Open Land Dumping: An Analysis of Heavy Metals Concentration of an Old Lead-Battery Dumpsite.

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ABSTRACT

Use of open land as dump sites by the manufacturing industries in developing countries without appropriate prevention of environmental hazards has resulted in prominent levels of waste and disposal effluents. This has resulted in the contamination of soil and the exposure of human populations to environmental and health hazards. This study focused on the investigation of soil contamination by heavy metals via waste disposal of a lead battery factory in Lalupon, Oyo State, Nigeria. Composite samples obtained from nine sample locations were digested with concentrated acids (HNO_3, $HClO_4$ and HF) and filtered. The filtrate obtained was analyzed for seven different analytes (Cu, Cr, Pb, Zn, Cd, Ni, and As) using atomic absorption spectroscopy (AAS). The lead content exceeded maximum allowable concentrations, MAC (100 ppm), in all points. Copper content was above MAC (50 ppm) in a majority of the points. Cd exceeded MAC (0.3 ppm) in just one point. The study shows that the soil in the old dump site has been contaminated heavily with Pb and Cu.

(Keywords: contamination, hazards, heavy metals, composite, MAC, AAS)

INTRODUCTION

The concentration of trace elements in the soil is increasingly becoming an issue of global concern, especially as soils constitute a crucial component of rural and urban environments, and can be considered as a very important "ecological crossroad" in the landscape (United States Department of Agriculture, 2001). All trace elements are toxic to living organisms at excessive concentrations but some are essential for normal healthy growth and reproduction by plants and animals at low but critical concentrations. Deficiencies in these essential elements or micronutrients can lead to disease and even death of the plant or animal. The essential trace elements include Co, Cr, Cu, Mn, Mo, Ni, Se, and Zn while Ag, As, Ba, Cd, Hg, Pb, Sb, and Th have no known essential function but cause toxicity above certain tolerance level. The most important heavy metals with regards to potential hazards and the occurrence in contaminated soils are As, Cd, Cr, Hg, Pb, and Zn (Alloway, 1995). The concentration of these toxic elements in soils may be derived from various sources, including anthropogenic pollution, weathering of natural high background rocks, and metal deposits (Asaah and Abimbola, 2006).

Heavy metal contamination of soil can occur as a result of anthropogenic activities such as manufacturing, mining, smelting procedures, and agriculture, as well as natural activities (Navarro et al., 2008; Brumelis et al., 1999; Vaalgamaa and Conley, 2008; Cortes et al., 2003). Chemical and metallurgical industries are the most important sources of heavy metals in the environment. Heavy metals get accumulated over time in soils and plants and could have a negative influence on physiological activities of plants (e.g. photosynthesis, gaseous exchange, and nutrient absorption), determining the reductions in plant growth, dry matter accumulation and yield.

Some of the heavy metals (lead, cadmium, and mercury), even in trace concentrations, are toxic to plants and animals (Ioan et al., 2008). Heavy metal pollution of soil enhances plant uptake causing accumulation in plant tissues and eventual phytotoxicity effects and can change plant communities (Gabriella et al., 2005). Exposure to lead in the soil can be harmful to humans. The health effects include increased blood pressure, headache, memory and concentration problems, fertility problems in men, miscarriage in women who are exposed during pregnancy, and damage to nervous system in children (Agusa et al., 2006; Needleman et al., 1990).

The aim of this research was to assess the heavy metals concentration in an old dump site in Lagelu local government area, Oyo state, Nigeria.

METHODOLOGY

Samples were collected at nine different locations. In each location, representative composite samples obtained were air dried and pulverized using a porcelain mortar and pestle. The grains obtained were sieved using 6µm sieve size mesh and the sieved grains obtained were stored in cleaned labeled polythene bags for further treatment. A total of 1g of each sample was digested in Teflon beaker with 10ml concentrated HNO_3 and was boiled until the solution was almost dried. 5ml $HClO_4$ was added further and the boiling continued until the solution was almost dried. 5ml HF was lastly added until the solution was dried while heating.

