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# Heavymetals in the Sediment of Ibiekuma Stream in Ekpoma, Edo State, Nigeria

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ABSTRACT: This study determined the concentrations of Fe, Cd, Cr, Cu, Mn, Ni, Pb, V and Zn in the sediment of Ibiekuma Stream in Ekpoma, Edo State, Nigeria. The contamination levels of the respective metals were varied and the range of monthly mean values in µg/g were Fe (236.9-876.32), Cd (0.01-0.36), Cr (0.08-0.14), Cu (1.05-1.97), Mn (11.16-15.42), Ni (0.020-0.35), Pb (0.11-0.92), V (0.008-0.017) and Zn (44.96-55.89). Metal seasonal mean values were not different except for Fe and Mn. The metal levels (except Cd) were lower than mean values for continental crust and unpolluted African inland water sediments and indicated that metal contamination in the stream might not pose immediate threats to the organisms therein and to people that utilize the stream for drinking and other domestic uses. However, because Cd levels were a bit elevated, close monitoring of metal pollution of the stream is recommended in view of possible future risks that Cd could pose in the system.

Key Words: Heavy metals; Pollution; Sediment; Ibiekuma Stream; Ekpoma; Edo State; Nigeria.

## Introduction

Over the last few decades, in many African countries, a considerable population growth has taken place accompanied by a steep increase in urbanization, industrial and agricultural land use (Saad *et al*, 1994; Ogbeibu and Ezeunara, 2002; Idodo-Umeh and Oronsaye, 2006). This has entailed a great increase in discharge of pollutants to receiving waters, causing undesirable effects on the aquatic environment.

In Africa and developing world, where environmental protection laws have not been enforced, industrial and domestic wastes are dumped indiscriminately into water bodies. These wastes have been reported to contain toxic and hazardous substances including heavy metals, which eventually settle in bottom sediments (Overcash *et al*, 1978; Ademoroti, 1996; Oguzie, 2002). According to Biney *et al* (1994), microbial and redox processes may change the properties of sediments and affect the composition of interstitial water, while reworking of the sediments by organisms will also bring sediments to the surface, where a significant fraction of heavy metals will be released. A good knowledge of the distribution of heavy metals in water and sediments plays a key role in detecting the sources of pollution in aquatic systems (Forstner and Wittmann, 1981; Idodo-Umeh and Oronsaye, 2006). Bottom sediments can therefore be used to monitor heavy metal pollution in aquatic ecosystems.

Ibiekuma Stream is vital to the people of Ekpoma and other surrounding communities. It is an important natural surface water in the area for drinking and domestic uses. The objective of this study is to determine the level of heavy metal pollution in the sediment of Ibiekuma Stream and establish baseline data for future comparisons.

## Materials and Methods

*Study Area*

Ibiekuma Stream, where this investigation was carried out, takes its source from within the Ambrose Alli University permanent site in Ekpoma, Edo State (Fig. 1). The perennial first order rainforest stream, drains the southern part of Ekpoma town in a west-east direction (Udo, 1970). The study area is characterized by a flat land surface, easily worked sandy loam soils . Geologically, the area is composed of the basement complex of the Precambrian era. Ekpoma and adjoining communities have recently witnessed an upsurge in urbanization and population density since the establishment of the State University in the town. This has led to an increase in the level of industrial and agricultural activities in the area. The main crops cultivated in the area are cassava, yam, rice, pineapple and corn (Edokpayi and Osimen, 2001).

