhancement of these metals in the soil environment within the dumpsite. Also the results of the principal component analysis revealed that the loading variances of trace metals such as cadmium, Vanadium, Lead and iron as well as zinc at the studied locations were relatively higher. These trace metals therefore are regarded as contaminants associated with the effluent and leachate produced from the waste at the dumpsite. As contaminants the metals may accumulate in the soil leading to trace metals toxicity in the soil at the dumpsite. The pollution index evaluated showed the following trends:Ar = Co =Mn= V <Ni < Cd < Cr<Cu<Zn<Fe<Pb. Fe and Pb showed higher pollution index when compared with other trace metals tested. In this case the effect of lead and iron toxicity cannot be overruled in view of the concentration recorded in the soil at the refuse dumpsite. Therefore, in view of the results obtained coupled with the negative effect associated with trace metals load it is important that refuse handling and management should be given utmost attention in Uyo municipality. This is necessary so as to prevent effect of such waste on land and water and plants at the dumpsite.Soil and water as a matrix have the tendency to accumulate the trace metal load and transferred same to plants and animals grown and widely consumed at the dumpsite.

INTRODUCTION

Offiong *et al*. (2013) reported that indiscriminately disposal of refuse in our immediate environment had not only affected the aesthetics of the environment but has also contributed to increase trace metal load in the soil ecosystem. This increase in trace metals load have affected other living resource in the soil environment at the refuse dumpsite. Ololade (2014) opined that such uncontrollable process has caused severe damage to the soil due to metal accumulation. Ololade (2014) also revealed that trace metals being non-biodegrade has the potential of entering the food chain through the animals. Leachate at the refuse dumpsite are enriched with metals. Hence there is possibility of trace metal from waste at the dumpsite to cause pollution of surface and the underground water qualities within the refuse dumpsite.

Hong *et al*. (2014) in their study revealed that trace metals are toxic to both plants and animals. The accumulation of such metals in the biotic components of environment often cause chronic and acute toxicityin the living resources within such environment. Hong *et al*. (2014) further stated that at low concentration the effect of trace metals pollution is always minimal. However, over times the effect stated manifesting leading to severe health consequences in humans (Rakesh *et al,* 2013). In humans such health consequences is always

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irreversible in view of the level of trace metal concentration in the body. The increase in accumulation in human remarkable lead to damage to vital organ such as the kidneys and liver (Rakesh *et al,*2013). In children trace metals accumulation lead to severe neurological disorders at birth especially when such abnormalities are not noticed on time (Rakesh *et al*, 2013). Trace metals accumulation at the refuse dumpsites have also affected medical plants occasionally and often utilized by the people within the area (Oyem and Oyem, 2009).

Rakesh *et al. (*2013) also reported that bioaccumulation and translocation indices of such metals in soil can also affect the edible parts of the pants. The increase in trace metal load in the edible portion of the plantscan hinderedplants growth and development (Oyem and Oyem,2008). Though government have provided designated dumpsite at the urban area for effective evacuation and disposal of these refuse. However not much have been done in segregatin gthe waste for effective management and disposal at the dumpsite in the urbanareas (Ofiong *et al*.2013). Improper segregation at source has over the years have prevented effective management and treatment of such waste at the disposalsites (Osayande and Opoke,2018). At the dumpsite all these wastes are clumped together thereby further compounding the situation. In most cases evacuation is politized leaving the evacuation process to untrained personnel. Also, the waste bins provided are not labelled to ensure effective segregation. Therefore, as reported by Akubugwu and Duru (2011) waste management strategies in urban areas have contributed to severe environmental degradation in modern cities in Nigeria. This has also contributed to indiscriminate disposal of such waste at unauthorized locations by government agencies saddled with that responsibility. In this case the problem of soil pollution will continue to persist despite the effort made by the government and other regulatory agencies to control indiscriminate at unauthorized locations in the cities (Akubugwu and Duru, 2011)

Therefore, since the effect caused by the indiscriminate handling of waste have not been properly evaluated and risk assessed. Trace metal load in the soil at the waste dumpsite will continue to remaina major concern urban areasin view of deleterious effect caused by trace metals load in the soil at the waste dumpsite (Akubugwu and Duru, 2011). The possibility of trace metal entering the food chain is obvious since the people cultivate edible plant species in the soil around the vicinity of the dumpsite (Akubugwu and Duru, 2011). These edible plant species are mostly vegetables widely consumed in urban areas without consideration given to the trace metal accumulation on the edible plant parts (Offiong *et al*, 2013). Therefore, this work was undertaken at the three-wastedumpsite in Uyo municipality in Akwa Ibom State so as to evaluate the trace metal load in the soilat the designated dumpsite.

