POLLUTION INDICES OF HEAVY METALS IN SEDIMENTS OF RIVER NIGER, BENUE AND AFTER CONFLUENCE IN LOKOJA, KOGI STATE, NIGERIA

BY

***P. A. Ekwumemgbo, K. I. Omonyi, B. Isuwa**

Department of Chemistry, Ahmadu Bello University, Zaria, Nigeria.

INTRODUCTION

- The analysis of river sediment is a useful method of studying environmental pollution with respect to heavy metals. Heavy metals accumulate in the sediment via complex physical and chemical adsorption mechanisms [Ankley *et al*., 1992].

- The occurrence of elevated concentrations of heavy metals in sediments found at the bottom of the water column can be a good indicator of man induced pollution rather than natural enrichment of the sediment by geological weathering [Wakida *et al*., 2008].

INTRODUCTION CON'T

- The assessment of sediment enrichment with element can be carried out in many ways. The most common one is the use of pollution indices which include pollution load index [PLI] and geo-accumulation index [I_{geo}].

- The PLI has been utilized to indicate the number of times by which the heavy metal concentrations in the sediment exceeds the background concentration [Adel *et al*., 2011], while I_{geo} measures the pollution status and gives a summative indication of the overall level of heavy metal toxicity in a particular sample [Singh *et al*., 1997].

- This work aimed at investigating the pollution status of sediment of river Niger, Benue and after Confluence for a period of one year on quarterly bases with respect to Cd, Pb and Zn.

Materials and Methods

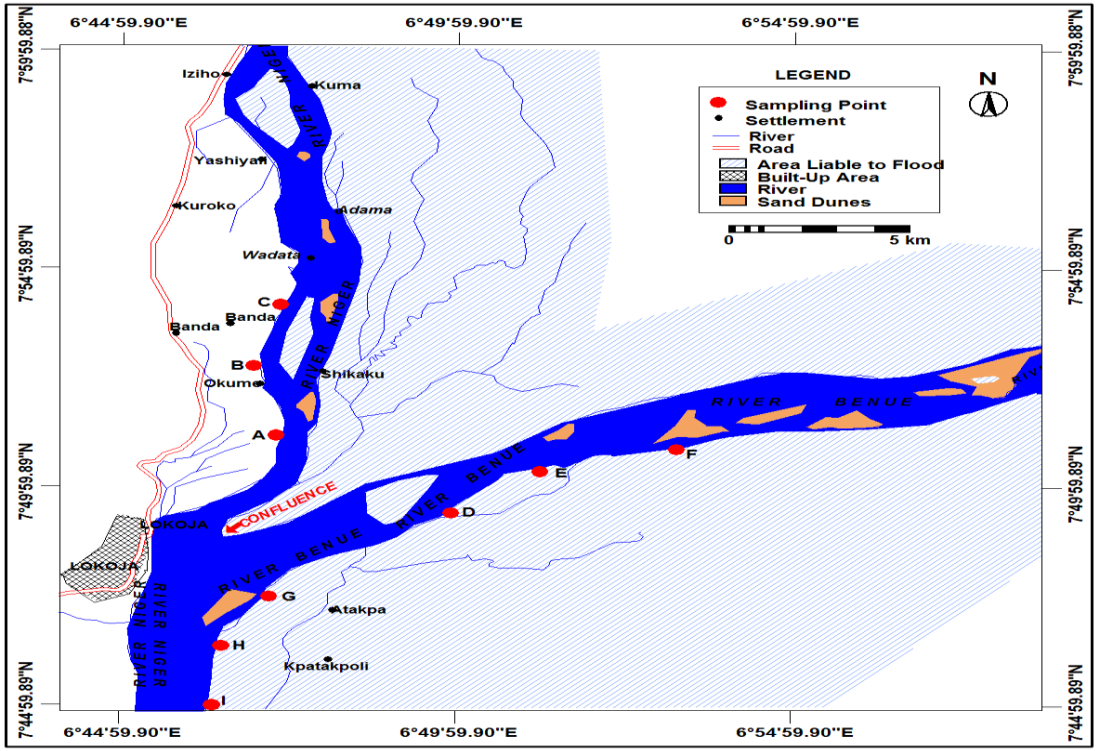


Fig. 3.2 : An Abstract of Lokoja Map Showing the Sampling Sites for Water and Sediment

Source: Modified from Topographic Map of Lokoja Sheet 247 N.E and N.W.

