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RESEARCH ARTICLE

IMPACT AND HAZARDS TO HEALTH ASSESSMENT OF ROADSIDE SOILS NEAR AN OPEN DUMP IN YENAGOA, BAYELSA STATE, NIGERIA

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ABSTRACT

The scope of heavy metals concentration in roadside soils along Yenagoa - Tombia road near an open dump has been examined, in order to evaluate their impact and hazards to health. Soil samples were collected from four sampling sites.The concentrations of heavy metals in each soil sample were determined using a GBC Avanta PM. Ver 2.02 AAS. The mean concentrations (mg/kg) in soils were: (0.10±0.04) Cd, (0.56±0.06) Cu, (0.82±0.53) Pb and (1.14±0.22) Zn, while the physicochemical parameters were: (6.23 ± 0.10) pH and 0.54±0.14 respectively. In an attempt to assess the impact and hazards to health, comparison with threshold or critical trigger concentrations for the contaminated soils, heavy metal concentrations in soils of various environments and geoaccumulation index was employed. According to geoaccumulation index, the roadside soil samples collected along Yenagoa – Tombia road near an open dump are classified as practically uncontaminated.

INTRODUCTION

The discovery, exploration and exploitation of natural resources such as crude oil in the Niger delta region as spur uncontrolled increase of rural-urban migration. This has led to growth of the urban population which have resulted in an increase in the production of different types of municipal solid wastes (MSW) ranging from degradable to non-degradable, which have adverse effects on the environment and human health. Solid wastes are defined to be useless and unwanted materials arising from human activities that are not free floating [WHO, 1971; Badmus *et a*l., 2014]. Release of pollutants through leachates from both active and former dumpsite pose a high risk to health and environmental threat, if not adequately managed (Ikem *et al*., 2002). Leachates percolating into the groundwater is a mixture of highly complex contaminants such as potentially toxic heavy metals; persistent organic pollutants (POPs), polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers PBDEs (Mor et al., 2006; Longe and Balogun, 2010; Oyeku and Eludoyin, 2010 and Galarpe and Parilla, 2012, Temilola *et al,* 2014).

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Among the pollutant sources that cause the contamination of soils, heavy metal contamination is of great environmental concerns because of their toxicity, persistent and can also transform to other species and easily accumulate to toxic levels in the top soil due to their non-biodegradable nature in the environment (Yuan *et al*., 2004; Lu *et al*., 2005; Sharma *et al*., 2007; Nwuche and Ugoji, 2008; Mohiuddin *et al*., 2010; Chengo *et a*l., 2013; Shazia *et al*., 2015). The presence and potential exposures of the community to groundwater contaminants may contribute to the predilection of human health impacts, from simple poisoning to cancer, heart diseases and teratogenic abnormalities (Sia Su, 2008). Study on the geochemistry of roadside soils in the Yenagoa – Tombia road as not been undertaken by previous workers. Few studies have been made on the dumpsite, but little attention has been focus on the contamination of the surrounding roadside soils. The Yenagoa – Tombia road is a major road linking Amassoma, where the Niger Delta University is situated and the area is fast growing with human population. The environment is constantly impacted with vehicular emission; in addition, there is HPEB 119 oil company, oil and gas pipelines, municipal solid wastes open dump and other human activities. This study was carried out to check the impact and hazards to health of some of the known most toxic heavy metals (cadmium, copper, lead and zinc) in roadside surface soils near an open dump along the Yenagoa – Tombia road, Bayelsa State, Nigeria.

MATERIALS AND METHODS

Description of study area

The study area lies between the coordinates of latitudes 04o15" North and latitude 05o23' South and longitude 05o22"West and 06o45" East. The dumpsite is located in Bayelsa State, along the road which serve as a link between Yenagoa, Tombia and as well as the Niger Delta University, Wilberforce Island (Fig 1).

Figure 1. Map of Yenagoa Showing the Sampling locations

Sampling and analysis

Sampling points were randomly selected close to the dumpsite. Sampling points were geo-located with Geographical Position System (GPS) to ensure consistency. Soil samples were collected from four locations near the dumpsite using auger at a depth of 0-15cm. The samples were transferred into pre-cleaned polyethylene bags and were then transported to the laboratory. At the laboratory, each soil sample was air dried at room temperature for days. Organic debris and other unwanted large particles were handpicked from each sample. The dried samples were homogenized with a mortar to pass through a 2mm sieve. The samples were labeled appropriately, stored in sealed polythene bags for digestion and analysis. The soil samples were digested in a mixture of concentrated nitric acid (HNO3), concentrated hydrochloric acid (HCl) and 27.5% hydrogen peroxide (H_2O_2) according to the USEPA method 3050B for the analysis of heavy metals and major ions (USEPA, 1996; Amadi *et al.,* 2012).

