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Health Implications of Heavy Metal Concentration on Soils: An Appraisal of Oke-Afa Refuse -Dump, Isolo , Lagos, Nigeria.

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Abstract: *The study investigated the concentration of heavy metals [Cadmium (Cd), Copper (Cu) and lead (Pd)] on topsoil of Oke-Afa refuse- dump in Isolo, Lagos, Nigeria. Samples taken from twenty (20) different spots from Oke-Afa refuse-dump were analyzed. The study linked the environmental pollution as result of concentration of heavy metals to public health. Total contents of Cadmium was found to range from 4.65 to 50.50mg/kg with mean of 19.35, total contents of Copper was found to range from 65.77 to 634.29mg/kg with mean of 259.08, and total contents of Lead was found to range from 109.23 to 821.45mg/kg with mean of 291.91. Comparison of the results obtained to those recorded in literature showed that the levels of Cadmium and Copper were very high and are referred to as heavily contaminated and contaminated respectively, while the result obtained for Lead falls within the reported range, hence considered uncontaminated. The study revealed that the Oke-Afa dump-site exposes the residents around Isolo community to unacceptable levels of environmental pollutants with adverse health impacts. It is recommended that, to forestall the ugly consequence of heavy metals in the soils of the refuse-dump; there is need to define principles, establish strategies, set up of administrative procedures, and enforce compliance and penalties for non-compliance using appropriate laws and proper waste management and disposal. Furthermore, in order to guarantee health safety in the community, knowledge of the concentration of heavy metals is expedient*
Key words*: Heavy metals, Refuse dump, Soil pollution, Total pollution*

I. Introduction

A serious problem faced nowadays is the problem concerning contaminated land. This problem is not only a recent problem but also one inherited from the past. To satisfy industrial and economic needs, land was used to cater for these demands without any thought for future. Contaminated land will be defined as the land that contains substances that when presence in sufficient quantities or concentrations are likely to cause harm, directly to man, to environment and other living organisms.

Moreover, human activities on soil result into food production that is consumed by the nation and this has a great significance on people's lives and health. But these human activities on soil have basically modified the situation of the upper ground which eventually imposes risks on human life and health. These activities of man introduce contamination of many kinds to the environment and consequently result into various forms of pollution.

However, comprehensive data on the levels of heavy metals in soil of Oke-Afa refuse dump are not available. These data are useful for comparison with data from areas suspected to be contaminated. In this study effort was made to determine the level of some selected heavy metals [i.e. Cadmium (Cd), Copper (Cu) and Lead (Pb)] in the Oke-afa refuse- dump. A comparison of the data obtained with other works done elsewhere and other information on safe levels of these metals was done to ascertain the heavy metal status of the Oke-Afa refuse- dump.

Soil contamination by heavy metals has been shown to inhibit soil microbial activities, in turn reducing soil fertility and inhibiting the germination of certain seed plants. Heavy metals contamination may also produce nutrient imbalance in plants with adverse effect on the synthesis and functioning of many biologically active compounds. Sequent accumulation of the metals in food chain is detriment to human health [1].

Heavy metals are widely distributed in the environment, in soil, in plants and animal tissues. The concentration of individual metals in living tissues is ordinarily very low and must be maintained with narrow limit to permit the optimum biological performances of most organisms [2].

Heavy metal accumulation in soil is an important requirement in environmental science. Sorption of heavy metals in soil is influenced by soil factors such as clay, PH, cat-ion exchange capacity and organic matter content [3]. Organic carbon in soil consists basically of humic substances which are formed by decomposition of natural organic matter. Humic substances are powerful complexing and chelating entities whose sorption characteristics or properties depend on their chemical composition

Furthermore, the world is undergoing a silent epidemic of environmental metal poisoning from ever increasing amount of metals been introduced to the biosphere [4]. Pollution by heavy metals occurs largely from industrial, domestic and agricultural wastes as well as composition of fossil fuels by automobiles and industries.

In Nigeria and many third world countries, domestic wastes from small-scale industries are deposited in refuse dumps. The composition of these dumps varies from site to site and depends on the peculiarities of the neighborhood [5].

Many of the sites contain significant amount of ash due to dumping of ash and the burning of the refuse on the dump site from time to time. These burnings get rid of organic materials and oxidize the metals, leaving the ash richer in metal content. The process of oxidation and corrosion makes the metals soluble and leach into the soil from where they are picked up by growing plants thereby entering the food chain [6, 7].The process also lead to contamination of underground water [8,9] while most of the metals get washed into streams and rivers during rain thereby contaminating the marine environment. Since these metals accumulate in fish and other aquatic organisms, they pose health risks to consumers.

II. Materials and Methods

The study area (Oke-Afa refuse-dump) is located in Isolo, Lagos, Nigeria. The site is divided into ten (10) clusters and each cluster is sub divided into ten (10) spots. Two samples each were randomly selected from each of the clusters given a total of twenty (20) samples used for this research work in March, 2012.

