ASSESSMENT OF HEAVY METAL CONTAMINATION IN ANAMBRA RIVER, NIGERIA

*[1]AGBABIAKA L.A. AND [2]K.N. IBEMENUGA
1. Department of Fisheries Technology, Federal Polytechnic, Nekede, Owerri, Imo state.
[2]Department of Biological Sciences, Chukwuemeka Odumegwu Ojukwu University, Uli, Nigeria
***Corresponding author**: agbabiakala@gmail.com.

ABSTRACT
The concentration of heavy metals (Cd, Zn, Mn, Cu, and Pb) in water and sediment samples collected from five study stations along Anambra River was assessed for one month. The samples were obtained in plastic containers and carried to the laboratory for analysis of the selected heavy metals. The concentration of the various heavy metals in water and sediment samples were determined using an atomic spectrophotometer. Data obtained were analyzed using descriptive analysis to establish means significant difference in the concentration of heavy metals was evaluated using Analysis of variance (ANOVA). Heavy metals in water occurred in the order Zn>Pb>Cu>Cd while the trend in sediment was Zn>Mn>Pb>Cu>Cd. All the studied heavy metals except for manganese were observed in the water at all the stations. In water and sediment samples, zinc dominated the other heavy metals at all the study stations. The concentration of cadmium, manganese, and lead were above the WHO acceptable limits while the concentrations of zinc and copper were within the permissible limits. Thus, Anambra River is slightly polluted. The river, therefore, should be treated and monitored to prevent further contamination.

Keywords: Heavy metals, Water, Sediment, River.

INTRODUCTION

Aquatic bodies have been heavily contaminated, surface waters being the most assaulted and polluted particularly through anthropogenic activities. Such activities include agriculture, irrigation, fire, urbanization, mining, and industrialization. These activities generate vast quantities of deleterious substances including heavy metal which negatively impact surface waters and sediments. Heavy metals are generally non-biodegradable and can be highly poisonous when accumulated above the threshold limit. Heavy metals in water undergo interactive reactions, including precipitation, adsorption, bioaccumulation in organisms, organic metallic complexing during sedimentation, and post dispositional effects of diagenesis (Zoumis *et al*., 2001; Tukura *et al*., 2007; Tukura, 2015). Sediment, a component of the aquatic body, refers to a material deposited on the bottom of a water body. They are important, sinks due to sedimentation which according to Moshchenko (2001) is the settling of suspended particles through the water column due to gravity and it is a fundamental mechanism that provides for the transport of matter from trophogenous areas to bottom communities. The study was undertaken to assess the concentration of heavy metals in water and sediment from the Anambra River.

MATERIALS AND METHODS

Anambra River (Omambala River) which covers a land area of 14,010 km^2 is located in the southeastern part of Nigeria. The Anambra River basin lies between latitudes 6°10' and 7°20'N and longitudes 6°35' and 7°40'E (Awachie and Hare, 1978) (Fig. 1). Two seasons namely rainy season and dry season operate in the area. The study was conducted for one month (July). Water and sediment samples used in this study were collected from five study stations of Anambra River. The water and sediment samples that were collected in plastic contains were transported to the laboratory for analysis of heavy metals. Four sampling points were selected from each study station and four replicate samples were taken from each point. The replicate samples were representative of the station from where they were collected. The concentrations of the heavy metals (Cadmium, Zinc, Manganese, Copper, and Lead) in water and sediment samples were determined using Atomic Spectrophotometer (AAS). Data were analyzed using descriptive analysis to establish means. Analysis of variance (ANOVA) was used to evaluate the significant difference in the concentration of the heavy metals.

