# HEAVY METALS STATUS OF SOIL AROUND WASTE DUMPSITES IN UGHELLI METROPOLIS, DELTA STATE

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***ABSTRACT***

*This study investigated the heavy metal status of soils around waste dumpsites in Ughell, metropolis, Delta State, Nigeria. Two different dumpsites were used for this study. For the metal analysis, soil samples were collected at 0-15cm depth. The soil samples were air dried for five days and sieved. 2.0g of the soil sample was digested with $HNO_3/HClO_4$ mixture and analysed for heavy metals (Fe, Pb, Cd, Zn, Cu and Mn) concentration using Atomic Absorption Spectrophotometer (AAS) Buck 200A model. The result obtained ranged from18.23-32.31mg/kg for Fe; 1.28-1.36mg/kg for Pb; 4.72-6.23mg/kg for Cd; 13.6-17.62mg/kg for Zn; 1.32-1.35mg/kg for Cu and 26.36-29.82mg/kg for Mn. The mean concentration of all the metals in the two sampling stations is in the order: Mn>Fe>Zn>Cd>Cu>Pb. The results when compared with the control site were quite higher indicating the metal enrichment of soil from the waste in the dumpsites. The results were within DPR target value except cadmium. The level of Cadmium in the present study calls for concern, considering the location of the sites and toxicity of cadmium. All hands must therefore be on deck to check the effect of these metals now and in the future in order to promote a healthy environment for sustainable development.*

***Keywords****; heavy metals, dumpsites, soil, concentration, waste, samples*

## INTRODUCTION

The ever increasing population coupled with the desire of most people for a higher material standard of living are resulting in worldwide pollution on a massive scale (Manahan, 2005). Municipal solid wastes normally termed as garbage or trash is an inevitable by-product of human urban settlements (Abah *et al.,* 2015). Large arable expanse of land have been transformed to dumpsites over time due to high population density and increasing urbanization rates and industrial processes which promote waste accumulation (Solomon *et al.,* 2015; Begum, *et al.,* 2009). Usually, these wastes are never screened or sorted out and consequently, heavy metals eventually find their way into the soil from metal scraps, agricultural and industrial wastes (Quek et al., 1998) deposited on the dumpsites, making it almost impossible for plants survival and healthy human habitation (Solomon *et al.,* 2015).

Heavy metals are chemical elements mostly with density greater than $4g/cm^3$ found in all kinds of soils, rocks and fresh water ecosystem (Adelekan and Abegunde 2011). Heavy metals in high concentration are harmful to the environment because of their potential toxicity to biota and indirect threat to human health from groundwater contamination and accumulation in food crops (Martinez *et al.,* 2000). Most of the heavy metals are extremely toxic because of their solubility in water; they are known to accumulate in living organisms and even at low levels they can result in long term cumulative health effect (Njagi *et al.,* 2016). The concentrations of heavy metals are associated with biological and geochemical cycles and are influenced by anthropogenic activities such as agricultural practices, transport, industrial activities and waste disposal (Lund, 1990; Abollino *et al.,* 2002).

The levels of heavy metals in the environment have been seriously increased during the last decades due to human activities (Bin *et al.,* 2001). Some heavy metals are essential to maintain human metabolism. Heavy metals are very harmful because of their non biodegradable nature, long biological half lives and their potential to accumulate in different body parts (Manahan, 2005; Wilson and Pyatt 2007). Excessive accumulation of heavy metals in agricultural soils, through waste water irrigation results in soil contamination as well as food quality and safety (Muchuweti *et al.,* 2006). Heavy metals such as cadmium, lead, copper; zinc and nickel are carcinogenic or have toxic effects on humans and the environment (Trichopoulous, 2001; Tutkdogan *et al.,* 2002; Kocasoy and Sachim 2007). Anthropogenic releases can increase the concentrations of these metals relative to their normal background values making the heavy metals to be considered as serious pollutants because of their toxicity, persistence and nondegradable conditions in the environment, thereby constituting threat to humans and other forms of biological life (Tam and Wong, 2000; Nwuche and Ugoji, 2008; Aina et al., 2009; Mohiuddin *et al.,* 2010; Adelekan and Abegunde 2011).

