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Water Quality Assessment of Kampani River, Plateau State, Nigeria

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Abstract

The paper assessed the physico-chemical and heavy metal levels of surface water collected from Kampani River, Wase Local Government Area of Plateau State. The analysis was done using standard procedures. The mean annual concentrations of the metals studied ranged from 0.32- 0.45mg/l for Cr; 0.11- 0.27mg/l for Cu; 0.33 – 0.45mg/l for Co; 0.05 – 0.91mg/l for Cd; 14.96 – 20.68mg/l for Fe; 1.01 – 5.30mg/l for Mn; 0.09 – 0.22mg/l for Ni; 0.80 – 1.68mg/l for Pb and 1.15–1.63mg/l for Zn. The Physico-chemical analysis revealed the following range of values 7.45 – 7.49 for pH; 27.86 – 103 µs/cm for Electrical conductivity; 18.82 – 20.76 NTU for turbidity; Total hardness,109.51 – 291.68mg/l; Alkalinity, 0.08 – 28.33mg/l; Chloride, 11.32 – 43.43mg/l and TDS,74.21 – 152.59mg/l. Most of the metals analysed showed significantly higher concentrations which follow the order Fe>Zn>Mn>Cd>Pb>Co>Cr>Cu>Ni during the dry season and Fe> Mn> Pb >Zn>Cr>Co>Cu>Ni >Cd in the wet season. Comparing with WHO , NIS and SON standards guidelines, the results revealed that the consumption of water from River Kampani could be disastrous to human health.

Keywords: Heavy Metal, Pollution, Assessment, Kampani river, Mining, Plateau state.

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1. Introduction

The increasing concentration of heavy metal in the biosphere is of great concern to the scientist all over to world. Heavy metals are found naturally and thus cannot be destroyed in soils, sediment or water by any chemical or biological means. They pose major environmental and human health problem due to their great ecological significance, toxicity and accumulative behavior [1, 2]. Heavy metals such as Lead, Iron, Manganese, Nickel, Arsenic, Zinc, Copper, Cobalt, Mercury, Chromium, cyanide, Bismuth, Antimony are considered as conservative pollutants [3] and thus are disastrous to human health. Other sources of heavy metal contamination are through atmospheric deposition and erosion of geological matrix, and through anthropogenic means by industrial effluent discharges from tanneries, breweries, textiles, potteries, electroplating, metal finishing, mining, dyeing, printing, ceramic, photographic industries as well as smelting, fossil fuel combustion and from agrochemical industries [4, 5] [6]. Their poisonous nature makes them the leading cause of death and diseases and accounts for the death of more than 14,000 people daily [7, 8]. The most recent in Nigeria, is the Zamfara lead poisoning that led to the dead of over 400 children in 2010 [9]. Heavy metals are known to cause diseases such as convulsion in small children, lung cancer, liver cancer, kidney disease, brain damage, respiratory tract infection, and poor vision among others [10, 11].

Mining, as one of the major anthropogenic sources of heavy metal in water [5, 12] has received so much attention due to its great health implication which is easily transferred through food chain. The greater damage of mining activity is witnessed in the localities as the case in Wase L.G.A., where tribute workers engaged in the manual as well as modern mining of minerals which could lead to indiscriminate disposal of some toxic substances such as heavy metals on land and in the aquatic system. This is hazardous since majority of the miners are ignorant of the consequences. The harmful effect of mining activity can only be known by measuring the concentration and distribution of heavy metals as well as other contaminants in water.

A lot of work on environmental monitoring has been reported in the southern and eastern part of Nigeria. However there is little information regarding the quality of water in the middle belt, particularly in the South eastern part of the Plateau State. This work aimed at assessing the levels of heavy metal pollution in water due to mining activity in Kampani River. This will go a long way in protecting the lives of people and animals particularly those exposed to the dangerous effect of this activity.

2.1. Study Area

Kampani River is situated in Wase Local Government Area, South Eastern Part of Plateau State, Nigeria. It is about 292.8Km from the State Capital. This River empties into River Benue, one of the major Rivers in Nigeria.

