American Journal of Environment and Sustainable Development
Vol. 4, No. 4, 2019, pp. 107-112
http://www.aiscience.org/journal/ajesd

Evaluation of the Impact of Landfill on Soil Quality: A Case Study of Akilapa and Oleyo Dumpsite, Osogbo, Nigeria

Akinrinlola Olumide[1, *], Ochonma Charles[1], Oyinloye Jide[2]

[1]Department of Chemistry, Federal University of Technology, Akure, Nigeria
[2]Department of Chemistry, Obafemi Awolowo University, Ile-Ife, Nigeria

Abstract

The degradation and pollution of soil attendant upon the operation of dumpsites is at an alarming rate. In this study, the physico-chemical properties, heavy metal concentration and chemical speciation of heavy metals in soils of two dumpsites in Osogbo were evaluated and compared with a control soil. The physico-chemical properties (pH, Electrical conductivity, Na, Ca, K, MG, % Organic matter, and Cation Exchange Capacity) of the dump soils is relatively higher than that of the control soil. Also, all the soil samples showed higher sand content, followed by Clay and then Silt. The ranges of heavy metal concentration (mg/kg) are as follows: Cu (0.58 – 21.50), Zn (0.90 – 31.90), Pb (0.01 – 30.01), Cr (0.05 – 10.03), Co (0.01), Mn (0.18 – 10.17), Fe (0.85 – 3.50), Ni (0.10 – 7.08), and Cd (0.01 – 5.08). The result of heavy metal speciation showed that higher quantity of all the determined metals are bound to the residual fraction. The research showed that the operation of dumpsites in those areas have greatly altered the physico-chemical content and massively increased the heavy metal concentration of the soil. Therefore, this study suggests the establishment of mitigating strategies in order to reduce continual contamination of the soil.

Keywords

Soil, Dumpsite, Physico-chemical Properties, Heavy Metals

Received: August 21, 2019 / Accepted: November 5, 2019 / Published online: December 27, 2019

1. Introduction

The adverse effect attendant upon the indiscriminate and improper disposal of municipal solid waste has sparked various research engagements. The occurrence of inadequate waste management system in under-developed and developing nations of Africa has engendered varying degree of environmental pollution such as contamination of soil quality, pollution of surface and ground water, destruction of flora and fauna and the impairment of the health of individuals living in such environment [1-2].

The improper operation of dumpsite which stems from factors such as absence of sensitization strategies, urbanization, proliferation of industrial activities, relaxed legislation etc. has immensely compromise the sanity of natural ecosystem [3]. One of the findings of Ayuba et al. [4] revealed that the density of solid waste in Nigeria ranges between 280 – 370 kg/m^3 with a daily generation of about 0.44 – 0.66 kg/capital/day and a yearly production of 25 million tons [5]. Furthermore, the need for good infrastructure elicited a massive rural-urban migration which has engendered a skyrocket in Nigeria's urban population [6].

Consequently, the population expansion resulted in the continual increase in waste generation and this necessitated the adoption of different waste disposal systems. Municipal solid waste falls within household, organic, plastic, metal and agricultural waste are generated from domestic, commercial and agricultural sources. In order to manage the waste generated from anthropogenic activities, various waste

* Corresponding author
E-mail address: oluatomic56@gmail.com (A. Olumide)

disposal techniques which include: source reduction, incineration, waste composting, waste recycling and operation of dump sites were established [7]. Amongst these methods, the most common method in most cities of developing nations is landfill operation.

However, there is an obvious deviation from the protocols guiding the usage of dumpsite. This has led to uncontrolled dumping of refuse in bushes, excavations, mined sites, road path etc. Oyekan and Sulyman [8] posited that about 87% of Nigerians resort to the operation of uncontrolled disposal system. As a consequence, there is an increase percolation of leachates into the soil and continual infiltration of run-off into surface and underground water. Due to this, the composition of soil and groundwater has been adversely altered [9].

Soil is an unconsolidated mineral or organic matter on the surface of the earth that supports the growth of plants, husbandry of animals and effective operation of other human activities [10]. It is one of the most valuable natural resources needed for the optimal use of human and natural resources [11]. It is a natural repository of metals whose quantities depend largely on the following factors: biological and hydrological cycling, microbial communities, pH, organic matter content etc [12]. However, the morphology, physico-chemical properties (pH, silt, organic matter etc.) and heavy metal concentration of soil has been compromised due to the percolation of leachates from dumpsites.

