Assessment of levels of Heavy Metals in Mechanic Village Dumpsite (along Imiringe Road) in Yenagoa

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ABSTRACT

Distribution of Cr, Cd, Pb, Sb, V and Ni ions in soils within the Yenagao mechanic workshop dumpsite was studied by analyzing the soil samples for their heavy metal ion concentration using atomic absorption spectrophotometer. The results indicated that soil concentrations of the studied heavy metal ions to be below the permissible limit. However, point of concern was raised considering the relative closeness of most of the metal ion concentrations to the limits, which indicated future contamination risk. Lead ion was the most concentrated heavy metal ion.

Key Words: Heavy metals, soil, contamination, mechanic workshops

INTRODUCTION

The toxicity of several heavy metals has been reviewed by several authors. Generally, heavy metals are those metals whose density is above 5 g/cm^3 and are toxic above certain threshold concentration (Shakhashiri and Bell, 2014). Heavy metal pollution is a serious environmental problem because it has the potential to contaminate edible plants and organism that depends in such plants for their food (Mohmood and Malik, 2014; Toth *et al.*, 2016). Heavy metals can be absorbed through root of plants and ultimately becomes transferred to man and other organism through the food chain (Eddy *et al*., 2004, 2005, 2006). For example, Ali and Al-Qantani (2012) reported that some vegetables, cereals and fruits in Saudi markets are contaminated by heavy metals and were attributed to the presence of heavy metals in the soil that these plants were cultivated. Similar correlation between heavy metals in the soil and plants was studied and reported by Toth *et al*., (2016)

Oil producing areas including Yenegoa have been reported to be prominent sources of heavy metal pollution, attributed to exploration and other oil related activities. Consequently, less attention is paid to other activities that may contribute significant quota to heavy metals pollution. For example some soils have been found to be contaminated with heavy metals due to irrigation of the land with sewage (Alghobar and Suresha, 2017; Bhati *et al*., 2016). Okeke *et al*., (2014) found that the weighted mean of the metals in the *Azadirachta indica* plants growing on Dass Park soils within some mechanic workshop were Cu (86.87 mg/kg) > Zn (63.18 mg/kg) > Mn (57.33 mg/kg) >Pb (17.04 mg/kg) >Cr (7.55 mg /kg) >Cd (2.71 mg/kg), while in soils, Cu (63.78 mg/kg) > Zn (63.44 mg/kg) > Pb (31.45 mg/kg)> Mn (31.37 mg/kg) >Cr (8.05 mg/kg) >Cd (1.80 mg/kg). The weighted means of the various metals that were investigated in the mechanic workshops were higher than those obtained in the control site. Ojiako and Okonkwo stated that the high concentrations of these heavy metals when compared with the WHO standard for Cu, Cr and Ni (0.02), Pb (0.02) and Cd (0.05 ppm) indicate danger to human health and other animals in the area. Ilemobayo and Kolad (2008) also reported excessive concentrations of heavy metals in soil located around the automobile workshops in Akure, (Nigeria) compared to other soils that are far away from the workshops. However, literature is scanty on levels of heavy metals in mechanic workshop or their corresponding dumpsites in Yenagao. Hence the present study investigated the levels of lead, nickel, vanadium, cadmium, chromium and antimony in some soils within the mechanic village dumpsites.

MATERIALS AND METHODS

Soil samples were randomly taken at a dumpsite located close to a mechanic workhsop along Imiringe road in Yenegao. The soil samples were collected at a depth of 2 feet. The map of Yenegao is shown in Fig. 1. Yenagoa is a Local Government Area in Bayelsa State, Nigeria. Its headquarters is Yenagoa - south of the area at 4°55′29″N 6°15′51″E. The L.G.A has an area of 706 km² and a population of 352,285 as at the 2006 census.

Heavy metal concentrations in the soil samples were analysed using atomic absorption spectrophotometer and the actual concentrations were obtained from the respective calibration curves that were developed by the machines.