Study Area

The study was conducted at three selected refuse dumpsitesin Uyo Municipality in Akwa Ibom State Nigeria. Uyo is the capital of Akwa Ibom State, Nigeria. The state was created out from Cross River State, Nigeria in 1992.Akwa Ibom State has thirty-one local Government Areas. Thestate shared boundary with Cross State in the South and Rivers and Abia State in the East. Akwa Ibom State has abundance natural resources such Crude oil mostly found in the coastal communities of the State. Apart from crude oil other natural resources found in Akwa Ibom State include solid minerals such as Copper, Iron Oreas well as tin and bauxite. Forest reserve found in the coastal areas of the state is also rich in abundance forest resources with unique biodiversity in Ibeno, Esit -Eket, Itu and Uruan Local Government Areas. Rainfall is all year round.

Figure 1 Specific Study Site

Soil Sampling Preparation and Laboratory Analysis

One gram of the oven dried ground soils previously washed with nitric acid and distilled water was placed in 100cm3 kjedahl digestion flask (Osayande and Opoke (2018). the samples were subjected to wetacid digestion reacted with 2cm3 of 60% perchloric acid (HClO4), 10cm3concentrated nitric acid (HNO3) and 1.0 cm3 concentrated sulphuric acid (H2SO4) ((AOAC, 1990)). The mixture was swirled gently and slowly at moderate heat on the digester, under a fume hood. The heating continuous until dense white fumes appeared which was then digested for 15 min, set aside to cool and diluted with distilled water. The mixture was filtered through the Whatman filter paper into a 100cm3 volumetric flask, diluted to mark (Osayande and Opoke, 2018). The blank and the samples were digested in the same way. The concentration of the metals present in each soil was obtained using HACH3900 model Spectrophotometer using ten 10mls of digested soil solution with the relative powder pillows. Dilution factors applied when the concentration was noticed high.

The ^{PH,} PotassiumCalcium, Magnesium, Phosphorus, Magnesium, Sodium were determined using HACH 3900 standards approved procedure with the required volume of the digested soil samples. Cations exchange capacity, Base sediment and Exchangeacidity were determined accordingJena *et al*. (2013)

Statistical Analysis

Regression coefficient, principal component analysis and multivariate agglomerate hierarchal cluster analysis were employed to analyse the trace metal properties of the soil samples at the wastedumpsite. The similarities between trace metals in the soil dumpsite was measured by cluster analysis. The sources of trace metals determined using the principal componentsanalysis in the soil at the dumpsites. The level ofcorrelation coefficient between trace metals in soil measured at $p<0,05$, $p<0.01$ inorder to determine the relationship between the trace metals in the soil at the waste dumpsites studied according to Hong*et al*. (2014).

RESULTS AND DISCUSSION

Physicochemical Properties of Soil at the Refuse Dumpsites

P^H

Table 1.0 show the physical properties of the soil samples at the dumpsite. The total P^H value of the studied soil sample with mean value of6.72 was higher than the value obtained at the background study site as shown in table 1. The mean P^Hvalue at the studied site was also higher than the permissible limits of 5.1-6.7 specified by Offiong *et al*. (2013). The slight increase in the P^H value shows that the soil at the study sight is slightly acidic. The lower P^H at the background study sample is consistent with Osayande and Opoke (2018) on their findings on the effect of mining activities in soil of Abakaliki in Ebonyi, State, Nigeria. The moderate increase in P^H value at the study locations may be attributed to the effect of waste effluent in the soil at the dumpsite. Despite slight increase in P^H in the studied soil, the soil is still suitable for mineral element mobilization for crops growth and development.

