



## AN ASSESSMENT OF DEPTH OF SOIL COPPER (CU)CONTAMINATION IN DUMPITES: CASE STUDY OF RAMAT POLYTECHNIC, MAIDUGURI

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### ABSTRACT

This is a study conducted in Ramat Polytechnic Maiduguri to assess the Cu content at three (3) soil depths of 0-15cm, 15-30cm and 30-45 cm at a dumpsite and Treachnig and Reach Farm of Polytechnic to establish contamination levels of soil. Soil parameters analysed alongside Copper (Cu) content were soil pH, Electrical Conductivity (EC)( $\text{dm}^{-1}$ ), Cation Exchange Capacity (CEC)( $\text{comlkg}^{-1}$ ), Effective Cation Exchange Capacity (ECEC)( $\text{comlkg}^{-1}$ ), Organic Carbon (%), Nitrogen (N %), Carbon Nitrogen Ratio (C: N), Phosphorus (ppm P) and Cations ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^{+}$ ,  $\text{Na}^{+}$ )( $\text{comlkg}^{-1}$ ). Data collection was subjected to analysis of variance using Statistix 8.0. Mean separation was done using LSD. The results indicated that the soil Cu contents were significantly higher in the samples collected at the dumpsite up to depths of 45cm at LSD of 0.88 compared to samples collected at the control sites. The soil pH of all samples was not acid but slightly above neutral toward being basic (7.46-7.96), C:N ratio was generally very low, Textural Class of dumpsite soil was Sandy Clay and while that at the control site was Sandy Clay Loam, no significant changes in soil Nitrogen, Organic Carbon, Potassium, Exchangeable Bases. The study recommended proper waste management practices and avoiding establishing dumpsites close to human and animal habitat as well as farms.

**Keywords:** Assessment, Contamination, Copper, Depth, Dumpsite

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### INTRODUCTION

The proliferation of open and unsafe dumpsites containing multiple disposals of domestic, municipal, industrial and medical wastes is a common practice in most cities in Nigeria. This practice of waste disposal by human activities within a municipality is generally an urban problem. Most soil pollution problems are associated with large amounts of heavy metals deposited on it through disposed waste. These metals, which are not biodegradable, are accumulated in living organisms when released into the environment. The waste generated by anthropogenic activities has become an environmental problem in many urban areas in developing countries as they progressively move towards industrialization (A Womeso, et al., 2010). Human activities such as technology, industrialization, agriculture, transportation, education, construction, commerce, nutrition and population are responsible for an increase in waste generation in any human society (Olarinoye, et al., 2010). Although solid waste can be an asset when properly managed, it poses the greatest threat to life due to its potential of contaminating terrestrial, aquatic and aerial environments (Bishop 2000).

They exert toxic effects when their concentrations are increased, and at this stage, they could be referred to as toxic metals. The present distribution of metals in the soil can serve as an indication of time, history and extent of pollution discharged in the area. Assessing the problems caused by contaminated soil typically



involved soil chemistry as well as laboratory and field studies to fully assess the extent and significance of any adverse environment effect (Osakwe et al., 2003). According to Merriam Webster (2010), pollution is the introduction of pollutants or contaminants into the natural environment (including soil that cause adverse changes. Components of pollutants or contaminants can be either foreign substances/energies or naturally occurring also can take the form of chemical, biological substances or even energy such as noise, heat or light (John Tarantino 2010).