Some researchers posited that the composition of soil at dumpsites contains large amount of heavy metals and base metal ions beyond permissible limit [13-14]. Furthermore, Uba et al. [15] and Okonronkwo et al. [16] revealed that the continued operation of dumpsites has led to increase in the concentration of heavy metals from landfills and they have the capacity to bio-accumulate and persist in soil for decades, thereby affecting the rate of plant growth and impairment of human health. Hence, the degree and magnitude of soil and contamination by heavy metals from infiltration of leachates are at an alarming rate.

In spite of myriad of researches carried out to evaluate the effect of dumpsites on soil qualities in Nigeria, no research has been tailored towards the investigation of the soil in some towns in Oshogbo. Hence, this study is aimed at investigating the impact of landfills on the physic-chemical properties, heavy metal concentration, chemical speciation and pollution indices of soil from Oleyo and Akilapa dumpsites.

Description of study area

The study areas are Oleyo dumpsite, Akilapa dumpsite and the control site. They are in the suburb of Olorunda Local Government Area of Osun state, Nigeria. The geographical coordinates of these locations determined by a Global Positioning System (GPS) are as follows: Akilapa dumpsite (Latitude N07°31.963' and Longitude E005°45.478'), Oleyo dumpsite (Latitude N07°31.874' and Longitude E005°45.494') and the control site (Latitude N07°29.161' and Longitude E005°44.130').

Figure 1. Pictorial view of Akilapa Dumpsite.

Figure 2. Pictorial view of Oleyo Dumpsite.

2. Materials and Method

2.1. Soil Sampling

The top soils of Oleyo and Akilapa dumpsites were collected at a depth of 15 cm using polyethylene bags and accurately labeled. The control soil sample was collected at a distance approximately 8km away from Akilapa and 10 km from Oleyo dumpsite respectively using a polyethylene bag. The three soil samples were air-dried for seven days, grounded with mortar and pestle, and then sieved with 1.5 mm sieve. The air-dried samples were kept packed with plastic bag for further analysis.

2.2. Physico-chemical Properties of Soil

Soil pH was determined using a glass coupled electrode pH meter while the Electrical Conductivity (EC) of soil sample were determined using a digital conductivity meter. Clay, Sand, Silt and moisture content of the soil samples were determined by hydrometer and Gravimetric method [17]. The percentage Organic Carbon (% OC) and percentage Organic Matter (% OM) were measured by methods described by [18]. The Cation Exchange Capacity (CEC) was determined by method described by [19]. Ca and Mg were analyzed by EDTA titrimetric method while K and Na were measured by flame photometry.

2.3. Heavy Metal Analysis

Heavy metals (Cu, Cd, Cr, Pb, Mn, Zn, Mn, Co, Ni and Fe) in soil samples were digested using an aqua regia solution and analyzed. Using atomic absorption spectrophotometer.

2.4. Sequential Extraction of Heavy Metals

The sequential extraction method described by Tessier, et al. [20] and modified by Uba et al. [16] was used in this study. In this method, heavy metals were separated into five operationally defined fractions namely Exchangeable (F1), bound to carbonate (F2), bond to Fe-Mn oxide (F3), bound to organic matter (F4) and residual fraction (F5). The extracted products (filtrates) were separately determined for heavy metals using an Alpha 4 Chem. Tech. Analytical Atomic Absorption Spectrometer (AAS) withgraphite atomizer.

3. Result and Discussion

3.1. Physico-chemical Properties of Soil

Table 1 reveals the result of the physiochemical properties of all the soil samples. The pH of the soil ranged between 7.10 – 8.10 whereby S2 having highest value. The pH of the soil samples from the dumpsites is slightly alkaline in comparison with that of the control soil which is neutral. Soil pH is inversely proportional to the mobility and solubility of metals [21]. In other words, the lower the soil pH, the higher the bioavailability of metals. Hence, the concentration of heavy metals in the soil samples from dumpsite decreased in this order S3<S1<S2. Oluseyi et al. [22] reported a similar range of value of 7.9 – 8.0 for soil from dumpsites in Lagos state.

