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Full Length Research Paper

An assessment of the organic pollution indicator levels of River Benue in Adamawa State, Nigeria

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The assessment of organic pollution Indicator levels of River Benue in Adamawa State was carried in ten sampling stations. The sampling was done in the months of February, March, and April 2007, representing dry season, while the months of August, September, and October 2007, represent the wet season. The water and sediment samples collected were analysed using standard procedures. The pollution indicators determined includes: Dissolve oxygen (DO), biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), and total organic carbon (TOC). The results for River Benue showed the following concentrations of the parameters assessed: The BOD_5 values ranged between 1.55 ± 0.68 and 3.72 ± 0.51 mg/l for dry season and 0.89 ± 0.11 and 1.70 ± 0.72 mg/l for wet season indicating that values were higher during dry season than wet season. Likewise the COD values were between 2.97 ± 0.47 and 3.57 ± 0.97 mg/l for dry season and 2.49 ± 0.47 and 2.90±0.31 mg/l for wet season. This shows high COD values during dry season than wet season. The TOC values ranged between 1.01 ± 0.06 and 1.52 ± 0.16% for dry season and 0.35 ± 0.06 and 0.56 ± 0.08% for wet season, while the DO values were between 5.27 and 6.41 mg/l for dry season and 6.32 and 8.32 mg/l for wet season. This showed that the DO was high during wet season than dry season. The BOD_5, COD and TOC were high during dry season, while the DO was low and vice versa. The correlation between BOD_5 versus COD gave a positive correlation of 0.652 and that of COD against TOC gave a positive correlation of 0.743 because all of them are products of oxidation. The correlation of DO against BOD_5 gave a negative correlation of 0.693. The values of the organic indicators studied were within the allowable limits of WHO and NAFDAC.

Key words: Organic indicators, pollution, River Benue, parameters, sediment, assessment.

INTRODUCTION

The demand for fresh water is always there with the ever-increasing population in the world. The oceans and rivers hold about 97% of the earth's total resource of water while the remaining 3% is buried underground to be economically exploited. However only 0.003% of the total volume of the later fraction is exploitable, though, the hydrological circle replenishes this. Many fresh water resources are contaminated through human activities. Each day some 25,000 people are said to die from their every day use of wastewater. Many millions more suffer from frequent and debilitating water borne illnesses. About half of the inhabitants of developing countries in particular do not have access to safe drinking water and 73% have no sanitation, some of their wastes eventually contaminate their drinking water supply leading to a high level of suffering (Mason, 1996).

The provision of water for domestic and other uses in rural and urban centers is one of the most intractable problems in Nigeria today. Access to adequate water of good quality is essential to health, food production and sustainable development.

Every human use of water, whether for drinking, irrigation, and industrial processes or for recreation has some quality requirements in order to make it acceptable.

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This quality criterion can be described in terms of physical, chemical and biological properties of such water (Gore, 1985; Verma, 2003).

In many places both surface and ground water is fouled with industrial, agricultural, and municipal wastes. According to the World Commission on water for the 21st century, more than half of the world's major rivers are so depleted and polluted that they endanger human health and poison surrounding ecosystems (Inter-press, 1999).

The sources of water pollution vary and involve almost every significant human activity. These include mostly the dumping of domestic wastes, sewage, agricultural wastes and industrial effluents into water bodies (Collocott and Dabson, 1974). The wastes dumped on land are also eventually washed into water example animal dung, litters, wind deposited pollutants. Also disturbances of the soil mantle by ploughing during cultivation, road making, stream irrigation/channelization, and mining break the protective vegetation cover and encourage soil washout by storm water during rainfall. In some areas, air pollutants like oxides of nitrogen and sulphur become acidic contaminants during rainfall (Ademoroti, 1996a). Increase in industrialization as a result of modern and sophisticated technology has introduced many synthetic materials into our environment. Some may be toxic or carcinogenic. The wastes arising from them find their way into water bodies, and hence they become contaminated. Aquatic biota is sensitive to pH. They cannot live in a medium having a salinity to which they are not adapted, also high temperatures encourages growth of bacteria and causes depletion in oxygen content of water (Bhatia, 2006).