Recently the concept of soil protection has received considerable attention around the globe. Pollution of the natural environment by heavy metals and other pollutants is a worldwide problem because most of the pollutants are indestructible and most of them have toxic effects on living organisms, when they exceed a certain concentration (Dalman et al, 2006; Chen et al, 2007). Municipal refuse dumps are important feeding sites for pestiferous species especially birds, rats, and stray animals; thereby contributing greatly to their sustenance and multiplication (Bellebaum, 2005). Established research has shown that sediments and dusts transported and stored in the urban environment have the potential to provide considerable loadings of heavy metals to receiving waters and water bodies, particularly with changing environment conditions (Pereira et al., 2007). Mmolawa et al, (2010) also in their study indicated that heavy metal contamination in the soil-water-plant ecosystem is of great concern because of possible influence on food chain. In the soil system, pollution by toxic metals is due to both natural processes, such as weathering of minerals and anthropogenic activities, related to industry, agriculture, burning of fossil fuels, vehicular emissions; mining and metallurgical processes and illegal mining kicked up to 300 people (Health GUARD, 2010). Soil pollutants from dry and atmospheric deposition and biological materials from vegetation significant quantities of particulate matter can also be attribute to anthropogenic sources such as industrial process ,abrasion of vehicular components and their exhaust emissions, incinerator, power plants and foundry operations, type and road surface wear (Sutherland and Tolosa, 2003; pagotto *et al.* 2000; 2005). These deposit as street sediment have become important medium for the study of anthropogenic pollutants and their possible sources (De Miguel *et al.*, 1997; naqerotte and Day, 1998; McAllier *et al.*, 2000; 2005). Urban street sediments have limited residence time and therefore provide a record of recent accumulations (Pereira *et al.*, 2007; pagotto *et al.*, 2001; Sutherland and Tolosa, 2003; Sutherland, 2003). Maiduguri metropolis for instance, has a network of tarred roads with open gutters, drains, ditches, frequently flanking the roads, the high population in Maiduguri results in a lot of urban activities which contributes to contamination through several sources, especially of heavy metals. According to Bababe, *et al.*, (2002), the major sources of contaminated for the soil in Maiduguri include large scale industries such as the asphalt plant, Nigerian bottling company; and small/medium scale industries such as the local smelting, blacksmith and tie and dye industries and water packaging industries; and electricity generating plants used in many homes and work places; large accumulation of municipal wastes and sewage; and several filling and gas station and the ever growing traffic. Bababe *et al.*, (2002), reported that most of the effluence harboring the contaminants empty into open gutters, drains and ditches at sides of road network of the metropolis which eventually block free flow of these gutter, drains and ditches. Inhabitants or government workers in some form of sanitation normally dredge the gutters, drains and ditches when such blockages occur and dump the dredged sediments and materials on the roadsides. Random deposition of wastes leads to adjacent lands getting enriched in trace metals and salts, thus dumpsite soils eventually become the repository for metals released from municipal waste sludge and several similar wastes deposited on it (Khairah J *at al.*, 2004; Sharma *et al.*, 2007). The severe problems associated with these are the infiltration of leachate into the surrounding environment, subsequent contamination of the land and groundwater (Kumar *et al.*, 2002). Heavy metals once introduced to the environment by one particular method may spread to various environmental components, which may be caused by the nature of interactions occurring in this natural system. Heavy metals may chemically or physically interact with the natural compound, which changes their forms of existence in the environment. In general they may react with particular species, change oxidation



states and precipitate (Dube *et al.*, 2000). Heavy metals may be bound or sorbed by particular natural substances, which may increase or decrease mobility (Hulanicki, 2000). The most frequent reported heavy metals with regards to potential hazards and occurrence in soil are Al, Co, Cu, Fe, Pb, Mn, Ni, and Zn. Accumulation of these metals in top soils are greatly influenced by traffic volume (Al-Kashman and Shawabkeh, 2009).

The aim of this study is to assess the levels of heavy metal (Cu) contamination in soil depths at a dumpsite Ramat Polytechnic Maiduguri, with a view to establishing the pollution or contamination status of dumpsite soil as a result of anthropogenic input.

#### Copper (Cu)

Lenntech (2009), gave and published the properties of Cu as shown below:

Atomic number	29
Atomic mass	63.546g.mol <sup>-1</sup>
Electronegativity according to Pauling	1.9
Density	8.9 gcm <sup>-3</sup> at 20°C
Melting point	1083 °C
Boiling point	2595 °C
Vanderwaals radius	0.128nm
Ionic radius	0.096nm (+1); 0.069nm (+3)
Isotopes	6
Electronic shell	[Ar] 3d <sup>10</sup> 4s <sup>1</sup>
Energy of first ionisation	743.5 kJ.mol <sup>-1</sup>
Energy of second ionisation	1946 kJ.mol <sup>-1</sup>
Standard potential	+0.522 V (Cu <sup>+</sup> / Cu); +0.345 V (Cu <sup>2+</sup> / Cu)
Discovered by	The ancients

Copper is a reddish metal with a face-centered cubic crystalline structure. It reflects red and orange light and absorbs other frequencies in the visible spectrum, due to its band structure, so it has a nice reddish colour. It is malleable, ductile, and an extremely good conductor of both heat and electricity. It is softer than iron but harder than zinc and can be polished to a bright finish. It is found in group 1b of the periodic table, together with silver and gold. Copper has low chemical reactivity. In moist air it slowly forms a greenish surface film called patina; this coating protects the metal from further attack (Lenntech, 2009).

