

Assessment of Physico-Chemical Parameters and Heavy Metal Levels in Waters of Upper Benue River, Adamawa State, Nigeria

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Abstract: Assessment of physicochemical parameters and heavy metal levels in water was conducted in of Upper Benue River, Adamawa state, Nigeria. Water samples were collected from four different sites once a month in triplicate from May 2014-October 2015. Water physicochemical parameters such as temperature, pH, Dissolved oxygen, conductivity, and transparency were analysed at the sites while Alkalinity, BOD, free CO₂, ammonia, Total dissolved solids, Nitrate and phosphate were analysed in the laboratories. Heavy metals (Cd, Cr, Cu, Ni, Pb and Zinc) in the water samples were determined using Atomic Absorption Spectroscopy (AAS). Temperature ranged between 26.49-27.25^oC and were within the recommended range. p^H fluctuated between 7.48-7.62 and was also within the recommended range. The values obtained for electrical conductivity were typical for fresh water since it ranged from 71.13-93.76Us/cm. Transparency was high during the dry season which correspond to the general tendency of high transparency during the dry season. Dissolved oxygen and biochemical oxygen demand values obtained in this study are likely pointers to low pollution level being experienced in the river. The values of phosphate and Nitrates obtained were high and above recommended level. Alkalinity values ranged between 79.87-119.13mg/l, which is within the recommended limits and correlate with BOD. TDS obtained in the study were low. Free carbon-dioxide was low and within the recommended range for tropical water. The mean level profile of Heavy metals in water in all the sites with the exception of site B was Cu>Zn>Ni>Pb. Site B had this profile Cu>Zn>Pb>Ni. Copper and Zinc were the abundant metal in water. Higher level of metal was observed in the dry season. There was an uneven distribution of metal in water. Except Zinc, all the metals observed were not significantly different between sites and months.

Key Words: Physicochemical parameters, Heavy metals, Water.

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I. Introduction

Physicochemical parameters is the sum total of the physical, Chemical and biological characteristics of water body (APHA, 1995). Studying of physicochemical parameters of rivers is aimed at protecting and maintaining the aquatic system, controlling pollution, planning of water resources management and other resources the rivers provide to the society (Abubakar, 2006). Study of water physicochemical parameters is very necessary because of its use in everyday life. Environment contamination is commonly exposing aquatic organism like fish to pollution and other problems including growth and reproduction (David *et al*, 2010). Pollution has been the problem of tropical waters and could be defined as the adding to water any substances or the changing of water's physical and chemical characteristics in any way which interferes with its use for legitimate purposes (Argrawal, 1989). In different parts of Nigeria, rivers are used for the disposal of refuse, human sewage, and waste waters from kitchens, abattoirs and industries. Streams and rivers running through areas of significant human influence such as farms, cities and industrial are mostly affected (Ajayi and Adeleye, 1977; Oluwande *et al*, 1983; Egborge, 1991; Fagade *et al*, 1994 and Ja'afaru *et al* 2000). The quality of water influences its biology. It influences species composition, diversity, stability, production and physiological conditions of indigenous population (APHA, 1991). Heavy metals contamination in water 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). 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 (Goldberg, 1972). 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). The current study is aimed at assessing the physicochemical parameters and Heavy metal concentration in waters of Upper Benue River, Adamawa State, Nigeria.

II. Materials 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. It shares boundary with Taraba in the south and west, Gombe state in its northwest and Borno state to the north. Adamawa state has an international boundary with Cameroon Republic along its Eastern border. The Benue which is the major river in the state rises from the highlands of Cameroon and flows to the south-ward to join the River Niger at Lokoja. Two seasonal periods are being experience in the state: the wet and the dry season. River Benue is the main source of water for irrigation, fishing, domestic and industrial purposes in the state. The main sources of water apart from rainfall are surface and ground water. The river is well is well dissected by network of rivers. The river is approximately 1,400 km long and it is almost navigable during the summer months. This study was conducted in the Upper Benue River and the study sites included Njoboliyo (Site A), Boronji (Site B), Jimeta under Bridge (Site C) and Numan Confluence (Site D).

