IRBAS www.irbas.academyirmbr.com March 2016
International Review of Basic and Applied Sciences Vol. 4 Issue.3

Comparative Assessment of Closed and Active Dumpsites Soil in Lagos State, Nigeria

SALAMI L
Environmental Engineering Research Unit, Department of Chemical and Polymer Engineering, Lagos State University, Epe, Lagos state, Nigeria.
Email: SalamiLukumon@yahoo.com

ODUNLAMI, M.O
Department of Chemical Engineering, Lagos state Polytechnic, Ikorodu, Lagos State, Nigeria.

FADAYINI O.
Department of Chemical Engineering, Lagos state Polytechnic, Ikorodu, Lagos State, Nigeria.

Abstract

Leachate from wastes in dumpsites constitutes a threat to the quality of dumpsite soil as it contaminates the soil. This paper assesses and compares the level of contamination in the soil of Oke Afa and Soluos dumpsites. Soil samples were taken from different locations in Oke Afa dumpsite at the surface and at the depth of 0.5 m and 1.0 m. Subsequently, soil samples were also collected from Soluos dumpsite at the surface and at the depth of 0.5 m and 1.0 m using stainless knife. All the soil samples were analysed for heavy metals using atomic Absorption Spectrophotometer. The soil samples were also analysed for pH using pH meter. The results of the analysis revealed that the concentrations of parameters analysed were higher in Soluos dumpsite than the Oke Afa dumpsite except for nickel and chromium which were not detected in Soluos dumpsite. The results in addition showed that in Soluos dumpsite, the concentrations of the parameters analysed decrease as the depth increases downward from the surface but in Oke Afa dumpsite, the concentrations of parameters analysed have no regular pattern as the depth increases downward from the surface. In the two dumpsites assessed, the values of the parameters analysed were below the maximum allowable limits for heavy metals in soil. It was concluded that the level of contamination were below the standard used for comparison in both dumpsites but there is likelihood of having higher concentrations of contaminants in future in Soluos dumpsite since the dumpsite is still receiving wastes from Lagos state.

Key Words: *Assessment, Concentration, Contamination, Comparative, Dumpsites, Soil, Wastes.*

Introduction

Solid waste disposals represent a significant source of metals release into the environment (Yarlagadda et al., 1995; Rizo et al., 2012; Bretzeland and Calderisi, 2011; Iweagbue et al., 2010 and Waheed at al., 2010). The precipitate that falls into a landfill, coupled with any disposal liquid waste results in the extraction of water soluble compounds and particulate matter of the waste and subsequently formation of leachate (Salami and Susu, 2013). The leachate migrates through the soil and the soil is contaminated with heavy metals such as lead, copper, zinc, iron, manganese, chromium and cadmium. These heavy metals in solid wastes lead to serious problems because they cannot be biodegraded (Hong et al., 202).

The increasing use of open and unsafe dumpsites containing multiple disposals of domestic, municipal, industrial and medical wastes is alarming especially in most cities in Nigeria (Lawal et al., 2012). The indiscriminate disposal of these solid wastes leads to pollution of the soil in the area. Soil pollution is a

widely global environmental problem. In 2011, Odukoya et al., carried out a research on the potential of soil contamination with toxic metals in the vicinity of active and abandoned dumpsites using OkeAfa dumpsite as abandoned dumpsite and Olusosun dumpsite as active dumpsite. The study revealed that both the abandoned dumpsite and active dumpsite were within very high and considerable degree of contamination respectively. However, this work is aimed to assess and compare the level of pollution in the soil of Oke Afa dumpsite which is a closed dumpsite and Soluos dumpsite which is still an active dumpsite. If the level of pollution in the two dumpsites can be established, it will help to put in place remediation measures hence the assessment of the dumpsites serves as a means of sanitising our environment and improving the quality of human life which justifies this research work.