#### Cu in the environment

Copper is a very common substance that occurs naturally in the environment and spreads through the environment through natural phenomena. Humans widely use copper, for instance it is applied in the industries and in agriculture. The production of copper has lifted over the last decades and due to this copper quantities in the environment have expanded (Lenntech, 2009).

The world's copper production is still rising; this basically means that more and more copper ends up in the environment. Rivers are depositing sludge on their banks that is contaminated with copper, due to the disposal of copper-containing wastewater. Copper enters the air, mainly through release during the combustion of fossil fuels. Copper in air will remain there for an eminent period of time, before it settles when it starts to rain. It will then end up mainly in soils. As a result soils may also contain large quantities of copper after copper from the air has settled (Lenntech, 2009).

Copper can be released into the environment by both natural sources and human activities. Examples of natural sources are wind-blown dust, decaying vegetation, forest fires and sea spray. A few examples of human activities that contribute to copper release have already been named. Other examples are mining,



metal production, wood production and phosphate fertilizer production. Because copper is released both naturally and through human activity it is very widespread in the environment. Copper is often found near mines, industrial settings, landfills and waste disposals (Lenntech, 2009).

Most copper compounds will settle and be bound to either water sediment or soil particles. Soluble copper compounds form the largest threat to human health. Usually water-soluble copper compounds occur in the environment after release through application in agriculture (Lenntech, 2009).

## **MATERIALS AND METHODS**

### **Area of Study**

Maiduguri is an old settlement situated on the fertile soil of the west bank of mega-Chad the ancient more extensive version of the present lake Chad, with the doming of the British of the turn of the century the old established market town was selected by them as the administrative capital of the province of Borno on the ancient kanuri empire spreading around the lake and for over two hundred miles to the west (wikipedia, 2013).

Ramat Polytechnic (the study area) is in Maiduguri- the capital city of Borno State. The study area is situated on Latitude  $11^{\circ} 51' N$  and Longitude  $13^{\circ} 15' E$  at an altitude of 354m above sea level (Wikipedia 2010). Ojanuga (2006), described the climate as dry sub-humid in nature characterized by a modal rainfall pattern and mean daily temperatura during cropping seasons ranging between  $23.2$  and  $34.3^{\circ}C$ . More recently study describe the climatic condition characterised by dry and hot season with the hottest months being March and April and coolest months being December and January, minimum temperature range is  $15-20^{\circ}C$  while the maximum temperature range is  $37-45^{\circ}C$  (Climate, Chart 2010; Wikipedia, 2010; Encyclopædia Britannica, 2008). The rainy season is usually short normally from the month of May to October with low relative humidity and average annual rainfall is 440-600mm. The area of study (semi-arid) has a generally low and plain topography with short grasses and thorny shrubs.

The geologic formation was initiated in the upper cretaceous the Bima sand stone over lies the basement rocks uncomfortable. There is an intense folding of the cretaceous formation at the end of the cretaceous leading to the formation of several anticlinal features and erosional activities partly wearing away the upper cretaceous strata thereby creating an unconformity surface (Okpikoro and Olorunniwo, 2010). The sedimentation commenced with the deposition of continental, poorly sorted, sparsely fossiliferous, medium to coarse grained sand stone (Bima formation) lying directly on the basement (Boboye and Abimbola, 2009).

Farming and animal rearing are the two main economic activities in the area. It is one of the Largest centers in West Africa producing major agricultural product like sorghum, Millet, maize, groundnut, cotton, fruit, vegetable, fish, hide and skin as well a gum Arabic Borno State dairy (2004). Arable farming and live stock grazing along with the high and increasing demand for fuel wood have contributed greatly to environmental degradation. The land use practices that effect the environment are cultivation, bush burning grazing deforestation and irrigation. The changes caused by these land use practices, especially cultivation are often positive because of careful adaptation by the inhabitant who has a vested interest in preserving their homestead (Udo, 1993).