River Benue

River Benue is the longest tributary of River Niger; being about 1,083 km in length. It rises in northern Cameroon as the Bénoué at about 1,340 m and, in its first 240 km, descends more than 600 m over many falls and rapids, the rest of its course being largely uninterrupted. During flood periods its waters are linked via the Mayo-Kebbi tributary with the Logone, which flows into Lake Chad. Below the Mayo-Kebbi the river is navigable all year by boats drawing less than 0.75 m and by larger boats for more restricted periods (Encyclopedia Britanica, 2004). A considerable volume of imports (particularly petroleum) is transported by river, and cotton and peanuts (groundnuts) are exported in the same way from the Chad region. Between Yola and Makurdi the Benue is joined by the Gongola, and it flows east and south for about 480 km. The Cameroun government built a Dam on the river near Lagdo town about 250 km away from Yola (Figure 1).

The various water pollutants known are derived from the factors responsible for water pollution such as agricultural and domestic waste, industrial waste (anthropogenic sources), and water from natural (biogenic) sources. These pollutants include: Organic and inorganic materials, salts, nutrients, heavy metals, pesticides, pathogens and heat. Some are biodegradable while some are non-biodegradable.

The biodegradable materials are easily oxidized by making use of the dissolved oxygen (DO) in water. The oxygen demanding water soon depletes the DO. As DO drops, fish and other aquatic life are threatened or killed in the extreme case. In this case, the DO may be about 3 mg/l or less. As much as 9.2 mg/l at 25°C is needed for support of aquatic life (Ademoroti, 1996b). Contamination of streams and rivers by nitrates and phosphates has been observed in many parts of the world. This leads to the process of nutrient enrichment, termed eutrophication, is especially important in ponds and lakes. It is fair to state that nitrates and phosphates are probably the key nutrients in controlling aquatic plant growth (Savita et al., 2005).

Adefemi et al. (2007) in their assessment of the physico-chemical of water of Maji dams in Ekiti State Nigeria found that the status of water samples from four major dams in Ekiti was assessed for a period of 3 years (dry and wet season). Results show that the parameters determined were higher in the dry season than wet season. The statistical analysis revealed that most of the physico-chemical parameters are significantly different except for temperature, conductivity and dissolved solids whose values are lower than the Table value (0.4975 at P = 0.05). The value increased from one year to another. The results are within the maximum allowable limits by USEPA (1999).

Ogabiela et al. (2007) in their analysis of tannery effluents from Sharada Industrial Estate Kano and physic-chemical parameters of the waste water such as TDS, TSS, and TS. Conductivity, alkalinity, chloride, BOD, COD, sulphide and Cr, were determined using standard methods. The concentrations of parameters were found to be higher than the limits set by the Federal Ministry of Environment for discharge of effluents by the tannery sector. The tannery effluents from the Sharada Industrial Estate pollute the Challawa River in Kano.

Ogugbuaja and Kinjir (2001) in their studies of some portions of rivers Benue and Gongola found that rivers Benue/Gongola confluence shows high concentration levels for some of the trace metals due mainly to increased river load deposition. High human activities at the abattoir rear the shores of river Benue probably led to an increased organic indicator levels obtained with a high negative COD/DO correlation coefficient (r – 0.98) was recorded. Low mineralization ratio (range 0.007 to 0.043) was attributable to sourcing of determined metals from a poorly mineralized area.

