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Heavy Metal Contamination in Selected Dumpsites of Osubi, Warri, Western Niger Delta, Nigeria

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Abstract:
This study investigated on the concentrations of five (5) heavy metals such as Cadmium, Lead, Copper, Manganese and Zinc on soil in dumpsites of Osubi vicinity in Delta state, Nigeria using acid digestion and Atomic Absorption spectrophotometer. The range of metal concentrations in the Osubi Municipal dumpsite were: Cu(4.7 – 9.25 Mg/Kg) , Pb(1.4 – 3.7 Mg/Kg) , Mn(12.9 -29.5 Mg/Kg) , Cd(<0.1 Mg/Kg) , Zn(3.05 – 11.4 Mg/Kg) whereas range of metal concentrations in Osubi Abattoir Dumpsite were Cu(9.35 – 23.45 Mg/Kg) , Pb(1.1 – 24.55 Mg/Kg) , Mn(44.1 - 71.6Mg/Kg) , Cd(<0.1 – 0.4 Mg/Kg) , Zn(49.7 – 201.8 Mg/Kg) and the ranges for the control samples were : Cu (2.85 – 3.6 Mg/Kg) , Pb (0.35 – 1.3 Mg/Kg) , Mn (22.15 -67.1 Mg/Kg) , Cd (<0.1 Mg/Kg) , Zn (5.95 – 17.85 Mg/Kg). The concentrations of heavy metals fell below the WHO/FAO standards for soil and all but Zn in Osubi Abattoir dumpsite fell within the permissible limit of the Dutch standard. The Geo Accumulation index showed no contamination in all samples except Pb and Zn in samples 5, 8 and 9 which shows moderate contamination. The contamination factor showed that all are uncontaminated except Pb and Zn in samples 5, 8 and 9 which are moderately contaminated and considerable contamination for Cd in sample 9. The Ecological Risk Factor showed that all heavy metals show low risk except Cd which shows considerable risk for its only sample seen and Lead which shows low moderate risk. In PLI (Pollution Load Index), all samples show no sign of pollution, although its value of 0.91 in sample 9 was close to the baseline of 1. In the comparison of dump sites, Osubi Abattoir was indicated to possess more heavy metal concentration than Osubi municipal dumpsite. The strong association between Pb/Cu, Mn/Cu, and Zn /Mn. Influenced by anthropogenic activities suggest a similar source .

Keywords: *Osubi, Dumpsite, Geoaccumulation index, Contamination factor, Ecological risk factor, Pollution load index*

1. Introduction

Waste has a major issue in various major cities in Nigeria. The inability for an effective medium for waste disposal has led to both chemical and biological pollution, which are hazardous to both plants and mankind. Urbanization, culture and habits, and rapid growth of population has contributed largely to the increasing rate of waste generation in major cities in Nigeria.

Other factors includes the improvement of quality of life of Nigerians , large consumption of imported and exported packaged commodities , and the increased industrial , agricultural and manufacturing activities in Nigeria. Due to lack of effective and efficient regulatory bodies, individuals, private and public firms, industries, market people and lastly The Government dispose wastes at unauthorized locations, and in an inappropriate manner. Solid waste has caused various impacts on the environment, particularly in various vicinities in Warri, Delta state.

Environments polluted by the impacts of waste disposal are very harmful to both plants and animals .The water and soil which serves as sources of food, when polluted can lead to implications on the soil quality, plant growth, and human health. Excessive trace metals in both water and soil around the region of waste disposal can led to implications on plant and human health .With the knowledge of the amount of heavy metals in the soil , the proposed area can be analyzed for heavy metals and can be determined for its suitability for humans ,plants and animals .The study is geared towards comparing and carrying out a systematic soil quality examination and looking into the effect of heavy metals on soil quality in Osubi area as well as examination of the parameters of soil pollution.

2. Location and Study Area

2.1. Osubi

Osubi is a growing community near Warri. The Warri Airport (also known as Osubi Airstrip) is located in the area, and there is a rapid infrastructural development around the airport region due to the closeness and prominence to the Niger Delta oil-producing area of Nigeria. Osubi is fast becoming a busy modern community with rapid expansion of building projects for the modern living. There is the world-renowned Nigeria Petroleum Training Institute (PTI) nearby, and other infrastructural developments in the area. This has led to the migration of people to the area, and uncontrolled and indiscriminate dumping of both industrial and domestic wastes which are direct threat to the quality of the environment, especially surface and groundwater resources. Leachate generated from industrial and domestic landfill during the rain may eventually percolate and contaminate groundwater. Consequently, pollution from landfills leads to potentially communicable diseases. Groundwater is the subsurface transporting agent for dissolved chemicals including contaminants. Materials dissolved from the wastes may be transported from the burial or disposal site by groundwater flow, with the result that the quality of water from wells is impacted by the contaminated groundwater. In addition, natural discharges of an aquifer, such as at springs and seeps, can return a contaminant to the surface. Also, contaminant emanating from dumpsites usually enters the aquifer system from the land surface, percolating down through the aerated soil and unsaturated (vadose) zone. This may extend 6 or 9 m into the soil, and many reductive and oxidative biological processes take place and this may also impact negatively on the quality of soil (NRC, 1984).

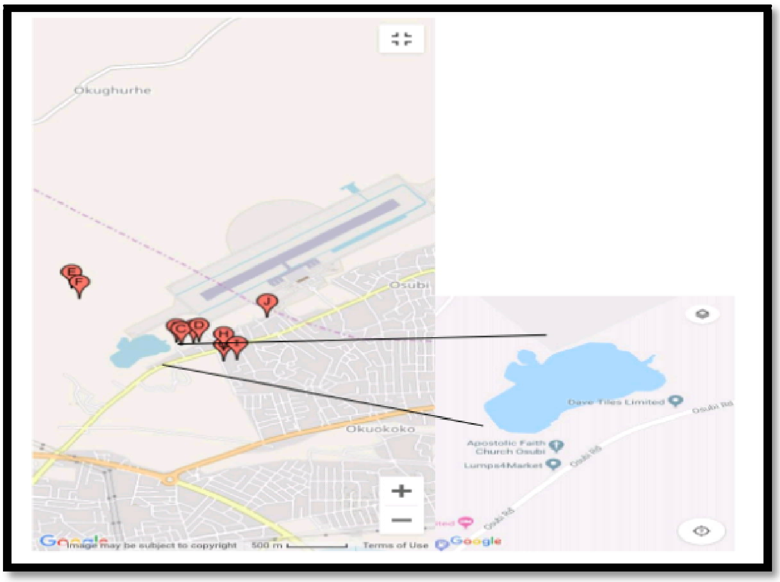

Figure 1: Map of Osubi Showing Sampling Points

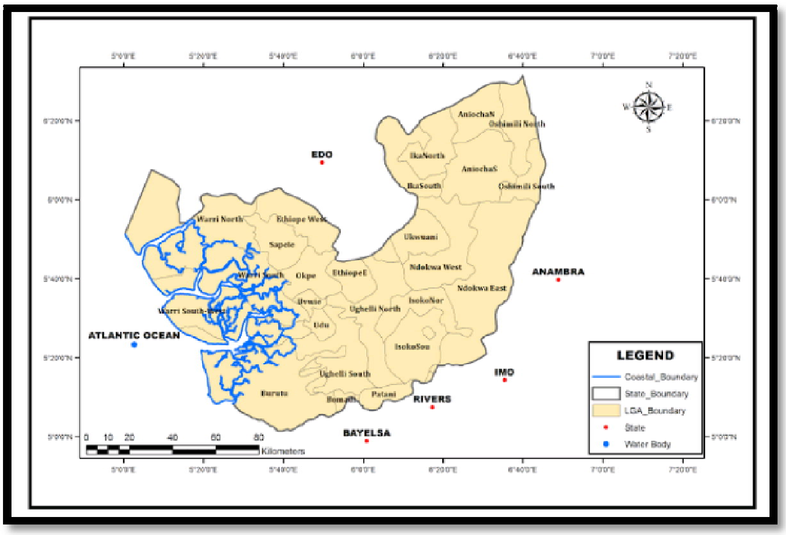

Figure 2: Map of Delta State Nigeria

Igeo	CLASS	Designation Quality Of Soil
>5	6	Extremely contaminated
4-5	5	Strongly To Extremely contaminated
3-4	4	Strongly contaminated
2-3	3	Moderately to Strongly contaminated
1-2	2	moderately contaminated
0-1	1	Uncontaminated to moderately contaminated
0	0	Uncontaminated