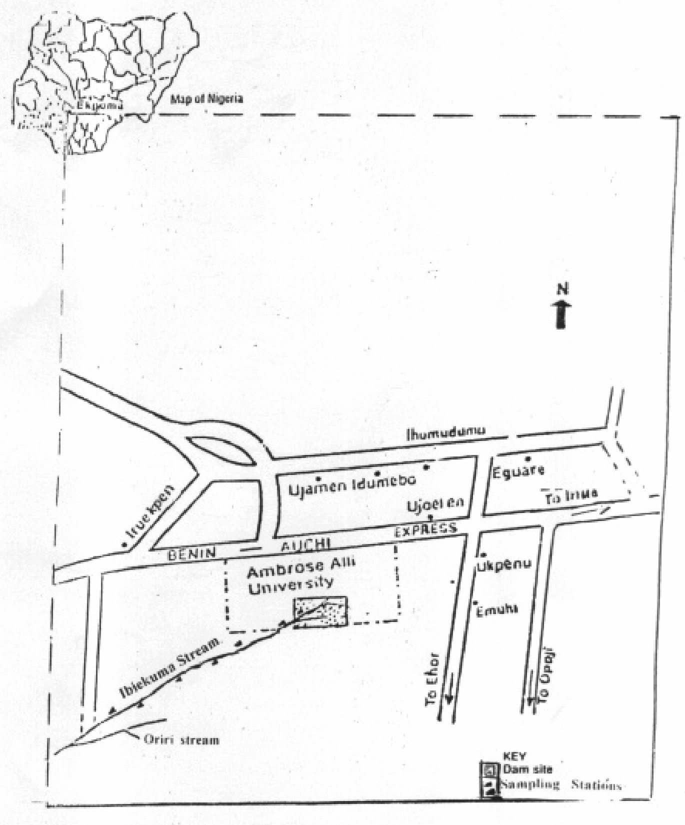


**Fig. 1: Ekpoma town showing location of Ibiekuma Stream**

*Sampling and Analyses*

Grab bottom sediment samples were collected monthly over a six-month period (January-June, 2005) and kept in plastic containers which had previously been treated with 10% nitric acid for 24 hours and rinsed with de-ionized water. The samples were transported to the Laboratory and stored frozen. The samples were later oven-dried to constant weight at $105^0$C, ground to powder and then sieved through a 650µm stainless sieve to remove ungrounded matter. 10grams of the sieved sediments was weighed into an acid-washed plastic polythene bottle and digested in a 100ml solution of conc. $HNO_3$ and HCl acids (1:1 ratio). The mixture was vigorously shaken in a mechanical shaker and then filtered through No 42 Whatman filter paper (Anderson, 1974; Idodo-Umeh and Oronsaye, 2006). The concentrations of the metals (Fe, Cd, Cr, Cu, Mn, Ni, Pb, V and Zn) were determined using a Varian Atomic Absorption Spectrophotometer (Spectra AA-10). A non-parametric statistical analysis was performed using the statistical package STATISTICA. Seasonal means were compared using the Student's t-test.

## Results

The results of the investigation are presented in Tables 1-3. The monthly mean values are given in Table 1, while the seasonal mean values are in Table 2. Table 3 shows the comparative values recorded in this study with those of some other inland water bodies in Africa.

The range of monthly mean values of the metals in µg/g were Fe (236.9-805.70); Cd (0.01-0.36); Cr (0.08-0.16); Cu (1.05-1.97); Mn (11.6-38.78); Ni (0.010-0.039); Pb (0.11-0.92); V (0.008-0.017 and Zn (44.96-55.89) (Table 1).

The seasonal mean values of the respective metals in µg/g were 682.0 (Dry season) and 356.4 (Rainy season) for Fe; 0.293 (Dry season) and 0.127 (Rain season)
for Cd; 0 11 (Dry season) and 0.12 (Rainy season) for Cr; 1.587(Dry season) and 1.157(Rainy season) for Cu; 22.97(Dry season) and 11.27(Rainy season) for Mn. The values of the other metals were 0.023(Dry season) and 0.020(Rainy season) for Ni; 0.40(Dry season) and 0.53(Rainy season) for Pb; 0.011(Dry season) and 0.014(Rainy season) for V and 51.68(Dry season) and 45.77(Rainy season) for Zn. Statistical analyses showed no significant differences ($p>0.05$) between the seasons for the metals except for Fe and Mn.(Table 2).

Table 1: Monthly mean concentrations of heavy metals in sediments of Ibiekuma Stream, during the study. (µg/g).

| Metal | Jan. | Feb. | Mar. | Apr. | May | Jun. | Mean |
|---|---|---|---|---|---|---|---|
| Fe | 805.7 | 876.3 | 364.0 | 236.9 | 399.9 | 432.5 | 519.22 |
| Cd | 0.34 | 0.18 | 0.36 | 0.01 | 0.15 | 0.22 | 0.21 |
| Cr | 0.11 | 0.14 | 0.09 | 0.16 | 0.08 | 0.12 | 0.12 |
| Cu | 1.97 | 1.44 | 1.35 | 1.28 | 1.14 | 1.05 | 1.37 |
| Mn | 15.42 | 14.71 | 38.78 | 11.20 | 11.45 | 11.16 | 17.12 |
| Ni | 0.039 | 0.020 | 0.010 | 0.030 | 0.020 | 0.010 | 0.022 |
| Pb | 0.35 | 0.11 | 0.74 | 0.92 | 0.25 | 0.43 | 0.47 |
| V | 0.011 | 0.008 | 0.013 | 0.016 | 0.010 | 0.017 | 0.013 |
| Zn | 55.89 | 52.83 | 46.33 | 44.96 | 46.12 | 46.22 | 48.73 |

Table 2: Seasonal mean values of heavy metals in sediments of Ibiekuma Stream

| Heavy Metal | Dry Season | Rainy Season | 2-Tail Probability |
|---|---|---|---|
| Fe | 682.0 | 356.43 | $p<0.05$ |
| Cd | 0.293 | 0.127 | $p>0.05$ |
| Cr | 0.11 | 0.12 | $p>0.05$ |
| Cu | 1.587 | 1.157 | $p>0.05$ |
| Mn | 22.97 | 11.27 | $P<0.05$ |
| Ni | 0.023 | 0.020 | $p>0.05$ |
| Pb | 0.40 | 0.53 | $p>0.05$ |
| V | 0.011 | 0.014 | $p>0.05$ |
| Zn | 51.68 | 45.77 | $p>0.05$ |

