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AN ASSESSMENT OF THE ORGANIC POLLUTION INDICATOR LEVELS OF RIVER GONGOLA IN ADAMAWA STATE, NIGERIA.

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ABSTRACT

An assessment of organic pollution indicator levels of River Gongola in Adamawa State was carried out in ten sampling stations. The sampling was done in the months of February, March, April, 2007 representing dry season and in the months of August, September, and October 2007 representing wet season. The water samples collected were analysed using standard procedures as described in Radojevic and Bashkin (1999) and Ademoroti (1996).The organic pollution levels determined includes Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC). The results revealed the following concentrations of the parameters assessed.BOD ranges between 2.64±0.11 to 2.96±0.80 for dry season and 2.06±0.08 to 2.31±0.05 for wet season. These values are high during dry season as compared to wet season. Likewise the COD ranges between2.43±0.48 to 4.38±0.92 for dry season and 1.57±0.52 to 3.48±0.35 for wet season. The values were also high during dry season than wet season. The TOC values ranges between 1.39±0.68 to 1.86±0.30 for dry season and 0.33±0.15 to 1.20±0.26 for wet season. It is also high in dry season than in wet season. While the DO values ranges between 5.44±0.19 to 6.44±0.16 for dry season and 6.94±0.43 to 7.81±0.75 for wet season. These values are high during wet season than dry season, which is in contrast to those of BOD, COD, and TOC. The correlation between DO/BOD is negative with a coefficient of -0.809, while that of COD/BOD gives a positive correlation of 0.515 and that of COD/TOC is also positive with a value of 0.457. These relationships agree with Radojevic and Bashkin (1999), and Ademoroti (1996). The above values are within the allowable limits of the WHO/NAFDAC (2001).

Key words: Organic indicators, pollution, River Gongola, Parameters, Sediment, Assessment.

INTRODUCTION

Access to safe drinking-water is essential to health, a basic human right and a component of effective policy for health protection. The importance of water, sanitation and hygiene for health and development has been reflected in the outcomes of a series of international policy forums. These have included health-oriented conferences such as the International Conference on Primary Health Care, held in Alma-Ata, Kazakhstan (former Soviet Union), in 1978. They have also included water-oriented conferences such as the 1977 World WaterConference in Mar del Plata, Argentina, which launched the water supply and sanitationdecade of 1981–1990, as well as the Millennium Development Goals adopted by the General Assembly of the United Nations (UN) in 2000 and the outcome of the Johannesburg World Summit for Sustainable Development in 2002. Most recently, the UN General Assembly declared the period from 2005 to 2015 as the International Decade for

Action, "Water for Life."(WHO, 2006). Access to safe drinking-water is important as a health and development issue at a national, regional and local level. In some regions, it has been shown that investments in water supply and sanitation can yield a net economic benefit, since the reductions in adverse health effects and health care costs outweigh the costs of undertaking the interventions. This is true for major water supply infrastructure investments through to water treatment in the home. Experience has also shown that interventions in improving access to safe water favour the poor in particular, whether in rural or urban areas, and can be an effective part of poverty alleviation strategies. 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. This quality criterion can be described in terms of physical, chemical and biological properties of such water (Gore, 1985 and Verma, 2003).

In m any 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 e.g 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, 1996). 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 qqto which they are not adapted, also high temperatures encourages growth of bacteria and causes depletion in oxygen content of water (Bhatia, 2006).

River Gongola

River Gongola is the principal tributary of the Benue River. It rises in several branches (including the Lere and Maijuju rivers) on the eastern slopes of the Jos Plateau and cascades (with several scenic waterfalls) onto the plains of the Gongola Basin, where it follows a northeasterly course. It then flows past Nafada and takes an abrupt turn toward the south. Its lower course veers to the southeast and, after receiving the Hawul (its chief tributary, which rises on the Biu Plateau), it continues in a southerly direction before joining the Benue, opposite the town of Numan, after a journey of 531 km. During the dry season, however, the upper Gongola and many of its tributaries practically disappear, and even the lower course becomes unavailable (Encyclopedia Britanica, 2004).

