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Evaluation of Pollution Profile and Physico-Chemical Parameters of Open Refuse Dumps in Sokoto, Nigeria

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Abstract

The increase in solid waste generationin Nigeria, especially in urban cities, has become a major environmental problem resulting from high population growth rate and poor management of the solid wastes. The absence of specialized (sanitary and engineered) landfills has led to the emergence of several open waste refuse dumps in towns and cities which, potentially, constitutes a major threat to surface and groundwater systems. This study analyzed the pollution profile and the potential of some selected refuse dumps in the city of Sokoto for groundwater contamination. The parameters analyzed include cation exchange capacity, exchangeable cations (Ca^{2+}, Mg^{2+},Na^{+} and K^{+}) and some selected heavy metals (Fe, Zn, Cd, Pb and Mn). The results indicated poor nutrient retention and attenuation capacity of the soil, thereby confirming the potential of groundwater contamination from the leachates produced in the refused dumps.

Keywords: Pollution; landfill; heavy metals; solid waste; parameters.

1.0 INTRODUCTION

The term landfill as described by Adamu (2013) is a unit operation for final disposal of municipal solid waste which is built to receive waste material only. In Nigeria, it is a small or large (depending on location) piece of land or an excavated site that is specifically designed and built to receive wastes (Ajala*et al.*, 2005).

The types of wastes deposited in the landfill and refuse dumps are usually categorised as household, industrial, commercial and medical which include electronics, paper, food waste, plastic containers and packaging, yard trimmings and other wastes from residential, commercial, and industrial sources (Adelana*et al.*, 2005). Specific landfills are also designed to accommodate hazardous waste.

In Nigeria, urbanization which was occasioned, according to Eni *et al* (2011),by high population concentration and increasing industrial and agricultural activities, results in significant increase in waste generation and its indiscriminate disposal in landfills or refuse dumps without being classified or characterised. This practice, however, has been established by several researchers to pose serious and significant threats to the environment (Adelana *et al.*, 2005; Adelana *et al*, 2008; Eni *et al*, 2011).

Although landfills are of great environmental importance especially in developing countries, high levels of air, water and soil contamination in a few well-publicised cases have led to an increasing number of epidemiological studies being carried out on the health risks they posed (Bayode*et al*., 2012). However, the majority of these studies focus on illegal dumps and hazardous waste sites, with very few investigations on municipal waste landfills.

Wide range of chemicals resulting from the waste degradation in the form of leachate, gas and particulate matter (PM) are released from landfills. Leachate from a landfill varies widely in composition depending on the age of the landfill and the type of waste it contains. It can usually contain both dissolved and suspended material. The generation of leachate is caused principally by precipitation and percolating through waste deposited in a landfill (Christensen *et al*., 2001). It is produced during the decomposition of carbonaceous material producing a wide range of compounds including methane, carbon dioxide and a complex mixture of xenobiotic organic compounds, inorganic macro components, dissolved organic matter and heavy metals (Bayode*et al*., 2012).

Due to variation across landscapes, each landfill, therefore, contains unique trace element concentrations based on its parent material and other soil-forming factors that may have added or removed these elements from the soil (Ede*et al*., 2011). High background concentrations of trace elements, whether natural or anthropogenic, could result in mobilization and release into surface and subsurface waters and subsequent incorporation into the food chain (Eni*et al*., 2011). Soil factors such as organic matter, type and amount of clay, pH and cation exchange capacity (CEC) may influence the quantity of trace elements available for mobilization and release or sorption in a soil (Balraz*et al*, 2003). Considering the leachate itself, landfills established prior to leachate management techniques are likely to release indeterminate volumes of leachates and can be considered to constitute a public health hazard, as migration of pollution episodes could potentially compromise groundwater and surface water sources (Zairi*et al*., 2004; Al-Mutairi*et al* 2009).

This research studied the pollution profile and the physico-chemical parameters of an open refuse dump in Dundaye area in Sokoto metropolis and established its potential as a source of hazardous pollutants and contaminants and their effect on groundwater quality.

2.0 MATERIALS AND METHODS

The evaluation of physico-chemical properties followed standard analytical procedures. Heavy metals were analysed through atomic absorption spectroscopy using Perkin Elmer model 306 Atomic Absorption Spectrophotometer. All reagents used in this research work were of analytical grade.

2.1 Sample Collection and Pre-treatment

The samples were collected monthly for a period of three months (between July and September) using spot sampling method and were labelled A, B and C for the different refuse dumps and 1, 2 and 3 for the first, second and third months respectively. The samples were collected from three spots, homogenized and transported to the laboratory.They were also air dried for three (3) days and sieved with a 2 mm mesh to remove big particles before analysis.

2.2 Physico-chemical Analyses

pH was measured using a standardized pH meter (Jenway Model 3015) while electrical conductivity was analysed using conductivity meter.Ca^{2+} and Mg^{2+} were determined by titrating 1g of the sample (to which 1 ml of 10% NaOH and distilled water were added) against 0.01M EDTA while Na^{+} and K^{+} were determined using flame emission spectrophotometry (FES) as recommended by Radojevich and Bashkin (2006).