Study Area

Oke Afa Dumpsite

Oke Afa dumpsite is a closed dumpsite situated in Isolo/Oshodi Local Government area of Lagos State, Nigeria. The dumpsite covers approximately three hectares of land. It was used as an abattoir before dumping of refuse started in 1990 which was closed in 1998. The dumpsite is located along a flowing river and major road connecting Alimosho Local Government and Isolo/Oshodi Local Government. Oke Afa dumpsite shown in plate 2.1.1 is a non-engineered dumpsite with a heap of wastes stream made up of domestic, market, commercial, industrial and institutional origins. The surrounding area is now well developed particularly for housing and commercial purposes. During operation of the site, different types of wastes ranging from organic to inorganic, hazardous and non hazardous were dumped in the site. The wastes were dumped without separation but the rag pickers who constituted the informal sector rummaged through the wastes, helped in segregating them by collecting the plastics and metals and sell them to the recycling industries.

Plate 2.1 1.A view of OkeAfa dumpsite in Isolo/Oshodi Local Government of LagosState, Nigeria

Soluos Dumpsite

The Soluos dumpsite is situated at Ikotun/Igando Local council development area of Alimosho Local Government in Lagos State, Nigeria. The dumpsite covers 3.2 hectares and surrounded by commercial, industrial and residential set up. It started operation in 1996. The dumpsite has witnessed rehabilitation which comprised reclamation of land, construction of accessible road for case of tipping, spreading and compaction of waste since inception (Longe and Balogun, 2010). The wastes are of different types, ranging

from organic to inorganic, hazardous and non hazardous. Like in all other existing dumpsites in the state, the waste stream is made up of domestic, market, commercial, industrial and institutional origins (Longe and Balogun, 2010). The Soluos dumpsite is a non-engineered landfill with a huge heap of waste. Trucks from different parts of Alimosho area of Lagos State collect and bring wastes to this site and dump them in irregular fashion. The wastes are dumped without separation but the rag pickers who constitute the informal sector rummage through the waste, help in segregating them by collecting the plastic and metals and sell them to the recycling industries. A view of Soluos dumpsite is shown in plate 2.2.1.

Plate 2.2.1: A view of Soluos dumpsite in Alimosho Local Government of Lagos State, Nigeria.

Methodology

Sampling of Soil Samples

Sampling of Oke Afa Dumpsite Soil

Soil samples were collected from five different locations, four extreme locations and centre location on oke Afa dumpsite, labelled 1, 2, 3, 4 and 5 respectively. At the surface, five soil samples were collected with the aid of stainless knife from different locations using 1 litre plastic bottles that had been cleaned by soaking in 10% nitric acid and rinsed with distilled water. The stainless knife was washed with distill water each time it was used for collection of sample before using it for another sample. The samples were labeled S1A, S2A, S3A, S4A, and S5A. Each location was then dug within 6 inches diameter up to a depth of 0.5m and soil samples were also taken in treated 1 litre plastic bottles labeled S1B, S2B, S3B, S4B and S5B. The different locations were further dug up to a depth of 1m and samples collected, labeled S1C, S2C, S3C, S4C, and S5C.

Sampling of Soluos Dumpsite Soil

Soil samples were collected from five different locations, four extreme locations and centre location on the Soluos dumpsite, labelled 6, 7, 8, 9 and 10 respectively. At the surface, five soil samples were taken with the aid of stainless knife from different locations using 1 litre plastic bottles that had been cleaned by soaking in 10% nitric acid and rinsed with distilled water. The stainless knife was washed with distill water each time it was used for collection of sample before using it for another sample. The samples were labeled S6A, S7A, S8A, S9A, and S10A. Each location was then dug within 6 inches diameter up to a depth of 0.5m and samples were also collected in treated 1 litre plastic bottles labeled S6B, S7B, S8B, S9B and

S10B. The different locations were further dug up to a depth of 1m and samples collected, labeled S6C, S7C, S8C, S9C, and S10C.

