THE RELATIONSHIP BETWEEN SURFACE WATER TEMPERATURE AND DISSOLVED OXYGEN IN RIVER BENUE AT MAKURDI

Akaahan, T. J. A[1]., Eneji, I. S.[2] & Azua, E. T[3].
1. Environmental Science and Zoology Unit Department of Biological Sciences University of Agriculture P.M.B. 2373 Makuedi Benue State, **NIGERIA**
2. Department of Chemistry University of Agriculture, P.M.B. 2373 Makuedi Benue State, **NIGERIA**
3. Environmental Science and Zoology Unit Department of Biological Sciences University of Agriculture P.M.B. 2373 Makuedi Benue State, **NIGERIA**

ABSTRACT

Poor sanitation practice is very common in the developing nations of the world as it is observed in Nigeria and River Benue at Makurdi. Waste are indiscriminately dumped in the river without recourse to the harm of the waste on the biodiversity of the river. To access the ecological integrity of river Benue at Makurdi, water samples were collected for two years from July 2011 to June 2013. Surface water temperature and dissolved oxygen content of the water samples were determined insitu using standard measuring metres. The correlation analysis between DO and surface water temperature in River Benue at Makurdi showed that correlation was significant at the brewery location only during the course of the study. Across the study locations in River Benue during the study period indicate that the R^2 valued varied from 0.0006- 0.17 indicating a very weak relationship between surface water temperature and dissolved oxygen in River Benue. This results showed clearly the DO content of River Benue at Makurdi depend on the organic waste dumped in the river and not surface water temperature. It was recommended that indiscriminate dumping of waste in to river should be discouraged.

Keywords: Relationship, DO, Surface water temperature, River Benue.

INTRODUCTION

Meteorological events and pollution are a few of the external factors which affect physico-chemical parameters such as temperature, pH and DO, of the waterbodies (Hacioglu and Dulger, 2009). These parameters have major influence on biochemical reactions that occur within the water. Sudden changes of these parameters may be indicative of the changing conditions of the water (Hacioglu and Dulger, 2009). Internal factors on the other hand include events which occur between and within the biota population in the water body (Bezuidenhout *et al*; 2002). The water temperature is one of the most important physical characteristic of ecosystem. It affects a number of water quality parameters that are concern for domestic, environmental, industrial and agricultural applications (Parashor, *et al*., 2007). The chemical and biological reaction rates increases with increase in water temperature (Parashor, *et al*., 2007., UNEP, 2006). Several studies have revealed that the growth, feeding, reproduction and migratory behavoiur of aquatic organisms including fish and shrimps are greatly influenced by temperature of water(Suski *et al* ., 2006., Fey, 2006., Crillet and Quetin 2006).

The amount of oxygen that can be held by water depends mainly on the water temperature (Garg 2006., Agunwamba *et al*; 2006). The determination of dissolved oxygen concentration relative to its saturation value and the rate of oxygen utilization measured as its BOD become a good measure for identifying the pollution status of a water body (Longe and Omole, 2008). The knowledge of the progressive utilization of oxygen in a water body has been widely used

as a measure of the amount of decomposable or organic matter contained in it at a given time (Longe and Omole, 2008). In rivers and streams the turbulence ensures that the oxygen is uniformly distributed across the water and in every shallow streams the oxygen may be super saturated (Abowei *et al* ., 2010). Dissolved oxygen is one of the vital parameters in water quality assessment. Its presence is essential in aquatic ecosystem in bringing out various biochemical changes and its effect on metabolic activities of organisms (Parashar *et al*., 2007). This study is aimed at determining the relationship of surface water temperature and DO in river Benue as the affect each other.

MATERIALS AND METHODS

Study Area

River Benue originate from the Cameroonian mountains and flows westwards into Nigeria. It is the second largest river in Nigeria and measures approximately 310,000 Ha. It is about 1.488Km in length with alluvia fertile flood plains on either banks (Welcomme, 1986). The Benue River flows through Makurdi and confluence with River Niger at Lokoja the capital of Kogi state, Nigeria. Makurdi the capital city of Benue state is located on Latitude $7^0$41' N and Longitude 8^0 28' E. The size of the River Benue within Makurdi and major settlement runs through is approximately 671 meters (Udo, 1981). The rainfall seasons at Makurdi produces a river regime of peak flows from August to early October and low flow from December to April. The rainy season which last for seven months (April to October) has a mean annual rainfall ranging from 1200-2000mm. High temperature values averaging 28-33^{0}C are recorded in Makurdi throughout the year, most notable from March to April. Harmantan winds are accompanied with cooling effects mostly during the nights of December and January (Nyagba, 1995). All the same the periodic dust plumes associated with this time of the year may encourage surface water pollution (Nyagba, 1995). Five sampling stations were selected along the river course at Makurdi , as shown in Fig 1 as follows:

Site I(N07^0 43.663' E008^0 35.427'): it is located behind Coca cola plc plant along Gboko road and it is approximate 1.5 kilometers away from Site II.