The soil has been classified as Typic Ustipsamment- it is physically characterized as sandy loam (Rayar, 1983) according to U.S.D.A soil classification (1975). The steady infiltration rate is 135mm/hr and average bulk density of the soil is  $1.5g/cm^3$ , (Grema and Hess, 1994).

### **Soil Sampling**

Soil samples were collected at a 'dumpsite' and 'control' site (the School Farm). The dumpsite is where all shorts of urban and domestic wastes are dumped, such wastes come from near-by comercial areas which compreses of several restuarants, business and computer centers, saloons as well as a metal workshop of the School's Center for Etrepreneursip Studies. Precisely, location of the dumpsite is where at the:

- North is Ramat Polytechnic Staff Quarters





- South are the complexes of center for entrepreneurship Studies and center for excellence.
- East is the Ramat Polytechnic Teaching and Research farm.
- West is the commercial/cafeteria Area.



Image 1



Image 2



Image 3



Image 4



Image 5



Image 6

**Image 1:**The Polytechnic's Staff Quarters Beyond the line of Trees.

**Image 2:**The White Building is the Polytechnic's Center for Entrepreneurship Studies.

**Image 3:**Part of the Polytechnic's Commercial Center, Most of which are Restaurants.

**Image 4:**The Polytechnic's Teaching and Research Farm.

**Image 5:**Close up of Dumpsite with Burning Refuse.

**Image 6:**Sample Collected by Students on Site.

Soil samples were randomly cored using a soil auger five (5) different locations the soil depths after which cored soil samples at corresponding depths were mixed to obtain a composite samples of three (3) soil depths of 0-15cm, 15-30cm and 30-45cm respectively. The composite samples were air dried and divided into three (3) replicates and put into labelled soil sampling bags. Labeled soil samples from dumpsite thus are:



- S1 (0-15cm) RI, S1 (0-15cm) RII, S1 (0-15cm) RIII
- S2 (15-30cm) RI, S2 (15-30cm) RII, S2 (15-30cm) RIII
- S3 (30-45cm) RI, S3 (30-45cm) RII, S3 (30-45cm) RIII

The control site as earlier mentioned was taken at the School's Teaching and Research farm, as in the case of the dumpsite soil samples were also cored at three (3) soil depths; this makes the fourth simple. The samples from the control site thus are:

- S4 (0-15cm) RI, S4 (0-15cm) RII, S4 (0-15cm) RIII
- S4 (15-30cm) RI, S4 (15-30cm) RII, S4 (15-30cm) RIII
- S4 (30-45cm) RI, S4 (30-45cm) RII, S4 (30-45cm) RIII

#### **Soil Analysis**

All soil analysis were conducted at the Soil Science Laboratory of Department of Soil Science University of Maiduguri except for soil Copper (Cu) contenten which was conducted at the Laboratory facility of National Food and Drug Agency and Control, Maiduguri Head Office.

#### **Soil pH**

Soil pH (soil reaction) was determined using the standard Electrometric method in water (1:2.5 distilled water suspensions); pH reading was taken with a glass electrode pH meter according to Thomas (1996).

#### **Soil Electrical Conductivity (EC)**

Soil EC was determined using the Electrometric method in soil-water suspension (1:2.5); EC reading was taken with an EC meter according to Thomas (1996).

#### **Soil Exchangeable Acidity**

This was determined by extracting the soil with KCL using the Extraction/Titration Method, McLean (1965).

#### **Soil Organic Carbon (OC%)**

Soil Organic Carbon was determined using the wet oxidation method of Walkey and Black as reported by Sparks (1996).

#### **Soil Nitrogen**

Soil Nitrogen (Total) was determined by Kjeldhal Method and Titrimery by Winkler, (1913) as described by Marc and Jacques (2006).

#### **Nitrogen: Carbon Ratio (C: N)**

The C: N ratio was determined by using information on total C and N, Marc and Jacques (2006).

#### **Soil Phosphorus**

Soil phosphorus was determined by Brey No. 1 Method, (Bray and Kurtz, 1945)

#### **Particle Size Analysis (PSA)**

Particle Size Analysis (Soil Texture) was determined by hydrometer method of Day, (1965).