RESULTS AND DISCUSSION

Heavy metals and physicochemical parameters

A total of seven soil quality chemical parameters (cadmium, Copper, Iron, Lead, Zinc, pH and TOC) were examined in this study. The mean contents of heavy metals and the physicochemical parameters in soils are presented in Table 1-2. The percentages of the heavy metals are represented graphically in Fig. 2. The pH ranged between 6.15 -6.35 with a mean of 6.23 ± 0.10, which was neutral or slightly acidic..Gray et al., (1998) reported H affects the mobility of heavy metals in soil.

It has been found that soil pH is correlated with the availability of nutrients to the plant. Oliver *et al*., 1998; Salam and Helmke, 1998;Amos-Tautua *et al* 2014 mentioned that aspH decreases, the solubility of metallic elements in the soil increases and they become more readily available to plants.

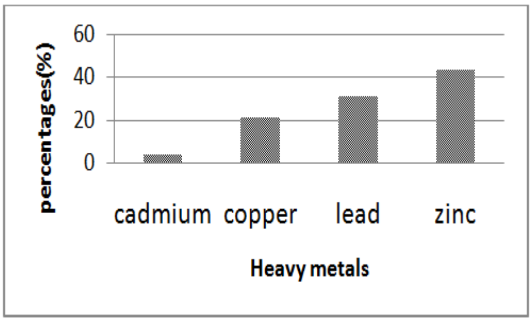

Figure 2. Percentages of heavy metals in roadside soils

Table 1. Total mean concentrations (mg/kg) of heavy

Metals in roadside soils

Metal	Range	Mean	Std	Max	Min
Cd	0.06-0.16	0.10	0.04	0.15	0.06
Cu	0.17-1.34	0.56	0.06	1.34	1.17
Pb	0.37-1.62	0.82	0.53	1.62	0.37
Zn	0.79-1.44	1.14	0.22	1.44	0.79
pH	6.15-6.35	6.23	0.10	6.35	6.15
TOC	0.33-0.70	0.54	0.14	0.70	0.33

Table 2. Site variation of mean concentration (mg/kg) of heavy metals. The data shows that, concentration (mg/kg) of cadmium in soils ranged from 0.058-0.158 with mean value of 0.099±0.040 and the highest distribution of cadmium was observed in SS 4 Table 2.Khalid *et al,* 2006 reported that concentration of cadmium in roadside soils of Northern England were0.3 - 3.8mg/kg with median value of 1.2mg/kg. The results of this study were below the threshold or critical trigger soil concentration of 3-15 mg/kg (ICRCL, 1987) and cadmium concentrations in various environments. Concentration (in range, mean ± standard deviation, mg/kg) for copper was 0.172-1.335, 0.558±0.06.Khalid *et al*, 2006 reported a range of 15.5 -240mg/kg with median of 80.4mg/kg for copper in roadside soils of Northern England.

Table 2. Site variation of mean concentration (mg/kg) of heavy metals

Site	Metals	Range	Mean±std	Variance
SS1	Cd	0.10-0.09	0.09±0.01	0.11
	Cu	1.98-0.24	0.99±0.90	0.91
	Pb	0.64-0.57	0.60±0.04	0.07
	Zn	1.30-0.92	1.16±0.21	0.18
SS2	Cd	0.16-0.05	0.10±0.06	0.6
	Cu	1.34-0.23	0.62±0.62	1.00
	Pb	0.60-0.37	0.52±0.13	0.25
	Zn	1.34-0.79	1.10±0.29	0.26
SS3	Cd	0.08-0.06	0.07±0.01	0.14
	Cu	0.21-0.17	0.19±0.02	0.11
	Pb	0.52-0.39	0.47±0.07	0.15
	Zn	1.44-0.81	1.16±0.32	0.28
SS4	Cd	0.15-0.14	0.14±0.02	0.01
	Cu	0.76-0.20	0.42±0.30	0.71
	Pb	1.66-1.62	1.63±0.03	0.02
	Zn	1.44-0.94	1.22±0.25	0.2

The results of this study shows that copper content in the roadside soils were below the limits of the threshold or critical trigger soil concentration of 130 mg/kg (ICRCL, 1987).

