

Evaluation of Some Heavy Metals Concentration in Soil Around Waste Dumpsite in Aniocha South L.G.A of Delta State Nigeria

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ABSTRACT: The study analyzed the concentration of heavy metals in selected dumpsites in Ogwashi-Uku and its environs, and the impact on human health as soil contamination from agricultural fields leads to contamination of agricultural products. These produce when consumed have adverse effects on human health. A total of 12 soil samples collected from the dumpsites using a soil auger were collected at different depths of 0-15 cm for each sampling point to assess heavy metal content. Analysis revealed that metal concentrations in soil samples ranged from 0.001 to 0.049 ppm, with average concentrations of Cd (9.58×10^{-3}), Pb (9.58×10^{-3}), Zn (0.030), K (0.020), Na (0.019), Cu (0.055) in ascending order. Although the concentration of heavy metals in this study is below the permissible limit of FAO/WHO, soil monitoring and remediation is recommended.

Keywords: Soil, Heavy metals, Dumpsites, Human health, AAS.

1. Introduction

Population growth and industrialization have led to an increase in the production of domestic, municipal and industrial waste, which is dumped untreated into landfills and water bodies (Ugbome et al., 2018). Most of this refuge was created by inappropriate agricultural and industrial expansion (Saheed et al., 2020). Urban areas characterized by a high level of industrial activity produce greater pollutants and are vulnerable to the illegal disposal of domestic and industrial waste (Tenee et al., 2015). Open dumping of waste is the most common method of waste management and is one of the latest global challenges facing cities and towns and this practice remains so in most parts of Nigeria (Ugbome et al., 2018). Nigeria is one of the developing countries in the world that has many towns and cities with inadequate waste management plans such as Ogwashi-Uku (Saheed et al., 2020). One of the main problems of dumpsites is air pollution, which can affect public health both in rural and urban areas (Adewale, 2009). Uncontrolled or illegal waste disposal is a disaster for human health and environmental degradation (Ugbome et al., 2018). Most of Nigeria's cities are growing without proper planning, resulting in open dumping of garbage in built-up areas where millions of people live. As a

result, such waste becomes the main source of soil pollution (Amadi et al., 2013). In some cases, waste is thrown into various dumpsites without considering the damage to the environment while in other cases remains are burnt in the open and the ashes are thrown away in open places.

The concentrations of heavy metals around waste dump sites are influenced by types of waste dumped along roadside are usually left over a long time to decompose naturally by micro-organisms, eaten by animals and picked by scavengers. Heavy metals are classified as metals and metalloids that have atomic densities greater than 5 g/cm^3 . Soil is considered contaminated when the concentration of heavy metals in this range exceeds the allowable limits for uncontaminated soil. In fact, soil pollution has adverse effect on food safety, thereby increasing health risk (Eyenubo et al., 2020). The uptake of these metals by plants, animals, flow of same into river bodies and into groundwater is a means of entry into the human food chain (Dosumu et al., 2003). The effects of these metals depend on the concentration and PH level in the system (Saheed et al., 2020). They also result in problems of the nervous system and the genitourinary system (Eyenubo et al., 2020). With regard to waste, the main dumpsite issues are air pollution in rural and urban areas which gives out gas that is composed of methane and carbon dioxide produced by degradation of such waste. Improper management of organic and inorganic waste materials in dumpsite could affect the soil toxic heavy metals; it could also be taken directly by man and other animal through inhalation of dusty soil. In Ogwashi-Uku and the surrounding area, there is no documented evidence of the devastating effects of heavy metals on humans. It is therefore significant to ascertain the level of these heavy metals concentration in the soil, highlight the measured heavy metal effect on human, create awareness of the dangers of heavy metals concentration in the soil around waste dumpsite and also suggest ways to manage and reduce heavy metal concentration and contamination in soil and environment.

Methodology

The study was carried out in three selected communities (Fig.1), in Aniocha south local government areas of Delta state.

A total of 12 soil samples collected from the dumpsites using a soil auger were collected at different depths of 0-15 cm for each sampling point to assess heavy metal content. At each sampling location, a handheld GPS was used to record their longitude, latitude and altitude. The collected samples were thoroughly mixed on the polyethylene bag and sent to the laboratory where they were air dried at room temperature for 3 days (USAID, 2009 and Kebede et al. 2016). Soil samples were disintegrated, crushed and ground into fine powder form and sieved into a 2 mm sieve with mortar and pestle for analytical purposes. The soil samples were analysed for Cu, Cd, Zn, Pb, K and Na using an AA240 Atomic Absorption Spectrometer. All chemicals used were of analytical reagent grade and deionized water were employed throughout for dilutions and washing. The average mean of all the values were determined.

