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Distributions of Cr, Zn and Pb in Soil along the Bank of River Kaduna, Nigeria

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Abstract

In this work X-ray Fluorescence techniques was used to determine the distribution of Cr, Zn and Pb in soil along the Bank of River Kaduna Nigeria. The mean concentrations of Cr, Zn and Pb are 160.0 ± 8.8 and 31. 4 ± 5.6 mg/kg respectively. The concentration of Cr is in the range of 107.0 ± 7 to 265.0 ± 130 mg/kg for Zn, the range is between 50.0 ± 6 to 103.0 ± 7.0 mg/kg while Pb is in the range of 19.0 ± 4.0 to 40.0 ± 5.0 mg/kg. The mean values obtained in this work compared favorably with other published works and are higher than the world average values of 100, 50 and 10 mg/kg for Cr, Zn and Pb respectively. However, the concentrations of Cr, Zn and Pb from this work are below the tolerable limit.

Keywords: Soil, river, X-Ray fluorescence, concentration, Cr, Zn and Pb.

Introduction

In many developing countries like Nigeria soils are affected by mine waste disposal, acid deposition, sewage, sludge and other anthropogenic activities. Radioactive materials can enter water in several ways by being deposited in surface water from the air, by entering ground water or surface water from the ground through erosion, seepage, or human activities such as mining, farming, storm water and industrial activities and by dissolving from underground mineral deposits as water flows through them[1]. The environment contains in abundance of man made and natural radionuclide as well as polluting heavy metals. Their accumulation and the inevitable impact on human health is a matter of serious international concern. There are several ways in which humans can come into contact with this radionuclide: inhalation from the passing cloud external exposure in contaminated soil surface and ingestion due to food chain transfer of radionuclide. The types of diseases that can occur include leukemia, thyroid, bone, breast, lung and others. As at 1988, there were 237 confirmed cases of illness resulting from this incident as well as 31 fatalities in the Soviet Union[2]. Similarly, in Nigeria over 400 children died of lead poisoning in Zamfara State due to artisanal mining activities[3].

Many heavy metals and radionuclide's (radioactive contaminates) occur naturally in the earth's soil. While trace amounts of heavy metals are not harmful to humans some even being necessary in our diet, accumulation over time can cause serious illness[4-6]. Heavy metals can have toxic effects on humans when they contaminate the soil or the ground water pollutant[7-9].

Moreover, many metal ions play dual roles in the human physiology; some are essential for life while most of them are toxic at deviated concentrations[10].

Ions such as sodium, potassium, magnesium and calcium are essential to sustain life. Additional metals such as manganese, iron, cobalt, copper, Zinc, chromium, vanadium, selenium and molybdenum are also essential for optimal growth, development and reproduction. These metals function mostly as catalysts for enzymes activity in human bodies but become toxic when their concentration becomes excessive. In addition to the mercury, lead, cadmium, silver aluminum, arsenic and barium[11], Epidemiological studies in recent years have indicated a strong association between the occurrence of several diseases in humans, particularly cardiovascular disease, kidney related disorders, neurocognitive effects and various forms of cancer and the presence of toxic trace metals[12-14].

In this research, the concentrations of Cr, Zn and Pb in soil samples obtained from five selected locations along the bank of river Kaduna Nigeria were determined using energy Dispersive X-Ray Fluorescence (EDXRF) Spectrometer model minipal 4.

Material and Methods

Five (5) soil samples were collected at five (5) different locations along the bank of river Kaduna, Nigeria namely; Gamji Recreational Area (GRA), Kabala Costain (KC), Nasarawa (NS), Unguwan Rimi (UR) and Zango (Zg) as shown in figure -1, at 10cm depth using a mechanical digger. The 10cm depth was carefully chosen as the appropriate depth to obtain the samples in line with the facts established that these pollutants are highly absorbed to clayed materials and organic matters in the study areas[15].

The five (5) soil samples collected from the sampling locations were pretreated by oven drying them at a regulated temperature of 50^0c for 48 hours. After drying, a series of mesh size 35μm was used to remove large undesirable particle sizes[15].

The dry test samples were analyzed using the energy dispersive X-ray florescence (EDXRF) minipal (4) model to determine the concentration of the metals (pollution in the soil samples.