Figure 1: Abstract Map of Lokoja Showing Sampling Points

- (A) Sample Collection
- (B) Sample Pre-treatment
- (C) Digestion (Maitera *et al*., 2011)
- (D) Preparation Of Calibration Curve (AOAC, 1998)
- (E) Measurement of Analytes: VARIAN AAS (240FS) was used for the measurement of the concentrations of Cd, Pb and Zn at wavelengths of 336.5, 283.3 and 213.9 nm respectively (APHA, 1992)

Data Analysis

- All data obtained were subjected to Analysis of Variance using SAS package and standard deviations separated using Duncan multiple range test.

- The pollution state of the sediments of the three rivers was determined using Pollution Load and Geoaccumulation indices [Tomlinson *et al*., 1980 and Boszke *et al*., 2004] using equation 1 and 2 respectively.

- **Pollution Load Index [PLI]** = $\sqrt[6]{[CF1 \times CF2 \times CF3 \times CF4 \times CF5 \times CF6]}$----------[1]

  Where CF = Contamination factor which is concentration of metal divided by background value. Background values are world average concentration of such metal. Background values used as reported for Shale [10] are: Cd [0.3 mg/kg], Pb [14.0 mg/L] and Zn [67 mg/kg**].**

Geoaccumulation Index [I_{geo}] = $\log_2[C_n / 1.5*B_n]$----------[2]

where C_n is the measured concentration of metal and B_n is the background value of the metal which is given above. The classification of the degree of contamination is shown in Table 1 [Hakanson, 1980].

Table 1: Pollution Load Index/Geoaccummulation Index

Class	Range	Remark
0	$I_{geo} \leq 0$	Unpolluted
1	$0 < I_{geo} < 1$	low to moderately polluted
2	$1 < I_{geo} < 2$	Moderately polluted
3	$2 < I_{geo} < 3$	Moderately to highly polluted
4	$3 < I_{geo} < 4$	Highly polluted
5	$4 < I_{geo} < 5$	Highly to extremely polluted
6	$5 < I_{geo} < 6$	Extremely polluted

