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Trace Metals Levels in Sediment from River Kaduna, North West Nigeria.

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----------ABSTRACT----------

Twenty aggregate samples of sediments were randomly collected from five sites across the length and breadth of the Kaduna River stretching over tens of kilometer within the Kaduna metropolis. Samples were analyzed using the Atomic Absorption Spectrophotometer (AAS) and results obtained showed considerate high levels Pb (20.94-48.43); Mn (7.42-57.09); Cd (0-58.59); Ni (24.58-575.60) and Co (0-29.98) mg/Kg, of some of the trace metals in industrial and farming areas as compared to other parts of the water body. This is particularly relevant due to the fact the river Kaduna is main source of drinking water to communities within the state and a major source of fish to Kaduna metropolis as well as neighboring town. Its water is used for irrigation farming which produces most of the vegetables served in the state. Concentrations of trace elements in sediments are important due to recent interest in contamination potential and toxic effect of these elements on humans and the environment. This study took preliminary assessment of the level and distribution of these five trace metals, namely Cu, Mn, Co, Cd and Ni. It is hoped that this will help enrich the baseline data for the area under study.

Keywords: AAS, Trace Metals, River Kaduna, Contamination, Concentration.

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I. INTRODUCTION

Heavy metals are major pollutants of marine ecosystem, particularly those elements which are toxic to marine organisms and humans of which As, Cd, Fe, Cr, Ni, Hg, Se, Zn, Cu and Mn are generally held to be most important. In the assessment of the pollution situation of some of these elements in the source of water supply to Kaduna town and some of its nearby Communities, knowledge of their present levels in sediments is necessary. The analysis of heavy metals in the sediments underlying the Kaduna River is important because it will help in enriching the baseline data for the area under study. Heavy metals are metallic element which is toxic and has a high density, specific gravity or atomic weight. Heavy metals are chemical elements with a specific gravity that is at least 5 times the specific gravity of water. The specific gravity of water is 1 at 4°C (39°F). Simply stated, specific gravity is a measure of density of a given amount of a solid substance when it is compared to an equal amount of water. Some well-known toxic metallic elements with a specific gravity that is five or more times that of water are arsenic, 5.7; cadmium, 8.65; iron, 7.9; lead, 11.34; and mercury, 13.546 (Spielgel and Farmer,. 1985).

Over the last century, global industrialization and natural processes have resulted in the release of large amounts of toxic compounds into the biosphere. This has lead to the problem of environmental pollution of ecological concern. Toxic substances where introduced into the environment as a result of man's activities causing injury to the health of the environment including life forms present in it and also appliances installed in it. Most of these pollutants enter the environment as emissions to the atmosphere or as discharges into water bodies or as dumps on the land. Heavy metals such as cadmium, copper, lead, vanadium and mercury are important environmental pollutants. Their presence in the atmosphere, soil and water even in traces can cause serious problems to all organism especially humans (Ejaz ul *et al* 2006). This is because heavy metals are non-degradable and persistent in eco-system. Also physical, chemical and biological processes may combine under certain conditions to concentrate metals rather than dilute them. According to Tariq *et al* (1966), there is a global concern about the rapidly deteriorating state of rivers with respect to heavy metal pollution. Serious metal pollution could result from the discharge of unregulated effluents into natural fresh water bodies (Spielgel and Farmer,. 1985).

River Kaduna is the major source of water supply to the Kaduna city. The river basin is a booming crop farming area in both dry and raining seasons. Fertilizers, herbicides and insecticides are used on these crops and are eventually washed into the river via surface run off. Most of the industries (Textile factories, NNPC Refinery, Peugeot Automobile Assembly Plants etc) located in the southern part of the city derive their water requirements from the river and discharge their wastes directly into the river. Trade wastes (from auto-mechanics, metal fabrication/finishing, abattoirs etc) are also directly or indirectly discharged into the river. Domestic sewage and refuse also find their way into the river from many settlements along the river via leaching, direct discharge and surface run off. Thus, there is every possibility of contamination of this water body, sediments and fishes, since industrial effluents and municipal wastes are known to contain high amounts of heavy metals (Abul *Kashan and Singh 1999).* According to Oladimeji (1986) there is presence of Copper, Chromium, Iron, Manganese, Nickel, Vanadium and Zinc in river Kaduna. Nwaedozie (2001) found that effluent discharged into the river contained heavy metals above the minimum level allowed for discharge into water bodies.