MATERIALS AND METHODS

The assessment of the organic parameters of surface water and aqueous sediment samples in River Benue in Adamawa State is the focus of this research. It is meant to assess and evaluate the

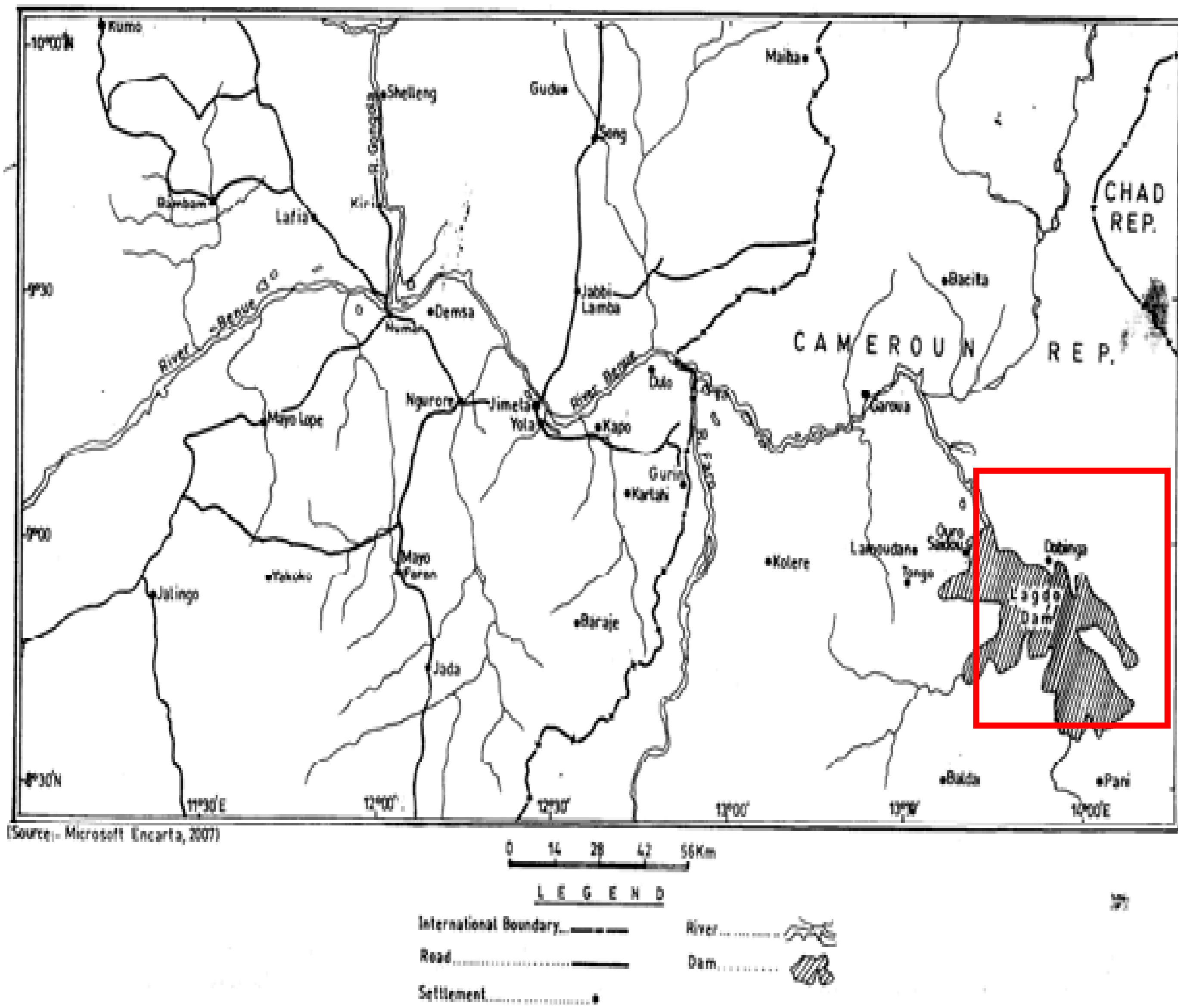

Figure 1. Map of Adamawa State Showing Lagdo dam in Cameroun.

water environment. This is aimed at ascertaining the quality, quantity and the causes of organic pollution levels in the water body and their effects on human, animal and aquatic organisms. The different procedures adopted in this work were outlined below.