Results/Discussion

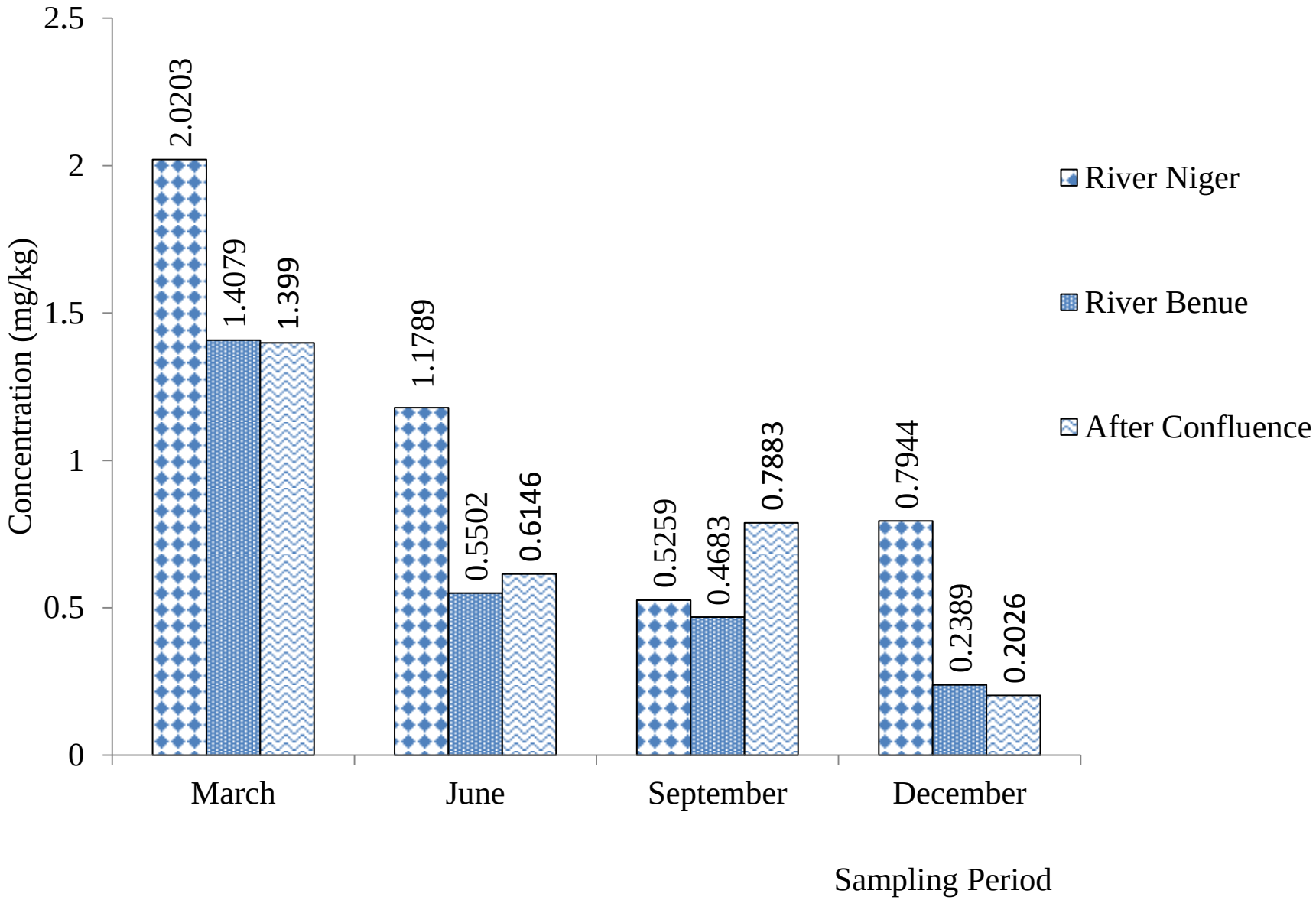


Figure 2: Concentration of Cd (mg/kg) in Sediment Samples with Respect to Sampling Period

Cadmium

- Cadmium is seen to range from 0.2026±0.1624 – 2.0203±1.2382 mg/kg (Figure 2) in the entire study period. The highest value was recorded in river Niger and least value recorded after the confluence point for the months of March and December respectively.

- Analysis of variance reveals significant difference of Cd in sediments of river Niger from the other two rivers [Benue and after Confluence] during the months of March, June and December respectively whereas in September, sediments after confluence varied significantly from those of river Niger and Benue with respect to Cd.

- The result shows that the three rivers had Cd above the permissible limit by ISQG (0.6000 mg/kg) in March. With particular reference to river Niger, Extreme values of Cd were recorded during the study period except for September. This result is in agreement with values reported by Olatunde and Oladele (2013) who reported Cd in the range of 0.3 - 3.4 mg/L.