The samples were collected with plastic spoons directly into Polythene bags and taken to the laboratory. The samples were spread on glass plates (5" x 5") dried in a drying chamber at 105^{o}C for 6hrs. This dried soil was ground and passed through 0.5mm mesh sieve. They were stored in plastic bottles until they were digested.

Each sample (2g) was weighted into a beaker and digested with 50cm^3 concentrated HNO_3 and 1cm^3 $HCLO_4$ once hot plate with gentle boiling. At completion of digestion, the samples were evaporated to dryness and the residue mix with 0.1m HNO_3 and filtered into a 100ml standard flask using whatman No.1 filter paper (Jensen, 1992). Blank determinations were caused out simultaneously with the samples. The metals Cadmium (Cd), Copper(Cu) and Lead(Pb) were determined using atomic absorption spectrophotometer (Buck Model 200A).

III. Results

The results of the study are shown in the table 3.1 below.

Table 3.1: Concentration of heavy metals in the refuse dump soil of Oke-Afa, Isolo**.**

Cadmium(Cd)	Copper (Cu)	Lead (Pb)
10.27	315.76	351.02
25.57	227.68	552.35
26.27	315.77	391.26
50.50	528.75	145.77
21.77	131.51	130.61
10.81	306.14	461.23
19.25	175.53	391.33
24.25	634.29	821.45
26.25	70.81	131.58
10.52	65.77	194.76
20.09	531.64	130.53
15.56	494.75	142.27
4.65	300.90	130.08
16.12	96.00	111.04
21.10	175.02	235.51
15.96	130.64	240.23
25.17	146.34	493.31
5.98	163.77	122.21
11.05	219.81	552.12
25.37	150.63	109.23

Source: Field survey 2012

Total cadmium was found to range from 4.65 to 50.50mg/kg with mean of 19.35, total copper was found to range from 65.77 to 634.29mg/kg with mean of 259.08, and total lead was found to range from 109.23 to 821.45mg/kg with mean of 291.91, as shown in the table 3.2 below:

Table3.2. Summary of the concentration of heavy metals from Oke-Afa refuse-dump

Metal	No. of Observation	Min	Max	Mean
Cadmium (Cd)	20	4.65	50.50	19.35
Copper (Cu)	20	65.77	634.29	259.08
Lead (Pb)	20	109.23	821.45	291.91

According to United Nations Environment Programme (UNEP) report 2007, the sources, risk level and health effects from exposure to the heavy metals are shown in table 3.3 below:

Table 3.3: The sources, risk level and health effects from exposure to the heavy metals

Heavy Metal	Sources of Environmental Exposure	Minimum Risk level	Chronic exposure toxicity effect
Cadimium	Electronics, plasticizers, batteries and contaminated water, electroplating, pigments, smelting and soldering, alloys, nuclear industry, cigarette smoke	Below 1µg/dl of blood	Irritation of the lung and gestroin-testinal tract, kidney deconcage, abnormalities of the skeletal system and cancer of the lungs and piostacte
Lead	Industrial, vehicular emissions, paints and beaming of plastics, papers, e.t.c	Blood lead levels below 10µg/dl of blood	Impairment of neurological development, suppression of the haematological system and kidney failure
Copper	Industrial, metallurgical industries, mines, contaminated drinking water, pesticides, windblown dust	Blood lead levels below 10µg/dl of blood	Pulmonary, heptic, digestive and other disorders

Source: UNEP report 2007
µg/dl – micrograms per deciliter of blood
µg/kg – milligrams per kilogram

3.1 Impact of Exposure on Public Health

However, the researchers in order to ascertain impact of studied refuse-dump site on public health, in October 2012, visited the hospitals located in Isolo community to collect data on reported cases. Data on reported cases were collected from Isolo General Hospital, Adeyemi Hospital and Tinu Hospital (all in Isolo), are highlighted in the table 3.4 below.

Table 3.4: Impacts on public health and system affected

	Isolo General Hospital				**Adeyemi Hospital**				**Tinu Hospital**			
	Children		**Adult**		**Children**		**Adult**		**Children**		**Adult**	
System affected	**No.**	**%**	**No.**	**%**	**N0.**	**%**	**N0.**	**%**	**N0.**	**%**	**N0.**	**%**
Dermatological (skin disorder)	22	8.3	26	8.6	20	7.6	28	8.4	26	10.5	30	9.1
Respiratory	80	30.1	74	24.3	76	29.0	77	23.1	69	28.0	75	22.8
Gastroenteritis (GE) [abdominal and intestinal problems]	31	11.7	27	8.9	28	10.7	30	9.0	26	10.6	33	10.0
Dental dis-order	26	9.8	46	15.1	28	10.7	41	12.3	22	8.9	40	12.2
Oto (affecting the hearing system)	10	3.8	15	4.9	08	3.1	14	4.2	09	3.6	12	3.6
Skeletal/muscular system	05	1.9	10	3.3	07	2.7	12	3.6	06	0.2	11	3.3
Central Nervous System	07	2.6	21	6.9	08	3.1	25	7.5	06	0.2	20	6.1
Eye Infections	32	12.0	4.0	13.2	31	11.8	42	12.6	25	10.1	40.1	12.2
Blood (anaemia)	05	1.9	04	1.3	04	1.5	03	0.9	06	10.2	09	2.7
Others	22	8.3	33	10.9	24	9.2	30	9.0	25	10.1	30	9.1
Normal	26	9.8	28	9.2	28	10.7	32	9.6	27	10.9	29	8.8