Study area

The study areas include:

(a) River Benue: Boronji, Jimeta water treatment plant, Jimeta bridge, Jambutu, Vinikilang, behind Jimeta Bridge, Fisheries, Bajabure I, Bajabure II and Jimeta car wash areas.
(b) All the areas mentioned above are in Adamawa State, Nigeria (Figure 2). As stated earlier, these body of water is the main source of water for irrigation, fishing, domestic and industrial purposes in the state. The sediments and water samples were collected from the above-mentioned locations.

Water sampling

Samples which are representatives of the water body were collected and examined. These samples were collected at designated areas as shown in Figure 2. Water samples were collected by lowering pre-cleaned plastic bottles into the bottom of the water body, 30 cm deep, and allowed to over flow before withdrawing. Twenty sampling points were used and the sampling points are approximately 100 m away from each other. A total of 200 samples were analyzed. Samples were collected in the months of February, March, April (dry season) and August, September, October (wet season) in the year 2007.

Storage and preservation

Since changes occur frequently in water samples, analysis was done immediately after collection. Where analysis could not commence

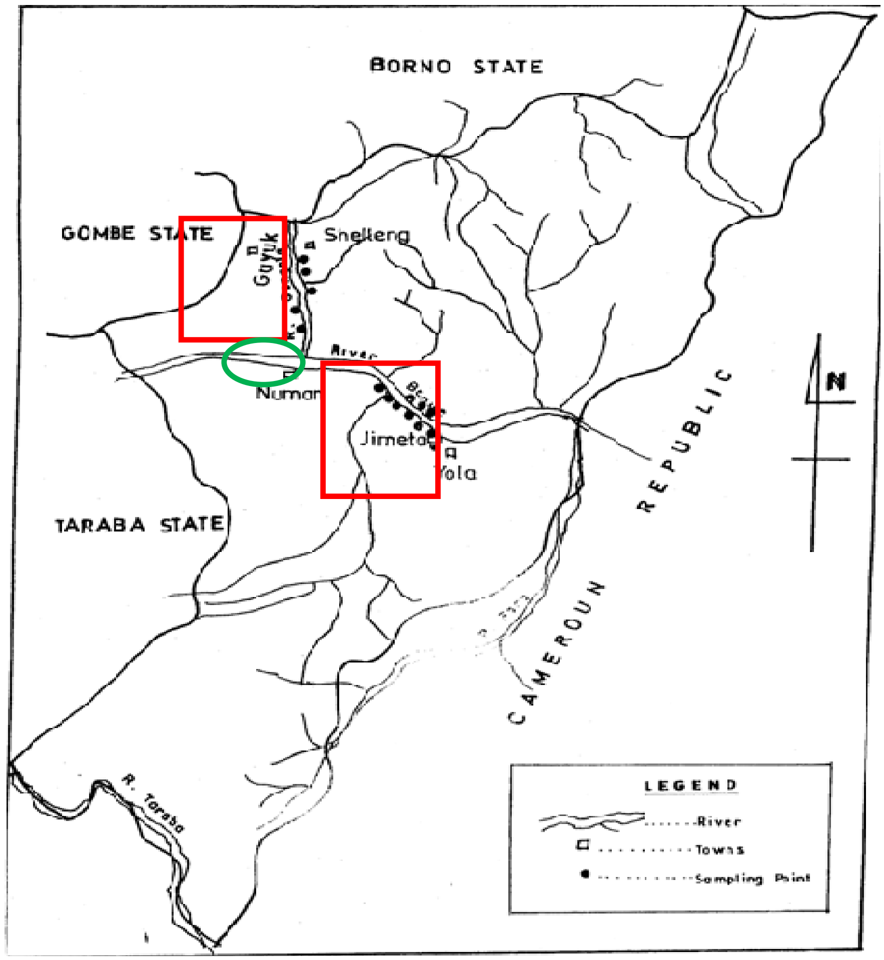

Figure 2. Map of Adamawa State showing study areas and sampling points.

commence immediately, samples were stored at 4°C or relevant preservatives were added depending on the parameter to be determined and duration of the preservation as described by APHA (1985).