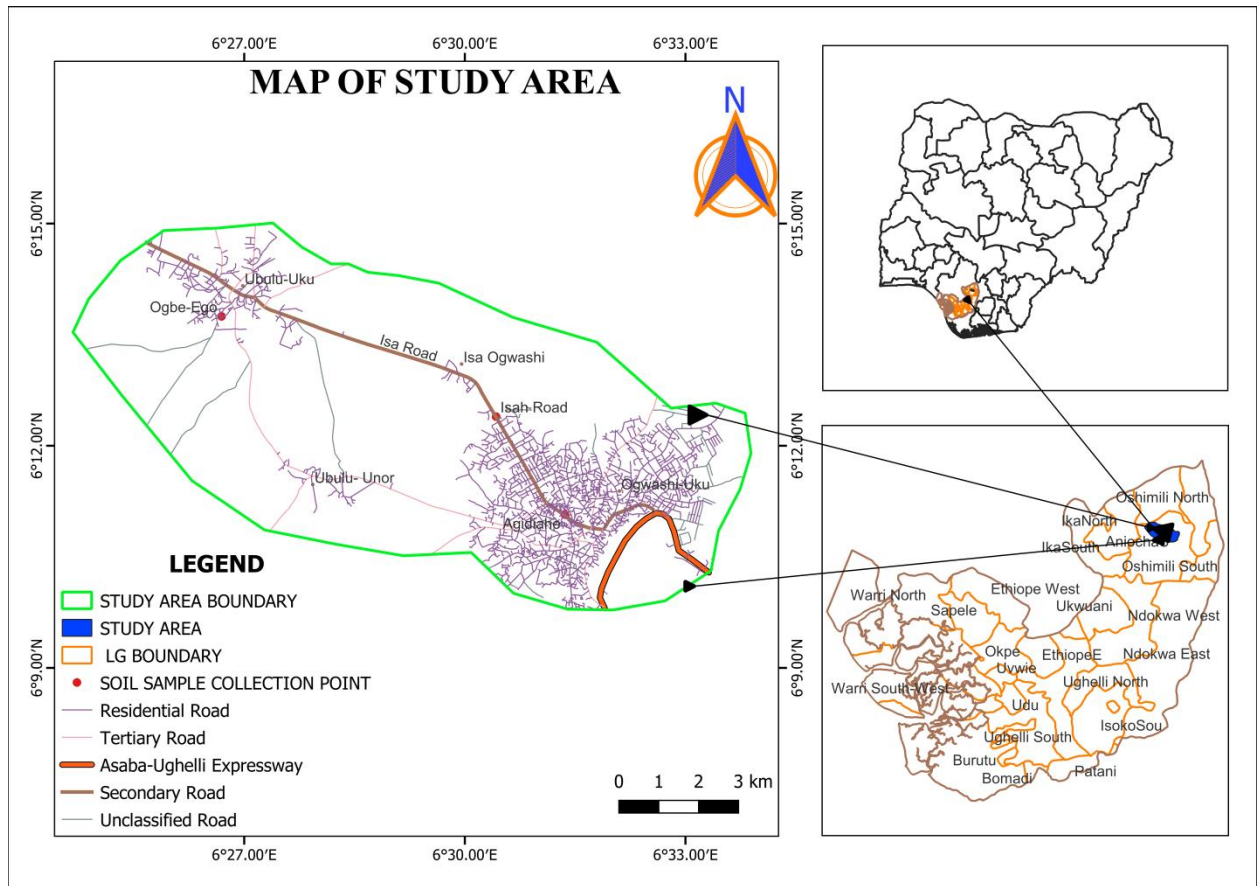


Figure 1: Map of the Study Area

Results

The results of the physiochemical analysis of the properties of heavy metals in soil sample from dumpsite in the study location are presented in Table 1 below.