Site II (N07^0 43.615' E008^0 35.300'): it is located directly behind Benue Brewery Plc along at Kilometer 5 along Gboko road. This site is impacted by the brewery effluents generated from the factory into the river.

Site III (N07^0 43.649' E008^0 35.302'): this site is located behind Mikap Nigeria Ltd, a rice processing factory along Gboko road. It is approximately 1 kilometer away from Site II and 2.5 kilometers away from site I. This site receive effluents from the rice mill into the river.

Site IV (N07^0 44.076' E008^0 32.840'): this site is located behind Wurukum abattoir close the new bridge across the river. Abattoir waste is washed directly into this site. Farming and sand dredging also take place at this site on routine bases.

Site V (N07^0 44.789' E008^0 30.624'): This site is located behind Wadata market along the river water course at Makurdi. Wastes from the heap refuse dumpsite behind the market are leached directly into the river.

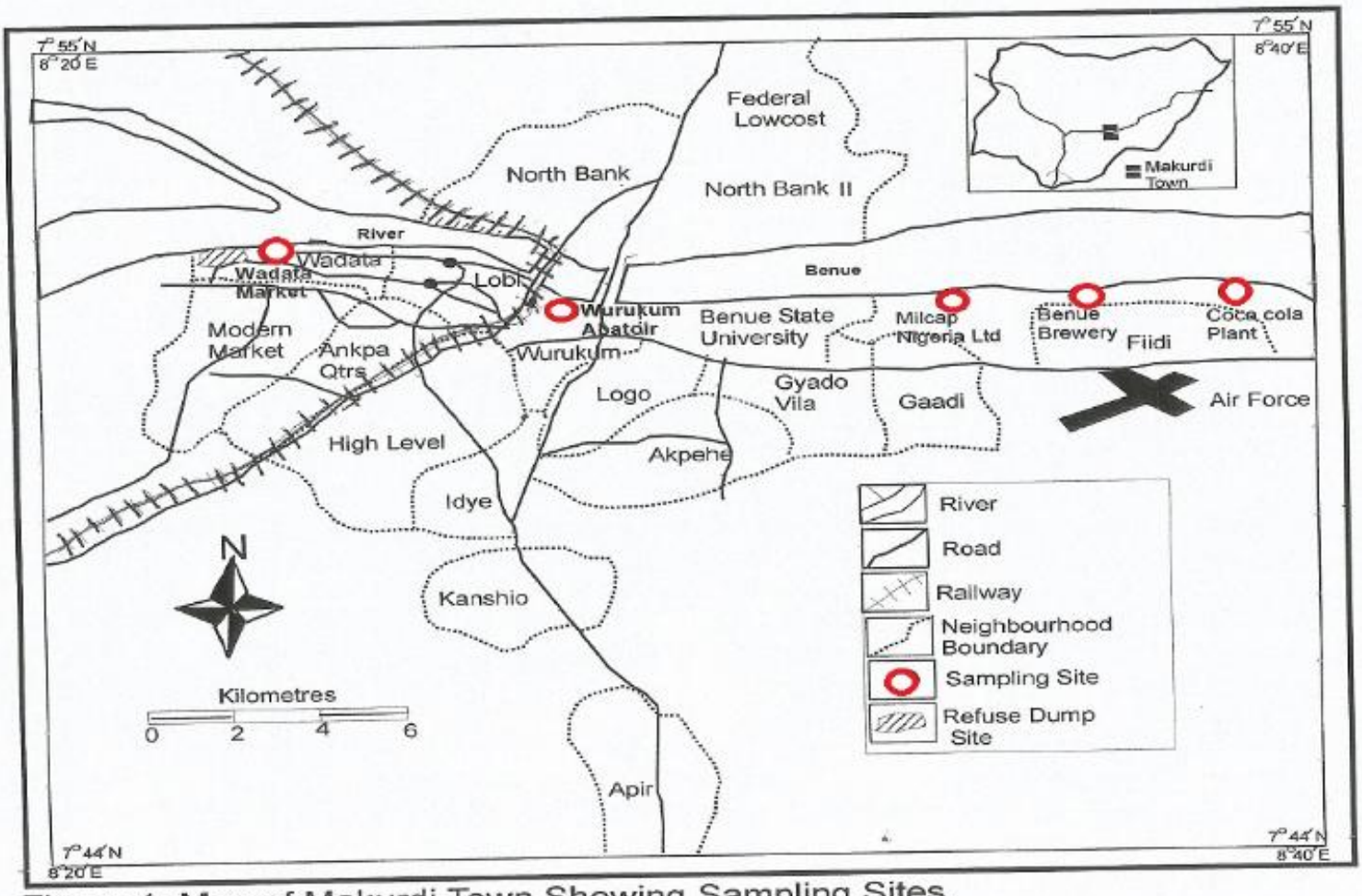

Figure 1: Map of Makurdi Town Showing Sampling Sites
Source: Ministry of Lands and Survey Makurdi

Data Collection

The average monthly precipitation data in Makurdi was obtained at the Nigerian Metrological Agency Air force Base, Makurdi, Benue State

Surface water Temperature

The surface water temperature was determined in situ on the field with the aid of a portable digital thermometer (HANNA Model). The thermometer was lowered into the water sample collected at the designated site and the value of the determined temperature was recorded. The mean value of three of such readings were calculated and recorded.

Dissolved Oxygen (DO)

The dissolved oxygen content of the test samples was determined in situ with the use of the JPB 607 model digital portable dissolved oxygen analyzer. The dissolved oxygen analyzer was calibrated with a buffer solution before the measurement of the samples. The electrode of the analyzer was lowered into the sampling bottle containing the sample to be measured. The DO content of the water samples were determined when the reading was stabilizered and