Moisture

In terms of the moisture content of the soil sample the mean concentration of 10.84 %in the soil at the control site was higher than 6.97% obtained in the studied soil samples. Indicating that the control soil sample retain water. This is good for soil aeration as well as microbial activities. This level of moisture in soil at the control site promotes nutrient availability to enhance plant growth and development. The value at studied sites is within the specification recommended for Nigerian soil (Adedosu *et al*.2013).

Nitrogen

In terms of the total nitrogen content in the soil of the studied dumpsite the mean concentration of 4.20 % nitrogen at the studied dumpsite was higher than the background values of 3.45% (Table 1). The value was also higher than 2.0 % permissible limits in soil reported by offiong *et al.* (2013). The high nitrogen at the studied site could be attributed to the high organic content at the waste dumpsite. The low background nitrogen at the control could be attributed to low organic content of the soil at the control site. The value obtained is consistent with that reported by Kogbara *et al. (*2015).

Phosphorus

The available phosphorus contents of 3,40 mg/kg in the soil of the refuse dumpsite was lower than the 20.0 mg/kg permissible limits. The moderate phosphorus values in the studied site was also lower than 4.11mg/kg background value obtained at the control site. The lower phosphorus value at the studied soil sample was consistent with that reported by Offiong *et al.* (2013) who reported a mean value of 6.25 mg/kg for arable soil of Port Authority in Cross River State Nigeria. The decrease in phosphorus content at the studied soil at the refuse dumpsite may be attributed to low organic content of the soil at the refuse dumpsite.

Potassium

The available potassium contents of 9.80 mg/kg in the soil of the waste dumpsite was lower than the10.0- 20.0 mg/kg permissible limits. The moderate potassium value in the studied site was also higher than 2.34mg/kg background value obtained at the control site. The phosphorus value at the studied site was higher than1.35 mg/kg reported by Offiong *et al*. (2013) on their findings in soil of Port Authority in Cross River State Nigeria. The increase in phosphorus content in the studied soil at the refuse dumpsite could be caused by the low sensitivity of phosphors to waste at the refuse dumpsite.

Magnesium

The available magnesium contents of 9.93 mg/kg in the soil of the refuse dumpsite was higher than the 0.6-1.2 mg/kg permissible limits. The magnesium value in the studied site was also higher than 6.75mg/kg background value obtained at the control site. The mean concentration of magnesium obtained in the soil at the refuse dumpsite was also higher than that reported by Adedosu *et al* (2013). The higher concentration of magnesium in the studied soil at the refuse dumpsite could be attributed to effluent generated by the waste at the refuse dumpsite.

Calcium

The mean concentration of 10.20mg/kg calcium obtained in the soil at the refuse dumpsite as shown in Table 1 was lower than the mean value obtained at the background studied site which served as control. The mean concentration at the studied location was also within the acceptable permissible limits of 10.0-20.0mg/kg as reported by Offiong *et al*.(2013). The value obtained in the studied soil sample was lower than that reported by Chibuike and Obiora (2014) on their findings on arable soil impacted by crude oil in the Niger Delta region of Nigeria. The moderate level of calcium content at the studied could be attributed low organic nature of the soil at the dumpsite.

Sodium

The mean concentration of sodium as shown in Tnnable1 9.83mg/kg was comparatively higher than 7.34 mg/kg obtained at the background site which was used as control. This is consistent with the findings by Chibuike and Obiora(2014) who reported 193.84mg/kg in their findings in soil impacted by crude oil. Therefore, indiscriminate disposal of refuse at the dumpsite may have elevated the concentration of sodium in the soil at the refuse dumpsite in Uyo municipality.

Exchangeable Acidity

The mean concentration of the exchangeable acidity at the refuse dumpsite as shown in Table 1 was higher than the value obtained at the control site. The 4.44 meg/gm of the exchangeable acidity reported in the studied soil at the dumpsite was also higher than 4.10 meg/gm permissible limits. However the mean concentration of 4.44 meg/gm in the studied soil exchange acidity was lower than reported by **(**Chinenyezeand Ekene, 2015) on their finding in the soil affected by the refuse dumpsite at Calabar, Cross River State, Nigeria.

