

Full Length Research Paper

Assessment of impact of leachate on soil physicochemical parameters in the vicinity of Elioazu dumpsite, Port Harcourt, Nigeria

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ABSTRACT

Abstract: The soil samples were collected 10m away from the edge of Elioazu dumpsite at four different locations labelled PH/01, PH/02, PH/03 and PH/04 at depths interval of 0.50m, 1m, 1.5m, and 2m respectively. Sample were collected with a stainless steel hand auger and analysed to determine the effect of Leachate on soil physicochemical parameters. Parameters analysed for were: PH, Total Organic carbon, (TOC), nitrate, phosphate and sulphate and heavy metals such as chromium, cadmium, copper, lead, nickel, zinc and iron were analysed using Atomic Absorption Spectrophotometer (AAS). While mean value, standard deviation were analyzed using E- view software 8.0. The results of the analysis showed that some of the parameters exceeded the maximum permissible limits of WHO permissible limit. The parameters that exceeded permissible limits were nickel, chromium, copper, cadmium and Lead. Parameters such PH, nitrate and zinc were below WHO permissible limit. For those parameters that above WHO permissible poses threat to groundwater, biological food chain and the environment. Consequently, some of the parameters that did not exceed permissible limits might become hazardous to the environment in the future if the landfill is not properly engineered to handle leachate leakages to the subsoil.

Keywords: Contamination, Soil, Leachate, Elioazu and Anthropogenic Activities

BACKGROUND INFORMATION

Leachate from dumpsites are one of the main types of wastewater that has the ability to contaminate the natural soil and groundwater if allowed to percolate through the subsoil without appropriate engineered facilities to mitigate its effect on the subsoil. Leachate is a hazardous liquid that originates from solid waste when it comes in contact with water. Dumpsite leachate is a major source

of soil contamination which is caused by the presence of anthropogenic chemicals or other alteration in the natural soil environment. Okafor and Onwuka (2013) asserted that the concern over soil contamination stems primarily from health risks, from direct contact with the contaminated soil, vapours from the contaminants, and from secondary contamination of water supplies within

and underlying the soil. Potentially greater risks are posed by the infiltration of hazardous chemicals present in the soil into groundwater aquifers used for human consumption. Agriculture in these areas faces major problems due to fact these heavy metal are transfer into crops and subsequently into the food chain (Wikipedia, 2009). Chronic exposure to chromium, lead and other metals, petroleum, solvents, and many pesticide and herbicide formulations can be carcinogenic, can cause congenital disorders, or can cause other chronic health conditions. Industrial or man-made concentrations of naturally-occurring substances, such as nitrate and ammonia associated with livestock manure from agricultural operations, have also been identified as health hazards in soil and groundwater (U.S.EPA, 2002).

Solid wastes placed in dumpsite are gradually decomposed, and liquids such as water, which infiltrates and percolates through the waste layer in a dumpsite, can remove soluble compounds encountered in the refuse or compounds formed by chemical and biological processes (Jeong-Hoon *et al.*, 2001; Tatsi *et al.*, 2002). Leachate formation results from the removal of these soluble compounds by the percolation of liquids through the refuse mass (El-Fadel *et al.*, 1997). Generation of leachate from landfill is a complex combination of physical, chemical and biological processes whereby waste age has effect on performance of landfill that generate leachate. Leachate discharge often leads to serious environmental problems such as percolation through subsoil causing pollution of ground water and surface water resources through run off. The risk of ground water pollution is probably the most severe environmental impact from dumpsite because historically most dumpsites are without engineered liners and leachate collection and treatment systems (Christenen, and Kjeldsen, 1995). Also, soil and groundwater acidification and nitrification have been linked to waste dumps (Bacud *et al.*, 1994).

INTRODUCTION

POLLUTANTS IN LEACHATE

The major environmental problems experienced at dumpsites have resulted from the loss of leachate from the site and although environmental regulations require that the level of leachate generated in dumpsite be controlled, in many cases the proper treatment (biological and physical /chemical treatment) and disposal of leachate does not occur (Robinson, 2005; Panthee, 2008). In an environment with undesirable and hazardous substances, leachates emerging from it will be pose risk to the surrounding organisms. The most critical pollutants present in dumpsite leachate can be divided into four groups (Baun *et al.*, 2004). Leachate may contain organic

and inorganic compounds, xenobiotic organic compounds (XOCs) and/or heavy metals, and are generally classified according to the hazardous substances present (Slacka *et al.*, 2005; Christensen *et al.*, 2001). These pollutants can be hazardous to the health of living organisms and the environment in general, for example hazardous XOCs and heavy metals, besides being bio accumulative and persistent, can be toxic, corrosive, flammable, reactive, carcinogenic, teratogenic, mutagenic and ecotoxic (Slacka *et al.*, 2005; Christensen *et al.*, 2001). As such, heavy metals are one of the typical components and of the essential parameters for the characterization of leachate. Gupta (2009) asserts that they may constitute an environmental problem if the leachate migrates into surface water or groundwater. Thus during recent decades, monitoring of heavy metals in dumpsite leachate has commonly been prescribed by the authorities and routinely performed by dumpsite operators (Kjeldsen *et al.*, 2002). This arises from the fact that metals are dissolved during landfill stabilization (Pinel-Raffaitin *et al.*, 2006; Cecen and Gursoy, 2000). Although the concentration of heavy metals changes from one landfill to another, in most dumpsite leachates the main heavy metals reported in the literature are Cd, Pb, Zn, Ni, Cr, and Cu (Cecen and Gursoy, 2000).