recorded immediately. The mean of three different readings were calculated recorded as DO of the test samples.

Data Analysis

Mean, standard deviation and correlation analysis were determined using SPSS version 22. The regression graph were plot with Microsoft ware version 13.

RESULTS

The data presented in Table 1 is the correlation analysis between DO and surface water temperature in River Benue at Makurdi. A perusal at the result showed that correlation was significant at the brewery location only during the course of the study. The result presented in Figure 2 is the average monthly maximum and minimum atmospheric temperature obtained at the Nigerian Metrological Agency Air Force Base Makurdi, Benue State. The result obtained indicates that the maximum temperature of 38.2^0C was recorded during the month of March 2012, which stands out throughout the period of the study (July 2011 - June 2013). Never the less, the minimum temperature of 14.5^0C was recorded during the month of December, 2011 throughout the period of the study. The average monthly precipitation data in Makurdi was obtained at the Nigerian Metrological Agency Air force Base, Makurdi, Benue State (Figure 3). The month of July 2012 was recorded with the highest average monthly rainfall of 351.90 mm and July 2011 with the lowest average monthly rainfall of 87.00 mm during the wet months. The dry months February 2012 and March 2013 were recorded with average monthly rainfall of 0.5 mm and 44.20 mm, respectively. All the same the dry months (November 2011, December 2011, January 2012, March 2012, December 2012, January 2013 and February 2013) did not record any rainfall throughout the study period.

The result presented in Figures:4-8 is the regression graph showing the relationship between surface water temperature and dissolved oxygen obtained at Coco cola, Brewery, Mikap Nigeria Ltd, Wurukum Abattoir and Wadata market of River Benue respectively during the 24 months study period. Across the study locations the R^2 valued varied from 0.0006- 0.17 indicating a very weak relationship between surface water temperature and dissolved oxygen in River Benue during the course of the study.