Almost all of the Gongola Basin lies in a dry savanna area. The basin has been enlarged by the Gongola's capture of several rivers that formerly flowed to Lake Chad—the sharp southerly bend east of Nafada is the result of the capture of the upper Gongola, and the Gungeru, another tributary from the Biu Plateau, is also a captured stream. The Gongola's floodplains are covered with a fertile black alluvial soil. Cotton, peanuts (groundnuts), and sorghum are grown for export to other parts of the nation; but millet, beans, cassava, onions, corn (maize), and rice are also cultivated.

The government built the Kiri Dam (completed 1984) on the river near Numan to provide irrigation and electricity for its Gongola sugar plantation project. The basin is also used as grazing ground for livestock.

The study area is River Gongola (Kiri-dam) in Numan and Shelleng local government areas of Adamawa State located within latitude 9^0 11^IN to $9^0 20^I$N and longitude $12^0 23^I$E and covers an area of about $305KM^2$. The Gongola River constitutes one of the major drainage system in the area next to River Benue. It is less than 150 m above mean sea level. The mean annual rainfall in Yola is 859.3 and 917.9mm in Yola (Ishaku, 1995).

The area is not highly industrialized, the functional industries are the Bajabure industrial complex, Savanna Sugar Company Plc, Yola oil mill and AFFCOT Nig. Ltd. Others are small-scale industries like the Naggae Company. However some small-scale metallurgical works are present (Ntekim and Bello, 2001).

Kiri-dam located on river Gongola in Shelleng L.G.A. in the state is mainly constructed in order to supply water to the Savannah Sugar Co. in Numan, Numan LGA for irrigation purpose. However ,a lot of fishing activities take place there. The economic resources are mainly agricultural, and crops such as groundnuts, maize and guinea corn are grown here. Adamawa State is an important breeding center for cattle, sheep and goat.

These sources of water supply are susceptible to pollution due to heavy human dependency on these river waters. Notably there is indiscriminate dumping of waste and agricultural practices taking place in the area. Waste disposal in the areas is through open dump for solid waste, pit latrines, septic tank for human wastes. Liquid wastes are admitted through the major drainage networks and emptied into the rivers Benue and Gongola. Hence, the necessity of monitoring the pollution level of the river water bodies in this area.

The various water pollutants known are derived from the factors responsible for water pollution such as agricultural wastes 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 3mg/l or less. As much as 9.2mg/l at 25^0C 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).