Table 1: Description and Characteristics of the Selected Dumpsites

Dumpsite	Age (yrs)	Coordinates	Amplitude (m)	Waste Description
Isah Road	20+	6.206547° 6.507071°	191	Plastics, tins, rags, papers, dry battery cells, bottles, motor parts, machine parts discarded metals, disposed food items, metal cables.
Ogbe – Ego	15+	6.229105° 6.444853°	183	Plastics, tins, rags, papers, dry battery cells, bottles, Discarded metals, disposed food items.
Agidiehe	15+	6.184505° 6.522677°	188	Plastics, tins, rags, papers, dry battery cells, bottles, machine parts, discarded metals, disposed food items, metal cables.

Table 2: Concentration of Elements in the Soil Sample of Selected Dumpsites.

Dumpsite Location	Depth (cm)	Heavy metal concentration (ppm)					
		Cd	Pb	Zn	K	Na	Cu
Isah Road	0 – 0.5	0.009	0.009	ND	0.025	0.023	0.009
	0.5 – 5	0.038	0.038	0.025	0.022	0.018	0.038
	5 – 10	0.011	0.011	0.002	0.012	0.015	0.011
	10 – 15	0.014	0.014	0.039	0.054	0.050	0.009
Ogbe – Ego	0 – 0.5	0.004	0.004	0.044	0.003	0.001	0.004
	0.5 – 5	0.005	0.005	0.017	0.023	0.020	0.005
	5 – 10	0.007	0.007	0.028	0.022	0.020	0.007
	10 – 15	0.003	0.003	0.022	0.034	0.034	0.003
Agidiahe	0 – 0.5	0.010	0.010	0.032	0.018	0.016	0.010
	0.5 – 5	0.001	0.001	ND	0.014	0.034	0.001
	5 – 10	0.011	0.011	0.049	0.011	0.011	0.011
	10 – 15	0.002	0.002	0.044	0.006	0.003	0.002

Cd – Cadmium Pb – Lead Zn – Zinc K- Potassium Na – Sodium Cu – Copper ND – Not detected

Table 3: Physiochemical Properties of Soil Sample for the Selected Dumpsites at Varying Depths

Depth (cm)	Isah Road				Ogbe – Ego				Agidiehe				Average			
	0–0.5	0.5–5	5–10	10–15	0–0.5	0.5–5	5–10	10–15	0–0.5	0.5–5	5–10	10–15	0–0.5	0.5–5	5–10	10–15
Moisture Content %	9.10	22.70	23.89	20.14	8.44	53.77	51.72	32.62	9.72	29.30	21.01	12.90	9.40	28.60	32.21	21.90
Soil Organic Matter %	0.11	0.16	0.40	0.20	0.10	0.20	0.91	0.15	0.11	0.67	0.12	0.12	0.11	0.34	0.50	0.20
Electrical Conductivity ($\mu\text{Sm/cm}$)	385	202	222	237	225	188	171	177	192	166	158	160	267.3	185.3	184	191.3
Exchange-able Acidity (Cmol/kg)	7.2	4.8	1.6	1.28	3.2	1.2	1.04	0.96	0.96	0.8	0.72	0.64	4.0	2.3	1.1	1.0
Cation Exchange Capacity (Cmol/kg)	7.67	5.30	2.03	1.70	3.64	1.60	1.43	1.40	1.32	1.10	1.03	1.00	4.21	3.0	1.5	1.4

Discussion

The physiochemical properties and heavy metal content of soil sample from selected dumpsites in Aniocha south local government area of Delta state have been presented in tables 1 – 3.

Table 2 shows concentration of heavy metals in the soil sample of dumpsites.

Moisture content in table 3 is proportional to the water holding capacity of the soil have values which ranged from 8.44 to 53.77% with Ogbe – Ego having the lowest and highest values at soil depths of 0 – 0.5 cm and 0.5 – 5 cm respectively. These values are however lower when compared to the moisture content values obtained in (Uba *et al.*, 2008).

The percentage for soil organic matter ranged from 0.10 to 0.91% which is quite low. Although Ogbe – Ego is not the oldest of the sampled dumpsites, but it has a higher organic matter decomposing factor. This known fact is the reason for an increase in the humus content and also gives high humic acid results and lower the soil pH value (Kebede *et al.*, 2016).

The Electrical Conductivity (EC) which is directly proportional to the salinity of the soil has values ranging from 158 to 385 $\mu\text{Sm}/\text{cm}$. The highest value was obtained at the dumpsite in Isah road at a depth of 0 – 0.5 cm and the lowest value was obtained at Agidiehe at depth 5 – 10 cm.