Table1: Correlational analysis between Dissolved oxygen and Surface water temperature in River Benue at Makurdi

Location	**P≤0.05**	**P≤0.01**	**Mean±SD DO(mg/L)**	**Mean±SD Temperature(^{0}C)**	**Sample Size(N)**
Coca-Cola	0.14	0.52	4.47±2.2	28.1±2.0	24
Brewery	0.41*	0.04	3.28±2.3	28.7±1.9	24
Mikap Nigeria Ltd	−0.02	0.91	3.09±1.7	29.01±1.8	24
Wurukum Abattoir	0.17	0.42	4.37±2.4	29.0±2.1	24
Wadata market	0.12	0.56	4.42±2.6	29.0±2.1	24

*Correlation is significant at 0.05 level (2-tailed)

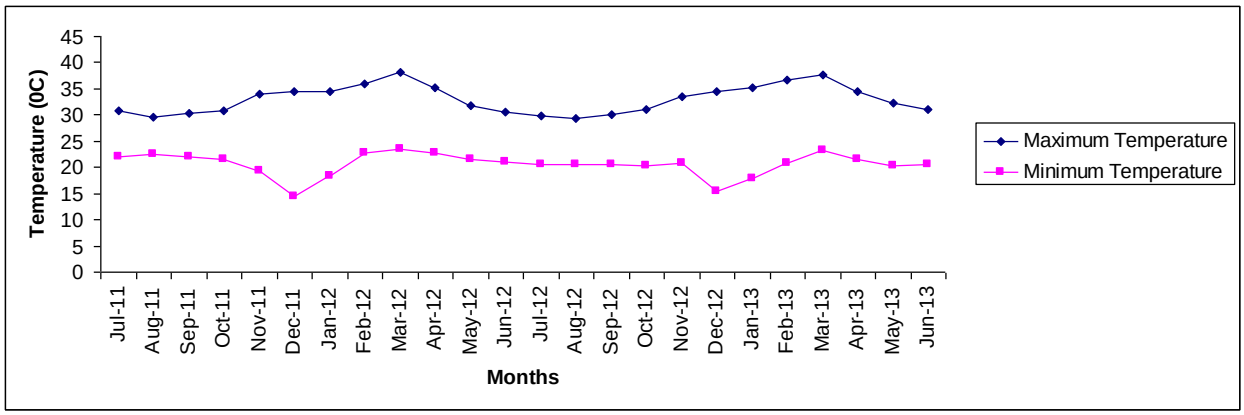

Fig 2: Monthly mean Atmospheric Temperature in Makurdi during the Study Period.