Results and Discussion

Soils from the various sampling locations along the bank of River Kaduna in Kaduna Metropolis were analyzed using energy dispersive X- ray Florescence (EDXRF) method. It was found out that the concentrations of the elements varied from one location to another. Inferential statistics was used to compare the concentration of Cr, Zn and Pb across Gamji Recreational Area (GRA) Kabala costain (KC), Nasarawa (NS), UngwanRimi (UR) and Zango (ZG) sampling locations of Kaduna metropolis. The one way ANOVA at the 5% level of significance was equally applied for the analysis. The percentage weight of Cr, Zn and Pb given in table=1 While table – 2 shows the concentration in ppm (mg/kg).

Chromium (Cr): From the result of the analysis the mean concentration of Cr is 160.0 ±8.8 mg/kg in range between 107.0 ± 7.0 to 265.0 ± 13.0 mg/kg with the highest value of 265.0 ± 13.0 mg/kg in GRA, and it follows the order GRA >NS>KC>UR>ZG> (figure -2). Soil sample obtained from GRA had the highest enrichment of Cr when compared to all other sites. This value is comparable to those reported for world soils[9]. Similarly, the average value, reported for contaminated soils from Southwest Polland[16] with respect to some heavy metals for all twenty four sample locations were higher than the values obtained in this study. The higher value of Cr in GRA as compared to the sampling locations could be attributed to the higher impact of anthropogenic sources of pollution in the area[17].

Zinc (Zn): The mean concentration of Zn is 68.8 ± 6.6 mg/kg between the range of 50.0 ± 6.0 to 103.0 ± 7.0mg/kg with highest value of 103.0 ± 7.0mg/kg obtained in the soil from KC sampling location than the other sampling sites. This is followed by UR GRA, NS and ZG respectively as in figure-3. The higher Zn value in KC could be attributed to higher anthropogenic activities in the area as compared to the other locations[17,18].

Lead (Pb): The result from table- 2 showed that the mean concentration of Pb is 31.4 ± 5.6 mg/kg in range between 19.0 ± 4.0 to 40.0 ± 5.0 mg/kg with highest values of 40.0 ± 5.0 and 40.0 ± 8.0 mg/kg obtained from GRA and KC respectively. This is shown in figure -4.