The residue obtained after the boiling was dissolved in 1ml conc. HNO_3. 10ml of distilled water was added to the dissolved residue of the digested sample and heated further to boiling; the solution was cooled and filtered. The filtrate obtained was put in 25ml standard flask and was made up to the mark with distilled water. The analytes (Cu, Cr, Pb, Zn, Cd, Ni, and As) content in each of the filtrate were determined using AAS.

RESULTS AND DISCUSSION

Table 1: Heavy Metals Concentrations in Selected Sample Locations in the Study Area.

Sample Locations	ANALYTES						
	Cu	Cr	Pb	Zn	Cd	Ni	As
1	**48.6± 5.5	0.1	*114.7± 1.3	37.8± 0.6	0.1	0.25± 0.05	0.15± 0.05
2	*52± 0.1	Nd	*116± 2.0	31.9± 3.3	Nd	0.1	Nd
3	38.5± 1.3	0.1	*113± 0.7	18.2± 1.1	0.1	0.2± 0.1	0.2± 0.05
4	**49.7± 0.5	0.2± 0.05	*104.5± 5.5	25.3± 0.8	*0.3± 0.05	0.4± 0.2	0.1
5	42.0± 2.3	0.1	*111.2± 2.7	17.7± 0.8	0.2± 0.05	0.4± 0.2	0.1
6	41.8± 0.9	0.2± 0.05	*166.9± 7.65	24.9± 3.6	0.2± 0.05	0.3± 0.05	0.2± 0.05
7	**48.6± 5.5	0.1	*112.1± 3.4	19.4± 4.2	0.1	0.4± 0.1	0.1
8	*50.5± 1.9	Nd	*143.5± 0.1	21.4± 0.9	0.1	0.4± 0.2	0.2± 0.1
9	47.0± 0.5	Nd	*143.9± 0.1	34.1± 1.8	Nd	0.1	Nd
MAC	50ppm	100ppm	100ppm	300ppm	0.3ppm	50ppm	20ppm

Nd – Not determinable
* Values that exceed maximum allowable conc. in soil
** Values that may exceed maximum allowable conc. in soil taking the error range into consideration
*** Values that have zero deviation or the second value needed for the average being not determinable.
MAC - Maximum allowable conc. in soil (Kloke, 1980; Kabata Pendias, 1995)

The results as shown in the table above reveal that the soil in the study area is not contaminated with these heavy metals (Cr, Zn, Ni, and As). All sample locations revealed that the soil is contaminated with Pb. The contamination with lead is explainable with the fact the study location is lead battery dump site. Thus, the study location is polluted with lead due to the anthropogenic effect and this pose hazards to human health as high concentration of Pb when exceeded the threshold levels has been reported to be toxic and can induce hypertension in adult and inhibit development of intelligence in fetus, cause problems in the synthesis of haemoglobin, kidney, gastro intestinal tract malfunctioning, acute or chronic damage to the nervous system (Agusa et al., 2006; Needleman et al., 1990).

The pollution of the soil with Cu as indicated in the results shows that the concentration of Cu exceeded maximum allowable concentration in soil in some points while the concentration of Cu may exceed maximum allowable concentration in some other points (as higher range value exceeded maximum allowable concentration in soil taking the error range into consideration).

Contamination of soil with Cu has health hazards implication as the excessive concentration of Cu could bring about anaemia, infections, thinning of bones, thyroid gland dysfunction, heart disease and nervous systems problems (Fleming and Trevors, 1989; Gharbi et al., 2005).

Cd contamination of the soil occurred in just one points and the contamination of the soil with Cd has been noted to impart hazards on human health as it has long term bioaccumulation, causes renal failure, lung disease/ cancer and bone defects (Johannes et al., 2006; Il'yasova, 2004).

CONCLUSION

This study hereby concludes that the dump site studied in this paper has been heavily contaminated with Pb and Cu owing to the anthropogenic activities by a automobile lead battery producer. This therefore has made the study area unsafe for humans and agricultural activities.

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