Several studies (Longe *et al.*, 2010; Esmail *et al.*, 2009; Longe and Enekeuchi, 2007) have shown that leachates outflow and percolation are source of groundwater and surface water pollution adjacent to landfill sites. Consequently, landfill constitutes potential health hazards and environment problem. In spite of these deleterious effects of landfills, they remained the cheapest and most widely accepted methods of depositing municipal solid waste (MSW) in most part of the world (El-Fadel *et al.*, 1997; Dsakalopoulos *et al.*, 1998; Jhamnani *et al.*, 2009). Okafor and Onwuka (2013) carried out a study on leachate pollution of soil and concluded that heavy metal concentration is higher than the recommended standards. Ohwoghere and Aweto (2013) studied leachate characterization and its effect on groundwater and surface water at a dumpsite and stated that groundwater beneath the landfill has the tendency of polluted over time unless the landfill is upgraded to a well engineered standard. Akinbile and Yusoff (2011) studied the impact of leachate on groundwater supplies in Akure, Nigeria. The study revealed that the concentration of waste materials in the landfill site had systematically polluted the soil and groundwater over time. They further stated that the effect of such pollution as determined from the study declined away from the polluting source. This implied that the contamination of the groundwater was more dependent on proximity to dump sites. Also, Oyeku and Eludoyin (2010) carried out a study on heavy contamination of groundwater resources and concluded that the groundwater in the study area were generally alkaline (8.3 ± 2.77) and contained Cu (0.02 ± 0.04 mg/l),

Fe (4.23 ± 6.4 mg/l), Pb (2.4 ± 3.3 mg/l) and Co (1.03 ± 1.1 mg/l) concentrations that are higher than the permissible limits recommended by the World Health Organization (0.5, 0.1, 0.01 and 0.0002 mg/l, respectively; $p > 0.05$).

Statement of the Problem

Ulakpa et al., (2016) stated there are various dumpsites exist in Nigeria which are without adequate soil protection measures of which the study area is not excluded. In many cases, this practice does result in the pollution of the soil and groundwater respectively. Elioizu dumpsite pose a potential risk to the environmental due to lack of leachate collection and treatment systems of which the ministry of environment has no baseline data on leachate characteristics. It is believed that leachate from these unengineered landfills can lead to contamination of nearby soils which can in turn leads to contamination of ground water and poisoning of the food chain (vegetables, fruits and tubers) around the sites.

Location and accessibility

The study area lies between latitude $4^{\circ}50'N$ - $4^{\circ}56'N$ and longitude $6^{\circ}58'E$ - $7^{\circ}02'E$. It located within the Port Harcourt municipal area of Rivers State. Elioizu dumpsite is situated along airport road in Obio/Akpor local government area, Port Harcourt, Rivers State Nigeria. The inhabitant of the area started dumping refuse at the dumpsite as far back 1991 and it occupies approximately four (4) hectares of land. Most of the wastes dispose at the dumpsite are solid wastes (domestic and non-hazardous industrial wastes). The dumpsite is bounded by block industries, a church, residential houses and farm lands.

METHODOLOGY

Sample collection and preparation

The soil samples were collected from a point 10m away from the edge of the dumpsite and labelled PH/01, PH/02, PH/03 and PH/04 for depths at 0.50m, 1m, 1.5m, and 2m respectively down hole. The sample collection was carried out with a stainless steel hand Auger. The coordinates and the surface elevations of the sampling point, taken with a Garmin etrex GPS was $4^{\circ}50'N$ - $4^{\circ}56'N$ and longitude $6^{\circ}58'E$ - $7^{\circ}02'E$ with elevation 23m. All the soil samples collected were sealed in a sterilized nylon and immediately stored in a cooler. They were taking to the laboratory for proper analysis to determine the pH, TOC, nitrates, phosphates and sulphates.

Presence of heavy metals such as chromium, cadmium, copper, lead, nickel, zinc and iron in the soil samples was analyzed using Atomic Absorption Spectrophotometer (AAS).

Statistical analyses

A relevant statistical package (E-views 8.0) was used to analyze the data to obtained mean and standard deviation.

Determination of pH in soil samples

20g of soil sample was weighed, mixing 50ml distilled water and was stirred for few minutes. It was allowed to stand for 15minutes, after which the pH meter was used to confirm the pH level.