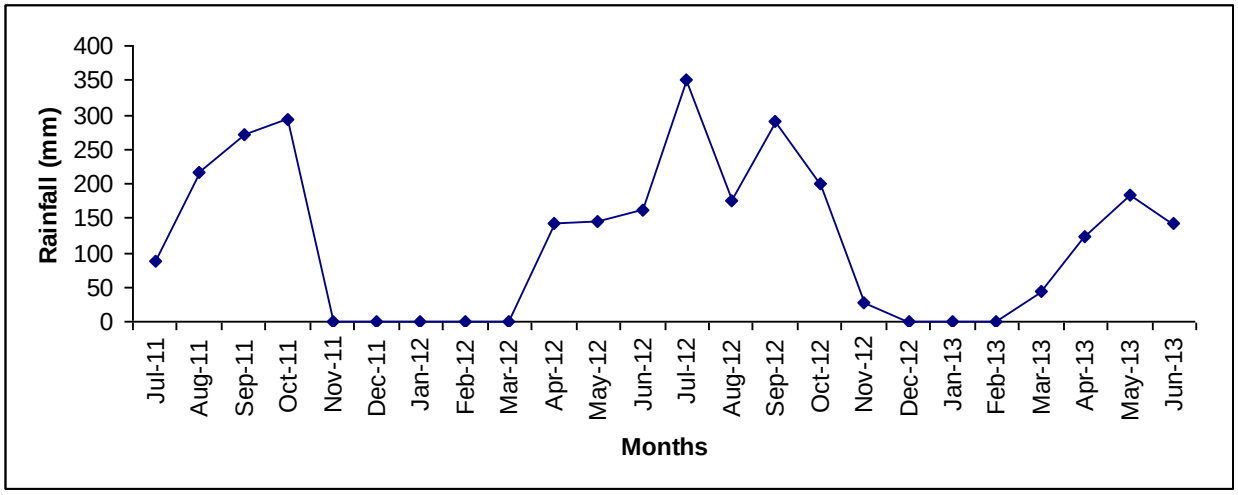

Fig 3: Monthly mean Rainfall in Makurdi during the Study Period

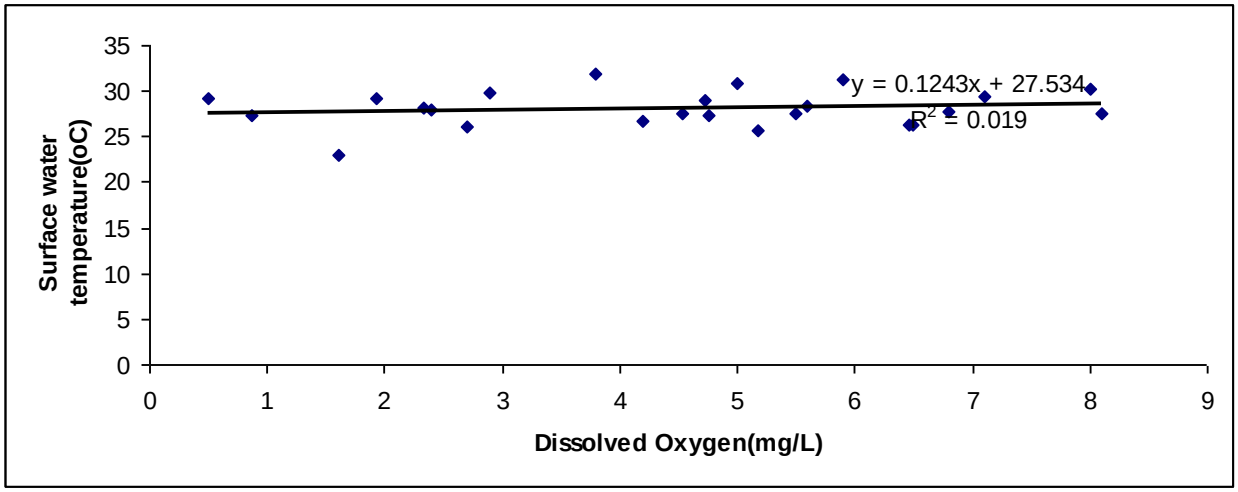

Fig 4: Relationship between surface water temperatures and dissolved Oxygen at Coca-cola Location of River Benue at Makurdi.

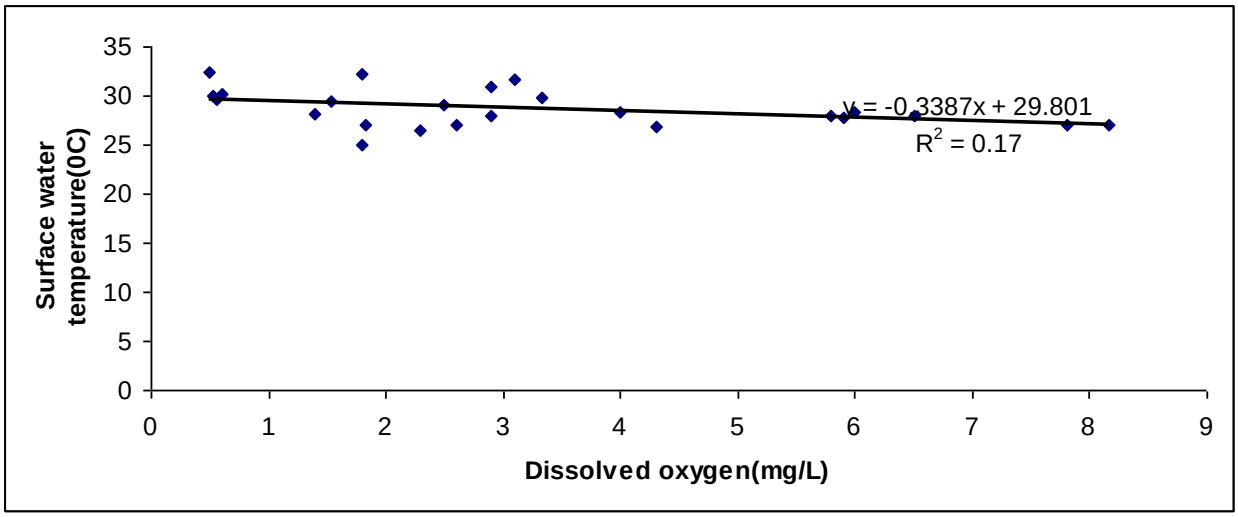

Fig 5: Relationship between surface water temperatures and dissolved Oxygen at Brewery Location of River Benue at Makurdi.