Exchangeable bases were determined using Walkley-Black digestion method before being titrated against

Heavy metals concentrations were determined using atomic absorption spectroscopy after 1 g of the sample was digested with 10 ml of concentrated HNO_3 and 2mL of perchloric acid, boiled and filtered before the analysis.

3.0 RESULTS AND DISCUSSION

The results of the physico-chemical analyses as presented in Table 1 showed that overall; the pH within the refuse dumps were in the acidic range. The findings did not agree with the results of Longe and Balogun (2009) who reported a predominantly alkaline pH in a similar study. This could be attributed to the nature of waste deposited in the landfills, age of the landfills and the climatic conditions of the study area. Inorganic ions (presented in mg/kg in the table) Ca^{2+} (ranged from0.70±0.00 – 0.85±0.00 mg/kg) Mg^{2+}(0.35±0.00 – 0.45±0.00 mg/kg), K^{+} (0.82±0.00 – 1.15±0.00 mg/kg) and Na^{+} (0.43±0.00 mg/kg – 0.57±0.00mg/kg) in all the samples were found to be low in concentrations and this may be responsible for the low pH recorded as reported byLaner*et al*., (2012).

Table 1: Results of the physico-chemical parameters investigated (mg/Kg).

Sample	pH	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	C.E.C (cmol/kg)
A_1	4.98±0.12	0.70±0.00	0.45±0.00	0.90±0.00	0.43±0.00	5.72±0.13
A_2	4.90±0.02	0.80±0.00	0.45±0.00	0.82±0.00	0.52±0.00	5.82±0.13
A_3	5.17±0.12	0.70±0.00	0.50±0.00	0.92±0.00	0.52±0.00	5.86±0.13
B_1	4.93±0.02	0.85±0.00	0.40±0.00	1.08±0.00	0.52±0.00	5.94±0.13
B_2	4.97±0.03	0.75±0.00	0.35±0.00	1.00±0.00	0.48±0.00	5.78±0.13
B_3	6.48±0.22	0.80±0.00	0.40±0.00	1.15±0.00	0.57±0.00	5.84±0.13
C_1	5.81±0.12	0.70±0.00	0.45±0.00	0.85±0.00	0.43±0.00	5.74±0.13
C_2	5.50±0.12	0.80±0.00	0.45±0.00	0.90±0.00	0.43±0.00	5.76±0.13
C_3	5.42±0.12	0.80±0.00	0.40±0.00	0.82±0.00	0.52±0.00	5.74±0.13

*Results are means ± standard deviation of three replicate analyses.

Although electrical conductivity was not measured in this study, literature showed that low concentrations of the inorganic ions may result in poor electrical conductivity in the refuse dumps analysed (Kewu and Wengi., 2008; Goorah*et al*., 2009; Longe and Balogun, 2009).

The cation exchange capacity (which ranged from 5.72±0.13 - 5.94±0.13 cmol/kg) showed poor ability for capacity for the attenuation of the parameters analysed and poor ability to hold unto essential soil nutrients. This was confirmed by the fluctuating nature of most of the results obtained with depth. It also agreed with the findings of Regadio*et al* (2012),which indicated that higher CEC values indicated higher capacity of the soil to protect groundwater from cation contamination.

Heavy metals analysed (presented in table 2) showed significant concentrations. High concentrations of metals according to Longeand Enekwechi (2007) are associated with young landfills due to high degree of metal solubilisation (during acidification stage) as shown by the pH recorded. Iron (detected only in B_2 and C_1) ranged from 4.013±0.1306 to 5.216±0.175 ppm which was higher than the levels recommended by CLEA (2009) for contaminatedland.

Table 2: Concentrations of the heavy metals analysed (ppm).

Sample	Mn	Zn	Fe	Pb	Cd
A_1	1.878±0.1113	ND	ND	ND	ND
A_2	0.515±0.0350	0.065±0.0214	ND	ND	ND
A_3	ND	ND	ND	5.182±0.1145	ND
B_1	ND	1.357±0.193	ND	0.773±0.042	0.152±0.032
B_2	0.635±0.042	ND	4.013±0.1306	2.912±0.0770	ND
B_3	0.162±0.015	0.125±0.029	ND	6.673±0.139	ND
C_1	1.122±0.069	ND	5.216±0.175	ND	ND
C_2	0.488±0.034	0.409±0.067	ND	ND	ND
C_3	0.057±0.009	0.980±0.009	ND	13.074±0.23	ND

*Results are means ± standard deviation of three replicate analyses *ND = Beyond detection limit.