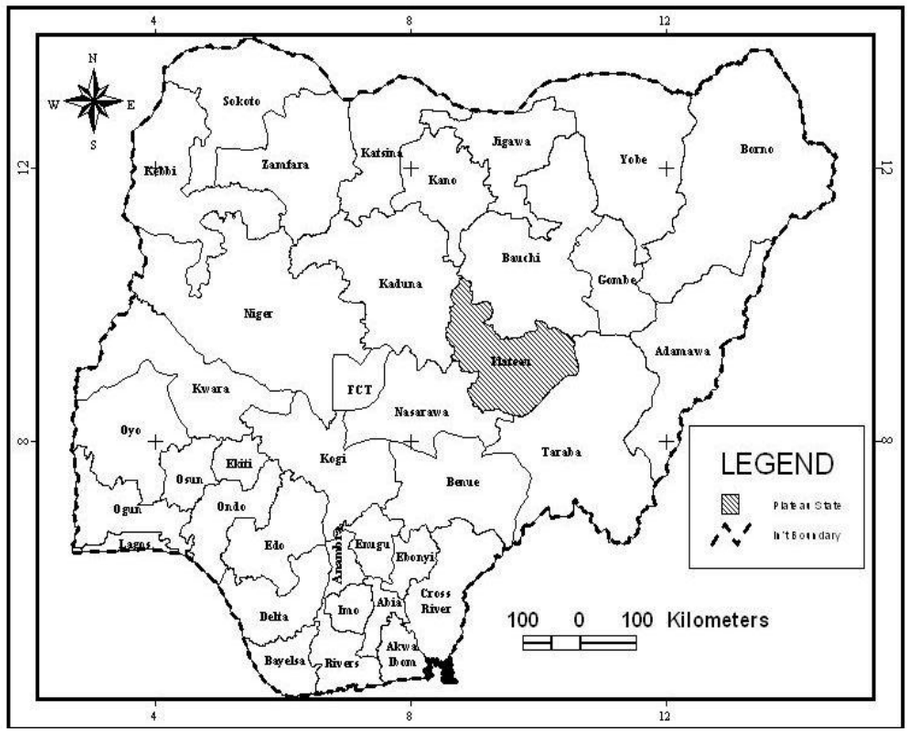

Fig-1. Map of Nigeria showing the Plateau State

Fig-2. Map of Plateau State showing the Wase L.G.A.

2.2. Sample Collection

Sampling was done during dry season between the month of March – April 2012 and September – October 2012 in the wet season. Samples were collected at five different points within a particular sampling station and at 1 km intervals between the sampling stations and along the plain of the River. Grab samples were collected in a 2L plastic container which were prewashed with detergent, then with Nitric acid solutions, rinsed with distilled water and finally with the water source. The samples collected were preserved at 4^{o}C before the analysis. Those for heavy metal determination were preserved by adding three drops of Nitric acid at the field [13, 14].

3. Experimental

The water temperature was measured on site with a glass mercury thermometer. The conductivity was determined using a Hanna Potable conductivity metre. and pH was measured with digital pH metre. Colour

determination was done using Lovibond comparator while turbidity was analysed by absorbance method [10]. Alkalinity, Total Hardness and Chloride were determined by titrimetric method. Total dissolved solid was done by Gravimetric method while metallic elements were analysed using Atomic Absorption Spectrophotometric method.

4. Results and Discussion

Tables 1,2,3,4 and 5 show the results for the physicochemical analysis and metallic elements contents of water samples from Kampani River. From Table 1, the mean temperature of the river for dry and wet seasons ranged between 24.2 – 26.6oC respectively. The temperature of the water appears to be high in the wet season (26.6oC). This reflected the air temperature of the eastern part of the state. The results of the pH measurement revealed that the water is slightly alkaline in both seasons 7.47 – 7.45.This may be due the presence of carbonates of Calcium and Magnesium [15]. The electrical conductivity values were low 27.86 – 103.0 µs/cm and were all within the WHO and SON standards [16]. The mean concentrations of Chlorides in the water were in the range 11.3 – 43.4 mg/l with high values in the wet season. This can be attributed to the effect of rainfall on rocks. The results of the total hardness showed that the wet season values 291.687mg/l were higher than that obtained in the dry season, 109.51mg/l. This could be due to runoff which washes away the mine wastes and rocks and deposit into the river. The alkalinity value of the water was higher than that obtained in the dry season while TDS showed high values only in the wet season and were all within the Standard limit .The high value of TDS could be due to the effect of rain and other dissolve salts in the River [17] . The river water was highly turbid with the annual mean concentration between 18.8mg/l – 20.8mg/l. This is above the standard set by WHO, SON and NIS (Table 3). Chlorides values were observed to be in the range of 11.3 – 43.4mg/l with higher concentrations observed in the wet season. Heavy metals analysis showed high values of Chromium 0.32 – 0.48mg/l; Cadmium 0.05 – 0.9 mg/l and Iron 14.96 – 20.20.68mg/l. The values of Manganese ranged between 1.01 – 5.3mg/l; Nickel 0.09 – 0.22 mg/l and Lead 0.8 – 1.68mg/l. The highest values of Chromium, Cobalt, Iron and Lead were found in the wet season while that of Copper, Cadmium and Zinc showed high concentrations in the dry season (Table 2 and 3). All the metals examined were above the acceptable limits set by WHO for drinking water except for Copper and Zinc which were low. The concentrations of heavy metals in the water during the dry season was in the order Fe>Zn>Mn>Cd>Pb>Co>Cr>Cu>Ni and Fe>Mn>Pb >Zn>Cr>Co>Cu>Ni >Cd in the wet season. Table 4 and 5 revealed that there is strong correlation between most of the metals which indicate same source.