Exchangeable Capacity values shows a slight decreasing variation, indicating that as depth increases, the value for exchangeable capacity also decreases at varying depths. This means that there is a correlation between exchangeable capacity and depth.

The value for the Cation Exchange Capacity (CEC) shows a slight decreasing variation for all considered dumpsites. The result shows that as depth increases for all dumpsite, the values decrease. Fatubarin and Olojugba's study on the effect of rainfall season on the chemical properties of the soil of a southern guinea savannah cation exchange capacity shows that CEC value increases as depth increases (Fatubarin and Olojugba, 2014). This difference may be due to differences in the soil property.

Effects of Detected Elements on Human Health.

Heavy metals such as Cadmium, Lead, Zinc, Potassium, Mercury, Arsenic, Sodium and Copper are everywhere in the air we breathe, the foods we eat, the water we drink and many beauty products we use on our skin. These heavy metals find their way into the human body and accumulate over a long period of time which makes them toxic to organs (liver, kidney, lungs, heart etc) in the human body.

Cadmium (Cd)

Cadmium a carcinogenic metal finds its way into the human body by being absorbed in the lungs and gastrointestinal tract and affects the kidney also causes osteo malacia (Sobha *et al.*, 2007). Effects of Cd on the human health depend on the exposure time to Cd. Cd at high levels cause's kidney problems, anaemia and bone marrow disorder. From results presented in table 4.2, the mean total concentration of Cd in the soil samples of the dumpsites analyzed are 0.019, 0.005 and 0.001 mg/Kg for Isah road, Ogbe-Ego and Agidiehe respectively.

The highest mean total concentration value of 0.019 mg/Kg is low when compared to internationally recommended limit of 3.0 mg/Kg by United States Environmental Protection Agency (USEPA, 1986) and (Maff and Welch, 1992).

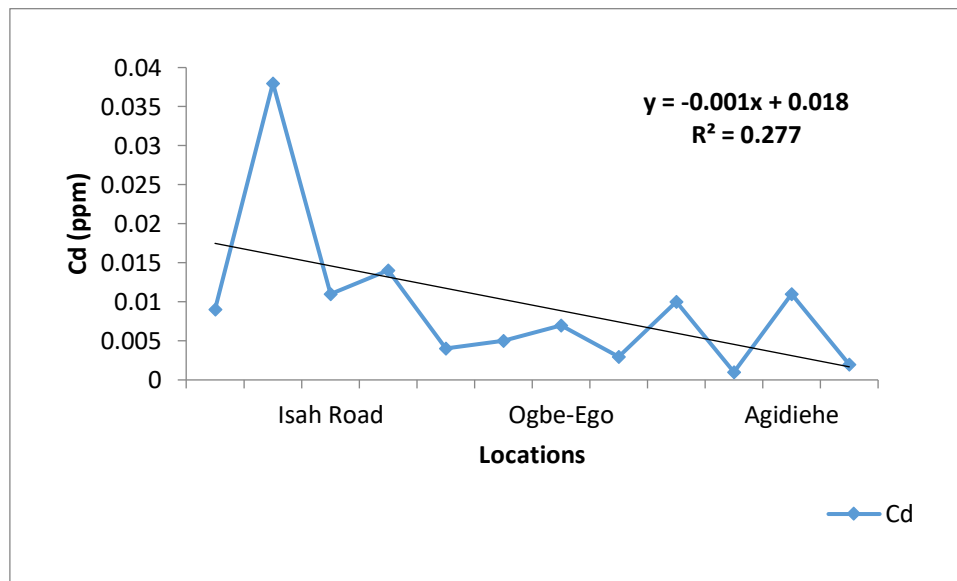


Figure. 2: Graph showing the relationship between Cd conc. and location.

Lead (Pb)

Lead occurs naturally in the earth crust and exposure to excess lead poisoning is toxic to human health. Lead which enters the body through the food and water we consume results to headache, irritability, abdominal pain and loss of weight. Other known health effects of lead poisoning are kidney dysfunction, poor performance of the liver and brain, reproductive system disorder (Odum, 2000) and (Singh and Kalamdhad, 2011). The values of lead mean concentration in this study ranged from 0.02, 0.0004 and 0.001 mg/Kg for Isah road, Ogbe-Ego and Agidiehe respectively. The concentration of lead for the considered dumpsites slightly increases and the decreases as depth increases which implies that there is no correlation between lead concentration and depth.