Dissolved Oxygen (DO) and biochemical oxygen demand (BOD) were obtained using DO meter and Chemical oxygen demand (COD) was determined according to the standard refluxing with $K_2Cr_2O_7$ method of APHA (1985). The sediment samples were analyzed for total organic carbon (TOC) using the Winkler Black titration method (Goerlitz and Brown, 1972). The digestion of sediment samples was done by dissolving 1 g of the dried powdered sediment samples in a clean 100 ml beaker. This was followed by the addition of 20 ml concentrated HCl in small portions, 5 ml of concentrated HNO_3 and 2 ml of HF. The mixture was covered with watch glasses and heated to near boiling for 1 h. It was filtered hot and made up to mark with distilled water in 100 ml volumetric flask.

Data analysis

Results were presented as mean ± SD. The Pearson's correlation analysis, Analysis of Variance (ANOVA) with Scheffe post hoc test and the student t-test were used for the statistical analyses of results obtained at 95% confidence level using Microsoft Excel 2007 package.

RESULTS

Dissolved oxygen (DO)

The mean seasonal variation of DO for River Benue water at each sampling location were as shown in Table 1. The DO values ranged from 5.27 ± 0.24 to 6.41 ± 0.21 mg/l for the dry season (February - April 2006) and 6.32 ± 1.25 to 8.32 ±1.13 mg/l for wet season (August to October 2006).

Biochemical oxygen demand (BOD_5)

Figure 3 is the scatter gram of DO against BOD_5 for River Benue. It showed that when DO was high, BOD_5 was low and vice versa which agrees with Radojevic and Bashkin (1999). It gave a negative correlation coefficient of 0.693. Table 1 was the mean seasonal variation of BOD_5, the values ranged from 1.55 ± 0.68 and 3.72 ± 0.51 mg/l for dry season and 0.88 ± 0.16 and 1.70 ± 0.79 mg/l for wet season.

Table 1. Mean ± SD variations of organic pollution Indicators in River Benue.

Season	Name of source	Code	Organic indicators			
			DO (mg/l)	BOD_5 (mg/l)	COD (mg/l)	TOC (%)
Dry	Water Boronji	RBBW	5.68 ±1.05	3.32 ± 1.31	3.06 ± 0.53	1.42 ± 1.08
	Water Treatment P.	RBTW	6.41 ± 0.21	2.97 ± 1.99	1.55 ± 0.68	1.04 ± 0.44
	Bridge	RBBdW	5.71 ± 0.17	3.23 ± 1.57	1.84 ± 0.96	1.15 ± 0.44
	Jambutu	RBJW	6.09 ± 0.08	2.97 ± 1.47	2.18 ± 0.79	1.19 ± 0.87
	Vinikilang	RBVW	5.76 ± 0.62	3.44 ± 1.11	2.89 ± 0.15	1.38 ± 0.69
	Behind Bridge	RBBbW	6.18 ± 0.31	3.29 ± 1.75	2.07 ± 1.16	1.17 ± 0.85
	Fisheries	RBFW	6.27 ± 0.37	3.00 ± 1.78	1.59 ± 1.08	1.01 ± 0.62
	Bajabure 1	RBB1W	5.77 ± 0.79	3.51 ± 1.14	3.15 ± 0.88	1.33 ± 1.19
	Bajabure 2	RBB2W	5.66 ± 0.00	3.57 ± 0.97	3.72 ± 0.51	1.52 ± 1.16
	Car Wash	RBCwW	5.27 ± 0.24	3.39 ± 1.57	2.69 ± 0.42	1.22 ± 1.10
Wet	Water Boronji	RBBW	7.31 ± 1.70	2.90 ± 0.66	1.56 ± 0.57	0.56 ± 0.15
	Water Treatment P.	RBTW	7.70 ± 2.08	2.73 ± 0.58	1.35 ± 0.56	0.44 ± 0.24
	Bridge	RBBdW	6.82 ± 0.85	2.87 ± 0.38	1.35 ± 0.27	0.48 ± 0.06
	Jambutu	RBJW	7.23 ± 1.55	2.82 ± 0.68	1.70 ± 0.62	0.50 ± 0.23
	Vinikilang	RBVW	7.39 ± 0.32	2.48 ± 0.32	0.89 ± 0.16	0.41 ± 0.01
	Behind Bridge	RBBbW	6.93 ± 0.58	2.83 ± 0.23	1.46 ± 0.30	0.50 ± 0.23
	Fisheries	RBFW	7.16 ± 1.92	2.50 ± 0.56	1.22 ± 0.38	0.47 ± 0.08
	Bajabure 1	RBB1W	6.93 ± 1.53	2.60 ± 0.31	1.09 ± 0.34	0.38 ± 0.19
	Bajabure 2	RBB2W	6.32 ± 1.25	2.58 ± 0.49	1.26 ± 0.24	0.43 ± 0.12
	Car Wash	RBCwW	8.32 ± 1.13	2.49 ± 0.41	1.20 ± 0.28	0.35 ± 0.06