Table 1: Geo Accumulation Classification

GRADE	Er VALUE	GRADE OF ECOLOGICAL
		RISK OF SINGLE METAL
A	Er < 5	Low Risk (LR)
B	5 ≤ Er < 10	Moderate Risk(MR)
C	10 ≤ Er < 20	Considerable Risk(CR)
D	20 ≤ Er < 40	High Risk(HR)
E	Er ≥ 40	Very High Risk(VHR)

Table 2: Ecological Risk Classification

2.2. Statistical Analysis

Different analytical tools were employed for various segments of the statistical analysis. Microsoft Excel was used to determine descriptive statistics of water and soil samples and Pearson's correlation. Pearson's correlation test (2-tailed) was used to determine the relationship heavy metals of soil samples.

Value	Designation Of Values
▯ 0.9	Very strong correlation
0.9– 0.81	Strong correlation
0.8– 0.31	Moderate correlation
< 0.3	Weak correlation

Table 3: Ecological Risk Classification

3. Result and Discussion

The key to an effective assessment of soil contamination with heavy metals is the use of suitable indicators and indices of pollution /contamination that can be regarded as a tool and guide for a comprehensive geochemical assessment of the soil environment state .The comprehensive way to assess the soil quality through the use of these indices are also demonstrated by the ability to estimate environmental risk and soil degradation due to long term accumulation of heavy metals .

The result of this work are thus illustrated and identified as thus:

3.1. Concentrations of Heavy Metals in the Dumpsites

S/N	LOCATION S	Cu(M g/kg)	Pb(M g/kg)	Mn(Mg/k g)	Cd(M g/kg)	Zn(M g/kg)	LONGITUDE S	LATITUDE
1	OSUBI 1	9.25	3.7	29.4	<0.1	11.4	N5°35'13.43''	E5°48'37.6''
2	OSUBI 2	5.65	1.5	12.9	<0.1	3.05	N5°35'13.34''	E5°48'33.26''
3	OSUBI 3	6.2	1.4	17.05	<0.1	4.55	N5°35'12.08''	E5°48'34.71''
4	0SUBI 4	4.7	3.2	29.5	<0.1	5.25	N5°35'13.52''	E5°48'39.52''
5	CONTROL 1	2.85	47.5	22.15	<0.1	17.85	N5°34'36.76''	E5°48'4.38''
6	CONTROL 2	3.6	0.35	50.75	<0.1	5.95	N5°34'36.6''	E5°48'4.92''
7	ABBATOIR 5	9.8	1.1	44.1	<0.1	49.7	N5°34'36.64''	E5°48'4.08''
8	ABBATOIR 6	9.35	5.75	57.6	<0.1	185.8	N5°35'9.97''	E5°48'46.3''
9	ABBATOIR 7	23.45	24.55	71.6	0.4	201.8	N5°35'6.04''	E5°48'49.9''
10	CONTROL 3	4.9	1.3	67.1	<0.1	16.45	N5°34'24.07''	E5°47'56.64''
11	MIN	2.85	0.35	12.9	<0.1	3.05		
12	MAX	23.45	47.5	71.6	0.4	201.8		
13	MEAN	7.975	9.035	40.21		50.18		
14	STANDARD DEVIATION	5.66	14.52	19.94	73.04			
15	BACKGROUND VALUES(Bn)(Clemente et al 2003 and Kabata pendias 2011)	55	15	900	0.1	70		
16	TOXIC	5	5	1	30	1		
RESPONSE FACTOR(Ha kanson ,1980 ,Xu et al,2008)								

Table 4: Showing the Locations and the Concentrations of Heavy Metals in the Area

3.2. Contamination Assessment

3.2.1. Geo Accumulation Factor

The mean values of geo-accumulation index (Igeo) in the surface soil (0-15 cm) are presented in

SAMPLES	CU	PB	MN	CD	ZN
sample 1	-3.1568	-2.604	-5.5209	ND	-3.203
sample 2	-3.868	-3.90689	-6.7094	ND	-5.1054
sample 3	-3.734	-4.0064	-6.307	ND	-4.528
sample 4	-4.1336	-2.8137	-5.5161	ND	-4.3219
sample 5	-4.8553	1.078	-5.9295	ND	-2.556
sample 6	-4.5183	-6.0064	-4.733	ND	-4.1413
sample 7	-3.0735	-4.354	-4.936	ND	-1.079
sample 8	-3.14135	-1.968	-4.5507	ND	0.8233
sample 9	-1.8148	0.12579	-4.2368	1.41503	0.9425
sample 10	-4.0735	-4.113	-4.3305	ND	-2.674

SAMPLES	CU	PB	MN	CD	ZN
MAX	-1.8148	1.078	-4.2368	1.415	0.9425
MIN	-4.8553	-6.0064	-6.7094	1.415	-5.1054
Mean	-3.636915	-2.85686	-5.27699	1.415	-2.58428
S.D	0.874011465	2.144712377	0.854575204	0	2.167564901

Table 5: below Table Geo Accumulation Dumpsite Result

3.2.2. Geo Accumulation Index

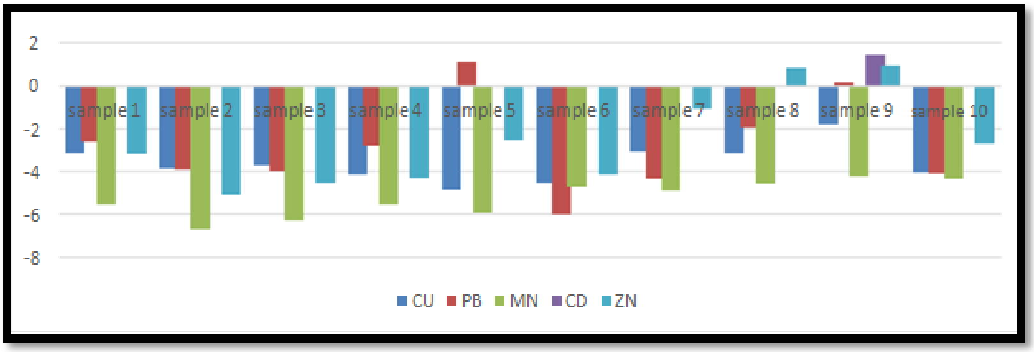

Figure 3: Histogram Showing the Geo Accumulation Index of All Samples

The calculated results for Igeo of heavy metals in soil in Osubi Dumpsites are assessed and illustrated in the figure above.

- The Igeo for Copper ranges from -4.8553 to -1.8148 with a mean value of -3.36369
- The Igeo for Lead ranges from -6.00 to 1.078 with a mean value of -2.85656
- The Igeo for Cadmium which occur in only one sample is -1.415
- The Igeo for Manganese ranges from -6.7094 to -4.24 with a mean value of- 5.27699
- The Igeo for Zinc ranges from -5.1054 to 0.9425 with a mean value of -2.58426

The mean value of Igeo decreased in the order of Mn > Cu > Pb > Zn > Cd.

3.2.3. Contamination Factor

The mean values of the contamination factor and pollution index of soils at 0-15 cm is presented in the table below.