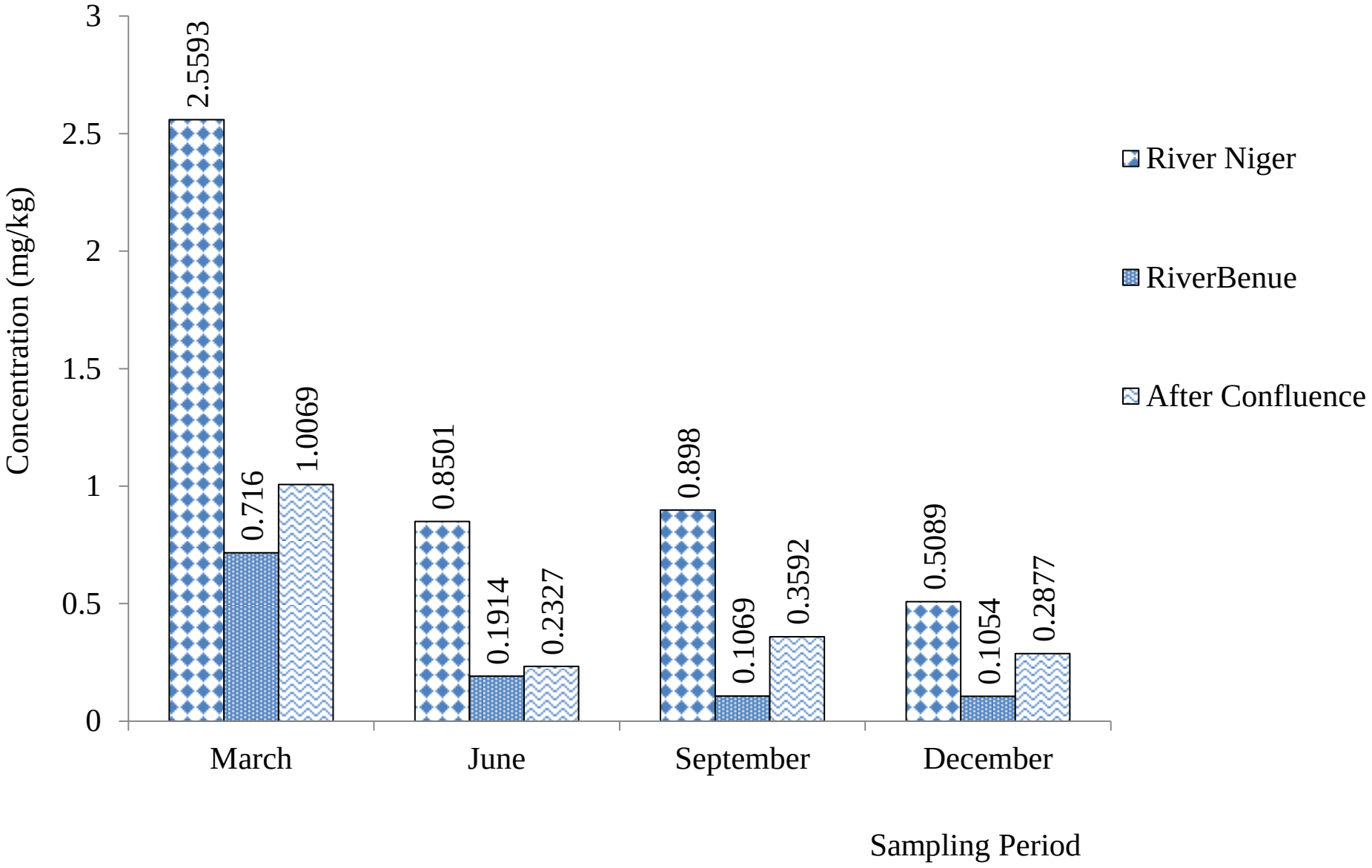


Figure 3: Concentration of Pb (mg/kg) in Sediment Samples with Respect to Sampling Period

Lead

- A sharp drop in Pb concentration was noted from March to June which was more than 300 %, 300 % and 400 % for river Niger, Benue and after Confluence respectively and a moderate decrease from June through December. River Niger recorded the highest concentration of lead in all the sampling months followed by Sediments after confluence and least by river Benue.

- The three rivers were found to vary significantly in each of the sampling period at $p<0.005$. However, sediments of the three rivers were not polluted with respect to lead as values obtained were far below the critical limit (35.00 mg/kg).