Base Sediment

The mean percentage base sediment of 100% as shown in Table 1 was higher than 97.0meg/gm obtained in the soil at the background study location adopted as control. The base sediment concentration was also lower than 64.0 % reported Offiong *et al***. (**2013) on their findings in the soil assessed near the Port Authority in Calabar Cross River State. The mean concentration of the Base sediment in the studied soil sample was also higher than 60-80% permissible limits recommended for arable Soil. The increase in the concentration of the base sediment at the study locations may be attributed to high organic content of the soil as results of indiscriminate waste disposal at the dumpsite.

Cations Exchange Capacity

The mean concentration of Cation Exchange capacity in table 1 showed lower cation exchange capacity in the soil at the studied site when compared with the background value. The mean concentration obtained in the studied soil sample at the dumpsite was lower than the one reported by Adedosu *et al*. (2013). The results obtained also indicated higher mean concentration at the control site. This is in agreement with findings by Chi buke and Obiora (2014) who also reported higher CEC at the control locations than the study site. The low range of CEC at the studied locations may be attributed to the effect of the indiscriminate disposal of waste at the refuse dumpsite. Effective management strategies should be employed to prevent the effect on plant growth and development.

Pollution Index of the Soil at Refuse Dumpsite

Table 2 shows that pollution index of the soil at the refuse dumpsite. The results showed that Iron and Lead pollution load in the soil was higher than others. This is because Iron and Lead had pollution index greater than 1. Other metals tested at the studied dumpsite had lower pollution index when compared with lead and Fe. The PLI represents the number of times by which the metal content in the soil exceeds the average natural background concentration and gives a summative indication of the overall level of heavy metal toxicity in a sample (Olade, 2014). The control samples were taken to represent natural background. According to Ololade (2014), PLI can give an estimate of metal contamination status and the necessary action that should be taken. Ololade (2014) revealed that the PLI can be obtained as a contamination factor (CF) of each metal with respect to the natural background value in the soil by applying Equations (1).

CF = Csample /Cbackground----------Equation 1

Csample: mean metal concentration in polluted soils;

Cbackground: mean metal concentration in natural background soil.

Table 1 Physico-chemical Properties of the Soil Samples of the Dumpsites

Periods in Months	PH	Moisture %	Nitrogen (mg/kg)	Phosphorus- (mg/kg)	Potassium- (mg/kg)	Calcium- (mg/kg)	Sodium mg/kg	Magnesium- (mg/kg)	EAmeg/gm	BS %	CEC meg/gm
3	6.88	7.89	4.06	3.05	10.66	15.16	12.06	12.34	4.45	100	.26
6	6.85	8.99	4.47	3.06	12.45	14.56	14.11	13.66	4.22	100	.27
8	6.78	6.34	5.55	2.34	12.11	10.11	13.88	13.88	5.22	100	.25
10	6.45	6.34	4.67	3.44	12.11	9.55	9.07	9.11	6.56	100	.20
12	6.88	6.89	4.67	2.89	9.05	8.07	8.44	8.54	6.24	100	.17
14	6.56	7.56	6.67	2.68	8.55	8.55	9.33	9.22	6.24	100	.21
16	6.57	8.25	3.78	4.33	8.55	9.98	9.23	9.22	5.34	100	.18
17	6.57	5.55	1.46	3.68	9.06	9.77	8.23	8.18	3.45	100	.18
18	6.89	5.36	2.35	3.68	8.14	8.33	8.01	7.18	2.56	100	.15
20	6.88	6.55	3.56	3.44	9.14	9.33	8.88	8.88	2.35	100	.18
22	6.64	6.07	4.56	4.06	9.86	9.06	9.88	8.11	2.45	100	.16
24	6.69	7.88	4.56	4.12	7.88	9.98	8.11	9.67	2.22	100	.19
Total	80.64	83.67	50.36	40.77	117.56	122.45	119.23	117.99	53.3	1200	2.4
Mean	6.72	6.9725	4.20	3.40	9.80	10.20	9.93	9.83	4.44	100	0.2
SD	0.16	1.33	1.36	0.61	1.63	2.28	2.18	2.21	1.66	-	.04
Background Value	6.44	10.84	3.45	4.11	6.76	2.34	6.78	7.34	1.23	45	9.89
Permissible limits*	5.1-6.5*	-	2.0 %*	20 mg/kg*	0.7-1.2mg/kg*	10-20mg/kg*	0.6-1.2mg/kg*	-	4.1meg/gm*	60-80 %*	10.0meg/100gm*