The Electrical Conductivity (EC) ranged between 101 – 372 µS/cm with highest value in S2 and lowest value in S3. The result showed that the leachates from the dumpsites had great impact on the EC of the soil samples. These values are agreeable with the EC value of 186 – 200 µS/cm reported by Amadi et al. [23] but lower than the value (6280 µS/cm) reported by Badmus et al. [24]. Seasonal variation and soil's moisture content have a great effect on the EC of soil [24]. During wet seasons, the moisture content of soil is reasonably high and this greatly increase the EC of soil due to the high concentration of ions in moisture filled soil because of easy mobility of salt in wet soil.

The Ca, Na, Mg and K concentration of all the soil samples ranged between 53.70-60.10 mg/kg, 23.50 – 28.00 mg/kg, 6.75 – 8.30 mg/kg, and 76.10 – 89.40 mg/kg respectively. All the major cations are highest in S2 with the exception of K which is highest in S1. The result showed that the concentrations of all the major cations are higher in the soil samples from dumpsites in comparison with the control site. Hence, it can be inferred that the dumpsite has increased the concentration of base ion metals in the soil. These values falls within the range reported for Na (18.96 – 490.12 mg/kg), K (85.68 – 842.24 mg/kg), and Ca (48.90 and 281.08 mg/kg) respectively [25].

The CEC of the soil samples ranged between 5.10 – 22.26 mg/kg with the highest value in S1 and lowest value in S3. The investigation showed that the CEC for the dump soils is greater than the control soil. The disparity may be attributed to relatively high pH and % OM as compared with the control soil because there is a direct relationship between CEC, pH and Organic matter. These findings are consistent with the investigation of Kebede et al. [26] who recorded a value range of 15 – 25 mg/kg for dump soils in Ethiopia.

Higher Organic matter indicates the degree of usefulness of soil for agricultural activities. The % OM ranged between 0.89 – 4.20. It can be observed that the % OM of the dump soils is relatively higher than those of the control soil. The difference may be as a result of the high pH of the dump soil viz-a-viz the control soil because the higher the pH, the higher the organic matter. These findings is consistent with the discovery of Oyedele et al. [27] who revealed that landfills had higher pH value and organic matter in comparison with the control soil.

The Clay/Silt/Sand content of the soil ranged between 8.48-10.48%, 3.28 – 11.28% and 78.24 – 88.24% respectively. In the dump soils, the sand has the highest percentage, followed by clay and silt while in the control soil; the sand also has the highest percentage, followed by the silt and clay. Similarly, Ideriah et al. [28] Also showed the same proportion of Sand/Clay/Silt in a dumpsite in Port-Harcourt, Nigeria. Soils that have high sand composition and low clay content have greater tendency for pollution through leaching [29]. The relatively high fraction of the dump soils as compared with the control soil is an indication of high permeability of leacheates.

Table 1. Physico-chemical properties of Soil samples.

Parameter	S1	S2	S3
pH	7.40	8.10	7.10
EC (µS/cm)	147	372	101
Na (mg/kg)	23.50	28.00	26.30
Ca (mg/kg)	55.21	60.10	53.70
Mg (mg/kg)	6.75	8.30	5.50
K (mg/kg)	89.40	85.80	76.10
CEC (mg/kg)	22.26	18.02	5.10
OM (%)	4.20	1.51	0.89
Clay (%)	8.48	8.48	10.48
Silt (%)	7.28	3.28	11.28
Sand (%)	84.24	88.24	78.24

*S1 = Soil from Akilapa Dumpsite; *S2 = Soil from Oleyo Dumpsite; *S3 = Soil from control site.

3.2. Heavy Metal Analysis

Table 2 showed the heavy metal concentration of all the soil samples. The lead concentration in S1 (30.01mg/kg) is higher compared to S2 (0.9 mg/kg) and S3 (1.2 mg/kg) which may be attributed to the disposal of lead-containing substance in the dumpsite. These values are far below the maximum permissible limit of 400 mg/kg set by WHO [30]. These values are not in agreement with the findings of Ambrose *et al.* [31], who reported a value range of 14.75-16.14 mg/kg for dump soils in Bayelsa state.

Cr concentration in all the soil samples increased in this order S1>S3>S2 with S1, S2 and S3 having 10.03mg/kg, 0.01mg/kg and 0.02mg/kg respectively. The high chromium content of S1 may be attributed to the dumping of waste comprising of lead-chromium batteries, colored polythene package, unused plastic materials and unfilled paint containers. The concentration of Cr in this study is lower than the permissible limit of 50 mg/kg [32].

