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Increasing Levels of Metal Pollutants in River Kubanni Zaria, Nigeria

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Abstract: The study examines the increasing levels of concentration of metal pollutants in river Kubanni Zaria, Nigeria. The main sources of data for the study are sediments from four distinctive zones of river Kubanni and materials from previous studies on the river. The samples were collected from the river for a period of eleven months, they were prepared in the laboratory and the Instrumental Nitrogen Activation Analysis (INAA) was adopted in the analysis of the data using Nigeria Research Reactor-1 (NIRR-1). Twenty-nine metal pollutants (Mg, Al, Ca, Ti, V, Mn, Dy, Na, K As, Br, La, Sm, Yb, U, Sc, Cr, Zn, Fe, Co, Rb, Cs, Ba, Eu, Hf, K, Ta, Sb and Tb) are identified in river Kubanni in various levels of concentration. A comparative analysis shows that there is steady increase in the levels of concentration of metal pollutants from 2001 to 2004 and to 2008 with resultant possible hazards on the population that depends on the river as the main source of water for domestic purposes. The reason for this increase in the levels of concentration of metal pollutants in river Kubanni is credited mainly to increase in anthropogenic activities within the catchment area. Finally the study makes useful recommendations on how to minimize the loading of river Kubanni with metal pollutants.

Keywords: Anthropogenic activities, chemical contaminants, comparative analysis, environment, levels of concentration

INTRODUCTION

The greatest challenge confronting the water supply agencies today are the the control and removal of poisonous chemical contaminants from water, this is because of abundancy of these chemical contaminants in our environments. Studies have revealed that these chemical pollutants enter the water bodies through point and non point (diffuse) sources which are difficult to control.

Metals are chemical elements which are known to be carcinogenic and fatal because of their bio-accumulation nature. Increased technology has lead to rapid industrial activities and by implication increased pollutants in the environment and therefore exposes man to environmental risk. Man's activities have increased the loading of municipal and industrial contaminants to the nations water ways, one of such water ways is the Kubanni River. The River is a major drianage artery dissecting Zaria town. The increased loading of the river channel bed with wastes could result in increased concentration of many metal contaminants in the water, consequently affect the survival of aquatic organisms and human beings that use such water for domestic purposes (Hankouraou, 1998).

Out of all pollutants of water, metals pose the greatest threat to man and the environment this is because these chemical elements are not easily removed from raw water by conventional treatment processes and they are carcinogenic (Gower, 1980). Water supply and incidences of water pollution have been a major concern in all parts of the world. Okafor (1985) is of the view that the type and incidence of water-borne diseases vary according to the socio-cultural characteristics and levels of economic development of a country. It is a common practice in Nigeria to find hawkers and roadside sellers contributing tremendously to the deplorable stage of cleanliness in our environment especially in cities. Tin cans used for packaging processed food, sweet wrappers, papers, used bulbs and polyethylene bags of the so-called pure water dot the entire streets.

Ademoroti (1988) observes that the discharge of untreated or incompletely wastes containing algae, nutrients, non-biodegradable, organic, metals and other toxicants will hasten deterioration of recieving water bodies such as rivers, lake or dams. It is therefore necessery to study the levels of concentration of the chemical elements in our rivers that are used for domestic purposes. The Kubanni basin has been dominated by human activities such as research institutes, it is possible that the river could be polluted through these means. Ewa *et al*. (2004) reported the presence of some chemical elements in the sediments of Kabanni River. The result shows that the variations in elements concentration, enrichment and turbidity could be traced to increased bed loading of metals drained into the river from authropognic sources such as chemicals from farmlands, refuse dumps and mechanical wastes which could be controlled to keep the stream relatively uncontaminated.

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Dim *et al*. (2002) also examined the Kubanni River sediments and reported the presence of uranium and thorium enrichment. They suggested that the probable contributory factors for enrichments of these metals in the Kubanni sediments are either phosphate fertilizers used on the neighbouring farms or aeolian depositions by the northeast trade (Hammattan) winds blowing from sahara desert across the Northen savanna region.

World Health Organization (1993) suggests that in the chioce of source of drinking water and its maintenance in a satisfactory condition, sanitary and topographic aspects of the area be paramount concern and that ideally situated source should be catchment areas that have experienced minimal human activities that may cause pollution. This condition hardly exists in developing countries and there is no certainity about the level of pollution The Kubanni River is one of the most important drainage basins in Zaria therefore, this study is intended to examine the increasing levels of concentration of metal pollutants in the entire Kubanni River. The need for periodic monitoring of the Kubanni waterway in order to assess the current status of these metal contaminants cannot be overemphasized because a large number of people and livestock depend on this river.