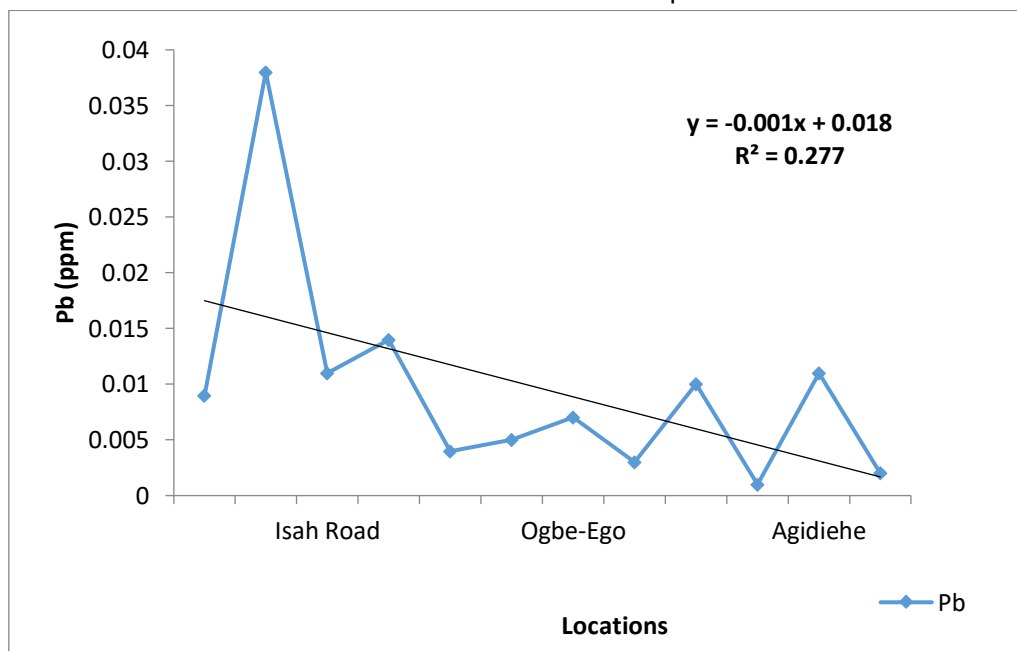


Figure 3: Graph showing the relationship between Pb conc. and location.

Zinc (Zn)

Zinc as an essential trace element is non-toxic when taken orally, it is used the treatment of skin problems like boils, sore throat and acne (Adegoke *et al.*, 2009). However, excess amount of zinc in

the human body can lead to impairment of reproduction and growth due to underperforming immune system (Adegoke *et al.*, 2009). The value of zinc in this study ranged from 0.002 to 0.049 mg/Kg. Although zinc was not detected in the dumpsite at Isah road at depth of 0 – 0.5 cm and also at Agidiahe dumpsite at depth of 0.5 – 5 cm. This value were however low when compared to the result of zinc concentration in Uba et al study of heavy metals availability in dumpsites of Zaria metropolis (Uba et al. 2008).