	Cu	Pb	Mn	Cd	Zn
sample 1	0.168	0.2467	0.03267	ND	0.16285
sample 2	0.102727	0.1	0.01433	ND	0.03961
sample 3	0.112727	0.0933	0.01894	ND	0.065
sample 4	0.08545	0.2133	0.03277	ND	0.075
sample 5	0.0518	3.166	0.02461	ND	0.255
sample 6	0.06545	0.0233	0.05638	ND	0.085
sample 7	0.17818	0.0733	0.049	ND	0.71
sample 8	0.17	0.3833	0.064	ND	2.65428
sample 9	0.4263	1.6366	0.07955	4	2.8828
sample 10	0.08909	0.0866	0.07455	ND	0.234
MAX	0.4263	3.166	0.07955	4	2.8828
MIN	0.0518	0.0233	0.01433	4	0.03961
Mean	0.144972	0.60224	0.04468	0.263964	0.716354
S.D	0.108474	1.01983	0.023356	0	1.100159

Table 6: Contamination Factor Result

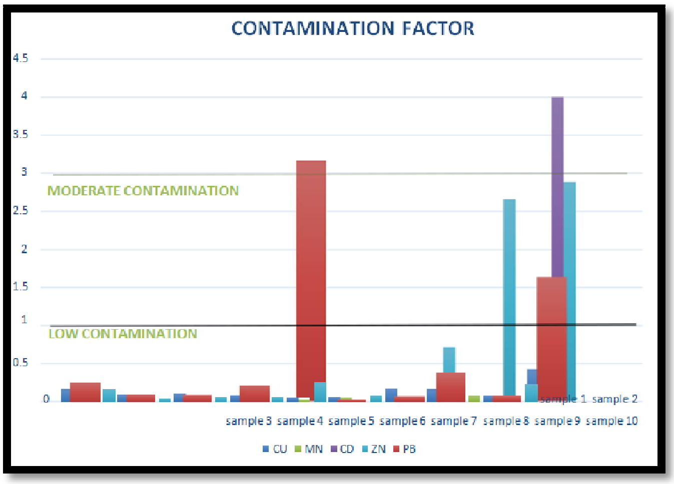

Figure 4: Histogram Showing the Contamination Index of All Samples

The values for contamination factor (CF) of soils at 0–15 cm are presented in Table.
The CF values of copper ranged from 0.0518 to 0.426 with a mean value of 0.145...
The CF value of lead ranged from 0.0233 to 3.166 with a mean value of 0.602.
The CF value of manganese ranged from 0.0143 to 0.08 with a mean value of 0.045 The CF value of zinc ranged from 0.0396 2.88 with a mean value of 0.595.
The mean values of CF at 0-15 cm increased in the order of Cd<Mn<Cu<Zn<Pb.

3.2.3.1. PLI (Pollution Load Index)

The table below shows the PLI values of the ten locations around Osubi and the mean values.

sample 1	0.1218
sample 2	0.049
sample 3	0.0599
sample 4	0.05559
sample 5	0.179
sample 6	0.051993
sample 7	0.146
sample 8	0.3
sample 9	0.91
sample 10	0.1077
MAX	0.91
MIN	0.049
Mean	0.198098
S.D	0.248444

Table 7: PLI Result

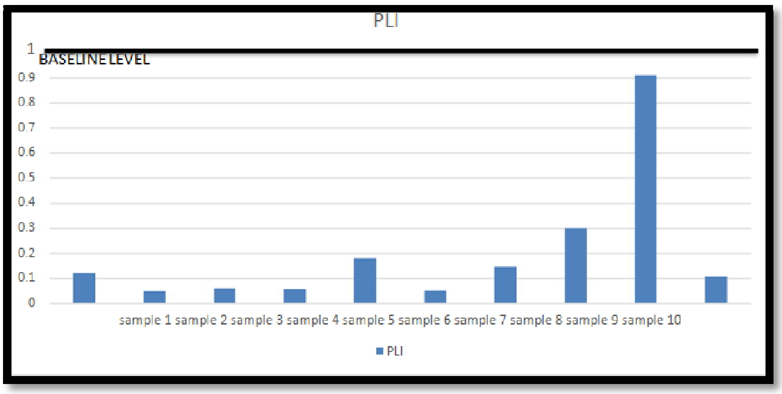

Figure 5: Histogram Showing the Pollution Load Index of All Samples

3.2.3.2. Ecological Risk Factor

The mean values of the Ecological Risk Factor of soils at 0-15 cm is presented in the table below

	Cu	Pb	Mn	Cd	Zn
sample 1	0.84	1.2335	0.03267	ND	0.16285
sample 2	0.5136	0.5	0.01433	ND	0.03961
sample 3	0.5636	0.4665	0.01894	ND	0.065
sample 4	0.427	1.0665	0.03277	ND	0.075
sample 5	0.259	15.83	0.02461	ND	0.255
sample 6	0.327	0.1165	0.05638	ND	0.085
sample 7	0.809	0.3665	0.049	ND	0.71
sample 8	0.85	1.9165	0.064	ND	2.65428
sample 9	2.1315	8.183	0.07955	120	2.8828
sample 10	0.44545	0.433	0.07455	ND	0.234
MAX	2.1315	15.83	-4.2368	12	0.9425
MIN	0.259	0.1165	-6.7094	12	-5.1054
Mean	0.716615	3.0112	-5.27699	-0.51639	-2.58428
S.D	0.512513	4.837479	0.810721	0	2.056333

Table 8: Table Showing Ecological Risk Factor Result

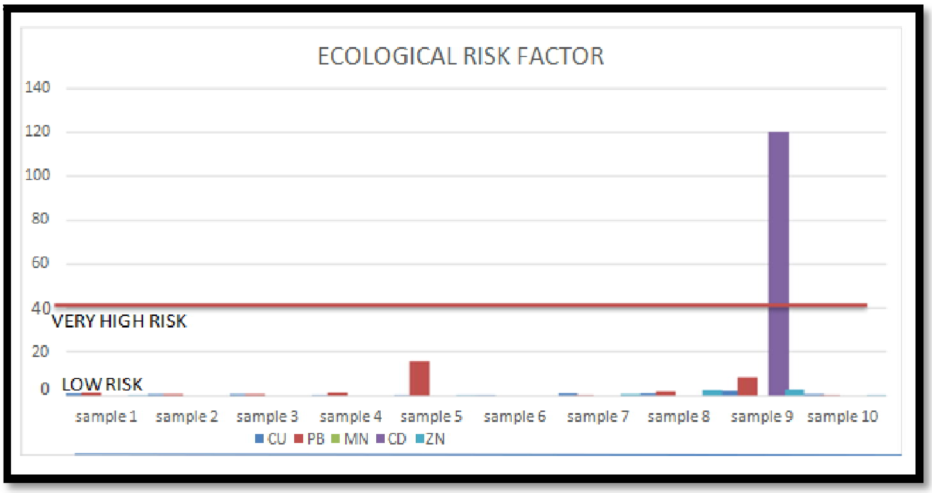

Figure 6: Histogram Showing the Ecological Risk Factor of All Samples

- Er of Copper in the soil samples range between 0.259 – 2.1315.
- Er of Lead range from 0.1165 – 8.183
- Er of Manganese range from 0.02461 to 0.079
- Cadmium which was inexistent in nine (9) samples but had a value of 12 in the only sample located
- Er of Zinc range from 0.075 to 2.882.

3.3. Correlation of Heavy Metals Concentration

Pearson's product of correlation coefficient was used to determine the relationship between heavy metal concentrations of soil samples.

For correlation significance, the criteria value of probabilities ($p<0.05$ and $p<0.01$) was used. At 0–15 cm, Very strong positive correlation was established between Pb/Cu and Zn /Mn.

Strong correlation was established between Mn/Cu.

Moderate correlation was established between Zn/Cu, Zn/Pb and Mn/Pb.

