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Heavy Metal Concentrations In The Soil Around Waste Dump At Airport Road Port Harcourt And Implication To Health

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ABSTRACT
The heavy metals(HM) concentrations in the soil and stagnant water around a waste dump in airport road Port Harcourt Nigeria was studied in order to determine the levels of the HM concentrations with respect to health implications. The analytical results on the soil samples depicts that most of the metals in the soil are higher than the World Health Organization W.H.O recommended standard. Lead (Pb) concentrations is very high in five soil samples. The lead concentrations fall within the range of 20-77ppm. Chromium (Cr) concentration is high in all the soil samples. Chromium in the soil is within the range of 3.8-155ppm. Iron (Fe) concentrations range between 16209-24795ppm, this value is tremendously high when compared with W.H.O. standard. Copper (Cu) is high in eight samples and falls within the range of 8.8-1057ppm. Nickel (Ni) has a range of 0.05-191ppm in the soil sample, this value is above 10ppm recommended by W.H.O. Zinc (Zn) has a range of 20-465ppm which is higher than 0.6ppm recommended by W.H.O. Cadmium (Cd) values range between 0.75-18.40ppm in the soil sample of the study area. Absorption of heavy metals from soil by plants have created channel through which heavy metals enter human body via food chain. Heavy metals become toxic in the body when it exceeds the permissible limit but no amount of lead (Pb) is tolerable in the body. The heavy metals in the water samples are insignificant when compared with the W.H.O. standard. Heavy metals contamination is found in the soil of the study area. Excessive heavy metals in human body are causative agents of non-communicable diseases like cardiac disorder, respiratory dysfunction, renal failures, liver and lungs problems, blindness, neuro-dysfunction, cancer and death. It is necessary that the heavy metals concentrations in the soil is monitored in order to ensure a healthy environment for human sustainability.
Keywords: Metals, Soil, dysfunction, Non-communicable diseases

INTRODUCTION

The soil is one of the sphere (biosphere) of the environment which deserve much attention. Onwualu-John and Offodile (2023) stated that every sphere of the environment interacts with each other in one form or the other. Heavy metal pollution in the biosphere (soil) is of a great concern because heavy metals pollution in a soil is a high risk to human, more so, heavy metals do not undergo degradation (Briffa et al, 2020). Prolong exposure to heavy metal is very dangerous to human and the environment (Mitra et al, 2022). Heavy metals pollution in the soil is rampant due to societal development and causes threat to life and environment because of its long stay in the soil, Yinjun et al. (2020). Sources of heavy metals in the soil around the waste dump is attributed to industrial discharge, wastes from hospitals, homes, agriculture and E wastes. Tchounwou et al 2012 documented that heavy metals in the soil and environment are associated with industrialization, domestic factors and agricultural factors.

Heavy metals in soil causes poor agricultural output and the entrance of the heavy metal in the body through food chain causes health problems, Nyiramigisha et al (2021). All heavy metals except lead(Pb) are not toxic when they are within the tolerable limit .

Heavy metals have pose much threat to life and to the environment (Cimbolakova et. al. 2020). Heavy metals pollution destroys the sustainability of the soil and environment. Heavy metal polluted soil has a way of contaminating the ground water through metal distribution. Heavy metals are causative agents to many diseases. Much concentrations of heavy metals in the environment have the ability to cause climate change (Andreea et. al. 2022). High concentrations of heavy metals in the soil or farm lands can pollute the water bodies (surface water and underground water) through runoff or through percolation/infiltration. Flooding and weathering facilitates metal distributions and through this process lands get contaminated with heavy metals.

The soil of the study area is heavily polluted by heavy metals; the heavy metals probably enter the soil through a nearby waste dump. High concentrations and long exposure of heavy metals pollution in a soil is a tremendous risk to crop production and human health (Ahmed et al., 2021), persistence high concentrations of heavy metals in the soil destroys the fertility of the soil.

This study is to evaluate the level of heavy metals concentrations in the soil around a dump site and to determine the health implications