The study area: The study area is the Kubanni River basin in Zaria, Kaduna state Nigeria. The river takes its course from the Kampagi Hills in Shika near Zaria. It flows in a south east direction of Ahmadu Bello University. The Kubanni River flows southwest into river Galma (Lat11 04`59.77”N-11 08`29.77”N and longitude 07 34`59.84”E-07 41`59.84”E). The Kubanni catchment area belongs to the north eastern part of Kaduna river which borders the Chad basin. It is located within the central High plains of northern Nigeria savanna region approximately 670 m above sea level (Yusuf, 1992).

The Kubanni River was damed by the authorities of Ahmadu Bello University (ABU) in 1973 at about 7.25 Km from source to provide water supply to the growing University community (Iguisi *et al*., 2001). The river flows through several research institutions such as Ahmadu Bello University Teaching Hospital, ABU main campus, Centre for Energy Research and Training, Institute of Agricultural Research, Nigeria College of Aviation Technology as well as several rural and urban settlements such as Samaru, Zango, Palladan, Kwangila, GRA, PZ, Tudun Jukun, Tudun Wada and Gyelesu.

MATERIALS AND METHODS

Primary and secondary sources of data are used for this study. The primary sources are sediments from four distinctive sections along the long profile of river Kubanni Zaria, Nigeria. The secondary sources are data that were generated by Iguisi *et al*. (2001) and Ewa *et al*. (2004).

The sediment samples were obtained at each sampling points along river Kubanni from January to October 2008 and were prepared in the laboratory and finally analyzed. The Certified reference materials IAEA-SL-3 (sediment) was used to determine the calibration factors for all the elements. The Instrumental Nitrogen Activation Analysis (INAA) technique was adopted in the analysis of the data using Nigeria Research Reactor-1 (NIRR-1). The Nigeria Research Reactor-1 is Miniature Neutron Source Reactor (MNSR), it is a low power nuclear reactor which has high enriched uranium as fuel, light water as moderator and beryllium as a reflector.

To analyze the data, two irradiation schemes were adopted based on the half life of the product radionuclide. For elements leading to short-lived activation product they were irradiated in the outer channel B4, where the spectrum is soft. For elements leading to long-lived activation products, samples were irradiated for 6 h in the inner irradiation channel. Following the short lived irradiation regime the first counting was done for 10 min after a waiting time of 2-5 min. The second round of counting was carried out for 10 min after a waiting period of 3-4 h. In the long irradiation regime the first round of counting was carried out for 30 min after a waiting time of 4-5 days. The second counting was performed for 60 min after a cooling period of 10-15 days. Finally, the identification of gamma-ray of product radio nuclides through their energies and quantitative analysis of their concentrations were obtained by using the gamma-ray spectrum analysis software, WINSPAN 2004.

RESULTS AND DISCUSSION

Table 1 shows that Iguisi *et al*. (2001) analyzed the surface water of Kubanni Dam using X-Ray Fluorescence (XRF) technique and a total number of eighteen metals were detected in various levels of concentration. These metals were copper 0.02 ppm, lead 0.05 ppm, iron 0.5 ppm, cadmium 0.6 ppm, Arsenic 0.02 ppm, Sulfur 33.1 ppm, Tin 0.5 ppm, Antimony 0.5 ppm, antimony 0.5 ppm, iodine 0.3 ppm, titanium 0.1 ppm, vanadium 0.7 ppm, chromium 0.05 ppm, cobalt 101 0.03 ppm, nickel 0.02 ppm, zinc 0.1 ppm, selerium 0.009 ppm, bromine 0.01 ppm and zirconium 0.05 ppm.

Ewa *et al*. (2004) analyzed the sediment from the entire course of river Kubanni using XRF technique and detected eleven metals of interest in various concentrations. The metals were potassium 21100 ppm, calcium 4300 ppm, titanium 4900 ppm, vanadium 244.5 ppm, iron 119 ppm, cobalt 164 ppm, zinc 148.2 ppm,

Table 1: Comparison of the current level of concentration of metal pollutants in river Kubanni with some previous studies