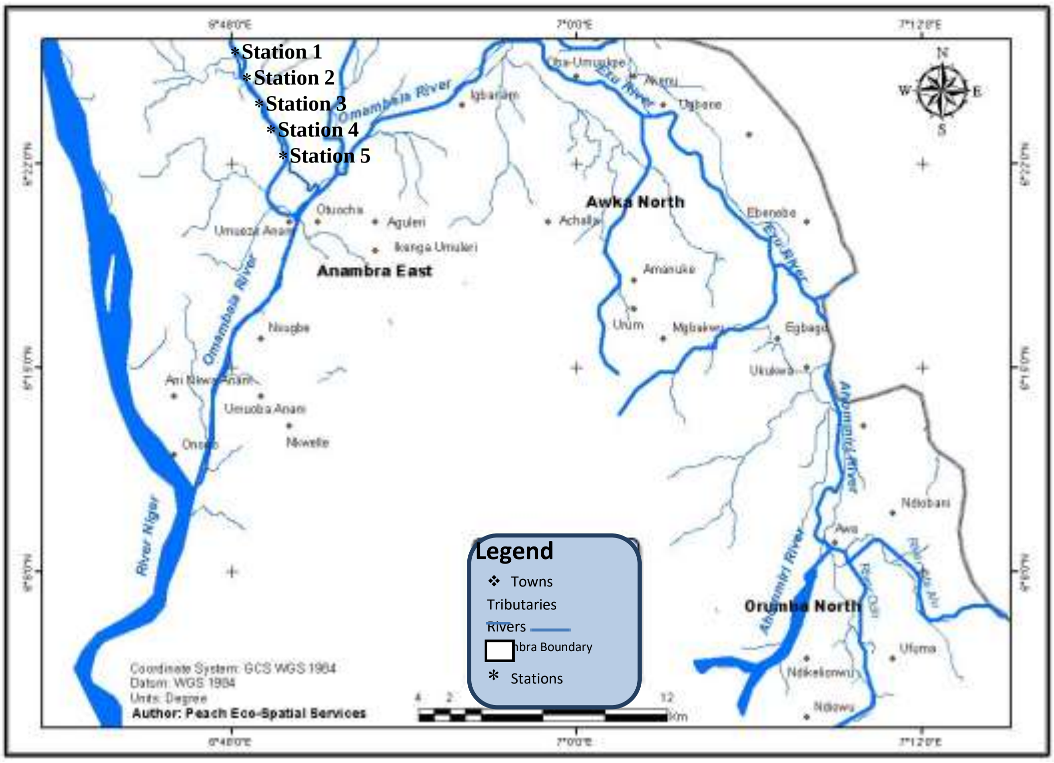

Fig. 1: Map of the Study Area

RESULTS AND DISCUSSION

The results of the heavy metal concentrations in water and sediment collected from Anambra River is shown (Tables 1 and 2). The heavy metals cadmium, zinc, copper and lead were detected while manganese was not detected from the water sample. Heavy metals observed in the water sample varied at the study stations Cadmium the least metal in the water sample at all the stations ranged from 0.001 mg/l in station 5 to 0.030 mg/l in station 2. The concentration of zinc varied from 4.54 mg/l in station 5 to 4.70 mg/l in station 4. The concentration of copper in mg/l varied from 0.040 (in stations 4 and 5) and 0.080 (in station 2). The variations in the concentration of heavy metals in water sample in relation to stations is presented in Fig. 2. Heavy metals in water in relation to the station were not significantly different ($p>0.05$). The following heavy metals were observed from the sediment sample: cadmium, zinc, manganese, copper, and lead. Only copper was restricted in distribution, occurring only at stations 2 and 3. Cadmium which ranged from 0.010 mg/kg to 0.030 mg/kg at stations 1 and 4 respectively, had the least concentration at all the study stations. The concentration of manganese varied from 0.80 mg/l at station 2 to 0.86 mg/kg at station 5. The concentration of zinc in sediment was highest at the five study stations. The highest (1.33 mg/kg) concentration was recorded at station 2 while the lowest concentration (1.15 mg/l) was recorded at station 1. Lead concentration ranged from 0.40 mg/kg (station 5) to 0.70 mg/kg (station 3). There was no significant difference ($p>0.05$) in the heavy metals in sediments in relation to stations. The variations of heavy metals in sediment in relation to stations is shown (Fig.3).