	Cu	Pb	Mn	Zn	Cd
Cu	1				
Pb	0.948836	1			
Mn	0.826602	0.778174	1		
Zn	0.772002	0.765918	0.931152	1	
Cd	ND	ND	ND	ND	1

Table 9: Table Showing the Correlation Coefficient

3.3.1. Comparison of Dumpsites

	CU	PB	MN	CD	ZN
sample 1	9.25	3.7	29.4	<0.1	11.4
sample 2	5.65	1.5	12.9	<0.1	3.05
sample 3	6.2	1.4	17.05	<0.1	4.55
sample 4	4.7	3.2	29.5	<0.1	5.25
MEAN	6.45	2.45	22.2125		6.0625
	CU	PB	MN	CD	ZN
sample 7	9.8	1.1	44.1	<0.1	49.7
sample 8	9.35	5.75	57.6	<0.1	185.8
sample 9	23.45	24.55	71.6	0.4	201.8
MEAN	14.2	10.46666667	57.76666667	0.4	145.7666667

Table 10: Table Showing the Heavy Metals Concentration in Osubi Municipal Dumpsite.

	Cu	Pb	Mn	Cd	Zn
sample 1	2.85	47.5	22.15	<0.1	17.85
sample 2	3.6	0.35	50.75	<0.1	5.95
sample 3	4.9	1.3	67.1	<0.1	16.45
MEAN	3.783333333	16.38333333	46.66666667		13.41666667

Table 11: Showing the Heavy Metals Concentration in Control Samples

3.3.2. The Heavy Metals Concentration against World Standard Limits

The results of the analysis carried out are illustrated and tabulated in the figures and tables shown below:

3.3.2.1. Copper

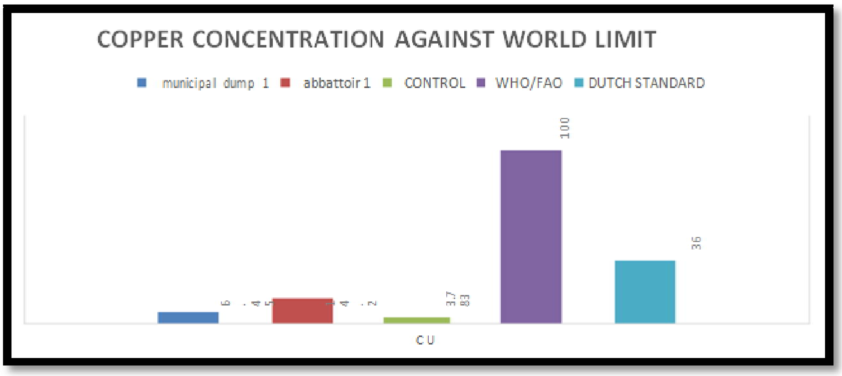

Figure 7: Graphical Comparison of Copper with World Standards

	municipal	abattoir 1	CONTROL	WHO/FAO	DUTCH
	dump 1			(WHO/FAO	STANDARD
				,2001)	
Cu (Mg/Kg)	6.45	14.2	3.783	100	36

Table 12: Comparison of Copper with World Standards

The range and mean concentration of Copper in surface soil samples in Osubi dumpsites are summarized in the table 13 above and illustrated in the figure 9 above.

3.3.2.1.1. Osubi Municipal Dumpsite

Copper concentration is 6.45 mg/kg and ranges from 4.7 to 9.25 mg/kg.

3.3.2.1.2. Osubi Abattoir Dumpsite

Copper concentration is 14.20 mg/kg and ranges from 9.35 to 23.45 mg/kg.

3.3.2.1.3. Control samples

Copper concentration is 3.78 mg/kg and ranges from 2.85 to 4.9 mg/kg.

3.3.2.2. Zinc

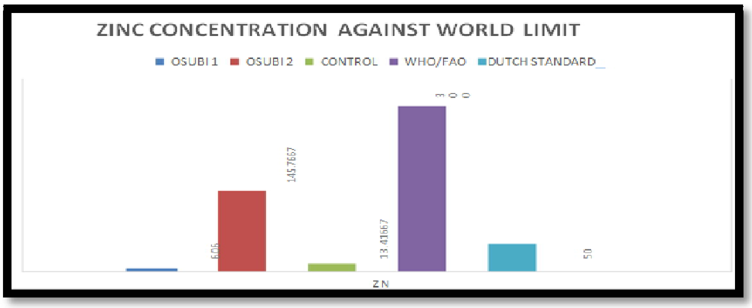

Figure 8: Graphical Comparison of Zinc with World Standards

	OSUBI 1	OSUBI 2	CONTROL	WHO/FAO (WHO/FAO ,2001)	DUTCH STANDARD (Denneman, 1990)
ZN (Mg/Kg)	6.06	145.7667	13.41667	300	50

Table 13: Comparison of Zinc with World Standards

3.3.2.2.1. Osubi Municipal Dumpsite
Zinc concentration is 6.06 mg/kg and ranges from 3.05 to 11.40 mg/kg.

3.3.2.2.2. Osubi Abattoir Dumpsite
Zinc concentration is 145.7667 mg/kg and ranges from 49.7 to 201.8 mg/kg.

3.3.2.2.3. Control Samples
Copper concentration is 13.417 mg/kg and ranges from 5.95 to 17.85 mg/kg.

3.3.2.3. Lead

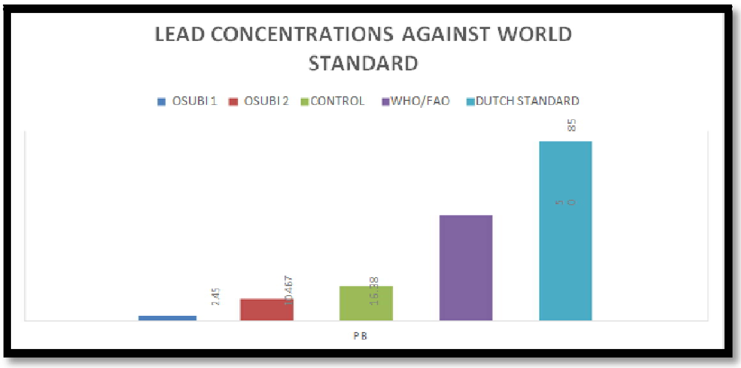

Figure 9: Graphical Comparison of Lead with World Standards

	OSUBI 1	OSUBI 2	CONTROL	WHO/FAO (WHO/FAO ,2001)	DUTCH STANDARD (Denneman, 1990)
PB (Mg/Kg)	2.45	10.467	16.38	50	85

Table 14: Comparison of Lead with World Standards

3.3.2.3.1. Osubi Municipal Dumpsite
Lead concentration is 2.45 mg/kg and ranges from 1.4 to 3.7 mg/kg.

3.3.2.3.2. Osubi Abattoir Dumpsite
Lead concentration is 10.467 mg/kg and ranges from 1.1 to 24.55 mg/kg.

3.3.2.3.3. Control samples
Lead concentration is 16.38mg/kg and ranges from 0.35 to 47.5 mg/kg.

3.3.2.4. Manganese

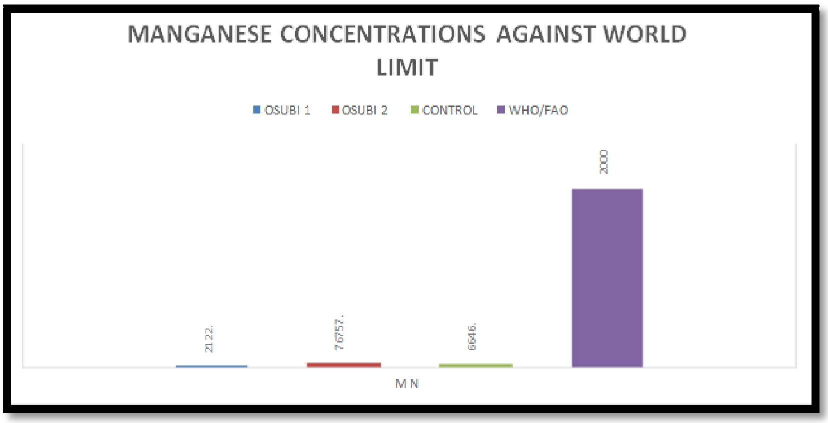

Figure 10: Graphical Comparison of Manganese with World Standards

	OSUBI 1	OSUBI 2	CONTROL	WHO/FAO (WHO/FAO ,2001)
Mn(Mg/Kg)	22.21	57.767	46.66	2000

Table 15: Comparison of Manganese with World Standards

3.3.2.4.1. Osubi Municipal Dumpsite

Manganese concentration is 22.21 mg/kg and ranges from 12.90 to 29.50 mg/kg. No Dutch limit for Manganese.