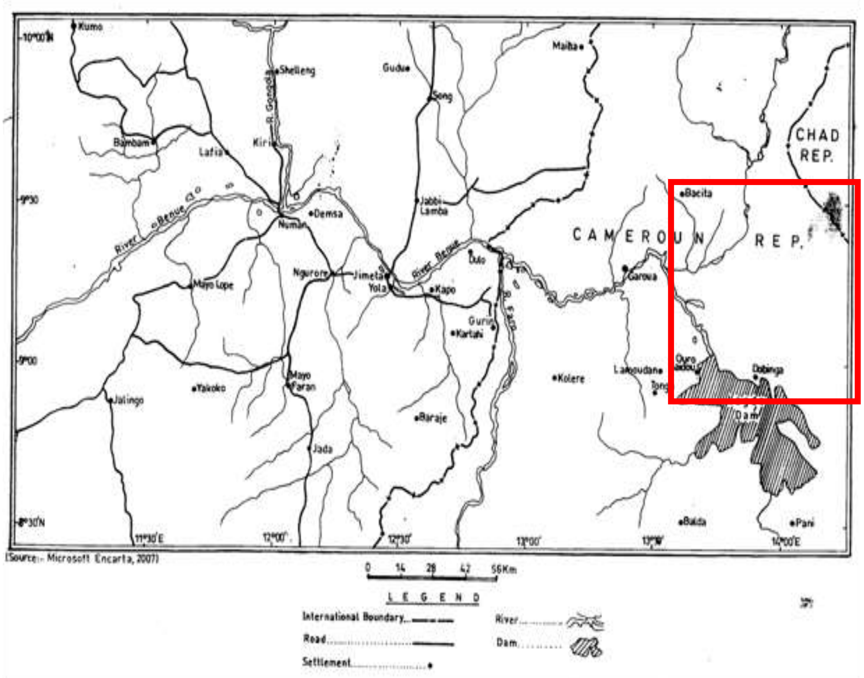

Figure 1.1: Map of Adamawa State Showing Study Areas and Sampling Points

Adefemi et a,l (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 3years (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 physicochemical 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 Gongola in Adamawa State is the focus of this research. It is meant to assess and evaluate the 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 Gongola: Bare, Dasso, Behind Kiri dam west bank, Kiri dam west bankI, and Kiri dam East bank I. behind Kiri dam East bank, kiri dam east bank II, Kiri dam west bank II, Kiri, Bobere.

(b) All the areas mentioned above are in Adamawa State, Nigeria (Figure 2.1).

As stated earlier these body of water is the main source of water for irrigation, fishing, domestic and industrial purposes in this area. 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 2.1. Water samples were collected by lowering pre-cleaned plastic bottles into the bottom of the water body, 30cm deep, and allowed to over flow before withdrawing. Twenty sampling points were used and the sampling points are approximately 100m 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 immediately, samples were stored at $4^{o}C$ 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 (1980). Detailed procedures for determination of all these parameters are given in section three (Results).

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 one gramme of the dried powdered sediment samples in a clean 100ml beaker. This was followed by the addition of 20ml concentrated HCl in small portions, 5ml of concentrated HNO_3 and 2ml of HF. The mixture was covered with watch glasses and heated to near boiling for one hour. It was filtered hot and made up to mark with distilled water in 100ml 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 Gongola water at each sampling location was shown in Table 3.1. The DO for River Gongola values ranged between 5.44±0.19 and 6.44±0.21mg/l for dry season (February to April 2006) and 6.94±0.43 and 7.81±0.75 mg/l for wet season (August to October 2006) as shown in Table 3.1.