- This results with respect to Pb contradicts high values of Pb (8.84-17.52) reported by Olatunde and Oladele (2013)

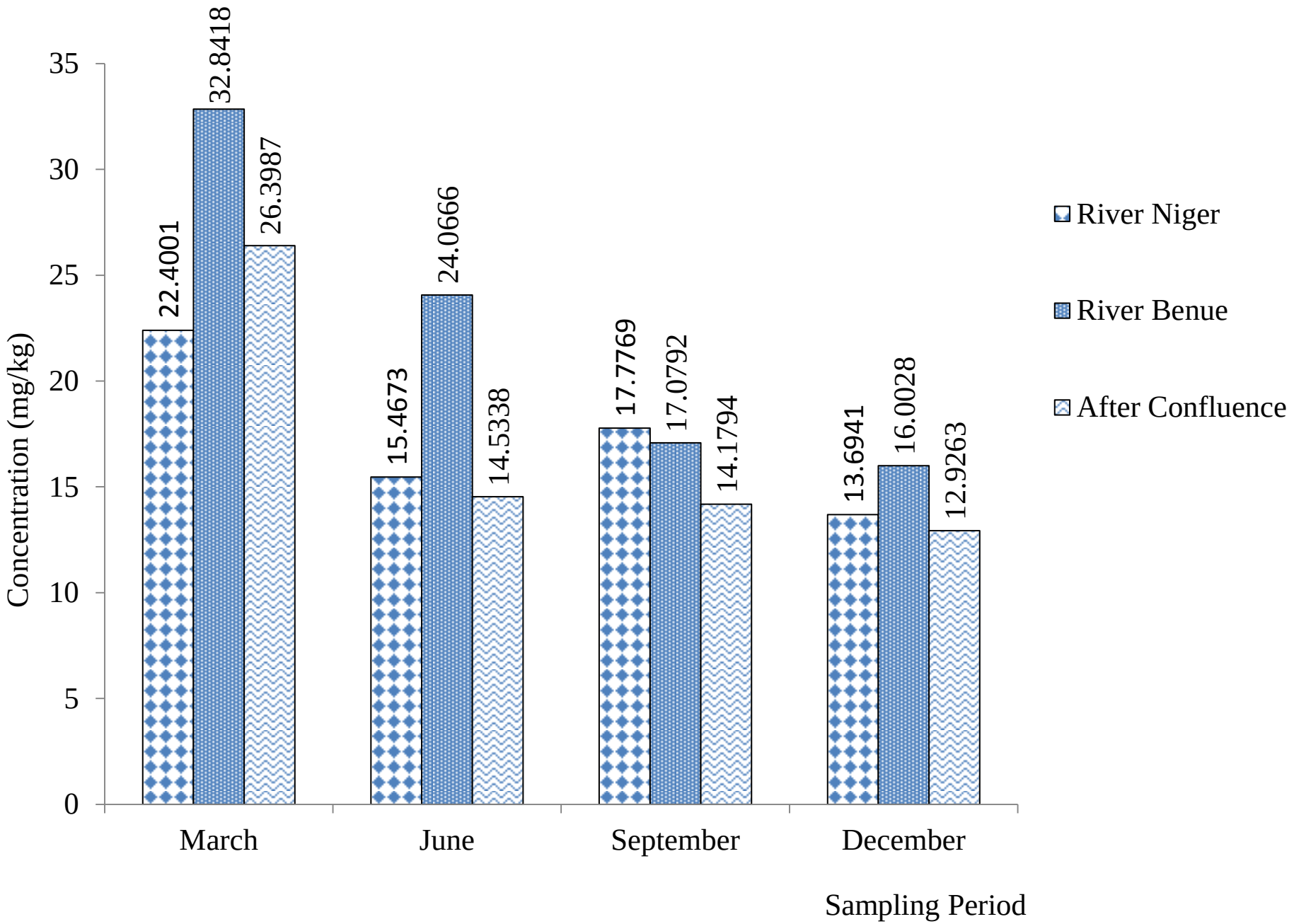


Figure 4: Concentration of Zn (mg/kg) in Sediment Samplrswith Respect to Sampling Period

Zinc

- Zinc was found to range from 12.9263±2.7577 - 32.8418±3.6669 mg/kg across the sampling period in all the rivers. River Benue recorded the highest zinc content (32.8418±3.6669 mg/kg) in March while sediments after confluence gave the least value (12.9263±2.7577 mg/kg) during December sampling.