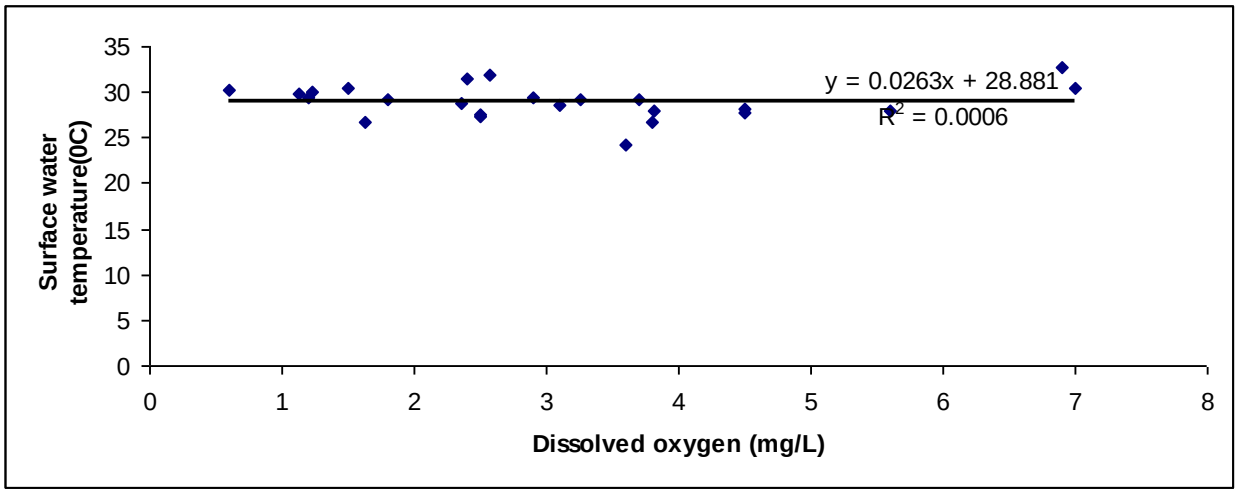

Fig 6: Relationship between surface water temperatures and dissolved Oxygen at Mikap Nigeria Ltd Location of River Benue at Makurdi.

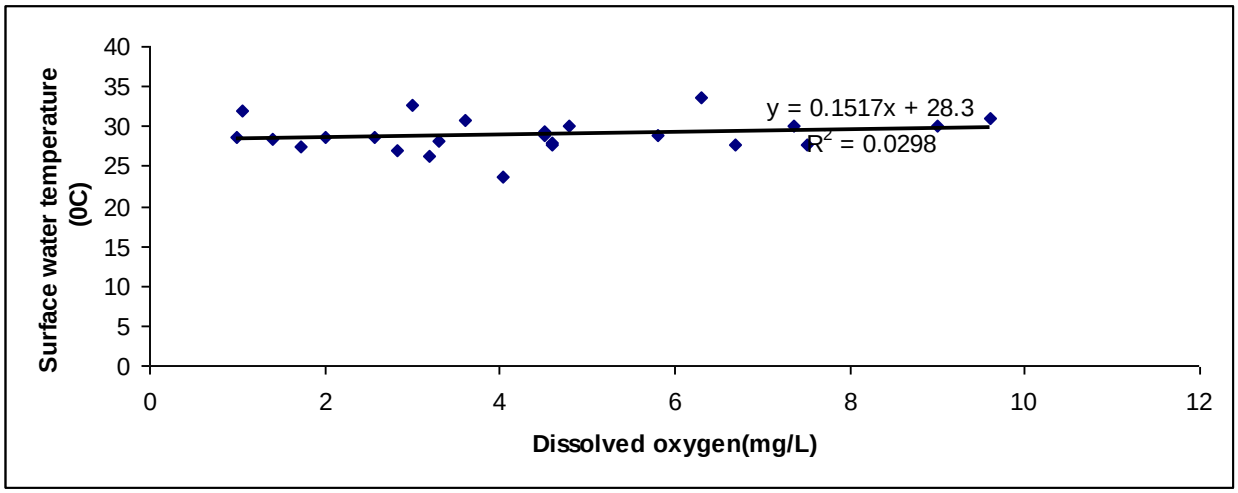

Fig 7: Relationship between surface water temperatures and dissolved Oxygen at Wurukum abattoir Location of River Benue at Makurdi.

