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Distribution of Heavy Metals in Sediments of Selected Streams in Ibadan Metropolis, Nigeria

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ABSTRACT

The concentration of Zinc (Zn), Copper (Cu), Nickel (Ni), Cadmium (Cd), Lead (Pb), Chromium (Cr) and Colbalt (Co) were determined in the five major streams sediment of Ibadan city; Odo-ona (S-1),Ogunpa (S-2),Ogbere (S-3),Kudeti (S-4) and Gege (S-5) to investigate consequences of population growth, urbanization, agricultural activities and uncontrolled direct dumping of wastes and sewages into aquatic environment.

The order of the concentration of most of these studied metals in all the streams sediments were found to be Gege>Ogunpa>Kudeti>Ogbere>Odo-ona. This is clear indication of effect of population growth, urbanization, agricultural activities, traffic congestion of Automobile and indiscriminate dumping of domestic waste and sewage into the aquatic environment.

The highest mean total concentration of all studied trace metals Zn (429.1µg/g), Cu(249.5µg/g), Ni(15.30µg/g), Cd(2.02µg/g), Pb(405.0µg/g), and Cr(67.4µg/g) were observed in Gege stream sediment(S-5) while that of Co was observed in Ogunpa stream sediment(S-2).There was no significant difference ($p>0.01$) in the distribution of Zn, Cr and Co in all the streams studied but significant difference ($p<0.01$) were observed in the distribution of Cu, Ni, Cd and Pb in all the streams sediment studied.

Heavy metal concentration for all studied sediments showed a high level of pollution in comparism to GESAMP, 1982, Solomon and Forstner, 1984 and Prater and Anderson, 1977.

Keywords: Stream, sediment, Heavy metal, Ibadan city.

1. Introduction

The occurrence of heavy metals in excess of natural background concentration level in aquatic ecosystems has become a thing of public concern. This increase in metal concentration in aquatic environments has been attributed to heavy metals inputs from anthropogenic sources including domestic wastes, mining and industrial activities, urban run-off, atmospheric fall-out, leaching of metals from garbage and solid wastes dump, etc. However, contaminations of aquatic ecosystem in developing nations are mostly related to the consequences of population growth, urbanization, agricultural activities and development of new industrial zones (Olade, 1987 and Paul & Pillai, 1983). Uncontrolled direct dumping of domestic waste and discharge of domestic and industrial sewage water into the aquatic environment are the other critical components of trace/heavy metal contamination (Tijani et al., 2004) especially in areas with lack of strict land-use plan and environmental protection regulations.

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The recognition of sediments as an integral part of cycling of elements, the ultimate sinks for heavy metals in the aquatic environment that gives vital information such as the sources, distribution and degree of pollution, cum their ability to release back the sediment-bound metal pollutants into the water column and consequently into the food chain within an aquatic environment with serious health and environmental implications, has stimulated interest in the study of trace element composition of sediments (Kakulu and Osibanjo,1988, Gibbs, 1977).

Based on the above background, assessment of the following heavy metals Copper(Cu), Cadmium(Cd), Chromium(Cr), Cobalt(Co), Lead (Pb), Nickel(Ni) and Zinc(Zn) status in the following five major streams sediment Ogunpa, Gege, Odo-ona, Ogbere and Kudeti in Ibadan metropolis, SW-Nigeria, becomes imperative to gives an insight into vulnerability of population growth, urbanization, agricultural activities, atmospheric fall-out, poor sanitation and indiscrete waste disposal and other anthropogenic activities that peculiar to populated urban catchments of a developing region.

2. Materials and Methods

Location: Latitude 7°21'N and Longitude 3°53'E

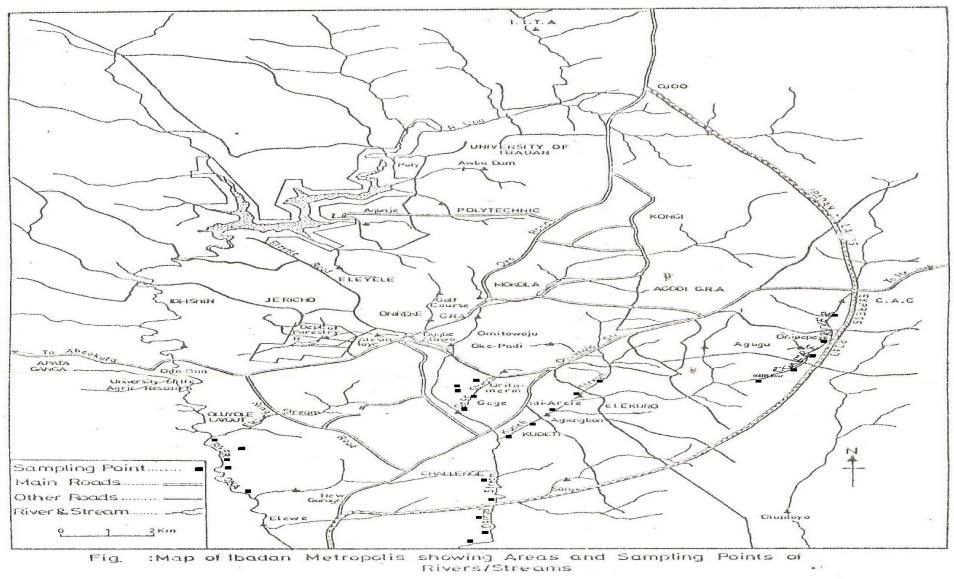

Fig. :Map of Ibadan Metropolis showing Areas and Sampling Points of Rivers/Streams