Determination of phosphate in soil samples

25ml of the extracted solution was added to 1g of soil sample and shake for 30 minutes. The suspension was

filtered through with a filter paper; 10ml of the extract was transferred into 50ml volumetric flask and diluted with distilled water until the flask was about 25ml full. 2ml ammonium molybdate reagents, 2ml stannous chloride was added and mixed with distilled water to 50ml mark. It was allowed stand for 30 minutes. Absorbance was measured at 700nm using 10mm cell curvet of the spectrophotometer.

Calculation:

PO_4^{3-} (mg/kg)=

$\frac{\text{Reading from curvet} \times \text{solution vol. (ml)} \times 1000}{\text{Aliquot (ml)} \times \text{sample weight (g)}}$

Determination of Sulphate in soil samples

25ml of the extracted solution was added to 5g of the soil sample and shaken for 30minutes. The suspension was filtered through a filter paper. 5-10ml of the extract was transferred into 50ml volumetric flask, 5ml of 50% acetic and 1ml of H_3PO_4 was added and the solution was swirl to mix. About 12ml of the flask with distilled water was mixed again. 1g of $BaCl_2 \cdot 2H_2O$ crystals was added without distilled mixing and was allowed to stand for 10minutes. The flask was inverted ten times and made to stand for 1hour. The turbidity as absorbance at 425nm was measured.

Calculation:

$$\text{SO}_4^{2-} (\text{mg/kg}) = \frac{\text{Reading from curvet} \times \text{solution vol. (ml)} \times 1000}{\text{Aliquot (ml)} \times \text{sample weight (g)}}$$

Determination of Nitrate in soil samples

5g of the soil sample was weighed into a conical flask and 125ml of distilled water was added. The bottle was shaken for 10 minutes on a rotary shaker and residue was obtained from the filter paper after filtration. 1ml of water sample was transferred into 10ml volumetric flask, 0.5ml of the Brucine reagent was rapidly added with 2ml of conc. Sulphuric acid and mixed for about 30 seconds. The flask was made to stand in cold water for about 15 minutes and absorbance at 410nm was measured.

Calculation:

$$\text{NO}_3^- (\text{mg/kg}) = \frac{C \left(\frac{\text{mg}}{\text{kg}} \right) \times \text{Extractant Volume (ml)} \times 1000}{\text{Volume of Extract (ml)} \times \text{sample weight (g)}}$$

Determination of Total Organic Carbon in soil samples

Sample was evaporated to dryness to a constant weight, grinded to fine powder in a mortar and 0.2g was weighed into 500ml conical flask. 10ml of 0.5M $\text{K}_2\text{Cr}_2\text{O}_7$ was added to the flask and gently swirl, while 20ml conc. H_2SO_4 was added rapidly, but splashing and directing the acid into the suspension was avoided. It was immediately swirl gently until the reagents are mixed for 1 minute and the flask was allowed to stand for 30 minutes. 200ml of distilled water and 10ml concentrated H_3PO_4 was added cautiously to avoid splashing. It was allowed to cool and 3-4 drops of ferroin indicator solution were added. Titration was made to wine-red colour end point with 0.25 FAS.

Calculation:

$$\text{TOC (\%)} = \frac{V_b - V \times M \times 1.38}{\text{sample weight (g)}}$$

Where

V_b = FAS used for blank (ml)

V_s = FAS used for sample (ml)

M = molarity of FAS

Determination of heavy metals in soil samples

Acid digestion for soil

Samples are dried to a constant weight at 105°C using oven and grinded to fine powder. About 2g of the

samples were weighed into 250ml clean beaker using a weigh balance, 25ml conc. HNO_3 was added for pre-oxidation, it was set on a heating mantle, place in fume cupboard and heated for 30min. The beaker was set down and allowed to cool, 10ml conc. HNO_3 was added again and the beaker was replaced on the heating mantle and digests for more 1hr. The beaker was then allowed to cool and distilled water was added to the solution to 50ml volume capacity. The solution was filtered with a filter paper and analyzed using Atomic Absorption Spectrophotometer (AAS).

RESULTS

The results of the soil analysis is as shown in the table 1 below

DISCUSSION

pH

Soil pH is a measure of the soil solution's acidity and alkalinity. pH is one of the factors that influences the transportation of contaminants in an environment, increasing acidity (low pH) can cause some metals and other pollutants to dissolve in water thereby releasing toxic elements that may pollute groundwater. Conversely, decreasing acidity (high pH) can cause certain soil nutrients to become insoluble and thereby unavailable for plant growth. pH value of the soil samples ranged from 5.15-6.00 down-hole indicating acidic conditions. The values were 5.15, 5.22, 6.00 and 5.31 at 0.5m, 1m, 1.5m, and 2m respectively see (Figure 1 below) with a mean value of 5.42 as shown in Table 1. The value of pH did not exceed the WHO permissible limit. The highest concentration of pH was at a depth of 1.5m with concentration of 6.0 which signify that the soil is acidic. The pH concentrations of the study area are acidic in nature.