Ewalu (1983) studied physicochemical parameters of the river and concluded that the river was polluted. The accumulation of heavy metals in the sediments of the Kaduna river is hoped to be determined as this will in giving an insight into the general safety of the products of this very important water body.

Materials and methods

Kaduna metropolis is located in Northern Nigeria (lat. 10.20^{o}N, long. 7.23^{o}E). The wet season is characterized by torrential rainfall from May to October, while the dry season is November to April. (Samali et al 2011). The natural vegetation cover is tropical grassland of the Northern guinea savannah type with short scattered trees interspersed with tall grasses. Urbanization has taken over the original vegetation of Kaduna. The soil is mainly sandy clay, which reduce infiltration and accelerate overland flow and erosion particularly where the soil surface has little or no vegetation cover.

The Malali river bank just like Barnawa river bank is where the Kaduna State Water Board Pump station is located. Nassarawa and Down quarters river bank is located in the southern part of Kaduna; and receives effluent from United Nigerian Textile Plc, Kaduna Textile Limited (KTL), Zamfara Textile Limited, Nigerian Brewery Limited etc. It is one of 53 drains that discharge into river Kaduna.

Sample Collection

Soil samples were collected from five sites along River Kaduna bank as follows; Malali, Ungwan Rimi, Barnawa, down quarters and Nassarawa. 20 aggregate samples were collected per site using spatula. They were harmonized and oven dried, grounded, sieved with 250micro mesh size and stored in plastic containers. The samples were taken in the month of November, a dry season period. Samples were stored in clean plastic bottles prior to analysis.

Table 1: Description of samples

Sample Key	Study Area
P1	Malali River Bank
P2	Unguwan Rimi River bank
P3	Barnawa River Bank
P4	Down Quarters River Bank
P5	Nassarawa River Bank

Sample Digestion and Analysis

1g of each soil sample was placed in a 250ml beaker, spiked with metal standard as described above and 3ml of 30% H_2O_2 was added. This was left to stand for 60mins until the vigorous reaction ceased. 75ml of 0.5M solution of HCl was added and the content heated gently at low heat on the hot plate for about 2 hours. The digested liquor was allowed to cool, filtered and brought to 100ml with the acid solution. Triplicate digestion of each sample together with the blank was conducted.

The digested soil samples were then analyzed using Atomic Absorptions Spectrophotometer (AAS) for copper, iron, cadmium, manganese and nickel. Triplicate digestion and analysis of the soil sample together with the blank was conducted.

RESULTS AND DISCUSSION

Table 1, below shows the concentration ranges and the corresponding wavelength for each element being analysed.

Table 1. Heavy metal concentration in sediments from River Kaduna (concentration in mg/Kg)

Metal	Concentration (mg/Kg)					
	P1	P2	P3	P4	P5	Average
Pb	20.94	25.37	30.21	36.48	48.48	32.30
Mn	7.42	10.13	20.11	43.81	57.09	27.71
Cd	0.00	09.33	20.11	43.81	58.59	26.37
Ni	24.58	94.07	113.00	220.44	575.60	205.54

Table 1 above shows the results of the total metal concentrations of Lead (Pb), Manganese (Mn), Cadmium (Cd), Nickel (Ni) and Cobalt (Co). The total metals determined along the five sites ranged from Pb (20.94-48.43); Mn (7.42-57.09); Cd (0-58.59); Ni (24.58-575.60) and Co (0-29.98) mg/Kg, which indicates, that soil along the river bank are polluted and deserves remediation. The extent of these metal distributions could also vary with the season. However, these samples were collected after the raining season period of August, when the seasonal variation of the flow of the river and the speed is low. Therefore, the above results will to great extent represent a true reflection of the soil characteristics within the period of the season.