3.3.2.4.2. Osubi Abattoir Dumpsite

Manganese concentration is 57.76 mg/kg and ranges from 44.1 to 71.60 mg/kg.

3.3.2.4.3. Control Samples

Manganese concentration is 32.916 mg/kg and ranges from 22.15 to 67.10 mg/kg.

3.3.2.5. Cadmium

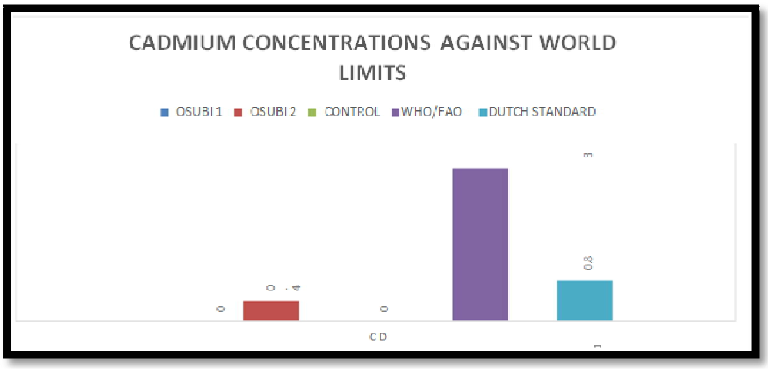

Figure 11: Graphical Comparison of Cadmium with World Standards

	OSUBI 1	OSUBI 2	CONTROL	WHO/FAO (WHO/FAO ,2001)	DUTCH STANDARD (Denneman, 1990)
CD (Mg/Kg)	ND	0.4	ND	3	0.8
Osubi Municipal Dumpsite					

Table 16: Comparison of Cadmium with World Standards

Cadmium concentration is of low concentration, and thus is not registered in osubi municipal dumpsite).

3.3.2.5.1. Osubi Abattoir Dumpsite

Cadmium concentration is of low concentration in its various samples except sample 9, where it has a concentration of 0.4mg/kg.

3.3.2.5.2. Control Samples

Cadmium concentration is of low concentration, and thus is not registered in osubi municipal.

4. Discussion

4.1. Contamination Assessment

4.1.1. Geo-Accumulation Index

From the results obtained, the following values were deduced:

- Samples 1 – 4 falls under the designation value 0 of uncontaminated.
- Sample 5 is uncontaminated except Pb which is moderately contaminated.
- Sample 6,7,8 and 10 are uncontaminated except Zn in sample 8 which ranges from uncontaminated to moderately contaminated.
- Sample 9 ranges from uncontaminated to moderately contaminated in both Pb and Zn and moderately contaminated in Cd.
- The mean value of Igeo decreased in the order of Mn > Cu > Pb > Zn > Cd.

4.1.2. Contamination Factor

From the results obtained, the following values were deduced:

- Samples 1 – 4 and sample 6 - 7 suffered low contamination.
- Sample 5 suffered low contamination except Pb which suffered considerable contamination
- Sample 8 suffered low contamination except Zn which suffered moderate contamination
- Sample 9 displayed moderate contamination for Pb and Zn, and considerable contamination for Cd.

4.1.3. Ecological Risk Factor

From the results obtained, the following values were deduced:

- E'r of Copper in the soil samples range between 0.259 – 2.1315 which indicates Low risk.
- E'r of Lead range from 0.1165 – 8.183, which Low to moderate risk.
- E'r of Manganese range from 0.02461 to 0.079, which indicates low risk.
- Cadmium which was inexistent in nine (9) samples showed considerable risk (CR) in the only location it occurred.
- E'r of Zinc range from 0.075 to 2.882 and fall within low risk (LR).

4.1.4. Pollution Load Index

From the results obtained, the following values were deduced:

All the values suggests no signs of pollution except sample 9

The sample of highest concentration is sample 9 of value 0.91 as against a baseline value of PLI is 1 .This value is close to the baseline value ,and could still suggest strong signs of pollution or deterioration of site quality .It suggests input from anthropogenic sources attributed to increased human activities .

4.1.5. Pearson's Correlation

- Very strong positive correlation was established between Pb/Cu and Zn /Mn.
- Strong correlation was established between Mn/Cu.
- Moderate correlation was established between Zn/Cu, Zn/Pb and Mn/Pb.
- Weak correlation was established between Cd/Mn, Cd/Cu, Cd/Zn, and Cd/Pb.

4.1.6. Concentration of Heavy Metals Against World Limits

4.1.6.1. Zinc

4.1.6.1.1. Osubi Municipal Dumpsite

Zinc concentration is 6.06 mg/kg and ranges from 3.05 to 11.40 mg/kg which below the WHO/FAO (2001) permissible limit of 300 mg/kg and below the Dutch standard (1994) permissible limit of 50 mg/kg.

4.1.6.1.2. Osubi Abattoir Dumpsite

Zinc concentration is 145.7667 mg/kg and ranges from 49.7 to 201.8 mg/kg which below the WHO/FAO (2001) permissible limit of 300 mg/kg and above the Dutch standard (1994) permissible limit of 50 mg/kg.

4.1.6.1.3. Control samples

Copper concentration is 13.417 mg/kg and ranges from 5.95 to 17.85 mg/kg which below the WHO/FAO (2001) permissible limit of 300 mg/kg and below the Dutch standard (1994) permissible limit of 50 mg/kg.

4.1.6.2. Copper

4.1.6.2.1. Osubi Municipal Dumpsite

Copper concentration is 6.45 mg/kg and ranges from 4.7 to 9.25 kg mg/kg which below the WHO/FAO (2001) permissible limit of 100 mg/kg and below the Dutch standard (1994) permissible limit of 36 mg/kg.

4.1.6.2.2. Osubi Abattoir Dumpsite

Copper concentration is 14.20 mg/kg and ranges from 9.35 to 23.45 mg/kg which below the WHO/FAO (2001) permissible limit of 100 mg/kg and below the Dutch standard (1994) permissible limit of 36 mg/kg.

4.1.6.2.3. Control Samples

Copper concentration is 3.78 mg/kg and ranges from 2.85 to 4.9 mg/kg which below the WHO/FAO (2001) permissible limit of 100 mg/kg and below the Dutch standard (1994) permissible limit of 36 mg/kg.

4.1.6.3. Lead

4.1.6.3.1. Osubi Municipal Dumpsite

Lead concentration is 2.45 mg/kg and ranges from 1.4 to 3.7 mg/kg which below the WHO/FAO (2001) permissible limit of 50 mg/kg and below the Dutch standard (1994) permissible limit of 85 mg/kg.

4.1.6.3.2. Osubi Abattoir Dumpsite

Lead concentration is 10.467 mg/kg and ranges from 1.1 to 24.55 mg/kg which below the WHO/FAO (2001) permissible limit of 50 mg/kg and below the Dutch standard (1994) permissible limit of 85 mg/kg.

4.1.6.3.3. Control samples

Lead concentration is 16.38mg/kg and ranges from 0.35 to 47.5 mg/kg which below the WHO/FAO (2001) permissible limit of 50 mg/kg and below the Dutch standard (1994) permissible limit of 85 mg/kg.

4.1.6.4. Manganese

4.1.6.4.1. Osubi Municipal Dumpsite

Manganese concentration is 22.21 mg/kg and ranges from 12.90 to 29.50 mg/kg which below the WHO/FAO (2001) permissible limit of 2000 mg/kg.