The concentration of cadmium in the soil samples varies between 0.01 – 5.08mg/kg with S1 having the highest Cd content. This is comparable with the findings of Akinbile [33] who evaluated heavy metal concentration of dump soils in Owerri, Nigeria.

The concentration of Cu ranged between 0.58 –21.50 mg/kg with S2 having the lowest Cu content. The highest value of Cu in S1 may be attributed to the disposal of waste containing fertilizer and pesticides used for agricultural purposes. The reported value is lower than the findings of Akinbile [33], who recorded a higher value of 31.7-101.9 mg/kg for dump soils in Ondo state. The concentration of Co in the soil samples is in the range of 0.01 mg/kg with that of S1 below detectable limit. Olayiwola et al. [34] reported a higher value of 0.33 – 0.63 mg/kg compared to our study.

The concentration of Mn and Ni varies between 0.18 – 10.17 mg/kg and 0. – 7.08 mg/kg respectively with S1 having the highest Mn and Ni concentration. The higher concentration of Mn and Ni may be due to the disposal of waste containing Manganese and Nickel. Awokunmi et al. [35] reported a reasonably higher value of 18 – 1620 mg/kg for Ni and 212 – 660 mg/kg for Mn.

The concentration of Fe and Zn ranged between 0.85 – 3.50mg/kg and 0.90 – 31.90 mg/kg respectively with S1 having the highest Fe and Zn content. The relatively high content of Fe and Zn in S1 as compared to S2 and S3 may be attributed to the continued disposal and burning of cosmetic waste, pesticide cans, thins etc [36]. These values arenot in agreement with those reported by Awokunmi et al. [35] for Fe (1221 – 8310 mg/kg) and Zn (360 – 8100 mg/kg) in a study carried out on dumpsites in Ekiti, Nigeria.

Table 2. Heavy Metal Concentration of Soil samples.

Metals (mg/kg)	S1	S2	S3
Cu	21.50	0.58	0.75
Cd	5.08	0.01	0.02
Cr	10.03	0.07	0.05
Co	BDL	0.01	0.01
Mn	10.17	0.18	0.19
Fe	23.50	0.85	2.50
Ni	7.08	0.10	0.62
Pb	30.01	0.02	0.01
Zn	31.90	0.90	1.20

*S1 = Soil from Akilapa Dumpsite; *S2 = Soil from Oleyo Dumpsite; *S3 = Soil from control site.

3.3. Chemical Speciation

The result of sequential extraction of Cd, Cr, Cu, Pb, Zn, Ni and Fe in sample S1, S2 and S3 respectively are presented in Table 3. The heavy metals were fractionized into five fractions namely: Exchangeable (F1), bound to carbonate (F2), bound to Fe-Mn oxide (F3), bound to organic matter (F4) and residual fraction (F5). The concentration of Cd in all the samples ranged between 0.60 – 8.00 mg/kg for all the fractions. The availability of Cd in S1, S2, and S3 respectively are in the order of F5>F3>F2>F1>F4. Also, the bio-availability and mobility of Cd is highest in S1 followed by S2 and then S3. The concentration of Cr in all the samples ranged between 0.50 – 19.00 mg/kg for all the fractions. The availability of Cr in S1, S2, and S3 respectively are in the order of F5>F3>F4>F2>F1. More so, the bio-availability and mobility of Cr is highest in S3 followed by S2 and then S1. The concentration of Cu in all the samples ranged between 1.50 – 39.50 mg/kg for all the fractions. The availability of Cu in S1, S2, and S3 respectively are in the order of F5>F3>F1>F4>F2. Furthermore, the bio-availability and mobility of Cu is highest in S2 followed by S3 and then S1. The concentration of Zn in all the samples ranged between 2.25 – 5375 mg/kg for all the fractions. The availability of Zn in S1, S2, and S3 respectively are in the order of F5>F3>F4>F2>F1 with the exception of F3 in S1 which has the highest concentration. Also, the bio-availability and mobility of Zn is highest in S2 followed by S3 and then S1. The concentration of Ni in all the samples ranged between 0.50 – 10.00 mg/kg for all the fractions. The availability of Ni in S1, S2, and S3 respectively are in the order of F5>F3>F4>F2>F1. Additionally, the bio-availability and mobility of Ni is highest in S3 followed by S1 and then S2. The concentration of Pb in all the samples ranged between 1.50 – 37.50 mg/kg for all the fractions. The availability of Pb in S1, S2, and S3 respectively are in the order of F5>F3>F2>F4>F1 with the exception of F3 in S1 which has the highest concentration. Moreover, the bio-availability and mobility of Pb is highest in S3 followed by S2 and then S1. The concentration of Fe in all the samples ranged between 1.00 – 48.00 mg/kg for all the fractions. The availability of

Cu in S1, S2, and S3 respectively are in the order of F5>F3>F4>F1>F2. Finally, the bio-availability and mobility of Fe is highest in S2 followed by S3 and then S1.