Figure 1: Image showing the study area

2.1 The study area

Ibadan metropolis and environs is located at latitude 7°21'N and longitude 3°53'E, about 110km northeast of Lagos, form the catchments of the Ogunpa, Gege, Odo-ona, Ogbere and Kudeti stream networks with approximately 315km^2 encompassing urban populated portion of Ibadan metropolis (Figure 1). The study area is characterized by tropical humid climate with two distinct seasons: the wet season which occurs between March and October with an average annual rainfall of about 1,250mm and dry season from November to February characterized by dry, dusty and relatively cold NE-SW trade winds. Ibadan metropolis is characterized by high population density of about 3,250 persons per sq. kilometer in comparison to the national average of 137 persons per sq. kilometer (Tijani et al;2004). Other

peculiar features of the Ibadan metropolis are poor land- use planning, lack of adequate water supply and sanitary conditions, lack of proper sewage and waste disposal systems, traffic congestion and direct dumping of domestic refuse and sewage water into the streams and rivers within the metropolis and its environs.

2.2 Sample collection

Twenty five sediment samples were collected at the sampling location shown in the Map (Figure 1) monthly for the period of three months, with an average of five samples collected along each of the five studied streams; Ogunpa, Gege, Odo-ona, Ogbere and Kudeti streams.

These sediments were collected in the dry season (April-June, 1998) with aids of van-veen grab and stored in well labelled black polythene bags that have been previously soaked in 10% HNO3(Nitric acid) and 1:1 HCl (Hydrochloric acid) for 24 hrs followed by rinsing with distilled water and then allowed to drain to dryness.

3. Metal Analysis

The sediment samples were air dried, grinded using mortar and pestle and sieved through 2mm mesh size to remove coarse materials.

Table 1: The Average metal concentration, standard deviation and range in µg/g in the sediment of studied streams/rivers of Ibadan metropolis.
(n)-non polluted environment, (m) - moderately polluted environment & (h) - highly polluted environment (Range values in parentheses)

Stream	Zn	Cu	Ni	Cd	Pb	Cr	Co
Odo-ona (S-1)	106.2±56.9 (29.1-189.1)^{a}	28.07±9.36 (16.3-49.5)^{a}	10.26±4.20 (5.20-71.8)^{d}	1.14±0.36 (0.63-3.10)^{b}	43.4±32.0 (17.0-113.0)^{b}	35.6±22.1 (10.4-68.1)^{c}	13.2±6.44 (7.90-26.1)^{d}
Ogunpa (S-2)	274.0±176.3 (151.1-572.1)^{d}	72.14±39.3 (31.4-123.5)^{d}	14.46±4.41 (7.90-18.7)^{e}	1.72±0.80 (1.03-3.10)^{c}	133.0±44.7 (81.0-189.0)^{c}	42.9±18.0 (24.7-72.7)^{a}	16.02±9.95 (9.00-32.8)^{e}
Ogbere (S-3)	201.5±72.0 (127.1-309.1)^{c}	49.24±10.6 (30.5-56.9)^{b}	10.38±1.88 (8.60-13.2)^{b}	0.86±0.14 (0.62-0.97)^{a}	113.8±70.8 (54.0-191.0)^{d}	35.9±18.2 (21.9-67.2)^{b}	14.3±2.61 (11.3-17.0)^{c}
Kudeti (S-4)	228.1±57.9 (165.1-305.1)^{b}	149.9±115.0 (45.1-287.5)^{e}	10.93±2.15 (8.70-13.1)^{c}	1.40±1.22 (0.62-3.20)^{e}	110.8±80.5 (63.0-231.0)^{e}	56.4±23.7 (31.4-83.1)^{d}	11.3±1.16 (9.90-12.3)^{a}
Gege (S-5)	429.1±379.0 (161.1-697.1)^{e}	249.5±14.0 (239.5-259.0)^{c}	15.30±0.57 (14.9-15.7)^{a}	2.02±0.95 (1.34-2.69)^{d}	405.0±19.8 (391.0-419.0)^{a}	67.4±38.0 (40.5-94.3)^{e}	10.7±1.84 (9.40-12.0)^{b}

Unpolluted Sediment (GESAMP)	95.0	33.0		0.11	19.0		
Prater & Anderson, 1977	<90- (n) 90-200- (m) >200- (h)	<25- (n) 25-50- (m) >50- (h)			<40 (n) >40 (h)	<25 (n) >25 (h)	

Then 5g of each of the 2mm mesh size sieved sediment samples were digested separately using Anderson method (Anderson, 1979) and the metals (Cu, Cd, Cr, Co, Pb, Ni & Zn) were analyzed using Buck scientific 200A model (AA-ES) Atomic absorption spectrophotometer (AAS).