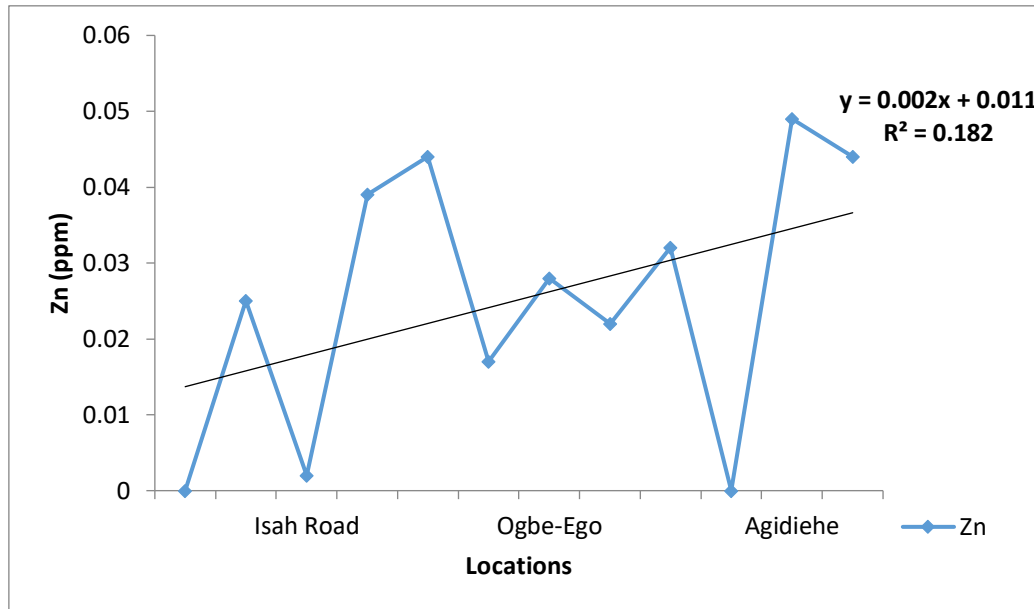


Figure 4: Graph showing the relationship between Zn conc. and location.

Potassium (K)

The kidney plays an important role to ensure that the body functions properly by removing waste products from the body. Potassium is an electrolyte found in most food we eat. In the right level, it helps in improving brain performance, support bone growth and reduces muscle cramp, However high potassium in the blood can be dangerous. It causes heart attack and sometimes leads to death. Potassium values in the study are quite low as lab analysis revealed them to range from 0.003 mg/Kg which is the lowest value obtained at a depth of 0 – 0.5 cm at Ogbe-Ego while the highest value obtained at depth of 10 – 15 cm is 0.054 mg/Kg at Isah road.

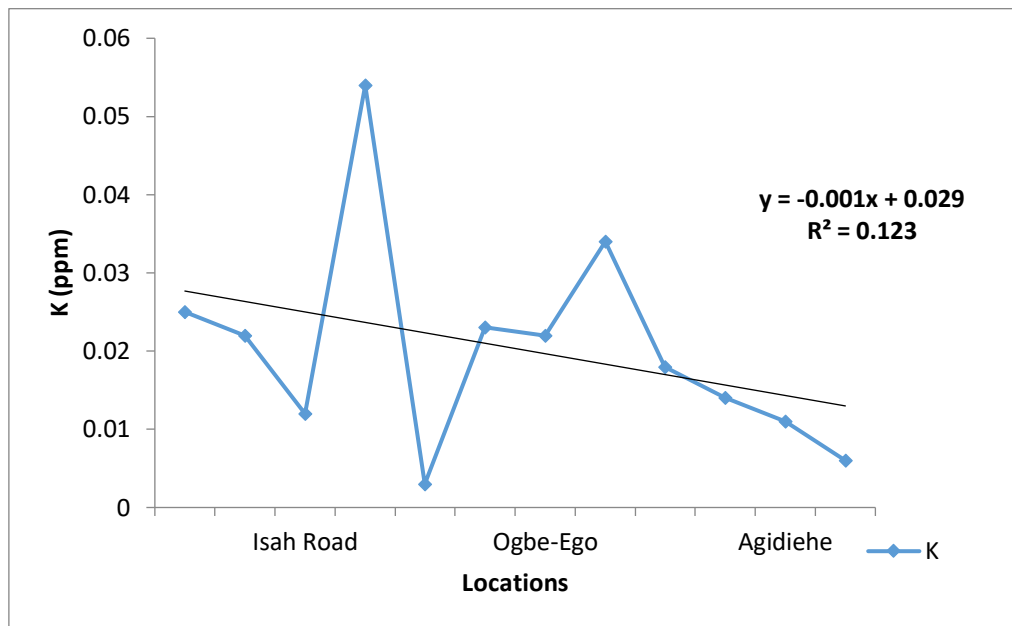


Figure 5: Graph showing the relationship between K conc. and location.

Sodium (Na)

Sodium is a light metal and a vital electrolyte that is necessary for the survival of humans but only in the right quantity. Excess amount of sodium in the body can cause muscle cramp, sore throat, skin, low brain performance and heart attack. This study has revealed that at depth of 10 – 15 cm, sodium concentration is 0.050 mg/Kg recorded at Isah road while the lowest value was recorded at Ogbe-Ego.