TOC (Total Organic Carbon)

There are three type of carbon form namely; elementary inorganic and organic carbon form. The primary sources for elemental carbon in soils and sediments are as incomplete combustion products of organic matter from geologic sources such as graphite and coal or dispersion of these carbon forms during mining, processing, or combustion of these materials. Inorganic carbon forms are present in soils and sediments typically as carbonates. The two most common carbonate minerals found in soils and sediments are calcite (CaCO_3) and dolomite [$\text{CaMg}(\text{CO}_3)_2$] although other forms may be

Table 1. Soil Analysis Results with corresponding depths

| PARAMETERS | DEPTH (m) | | | | MEAN | STANDARD DEVIATION | WHO |
|-------------------|-------------|-------------|-------------|-------------|--------|--------------------|-----------|
| | 0.5 (PH/01) | 1.0 (PH/02) | 1.5 (PH/03) | 2.0 (PH/04) | | | |
| pH | 5.15 | 5.22 | 6.00 | 5.30 | 5.42 | 0.393 | 6.5 – 8.5 |
| TOC (%) | 2.932 | 0.517 | 0.293 | 1.207 | 1.897 | 1.227 | - |
| Nitrate (mg/kg) | 0.127 | 0.137 | 0.108 | 0.1354 | 0.127 | 0.013 | 3 |
| Sulphate (mg/kg) | 97.50 | 57.20 | 37.70 | 29.90 | 55.57 | 30.216 | - |
| Phosphate (mg/kg) | 775.50 | 375.00 | 200.00 | 62.50 | 493.75 | 328.073 | - |
| Chromium (mg/kg) | 0.95 | 0.41 | 2.31 | 1.70 | 1.342 | 0.955 | 0.25 |
| Cadmium (mg/kg) | 0.17 | 0.20 | 0.11 | 0.11 | 0.147 | 0.045 | 0.085 |
| Copper (mg/kg) | <0.001 | 0.02 | 0.59 | 0.05 | 0.165 | 0.283 | 0.1 |
| Lead (mg/kg) | 0.64 | 0.02 | 0.88 | <0.001 | 0.385 | 0.443 | 0.42 |
| Nickel (mg/kg) | 0.78 | <0.001 | 0.07 | 0.44 | 0.322 | 0.360 | 0.075 |
| Zinc (mg/kg) | 1.00 | 0.20 | 0.71 | 0.66 | 0.642 | 0.331 | 7.5 |
| Iron (mg/kg) | 38.90 | 37.50 | 6.90 | 17.5 | 25.50 | 15.632 | N/A |

N/A – Not Available.

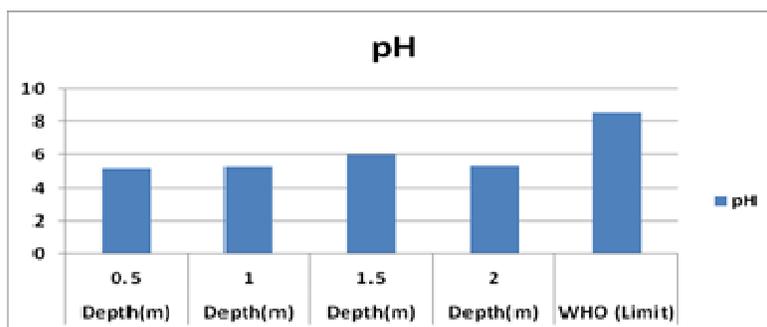


Figure 1. Distribution of pH in the Dumpsite Soil Profile against WHO Permissible Limit

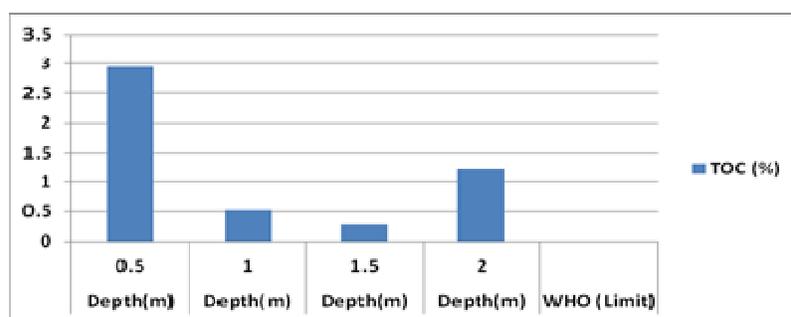


Figure 2. Distribution of TOC (%) in the Dumpsite Soil Profile against WHO Permissible Limit.

present (e.g., siderite, $FeCO_3$) depending on where the soils were formed or where the sediment source was located. While the organic carbon forms are naturally-occurring organic carbon sources that are derived as a result of contamination through anthropogenic activities. The spills or releases of contaminants into the environment increase the total carbon content present in

the soil or sediment. Our emphasis is on organic carbon because it is as a result of anthropogenic activities. The values of TOC ranges from 2.9325%, 0.5175%, 2.9325% and 1.2075% at depth of 0.5m, 1m, 1.5m, and 2m respectively as shown in Figure 2, with a mean of 1.897% as shown in Table 1.