Table 3: Comparison of mean metal levels in sediment of Ibiekuma Stream with those of some Water bodies. (µg/g)

| Water body | Fe | Cd | Cr | Cu | Mn | Ni | Pb | V | Zn | Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| Ibiekuma Stream | 519.2 | 0.21 | 0.12 | 1.37 | 17.12 | 0.022 | 0.47 | 0.013 | 48.73 | This Study |
| Eriora River, Delta State | - | 302 302 | 87.00 | 1600 | 11.37 | 407.0 | 713.0 | 8.00 | 43.25 | Idodo-Umeh and Oronsaye, 2006 |
| Lower Ikpoba Benin City | 8.0 | 1.50 | 0.9 | 1.90 | 4.60 | 4.0 | 3.30 | - | 4.70 | Oguzie,2002 |
| Niger Delta | $2x10^4$ | 0.8 | - | 239 | 349.0 | - | 321.0 | - | 62.00 | Kakulu and Osibanjo, 1988 |
| Lower Volta River, Ghana | $56x10^4$ | 0.20 | - | 28.9 | 295.00 | - | 16.70 | - | 43.c 00 | Biney, 1991 |
| Lake Mariut, Egypt | $26x10^3$ | 0.20 | - | 38.0 | 958 | - | 7.3 | - | 94 | Saad *et al*, 1985 |
| Swatkops River, S.Africa | $15x10^3$ | 1.0 | - | 10.5 | 177 | - | 17.8 | - | 35.5 | Watling and Emmerson, 1981 |
| Continental Crust | $56x10^3$ | 0.10 | - | 55 | 950 | - | 12-20 | - | 70 | Taylor, 1964 |
| Unpolluted Sediments | $41x10^3$ | 0.11 | - | 33 | 770 | - | 19 | - | 95 | Salomons and Forstner, 1984 |

## Discussion

Sediments are sinks for many pollutants including heavy metals. Bower (1979) reported that sediments are the major depository of metals; in some cases holding over 99% of the total amount of a metal present in amounts several times higher than their natural background levels and pollute sediments in regions near large industrial and urban areas (Ndiokwere, 1982; Egborge, 1991; Ademoroti,1996). Consequently, sediments enriched by heavy metals constitute a threat to the health of aquatic organisms (Forstner and Wittmann, 1981; Law and Singh, 1991, US Environmental Protection Agency, 2003).

The mean values of FE, Cd, Cr, Cu, Mn, Ni, Pb V and Zn in sediments of Ibiekuma Stream as recorded in this study were low in comparison (Table 3) to those reported for inland water sediments in Nigeria: Niger Delta (Kakulu and Osibanjo, 1988); Lower Ikpoba River, Benin City (Oguzie, 2002) and Eriora River, Delta State (Idodo-Umeh and Oronsaye, 2006). The values were also lower than those reported for unpolluted and polluted sediments of many inland water bodies in Africa (Watling and Emmerson, 1981; Salomon and Forstner, 1984; Saad *et al*, 1985; Biney, 1991). Dry season mean values of Fe and Mn were significantly higher ($p<0.05$) than the rainy season values This could be attributed to adsorption to sediment particles as a result of the reduced water volume usually associated with increased evaporation rate in the dry season. Similar findings have been reported for Lower Ikpoba River (Oguzie, 2002) and water bodies in Burkina Faso (Etienne *et al*, 1997).

The results of this investigation showed that the sediment of Ibiekuma Stream is relatively unpolluted with heavy metals and could therefore not pose immediate threat to the health of aquatic organisms. However, the level of Cd need to be closely monitored as it exceeded Cd levels in the Continental crust and unpolluted sediments (Taylor, 1964; GESAMP;1982) and similar to those reported for polluted Lower Volta River, Ghana (Biney, 1991) and Lake Mariut, Egypt (Saad *et al*, 1985). This finding might not be unconnected with increasing urbanization and population density of Ekpoma town and the resultant increase in municipal and agricultural runoffs drained into the stream. High values of heavy metals in sediments in Nigerian aquatic environment have generally been linked to industrialization, urbanization and high human population density (Mombeshora *et al*, 1983; Onyari and Wadiga, 1989; Okoye *et al*, 1991; Oguzie, 2002). Urbanization and population density of Ekpoma have increased recently after the establishment of the State University in the town.

### *Conclusion*

This investigation showed that heavy metal contamination of the sediment of Ibiekuma Stream is low and could not pose immediate threats to the health of both the aquatic organisms in the system and the people that utilize the stream for drinking and other domestic uses. However, because Cd levels recorded were a bit elevated, close monitoring of heavy metal pollution of the stream is recommended in view of possible future risks that Cd could pose in the stream.

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