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Seasonal Variability of Heavy Metal Concentration in Water And Sediments from Upper River Benue, Yola- Adamawa State

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Abstract: *Seasonal Variability of Heavy in water and sediments of Upper River in Yola Adamawa State was investigated from May 2018 to April 2019. Water and sediments were sampled in both wet and dry season. Sediments were sampled from seabed surface using a homemade Auger sampling device.Heavy metals Cu, Cd, Cr, Ni, Pb and Zn in the water and sediment samples were determined as described using a Buck Scientific 200A model, Atomic Absorption Spectrophotometer (AAS)and the values obtained were expressed in milligram per liter (mg/l) and milligram per kilogram (mg/kg) respectively. Data obtained in this study were subjected to descriptive statistics to establish means, standard errors, one way analysis of variance (ANOVA) was used to determine the mean significant seasonal variation (at 0.05) of heavy metals in water and sediments from the sampling stations using Statistical Package for Scientists and Engineers (Statistix 9.0). All the heavy metals under investigation were detected in water sample except Cadmium and Chromium which were below detection level inboth wet and dry season. All the heavy metals under investigation were detected in Sediment sampled in both seasons.A slight variation was observed from the mean values of heavy metal in water and sediment in this study. Heavy metals present in water during the period of this study were high both in wet and dry season with maximum value reported in the dry seasonand was above permissible level except Zinc. All the heavy metals present in sediments during the period of this study were high during the dry season except copper, nickel and zinc when compared with the value obtained in the wet season.The values of these heavy metals obtained in sediments in both wet and dry seasons were compared with GESAMP (1987) values for unpolluted sediments. Maximum value was reported in the dry season. The values of all the heavy metal investigated exceeded the allowable limit for unpolluted sediments with the exception of copper, nickel and zinc. Generally, the dry season recorded higher heavy metals than the wet season. From the above findings therefore, Upper Benue River water and sediments investigated are said to be moderately polluted with these heavy metals especially in the dry season.*

Key Words: *Season, Upper River Benue, Pollution, Heavy metals, Water, Sediments.*

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I. Introduction

Heavy metals contamination in water and Sediments may arise in many ways. Some of them are being mobilized by man to the atmosphere and hydrosphere at rates compared to and sometimes exceeding those by weathering process. The several human activities that may result to water pollution include agriculture, irrigation, fire, urbanization, mining and industrialization (Goudie, 1990). These activities have been documented to have impacted negatively in some specified Nigerian surface waters especially in the Niger-Delta region (Izonfuo and Bariweni, 2001). Also these activities have affected the soils of industrial areas in southern Nigeria (Olajire*et al*., 2003). The agricultural drainage water containing pesticides and fertilizers and effluents of industrial activities and runoffs in addition to sewage effluents supply the water bodies and sediment with huge quantities of inorganic anions and heavy metals (ECDG, 2012). Anthropogenic heavy metals following their introduction to water bodies through atmospheric fallout or through the use of domestic antiseptic soaps and pesticides in our farms are washed into the water and concentrated by aquatic organisms. Discharge of industrial wastes also constitute about 62% of total source of heavy metal such as Lead (Pb), Zinc (Zn), Copper (Cu), Nickel (Ni), Cadmium (Cd), Chromium (Cr) and Manganese (Mn) which are responsible not only for degrading the water quality of a river or sea but for killing a number of aquatic organisms (Abubakar and Garba, 2006). These metals are toxic after large accumulation in the body of flora and fauna and later pass on through the food chain from fish to man (Ayodele and Abubakar, 2001).Sediments are important sink for various pollutants such as Heavy metals and also play a useful role in the contamination of Aquatic system. Sediments particularly the surface ones may serve as a metal pool that can release back metal to the overlying water via natural and anthropogenic process, causing potential adverse health effect to the ecosystem because of their serious toxicity and persistence. Data from Sediments can provide information on the impact of distant

human activity on the wider ecosystem. The composition of Sediments sequences provide the best natural achieves of recent environmental changes. Sediment quality is a good indicator of pollution in water column where it tends to concentrate the heavy metals and other organic pollutants. Sediment and soil particles carried to a streambed, lake, or ocean, can also be a pollutant if it is present in large amounts. Accumulation of metals occur in upper sediment in aquatic environment by biological and geochemical mechanism and become toxic to zoobenthos and fish, resulting in death, reduced growth, or impaired reproduction and lower species diversity (Praveena*et al.*,2008). Also, as a result of heavy metalcontaminations, several endemic fish species have become threatened. Since the rivers have become the natural dustbins for discharging all sorts of waste, industrial and other wastes, this envisages a great concern with the ecology of polluted waters and its perspectives with regard to its fitness for biotic community including fishes, hence the need for this research.

II. Material And Methods

Study Area

Adamawa State is located at the North Eastern part of Nigeria. It lies between latitude 7° and 11° N of the equator and between longitude 11° and 14° E of the Greenwich meridian. It has an altitude of 185.9 and covers a land area of about 38,741km. Two seasonal periods are experienced in the state: the wet and the dry seasons. The months of May to October constitute the wet season. During this period no place receives less than 60mm of rain. The months of November to April constitute the dry season. It experiences harmattan between the months of November to February. March and April are the hottest months (42.78°), while November and December are the coldest months (11.11°). Adebayo and Tukur (1999, (UBRDA, 1985,River Benue is the main source of water for irrigation, fishing, domestic and industrial purposes in the state.