Iguisi *et al*. (2001)		EWA *et al*. (2004)		Current level	
Element concentration PPM		Element concentration PPM		Element concentration in PPM	
Copper	0.02	Potassium	2.110	Magnessium	2800
Lead	0.05	Calcium	0.430	Aluminium	40000
Iron	0.50	Titanium	0.490	Calcium	4200
Cadium	0.60	Vanadium	244.5	Titanium	2900
Arsenic	0.02	Iron	1.190	Vanadium	35.35
Sulfur	3.10	Cobalt	16.40	Manganese	247.75
Tin	0.50	Zinc	148.8	Dysprosium	6.340
Antimony	0.50	Rubidium	118.2	Sodium	2100
Iodine	0.30	Strotium	69.10	Potassium	19900
Titanium	0.10	Zirconium	884.2	Arsenic	2.020
Vanadium	0.07	Niobium	33.10	Bromine	0.990
Chromium	0.05			Lanthanium	35.51
Cobalt	0.03	Total = 11 metals		Samarium	29.64
Nickel	0.02	Lab technique = XRF		Yitterbium	5.860
Zinc	0.10			Uranium	5.490
Selerium	0.009			Scandium	3.640
Bromine	0.01			Chromium	24.29
Zirconium	0.05			Iron	16500
				Cobalt	4.170
Total = 18 metals				Zinc	103.66
Lab tech. = XRF				Rubidium	121.72
				Caescium	3.710
				Barium	402.06
				Europium	0.830
				Lutetium	0.680
				Hafnium	18.88
				Tantalum	2.060
				Aantimony	1.360
				Thorium	21.44
				Total = 29 metals	
				Lab tech. = NAA	

Iguisi *et al*. (2001), Ewa *et al*. (2004) and Fieldwork (2008)

rubidium 118.2 ppm, strontium 69.1 ppm, zirconium 884.2 ppm, strontium 33.1 ppm. Although Iguisi *et al*. (2001) and Ewa *et al*. (2004) used the same laboratory technique (XRF) for their analysis, different metals of interest were detected and metals like titanium, vanadium, iron, cobalt, zinc and zirconium show different levels of concentration in the two studies.

The result of the analysis of the current level of concentration of metal pollutants in river Kubanni using a much more sophisticated and highly accurate method; the Instrumental Nitrogen Activation Analysis (INAA) shows the concentration of twenty nine metal pollutants in different levels of concentration as observed in Table 1. The INAA technique was adopted because it is capable of detecting all the metal pollutants that are present in the river sediment in a more accurate manner. The twenty nine metal contaminants that were detected in various levels of concentration are Mg 2800 ppm, Al 40 ppm, Ca 4200 ppm, Ti 2900 ppm,V 35 0.35 ppm, Mn 247.75 ppm, Dy 6.34 ppm, Na 2100 ppm, K 19900 ppm, As 2.02 ppm, Br 0.99 ppm, La 35.53 ppm, Sm 29.64 ppm, Yb 5.86 ppm, U 5.49 ppm, Sc 3.64 ppm, Cr. 24.29 ppm, Fe 16500 ppm, Co 4.17 ppm, Zn 103.66 ppm, Rb 121.72 ppm, Cs 3.71 ppm, Ba 402.06 ppm, Eu 0.83 ppm, Lu 0.68 ppm, Hf 18.88 ppm, Ta 2.06 ppm, Sb 1.36 ppm and Th 21.44 ppm.

It is observed from Table 1 that the following metal pollutants were detected by Iguisi *et al*. (2001) and Ewa *et al*. (2004) and they are also detected in the present study. The levels of concentration of Ti in river Kubanni in 2001 was 0.1 ppm, 0.49 ppm in 2004 and 2900 ppm in this study, Ca was 0.43 ppm in 2004 and 4200 ppm in this study, Fe 0.5 pm in 2001, 1.19 ppm in 2004 and 16500 ppm in the present study, As was 0.02 ppm in 2001 and 2.02 ppm in this study, V was 0.07 in 2001, 244.5 in 2004 and 35.35 ppm in the present study, Cr is 0.05 pm in 2001 and 24. 29 ppm in present study, Co was 0.03 ppm in 2001, 16.4 ppm in 2004 and 4.17 ppm in this study, Zn was 0.01 ppm in 2001, 148.8 in 2004 and 103. 66 ppm in this study, Br was 0.01 ppm in 2001 and 0.99 in this study and finally Rb was 118.2 ppm in 2004 and 121.71 ppm in this study.

From the result of the comparative analysis of the levels of concentration of metal pollutants in river Kubanni at different periods i.e., Iguisi *et al*. (2001) and Ewa *et al*. (2004) and the present study in (Table 1), it is observed that Ti, V, Fe, Co and Zn show a considerable level of increase in concentration in the river from 2001 to 2004. This increase in the level of concentration of these elements in the river can be attributed to increase washing of debris and effluents from the catchment area into the river. The entire basin is thickly populated and a lot of human activities take place within the area.