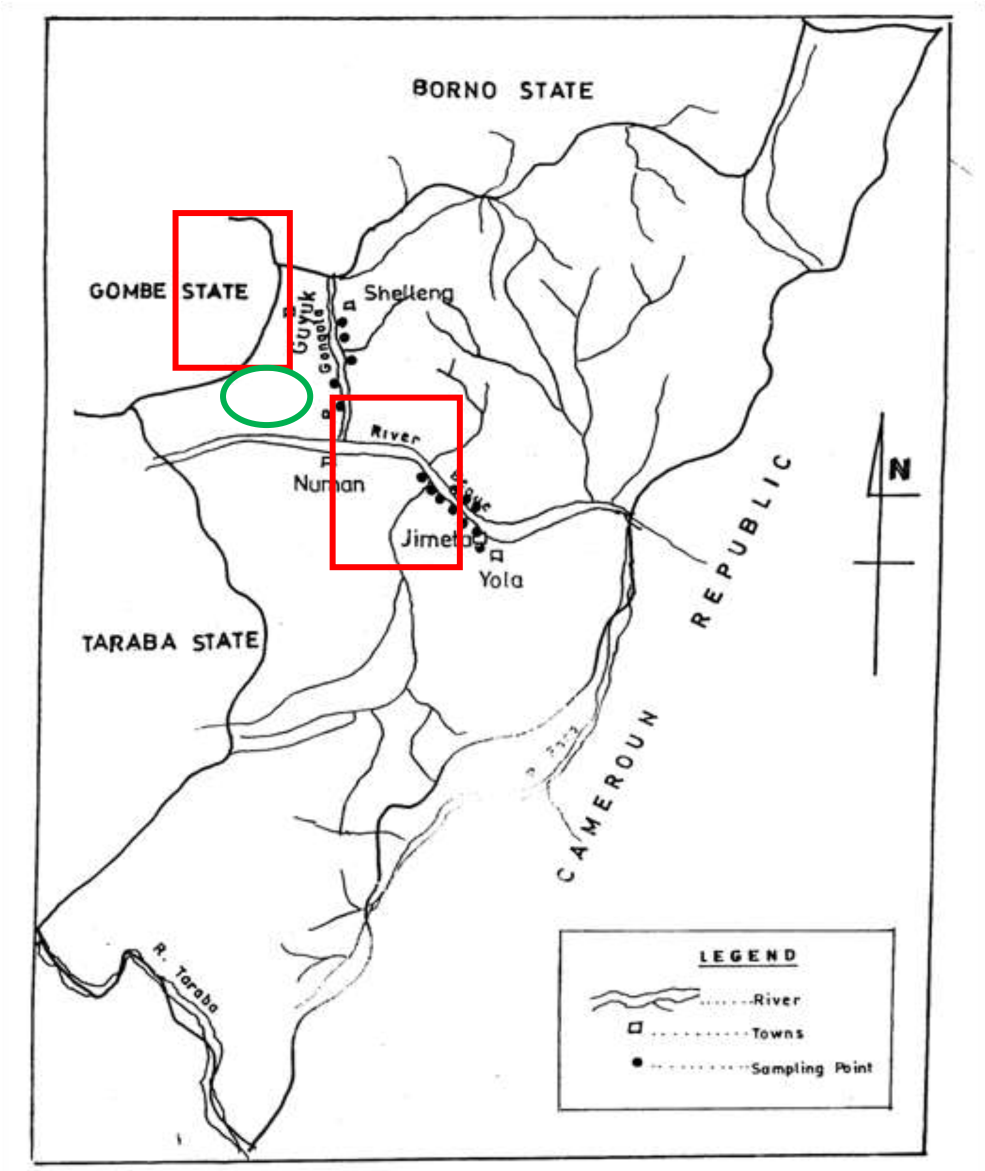

Figure 2.1: Map of Adamawa State Showing Study Areas and Sampling Points

Biochemical Oxygen Demand (BOD_5)

Figure 3.1 is the scatter gram of DO against BOD_5 for River Gongola. 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 3.1 was the mean seasonal variation of BOD_5, The BOD_5 for River Gongola ranged between 2.64±0.11 and 2.96±0.80 mg/l for dry season and 2.06±0.08 and 2.31±0.05mg/l for wet season as shown in table 3.1. Likewise Figure 3.1b is the scatter gram of DO against BOD_5 for River Gongola which showed negative correlation.

Chemical Oxygen Demand (COD)

Table 3.1 showed the mean seasonal variation of organic pollution levels for River Gongola. The COD values for River Gongola ranged between 2.43±0.48 and 4.38±0.92 mg/l for dry season and 1.57±0.52 and 3.48±0.35mg/l for wet season as shown in table 3.2b and the correlation of COD versus BOD_5 in Figure 3.2b was positive with a value of 0.515 meaning the two parameters are likely from the same source.

Total Organic Carbon (TOC)

The TOC values for River Gongola ranged between 1.39±0.68 to 1.86±0.30% for dry season and 0.33±0.15 and 1.20±0.11% for wet season as shown in table 3.1 above and the correlation of TOC against COD was also positive as in Figure 3.3.

Table 3.2b: Mean ± SD Variations of Organic pollution Indicators in River Gongola