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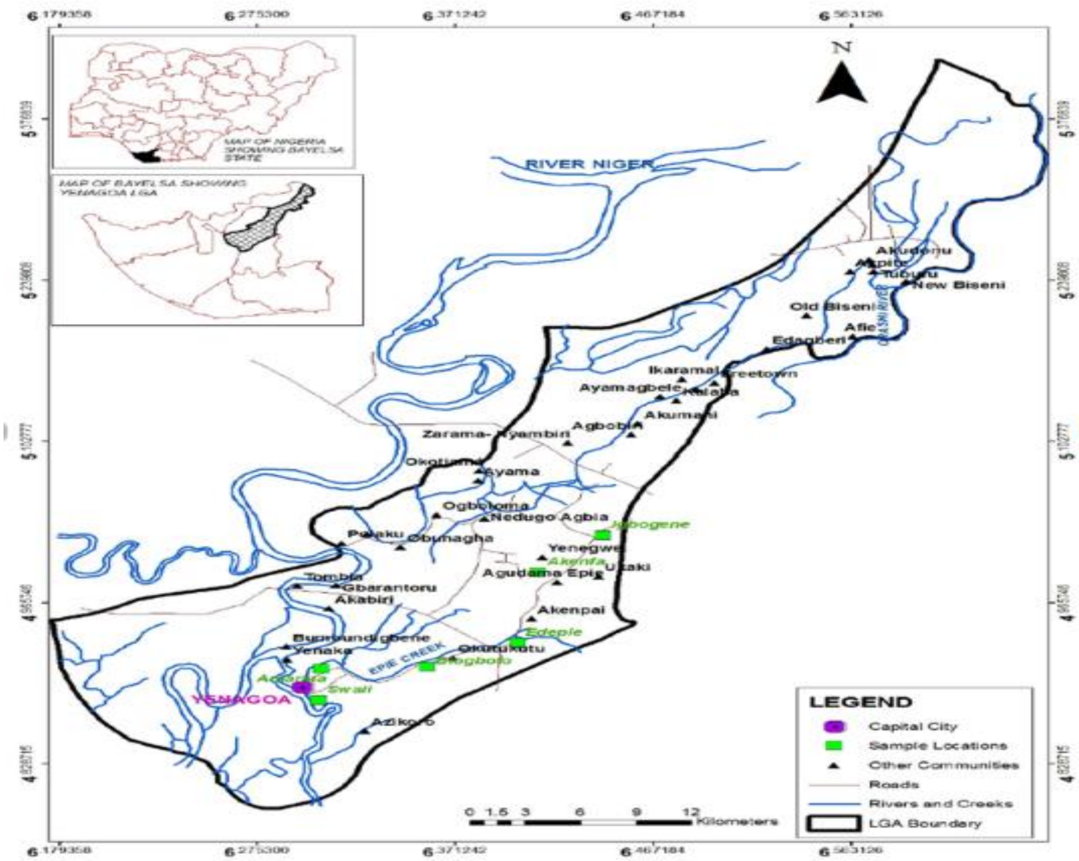

Fig. 1: Map of Yenagao

RESULTS AND DISCUSSIONS

Mean concentrations of Sb, V, Cr, Pb, Cd and Ni are presented in Table 1. Mean concentration of Pb^{2+} ion ranged from 24.12 mg/g to 26.62. The standard deviations in all cases were significantly lower than the mean indicating good variability. These concentrations are below the WHO permissible limit of 2 mg/kg. Nickel ion concentrations ranged from 7.84 to 12.23 mg/g with the least and highest recorded in sampling location 4 and 1 respectively. Nickel is relatively essential to humans and animal but above certain concentration, it may exert toxic effect. WHO soil permissible limit for nickel is 10 mg/kg indicating that, based on WHO standard, the observed measured concentrations of nickel ions in all the studied location is within the permissible limit. Vanadium is one of the heavy metals that is native to crude oil and crude oil fractions. The presence of vanadium in some soils around mechanic village has been widely reported. In this study, vanadium ion concentration was found

Table 1: Concentration of heavy metal in the studied site

Sampling stations	Pb (mg/g)	Ni (mg/g)	V (mg/g)	Cd (mg/g)	Cr (mg/g)	Sb (mg/g)
1	23.54 ±0.61	12.23 ± 0.90	1.98 ± 0.98	1.52 ± 0.89	8.12 ± 0.40	6.67 ± 0.41
2	23.42 ± 0.43	10.98 ± 0.72	2.21 ± 0.45	1.88 ± 0.09	10.11 ± 0.91	5.81 ± 0.52
3	25.36 1.33	8.41 ± 0.66	2.98 ± 0.66	2.18 ± 0.29	11.21 ± 0.02	5.92 ± 0.42
4	26.62 ± 1.46	7.84 ± 0.04	3.24 ± 1.24	3.12 ± 0.99	17.54 ± 2.10	5.21 ± 0.60
5	24.12 ± 1.36	8.20 ± 1.10	3.10 ± 1.54	1.91 ± 0.76	16.22 ± 0.98	7.83 ± 0.92
6	24.26 ± o.26	9.02 ± 0.98	2.28 ± 0.08	2.10 ± 0.88	20.12 ± 1.20	7.41 ± 0.58
7	25.44 ± 0.89	7.97 ± 0.60	1.09 ± 0.05	2.50 ± 0.98	22.81 ± 1.40	6.62 ± 0.81

to range from 1. 09 to 3.24 mg/g. The deviation was very low compared to the mean values. The measure concentration is below the WHO permissible limit. However, this still gives an impression that bioaccumulation may risk the soil to future contamination. According to Vodyaniskii (2016), the hazard of lead, zinc, and cobalt is lower in these soils, than that of vanadium, antimony, and barium. This implies that vanadium is more toxic than lead, zinc and cobalt. Generally, background soil concentration of vanadium is estimated to be between 3 and 300 micro grams indicating that the source of vanadium in the studied soil is not natural but may be associated with activities within the mechanic workshop.