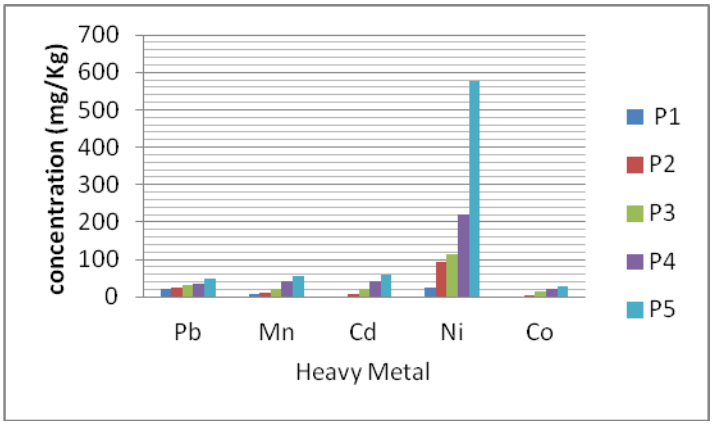

Figure1. Trace element distribution in sediments for River Kaduna

The concentration of lead along the river course shows a fair constancy (20.94-48.43 mg/Kg); with a gradual increase in areas where great human or industrial activities take place. The low value of lead obtained at Malali and Unguwan Rimi (20.94 and 25.37 mg/Kg) may have been one of the reasons why the Kaduna State government sited in these places the water intake pumps for the supply of water to the municipality. The highest level of soil lead concentration was found in United Textile Limited/Down Quarters area where great industrial effluents from textile, automobile and brewery industries enter the river.

Lead contamination of living environment is well documented, according to Odukoya and Ajayin (1987), it is very toxic and has very chronic health implications, even at low levels. Infection of it causes mental retardation in children and renal disease. Lead replaces calcium in the bone and its' effects is cumulative and long term exposure has been noted to cause serious health hazards (Essien 1992).

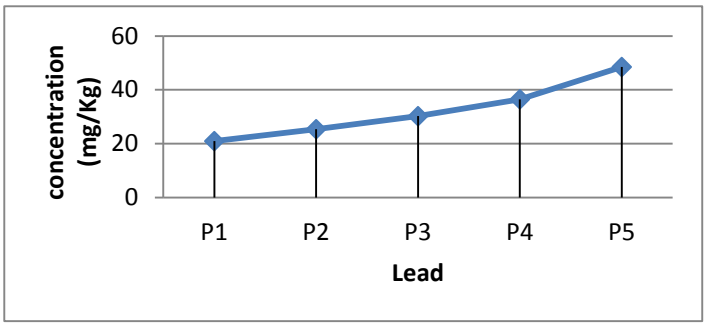

Figure2. The distributions of lead

From the figure 3 below, The variation of manganese shows a pattern different from lead. It is found in high levels in Malali, Ungwan Rimi, Baranawa and towards Nassarawa Industrial area. It seems to show antagonist behavior to lead. The permissible range for the concentration of manganese in soil is 100-4,000 mg/kg (Vecera *et al.*, 1999). This then shows manganese is not a threat to the water body.

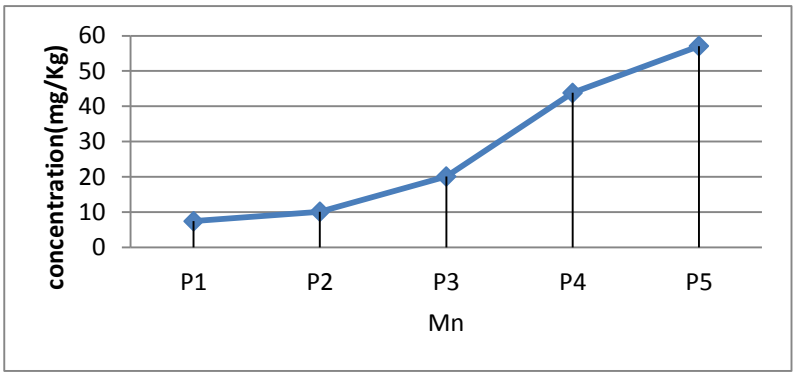

Figure3. Manganese concentration in sediments from River Kaduna

The concentration of Nickel was found to be very high along Down Quarters and Nassarawa area axis with 575.60 and 220.44 mg/Kg respectively. This is the highest concentration of metal found in this investigation. This is not unexpected as this area is associated with the highest industrial pollution activities with all the Textile Industries dumping their untreated waste effluents into the River at these points. Nickel is the only metal found in large quantities in the entire Kaduna River. Its trend is similar to other metals where there is an increased amount in areas with intense industrial activities.