4. Results and Discussion

The mean concentration of Zinc (Zn), Lead (Pb), Copper (Cu), Chromium (Cr), Cobalt (Cr), Nickel (Ni) and Cadmium (Cd) in the sediment of the following studied streams; Odo-ona (S-1), Ogunpa (S-2), Ogbere (S-3), Kudeti (S-4) and Gege (S-5) in Ibadan metropolis are presented in Table 1.

Variation observed in the metal distribution from the streams sediment could be attributed to environmental contents of the different area(s) of Ibadan city, such as activities around the studied area, population density, traffic volume (Automobile vehicles), domestic/ municipal waste disposal, sewage effluent, Atmospheric fall-out, natural origin and little contribution from industrial effluent since these areas are not industrially develop. The trend in heavy metals distribution in order of decreasing average concentration in all the studied streams sediment were as follow; Odo-ona(S-1); Zn>Pb>Cr>Cu>Co>Ni>Cd, Ogunpa(S-2); Zn>Pb>Cu>Cr>Co>Ni>Cd, Ogbere(S-2); Zn>Pb>Cu>Cr>Co>Ni>Cd, Kudeti(S-4); Zn>Cu>Pb>Cr>Co>Ni>Cd and Gege(S-5); Zn>Pb>Cu>Cr>Ni>Co>Cd.

Therefore, the most abundant metals in all the studied streams sediment are Zn, Pb and Cu with the mean concentration ranges from (106.2-429.1)µg/g, (43.4-405.0) µg/g, and (28.1-249.1) µg/g, respectively, while Cr (35.6-67.4) µg/g, Co (10.7-16.0) µg/g, and Ni (10.3-15.3) µg/g are moderately present and the least abundant is Cd (1.14-2.02) µg/g. This is similar to the findings of Tijani and Onodera, 1994 on the sediment of stream of Ibadan city.

The highest mean concentration values of all the studied metals were recorded in Gege stream sediment (S-5) for Zn (421.1) µg/g, Cu (249.5) µg/g, Pb (405.0) µg/g, Cr (67.4) µg/g, Ni(15.3) µg/g, and Cd (2.02) µg/g except that of cobalt Co (16.02) µg/g which was recorded in Ogunpa stream sediment(S-2) while the lowest mean concentration of the studied metals were recorded in Odo-ona stream (S-1) for Zn (106.2) µg/g, Cu (28.07) µg/g, Ni (10.26) µg/g and Pb (43.4) µg/g except those of Co (10.7) µg/g and Cd (0.86) µg/g which were observed at Gege stream (S-5) and Ogbere stream (S-3) respectively.

The values of the studied heavy metals from all the studied streams sediment of Ibadan City were compared with the GESAMP, 1982 and Solomon and Forstner, 1984 limits for unpolluted sediment. The levels of these studied metals in the streams sediment were observed higher than the limits. At the same time assessment of the pollution status of these metals in the studied sediments were done by drawn comparison between this present results and Prater and Anderson, 1977 values and they were all observed to fall within moderately and highly polluted ranges. Therefore, it is discernable (Table 1) that sediments of the studied streams of Ibadan City are highly polluted with the studied heavy metals, most especially Gege stream (S-5) sediment.

The analysis of variance (ANOVA) for the twenty five sampling sites and five studied streams at ($p>0.01$)/ 1% level of confidence shown that there is no significant difference ($p>0.01$) in the result of Zn, Cr and Co obtained in all the streams studied, but there is a significant difference ($p<0.01$) in Cu, Ni, Cd and Pb obtained in all the streams sediment studied. Thus, the significant variation in Cu, Ni, Cd and Pb in all the streams studied indicates the exposure of the streams to different sources of heavy metals pollution. While in the case of Zn, Cr and Co there is no significant variation in the distribution levels of these metals in all the streams sediments studied which suggested that the streams were exposed to relatively the same heavy metal pollution sources, which may be from natural origin, Atmospheric fall-out and urban run-off etc.

5. Conclusion

The occurrence of enhanced concentration of trace metals in the studied stream sediments of Ibadan city is a clear indication of anthropogenic pollution from population increase(s) and urbanization coupled with lack of proper waste disposal systems. These call for improvement before the trace metals plough back into the food chains to cause serious health hazard in man.

Therefore, in order to forestall the health implications of these studied trace metals in the city there is need for formation of proactive State Ministry of Environment, promulgation of effective laws that would hinder the dumping of waste in the streams and sensitization of the populace on the needs for proper disposition of their wastes.

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