Legend: *Offiong *et al* 2013

Table 2 Trace Metal Concentration at the Dumpsite in mg/kg

Periods in months	Iron	Zinc	Lead	Nickel	Cadmium	Chromium	Copper	Vanadium	Manganese	Cobalt	Arsenic
3	67.15	13.15	70.11	0.01	0.02	0.16	3.46	0.01	0.01	0.01	0.01
6	63.16	14.45	69.22	0.01	0.01	0.13	3.67	0.01	0,02	0,02	0.01
8	63.17	16.38	68.37	0.01	0.01	0.11	4.67	0.01	0.02	0.02	0.20
10	64.33	16.77	78.11	0.01	0.01	0.13	5.67	0.01	0.02	0.01	0.01
12	67.11	14.47	75.22	0.02	0.01	0.16	6.77	0.01	0.01	0.01	0.01
14	62.35	10.33	78.45	0.01	0.02	0.11	6.33	0.02	0.01	0.01	0.01
16	67.08	10.34	78.33	0.02	0.03	0.11	5.11	0.01	0.01	0.01	0.01
17	45.23	8.96	81.11	0.01	0.01	0.12	4.33	0.01	0.02	0.01	0.01
18	55.37	12.11	72.17	0.01	0.03	0.12	5.33	0.02	0.02	0.01	0.01
20	67.35	13.22	81.13	0.02	0.02	0.11	5.44	0.02	0.01	0.01	0.01
22	51.22	12.33	77.88	0.03	0.05	0.13	5.13	0.02	0.01	0.02	0.01
24	52.34	11.89	74.33	0.04	0.02	0.14	4.88	0.01	0.01	0.02	0.01
Total	725.86	154.40	904.43	0.200	0.24	1.53	60.79	0.16	0.15	0.14	0.13
Mean	60.48	12.87	75.37	0.017	0.02	0.13	5.07	.01	0.01	.01	.03
SD	7.52	2.39	4.51	.010	0.010	0.02	0.97	0.00	0.01	.004	.003
Natural Background Values	34.12	72.85	10,25	14.05	1.65	8.2	127.85	-	12	-	-
Pollution Index	1.78	0.17	7.35	.001	.01	.01	.04	-	.00	-	-

In the study, the contamination factor and pollution load index are presented in Table 2. The CFs for the eleven metals in the different soil matrix ranged between 0.00 (Ar) to 7.84 (Pb). The trend is such that highest CFs was observed in Pb and Fe and least in Ar, Co,Mn. In general, the increasing order of CFs is Ar = Co =Mn= V <Ni < Cd < Cr<Cu<Zn<Fe<Pb. Consequently, soils from the refuse dumpsites are considered to be of pollution concern in view of indiscriminate disposal of waste at the refuse dumpsites.

Multivariate Analysis

Correlation Analysis

Correlation matrix in table4 shows that , most of the trace metals correlated with one another either positively or negatively , but also insignificant at P< 0.05 as indicated by their r values in table 4 .However strong positive correlation existed between Mn and Co at P<0.01 wit r value of 1.00.Vanadium also correlated significantly but positively with cadmium at P<0.05 with r value of 0.612.Consequently the present of vanadium in the refuse may have lead to the increase in the concentration of cadmium at the dumpsite .Nevertheless the availability of other trace metals in the studied dumpsite may have influenced the availability of the other negatively but insignificantly and therefore their concentration may be affected by variable factors (Gustavo *et al.*2009).