Analysis of Soil Samples

For the analysis of soil samples, the method of Adelekan and Alawode (2011) was used. The fresh soil was spread on a clean plastic sheet placed on a flat surface and air dried in open air in the laboratory under room conditions for 24 hours. Afterwards, the soil was sieved using a 0.5mm sieve. After sieving, 0.5g was weighed from the sieved soil of each sample and put into a Pyrex beaker. Ten ml of perchloric/nitric acid mixture ratio 1 : 2 was added to the sample. The beaker was then covered with a lid and placed on a hot plate at 105^0C for 30 minutes in a fume cupboard for digestion. After the 30 minutes period, the beaker containing the digested solution was brought out of the fume cupboard and allowed to cool. After cooling, the mixture was transferred into a 25ml volumetric flask and made to 25ml mark with distilled water. Next, the 25ml solution was used for the determination of the concentration of heavy metals using an Atomic Absorption Spectrophotometer, (AAS, Perkin-Elmer, Model 2380). pH meter was used for the analysis of pH.

Results and Discussion

Tables 1 to 3 showed the characteristics of soil samples of Oke Afa dumpsite taken at the surface, at a depth of 0.5m and 1.0m respectively while Tables 4 to 6 presented the characteristics of soil samples of Soluos dumpsite collected at the surface, at a depth of 0.5m and 1.0m respectively. Table 7 shows the values of maximum allowable limits for heavy metals in soil used in different countries.

Table 1 Characteristics of OkeAfa soil sample at the surface

Parameters(mg/kg)	SIA	S2A	S3A	S4A	S5A
pH	5.81	5.70	5.69	5.67	5.65
Pb	0.025	0.029	0.021	0.019	0.028
Cd	ND	ND	ND	ND	ND
Ca	11.53	11.69	12.18	11.59	11.61
Cu	2.70	2.816	2.981	3.001	2.860
Ni	4.65	4.78	5.611	4.99	5.086
Cr	0.275	0.269	0.279	0.271	0.276
Mg	13.05	13.025	12.525	12.75	13.525
Fe	39.65	37.475	37.525	37.775	37.80

Table 2 Characteristics of OkeAfa soil sample at the depth of 0.5m

Parameters(mg/kg)	S1B	S2B	S3B	S4B	S5B
pH	6.81	6.42	6.39	6.24	6.20
Pb	0.05	0.056	0.049	0.05	0.048
Cd	ND	ND	ND	ND	ND
Ca	8.73	9.14	8.96	9.41	8.98
Cu	2.225	2.318	2.162	2.226	2.249
Ni	5.67	6.025	5.986	6.149	5.881
Cr	0.4	0.398	0.401	0.4	0.397
Mg	14.70	14.40	14.975	14.675	14.70
Fe	40.025	40.00	39.975	40.00	40.075

Table 3 Characteristics of OkeAfa soil sample at the depth 1.0m

Parameters(mg/kg)	SIC	S2C	S3C	S4C	S5C
pH	4.99	4.98	4.92	4.74	4.70
Pb	0.0026	0.026	0.024	0.022	0.021
Cd	ND	ND	ND	ND	ND
Ca	13.56	13.98	12.91	13.61	14.08
Cu	2.40	2.641	2.582	2.461	2.381
Ni	8.625	8.561	8.636	8.499	8.341
Cr	0.25	0.266	0.268	0.251	0.268
Mg	12.775	13.575	14.225	14.450	14.675
Fe	38.075	38.00	38.016	39.001	38.081

Table 4 Characteristics of Soluos soil sample at the surface

Parameters(mg/kg)	S6A	S7A	S8A	S9A	S10A
pH	7.06	7.21	6.83	7.40	6.87
Pb	9.60	16.27	8.99	6.71	5.20
Cd	ND	ND	ND	ND	ND
Ca	1457.84	1386.31	1879.82	371.19	1803.55
Cu	21.90	28.73	14.00	10.42	15.40
Ni	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND
Mg	442.82	240.62	548.15	360.81	438.26
Fe	1227.17	4646.32	1551.75	1249.82	5049.70

Table 5 Characteristics of Soluos soil sample at the depth of 0.5m

Parameters(mg/kg)	S6B	S7B	S8B	S9B	S10B
pH	7.19	7.07	7.01	7.70	6.50
Pb	9.23	14.10	8.13	5.20	8.12
Cd	0.091	0.15	0.009	0.143	0.048
Ca	1350	1212	1789.11	492.48	15.03
Cu	20.21	22.43	12.22	10.12	15.20
Ni	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND
Mg	431.22	210	482.21	400.74	513.22
Fe	1080.11	4456	1327.27	1108.19	4,897.78