This present study was embarked upon to determine the concentration of heavy metals in soils around some waste dumpsites in Ughelli metropolis and ascertain the extent to which the soil is contaminated by the heavy metals investigated.

## MATERIALS AND METHODS

### Study Area

Ughelli is the administrative headquarters of Ughelli North local government area of Delta State. Ughelli is situated at latitude 5.49°N and longitude 6.01°E and lies at an altitude of 27 meters above the sea level. Ughelli is an oil rich town accommodating many oil companies. It is one of the commercial towns in Delta State. Indiscriminate dumping activities have led to the pollution of the soil.

**Sample Collection and Preparation**

Soil samples around dumpsites located in two different locations; Oteri road and Patani road within Ughelli metropolis were collected at 0 – 15cm depth using a stainless steel soil augur. A third sample was collected from another location that was not a dumpsite to serve as a control. Samples were collected in clean polythene bags and taken to the laboratory for analysis. The samples were air dried in the laboratory for four days at room temperature and large objects (sticks, stones plastics, etc) removed (Asiagwu et al., 2007). The dried samples were crushed into fine powder using agate mortar and pestle and thereafter sieved through a 100 mesh screen to obtain a homogenous particle size ($\leq 150\mu m$). The soil particles that penetrated the screen were used for the experimental work.

## METHODS

**Digestion**

2 grams of each soil sample was measured and put in a separate beaker. 10ml of nitric/perchloric acid 2:1 was added to the sample. The samples were digested at 105˚C for 1 hour. Next HCl and distilled water 1:1 ratio was added to the digested sample and transferred to the digester again and the mixture were heated for 30minutes. The digestate was removed from the digester and allowed to cool to room temperature. The digests were filtered into 50ml standard flask using Whatman No 1 filter paper and made up to the mark after quantitatively transferring reinsates with distilled water. The filtrates were transferred into clean dry plastic containers for storage prior to AAS analysis.

**Metal Analysis**

Determination of heavy metals was done using Atomic Absorption Spectrophotometer (Buck 200A model).

## RESULTS

The results of the heavy metal analysis are presented in table 1 and figure 1. The results of the vertical distribution of heavy metals determined in soil (in mg/kg) around waste dumpsites in Ughelli showed high concentration of the metals in Patani road than Oteri road. The mean concentration of all the metals in the sampling stations follows in the order: Mn>Fe>Zn>Cd>Cu>Pb (Table 1). Iron result ranged from 18.23/kg – 32.31mg/kg with a mean concentration of 25.25mg/kg as shown in table 1. The iron result was lower than 10.71mg/kg recorded for the control. The concentration of iron was comparable with those obtained from soils in Kaduna metropolis which were in the range of 19.56 - 25.47 mg/kg of dry soil (Ajibola and Ozigis, 2005) (Table 2). Iron result varied significantly with the range of 22.01– 525.50 mg/kg obtained by Njagi et al (2016) for Kadhodeki dumpsite in Kenya and 185.57 - 213.97mg/kg reported for Akure metropolis by Anietie and Labunmi, (2015) (Table 2). Iron result was lower than the 1000mg/kg permissible limit by USEPA (1986) for soil as shown in table 3.

Lead result ranged from 1.28 – 1.36mg/kg with an average value of 1.32mg/kg. The result obtained was greater than the 0.06mg/kg recorded for the control. Lead result in this study was lower than the range of 19.79 – 60.22mg/kg obtained by Njagi *et al.,* (2016) for Kadhodeki dumpsite in Kenya. However the result was within the range of 0.101-2.003mg/kg reported by Odhiambo *et al.*, (2015) for Narok Kenya and 0.24 - 2.15mg/kg reported by Amadi and Nwankwoala, 2013 for Aba (Table 2). Lead result in this study was lower than the 85mg/kg target value by DPR (2002) (Table 3).