Table 1: Concentration of Heavy Metals in Water (mg/l)

Heavy metals	Station 1	Station 2	Station 3	Station 4	Station 5
Cd	0.020	0.030	0.020	0.020	0.001
Zn	4.62	4.58	4.60	4.70	4.54
Mn	ND	ND	ND	ND	ND
Cu	0.050	0.080	0.050	0.040	0.040
Pb	0.900	1.000	0.900	0.800	1.000

NB: ND = not detected

Table 2: Concentration of Heavy Metals in Sediments (mg/kg)

Heavy metals	Station 1	Station 2	Station 3	Station 4	Station 5
Cd	0.010	0.020	0.010	0.030	0.020
Zn	1.20	1.23	1.15	1.18	1.22
Mn	0.85	0.80	0.83	0.84	0.86
Cu	ND	0.01	0.02	ND	ND
Pb	0.50	0.60	0.70	0.60	0.40

NB: ND = not detected

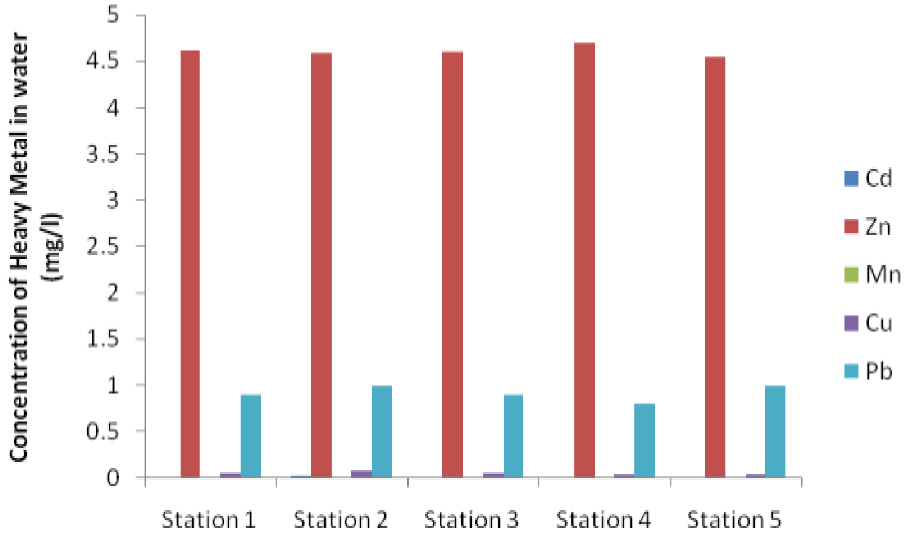

Fig. 2: Variations in heavy metal concentrations (mg/l) in water in relation to stations

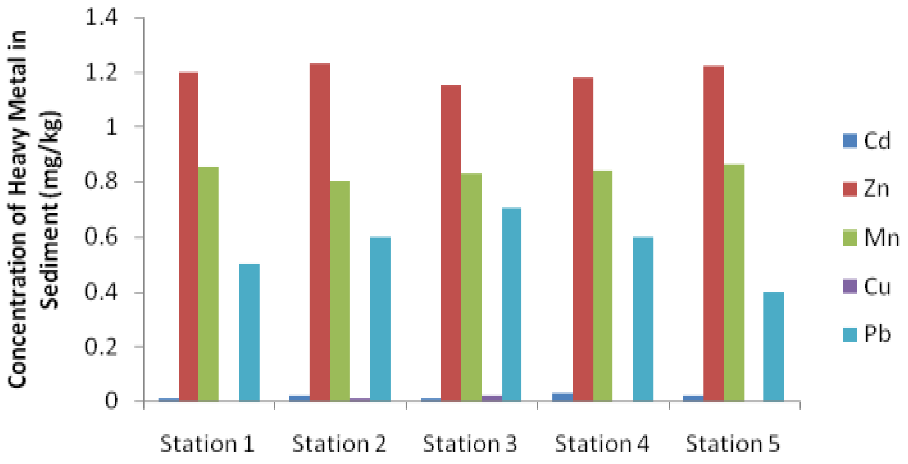

Fig. 3: Variations in heavy metal concentrations (mg/kg) in sediments in relation to stations

The heavy metals (Cd, Zn, Cu, Pb) encountered in water except for manganese occurred in the order Zn>Pb>Cu>Cd. The trend of concentration of heavy metals in sediment is Zn>Mn>Pb>Cu>Cd.