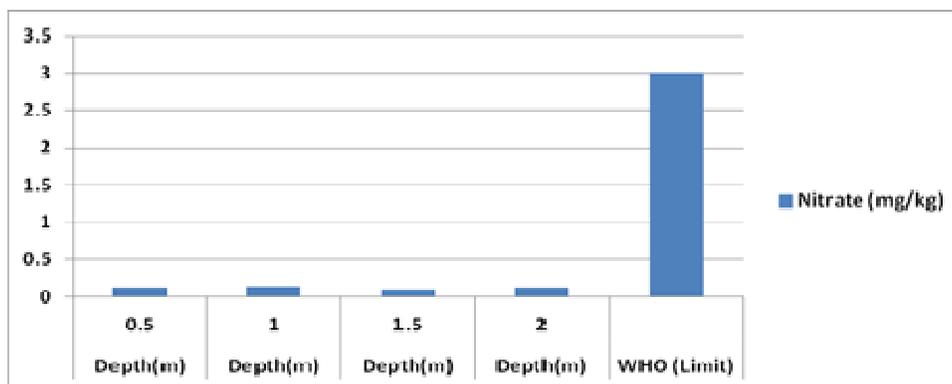


Figure 3. Distribution of Nitrate in the Dumpsite Soil Profile against WHO Permissible Limit.

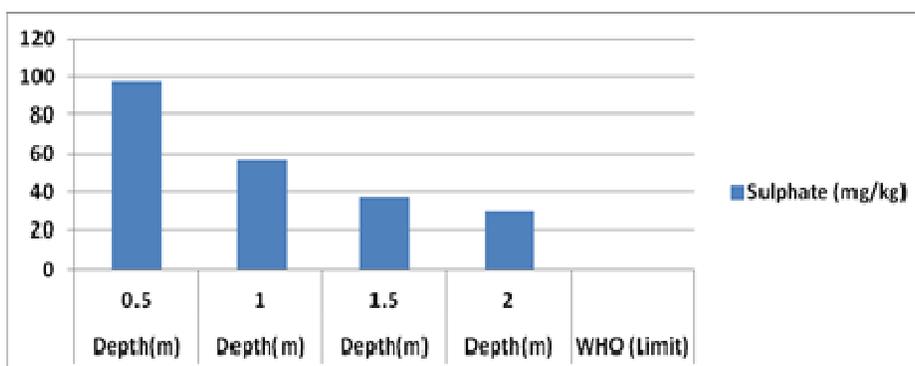


Figure 4. Distribution of Sulphate in the Dumpsite Soil Profile against WHO Permissible Limit.

Nitrate

Nitrate the major sources in water are through organic matter from man-made pollutants such as agricultural fertilizers (Ezeh *et al.*, 2016). The values ranges from 0.12744mg/kg, 0.1376mg/kg, 0.10832mg/kg and 0.13544mg/kg at the depth of 0.5m, 1m, 1.5m, and 2m respectively see (Figure 3), with a mean of 0.127mg/kg as shown in Table 1. The concentrations of nitrate were below WHO permissible limit. The common source of human exposure to nitrate is through vegetables and meat in the diet (Eyankware *et al.*, 2014).

Sulphate

The principle source of sulphate include rock weathering, input from volcanoes and input from biological or biochemical process (Ezeh *et al.*, 2016). Sulphate showed steady decrease in concentration with respect to depth increase. The values were 97.5mg/kg, 57.2mg/kg, 37.7mg/kg and 29.9mg/kg at depth of 0.5m, 1m, 1.5m, and 2m respectively see Figure 5 with the mean of 55.57mg/kg as shown in Table 1.

Phosphate

Phosphorus is an essential element classified as a macro nutrient because of the relatively large amount required by plants. It is also used for fertilizer production. Phosphate concentration in the soil samples shows a steady decrease then a rapid increase with respect to depth increase. The concentration of phosphate ranges from 775mg/kg, 375mg/kg, 200mg/kg and 625mg/kg at depth of 0.5m, 1m, 1.5m, and 2m respectively see Figure 5. With a mean of 493.75mg/kg see Table 1. The high value of phosphate in the soil samples are strong reflection of the impact of leachate on soil.

Chromium (Cr)

Chromium is not a common element and does not occur naturally in elemental form but mainly in compounds. It can be released to the environment via leakage and poor storage. The principal sources of chromium contaminated soil and groundwater are electroplating, textile manufacturing, leather tanning, pigment manufacturing,

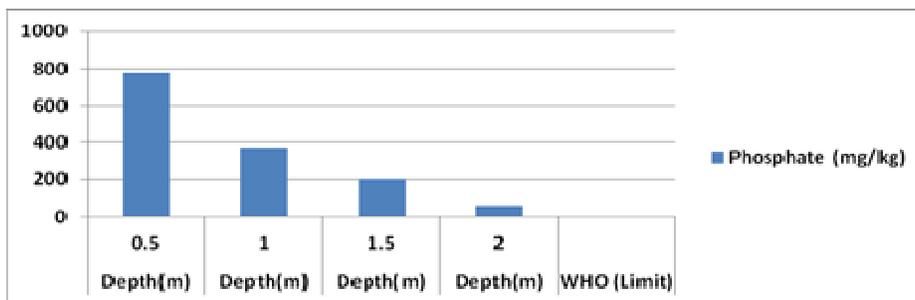


Figure 5. Distribution of Phosphate in the Dumpsite Soil Profile against WHO Permissible Limit.