			Organic Indicators			
Season	**Name of Source**	**Code**	**DO(mg/l)**	**BOD_5(mg/l)**	**COD(mg/l)**	**TOC(%)**
Dry	Water Bare	RGBW	5.95±0.39	2.80±1.72	3.38±0.48	1.65±0.75
	Water Dasso	RGDW	6.01±0.78	2.71±1.95	3.21±0.57	1.53±0.64
	B/Dam West Bank	RGDbwW	6.09±0.28	2.66±1.93	2.94±032	1.47±0.92
	Dam West Bank 1	RGDw1W	6.05±0.33	2.70±1.90	3.23±0.76	1.43±0.75
	Dam eAST Bank 1	RGDe1W	6.44±0.19	2.68±2.11	2.43±0.48	1.39±0.68
	Dam Bobere	RGD_BW	6.30±0.42	2.64±2.11	2.71±1.50	1.66±0.28
	Dam East Bank 2	RGDe2W	5.78±0.19	2.93±1.80	3.88±0.92	1.86±0.58
	B/Dam East Bank	RGDbeW	5.96±0.28	2.82±1.88	3.86±1.28	1.58±1.09
	Dam West Bank 2	RGDw2W	5.44±0.21	2.96±1.61	4.38±1.16	1.86±1.30
	Dam Kiri	RGD_KW	5.95±0.78	2.82±1.85	3.14±0.68	1.57±0.79
Wet	Water Bare	RGBW	7.41±0.19	2.22±0.12	2.68±0.40	0.83±0.14
	Water Dasso	RGDW	7.75±0.59	2.19±0.19	2.28±0.54	0.68±0.21
	B/Dam West Bank	RGDbwW	7.24±0.31	2.16±0.04	2.46±0.22	0.45±0.05
	Dam West Bank 1	RGDw1W	7.81±0.75	2.06±0.08	1.57±0.52	0.33±0.12
	Dam eAST Bank 1	RGDe1W	7.24±0.34	2.31±0.05	2.72±0.41	0.87±0.25
	Dam Bobere	RGD_BW	7.40±0.46	2.21±0.16	2.29±0.36	0.61±0.01
	Dam East Bank 2	RGDe2W	7.65±1.26	2.14±0.10	2.16±0.97	0.86±0.67
	B/Dam East Bank	RGDbeW	7.33±0.41	2.25±0.19	2.94±0.81	0.83±0.11
	Dam West Bank 2	RGDw2W	6.94±0.43	2.29±0.03	3.48±0.36	1.20±0.46
	Dam Kiri	RGD_KW	7.04±0.76	2.27±0.10	2.54±0.96	0.54±0.22