4.1.6.4.2. Osubi Abattoir Dumpsite

Manganese concentration is 57.76 mg/kg and ranges from 44.1 to 71.60 mg/kg which below the WHO/FAO (2001) permissible limit of 2000 mg/kg.

4.1.6.4.3. Control Samples

Manganese concentration is 32.916 mg/kg and ranges from 22.15 to 67.10 mg/kg which below the WHO/FAO (2001) permissible limit of 2000 mg/kg.

4.1.6.5. Cadmuim

4.1.6.5.1. Osubi Municipal Dumpsite

Cadmium concentration is of low concentration, and thus is not registered in osubi municipal dumpsite).

4.1.6.5.2. Osubi Abattoir Dumpsite

Cadmium concentration is of low concentration in its various samples except sample 9, where it has a concentration of 0.4mg/kg which below the WHO/FAO (2001) permissible limit of 3 mg/kg and below the Dutch standard (1994) permissible limit of 0.8 mg/kg.

4.1.6.5.3. Control Samples

Cadmium concentration is of low concentration, and thus is not registered in osubi municipal.

<u>4.1.7. Comparison between the Two Dumpsites</u>

From table 4 and table 5 above, the table for Osubi Dumpsites were obtained showing the concentrations of the various heavy metals with their mean values, and the results are as thus:

4.1.7.1. Zinc

The Zinc mean concentration in Abattoir Dumpsite of 145.767 mg/kg is higher than 6.0625 mg/kg in Osubi municipal Dumpsite.

4.1.7.2. Copper

The Copper mean concentration in Abattoir Dumpsite of 14.2 mg/kg is higher than 6.45 mg/kg in Osubi municipal Dumpsite.

4.1.7.3. Lead

The Lead mean concentration in Abattoir Dumpsite of 10.467 mg/kg is higher than 2.45 mg/kg in Osubi municipal Dumpsite.

4.1.7.4. Manganese

The Manganese mean concentration in Abattoir Dumpsite of 57.767 mg/kg is higher than 22.213 mg/kg in Osubi municipal Dumpsite.

4.1.7.5. Cadmium

The Cadmium concentration is inexistent in all locations except in Osubi Abattoir where it has a concentration of 0.4mg/kg.

Overall, it can be seen from the results that Osubi Abattoir Dumpsite has a higher concentration of heavy metals than Osubi municipal Dumpsite.

The following could be reasons for such high differences in heavy metals:

- The ages of the Dumpsites: The Abattoir Dumpsite was created in 2008, while the municipal Dumpsite was created in 2014. (Irabor Asibor et al ,2017).The older the dumpsite, the more concentration of heavy metals that is assumed to accumulate.
- Type of waste deposited : Although according to (Irabor Asibor et al ,2017) ,The municipal Dumpsite receives more waste monthly ,higher composition of the waste are inorganic products , such as Polythene products ,Plastic and glass bottles ,paper, and the most being the scrap bottles and foam etc and the organic waste comprises of 3.56 % unlike the Abattoir dumpsite whose organic composition makes up for 7.62% of wastes.
- Sizes of Dumpsites : According to (Asibor et al ,2017) , The Abattoir Dumpsite occupies 400 x 200 m unlike The municipal Dumpsite that occupies 600 x 400 m ,which is larger than the former .The implications of this ,involves the concentration of heavy metals .A smaller dumpsite leads to a better concentrated accumulation of heavy metals unlike a larger one where the concentrations are more discrete than the smaller one .

5. Conclusion and Recommendations

The heavy metals concentration of soils was used to calculate the enrichment factor, geoaccumulation index, contamination factor and pollution load index of soils. The contamination assessment methods used in this study showed that heavy metal contamination in soil at the study area was generally low except Zn and Pb concentrations in samples 5 , 8 and 9 which indicated moderate contamination , moderate risk of Pb in the study area and slight signs of pollution in location 9 of the study area .

From the test and results obtained from the research it was discovered that the heavy metal concentrations of soil for both dumpsites in the study area fall within the permissible limits of the WHO and Dutch standards except Osubi Abattoir heavy metal concentration of Zinc. This could be influenced by the materials dumped at each site, the anthropogenic activities in the vicinity and the hyper accumulation potentials of the species at the site.

From the results and discussion, it has been observed that Osubi Abattoir dumpsite has more concentrations of heavy metals than Osubi municipal dumpsite, which can be attributed to the high disposal of organic wastes in it, age and size of the dumpsite.

The strong association between Pb/Cu. Mn/Cu, and Zn /Mn influenced by anthropogenic activities suggest a similar source.

6. Recommendations

Based on the results obtained from this study, the following recommendations become necessary:

- Public enlightenment on health hazard associated with contaminated soil should be given to the populace by health workers.
- There is need for public enlightenment of the populace on the effects of heavy metal concentration to humans and plants.
- There should be provision of adequate disposal facilities by government authorities and agencies to each residential area/household to aid proper refuse collection and effective disposal
- Solid waste dumpsite sites should be created by relevant authorities, and these sites should be far from residential areas. By doing this, strict environmental laws and regulations should be put in place for anyone who breaks the law, by this, people would be careful in the way and manner the dumpsite their waste.
- There is need for development of research and analytical capability for an effective information system on the environment which should include a monitoring network to measure the result of government efforts to improve the quality of the information passed across.
- Although the metal loading of the study area is presently low, further investigations should be conducted periodically to assess the level of heavy metals in the marine environment of the Western Region in order to assess health risk of the communities.

7. References

i. A.A. Adepelumi, B.D. Ako and T.R. Ajayi (2001) Groundwater contamination in the basement-complex area of Ile-Ife, southwestern Nigeria: A case study using the electrical-resistivity geophysical method. Hydrogeology Journal, 9: Pp. 611-622

ii. Akinranti S. Ajibola (2016), Assessment of Trace and Major Elements Contamination in Waste Soils: Leaching Potential from Active and Closed Landfills in Lagos, Nigeria. Journal of Environment and Earth Science Vol.6, No.5, Pp. 8-15

iii. Ali Chabuk, Nadhir Al-Ansari, Hussein Musa Hussein, Suhair Kamaleddin, Sven Knutsson, Roland Puschand Jan Laue(2017), Soil Characteristics in Selected Landfill Sites in the Babylon Governorate, Iraq. Journal of Civil Engineering and Architecture 11 doi: 10.17265/1934-7359. Pp. 348-363.

iv. Atiemo, M. (2011). Contamination assessment of heavy metals in road dust from selected roads in Accra, Ghana. Research Journal of Environmental and Earth Sciences, 3(5), Pp. 473– 480.

v. Baker A.J.M., McGrath S.P., Reeves R.D., Smith J.A.C.: Metal hyper-accumulator plants: a review of the ecology and physiology of a biological resource for phyto remediation of metal-polluted soils, in: Phytoremediation of Contaminated Soil and Water, CRC Press, Boca Raton, FL, 2000, Pp. 85-107.

vi. C. N. Ehirim, and C. N. Nwankwo, Evaluation of aquifer characteristics and groundwater quality using geoelectric method in Choba, Port Harcourt. Archives of Applied Science Research, 2(2): (2010) Pp. 396-403.

vii. Chen, T-B., Zheng, Y-M., Lei, M., Huang, Z-C., Wu, H-T., Chen, H., Fan, K-K., Yu, K., Wu, X., & Tian, Q.-Z. (2005). Assessment of heavy metal pollution in surface soils of urban parks in Beijing, China. Chemosphere, 60(4), Pp. 542–551.

viii. Christopher Oluwakunmi Akinbile(2012), Environmental Impact of Landfill on Groundwater Quality and Agricultural Soils in Nigeria .Soil & Water Res., 7, Pp. 18–26.

ix. Crowley D.E., Wang Y.C., Reid C.P.P., Szaniszlo P.J. (1991): Mechanisms of iron acquisition from siderophores by microorganisms and plants, Plant and Soil, 130, Pp. 179-198.