The result indicated that all the heavy metals in all the soil samples (S1, S2 and S3) are bounded to the residual fraction (i.e. to silicates and detrital materials). These claims are in agreement with the findings of Uba et al. [15] which showed that heavy metals are often bound to residual fractions. According to the result, reasonable amount of the heavy metal are also bounded to Fe-Mn oxide (reducible fraction).

Table 3. Sequential Extraction of Soil Samples.

Metals (mg/kg)	Dumpsite	F1	F2	F3	F4	F5
	S1	0.60	0.75	2.75	ND	8.00
Cd	S2	ND	1.35	2.35	ND	7.00
	S3	ND	0.60	3.50	ND	4.00
	S1	0.50	0.75	5.25	1.50	7.00
Cr	S2	0.50	0.50	7.25	3.25	19.00
	S3	0.50	0.75	7.50	3.25	12.75
	S1	3.75	2.50	15.50	4.00	8.00
Cu	S2	3.75	2.75	18.75	2.50	37.50
	S3	2.75	1.50	14.75	2.50	39.50
	S1	2.25	3.50	950.00	62.50	9.00
Zn	S2	2.25	3.25	1100.00	100.00	5375.00
	S3	1.25	2.25	1975.00	100.00	2800.00
	S1	1.00	1.00	4.00	2.50	10.00
Ni	S2	0.50	1.00	3.25	1.50	10.25
	S3	0.50	0.50	4.75	3.25	9.50
	S1	2.25	5.00	17.50	5.25	11.00
Pb	S2	1.50	5.00	15.00	4.50	37.50
	S3	5.25	4.25	25.25	2.50	25.00
	S1	5.25	3.25	10.00	4.35	13.00
Fe	S2	3.75	4.25	12.75	6.25	48.00
	S3	2.25	1.00	15.50	7.35	33.75

*S1 = Soil from Akilapa Dumpsite; *S2 = Soil from Oleyo Dumpsite; *S3 = Soil from control site; F1 = Exchangeabe; F2 = Bound to Carbonate; F3 = Bound to Fe-Mn oxide; F4 = Bound to organic matter; F5 = Residual fraction.

4. Conclusion

From the study, it can be concluded that the dumpsite has greatly alter the physicochemical and heavy metal composition of the soil due an increase in the two parameters with respect to the soil from the control site. The result of heavy metal speciation showed that higher quantity of all the determined metals are bound to the residual fraction. Also, research showed that the operation of dumpsite in those areas has greatly alter the physico-chemical content and massively increased the heavy metal concentration of the soil. It was observed that Akilapa dumpsite has higher heavy metal concentration compared with Oleyo dumpsite. The improper discharge of high metal wastes, sewage sludge and waste combustion might be attributable to the high heavy metal concentration in Akilapa site. Therefore, this study suggests the establishment of mitigating strategies in order to reduce continual contamination of the soil.

References

[1] Angaye, T. C. N., Zige, D. V. and Izah, S. C. (2015). Microbial load and heavy metals properties of leachates from solid wastes dumpsites in the Niger Delta, Nigeria. *Journal of Environmental Treatment Techniques*, 3 (3): 175-180.

[2] Abur, B. T., Oguche, E. E., Duvuna, G. A. (2014). Characterization of Municipal Solid Waste in the Federal Capital Abuja, Nigeria. *Global Journal of Science Frontier Research: Environment & Earth Science*, 14 (2): 1-6.

[3] Amuda, O. S., Adebisi, S. A., Jimoda, L. A., Alade, A. O (2014). Challenges and Possible Panacea to the Municipal Solid Wastes Management in Nigeria. *Journal of Sustainable Development Studies*, 6 (1): 64-70.