Table 6 Characteristics of Soluos soil sample at the depth of 1.0m

Parameters(mg/kg)	S6C	S7C	S8C	S9C	S10C
pH	6.89	6.42	7.01	7.56	6.21
Pb	8.23	13.56	7.99	4.56	7.54
Cd	0.093	0.13	0.001	0.13	0.057
Ca	1181.21	1121.31	1578.40	390.52	1401.22
Cu	20.00	19.34	10.72	9.76	13.40
Ni	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND
Mg	400.11	208.22	452.11	358.11	412.88
Fe	980.99	3451	1281.56	908.11	3598.22

Table 7 Values of Maximum Allowable limits (M.A.L) for heavy metals in soil (mg/kg) used in different Countries

Chemical elements	Austria	Canada	Poland	Japan	Britain	Germany
Cd	5	8	3	-	3	2
Co	50	25	50	50	-	-
Cr	100	75	100	-	50	200
Cu	100	100	100	125	100	50
Ni	100	100	100	100	50	100
Pb	100	200	100	400	100	500
Zn	300	400	300	250	300	300

Source: Lacatusu, 2000 [12]

The pH of surface soil samples from Oke Afa dumpsite ranged from 5.65 to 5.81 as shown in Table 1, which indicated the surface soil of Oke Afa closed dumpsite is acidic in nature. This is in contrary with the finding from Soluos dumpsite where the surface soil sample varied from 6.83 to 7.4 as shown in Table 4, revealing that the surface soil of Soluos dumpsite is neutral. This shows the surface soil of dumpsites varies in pH. At the surface soil of both Soluos and Oke Afa dumpsites, cadmium was not detected. However, at the surface soil of Soluos dumpsite, nickel and chromium were not detected but they were detected at the surface soil of Oke Afa dumpsite ranging between 4.65 and 5.611 mg/kg and between 0.269 and 0.279mg/kg respectively. This indicates the likelihood of not dumping nickel and chromium based compound in Soluos dumpsite.

The concentrations of magnesium and iron were very low at the surface soil of Oke Afa dumpsite when compare with the concentrations of surface soil of Soluos dumpsite. In Oke Afa dumpsite, the concentrations of magnesium and iron in the surface soil varied between 12.525 and 13.525 mg/kg and between 39.6 5mg/kg and 37.80mg/kg respectively. In Soluos dumpsite, the concentrations of magnesium and iron in the surface soil ranged between 240.62 and 442.82 mg/kg and between 1227.17 and 5,049 mg/kg respectively. This reveals the high level of dumping of magnesium and iron based compounds in Soluos dumpsite than Oke Afa dumpsite. Moreover, the concentrations of calcium in soil surface of Soluos dumpsite.

At the depth of 0.5m, the pH of soil in Oke Afa dumpsite ranged between 6.20 and 6.81 while the pH of soil in Soluos dumpsite varied between 6.50 and 7.70. At this depth, nickel and chromium were not detected in Soluos dumpsite but present in OkeAfa dumpsite. The concentrations of nickel and chromium Oke Afa dumpsite varied between 5.67 and 5.149 mg/kg and between 0.397 and 0.401 mg/kg respectively at the depth of 0.5m. The absence of nickel and chromium at this depth in Soluos dumpsite is expected since they were not detected at the surface. The concentrations of magnesium and iron in Soluos dumpsite ranged between 210 and 513.22 mg/kg and between 1080.11 and 4,897 mg/kg respectively at the depth of 0.5m while the concentrations varied between 14.40 and 14.975 mg/kg and between 39.975 and 40.075 mg/kg respectively at the depth of 0.5m in Oke Afa dumpsite. This behavior is also expected as this was the trend at the surface.