x. D. Adamcová, M. D. Vaverková, S. Bartoˇn, Z. Havlíˇcek, and E.Bˇroušková (2016),Soil contamination in landfills: a case study of a landfill in Czech Republic.Solid Earth, 7, Pp. 239– 247.

xi. D. Okoro, P.O. Oviasogie&F.E. Oviasogie (2011) Soil quality assessment 33 months after crude oil spillage and clean-up ,Chemical Speciation & Bioavailability, 23:1, , DOI: 10.3184/095422911X12963991543492.Pp. 1-6

xii. Denneman and Robberse (1990); Ministry of Housing, Netherland 1994

xiii. Environment Agency (England) (2009) Human health toxicological assessment of contaminants in soil. Science report - Final SC050021/ SR2. Bristol: Environment Agency.P. 45.

xiv. EvangelinRamani ,SujathaGurucharan R ,Ramprasad C, Sornakumar V (2013),Impact of Municipal Solid Waste Dumping on the Geotechnical Properties of Soil and Ground Water in Ariyamangalam, Trichy, India.Vol.18 ,Pp. 2120 -2132.

xv. O. L. Asseez, (1989). Review of the Stratigraphy, Sedimentation and Structure of the Niger Delta. Edited by Kogbe, Rock View (Nig) Ltd. Jos. Pp 311-324.

xvi. DeVolder P.S., Brown S.L., Hesterberg D. and Pandya K., (2003). Metal bioavailability and speciation in a wetland tailings repository amended with bio solids compost, wood ash, and sulfate. Journal of Environmental Quality 32(3):Pp. 851–864.

xvii. EgunNkonyeasua Kingsley,IniagheOkiroro, Paschal, Evbayiro, Osagie Jude (2016). Assessment of landfill sites for solid waste management in Delta state, Nigeria. Journal of Environment and Waste Management.Vol. 3(1), Pp. 116-122.

xviii. F.O. Odemerho and D.O. Ejemeyovwi. The Physiographic Provinces and Drainage Systems of Delta State, Nigeria, In: F.O. Odemerho et al.(eds) Delta State in Maps, Delta State University, Abraka, (2007) Pp. 9-17.

xix. Environmental and Social Management Plan (ESMP): Refuse Collection and Disposal Activity in Six Pilot Cities in Delta State, Nigeria (2015). SEEFOR Project .Pp. 1-183:

xx. G.A. Wigwe. (1975). The Niger Delta: Physical. In G.E.K. Ofomata (ed). Nigeria in maps:

xxi. Eastern States. Ethiope Publ. House, Benin City Pp. 380–400.

xxii. Godwin E. Nwajei (2002), Heavy Metals Contamination Of Soils In Selected Waste Dumping Sites In Warr/Effurun, Delta State, Nigeria .Academy Journal Of Science And Engineering (Ajse) Vol 5 No 1 .Pp. 7 – 13

xxiii. Hakanson L. (1980), An ecological risk index for aquatic pollution control. A sedimentological approach. V14; Pp. 975 – 1001.

xxiv. I.A. Akpoborie, A.A.I. Etobro, B. Nfor, and S. Odagwe. (2011), Aspects of the geology and groundwater conditions of Asaba, Nigeria. Archives of Applied Science Research, 3(2), Pp. 537– 550

xxv. Ikpesu, Jasper Ejovwokoghene, COSS (2016), Determination Of Heavy Metals In Soils In Nigerian Agip Oil Company Obiafor/Obrikom Environs, Journal of Multidisciplinary Engineering Science and Technology (JMEST) ISSN: 3159-0040 Vol. 3 Issue 2, Pp. 3995 - 4007.

xxvi. Irabor Godwin Asibor and Oghenekohwiroro Edjere|(2017), Assessment of the activities of scavengers and their economic impacts in waste recovery in Warri metropolis, Delta State Nigeria , International Research Journal of Public and Environmental Health Vol.4 (2),Pp. 22-29 .

xxvii. Jadia C.D., Fulekar M.H. (2008): Phytotoxicity and remediation of heavy metals by fibrous root grass (sorghum), Journal of Applied Biosciences, 10, Pp. 491-499.

xxviii. John D. Njoku, ToochukwuE.Ebe And Akachukwu O. Enem (2016), Analysis of Heavy Metal Contamination by Artisanal Refining Plants in The Niger Delta Region, Southern Nigeria. British Journal Of Environmental Sciences, European Centre For Research Training And Development Uk.Vol.4, No.3, Pp.39-48.

xxix. Jones L.H.P. and Jarvis S.C., (1981). "The fate of heavy metals," in The Chemistry of Soil Processes, Green D.J. and Hayes M. H. B., Eds., p. 593, John Wiley & Sons, New York, NY, USA Heavy Metal Contamination And Physicochemical Characteristics Of Soils From Automobile Workshops In Abraka, Delta State, Nigeria . International Journal of Natural Sciences Research. Vol. 2, No. 4, Issn(E): 2311-4746, Issn(P): 2311-7435, Pp. 48-58

xxx. Kabata-Pendias A. and Pendias H., (2001). Trace Metals in Soils and Plants.CRC Press, Boca Raton, Fla, USA, 2nd edition.

xxxi. K. C. Short., and A. J. Stauble (1967), Outline of Geology of Niger Delta: AAPG Bull., 51 Pp.761-779.

xxxii. Keller C., McGrath S.P. and Dunham S.J., (2002). Trace metal leaching through a soil grassland system after sewage sludge application. Journal of Environmental Quality 31(5):Pp. 1550–1560.

xxxiii. Khan S., Cao Q., Zheng Y.M., Huang Y.Z. and Zhu Y. G., (2008). Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China. Environmental Pollution 152(3):Pp. 686–692.

xxxiv. Kuo S., Heilman P.E. and Baker A.S., (1983). Distribution and forms of copper, zinc, cadmium, iron, and manganese in soils near a copper smelter. Soil Science 135:Pp. 101–109.

xxxv. Lim, J.-H., Sabin, L. D., Schiff, K. C., & Stolzenbach, K. D. (2006). Concentration, size distribution, and dry deposition rate of particle-associated metals in the Los Angeles region. Atmospheric Environment, 40(40), Pp. 7810–7823.

xxxvi. Lu, X., Wang, L., Lei, K., Huang, J., & Zhai, Y. (2009). Contamination assessment of copper, lead, zinc, manganese and nickel in street dust of Baoji, NW China. Journal of Hazardous Materials, 161(2-3), Pp. 1058–62.

xxxvii. Mattigod S.V. and Page A.L., (1983). Assessment of metal pollution in soil. Applied Magdalena Daria Vaverková, Jan Zloch, MajaRadziemska, Dana Adamcová (2017), Environmental Impact of Landfill on Soils – The Example of The Czech Republic. Polish Journal of Soil Science. Vol. L/1 2017 Pl Issn 0079-2985, Pp. 94-105.

xxxviii. McLaughlin M.J., Hamon R.E., McLaren R.G., Speir T.W. and Rogers S.L., (2000). Review: a bioavailability based rationale for controlling metal and metalloid contamination of agricultural land in Australia and New Zealand. Australian Journal of Soil Research38(6): Pp. 1037–1086.

xxxix. McLaren R.G., Clucas L.M., Taylor M.D. and Hendry T., (2004). Leaching of macronutrients and metals from undisturbed soils treated with metal spiked sewage sludge. 2. Leaching of metals. Australian Journal of Soil Research 42(4):Pp. 459–471.

xl. McLaren R.G., Clucas L.M. and Taylor M.D., (2005). Leaching of macronutrients and metals from undisturbed soils treated with metal spiked sewage sludge. 3. Distribution of residual metals. Australian Journal of Soil Research 43(2):Pp. 159–170.

xli. Mondol, M.N.; Chamon, A.S.; Faiz, B.; Elahi, S.F (2011). Seasonal variation of heavy metal concentrations in Water and plant samples around Tejgaon industrial Area of Bangladesh. J. Bangladesh Acad. Sci., 35, Pp. 19–41.