Principal Component Analysis

The results of the principal component analysis of trace metals in the soil at the refuse dumpsite are shown on table3 .Results obtained indicated five main components with Eigen value greater than one and significant total variance of 84.61% .Factor one contributed total variance of 32.89% with strong positive correlation with Manganese, Cobalt and Zinc but with negative loading for lead. This actually represented the impact of the trace metal in the soil was influenced by the leachate and effluent produced at the dumpsite. Factor two contributed total variance of 17.36 % with strong positive loading on Zinc and Arsenic this represented the impact of the leachate and other associated waste in the soil at the refuse dumpsite. Factor three accounted for total variance of 13.56 % and defined strong loading for Chromium and Nickel. This represented the impact of other industrial activities as well as effluent generated by the waste leachate at the dumpsite into the soil.

Factor four contributed total variance of 11.41 % and showed significant positive correlation with Fe. This represented the impact of leach ate effluents generated by the waste at the dumpsite. The fifth factor contributed total variance of 10.00% and showed positive loading with Cadmium. This also represented the effect of the leachate effluent generated at the refuse dumpsite causing soil degradation.

Cluster Analysis

The association among the trace metals at the soil dumpsite is illustrated in figure 2. Figure 2 shows two main clusters. Clusters showed were based on Wards method of extraction. Cluster 1 showed linkage between Cd, Cr, Cu, V, Ni,Mn, Co, Zn, Ar. While cluster two shows linkage between Feand Pb.Cluster 1 can be sub-divided into Mn and Co as well as Ni, V, Cd, Ar, Co,Mn,V and Cd. The link ages and interactions among these trace metals showed close similarities existed between them in the soil at the refuse dumpsite. The relationship showed these metals as contaminants in the soil at the refuse dumpsite originated from waste at the dumpsite due to leachate released into the soil matrix. However, Ni and Zn are also regarded as contaminant that originated from mixed anthropogenic and lithogenic sources in view of the similarities showed by these metals (Zn and Ni) with Iron. Pb in cluster 11 showed the same lithogenic relationship with Iron. As such may be regarded as contaminant originated from the same geological origin and formation. This is in line with the results obtained from the principal component analysis.

A plot of the major principal components of PCA resulted in five different plots (figure 3). The plot 1 showed very strong positive loading for Manganese, Cobalt and Zinc which is actually similar to factor 1(Figure 3). Plot two however showed strong positive loading for Zinc and Arsenic similar to factor two. Plot three of the cluster showed positive loading for Chromium and Nickel which is similar to factor three(Figure 3). The Fourth plot showed strong loading for Fe similar to factor Four, the final plot five showed positive cluster for Cadmium similar to factor five, Others showed negative relationship with no factor loading for any other trace metals as showed in the plots. As such the relationship and similarities among other trace metals drafted towards zero as shown in figure 3.

Table 3 Total Variance of Principal Component Explained at Dumpsite

Total Variance Explained Dumpsites									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.552	32.288	32.288	3.552	32.288	32.288	2.529	22.993	22.993
2	1.910	17.361	49.649	1.910	17.361	49.649	1.857	16.883	39.876
3	1.491	13.557	63.206	1.491	13.557	63.206	1.812	16.476	56.352
4	1.255	11.406	74.612	1.255	11.406	74.612	1.599	14.536	70.888
5	1.100	10.001	84.613	1.100	10.001	84.613	1.510	13.724	84.613
6	.682	6.201	90.814						
7	.486	4.420	95.234						
8	.294	2.670	97.903						
9	.158	1.437	99.341						
10	.073	.659	100.000						
11	5.144E-6	4.676E-5	100.000						

Table 4 Correlation Coefficient of Trace Metal in the Soil at the Dumpsite.

Trace metals-mg/kg	Fe	Zn	Pb	Ni	Cd	Cr	Cu	V	Mn	Co	Ar
Fe	1.00										
Zn	.499	1.00									
Pb	-.219	-.497	1.00								
Ni	-.281	-.177	.214	1.00							
Cd	-.269	-.366	.202	.459	1.00						
Cr	.107	.246	-.326	.203	-.125	1.00					
Cu	.176	.026	.471	.161	.056	-.103	1.00				
V	-.139	-.269	.334	.063	.612*	-.407	.374	1.00			
Mn	.109	.211	-.430	-.218	-.264	.041	-.455	-.215	1.00		
Co	.109	.210	-.432	-.209	-.259	.043	-.455	-.213	1.000**	1.00	
Ar	.112	.463	-.488	-.213	-.261	-.304	-.129	-.213	-.087	-.087	1.00