Sample Collection:

Water physicochemical parameters such as temperature, pH, Dissolved oxygen, conductivity, and transparency were analysed at the sites while Alkalinity, BOD, free CO₂, ammonia, Total dissolved solids, Nitrate and phosphate were analysed in the laboratories. Surface water was collected on a monthly basis using a sampling procedure as guided by Radojevic and Bashkin (2006). Water for heavy metal determination was collected by lowering pre-cleaned plastic bottles into the bottom of the water body, 30 cm deep, and allowed to over flow before withdrawing from different fishing landing sites of the Upper Benue River.

III. Sample Analysis

Physicochemical parameters

Temperature was determined directly at the sampling site (insitu) using a mercury bulb thermometer (Glaswekwer tein model). The pH of the water body was determined at the site (insitu) using pH meter (model: Pen type pH meter). Conductivity was determined at the site using conductivity meter (model: Large.

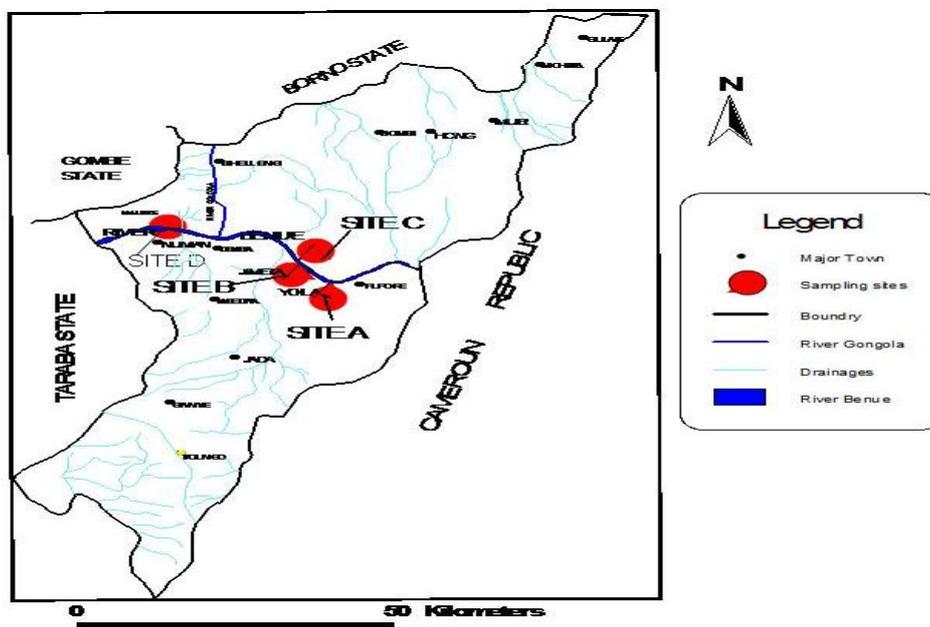


Fig 1: Map of Adamawa State Showing Study Area and Sampling Sites.

display conductivity pen-850037). Dissolved Oxygen was determined at the site using DO meter (model: Jenway 970 DO meter as recommended by APHA, AWWA and WPCF (1989). Secchi disc depth was used to determined transparency of water as described by Stirling (1985). Ammonia Alkalinity, Phosphate and Nitrate were measured using a testab water investigation kit as recommended by (Cambell and Wilberger, 1992).

Determination of Heavy Metals in Water:

Heavy metals (Cu, Ni, Pb and Zinc) in the water samples were determined using Atomic Absorption Spectroscopy (AAS) as described by (APHA 1998; Radojevic and Bashkin, 1999).