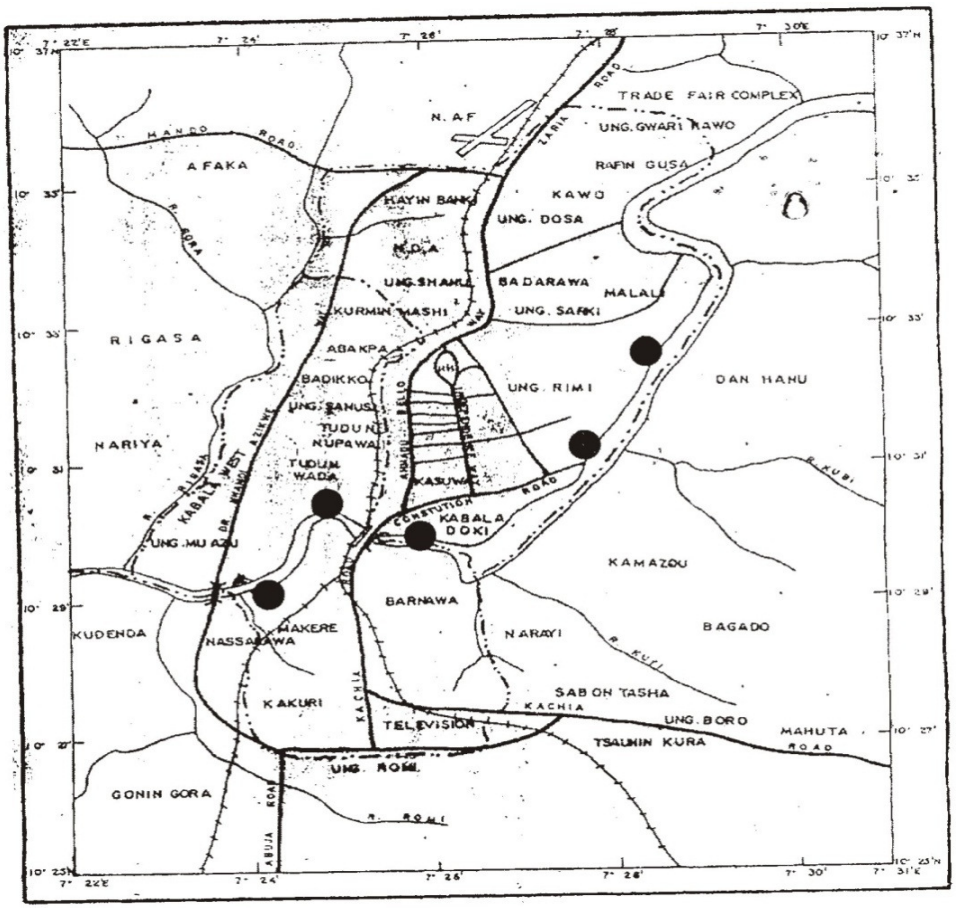

Figure-1
Map of kaduna metropolis showing the sampling locations

The higher amount of Pb in GRA and KC as compared to other locations could be attributed to the presence of heavy traffic, agricultural and other anthropogenic practice around these area[7,9,20,21].

In the sampling locations Cr was found out to have the highest percentage followed by Zn and Pb as shown in figure- 5.

The ANOVA (P = 0.923 > 0.05) indicated that there is no significant difference in the metals across the five locations. In other words all the locations have similar pattern of metal concentrations.

Similarly, the ANOVA (0.000> 0.05) showed that there is a significant difference in the relative abundance of the various metals. In other words some metals are more abundant than other in all the locations.

Conclusion

The concentration of Cr, Zn and Pb in soil along the bank of river Kaduna, Nigeria were investigated and the results showed that Cr has a mean concentration of 160 ±8.8 mg/kg in range between 107 ± 7.0 to 265.0 ± 13.0 mg/kg, Zn has a mean value of 68.8 ± 6.6 mg/kg in range between 50 ± 6.0 to 130 ± 7.0 mg/kg while Pb has a mean value of 31.4 ± 5.6 mg/kg in range of 19.0 ± 4.0 to 40.0 ± 5.0 mg/kg. The result obtained in this work compared well with other published works. The mean values of these metals from this study showed higher values than the world average values of 100, 50 and 10 mg/kg for Cr, Zn and Pb respectively in all the sampling locations the concentration of Cr, Zn and Pb were below the tolerable limit.

Table-1
Percentage weight of Cr, Zn and Pb

S/no	Location	Percentage weight					
		Cr		Zn		Pb	
		% weight	StdErr	% weight	StdErr	% weight	StdErr
1	CRA	0.0142	0.0008	0.0103	0.0007	0.004	0.0005
2	KC	0.0265	0.0013	0.0063	0.0009	0.004	0.0008
3	NS	0.0168	0.0008	0.0058	0.0005	0.0019	0.0004
4	UR	0.0118	0.0008	0.007	0.0006	0.0032	0.0005
5	Zg	0.0107	0.007	0.0050	0.0006	0.0026	0.0004

Table-2
Concentrations of Cr, Zn and Pb in PPM (mg/kg)

S/No	Location	Concentrations in mg/kg.		
		Cr	Zn	Pb
1	GRA	142.0 ± 7.0	103.0± 7.0	40.0 ± 5.0
2	KC	265.0 ± 13.0	63.0. ± 9.0	40.0 ± 8.0
3	NS	168.0 ± 8.0	58.0 ± 5.0	19.0 ± 4.0
4	UR	118.0 ± 8.0	70.0 ± 6.0	32.0 ± 5.0
5	Zg	107.0 ± 7.0	50.0 ± 6.0	26.0 ± 4.0
	Mean	160.0 ± 8.8	68.8 ± 6.6	31.4 ± 5.6