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed)

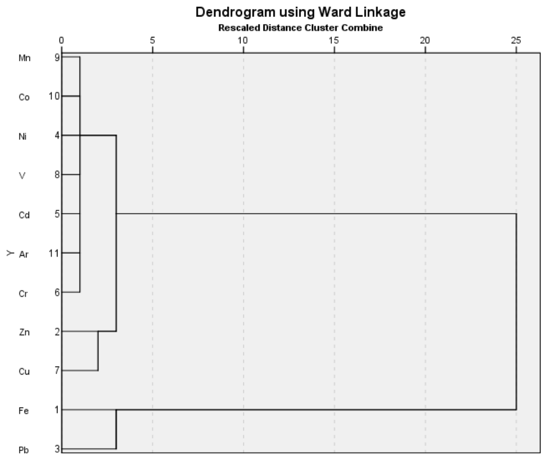

Figure 2 Hierarchical Clusters Formed among Trace Metal at Dumpsite Soil

Table 5 Component Extracted

	Components				
	1	2	3	4	5
Pb	-.761	-.036	-.079	.345	-.377
Mn	.712	-.582	-.195	.250	.117
Co	.710	-.584	-.191	.247	.124
Cd	-.623	-.327	-.010	-.192	.588
V	-.615	-.106	-.457	.184	.479
Zn	.613	.511	.105	.092	.389
Cu	-.522	.497	.020	.492	.103
Cr	.266	-.045	.883	.105	.069
Ni	-.438	-.212	.544	-.197	.327
Ar	.372	.564	-.337	-.591	.121
Fe	.385	.488	.003	.540	.254

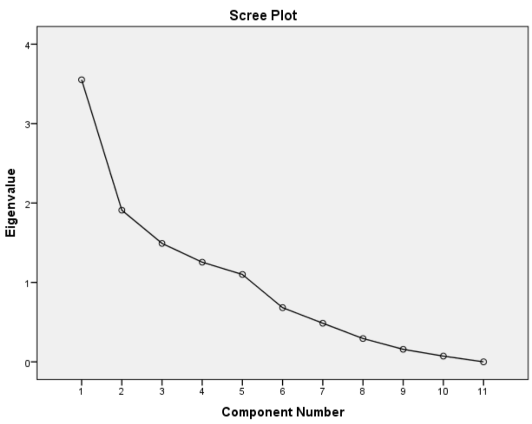

Figure 3 Plots of Major Principal Components of Trace Metal in Soil at Dumpsite

CONCLUSION

The study showed that indiscriminate disposal of waste at the dumpsite in the rural areas of Uyo municipality has contributed significantly to trace metal load in the soil. The results of the multivariate analysis showed that the soil at the waste dumpsite is affected by the various degree of trace metal loads. The study showed that the rate of loading depends on effect of anthropogenic and natural processes in the soil at the dumpsite. The Pollution index capacity of iron and lead in the soil at the waste dumpsite also defined the pollution load capacity of Iron and lead in the studied soil samples. There is tendency of Fe and lead toxicity in the soil at the dumpsite in view of the pollution index capacities of these metals in the studied soil. Therefore the consumption of edible vegetable plant species such *Telenium trainagulare* often cultivated in the soil at the dumpsite should be discouraged. This is necessary so as to prevent highly toxic trace metals such as lead from entering the food chain.

Furthermore, there is need to also segregate waste at source so as to enhance proper handling and disposal. Waste evacuation, treatment and disposal should also be handled by trained waste agency and not by untrained personnel. Re-cycling plant should also be built to facilitate the recycling of waste considered still useful for other purposes. Post impact assessment should also be conducted at the designated dumpsite within the Uyo municipality so as to ascertain the impact done on edible plants and water widely consumed within these areas. Waste disposal agencies working for the government should be trained on how to handle different types of waste such as combustible, non-combustible and hazardous waste at the designated locations. All waste containers should be properly labelled to ensure waste segregation at source. This is critical in effective waste management process and pollution prevention.

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