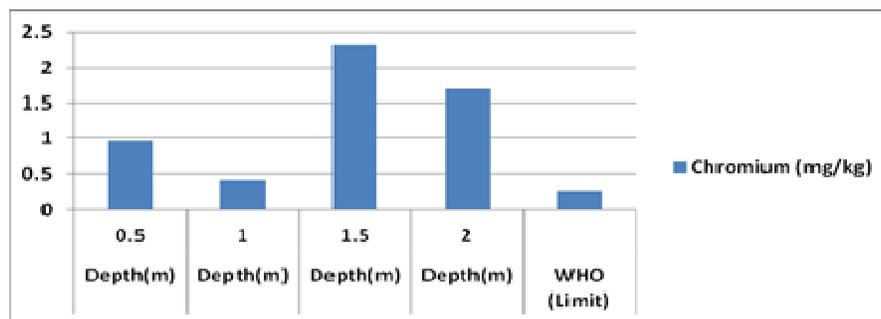


Figure 6. Distribution of Chromium (Cr) in the Dumpsite Soil Profile against WHO Permissible Limit.

wood preserving, and chromium waste disposal (U.S.EPA, 1997).

The values ranges from 0.95mg/kg, 0.41mg/kg, 2.31mg/kg, and 1.70 mg/kg at the depth of 0.5m, 1m, 1.5m, and 2m respectively see Figure 6 with a mean of 1.342mg/kg as shown in Table 1. The result shows that chromium (Cr) exceed WHO (Okafor *et al.*, 2013) permissible limit of 0.25 mg/kg see Table 1.

Cadmium (Cd)

Cadmium is widely distributed in the earth’s crust. Human activities (such as mining, metal production, and combustion of fossil fuels) can result in elevated cadmium concentrations in the environment. The chemistry of cadmium in the soil environment is to a great extent controlled by pH concentration. Under acidic conditions as stated in the pH concentration at depth of 0.5m, 1m, 1.5m and 2m respectively see Figure 2. Cadmium solubility increases and very little adsorption of cadmium by soil colloids, hydrous oxides, and organic matter takes place (U.S. EPA. 1999). At pH values greater than 6, cadmium is absorbed by the soil solid phase or is precipitated, and the concentrations of dissolved cadmium are greatly reduced. Cadmium forms soluble complexes with inorganic and organic ligands, in

particular with chloride ions.

The values of cadmium ranges from 0.17mg/kg, 0.20mg/kg, 0.11mg/kg, and 0.11mg/kg at the depth 0.5m, 1m, 1.5m, and 2m respectively as shown in Figure 7, with a mean of 0.147mg/kg. The concentration of cadmium exceed WHO (Okafor *et al.*, 2013) thus signifying that the soil is not contaminated by cadmium. Major effects are desquamation of epithelium of the gastrointestinal tract, necrosis of the gastric and intestinal mucosa and dystrophic changes of liver, heart and kidneys (Krajnc *et al.*, 1987).

Copper (Cu)

Copper is a very common substance that occurs naturally in the environment and spreads enter the environment via natural phenomena (Obasi *et al.*, 2015). The values ranges from <0.001mg/kg, 0.02mg/kg, 0.59mg/kg, 0.05mg/kg at a depth of 0.5m, 1m, 1.5m, and 2m respectively as shown in Figure 8, with a mean of 0.164mg/kg see Table 1. The concentration of copper exceed WHO (Okafor *et al.*, 2013) permissible limit at the 1.5m (PH/03). While it was below WHO (Okafor *et al.*, 2013) limit at the depth of 0.5m (PH/01), 1.0m(PH/02), 2.0m(PH/04) see Figure 8.

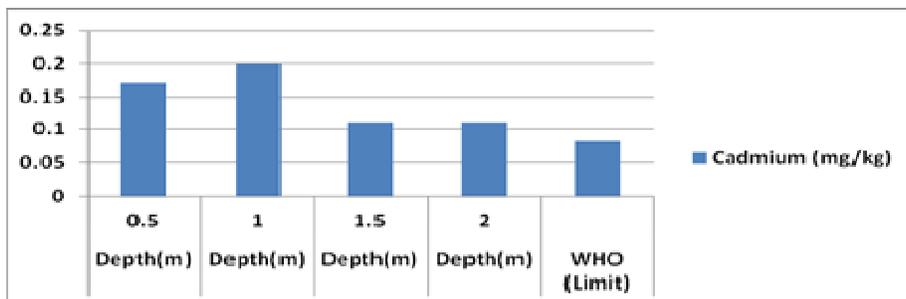


Figure 7. Distribution of Cadmium (Cd) in the Dumpsite Soil Profile against WHO Permissible Limit.