#### **Soil Exchangeable Bases (Cations)**

The exchangeable bases in the soil were extracted with 1N neutral ammonium acetate (NH<sub>4</sub>OAC) buffer according to Helmke and Sparks (1996). The concentrations of Na and K were determined with the flame photometer while that of Ca and Mg by Atomic Absorption Spectrophotometer (AAS).

#### **STATISTICAL ANALYSIS**

All data collected were subjected to analysis of variance using using Statistix 8.0. Mean separation was done using LSD.

#### **Results and Discussions**

#### **Soil pH, Electrical Conductivity (EC), Texture, Exchangeable Acidity (EA), Cation Exchange Capacity (CEC) and Effective Exchangeable Acidity (ECEC)**

Table 1 shows the mean values of pH, Electrical Conductivity (EC), Particle Size Analysis (PSA) of clay, sand and silt, Cation Exchange Capacity (CEC) and Effective Cation Exchange Capacity (ECEC). The mean soil pH



values of samples collected at the dumpsite at depths of 0-15cm, 15-30cm, and 30-45cm were 7.87, 7.89 and 7.89 respectively which was not significant at an LSD of 0.32. While mean pH values for the control samples at soil depths of 0-15cm, 15-30cm and 30-45cm were 7.46, 7.92, and 7.85 respectively. These pH values generally indicate that the soil samples at the dumpsite are not acidic but more of neutral towards alkalinity.

Soil Electrical Conductivity (EC) of dumpsite samples had mean values of 247.23, 241.40 and 170.40  $\text{dms}^{-1}$  for soil depths of 0-15cm, 15-30cm, and 30-45cm respectively. These values were significantly reducing with an LSD of 0.31. Control samples also had significant differences in values at depths of 0-15cm, 15-30cm, and 30-45cm having values of 110.73, 97.08 and 89.47  $\text{dms}^{-1}$ , respectively.

Particle size analysis of the soil samples indicated mean percent values of clay, sand and silt particles at the various depths of soil samples collected. The clay particles had mean percent values of 14.00, 14.00 and 10.49 at 0-15cm, 15-30cm, and 30-45cm respectively with a control samples having 14.00, 11.50, 11.50 percent clay at 0-15cm, 15-30cm, and 30-45cm respectively. Sand particles had 73.43%, 73.43% and 72.23% at 0-15cm, 15-30cm, and 30-45cm depth of soil respectively. Soil particle had slightly higher percentage compared to mean values of the control samples showing mean percentage of 71.00, 72.23 and 73.90 respectively. Percent silt of soil samples at the depths of 0-15cm, 15-30cm, and 30-45cm were 12.47%, 12.43% and 16.26% respectively with control soil at the depths of 0-15cm, 15-30cm and 30-45cm having 14.98, 16.44 and 15.00 respectively. With the soil textural class triangle, the soil texture of the dumpsite was Sandy loam while that of the control site Sandy clay loam.

Values of cation exchange capacities of the soil samples collected at the dumpsites at the depths of 0-15cm, 15-30cm and 30-45cm indicated 11.66, 15.08 and 15.25  $\text{cmolkg}^{-1}$  respectively. Corresponding Effective Cation Exchange Capacity (ECEC) of the same soil depths showed 12.46, 15.49 and 15.55  $\text{cmolkg}^{-1}$  respectively. Control soil samples at depths of 0-15cm, 15-30cm and 30-45cm had Cation Exchange Capacities (CEC) and Effective Cation Exchange Capacity (ECEC) had corresponding mean values of 13.81, 13.25 and 15.96  $\text{cmolkg}^{-1}$  and 14.43, 13.44 and 16.16  $\text{cmolkg}^{-1}$  respectively.