- Values of Zn were below the recommended limit (123.0000 mg/kg) by ISQG and there was significant difference in Zn concentrations in the three rivers with the exception of rive Niger and Confluence in June, December and river Niger and Benue in September.

- The general high values recorded in March could likely be attributed to human activities and global warming with reference to the preceded flood in the study area and the relatively low values in other months could be as a result of gradual dissolution of these metals.

Pollution Load Index (PLI)

Table 2: Pollution Load Index [PLI] of Heavy Metal in Sediment Sample					
Month	River	CF_{Cd}	CF_{Pb}	CF_{Zn}	PLI
March	R. Benue	4.6930	0.0511	0.4902	0.6094
	R. Niger	6.7343	0.1828	0.3343	1.0248
	Confluence	4.6633	0.0719	0.3940	0.7213
June	R. Benue	1.8340	0.0137	0.3592	0.3051
	R. Niger	3.9297	0.0607	0.2309	0.6967
	Confluence	2.0487	0.0166	0.2169	0.4428
September	R. Benue	1.5610	0.0076	0.2549	0.2631
	R. Niger	1.7530	0.0641	0.2653	0.6423
	Confluence	2.6277	0.0257	0.2116	0.4141
December	R. Benue	0.7963	0.0075	0.2388	0.2088
	R. Niger	2.6480	0.0364	0.2044	0.4985
	Confluence	0.6753	0.0206	0.1929	0.2990

CF_{Cd} =Contamination factor of Cd, CF_{Pb} =Contamination factor of Pb and CF_{Zn} =Contamination factor of Zn

- Pollution load index (Table 2) of this study show that the CF values of Pb and Zn in the sediments of the study areas were low [<1]. However, Cd recorded relatively high values. In spite the low values of CF, it suggests influence of external discrete sources like industrial activities, agricultural runoff and other anthropogenic inputs.

- According to Hakanson's degree of pollution classification, river Benue and Confluence shows low degree of pollution (0.6094 and 0.7213) respectively while river Niger shows moderate degree of contamination (1.0248) in March with respect to the analyzed heavy metals.

- In June, September and December, all the three rivers had low degree of pollution with reference to the three heavy metals analyzed as values were below 1. This analysis indicated low anthropogenic role in the heavy metal content of the sediment. This analysis conforms to reports of other researchers [13,].

Geoaccumulation Idex [I_{geo}]

Table 3: Geoaccumulation Idex [I_{geo}] of Heavy Metals in Sediment				
Period	River	I_{geo}Cd	I_{geo}Pb	I_{geo}Zn
March	R. Benue	0.9907	-2.9346	-0.9715
	R. Niger	1.3056	-1.8282	-1.3038
	Confluence	0.9852	-2.6285	-1.1612
June	R. Benue	0.1746	-4.0896	-1.2415
	R. Niger	0.8365	-2.7855	-1.6255
	Confluence	0.2708	-3.9108	-1.6796
September	R. Benue	0.0346	-4.5865	-1.5394
	R. Niger	0.1354	-2.7379	-1.5046
	Confluence	0.4870	-3.5338	-1.7010
December	R. Benue	-0.5500	-4.5988	-1.5959
	R. Niger	0.4937	-3.2312	-1.7313
	Confluence	-0.6931	-3.7266	-1.7814

- Geoaccumulation index (Table 3) assesses the pollution status of each analyzed heavy metal.

- The results indicate moderate pollution by cadmium in all the rivers in March, June and September whereas in December, only river Niger recorded moderate pollution thereby amounting to 83.33% moderate pollution by Cd. The other rivers [Benue and Confluence] were unpolluted resulting to only 25% moderate pollution of the entire study period.

- The I_{geo} of Pb and Zn indicates no pollution during the study period in all the rivers with respect to the said heavy metals.

Conclusion

- It was discovered that Cd in the sediment was above the recommended value by ISQG. Pollution Load Index shows low to moderate pollution of the sediments by the studied heavy metals while Geoaccumulation index suggest that the pollution of the sediment is largely due to cadmium. These indices suggest arthropogenic influence for these metals and hence call for precautionary measures.

THANK YOU

ALL

FOR LISTENING