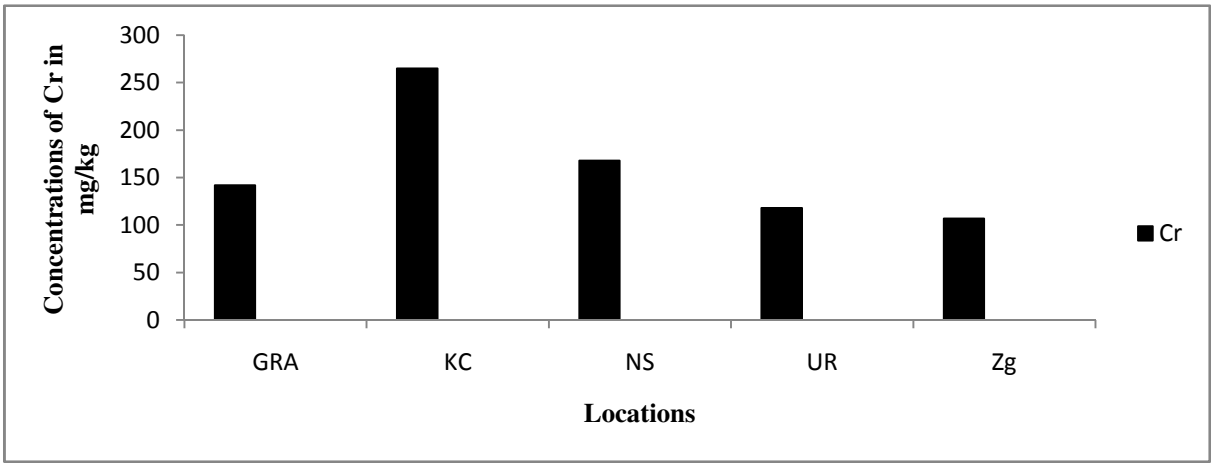

Figure-2
Plot of Concentration of Cr in mg/kg by Location

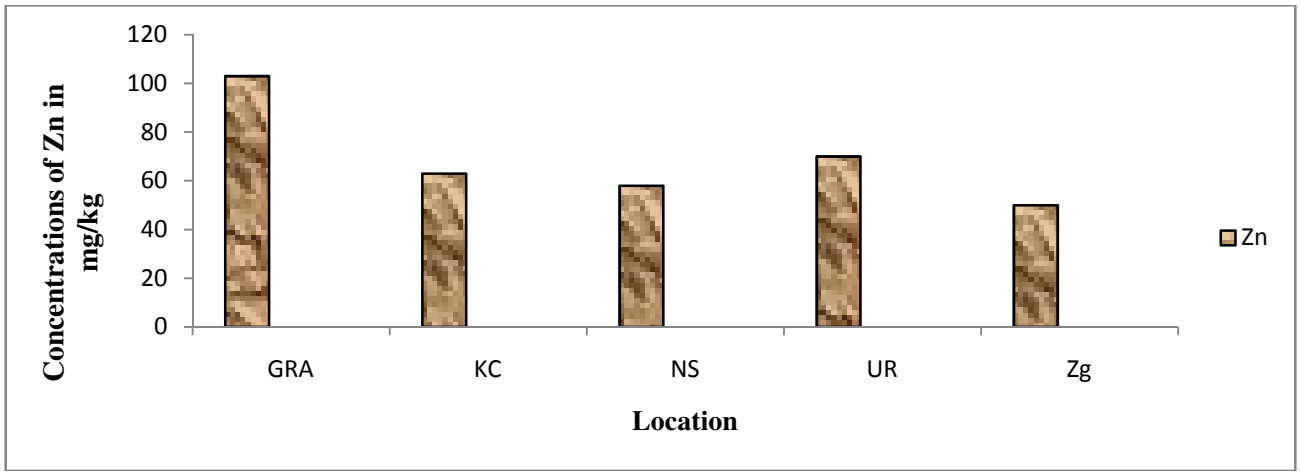

Figure-3
Plot of Concentration of Zn in mg/kg by Location

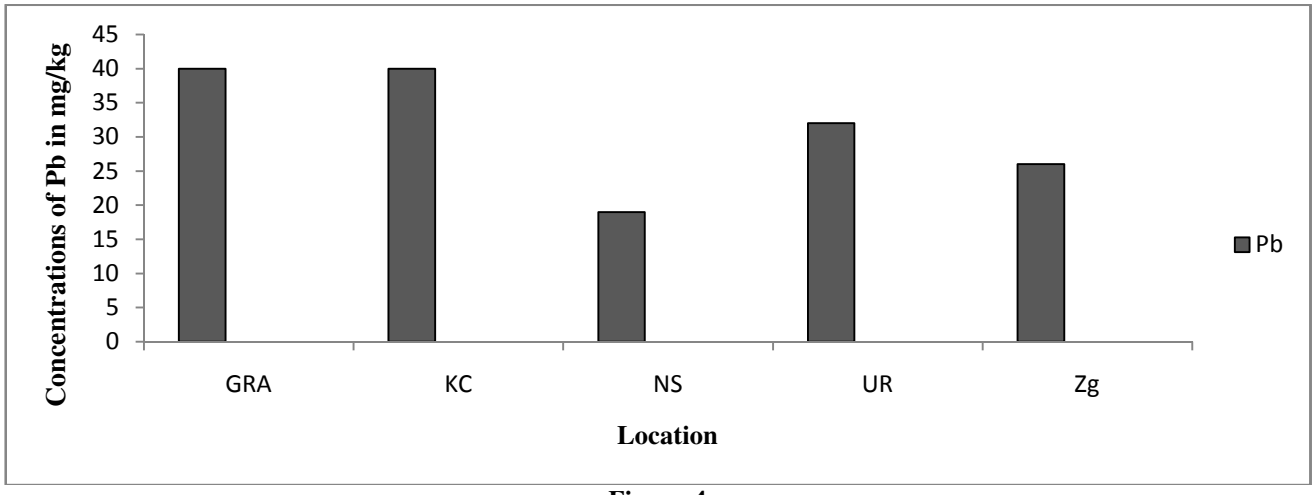