Water Sampling

Water was collected by lowering pre-cleaned plastic bottles of 250ml into the bottom of the water body, 30 cm deep, and allowed to over flow before withdrawing from the four different sampling sites of the Upper Benue River in dry season. Water sample were preserved using manganese sulphate and alkaline reagent (potassium iodine plus potassium hydroxide) before being transported to the laboratory for processing of heavy metals.

Sediments Sampling

Sediments were sampled from waterbeds surface in both wet and dry seasons. Sediments were sampled from seabed surface using a homemade Auger sampling device as used by Ladigbolu, (2010). The samples were packed in plastic bags that have been previously soaked in 10%HNO_3 (Nitric acid) and 1:1 HCL (hydrochloric acid) for 24hrs followed by rinsing with distilled water and then allowed to drain to dryness in order to sterilized the plastic bags. Composite of one kilogram of sediments was collected at each sampling sites. Sediments were preserved for the analysis of heavy metals.

Water and Sediments Digestion

Water samples were acidified immediately by adding 3-4cm3 of concentrated nitric acid per litre of sample. These preserve the sample by minimizing the absorption of trace metal on to the wall of the container. All batches of Sediment samples were air dried in the laboratory before homogenizing. The samples were oven dried to constant weight at 105^{o}C. The samples were then grounded using mortar and pestle and sieved through 2mm mesh size to remove coarse materials. 5g of each of the 2mm mesh sized sieved sediments were digested separately using the method described by Lee and Cundy (2001). Digestion of sediment sample was done by dissolving 5g of 2mm sieved sediment sample into 100ml beaker. This was followed by adding 5ml of concentrated HNO_3 and 2ml of HCL. The mixture was covered with watch glass and heated to boiling point for 1 hour. It was then filtered and distilled water was added to make it up to mark. The sample was them analysed for heavy metals.

Determination of Heavy Metals in Water

Heavy metals Cu, Cd, Cr, Ni, Pb and Zn in the digested water and Sediments samples were determined as described by APHA (2005).Ajayi and Osibanjo (1981) using a Buck Scientific 200A model, Atomic Absorption Spectrophotometer (AAS)and the values obtained were expressed in milligram per liter (mg/l) (APHA 1995). Procedural blanks were prepared and aspirated along with the analytical samples in order to correct for background absorption and the values obtained were expressed in milligram per litre (mg/l) for water samples and milligram per kilogram (mg/kg) for Sediments samples (APHA 1995). The levels of heavy metals in water and Sediments samples were evaluated by comparing the statistical mean levels of the metals in the water and Sediments samples obtained in dry and wet season.

Data Analysis

Data obtained in this study in wet and dry season were subjected to descriptive statistics to establish means, standard errors, one way analysis of variance (ANOVA) was used to determine the mean significant variation (at 0.05) in heavy metals in the sampling stations using Statistical Package for Scientists and Engineers (Statistix 9.0).

III. Results

All the heavy metals under investigation were detected in water sample in both dry and wet season except Cadmium and Chromium which were below detection level. The seasonal monthly variation of heavy metal in water is presentedon Table 1.Wet season recorded the highest value (0.33+0.06) of copper in July while dry season recorded the lowest value (0.09+0.05) in November. Dry season recorded the highest value (0.06+0.79) of Nickel in February while wet season recorded the lowest value (0.02+0.01) in August. Dry season recorded the highest value (0.5++0.19) of lead in March and April while wet season recorded the lowest value (0.01+0.71) in June. Dry season recorded the highest value (0.30+0.02) of Zinc in December while wet season recorded the lowest (0.07+0.01) in May. There was a significantly different between season and level of heavy metal in water.

All the heavy metals under investigation were detected in Sediment sample in both dry and wet season. The seasonal monthly variation of heavy metal in sediment is presented on Table 2. Wet season recorded the highest value (0.57+2.78) of Cadmium in May while dry season recorded the lowest value (0.06+02.70) in December. Dry season recorded the highest value (2.96+0.94) of Chromium in December while wet season recorded the lowest value (0.70+0.23) in September. Dry season recorded the highest value (19.05+0.58) in December while Wet season recorded the lowest value (17.50+0.54) in August. Dry season recorded the highest value (012.01+0.60) of Nickel in November while wet season recorded the lowest value (8.35+0.61) in May. Dry season recorded the highest value (2.93+0.24) of lead in November while wet season recorded the lowest value (0.51+0.22) in September. Dry season recorded the highest value (6.15+0.49) of Zinc in December while wet season recorded the lowest (02.21+0.47) in July. There was a significantly different between season and level of heavy metal in sediments.

Table 1: Mean Seasonal Variation of Heavy Metals in Water of Upper Benue River.