The concentrations of cadmium ranged from 4.72 – 6.23mg/kg with a mean value of 5.48mg/kg. The result was higher than the 0.35mg/kg obtained for the control as shown in table 1. Cadmium result obtained was higher than the range of 0.105 - 1.005mg/kg obtained by Odhiambo *et al.*, (2015) and 0.18 - 2.60mg/kg by Amadi and Nwankwoala, 2013 for Narok Kenya and Aba respectively. However the result was lower than the range of 28.56 - 40.17mg/kg obtained by Anietie and Labunmi, (2015) for Akure metropolis Table 2. The result obtained in this present study was quite higher than the target value of 0.80mg/kg set by DPR (2002). Cadmium gets accumulated in the intestine, liver and kidney when ingested by humans and chronic exposure may lead to proximal tubular disease and osteomalacia (Pascual *et al.,* 2004).The level of cadmium obtained in this study calls for concern considering the toxicity of cadmium.

Zinc concentration ranged from 13.16 – 17.62mg/kg with a mean value of 15.39mg/kg. Zinc result obtained was higher than 4.35mg/kg in the control. Zinc concentration was above the range of 0.728 - 4.654mg/kg reported by Odhiambo *et al.,* (2015) and 2.40 - 28.50mg/kg by Amadi and Nwankwoala, (2013) for Narok Kenya and Aba respectively. Similarly result obtained was very much below the range of 128.11 – 289.27mg/kg reported by Njagi et al., (2016) for Kadhodeki dumpsite in Kenya and 86.29 - 95.28mg/kg by Anietie and Labunmi, 2015 for Akure metropolis (Table 2). Zinc result was below the 146mg/kg target value permitted by DPR, (2002) for soil and sediments (Table 3).

**Table 1 Distribution of metals (mg/kg) of soil around waste dumpsite in Ughelli metropolis**

| Sample location | Metal concentration (mg/kg) | | | | | |
|---|---|---|---|---|---|---|
| | Fe | Pb | Cd | Zn | Cu | Mn |
| **Oteri road dumpsite soil** | 18.23 | 1.28 | 4.72 | 17.62 | 1.32 | 29.82 |
| **Patani road dumpsite soil** | 32.31 | 1.36 | 6.23 | 13.16 | 1.35 | 26.36 |
| **Mean** | 25.27 | 1.32 | 5.48 | 15.39 | 1.34 | 28.09 |
| **Control site soil** | 10.71 | 0.06 | 0.35 | 4.35 | 0.38 | 4.28 |

**Table .2 Comparison of the Range of Heavy Metals (mg/kg) of Dumpsite Soils in Present Study with that of Other Researchers**

| Metal | Concentration (mg/kg) | |
|---|---|---|
| | Present study | Previous studies |
| Fe | 18.23 - 32.31 | 22.01 - 525.50[a] |
| | | 185.57 - 213.97[b] |
| | | 19.56 - 25.47[c] |
| Pb | 1.28 - 1.36 | 40.66 - 56.16[b] |
| | | 0.101 - 2.003[d] |
| | | 0.24 - 2.15[e] |
| Cd | 4.72-6.23 | 28.56 - 40.17[b] |
| | | 0.105 - 1.005[d] |
| | | 0.18 - 2.60[e] |
| Zn | 13.16-17.16 | 40 - 336[a] |
| | | 86.29 - 95.28[b] |
| | | 0.728 - 4.654[d] |
| | | 2.40 - 28.50[e] |
| Cu | 1.32-1.35 | 43.02 - 2089.61[a] |
| | | 31.34 - 52.48[b] |
| | | 1.06 - 15.98[e] |
| Mn | 26.36-29.82 | 5490.60 - 14419.10[a] |
| | | 0.30 - 92.10[e] |

[a]Njagi *et al.*, 2016; [b]Anietie and Labunmi, 2015; [c]Ajibola and Ozigis, 2005; [d]Odhiambo *et al.*, 2015; [e]Amadi and Nwankwoala, 2013

**Table 3: Department of Petroleum Resources (DPR, 2002) Target Value**

| Metal | Target values (mg/kg) |
|---|---|
| Cadmium | 0.8 |
| Chromium | 100 |
| Copper | 36 |
| Nickel | 35 |
| Lead | 85 |
| Zinc | 146 |
| Cobalt | 20 |
| Manganese | 100-300* |
| Iron | 1000* |