Since Kampani is not an industrial area, the high concentrations of these metals can be traced to the mining activity going on in the area for decades and the natural deposit of these metals in the earth crust. The use of charger batteries, fertilizer application on farm land especially those close to the river, as well the use of pesticides in fishing could also be another contributing factor.

4.1. Statistical Analysis

The results obtained were subjected to statistical analysis such as correlation matrix. The correlation coefficient matrix of the parameters determined is presented in Tables 4 and 5. The correlation coefficient of 0.5 was taken as significant.

5. Conclusion

The examination of water quality parameters in Kampani River revealed that the water contain high level of toxic metals such as Chromium, Lead, Cadmium, Manganese, Cobalt and Nickel which are capable of causing diseases such as cancer, kidney damage, liver problem, neurological disorder and Hepatitis among others. The values exceeded the limit set by WHO, NIS and SON for drinking water. So the River is therefore, said to be polluted. Moreover, the River requires urgent attention in order to prevent heavy metal poisoning.

Table-1. Physico-chemical parameters of water samples from kampani river

SAMPLE LOCATION	Temp (oC)	pH	E.C (µs/cm)	Colour (Hz)	Turbidity (NTU)	T.Harness (mg/l)	T.Alkalinity (mg/l)	Chloride (mg/l)	TDS (mg/l)
Dry Season: Point 1	26.oo ± 0.71	7.45 ±0.26	25.00 ±0.00	6.00 ±0.00	20.83 ±8.05	97.50 ±0.50	29.11 ±1.02	8.74 ±3.25	37.50 ± 2.21
Point 2	27.00 ±0.58	7.44 ±0.12	30.00 ±0.00	6.00 ±0.00	32.70 ±5.15	113.53 ±2.16	27.63 ±1.14	13.58 ±3.77	44.98 ±6.00
Point 3	26.50 ±0.58	7.39 ±0.31	30.00 ±0.00	6.00 ±0.00	22.00 ±1.41	117.33 ±1.16	28.34 ±1.02	13.03 ±1.96	44.98h ±1.61
Point 4	26.75 ±0.96	7.18 ±0.11	26.25 ±1.6	6.00 ±0.00	7.53 ±0.74	109.6 ±3.51	28.25 ±4.53	9.94 ±4.75	39.37 ±3.74
Wet Season: Point 1	24.00 ±0.41	7.65 ± 0.06	118.00 ±4.47	6.40 0.00	43.57 31.39	289.64 ±13.02	.07 ±0.01	27.69 ±7.92	176.93 ±6.67
Point 2	24.00 ±0.00	785,00 ±0.05	6.40 ±5.00	13.00 ±0.00	287.55 ±0.07	0.07 ±8.63	54.67 ±0.04	115.48 ±17.04	±14.42
Point 3	24.00 ±0.00	7.34 ±0.11	115.00 ±5.77	6.4 ±0.00	11.10 ±1,23	295.64 ±12.67	0.09 ±0.01	51.12 ±12.50	176.98 ±9.59
Point 4	24.00 ±0.48	7.40 ±0.02	94.00 ± 4.80	6.4 ±0.00	7.61 ±1.31	2 93.88 ±6.50	0.09 ±0.003	40.23 ±6.31	140.99 ±7.20