Statistical Analysis

Data obtained in this study were analysed using one way analysis of variance (ANOVA) Statistix 9.0 Statistical Package for Scientists and Engineers (2012) to determine the mean significant variation (at 0.05) in physicochemical parameters and heavy metals in the sampling stations.

IV. Results

Physicochemical parameters:

The mean variation of physicochemical Parameters of water measured from different Sites of Upper Benue River is presented in Table 1. The lowest Temperature value of 26.49°C was observed in Site D while highest Temperature value of 27.25°C was observed in Site C. There was a significant variation ($P < 0.05$) between Sites. The lowest pH value of 7.48 was obtained in Site A while highest pH value of 7.62 was obtained in Site C. There was no significant variation ($P > 0.05$) between Sites. The lowest Conductivity value of 86.14 μ S/cm was recorded in Site A while the highest Conductivity value of 92.96 μ S/cm was recorded in Site B. There was a significant ($P < 0.05$) variation between Sites. The lowest Transparency level of 21.58 cm was recorded in Site A while the highest Transparency value of 24.09 cm was recorded in site D. There was a significant variation ($P < 0.05$) between Sites. The lowest Dissolved Oxygen value of 7.17mg/l was observed in Site A while highest Dissolved Oxygen value of 7.29mg/l was observed in Site B. There were no significant in variability ($P < 0.05$) between Sites. The lowest BOD value of 3.39mg/l was recorded in site A while the highest BOD values of 3.56mg/l were recorded in site C and D. There was a significant variability ($P < 0.05$) between Sites. The lowest Total Ammonia value of 0.07mg/l was observed in site C while the highest Total ammonia value of 0.09mg/l was observed in site D. Ammonia differed significantly ($P < 0.050$) between Sites. The lowest Phosphate value of 2.40mg/l was recorded in site C while the highest phosphate value of 2.72mg/l was recorded in sites A. Phosphate differed significantly ($P < 0.05$) between Sites. The lowest Nitrate value of 3.01mg/l was recorded in Site B while Site C recorded the highest nitrate value of 3.45mg/l. Nitrate differed significantly ($P < 0.05$) between Sites. The lowest Alkalinity value of 91.33mg/laws recorded in Site B while the highest value of 93.77mg/laws recorded in Site A. There was no significant difference ($P > 0.05$) between Sites. The lowest free CO₂ value recorded was 0.38/mgl in sites B and D while the highest free CO₂ value recorded was 0.39/mgl in sites A and D. There was significance difference ($P < 0.05$) between Sites. The lowest TDS value of 57.53/mgl was recorded in site C while the highest TDS value of 62.41/mgl was recorded in site D. There was significant difference ($P < 0.05$) between Sites.

Heavy Metals In Water:

The Concentration of Copper, Nickel, Lead and Zinc in Water measured from four different Sites of Upper Benue River is presented in Table 2. The result showed that the lowest Copper value of 0.19mg/l was recorded in Site A while the highest Copper value of 0.22mg/l was recorded at Site B. Copper was not significantly different ($P > 0.05$) between Sites. The lowest Nickel value 0.02mg/l was recorded from Site A while the highest value of 0.05 mg/l was recorded from Site C. Nickel was not significantly different ($P > 0.05$) between Sites. The lowest Lead value of 0.02 mg/l was recorded in Site A while the highest Lead value of 0.04 was reported from Site B. Lead was not significantly different ($P > 0.05$) between Sites. The lowest value of Zinc 0.01mg/l was recorded in Site A while the highest value of 0.12mg/l was recorded in Site D. Zinc different significantly ($P < 0.05$) between Sites.

V. Discussion

The result of the study showed some marked variation in physiochemical parameters between sampling sites. The slight variation in some physiochemical parameters could be attributed to the flow variability and changes in water shed condition. These agrees with the observation of Ali et al. (2007) and Chukwu and Nwankwo, (2003) who reported that the high variability of water quality may be due to impact of many factors such as rainfall, surface run-off and catchments activities during the wet and dry season periods. Adebisi, (1981) also reported that in tropical systems, marked variation in temperature and rainfall between seasons influence the physiochemical characteristics of the water body. Physicochemical parameters were within the recommended range for freshwater fish (Stirling,1985).