The least concentration of cadmium recorded in this study is both water and sediment agree with Lawal-Are and Babaranti (2014) who obtained similar results. Cadmium concentration and sediment in Anambra River were above the World Health Organization (WHO) (2008) permissible limit is fatal causing according to Oronsaye (1987) histopathological alteration in stickleback, *Gastrerostus aculeatus* and *Itai-itai* disease (Erickson *et al*., 1983). Sources of cadmium include plastic, batteries and fossil fuels and children's toys. Cadmium is present in children's toys at a level above the regulatory standard (Finch *et al*., 2015; Obaro *et al*., 2015). The dominance of zinc over all other metals in the study show a high accumulation of the metal in water and sediment samples. The mean concentration of zinc in water obtained in this study is lower than 10 mg/l which Kakulu and Osibanjo (1992) recorded for Calabar River. The mean concentration recorded in water was within the WHO acceptable standard while the sediments mean value was below the WHO allowable limit. Zinc is an essential trace element that is easily bioaccumulated by aquatic life. However, it is toxic at levels above permissible limits. The mean concentration of copper in water was within the WHO acceptable standard while the sediment mean value was below the acceptable standard. Copper not being detected in stations 1, 4 and 5 may be due to the concentration of anthropogenic activities occurring in them. Copper enter aquatic environments through anthropogenic sources. The entry of water through anthropogenic sources may lead to significant concentrations entering the aquatic environment (either directly via sewage or industrial discharges through natural sources, e.g. from the weathering of rocks or the solution of copper minerals (Canadian Council of Resource and Environmental Ministers (CCRM, 1987; Cole *et al*., 1999). The mean concentration of manganese obtained from sediment was above the WHO allowable limit. The non-detection of this metal in water in this study Odiette (1999) attributed to the fact that heavy metals accumulate in sediments to elevated levels because sediment serves as a sink or as a reservoir. Manganese in water and sediment come from varied sources including paint, fertilizers, and pesticides. A lower mean value of 0.026 mg/l was recorded for Ikpoba Reservoir (Wangboje and Ekundayo, 2013). The mean levels of lead obtained for sediment exceeded the WHO permissible limit. The mean concentration of lead in water obtained in this study was higher than 0.06 mg/l concentration of lead in water obtained by Lawal-Are and Babaranti (2014). The result for sediment recorded in this study was lower than 5.88 mg/kg they obtained in their studies. Lead in water could be conceived to mainly originate from an industrial and domestic discharge of wastes in the river and is non-essential for plants and animals and is toxic by ingestion-being a cumulative poison, producing damaging effects on the kidney, liver, tissues, blood vessels, nervous system and depresses sperm count (Anglin-Brown *et al*., 1995; Tijani *et al*., 2004; Amadi (2012).

Table 3: Values of Heavy Metals in Water and Sediments from Anambra River compared with Acceptable Standard

Heavy metals	Water sample	Sediments	WHO, 2018
Cd	0.018±0.01	0.018±0.01	0.005
Zn	4.61±0.06	1.20±0.03	5.0
Mn	Nd	0.84±0.02	0.1
Cu	0.05±0.02	0.02±0.01	0.05
Pb	0.92±0.08	0.56±0.11	0.05

Nd = Not detectable

CONCLUSION AND RECOMMENDATION

Anambra River is slightly polluted. Only zinc and copper were within the WHO Permissible limit. Anambra River, therefore, should be adequately monitored to prevent further contamination which will seriously affect its health.

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