[4] Ayuba, K. A., Abd-Manaf, L., Sabrina A. H., Azmin, S. W. (2013). Current Status of Municipal Solid Waste Management Practise in FCT Abuja. *Research Journal of Environmental and Earth Sciences*, 5 (6): 295 –304.

[5] Ogwueleka, T. C., 2009. Municipal solid waste characteristics and management in Nigeria. Iran *J. Environ. Health Sci. Eng*., 6 (3): 173-180.

[6] Adejobi, O. S., Olorunnimbe, R. O. (2012). Challenges of Waste Management and Climate Change in Nigeria: Lagos State Metropolis Experience. *African J. Sci. Res*. 7 (1): 346-362.

[7] Adekunle, I. M., Adebola, A. A., Aderonke, K. A., Pius, O. A., Toyin, A. A. (2011). Recycling of organic wastes through composting for land applications: A Nigerian experience. *Waste Management Res*., 29 (6): 582-93.

[8] Oyekan, T. K., Sulyman, A. O. (2013). Health Impact Assessment of Community-based Solid Waste Management Facilities in Ilorin West Local Government Area Kwara State, Nigeria. Journal of Geography and Regional Planning, 8 (6): 26-36.

[9] Kola-Olusanya, A. (2012). Impact of Municipal Solid Wastes on Underground Water Sources in Nigeria. *European Scientific Journal*, 8 (11): 1-19.

[10] Brady, N. C., Weil, R. R., 2008. The nature and properties of soils. Fourteenth Edition, Prentice Hall, New York. USA. 965 p.

[11] Sumithra, S., Ankalaiah, C., Janardhana, R. D., Yamuna, R. T., 2013. A case study on physicochemical characteristics of soil around industrial and agricultural area of Yerraguntla, Kadapa district, A. P, India. *International Journal of Geology, Earth & Environmental Sciences* 3 (2): 28–34.

[12] Musa, A. A., Labo, A. S., Lamido, S. M., Salisu, S. A., Ibrahim, M. B., Bello, N. (2016). Characterization of Municipal Solid Waste, In Kazaure Local Government Area, Jigawa State, Nigeria. International journal of engineering sciences & research Technology, 5 (7): 292-296.

[13] Odukoya, O. O., O. Bamgbose and T. A. Arowolo, 2000. Heavy metals in topsoil of Abeokuta dumpsites. Global J. Pure Applied Sci., 7: 467-472.

[14] Dara SS (1993). A textbook of environmental chemistry and pollutioncontrol. S. Chand & Company Ltd. Ram Nagar, New Delhi 110055.

[15] Okoronkwo, N. E., J. C. Igwe and E. C. Onwuchekwa, 2005. Risk and health implication of polluted soils for crop production. Afr. J. Biotechnol., 4: 152-1524.

[16] Uba, S., A. Uzairu, G. F. S Harrison, M. L. Balarabe and O. J. Okunola, 2008. Assessment of heavy metals bioavailability in dumpsites of Zaria Metropolis, Nigeria. Afr. J. Biotechnology., 7: 122-130.

[17] Wufem, B. M., Ibrahim, A. Q., Maina, H. M., Gungsat, N. J., Barnabas, N. J., 2014. Quality evaluation and physico-chemical properties of soils around a cement factory in Gombe State, Nigeria. International Conference on Advances in Agricultural, Biological & Environmental Sciences (AABES-2014) Oct 15-16, 2014 Dubai, UAE.

[18] Maguire, R. O., Heckendorn, S. E., 2005. Laboratory procedures. Virginia Tech Soil Testing Laboratory. Virginia Cooperative Extension, Publication 452-881. Available at [25.11.2017]: https://vtechworks.lib.vt.edu/bitstream/handle/10919/55039/452-881.pdf?sequence=1&isAllowed=y.

[19] AMOS-TAUTUA, Bamidele Martin W., ONIGBINDE, Adebayo O. and ERE, Diepreye (2014). Assessment of some heavy metals and physicochemical properties in surface soils of municipal open waste dumpsite in Yenagoa, Nigeria. African Journal of Environmental Science and Technology. Vol. 8 (1), pp. 41-47. DOI: 10.5897/AJEST2013.1621.

[20] Tessier, A., Campbell, P. G. C. and Bisson, M. (1979). Sequential extraction procedurefor the speciation of particulate tracemetals. Anal. Chem., 51 (7), 844-851.