Heavy Metals in Water:

The result of the analysis of Heavy metal in water showed some variations with the exception of Cadmium and Chromium which were beyond detection level in the water samples. The non-detection of these

heavy metals may be due to the inability of the metals to dissolve in water and got deposited to the bottom in the sediments and this is because water sediment are metal reservoirs trapping all the heavy metal that escapes 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 analysed varied among the sampling sites and months, which indicated uneven distribution of the metals along the stretch of the river. This could be attributed to differences in the level of human activities taking place at the sampling sites. The mean level profile of heavy metal at sites with the exception of site B is Cu>Zn>Ni>Pb. Site B had this profile Cu>Zn>Pb>Ni. The above profile indicated that Cu and Zn were the most abundant metal in water samples. This finding corresponds with the findings of Obasohan *et al.* (2000).

VI. Conclusion

Result of the study showed that the values for physiochemical parameters obtained with the exception of phosphate, nitrate and ammonia were within the recommended safety limit. Among the heavy metals under investigation, Chromium and Cadmium were below detection level in water. All the metals present were within the recommended limit.

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Table 1: Mean Variation of Physicochemical Parameters of Water from different Sites of Upper Benue River.

Parameters	SiteA	SiteB	SiteC	SiteD	Mean
Temperature (°C)	27.14 ^a	27.13 ^a	27.25 ^a	26.49 ^b	27.00
pH	7.48 ^a	7.52 ^a	7.62 ^a	7.53 ^a	7.53
Conductivity (µS/cm)	86.14 ^b	92.96 ^b	86.50 ^a	93.76 ^a	89.84
Transparency (cm)	21.58 ^b	22.93 ^a	23.82 ^a	24.09 ^a	23.10
Dissolved Oxygen (mg/l)	7.17 ^a	7.29 ^a	7.18 ^a	7.18 ^a	7.23
B O D (mg/l)	3.39 ^b	3.46 ^b	3.56 ^{ab}	3.56 ^a	3.67
Ammonia (mg/l)	0.08 ^b	0.08 ^b	0.07 ^c	0.09 ^a	0.08
Phosphate (mg/l)	2.72 ^a	2.51 ^{ab}	2.40 ^b	2.56 ^{ab}	2.55
Nitrate (mg/l)	3.02 ^b	3.01 ^b	3.45 ^a	3.30 ^a	3.20
Alkalinity (mg/l)	93.77 ^a	91.33 ^a	93.28 ^a	92.79 ^a	92.00
TDS (mg/l)	58.73 ^{ab}	58.85 ^{ab}	57.53 ^c	62.41 ^a	59.38
Free CO ₂ (mg/l)	0.39 ^a	0.38 ^b	0.39 ^a	0.38 ^b	0.38

Means with the same superscript are not significantly (P>0.05) different from each other

SiteA-Njoboliyo

SiteB-Boronji

SiteC-Jimeta Bridge

SiteD-Numan confluence

Table 2: Mean Variation of Heavy metal Concentration of water from different Sites of Upper Benue River.

Sites	Copper(mg/l)	Nickel(mg/l)	Lead(mg/l)	Zinc(mg/l)
SiteA	0.19 ^a	0.02 ^b	0.02 ^b	0.10 ^b
SiteB	0.22 ^a	0.03 ^b	0.04 ^a	0.11 ^b
SiteC	0.20 ^a	0.05 ^a	0.03 ^b	0.10 ^b
SiteD	0.21 ^a	0.04 ^b	0.03 ^b	0.12 ^a

Means with the same superscript are not significantly (P>0.05) different from each other

SiteA-Njoboliyo

SiteB-Boronji

SiteC-Jimeta Bridge

SiteD-Numan confluence

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