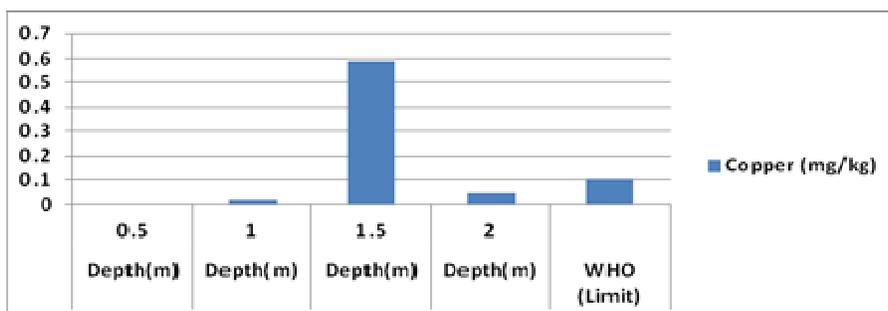


Figure 8. Vertical Distribution of Copper (Cu) in the Dumpsite Soil Profile Plotted against WHO Permissible Limit.

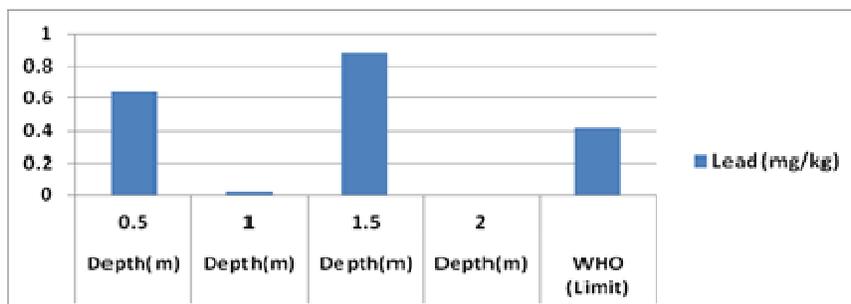


Figure 9. Vertical Distribution of Lead (Pb) in the Dumpsite Soil Profile Plotted against WHO Permissible Limit.

Lead (Pb)

Lead is a naturally occurring element found in small amount in the earth's crust (U.S. EPA, 1997). Lead detected in soil samples originates from used batteries and other lead bearing wastes in the dumpsite. The values ranges from 0.64mg/kg, 0.02mg/kg, 0.88mg/kg, and <0.001mg/kg at depth of 0.5m, 1m, 1.5m, and 2m respectively as shown in Figure 9. With a mean of 0.38 mg/kg see Table 1. The concentration of lead exceed WHO 0.42 mg/kg (Okafor *et al.*, 2013) permissible limit at the depth of 0.5m (PH/01) and at the dept of 1.5m (PH/03) and below WHO permissible limit at a depth of 1m

(PH/02) and 2.0m (PH/04) As there is evidence from human studies that adverse effects other than cancer may occur at very low lead levels and that a guideline thus derived would also be protective for carcinogenic effects, it is considered appropriate to derive the guideline using the TDI approach (WHO, 2011).

Nickel (Ni)

Naturally, nickel occurs widely in the environment, being released through both natural and anthropogenic sources, but seldom in its elemental form (DEPA, 2005a; Cempel and Nikel, 2006). The values were 0.78mg/kg,

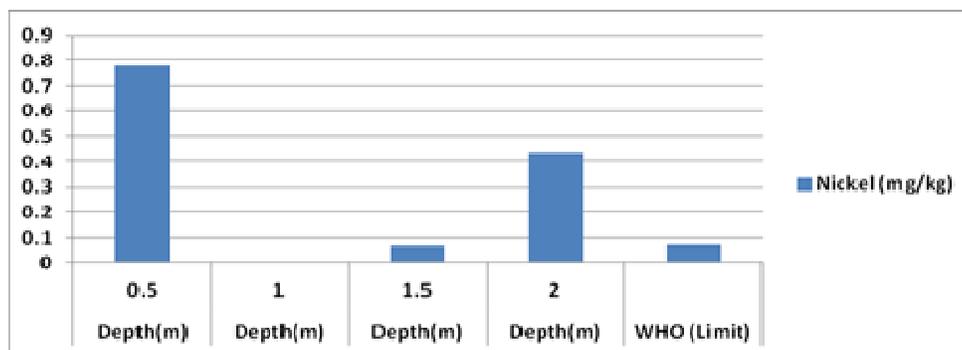


Figure 10. Distribution of Nickel (Ni) in the Dumpsite Soil Profile Plotted against WHO Permissible Limit.

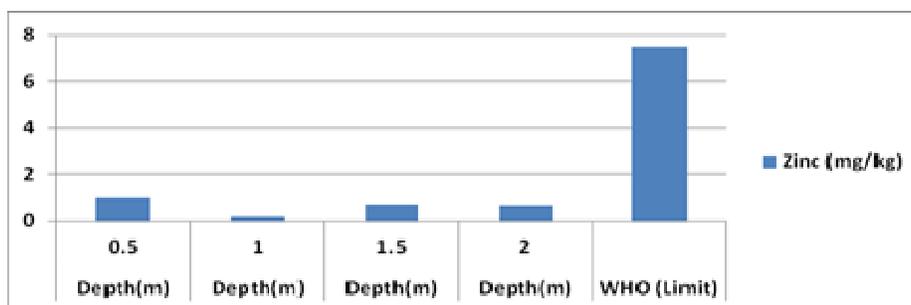


Figure 11. Distribution of Zinc (Zn) in the Dumpsite Soil Profile Plotted against WHO Permissible Limit.