The concentration of lead ranged from 0.366-1.617 mg/kg with a mean 0.816±0.53 mg/kg. Khalid *et al,* 2006 reported a range of 25.0 -1198mg/kg with median of 175mg/kg for lead in roadside soils of Northern England.

The results of this study shows that lead content in the roadside soils along the Yenagoa – Tombia road, Bayelsa State, Nigeria were below the limits of the threshold or critical trigger soil concentration of 500 – 2000mg/kg (ICRCL 1987). Zinc levels in roadside soil samples ranged from (0.785-1.435), with a mean value of (1.143±0.22 mg/kg). Khalid *et al.*, 2006 reported a range of 56.7 – 480.0 mg/kg with median value of 150mg/kg for zinc in roadside soils of Northern England. The results of this study shows that zinc content in the roadside soils were below the limits of the threshold or critical trigger soil concentration of 300mg/kg (ICRCL 1987).

Impact and hazards to health assessment

A comparison of metal concentration with different values reported for different soils is generally taken as the quick and practical method for detecting heavy metal contamination, impact and hazards to health. The mean concentrations of the metals (mg/kg) analyzed in the roadside soils decrease in sequence as: Zn (1.14±0.22) > Pb(0.82±0.53) > Cu(0.56±0.06) > Cd(0.56±0.06) respectively. The comparison study with different soils revealed that the average heavy metal load of Yenagoa – Tombia road , Bayelsa State, Nigeria was low. The results of this study have shown that heavy metal content in the roadside soils were below the limits of the threshold or critical trigger concentration for the contaminated soils (Table 3).

The Geo-accumulation index (Igeo

The Geo-accumulation index (Igeo), introduced by Muller (1979) for determining the extent of metal accumulation in sediments, and has been used byvarious workers in their studies (Sagheer**,** 2013) etc. Geo-I = Log [Metal content, Cn] Sample / [1.5 * Metal content, Bn] background Where, Cn is the concentration of element 'n' and Bn is the geochemical background value of the metal (n).1.5 is the background matrix correction factor due to lithogenic effects. The geo-accumulation index (Igeo) scale consists of seven grades (0-6) ranging from practically to extremely contaminated.

Table 3.The threshold or critical trigger concentrations (ICRCL 1987)

HMs	This study	Critical concentration	Classification of HMs
Cd	0.56±0.06	3 -15 mg/kg	May pose hazard to health
Cu	0.56±0.06	130 mg/kg	phytotoxic
Pb	0.82±0.53	500 – 2000 mg/kg	May pose hazard to health
Zn	1.14±0.22	300 mg/kg	phytotoxic

Table 4. Six classes of the geoaccummulation index (Muller, 1981)

Class	Value	Soil Quality	metal	Igeo	Quality of soil
0	Igeo<0	Practically uncontaminated	Cd	-2.18	practically uncontaminated
1	0<Igeo<1	Uncontaminated to moderately uncontaminated	Cu	-3.72	practically uncontaminated
2	1<Igeo<2	Moderately contaminated	Pb	-1.44	practically uncontaminated
3	2<Igeo<3	Moderately to heavily contaminated	Zn	-3.718	practically uncontaminated

The environmental state of the soil was determined by the Geo-accumulation index "*I*geo". According to Müller (1981) the scale of the intensity of pollution is classified into seven classes of Igeo (Table 4).

Conclusion

The pH ranged between 6.15 - 6.35 with a mean of 6.23 ± 0.10, which was neutral or slightly acidic and organic carbon was found in the soil samples rangedfrom (0.33 – 0.70) with a mean of 0.54±0.14). Results of heavy metals concentration in the roadside soils collected along Yenagoa – Tombia road, Bayelsa State, show heavy metal accumulation. Zn was found to be the highest occurring heavy metal and Cd was the least occurring heavy metal. Heavy metal concentrations in the soils from the roadside in this study area were low as compared to the background levels for cadmium, copper, lead and zinc of various environments. The concentrations of the heavy metals in this study were also below the threshold or critical maximum levels above which toxicity is possible. Open dump is commonly practiced in developing countries because of its inexpensive nature, however, the impact and hazards to health of the community was not duly considered. Therefore, in order to safeguard public health and environmental threat, controlled dump is recommended.

COMPETING INTERESTS

Authors have declared that no competing interests exist

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