The result of the current study compared with Iguisi *et al*. (2001) shows tremendous difference in the

levels of concentration of metal pollutants in the stream. The levels of concentration of Ti, Fe, As, Sb, V, Cr, Co, Zn and Br are observed to be far higher than the concentration in 2001. The high increase in the levels of concentration of these metal pollutants from 2001 to date can also be attributed to increase in human activities within the catchment area which have resulted in draining of foreign materials that contain these chemical elements into the river by overland and base flow.

Table 1 shows that Ewa *et al*. (2004) analyzed eleven metals of interest and out of these metals, K, Ca, Ti, V, Fe, Co, Zn and Rb are also detected in the present study but in extreme high concentrations, except Zn, Co and V that have lower levels of concentration. Generally, the levels of concentration of metals in Kubanni River is on a steady increase as observed from the study of Iguisi *et al*. (2001) and Ewa *et al*. (2004) and also from Iguisi *et al*. (2001) and Ewa *et al*. (2004) and the present study because of the nature of the sources of these chemical elements. There seems to be a slight deviation from the results of Ewa *et al*. (2004) and the present study for V, Co and Zn. The main reason for this deviation could be from different level of accuracy of the laboratory techniques adopted in the two studies and probably as a result of differences in the duration and area coverage of the two studies.

Both Iguisi *et al*. (2001) and Ewa *et al*. (2004) used the XRF technique in the analysis of their study which were restricted to specific regions of the river while the present study adopted the INAA technique which is much more sophisticated with the highest degree of accuracy (Jonah *et al*., 2006) and also covered the entire river for a period of eleven months. The INAA technique is very dependable and highly accurate and as such it was able to detect all the metal pollutants in Kubanni River in very high levels of concentration above the previous ones (Table 1). The result of the analysis have shown that river Kubanni currently contained metal contaminants such as Mg, Al, Ca, Ti, V, Mn, Dy, Na, K, As, Br, La, Sm, Yb, U, Sc, Cr, Fe, Co, Zn, Rb, Cs, Ba, Eu, Lu, Hf, Ta, Sb and Th in very high levels of concentration and these concentrations are on gradual increase with resultant possible hazards on the health of the population that depends on this river as the main source of water for domestic purpose.

CONCLUSION

The study has tried a comparative analysis of levels of concentration of different metal contaminants in river Kubanni. It is observed from this study that the levels of concentration of Ti, Fe, As, SB, Cr, Co, Zn and Br are higher as compared to Iguisi *et al*. (2001). The study of Iguisi *et al*. (2001) was compared with Ewa *et al*. (2004) and it was observed that Ti, V, Fe and Zn showed a considerable level of increase in concentration from 2001-2004 and finally the result obtained from this study was campared with Ewa *et al*. (2004) and it was observed that the metal contaminants show a level of increase in their concentration.

Generally, the levels of concentration of metal pollutants in river Kubanni is on steady increase as observed from Iguisi *et al*. (2001) and Ewa *et al*. (2004) and the present study, the slight deviation observed from the study of Ewa *et al*. (2004) and the present study for V, Co and Zn could be from different levels of analytical accurancy as a result of different laboratory techniques adopted in the studies as well as duration and area coverage of the study.

RECOMMENDATIONS

To protect the Kubanni River and other water resources meant for human consumption from increase pollution by chemical contaminants, this study makes the following recommendations:

- Indiscriminant dumping of refuse which litter the built up area of the Kubanni catchment area should be discouraged by the Government because most of these metal contaminants and other chemical elements that have their origin from decay of substances in the dumps. An acceptable method of sanitary land fill should be introduced.
- Ugly practices such as discharging of engine oil, petrol, used batteries, electric bulbs, grease, training and salon effluents into drains which finally end up into the river should be discouraged. Government should rather organize collection system of waste labricants which can be recycled if possible.
- The use of toxic chemicals for farming especially the use of insecticides, herbicides and chemical fertilizers should be controlled. It is possible to obtain optimum agriculture yeild within the drainage basin without contaminating the river with chemical elements.
- The location of industries and research institutions should be far away from water bbodies. For already existing factories steps should be taken to remove some of the poisonous and harmful chemicals from the effluents before discharging them to the remote areas.
- Our towns and cities should have simple effective sewage treatment. Raw sewage should not be discharged into public drains.

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