**Table 1: Assessment of Soil pH, EC, Texture, CEC and ECEC on Dumpsite and School Farm at Various Soil Depths.**

Sampling Sites	Soil Depths (cm)	pH	EC $\text{dms}^{-1}$	Particle Size Analysis (PSA)			Cation Exchange Capacity (CEC) ( $\text{cmolkg}^{-1}$ )	Effective Cation Exchange Capacity (ECEC) ( $\text{cmolkg}^{-1}$ )
				Clay (%)	Sand (%)	Silt (%)		
Soil Samples (From Dumpsite)	S1 (0-15cm)	7.87 <sup>b</sup>	247.23 <sup>a</sup>	14.00 <sup>a</sup>	73.43 <sup>a</sup>	12.47 <sup>b</sup>	11.66 <sup>c</sup>	12.46 <sup>c</sup>
	S2 (15-30cm)	7.96 <sup>a</sup>	241.40 <sup>b</sup>	14.00 <sup>a</sup>	73.43 <sup>a</sup>	12.43 <sup>b</sup>	15.08 <sup>b</sup>	15.49 <sup>b</sup>
	S3 (30-45cm)	7.89 <sup>b</sup>	170.40 <sup>c</sup>	10.49 <sup>b</sup>	72.25 <sup>b</sup>	16.26 <sup>a</sup>	15.25 <sup>a</sup>	15.55 <sup>a</sup>
	LSD	0.32	0.31		0.09	0.09	0.01	0.01
Control Samples (From School Farm)	S4 (0-15cm)	7.46 <sup>c</sup>	110.73 <sup>a</sup>	14.00 <sup>a</sup>	71.00 <sup>c</sup>	14.98 <sup>b</sup>	13.81 <sup>b</sup>	14.43 <sup>b</sup>
	S4 (15-30cm)	7.92 <sup>a</sup>	97.08 <sup>b</sup>	11.50 <sup>b</sup>	72.23 <sup>b</sup>	16.44 <sup>a</sup>	13.25 <sup>c</sup>	13.44 <sup>c</sup>
	S4 (30-45cm)	7.85 <sup>b</sup>	89.47 <sup>c</sup>	11.50 <sup>b</sup>	73.46 <sup>a</sup>	15.00 <sup>b</sup>	15.96 <sup>a</sup>	16.16 <sup>a</sup>
	LSD	0.05	0.08	0.16	0.12	0.03	0.02	0.07



Soil Exchangeable Bases ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^+$ ,  $\text{Na}^+$ )

TABLE (2) INDICATE SOIL EXCHANGEABLE BASES (CATIONS) AT DIFFERENT DEPTHS OF SOIL AND DUMPSITE AS WELL AS AT DIFFERENT DEPTHS OF SOIL AT THE CONTROL SITE (SCHOOL FARM). EXCHANGEABLE  $\text{Ca}^{2+}$  AT SOIL DEPTHS OF 0-15CM, 15-30CM AND 30-45CM AT THE DUMPSITE SHOWED 8.30, 11.47 AND 10.13  $\text{cmolkg}^{-1}$  REPECTIVELY WITH 0.03 LEAST SIGNIFICANT DIFFERENCE, WHILE AT THE SAME DEPTHS AT THE CONTROL SITE (SCHOOL FARM) THE VALUES WERE 8.60, 9.60 AND 12.40 $\text{cmolkg}^{-1}$ .

Values of exchangeable  $\text{Mg}^{2+}$  were 2.37, 2.73 and 3.57  $\text{cmolkg}^{-1}$  for dumpsite soil at the depths of 0-15, 15-30 and 30-45cm respectively and 0.12 as LSD, while at the equivalent soil depths at the control site the values for exchangeable  $\text{Mg}^{2+}$  were 4.17, 2.60 and 2.40  $\text{cmolkg}^{-1}$  respectively.

Potassium ion ( $\text{K}^+$ ) values on the soil samples of control site at the depths of 0-15cm, 15-30cm and 30-45cm showed 0.76, 0.83 and 0.90  $\text{cmolkg}^{-1}$  respectively, while exchangeable  $\text{K}^+$  values in simple soils at the dumpsite at depth of 0-15, 15-30 and 30-45cm were 0.86, 0.55 and 1.12  $\text{cmolkg}^{-1}$  respectively with Least Significant Difference of 0.02

Exchangeable  $\text{Na}^+$  values in soil of sumpsite at the depth of 0-15cm was 0.20  $\text{cmolkg}^{-1}$ , 15-30cm was 0.33  $\text{cmolkg}^{-1}$  and at the depth of 30-45cm was 0.31  $\text{cmolkg}^{-1}$  with an LSD of 0.02. At depths of 0-15, 15-30 and 30-45cm, soil saples at the control site gave values of exchangeable  $\text{Na}^+$  as 0.22, 0.21 and 0.25  $\text{cmolkg}^{-1}$  respectively.