* USEPA (1986)

## DISCUSSION

Copper concentrations ranged from 1.32 – 1.35mg/kg with an average value of 1.34mg/kg (Table 1). The result was above the 0.38mg/kg for the control. Copper result was within the range of 1.06 - 15.98mg/kg reported by Amadi and Nwankwoala, (2013) for Aba but lower than the range of 31.34 – 52.48mg/kg reported by Anietie and Labunmi, (2015) for Akure metropolis. The result was also very much lower than the range of 143.02 – 2089.61mg/kg reported by Njagi *et al.,* (2016) for Kadhodeki dumpsite in Kenya. Copper concentration was below the 36mg/kg target value permitted by DPR (2002).

Manganese concentration ranged from 26.36 – 29.82mg/kg with a mean concentration of 28.09mg/kg. The result was high compared to the 4.28mg/kg obtained for the control. The result was lower than the range of 5490.60 – 14419.10mg/kg reported by Njagi *et al.,* (2016) for Kadhodeki dumpsite, Kenya. The concentration of the metal was within the 100 - 300mg/kg acceptable value by USEPA, (1986) for soil.

The results obtained in both sites are far above the values obtained from the control site. This is an indication that metal enrichment in the soil was caused by waste present in sampled dumpsites as shown in table 1.

## CONCLUSION

The concentration of the heavy metals obtained in this study follow the sequence: Mn>Fe >Zn>Cd>Cu>Pb for soil around "Oteri road dumpsite" and Fe> Mn>Zn>Cd>Pb>Cu for soil around "Patani road dumpsite". It is worthy of note that the heavy metal concentration obtained though elevated as a result of waste present in the dumpsites were below DPR permissible target limits except cadmium. Cadmium result obtained in this study calls for concern. Therefore all hands must be on deck to put things right in order to promote a healthy environment for sustainable development.

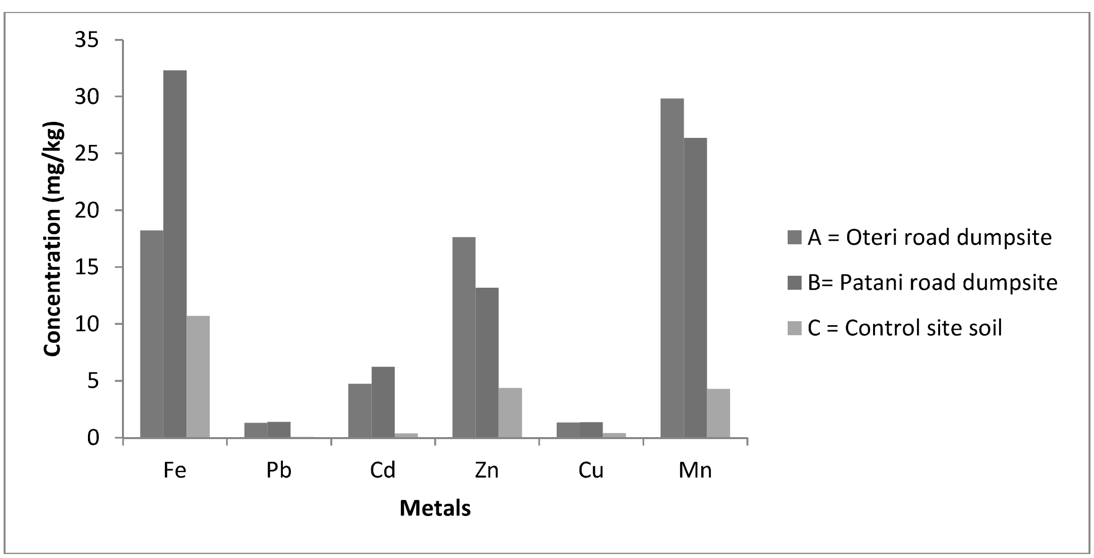


*Figure 1 Bar chart showing the distribution of Fe, Pb, Cd, Zn, Cu, and Mn in Ughelli Metropolis dumpsites*

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