Manganese (the highest value obtained in A_1 and the lowest in B_3) is higher than the levels recommended in the EU directive 86/278/EEC (EU, 2009) for landfills under acidic conditions. Cadmium was detected in only B1 and is below the recommended limit for agricultural land and lands used for sewage and sludge disposal (CLEA, 2009). Zinc, where detected, was found to be lower than the approved limit for contaminated soils at pH between 5.50 and 7.00 as reported in CLEA (2009). This result is also in line with the findings of Mor*et al* (2009). Lead also ranged from 0.773±0.042 to 13.074±0.23ppm and was found to be lower than recommended limit for soils used for agricultural and refuse and sewage disposal applications (Musa *et al*., 2004; CLEA, 2009).

4.0 CONCLUSION

The results obtained from the study indicated the presence of all the parameters analysed. The results showed that the parameters fluctuate with increasing depth and that the soils have poor ability for the attenuation of exchangeable cations which highlights the vulnerability of the groundwater within the areas for contamination from the leachate produced in the refuse dumps. It is, therefore, expected that robust policies that could ensure creation of specialised centres for proper refuse disposal are formulated and implemented.

5.0 REFERENCES

Adamu, G.K., R. Tukur, and A.I. Kankara, (2013). Groundwater Assessment in the basement complex of Kano State, Nigeria., American *Journal of EngineeringResearch*, Vol.2, Issue 7, PP. 171-175.

Adelana, S.M.A, Bale, R.B., Olakehinde, P.I and M.Wu.(2005). The impact of anthropogenic activities over groundwater quality of coastal Aquifer in Southern Nigeria. Proceeding in Aquifer vulnerability, and Risks.2nd international workshop and 4th congress on the protection and management of Groundwater.RaggiadiColornoparma.

Adelana, S.M.A., T.A.Abiye., B.C.W., Nkhuwa., C. Tindunugaya, and M.S., Oga(2008). Urban groundwater. Management and Protection in Sub-Saharan Africa:

Adeyemi, G.O. and O.O. Temowo.(2010). Hydrogeological Investigation of waste dump Environmental near Ibadan, Southwestern Nigeria. Proceedings, Annual Conference of Nigerian Association of Hydrogeologists on water Resources Development and Climate Change 12.

Ajala, O. (2005). Environmental impact of Urbanization, nature and the Nigeria: Fadare*et al* (eds) Globalization, Cultural and Nigerian Built Environmental, Faculty of Environmental Design and Management, OAU, PP. 192-199.

Balraz, M., Kaplan, P.O., Ranjithan, S.R., Rynk, R., (2003).Life cycle-assessment evaluating environmental impacts of solid waste management alternatives. Biocycle 44, 52-56

Bayode, S., M.O Lurunfemi., and J.S. Ojo.(2012). Assessment of impact of some waste dumpsite on groundwater quality in some part of Akure metropolis southwestern Nigeria. Pacific *Journal of Technology*, Vol. 13, NO.2, pp.528-536.

Christensen, T.H., Kjedsen, P., Bjera, P.L., Jensen, D.L., Christensen, J.B., Baun, A., Albrectsen, H.J., Heron, G. (2001). Biogeochemistry of landfill leachate plumes. Applied Geochemistry 16,659-718.

Edet, A.E., T.N. Nganje., A.J. Ukpong., and A.S. Ekwere.(2011). Groundwater Chemistry and quality of Nigeria: A status review. African *Journal of Environmental Scienceand Technology*, Vol.5 (13), PP. 1152-1169.

Eni, D.V., J. Obiefuna., C. Oko., and I. Ekwok.(2011). Impact of Urbanization on Sub-Surface Western quality in Calabar municipality, Nigeria. *International Journal of Humanities and Social Sciences,*Vol.I, Issue 10, PP.167-172.

Goorah, S., Esmyot, M., Boojhawon, R., (2009). The health impact of non hazardous solid waste disposal in a community: The case of the more chicose landfill in Mauritius. *Journal of Environment Health* 72, 48-54.

Kewu, PI.,Wenqi, Gong. (2008) biodegradability enhancement of municipal landfill leachate.

Longe, E.O and Balogun, M.R. (2010) Groundwater quality assessment nears a municipal landfill, Lagos, Nigeria. Research *Journal of Applied Sciences, Engineering and Technology*. (2) 1:39-44.

Longe, E.O. and Enekwechi, L.O. (2007) Investigation on potential groundwater impacts and influence of Local Hydrogeology on Natural attention of Leachate at a municipal landfill. *International Journal of Science and Technology*. (4) 1:1330140.

Longe, E.O., Kehinde, M.O. (2005). Investigation of potential groundwater impacts at an unlined waste disposal site in Agege, Logos, Nigeria. Proc. 3rd. Faculty of Engineering International Conference, University of Lagos, 21-29.

Radojuvic, M and Bashkin, V (2006).Practical Environmental Analysis (2ndEdition).Mor, S., Ravindra, K., Dahiya, R.P., Chandra, A., (2006). Leachate characterization and assessment of groundwater pollution near municipal solid waste landfill site. Environ. Monit.Assess., 4:325 – 334.

Musa, H.I. Yakasai I.A,, and Musa H.H.(2004). Determination of lead concentration in well and boreholes in Zaria, Nigeria.*Chemical Class Journal*, Vol.PP.14-18.