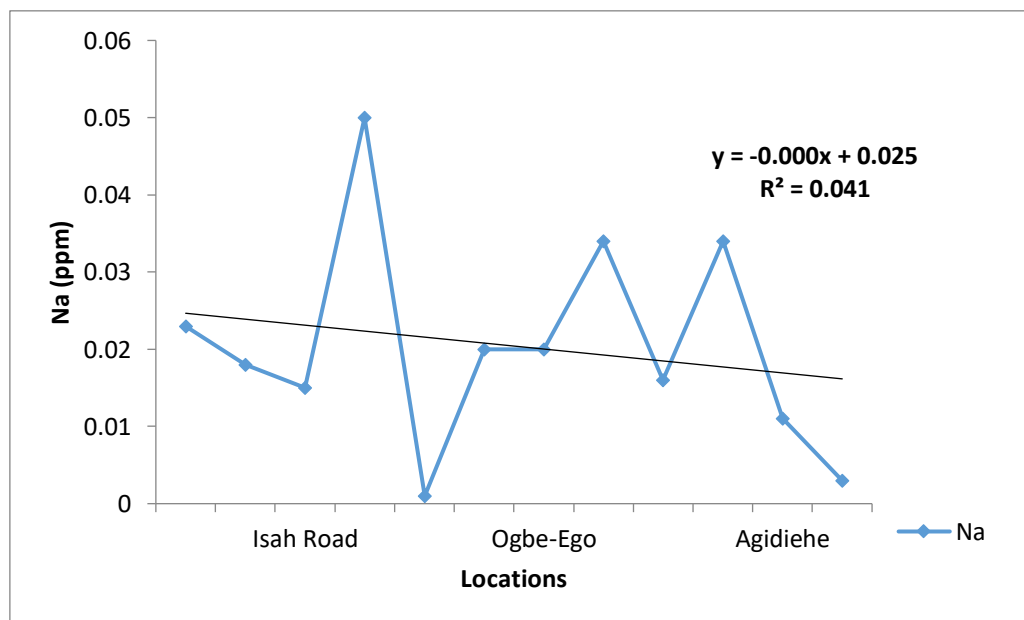


Figure 6: Graph showing the relationship between Na conc. and location.

Copper (Cu)

Copper is an element found everywhere in the soil and it is a trace mineral that helps in the formation of red blood cells. As a trace element, only little amount of copper is needed in the human body for proper growth. Excessive human intake of copper may lead to anaemia, severe mucosal irritation and corrosion, abdominal pain, nausea, vomiting, bone abnormalities, hepatic and renal damage, irregular

heartbeat, widespread capillary damage and central nervous system irritation followed by depression. Severe cases of copper accumulation can also lead to gastrointestinal irritation and possible necrotic changes in the liver and kidney can also occur (Odum, 2000, Argun *et al.*, 2007 and Singh and Kalamdhad, 2011).

The concentration of copper for Isah road and Ogbe-Ego slightly increases and then decreases as depth increases while the concentration of copper for Agidiehe slightly decreases and the increase as depth increases.

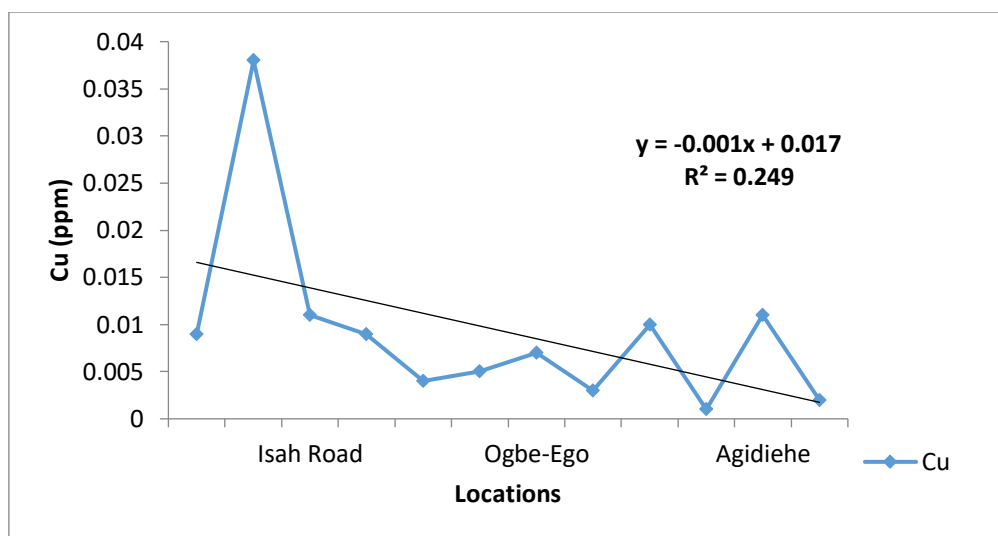


Figure 7: Graph showing the relationship between Na conc. and location.