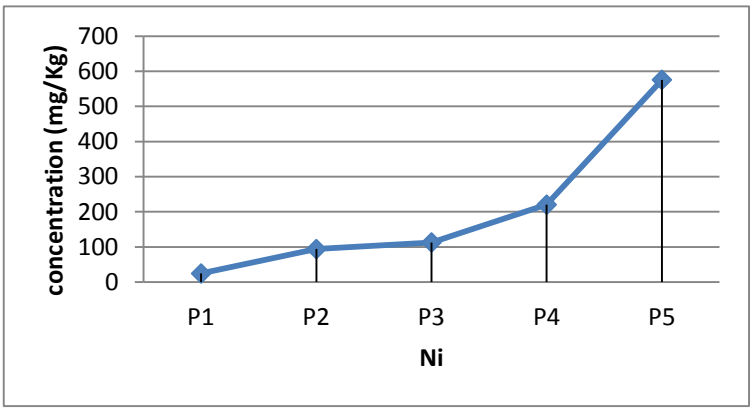

Figure4.Nickel concentration (mg/Kg) in sediments from river Kaduna

The mean concentration of cadmium in the sediments samples of the study area (0±58.59 mg/kg) is higher than the permissible limit (0.01 to 3.00 mg/kg) of cadmium in soil. The soil is therefore considered to be polluted by cadmium. Exposure to high cadmium levels may result in disease known as osteoporosis (Akesson et al., 2006). Cadmium is regarded as the most hazardous trace element and its poisoning causes damage to kidney and heart and prolonged exposure results in loss of calcium from the bone (Udoessien, 2003). Cadmium derives its toxicological properties from its chemical similarity to zinc, an essential micronutrient for plants, animals and humans. The distribution of Cadmium along the water shows a similar pattern as seen in Cobalt. This is not unexpected as this group of metals have similar characteristic (Lawson, E.O. 2011).

The high level of cadmium at Down Quarters may be associated with the discharged effluents from National Power Authority Transformer/Motor Yard and the old Railway Maintenance Yard/Market activities that drain into the area.

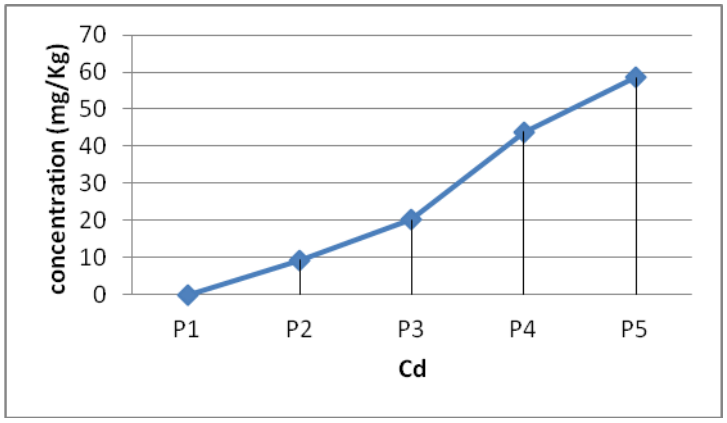

Figure5. The distributions of Cadmium

The range for Co in the samples were found to be between (0-29.98) mg/Kg,These values were within the permissible natural limit of cobalt in soil (1-40 mg/kg) (Vecera *et al*., 1999). Exposure to Co may cause dermatitis and diseases of the blood cell (Avila, 1992).

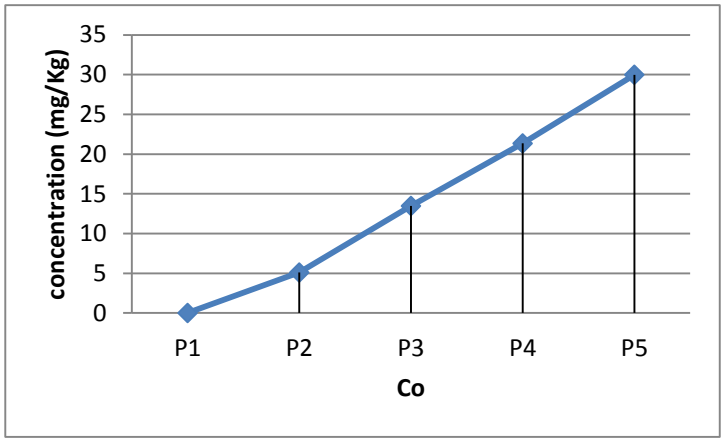

Figure 6. Cobalt concentration in sediments from river Kaduna

II. CONCLUSIONS

It is apparent from the results of this work, that sediments from all the river banks contain high levels of these metals concerned and should be of concern. Thus the water if properly treated will then be fit for drinking, Food processing, agriculture and fishing. However, considerable low concentration was recorded in part of the river body where there are little or no industrial or Farming activities.

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