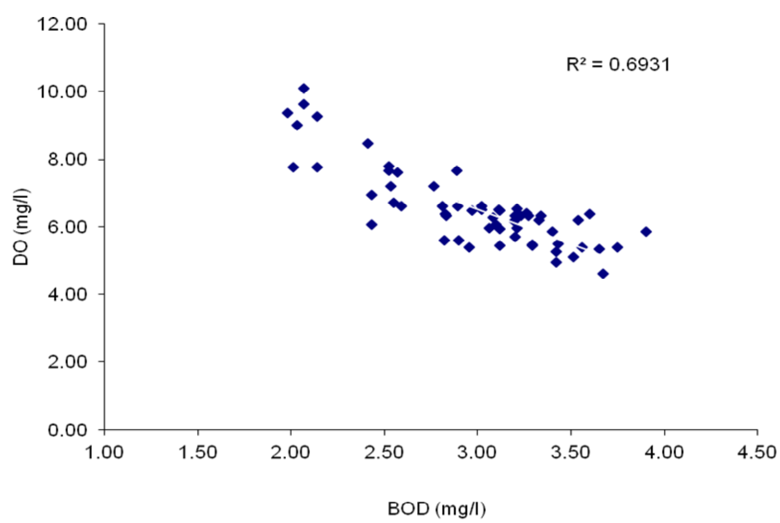

Figure 3. BOD against DO for River Benue.

Chemical oxygen demand (COD)

Table1 showed the mean seasonal variation of organic pollution levels for River Benue indicating that the COD values ranged between 2.97 ± 1.47 and 3.72 ± 0.97 mg/l for dry season and 2.49 ± 0.42 and 2.97 ± 1.31 mg/l for wet season, the dry season being higher than the wet season. The scatter gram of COD versus BOD_5 in Figure 4 showed positive correlations of 0.652 meaning the two parameters are likely from the same source.

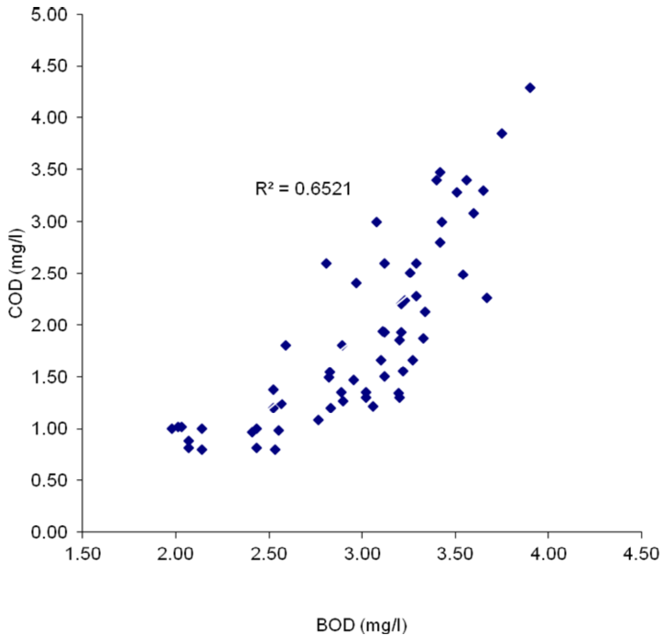

Figure 4. BOD_5 against COD for River Benue.