Conclusion

The concentration and physiochemical properties of heavy metals in soil samples from selected dumpsites have been analyzed and result presented in tables above. The result from the analysis revealed that values of heavy metals slightly increase and then decreases as depth increases for all dumpsites considered indicating that there is no correlation between element concentration and depth. Although the values for the concentration and physiochemical properties are lower than the internationally recommended limit and pose no immediate threat to the populace, accumulation of these toxic metals over time may be harmful to human health.

Conflicts of Interest

There are no conflicts to declare.

References

- Adegoke, J.A., Agbaje, W.B., and Isaac, O.O. (2009). Evaluation of Heavy Metal Status of Water and Soil at Ikogosi Warm Spring, Ondo State, Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 2 (3).
- Amadi, A.N. and Nwankwoala, H.O. (2013). Evaluation of heavy metal in soils from Enyimba dumpsite in Aba, south-eastern Nigeria using contamination factors and geo-Accumulation index. *Energy and Environment research*, 3 (1), 125-134.
- Argun, M.E., Dursun, S., Ozdemir, C., and Karatas, M. (2007). Heavy metal adsorption by modified oak sawdust: Thermodynamics and kinetics. *Journal of Hazardous*

- Eyenubo, O.B., Peretomode, O., Egharevba, F. and Osakwe, S.A. (2020). Assessment of some heavy metal pollution on soil through E-waste dumping activity and unpolluted soil in Abraka, Delta state, Nigeria. *Arid Zone Journal of engineering, technology and Environment*.16(4),741-750.
- Fatubarin, A., and Olojugba, M.R. (2014). Effect of rainfall season on the chemical properties of the soil of a Southern Guinea Savanna ecosystem in Nigeria. *Academic Journals of Ecology and the Natural Environment*, 6(4), 182-189.
- Kebede, A.A., Olani, D.D. and Edesa, T.G. (2016). Heavy Metal Content and Physico-Chemical Properties of Soil around Solid Waste Disposal Sites. *American Journal of Scientific and Industrial Research*, 7(5), 129–139.
- Maff and Welch Office Agriculture Department (1992). Code of good agricultural practice for the protection of soil. Draft Consultation Document, MAFF London.
- Odum, H.T. (2000). Back Ground of Published Studies on Lead and Wetland. In: Howard T. Odum (Ed), *Heavy Metals in the Environment Using Wetlands for Their Removal*, Lewis Publishers, New York USA, pp. 32.
- Saheed ,I.O.,Azeez ,S.O.,Jimoh,A.A., Obaro, V.A. and Adepoju, (2020). Assessment of some heavy metal concentration in soil and groundwater around refuse dumpsite in Ibadan metropolis, Nigeria. *Nigerian journal of technology*, 39(1), 301-305.
- Singh, J. and Kalamdhad, A.S.(2011). Effects of Heavy Metals on Soil, Plants, Human Health and Aquatic Life. *Int. J. Res. Chem. Environ*, 1(2), 15-21.
- Tenee, F.B.G. and Eshalomi, T.N.M. (). Heavy metal content in plants and soils in abandoned solid waste dumpsite in portharcourt, Nigeria. *Research journal of environmental toxicology*, 9(6), 342-349.
- Uba, S., Uzairu, A., Harrison, G.F.S., Balarabe, M.L., and Okunola, O.J. (2008). Assessment of heavy metals bioavailability in dumpsites of Zaria Metropolis, Nigeria. *African Journal of Biotechnology*, 7 (2), 122-130.
- United State Environmental Protection Agency, “Guidelines values for soil quality, USAID (2009) “Solid waste generation, handling, treatment and disposal” Forum the American People, vol. 11, 1992.
- USEPA. (1986). Test Methods of Evaluation for Solid Waste (USEPA S/W 846 UEPA Washington DC).
- Dosumu, O.O., Salami, N., and Adekola, F.A. (2003). Comparative study of trace element levels. *Bull. Chem. Soc. Ethiop*17 (1), 107-112.



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