Others: malaria, chicken pox, septic wounds, congenital abnormalities, cardiovascular diseases and lung cancer. **Source: field survey 2012**

IV. Discussion

4.1 Comparison of the Result with the Recorded Literature

Levels of soil contamination by heavy metals according to UK Department of Environment Interdepartmental committee on redevelopment of contaminated land (*DOE ICRCC*) as found in [4,10] are presented on the table 3.5 below:

Table 3.5: Levels of soil contamination by heavy metals.

Heavy metal	Uncontaminated soils (mg/kg)	Slightly contaminated soils (mg/kg)	Contaminated soils (mg/kg)	Heavily contaminated Soils (mg/kg)
Cadmium (Cd)	0 -1	1-3	3-10	10-50
Copper (Cu)	0-100	100-200	200-500	500-2500
Lead(Pb)	0-500	500-1000	1000-2000	2000-10000

Source: DOE-ICRCL as contaminated in Alloway (1993)

However, when the data obtained in table 3.2 above is compaired with that of [4, 10, and 11], the result of concentration of heavy metals at Oke-Afa refuse dump is presented in table 3.6 below:

Table 3.6: Concentration of metals

Metal	No of observation	Mean (mg/kg)	Remark
Cadmium (Cd)	20	19.35	Heavily contaminated
Copper (Cu)	20	259.08	Contaminated
Lead (Pb)	20	291.91	Uncontaminated

Source: Field survey 2012

4.2 Soil heavy metal concentration

The relative abundance of the heavy metals in top soils of Oke-Afa refuse dump was in the order Cd>Cu>Pb. This is indicated in the table 3.2 where the study dump site is heavily contaminated with Cadmium (Cd) [19.35 (mg/kg)], contaminated with Copper (Cu) [259.08 (mg/kg)] and uncontaminated with Lead (Pb) [291.91(mg/kg)]. The higher concentration of Cadmium (Cd) and Copper(Cu) in the study is as the results of dumping and burning of refuse on the dump site from time to time, which get rid of organic materials and oxidize the metal, leaving the ash richer in metal contents. The low concentration of lead (Pb) at the study site suggests that the source of lead in the environment is essentially un-anthropogenic (natural).

4.3 Impact on Public Health

From the study, it was observed that Oke-Afa dump-site exposes the residents around Isolo community to unacceptable levels of environmental pollutants with adverse health impacts. An appreciable number of children and adults living around Oke-Afa refuse-dump had illnesses related to respiratory, gastrointestinal and dermatological system such as upper respiratory tract infections, chronic bronchitis, asthma, fungal infections, inflammation and itching of the skin as shown in table 3.4.

However, the high levels of cadmium and copper in the soil sample analyzed are negatively impacting on Isolo community near the refuse-dump which is reflected in the result presented in table 3.4 above.

Furthermore, natural concentration of heavy metals in soils depends primarily on the type and chemistry of the parent materials from which the soils are derived. Human activities on these soils basically modified the situation of the upper ground resulting in the increase in concentration of these metals which eventually imposes risk on human health.

V. Conclusion

The study linked the environmental pollution as result of concentration of heavy metals to public health. Soil samples analyzed from Oke-Afa refuse-dump Isolo, showed high concentration of heavy metals from the site in particular cadmium, copper and lead. At the same time, data collected on the reported cases from the hospitals within the Isolo community indicates a high incidence of diseases that are associated with high exposure levels to these heavy metal pollutants.

In order to forestall the ugly consequence of heavy metals in the soils of the refuse-dump; there is need to define principles, establish strategies, set up of administrative procedures, enforce compliance and penalties for non-compliance using appropriate laws and proper waste management and disposal.

Moreover, the land use policy should be such that the areas suspected to be high in heavy metals are set aside for industrial sites and areas with tolerable limits for agricultural and residential uses.

In conclusion, in order to guarantee health safety in the community, knowledge of the distribution of heavy metals is expedient. This will enable the control of factors that seem to promote the total and extractable contents of these soils and ultimately control the fraction that is ingested by man. This will raise awareness and stimulate acquisition of remedies and preparedness in handling cases of heavy metal contamination, toxicity and poisoning.

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