Months	Copper(mg/l)	Nickel(mg/l)	Lead(mg/l)	Zinc(mg/l)
Wet Season				
May	0.27±0.16	0.05±0.29	0.04±0.12	0.07±0.01
Jun	0.27±0.66	0.04±0.05	0.01±0.71	0.10±0.08
Jul	0.33±0.06	0.04±0.09	0.03±0.21	0.10±0.04
Aug	0.12±0.07	0.02±0.01	0.03±0.11	0.09±0.02
Sep	0.11±0.06	0.04±0.29	0.02±0.61	0.08±0.49
Oct	0.12±0.02	0.05±0.09	0.03±0.11	0.09±0.12
Dry Season				
Nov	0.09±0.05	0.03±0.09	0.02±0.19	0.19±0.07
Dec	0.27±0.09	0.04±0.07	0.04±0.11	0.30±0.08
Jan	0.26±0.06	0.05±0.09	0.03±0.31	0.23±0.01
Feb	0.20±0.05	0.06±0.79	0.04±0.11	0.07±0.09
Mar	0.19±0.16	0.03±0.09	0.05±0.19	0.08±0.03
Apr	0.15±0.06	0.04±0.08	0.05±0.41	0.08±0.05
Mean	0.21	0.04	0.04	0.15

P<0.05=There was significant difference, P>0.05= There was no significant difference.

Table 2: Mean Seasonal Variation of Heavy Metal in Sediments of Upper Benue River

Months	Cadmium(mg/kg)	Chromium(mg/kg)	Copper(mg/kg)	Nickel(mg/kg)	Lead(mg/kg)	Zinc(mg/kg)
Wet Season	0.57±2.78	1.13±0.21	18.28±0.59	8.35±0.61	1.41±0.85	2.66±0.42
May						
Jun	0.56±2.82	0.86±0.29	18.45±0.51	9.80±0.63	0.62±0.28	2.39±0.97
Jul	0.56±2.78	0.81±0.24	17.87±0.36	9.71±0.65	0.93±0.24	2.21±0.47
Aug	0.50±2.98	1.03±0.26	17.50±0.54	9.94±0.68	0.58±0.22	2.62±0.44
Sep	0.49±2.76	0.70±0.23	17.91±0.51	10.31±0.65	0.51±0.24	2.76±0.47
Oct	0.42±2.72	1.07±0.24	18.12±0.56	10.47±0.68	0.65±0.25	3.40±0.44
Dry Season						
Nov	0.21±2.71	1.60±0.24	18.80±0.56	12.01±0.60	2.93±0.24	3.65±0.87
Dec	0.06±2.70	2.96±0.94	19.05±0.58	9.51±0.65	2.89±0.35	6.15±0.49
Jan	0.07±2.77	1.11±0.24	18.01±0.16	10.27±0.63	2.54±0.85	2.08±0.42
Feb	0.59±2.74	0.93±0.27	19.74±0.56	7.90±0.64	2.48±0.22	2.48±0.17
Mar	0.87±2.71	0.71±0.24	19.43±0.56	9.37±0.61	2.48±0.25	2.30±0.44
Apr	0.93±2.78	1.01±0.23	19.24±0.59	8.44±0.65	2.82±0.24	2.35±0.17
Mean	0.46	1.39	19.05	9.41	2.69	3.17

P<0.05=There was significant difference, P>0.05= There was no significant difference.

IV. Discussion

There was a slight variation in Heavy metal concentration in water between seasons. Heavy metals Cu, Ni, Pb and Zn values were high in dry season (December, February and March) respectively when compared to wet season in water of Upper Benue River. Cadmium and Chromium were not detected in both wet and dry season in water. The non-detection of Cadmium and Chromium heavy metals in water may be due to the inability of the metals to dissolve in water and got deposited to the bottom in the sediments as observed in this study and this is because water sediment are metal reservoirs trapping all the heavy metals that escape detection in water. Research has revealed that nearly all metal content in aquatic environment resides in water sediment (Ademorati, 1996). The mean value of all the metal present varied among the seasons, which indicated uneven distribution of the heavy metals along the stretch of the river during the study period. This could be attributed to the variations in natural and anthropogenic activities during the wet and dry season. This is in line with the study of Chukwu and Nwankwo, (2003) who reported that the high variability of heavy metals may be attributed to impact of many factors such as rainfall, surface run-off from farms, tributaries and catchments activities during the wet and dry season periods.

All the heavy metals investigated were present in sediments. Sediments are metal reservoirs trapping all the heavy metals that escaped detection in water. Research has revealed that nearly all metals content in aquatic environment resides in water sediments (Ademorati, 1996). The result of the heavy metal in sediments in this study showed some variability of metal distribution from one site to another and from one metal to another in both wet and dry season. This variation could be attributed to variation in environmental content of different sampling sites as well as the diversity of the different activities taking place around the study area during the study periods.

V. Conclusion

All the metals present in water exceeded the permissible level except zinc. Heavy metals Cu, Ni, Pb and Zn values were high in dry season (December, February and March) respectively when compared to wet season in water of Upper Benue River. All heavy metal under investigation were present in the sediments. Apart from copper and zinc, all the metals investigated were above the recommended range for unpolluted sediments.

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