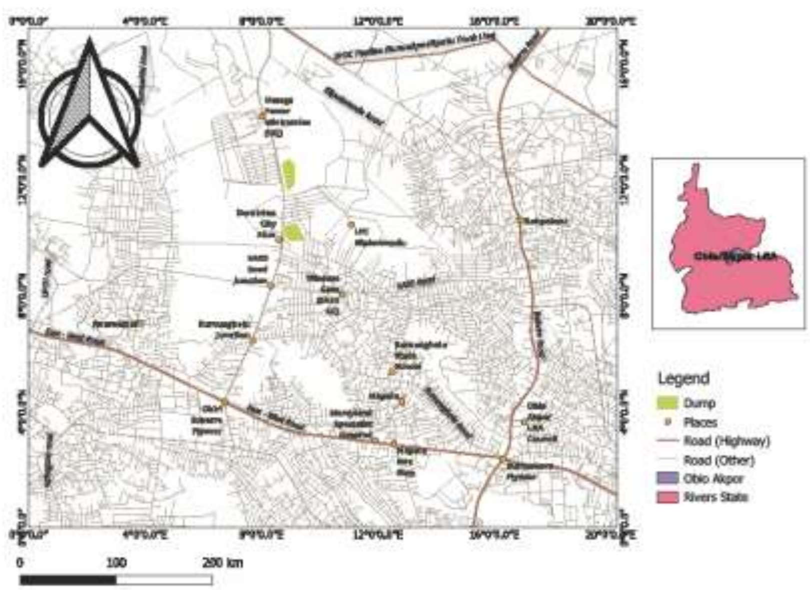

Figure 1: Map showing the study area and environ

Geologic Setting

The study area is part of the Niger Delta Basin. The Niger Delta Basin consist of Benin Formation, Agbada Formation and Akata Formation. Wright et al, (1985), described each unit of the basin, the Benin Formation is described as the delta top sand which consist of sands and gravels, poorly sorted, and cross bedded with clay and the sediment thickness is about 2000m, while the Agbada Formation represents the offshore and continental shelf environment which consist of sequence of sands followed by shales and have a thickness of about 400m, then the Akata Formation is described as the continental slope mud and fine sand emplaced at the delta front., the Akata Formation is between 600 and 6000m thick

MATERIALS AND METHOD

Fresh soil samples were collected at different location around the waste dumps and water samples were also collected from stagnant waters very close to the dumpsite. The soil sampling was done in a grid pattern which involves dividing the site into units, the soil samples were collected with a trowel to a depth

of about 7inches. Plant debris and rock fragments were avoided during the sample collection, the soil samples were put inside cellophane bag and sent to laboratory for soil sample analysis.
The water samples were put in rubber container and placed inside in a cooler that contains ice block before being sent to laboratory for analysis. The water sample were digested with nitric acid and AAS (Atomic Absorption Spectrometry) was used to analyze for the heavy metals. The results were compared with world health organization (W.H.O) standard.

RESULTS AND DISCUSSIONS

Table1.0: Shows heavy metals concentrations in the soil samples and in a stagnant water near the dump site

	Heavy Metals Concentrations in Parts Per Million(PPM)							
samples	Pb	Hg	Cr	Fe	Cu	Ni	Zn	Cd
S1	23.85	Nd	56.10	22704.00	8.80	Nd	33.30	5.20
S2	32.90	Nd	80.30	24795.00	15.85	0.05	19.95	5.15
S3	20.20	Nd	91.50	20863.00	15.65	1.20	91.55	2.30
S4	Nd		3.75	18404.74	42.80	23.85	212.80	0.75
S5	77.25		147.05	22826.65	1056.50	176.10	637.50	18.40
S6	Nd		48.25	20118.85	68.75	16.25	308.80	0.95
S7	Nd		57.75	16209.30	27.65	27.80	115.65	6.70
S8	Nd		34.70	16515.70	37.70	108.10	152.70	5.95
S9	20.80		154.85	22616.05	291.70	190.80	465.05	6.95
Range	20-77		3.8-155	16209-24795	8.8-1057	0.05-191	20-465	0.75-18.40
Mean	43.75		74.91	18536.59	173.9	68.018	226.36	5.81
W1	ND		0.029	3.559	Nil	Nil	0.003	0.115
W2	ND		0.053	3.559	0.203	0.481	0.365	0.083
W.H.O	2		1.6	425.5	10	10	0.6	0.02