xlii. Muller G. (1969), Index of geo-accumulation in sediments of the Rhine River. V 2(3); Pp. 108 - 118.

xliii. Muller, G. (1969). Index of geoaccumulation in sediments of the Rhine River. Geological Journal, 2, Pp. 108–118.

xliv. NRC. National Research Council, Groundwater Contamination, Geophysics Research Forum, National Research Council, National Academy Press, Washington, D.C., (1984 Pp. 3 - 10.

xlv. Nwajei, G. E., Dibofori-orji, A. N., Oberhiri, V. U. and Nwajei, R. I.(2014),Heavy Metals Concentration In Soils And Vegetation Around Selected Waste Dumpsites In Delta State. Asian Journal Of Science And Technology Vol. 5, Issue 9, Pp. 567-572.

xlvi. Obafemi, A A; Eludoyin, O S; Akinbosola, B M, J. (2012), Public Perception of Environmental Pollution in Warri, Nigeria Appl. Sci. Environ. Manage. Vol. 16 (3) JASEM ISSN 1119-8362, Pp. 233 – 240.

xlvii. Odukoya, Abiodun (2015), Contamination Assessment of Toxic Elements in The Soil Within and Around Two Dumpsites in Lagos, Nigeria. Ife Journal Of Science Vol. 17, No. 2, Pp. 351-361.

xlviii. Ofomola, Mo; Umayah, Os; Akpoyibo O (2017), Contamination Assessment of Dumpsites in Ughelli, Nigeria Using the Leachate Pollution Index Method. J. Appl. Sci. Environ. Manage. Vol. 21 (1) JASEM ISSN 1119-8362, Pp. 77-84.

xlix. Omo-Irabor, Izeze, Elijah Ovie,Adepoju Isaac Oludare(2018), Assessment Of Heavy Metals Contamination In Soil Due To Leachate Migration From Open Dumpsites In Agbor Area, Delta State. Nigeria. Pacific International Journal Issn 2616-4825 Vol. 02 No.2, Pp. 30-44.

l. Osakwe Stephen Anapuwa (2014), Heavy Metal Contamination and Physicochemical Characteristics of Soils from Automobile Workshops in Abraka, Delta State, Nigeria. International Journal of Natural Sciences Research. Vol. 2, No. 4, Issn(E): 2311-4746, Issn(P): 2311-7435, Pp. 48-58.

li. Oshoma, Ce; Igbeta, B; Omonigho, Se (2017), Analysis of Microbiological and Physiochemical Properties Of Top Soil From Municipal Dumpsites in Benin City. Vol. 21 (5) JASEM ISSN 1119-8362, Pp. 985-990

lii. Otobo Egwebe; Aigbogun, C.O; Ifedili, S.O (2007), Geoelectrical Evaluation of Waste Dump Sites at Warri And Its Environ, Delta State, Nigeria. J. Appl. Sci. Environ. Manage. Vol. 11 (2). Pp. 61 - 64.

liii. Ozebo Vitalis Chidi, Olufemi A. Idowu, Saheed Ganiyu (2014), Physico-chemical Properties of Soil Samples and Dumpsite Environmental Impact on Groundwater Quality in South Western Nigeria.The African Review of Physics Pp.103-114.

liv. P. O. Nwaka, B. Anegbe, O. Adeniyi, I. G. Okunzuwa and A. Jidonwo (2018), Impact of Leachate on Physicochemical Properties of Soil, Within the Vicinity of Oghara Medical Dumpsite, Delta State Nigeria. Physical Science International Journal 17(1): Article no.PSIJ.37470 ISSN: 2348-0130, Pp. 1-14.

lv. P. V. Sharma, (1997), Environmental and engineering Geophysics. Cambridge University Press, pp 265 – 281.

lvi. Roa, M.S.; Gopalkrishnan, R.; Venkatesh, B.R(2001). Medical geology—An emerging field in environmental science. In National Symposium on Role of Earth Sciences, Integrated and Related Societal Issues, Lucknow, India, 2–4 November 2001, GSI Spl. Pub. No. 65, Pp. 213– 222.

lvii. Tomlinson DC ,Wilson DJ ,Harris CR ,Jeffrey DW (1980), .Problems in heavy metals in estuaries and the formation of pollution index .V 33;Pp. 566 -575

lviii. VinothKumar(2017), Contamination of Groundwater Quality Due to Municipal Solid Waste Disposal – A GIS Based Study in Perungudi Dump Yard .International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 04 Issue: 05 .Pp. 952 -964

lix. Salt D.E., Blaylock M., Kumar P.B.A.N., Dushenkov V., Ensley B.D., Chet I., Raskin I.: Phytoremediation (1995), a novel strategy for the removal of toxic metal from the environment using plants, Biotechnology, 13, Pp. 468-474.

lx. Salt D.E., Rauser W.E.: MgATP-dependent transport of phytochelatins across the tonoplast of oat roots, Plant Physiology,1995, 107, Pp. 1293-1301.

lxi. Science Communication Unit, University of the West of England, Bristol (2013). Science for Environment Policy In-depth Report: Soil Contamination: Impacts on Human Health. Report produced for the European Commission DG Environment, September 2013. Selvam A., Wong J.W.: Phytochelatin synthesis and cadmium uptake of Brassica napus, Environmental Technology, 2008, 29, Pp 765-773.

lxii. Smith L.A., Means J.L. and Chen A., (1995). Remedial Options for Metals-Contaminated Sites.Lewis Publishers, Boca Raton, Fla, USA Pp 768 -772.

lxiii. Sriprang R., Hayashi M., Ono H., Takagi M., Hirata K., Murooka Y. (2003). Enhanced accumulation of Cd2+ by a Mesorhizobium sp. transformed with a gene from Arabidopsis thaliana coding for phytochelatin synthase, Applied and Environmental Microbiology, , 69, Pp. 1791-1796.

lxiv. Useh Mercy Uwem, and Dauda Mary Sunday. Chemical Evaluation of Petroleum Sludge Impacted Soils from Itsekiri Communities around Warri Refinery, Delta State, Nigeria (2018). Chemical Science International Journal23(4): Pp. 1-15.

lxv. Sumner M. E., (2000). Beneficial use of effluents, wastes, and bio solids. Communications in Soil Science and Plant Analysis 31(11–14):1701–1715. Pp. 11-14.

lxvi. Tang Y.T., Qiu R.L., Zeng X.W., Ying R.R., Yu F.M., Zhou X.Y. (2009): Lead, zinc, cadmium hyperaccumulation and growth stimulation in Arabis paniculata, Environmental and Experimental Botany, , 66, Pp 126-134.

lxvii. USEPA Rep. 832/R-93/003, USEPA, Washington, DC, USA. USEPA, (1996). Report: recent Developments for In Situ Treatment of Metals contaminated Soils, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

lxviii. Waste Sampling and Testing for Disposal to Landfill (2013), Pp. 1 – 37

lxix. WHO/FAO (2001).Codex Alimentarius Commission .Food Additives and Contaminants .Joint FAO/WHO Food standards Programme, ALINORM 10/12A:.Fertiliizers and their efficient use. Pp. 1-289

lxx. Wu G., Kang H., Zhan X., Shao H., Chu L., Ruan C (2010).: A critical review on the bioremoval of hazardous heavy metals from contaminated soils: Issues, progress, eco-environmental concerns and opportunities, Journal of Hazardous Materials, , 174,Pp 1-8.

lxxi. Yaylali-Abanuz, G (2011). Heavy metal contamination of surface soil around Gebze industrial area, Turkey. Microchem. J., 99, Pp 82–92.

lxxii. ZiadAbdelsalamMilad (2014), An Experimental Investigation of Landfill Leachate Impact on Surrounding Soil. Geoenvironmental Research Centre, Cardiff School of Engineering Cardiff University.Pp. 1 – 334.