The concentrations of lead at the depth of 0.5m in Oke Afa dumpsite were less than 0.06 mg/kg while the concentrations ranged between 5.20 and 14.10 mg/kg in Soluos dumpsite at the depth of 0.5m. This is also the trend the surface soil in the two dumpsites which shows that more of lead based compounds are being dumped in Soluos dumpsite. The concentrations of calcium in Soluos dumpsite ranged between 15.03 and 1 789.11 mg/kg at the depth of 0.5m while it varied between 8.73 and 9.41 mg/kg in Oke Afa dumpsite at the depth of 0.5m. In the case of copper, the pattern at the surface soil was also the pattern at the depth of 0.5m in both dumpsites.

At the depth of 1.0 m, the pH in soil of Oke Afa dumpsite varied between 4.70 and 4.99 while it ranged between 6.21 and 7.56 in Soluos dumpsite. At this depth, the Oke Afa dumpsite is acidic while that of

Ssoluos dumpsite can be taken to be neutral. Nickel and chromium were not detected in Soluos dumpsite at this depth but were detected in Oke Afa dumpsite which is also the situation at the surface and at the depth of 0.5 m. This reveals that whatever is not detected at the surface is not likely to be detected beneath the surface. The concentrations of magnesium and iron at the depth of 1.0m in Soluos dumpsite were very high when compare to the concentrations in Oke Afa at the same depth. This is in line with the trend at the surface and the depth of 0.5m.

In Tables 1 to 3, there is no definite pattern for the parameters analyzed for the soil samples as we move from the surface downward. It is expected that the concentrations of metals will decrease as we move down the soil profile if sorption, natural attenuation, dilution and chemical transformation occur (Yadau and Jauswal, 2011; Xiaoli et al., 2007; Okoronkwo et al., 2006; Marijan et al., 1998; Esakku et al., 1998; aluko et al., 2003; Adjia et al., 2008 and Mohammed and Elsayed, 2007). The soil of Oke Afa dumpsite has no regular trend. This means sorption, natural attenuation, dilution or chemical transformations may not have occured in Oke Afa dumpsite. In the case of Soluos dumpsite, the concentrations of parameters analyzed decreases as we move from the surface down ward. This is an indication that sorption, natural attenuation, dilution or chemical transformation would have taken place in Soluos dumpsite soil.

For the purpose of comparison with standard, the standard for soil is very scarce in the country hence the standard used in this work is the standard of European soil Bureau, 2000 in the work of Lacatusu, 2000 which shows the maximum allowable limits for heavy metals in soil used in different countries. Comparing Tables 1 to 6 with Table 7, for the available elements in Table 7, it pointed out that Oke Afa and Soluos dumpsites soil parameters investigated have not exceeded the values of maximum allowable limits for heavy metals in soil as at the time this work was carried out. The concentrations of parameters analyzed were higher in Soluos dumpsite than Oke Afa dumpsite. Though Oke Afa dumpsite is closed, Soluos dumpsite is still active, hence the tendency of having higher concentrations of parameters considered in future is very high.

Conclusion

The concentrations of the parameters analyzed were higher in Soluos dumpsite soil than the Oke Afa dumpsite soil except where the analyzed parameters were not detected. The soil profile of Soluos dumpsite has a definite pattern of decrease in concentrations of the analyzed parameters as the depth increases downward. The soil profile of Oke Afa dumpsite has irregular pattern. The concentrations of the analyzed parameters have no definite trend as the depth increases downward. The soil sample of both the Soluos and Oke Afa dumpsites investigated do not exceed the values of maximum allowable limits for heavy metals in soil used in different countries. The level of contamination seemed to be low in both dumpsites but it is likely the future concentrations of the analyzed parameters will be higher than the present concentrations in Soluos dumpsite soil since Soluos dumpsite is still very active.

References

Adelekan, B.A. & Alawode, A.O. (2011). Contributions of municipal refuse dumps to heavy metals concentrations in soil profile and groundwater in Ibadan, Nigeria. Journal of Applied Biosciences, 40: 2727 – 2737.

Adjia, R. Fezeu, M.W.L., Tehatchueng, J. B. Sorho, S., Echevarria, G. & Ngassoum, M. B. (2008). Long term effect of municipal solid waste amendment on soil heavy metal content of sites used for periurban agriculture in Ngaoundere, Cameroon. African Journal of Environment Science and Technology, 2 (12), 412- 421.