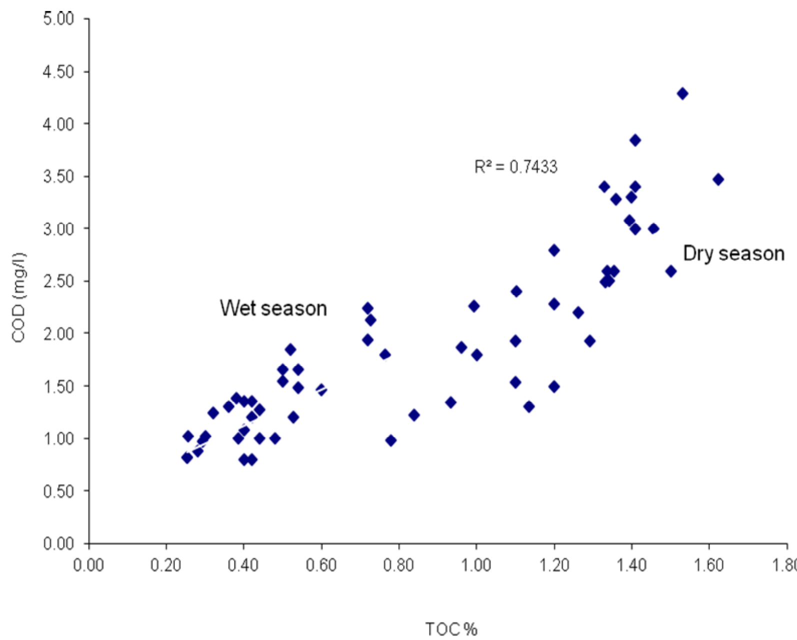

Figure 5. TOC against COD for River Benue.

Total organic carbon (TOC)

Table 1 shows the percentage of TOC for River Benue, which were between 1.01 ± 0.62 and 1.52 ± 1.16% for dry season and 0.35 ± 0.06 and 0.56 ± 0.03% for wet season. The correlation of TOC versus COD was positive with a value of 0.743 as shown in Figure 5.

DISCUSSION

The measurement of organic pollution level from non-point source either from farm, business or home which affect the quality of water in River Benue is of concern in this study. Human activities such as agriculture, urbanization and industrial development are treating the atmosphere

atmosphere as they transport large quantities of pollutants that can affect aquatic lives. Human activities are capable of altering and affecting each part of the hydrologic cycle chemically, physically or biologically. The measurement of chemical variables was employed in this work to assess the pollution levels of River Benue. The indicators determined includes: Dissolved oxygen (DO), biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), and total organic carbon (TOC) as organic pollutants. The dissolved oxygen concentration found in this work was higher during the wet season than dry season. Even though that of BOD_5, COD and TOC were high in the dry season than the wet season though all these values fluctuates at different locations from upstream to downstream this may be to the non-point source of assessment . All the values were within the permissible limits of WHO (2006) and NAFDAC (2001). The low DO values in dry season may not be unconnected to the high temperatures in the dry season. A negative correlation was established between DO and BOD_5, COD and TOC. The observed relationship profile is expected and it is in agreement with established patterns (WHO, 2006).

Conclusion

The DO values for river Benue were within the permissible limits of WHO (2006) and the values of the organic pollutants that is, biological oxygen demand (BOD_5), chemical oxygen demand (COD), and total organic carbon (TOC) are within the permissible limits of WHO and their correlation with one another is positive indicating both are products of oxidation of organic matter. On a general note, River Benue can be said to be moderately clean and good for fishing and irrigation purposes but not clean for human consumption. Hence, it cannot be considered to be polluted now but it stands the risk of getting polluted based only on the organic pollution levels.

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