Figure-4
Plot of Concentration of Pb in mg/kg by Location

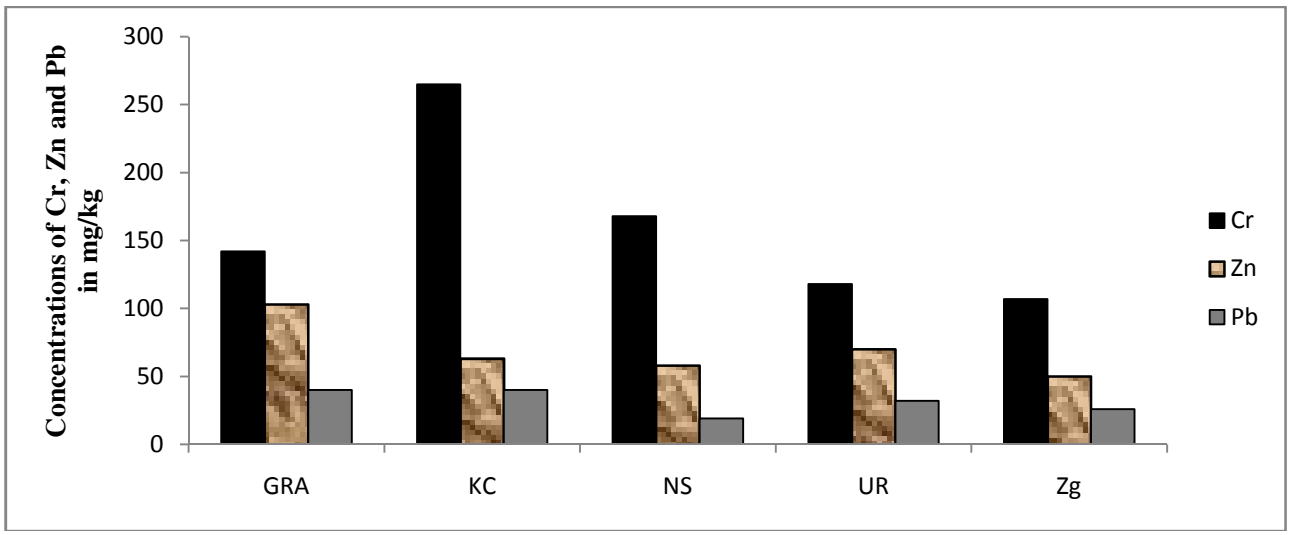

Figure-5
Plot of Concentrations of Cr, Zn and Pb in mg/kg by Locations

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