Table-2. Heavy metal content of water samples from kampani river

SAMPLE	ELEMENTS								
LOCATIONS	**Cr**	**Cu**	**Co**	**Cd**	**Fe**	**Mn**	**Ni**	**Pb**	**Zn**
Dry Season : point 1	0.34	0.11	0.22	2.23	11.06	0.34	0.22	1.01	1.96
Point 2	0.29	0.14	0.28	0.07	16.40	2.14	0.11	0.52	0.99
Point 3	0.38	0.11	0.55	0.92	14.12	1.17	0.35	0.59	2.14
Point 4	0.28	0.73	0.71	0.40	18.26	0.39	0.21	1.10	1.41
Wet Season: Point 1	0.45	0.14	0.44	0.06	17.70	4.80	0.09	1.52	0.96
Point 2	0.49	0.10	0.36	0.03	14.86	4.65	0.07	1.45	1.00
Point 3	0.42	0.08	0.40	0.05	26.11	5.23	0.10	1.31	1.48
Point 4	0.54	0.10	0.59	0.06	24.07	6.90	0.12	2.44	1.17

Table-3. Seasonal variation of heavy metal content of water from kampani river

Parameter	**Wet Season**	**Dry season**	**Annual Mean values**	**WHO**	**NIS**	**SON**
Temperature (°C)	26.56±0.43 (26-27)	24.15 ±0.30 (24-24.60)	25.36	25	Ambient	25
pH	7.49 (7.18-7.45)	7.45 (7.34-7.65)	7.49	6.5-8.5	6.5-8.5	6.5-8.5
Conductivity (µs/cm	27.86±2.53 (25-30)	103.00±16.00 (85-118)	79.01	50-500		1000
Colour (Hz)	6.4	6.4	6.20		15	
Turbidity (NTU)	20.76±10.31 (7.53-32.70)	18.82±16.65 (7.61-43.57)	19.79	5	5	5
T.Hardness (mg/l)	109.51±8.59 (97.50-117.33)	291.68±3.73 (287.55-295.64)	200.59	500	150	100
T.Alkalinity (mg/l)	28.33±0.61 (27.63-29.11)	8.00±1.20 (7.00-9.00)	14..17	50		100
Chloride (mg/l)	11.32±2.35 (8.74-13.58)	43.43±12.16 (27.69-54.67)	27.37	250	250	100
TDS (mg/l)	41.71±3.391 (37.50-44.98)	152.59±29.99 (140.97-176.98)	97.15	1200	500	500
Cr (mg/l)	0.32±0.04 (0.28-0.38)	0.48±0.04 (0.42-0.54)	0.40	0.05	0.05	0.05
Cu(mg/l)	0.27±0.31 (0.11-0.73)	0.11±0.026 (0.08-0.14)	0.19	1.0	1.0	1.0
Co (mg/l)	0.33±0.265 (0.22-0.71)	0.45±0.069 (0.36-0.59)	0.39			
Cd(mg/l)	0.91±0.950 (0.07-0.92)	0.05±0.123 (0.03-0.06)	0.48	0.01	0.003	0.003
Fe (mg/l)	14.96±3.104 (11.06-18.26)	20.68±4.40 (14.86-26.11)	17.82	0.3	0.3	0.3
Mn (mg/l)	1.01±0.844 (0.39-2.14)	5.30±1.032 (4.65-6.90)	3.16	0.1	0.2	0.05
Ni(mg/l)	0.22±0.097 (0.11-0.35)	0.09±0.031 (0.07-0.12)	0.16	0.07	0.02	0.02
Pb(mg/l)	0.80±0.298 (0.52-1.10)	1.68±0.516 (1.31-2.44)	1.24	0.01	0.01	0.01
Zn(mg/l) (mg/l)	1.63±0.523 (0.99-2.14)	1.15±0.238 (0.96-1.48)	1.39	0.1	3.0	5.0

Table-4. Correlation coefficient matrix of water sample for dry season

	Cr	**Cu**	**Co**	**Cd**	**Fe**	**Mn**	**Ni**	**Pb**	**Zn**
Cr	1	.825	.832	.299	.469	.953	.527	-.520	.705
Cu		1	.387	-.290	-.045	.950	-.038	-.382	.357
Co			1	.735	.723	.624	.907	-.617	.894
Cd				1	.909	.018	.935	-.153	.531
Ni							1	-.479	.797
Pb								1	-.899
Zn									1

Table-5. Correlation matrix of heavy metals from kampani river for wet season

	Cr	Cu	Co	Cd	Fe	Mn	Ni	Pb	Zn
Cr	1	.025	.686	.045	-.111	.687	.339	.877	-.389
Cu		1	.086	.375	-.571	-.263	-.191	.026	-.798
Co			1	.727	.475	.938	.885	.950*	.024
Cd				1	.538	.548	.793	.486	.130
Fe					1	.630	.825	.292	.880
Mn						1	.905	.923	.273
Ni							1	.738	.464
Pb								1	-.115
Zn									1

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