<0.001mg/kg, 0.07mg/kg, and 0.44mg/kg at a depth of 0.5m, 1m, 1.5m, and 2m respectively as shown in Figure 10, with a mean value of 0.332 mg/kg see Table 1. The concentration of nickel exceeds WHO (Okafor *et al.*, 2013) 0.075mg/kg limit permissible limit at the depth of 0.5m (PH/01), 1.5m (PH/03) and 2.0m (PH/04) respectively and below WHO permissible limit at the depth of 1m (PH/02). WHO permissible limit at the depth of 1m (PH/02). Dermal absorption of nickel through human skin is quite very limited, and its uptake from soil is rather fewer. Moody, *et al.*, (2009) studied an in vitro dermal absorption of radioactive nickel chloride through human breast skin for a period of 24 hr with and without a spiked reference soil; the obtained results revealed a mean dermal absorption of 1% with soil and 23% without soil presence. Further studies showed that most nickel applied as a soluble salt is bound within the skin and does not reach systematic circulation (Hostynek *et al.*, 2001; Turkhall *et al.*, 2008), hence, nickel allergy in the form of contact dermatitis is a very common and well-known reaction in nickel is an essential nutritional trace metal based on its deficiency in several animal species, but its functional importance has not yet been clearly documented.

Zinc (Zn)

Zinc is a transition metal that occurs naturally in soil about 70mg/kg in crystal rock. It is a very important material used in the production of batteries, rubber goods, paints, cosmetics, chemicals, pharmaceuticals, and a protective coating for iron and steel. It is also used as a micronutrient in agricultural fertilizers. The values ranges from 1.00mg/kg, 0.20mg/kg, 0.71mg/kg and 0.66mg/kg at depth of 0.5m, 1m, 1.5m, and 2m respectively see Figure 11 above, with a mean value of 0.6425mg/kg as shown in Table 1. Zn concentration in the soil samples is very low compared to WHO (Okafor *et al.*, 2013) maximum permissible limit of mg/kg indicating that the soil from the dumpsite is not contaminated with Zinc.

Iron (Fe)

Iron is a commonly occurring metallic element. The values ranges from 38.9mg/kg, 37.5mg/kg, 6.9mg/kg and 17.5mg/kg at depth range of 0.5m, 1m, 1.5m and 2m respectively see Figure 12, with a mean value of 25.5mg/kg see Table 1.

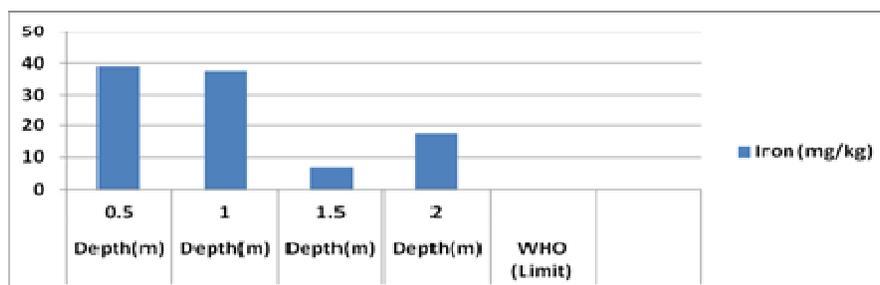


Figure 12. Distribution of Iron (Fe) in the Dumpsite Soil Profile against WHO Permissible Limit.

CONCLUSION

From the soil analysis conducted, it is observed that some of the analysed parameters were below WHO permissible limit these parameters are pH, nitrate and zinc. The concentrations of nickel were above (WHO) permissible limit at depth of 0.5m (PH/01), 1.5m (PH/03) and 2m (PH/04) and below WHO limit at the depth of 1.0m (PH/02). The concentration of copper exceed (WHO) permissible limit at the depth of 1.5m (PH/03) and below the limit at 0.5m (PH/01), 1.0m (PH/02) and 2.0m (PH/04). The concentration of cadmium and chromium exceed WHO limit at various depth analyzed. Lead has concentration that exceed WHO permissible limit at 0.5m (PH/01), 1.5m (PH/03) and below 1m (PH/02) and 2m (PH/04).

RECOMMEDATION

It is recommended that the waste management board of the state and the local government council should partner to upgrade the Eliozu refuse dump site and others into well engineered sanitary landfills. Due to the difficulty in sourcing for data regarding the standards and regulations of soil contamination by pollutants, And finally Federal Environmental Protection Agency (FEPA) in Nigeria should properly document the guidelines and regulations governing soil contamination in Nigeria to aid further research in the subject matter.

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