S1-S9 = Soil samples
W1-W2= stagnant water samples

Lead in the samples are higher than W.H.O. recommended value and this makes the soil to be hazardous to health. The absorption of lead by the plant root into the crop as well as being consumed by human is detrimental to health, it can result to damage of the renal, reproductive and central nervous system (Gagan et al., 2012). World Health Organization stated that lead poisoning in the environment/soil can result from lead acid batteries, pigments, lead paints, stained glass, solders, lead crystal glassware, ammunition, ceramic glazes, jewelry, toys, some cosmetics, mining. There is no amount of lead that is tolerable to health
Chromium in the whole samples are higher than WHO recommended value (Table 1.0). The implication of high concentration of chromium in the soil is that when the chromium enters human body through food chain, it causes skin irritatation, asthmatic reaction, bronchial carcinomas and renal deficiency (Baruthio, 1992). Ming et al, 2022 stated chromium can enter the soil through geogenic and anthropogenic process. Chromium has been regarded as one of the most hazardous element, chromium toxicity results to organ impairment and cancer (Xumeng2022). Chromium persist for a long time in soil due to high solubility of chromium (IV), Oze et al., 2007. Chromium VI persist in water and in soil but highly stable in soil, it is soluble and toxic to man, animals and plants (Ertani et al 2017). Reaction of geogenic chromium (111) with MnO results to formation of chromium (iv) Hausladen and Fendorf, 2017.
Iron is required for healthy life (Nazanin et. Al. 2014). When the concentration of iron is very high in the soil, it can affect the surface water through runoff from the soil, this phenomenon also affects the aesthetic nature of the soil, the aquatic life, the hardness of the water as well as human health, if iron is being ingested. Excess iron in the body results to stomach upset, inflammation, stunted growth in children, and impaired organ development (Lonnerd, 2017). Table 1.0 indicates that the iron

concentration in the soil is extremely high when compared with the WHO standard. There is every tendency that the iron content of the soil will be absorbed by the plant due to the soluble nature of iron and this will probably affect the crop yield.

The main source of iron in soils is from secondary oxides absorbed or precipitated onto soil and iron–organic matter complexes (Jones, 2020). Leaching of organic matter and ferruginized top soil can increase the concentrations of iron in the soil. Trapped water in the pore spaces of the soil can get oxidize and add iron to the soil.

Copper is higher than WHO standard in all the samples except in sample S1 which is lower than the WHO recommended standard. There is no harm in the sample being lower than the WHO standard. Copper is toxic and hazardous when the permissible limit is exceeded. High content of copper in human through either ingestion, contact or inhalation of dust that contain copper can result to health issues like Wilson's disease (Hordyjewska et. Al., 2014). Shotyk (2020) Stated that much concentrations of Cu in soil is from peat which can be either be anthropogenic or natural inputs from mineral–water interactions in deeper layers. Application of fungicides and swine manure to the soil, solid waste, dust fallout, metal scraps and antifouling paint particles contributes copper to the soil (Giovana et al., 2023).

Nickel in samples S2 and S3 are lower than WHO standard while in other samples nickel concentrations is higher in values than WHO standard. High concentration of nickel in the soil can alter the natural state of the crops that grow on such soil and invariably affect the health of humans that consume the crops. When the tolerable limit of nickel in the body is exceeded, it results to Genotoxicity, carcinogenicity and immunotoxicity (Kusal et. al.2019). Much concentrations of nickel in water can cause skin irritation. Nickel enters the soil through anthropogenic contamination which is attributed to industry and agriculture (Yahaya A. I. 2011). Sewage disposal in the soil also contributes to Nickel contamination in the soil.

Mertens and Smolders (2013) stated that Zinc (Zn) contamination in the soil is as a result of anthropogenic activities through fertilization, sewage/sludge application, Zn smelters, and under galvanized structures. Noulas et al 2018 documented that Zn in surface and groundwater are through erosion of Zn contaminated soil. Zn accumulation in the soil could occur through the disintegration of a parent rock. Zinc concentration in all the samples are higher than WHO standard. Much intake of Zn into the body either through food chain or water or contact have negative effect on the body, it causes nausea, vomiting, fatigue and lethargy (Fasmire, 1990).

Cadmium (Cd) in the soil can be elevated through decompose matters, the natural sources of Cd in soils in derived from the weathering and deposition processes of a parent rock, the anthropogenic sources of Cd in soils is mainly derived from the mining of lead-zinc ores (Yinjun et al 2020). High concentration of cadmium in the body via food or water or air can cause problems on human bone, kidney, liver, cancer and death (Mehrdad et. al. 2017). The cadmium in the soil samples is higher than WHO recommended standard

The minimal concentrations of the heavy metals in the water samples indicate that the water samples do not have direct contact with the heavy metal contaminated soil, it could also be that the heavy metal contaminated soil have not experience erosional processes and this makes the metal concentration in the soil to be high. Erosional processes can reduce the high levels of heavy metals in a specific soil but the implication is that it results to metals distributions to an uncontaminated soil. The water samples being devoid of heavy metals pollution/contamination could be that the solubility and the distributions/migrations of the metals are slow.

Conclusion

The knowledge of metal/elemental genesis and fissions are important in environmental sustainability. The distribution of metals in the environment can deteriorate the environment and makes it hazardous for human beings. Proper waste management is a vital key in controlling the spread of heavy metals in the environment. The type of fertilizers and application of it in the soil should be monitored and done appropriately in order not to create an anomaly in the soil. The background values of soils with respect to metals concentrations should be known before such a soil is used for agriculture.

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