[21] Gray CW, McLaren RG, Roberts AH, Condron LM (1998). Sorption and desorption of cadmium from some New Zealand soils: Effect of pH and contact time. Aust. J. Soil Res. 36: 199-216.

[22] Oluseyi, T., Adetunde, A., Amadi, E. (2014). Impact Assessment of Dumpsites on Quality of Near-By Soil and Underground Water: A Case Study of An Abandoned and A Functional Dumpsite in Lagos, Nigeria. International Journal of Science, Environment and Technology, 3 (3): 1004-1015.

[23] Amadi, A. N., Olasehinde P. I., Okosun E. A., Okoye N. O., Okunlola I. A., Alkali, Y. B., Dan-Hassan M. A.(2012). A Comparative Study on the Impact of Avu and Ihie Dumpsites on Soil Quality in Southeastern Nigeria. *American Journal of Chemistry*, 2 (1): 17-23.

[24] Badmus BS, Ozebo VC, Idowu OA, Ganiyu SA, Olurin OT. *Physico-chemical properties of soil samples and dumpsite environmentalimpact on groundwater quality in South WesternNigeria*. The African Review of Physics 2014; 9: 0015. Australian Journal of Basic and Applied Sciences, 5 (11): 763-770, 2011 ISSN 1991-8178.

[25] Amadi, Akobundu N. (2016). Assessing the Effects of Aladimma Dumpsite on Soil and Groundwater Using Water Quality Index and Factor Analysis. American journal of scientific and industrial research © 2016, Science Huβ, http://www.scihub.org/AJSIR ISSN: 2153-649X, doi: 10.5251/ajsir.2016.7.5.129.136.

[26] Asmamaw Abera Kebede, Dessalegn Dadi Olani2, Tadesse Getahun Edesa, Yohannes Tefera Damtew. (2016) Heavy Metal Content and Physico Chemical Properties of Soil around Solid Waste Disposal Sites. American journal of scientific and industrial research.

[27] Oyedele DJ, Gasu MB, Awotoye O. O. (2008). Changes in soil properties and plant uptake of heavy metals on selected municipal solid waste dump sites in Ile-Ife, Nigeria. Afr. J. Environ. Sci. Technol. 3 (5): 107-115.

[28] Ideriah TKJ, Omuaru VOT, Adiukwu PA (2006). Soil quality around a waste dumpsite in Port Harcourt, Nigeria. Afr. J. Ecol. 44: 388-394.

[29] Nyles CB, Ray RN (1999). The Nature and Properties of Soils. 12th Ed. United States of America. pp. 743-785.

[30] World Health Organization (WHO) (1993). Standard maxima for metals in Agricultural soils.

[31] Ambrose, I., Braid, W., Essien, J. P (2015). Assessment of Air Quality (Bioaerosols) of the Municipal WasteDumpsite in Uyo Urban, Akwa Ibom State, Nigeria. International Journal of Scientific and ResearchPublications, 5 (9): 1-6.

[32] MAFF (Ministry of Agriculture, Fisheries and Food) and Welch Office Agriculture Department (1992). Code of Good Agriculture Practice for the Protection of Soil. Draft Consultation Document, MAFF, London.

[33] Akinbile, C. O (2012). Environmental Impact of Landfill on Groundwater Quality and Agricultural Soils in Nigeria. *Soil and Water Resource*, 7 (1): 18-26.

[34] Hammed. A Olayiwola Lukuman Abudulawal Gbola. K. Adewuyi* Mohammed O. Azeez (2017). Heavy Metal Contents in Soil and Plants at Dumpsites: A Case Study of Awotan and Ajakanga Dumpsite Ibadan, Oyo State, Nigeria. Journal of Environment and Earth Science www.iiste.orgISSN 2224-3216 (Paper) ISSN 2225-0948 (Online) Vol. 7, No. 4, 2017.

[35] E. E. Awokunmi1*, S. S. Asaolu and K. O. Ipinmoroti (2010). Effect of leaching on heavy metals concentration of soil in some dumpsites. African Journal of Environmental Science and Technology Vol. 4 (8), pp. 495-499.

[36] Maneyahilishal Tefera, Ftsum Gebreyohannes, Mekala Saraswathi (2018). Heavy metal analysis in the soils of in and around Robe town, Bale zone, South Eastern, Ethiopia Eurasian J Soil Sci., 7 (3) 251-256.