**Table 2: Assesment of Soil Cations on Dumpsite and School Farm at Various Soil Depths.**

Sampling Sites	Soil Depths (cm)	$\text{Ca}^{2+}$ ( $\text{cmolkg}^{-1}$ )	$\text{Mg}^{2+}$ ( $\text{cmolkg}^{-1}$ )	$\text{K}^+$ ( $\text{cmolkg}^{-1}$ ) <sup>+</sup>	$\text{Na}^+$ ( $\text{cmolkg}^{-1}$ )
Soil Samples (From Dumpsite)	S1 (0-15cm)	8.30 <sup>b</sup>	2.37 <sup>c</sup>	0.86 <sup>b</sup>	0.20 <sup>c</sup>
	S2 (15-30cm)	11.47 <sup>a</sup>	2.37 <sup>b</sup>	0.55 <sup>c</sup>	0.33 <sup>a</sup>
	S3 (30-45cm)	10.13 <sup>ab</sup>	3.57 <sup>a</sup>	1.12 <sup>a</sup>	0.31 <sup>b</sup>
	LSD		0.12	0.02	0.02
Control Samples (From School Farm)	S4 (0-15cm)	8.60 <sup>c</sup>	4.17 <sup>a</sup>	0.76 <sup>c</sup>	0.22 <sup>ab</sup>
	S4 (15-30cm)	9.60 <sup>b</sup>	2.60 <sup>b</sup>	0.83 <sup>b</sup>	0.21 <sup>b</sup>
	S4 (30-45cm)	12.40 <sup>a</sup>	2.40 <sup>b</sup>	0.90 <sup>a</sup>	0.25 <sup>a</sup>
	LSD	0.19	0.24	0.02	0.03

**Soil Nitrogen (N), Organic Carbon (OC), Carbon: Nitrogen Ratio (C: N), and Phosphorus (P)**

Table (3) shows values of Nitrogen (N%), Organic Carbon (OC%), Carbon-Nitrogen Ratio (C: N) and Phosphorus (ppmP) at the different soil depths (0-15, 15-30 and 30-45cm) and two sites (dumpsite and school farm). Mean Nitrogen values at the dumpsite at depths of 0-15, 15-30 and 30-45cm were 0.17%, 0.13% and 0.10% while at the control site at depths of 0-15, 15-30 and 30-45cm mean Nitrogen values were 0.20, 0.11 and 0.11 percent respectively.

Percent Organic Carbon Values (OC%) of soil samples at the control sites at depths of 0-15, 15-30 and 30-45cm showed mean values of 0.67%, 0.46% and 0.31% respectively. At the dumpsite, the mean percent values of Organic Carbon were 0.56% for soil depth of 0-15cm, 0.40% for soil depth of 15-30cm and 0.25% at depth of 30-45cm.





Carbon-Nitrogen Ratios for soil samples at the dumpsite at depths of 0-15, 15-30 and 30-45cm had mean values of 3.34, 2.92 and 2.47 respectively indicating significant differences at each depth with LSD of 0.7. As for the control site, the mean values of C:N ratio were 3.33 for soil depth of 0-15cm, 3.46 for soil depth of 15-30cm and 2.81 for soil depth of 30-45cm.

Values of Phosphorus (ppm P) revealed mean values of 16.45, 17.50 and 16.44 ppm for soil of depths 0-15, 15-30 and 30-45cm samples taken at dumpsite. While at control site, mean values of Phosphorus of soil samples taken at 0-15, 15-30 and 30-45cm depths had 18.21, 17.12 and 15.05ppm P respectively.