Aluko, O. O., Sridhar, M.K.C. & Oluwande, P. A. (2003). Characterization of leachates from a municipal solid waste landfill site in Ibadan, Nigeria. Journal of Environmental Health Resources, 2 (1), 32-37.

Bretzel, F. C. & Calderisi, M. (2011). Contribution of a municipal solid waste incinerator to the trace metals in the surrounding. Environmental Monitoring Assessment, 182, 523-533.

Esakku, S., Palanivelu, K. & Kurian, J. (2003). Assessment of heavy metals in a municipal solid waste dumpsite. Workshop on Sustainable Landfill Management, Chennal, India, 139-145.

Hong, K. J., Tokunaga, S. & Kajiuchi, T. (2002|). Evaluation of remediation process with plant-derived biosurfactant for recovery of heavy metals from contaminated soil. Chemosphere 49, 379-387.

Iweagbue, C. M. A., Nwajei, G. E. Ogala, J. E. & Overah, C. L. (2010). Determination of trace metal concentrations in soil profiles of municipal waste dumps in Nigeria. Environmental Geochemistry Health, 32, 415-430.

Lacatusu, R., (2000). Appraising Levels of Soil Contamination and Pollution with Heavy Metals, European Soil Bureau, 93- 402.

Lawal, I. B., Stephen, S. H., Gani, A. D. & Muhammad, T. (2012). Study of vertical migration of heavy metal in dumpsite soil. ARPN Journal of Science and Technology, 2 (2), 49-54.

Long, E. O. & Balogun, MR (2010). Groundwater quality assessment near a municipal landfill, Lagos. Nigeria. Research Journal of Applied Science, Engineering and Technology. 2(1), 39 – 44.

Marijan, A. Nevenka, M., Bozena, C., Esad, P. & Vesna, S. (1998). The impact of contamination from a municipal solid waste land fills on underlying soil. Water Science Technology, 37 (8), 203-210.

Mohammed R. & Elsayed, A. S. (2007). Dispension and deposition of heavy metals around two municipal solid waste dumpsite, Journal of Agriculture and Environmental Science, 2 (3), 204-212.

Odukoya, A. M. ,Abimbola, A. F. & Lawal, O (2011). Potential soil contamination with toxic metals in the vicinity of active and abandoned dumpsites. Agriculture and Biology Journal of North America, 2(5), 785 – 790.

Okoronkwo, N. E., Odemelam, S. A. & Ano, O. A. (2006). Levels of toxic elements in soil of abandoned waste dumpsite. African Journal of Biotechnology. 5 (13), 1241-1244.

Rizo, O. D., Merlo, M. H., Castillo, F. E. & Lopez, J. A. O. (2012). Assessment of metal pollution in soils of waste open dump. Bull Environmental Contamination Toxicology, 88, 182-186.

Salami, L. & Susu, A. A. (2013). Leachate characterization and assessment of groundwater quality: A case of soluos dumpsite in Lagos State, Nigeria. Greener Journal of Science, Engineering and Technology Research, 3 (2), 042-061.

Waheed, S., Siddique, N., Hamid, Q. & Chaudhry, M. M. (2010). Assessing soil pollution from a municipal waste dumpsite in Islamabad, Pakistan. Journal of Radional Nuclear Chemistry, 285. 723-732.

Xiaoli, C., Shimaoka, T., Xianyan, C., Qiang, G. & Youcai, Z. (2007). Characteristics and mobility of heavy metals in an MSW Landfill: Implications in risk assessment and reclamation. Journal of Hazardous materials, 144 (2), 485-491.

Yadau, R. R. & Jauswal, D. K. (2011). Two dimensional analytical solutions for point source contaminants transport in semi-infinite homogenerousponus medium. Journal of Engineering Science and Technology, 6 (4), 459-468.

Yarlagadda, P. S., Matsumoto, M.R., VanBenschoten, J. E. & Kathuria, A. (1995). Characteristics of heavy metals in contaminated soils. Journal of Environmental Engineering, 121(4), 276-286.