Cadmium ion concentrations in the soils around the dumpsite varied from 1.52 (0.00152 mg/kg) to 3.12 mg/g (0.00312 mg/kg) while the standard deviation ranged from 0.009 to 0.99 indicating a relatively wide range. Cadmium ion is known to complement lead ion in exerting their toxic effect. These metal ions are divalent and could replace useful elements (such as Ca^{2+}) in the human body, thereby poisoning the blood. WHO permissible limit for calcium is as low as 0.02 mg/g indicating that it is toxic at concentration lower than other heavy metal ions discussed earlier. Measured concentrations of cadmium ions in the various sampling locations are lower than the permissible limit.

Chromium ion concentrations were found to range from 8.12 (in station 1) to 22.81 mg/g (in station 7). Variability measured through standard deviation was relatively high (0.40 to 1.40). WHO permissible limit for chromium ion in soil is 1.30 mg/kg which is higher than the recorded values in all the sampling stations. Therefore, these soils are not yet contaminated by chromium.

Antimony ions were distributed in the soil samples within the range of 5.81 to 7.41 mg/g and displayed variability ranging from 0.41 to 0.92 which is relatively low compared to those of Cr, V and Pb ions. The measured concentrations of antimony ions in all the studied locations is below the WHO permissible limit in the soil.

Table 2 presents inter-correlation Table for the studied heavy metal ions in the soil samples.

Table 2: Inter-correlation between heavy metal ions

	Pb	*Ni*	*V*	*Cd*	*Cr*	*Sb*
Pb	1.0000					
Ni	-0.7696	1.0000				
V	0.2635	-0.2938	1.0000			
Cd	0.9376	-0.7459	0.2237	1.0000		
Cr	0.5062	-0.7466	-0.2495	0.5997	1.0000	
Sb	-0.5034	-0.0149	-0.1649	-0.5298	0.2747	1.0000

The results indicated strong correlation between lead and cadmium ions (r = 0.9376) which explains why the concentrations of the two metal ions seems to increase simultaneously. These metal ions can compete with soil calcium and magnesium and reduce their useful roles to plants cultivated in such soil. Correlation between chromium ion and lead ion (r = 0.5062) and also chromium and cadmium (r = 0.5997) were also positive indicating the concentrations of these metal ions increase with each other and also suggests that they might have had the same source (i.e waste from mechanic workshop). Of significant interest were the negative correlations that were observed for Pb/Ni, Pb/Sb, Cd/Ni, V/Ni and Cd/Sb. This implies that the concentration of one metal ion increases while the other decreases.

Fig. 2 is a column plot that shows summary of concentration profiles for all the studied heavy metal ions in soils within the mechanic workshop dumpsite. The Figure clearly reveals that lead ion is the most concentrated heavy metal ion in the dumpsite. The source of these metals maybe connected with disposal of waste engine oil, diesel, petrol and other crude products.

CONCLUSION

Concentrations of Cr, V, Cd, Ni, Pb and Sb in soils within Yenagoa mechanic dumpsite are below the permissible limits. However, some of these values are relatively high and may over a short period of time grow to contamination levels via bioaccumulation. Therefore, there is need to adopt better waste management system for wastes generated by the mechanic workshops.

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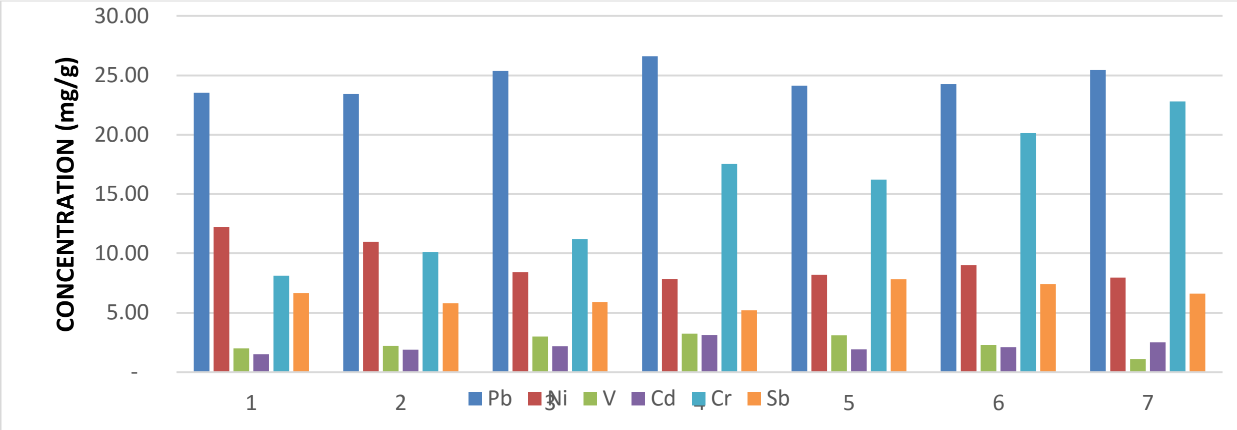

Fig. 2: Summary of distribution of the studied heavy metal ions in soils within the dumpsite

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