**Table 3: Assessment of Soil N (%), OC (%), C:N and P (ppm) on Dumpsite and School Farm at Various Soil Depths.**

Sampling Sites	Soil Depths (cm)	Nitrogen (N%)	Organic Carbon (OC%)	Carbon Nitrogen Ratio (C:N)	Phosphorus (ppmP)
Soil Samples (From Dumpsite)	S1 (0-15cm)	0.17 <sup>a</sup>	0.56 <sup>a</sup>	3.34 <sup>a</sup>	16.45 <sup>b</sup>
	S2 (15-30cm)	0.13 <sup>b</sup>	0.40 <sup>b</sup>	2.92 <sup>b</sup>	17.50 <sup>a</sup>
	S3 (30-45cm)	0.10 <sup>c</sup>	0.25 <sup>c</sup>	2.47 <sup>c</sup>	16.44 <sup>c</sup>
	LSD	0.01	0.01	0.07	0.01
Control Samples (From School Farm)	S4 (0-15cm)	0.02 <sup>a</sup>	0.67 <sup>a</sup>	3.33 <sup>b</sup>	18.21 <sup>a</sup>
	S4 (15-30cm)	0.11 <sup>b</sup>	0.46 <sup>b</sup>	3.46 <sup>a</sup>	17.12 <sup>b</sup>
	S4 (30-45cm)	0.1 <sup>b</sup>	0.31 <sup>c</sup>	2.81 <sup>c</sup>	15.05 <sup>c</sup>
	LSD	0.02	0.02	0.07	0.07

#### Soil Copper Content

Table (4) shows the mean values for total Copper (Cu) contents of soil samples taken at 0-15, 15-30 and 30-45cm of both the dumpsite and the control site. Mean soil Cu content at the control site where soil samples were taken at the depths of 0-15, 15-30 and 30-45cm showed 1.21, 1.26 and 1.46mg/kg respectively. There seemed to be significant differences of Cu contents amongst the different soil depths of the dumpsite with soil Cu contents at soil depths of 0-15, 15-30 and 30-45cm reading mean values of 1.56, 1.62 and 1.68mg/kg respectively.

**Table 4: Assessment of Soil Cu (mg/kg) on Dumpsite and School Farm at Various Soil Depths.**

Sampling Sites	Soil Depths (cm)	Copper (mg/kg)
Soil Samples (From Dumpsite)	S1 (0-15cm)	1.56 <sup>C</sup>
	S2 (15-30cm)	1.62 <sup>B</sup>
	S3 (30-45cm)	1.68 <sup>A</sup>
	LSD	0.88
Control Samples (From School Farm)	S4 (0-15cm)	1.21 <sup>A</sup>
	S4	1.26 <sup>A</sup>



(15-30cm)	
S4	1.46 <sup>A</sup>
(30-45cm)	
LSD	0.33

### Discussions

The contamination of the dumpsites was obviously indicated by the higher concentrations of Cu a heavy metal and the downward migration as against the control (School Farm) site. This indicates the presence of metal containing wastes which contributed heavy metal accumulation and pollution. The dumpsite in question is made up of all sorts of domestic and urban wastes from left over foods and food by-products, polythene bags of all sorts, empty cans, plastics and boxes from cosmetic and chemical products, metal scraps and a lot more. This variety of heavy metal generating wastes is because of the kind of human activities around it as well as the several small power generating sets (generators); there is a commercial center with several business/computer centers, several restaurants and saloons, the metal workshop of the Polytechnic's Entrepreneurship Studies and a number of feeder roads where motor vehicles drive. This findings is similar to and is supported by the separate studies of Iwegbue, *et al.* (2010) and that of Azeez, *et al.* (2011) who worked on "Determination of trace metal concentrations in soil profiles of municipal wastedumps" in Nigeria and "Implication of heavy metals distribution in municipal solid waste disposal system: A case study of Abeokuta"; in Nigeria.

The mobility of heavy metal cations are said to be more mobile under acidic conditions as reported by Alloway, (1990). However, in general pH obtained in this study was about neutral approaching alkaline; consequently the mobility of metal ions may not have been favored completely by the pH. Factors, such as gravity, resulting from reoccurrences of heavy rainfall and constant leaching over the years may be attributable; this is also described in the study conducted by Lawan, *et al.* (2012)

The concentrations of metals (as in this case Cu) are observed to be favoured by increase in %N, %OC and P (ppm P), as they relate in increases in the rates of metal ion absorptions. The decomposition of the organic components of waste by the action of microorganisms increases the level of organic matter in the dump soil (from left over foods and wastes from the restaurants near by as source microorganisms); this trend is also described both by Alloway, (1990) and Lawan, *et al.* (2012).

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