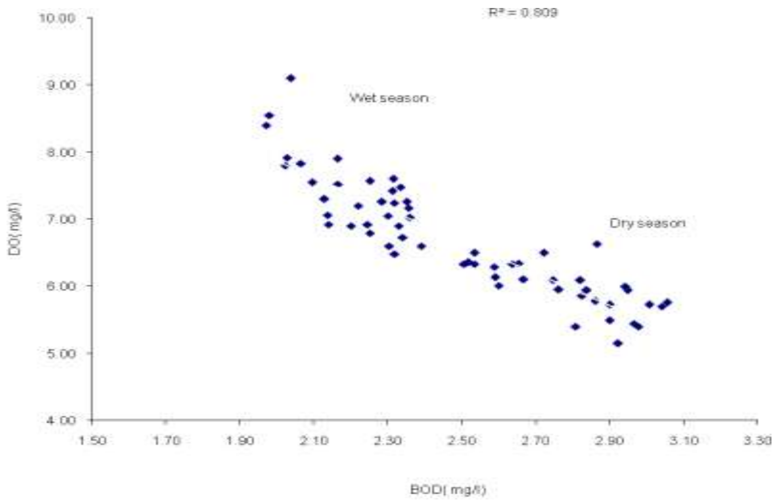

Figure 3-1b BOD_5 against DO for River Gongola

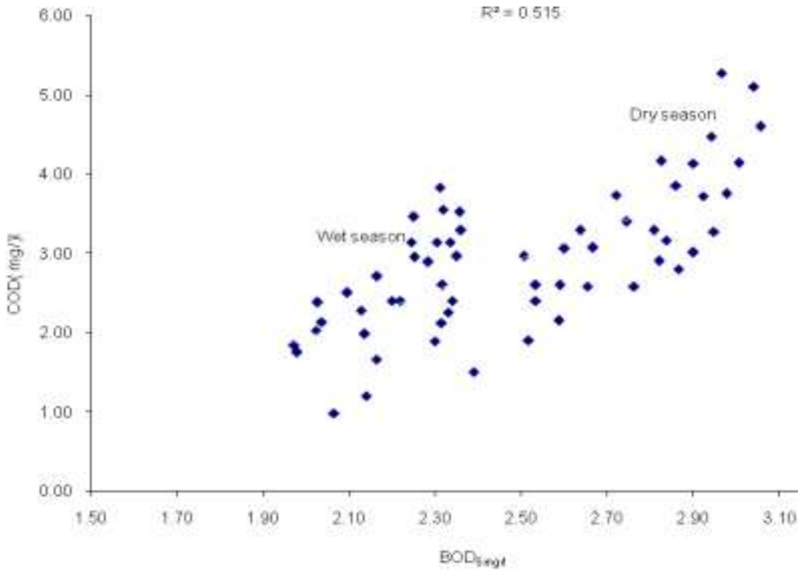

Figure 3.2b BOD_5 against COD for River Gongola

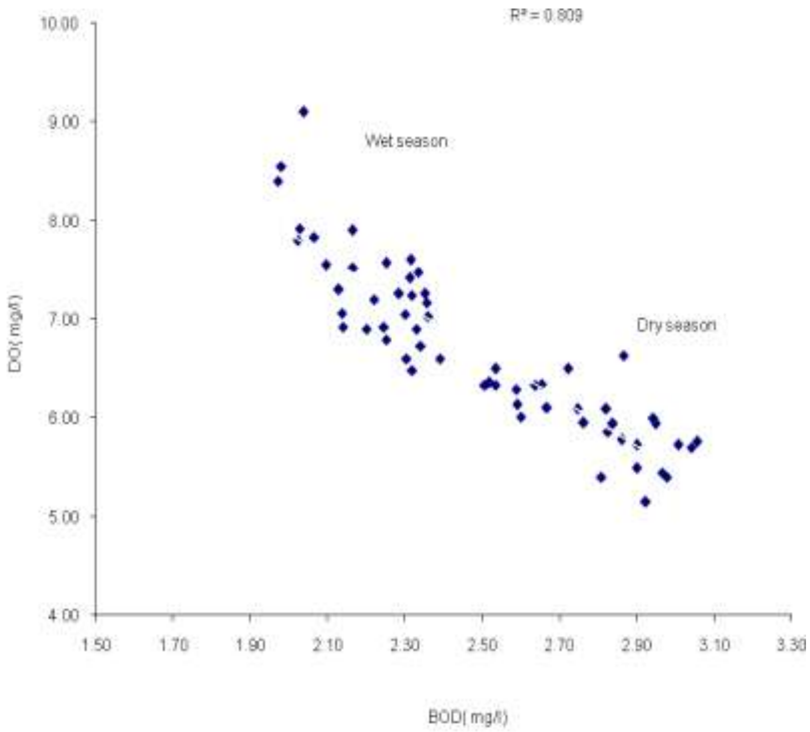

Figure 3-1b BOD_5 against DO for River Gongola

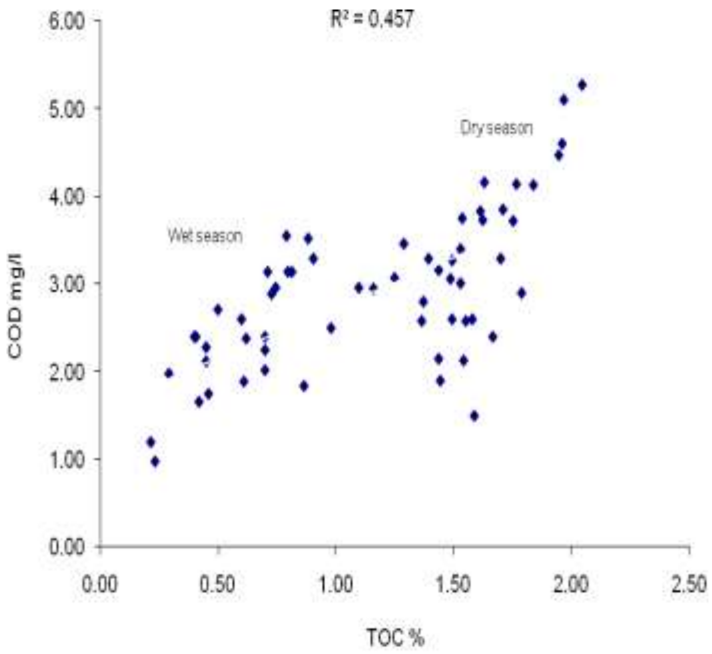

Figure 3.3b: TOC against COD for River Gongola

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 Gongola is of concern in this study. Human activities such as agriculture, urbanization and industrial development are treating the 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 Gongola. 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 Gongola were within the permissible limits of WHO (2006) and The values of the organic indicators i.e. 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 Gongola 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.

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