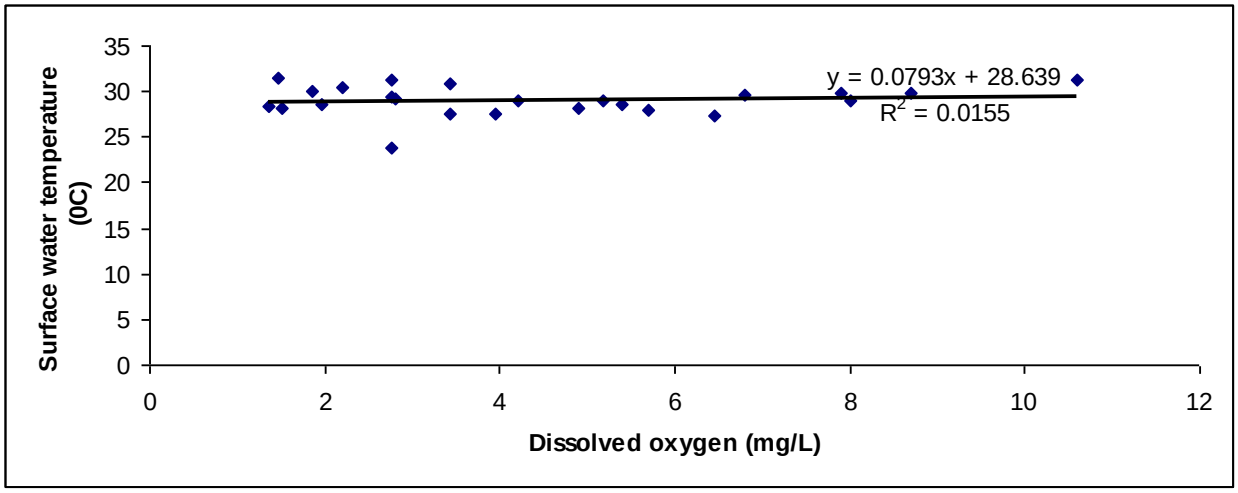

Fig 8: Relationship between surface water temperatures and dissolved Oxygen at Wadata market Location of River Benue at Makurdi.

DISCUSSION

There were slight variation in surface water temperature at all the locations during the study period. This may be due to the atmospheric temperature in Makurdi. The surface water temperature reported in an earlier study in River Benue disagrees with the finding of this present study in River Benue (Eneji, *et al*., 2012). The dissolved oxygen is inversely proportional to temperature and the maximum oxygen that can be dissolved in water at most ambient temperature is about 10.00mg/L (Hacioglu and Dulger, 2009). In the present investigation the mean DO value of 3.93 ± 0.21 mg/L was obtained. This result is similar to one of an earlier study in River Benue that reported much lower mean value of DO (1.80 ± 0.06 mg/L) during the course of the study (Eneji, *et al*., 2012). Maitera *et al*.(2010) reported higher values of DO in the range of 5.27 ± 0.24 to 6.41 ± 0.21 in River Benue at Adamawa State, Nigeria. Similarly Wazir and Ogugbuaja (2010) reported DO that varied from 5.87 ± 0.43 to 7.38 ± 0.43 in River Yobe, Nigeria. These findings differs significantly with the result of this present investigation study. This may due to the different location and the human activities in the rivers. However Ziauddin *et al*. (2013) reported DO that ranged from 7.21±0.19- 8.41±0.1mg/L in west Bengal flood plain that also varies with the findings of this study. The low DO obtained in this study may be due to presence of oxygen consuming waste disposed in the river through the land based activities of man as was observed during the course of the research. Similarly, Agboola and Denloye (2011) reported DO in the range of 2.03 - 2.44 mg/L in Abesan River in Lagos, Nigeria. Okayi *et al.* (2011) reported DO in River Benue in the range of 3.6 - 4.9mg/L. Indabawa (2010) reported a mean DO value of 15.44 mg/L in the Challawa River in Kano. Abowei (2010) reported DO in the range of 3.2 ± 0.1 to 7.3 ± 0.16 mg/L in Nkoro, River Niger Delta Nigeria. These results differs greatly with the result of the current study. The spatial variation of DO in River Benue during the present study was lowest at Mikap Nigeria Ltd location throughout the study period .The lowest value of DO obtained at this may be due to the impact of waste that is discharge into the River. During the course of this present study surface water temperature show very weak relationship with dissolved oxygen. This indicate clearly the status of dissolved oxygen in river Benue at the studied location is due the level of organic waste in River Benue and not the surface water temperature. Similarly surface water temperature was only significantly correlated with DO only at Brewery location. This maybe at this station surface water temperature was affected the concentration of DO and not at any station during the study

period. This study showed that in River Benue at Makurdi, DO was independent of the surface water temperature but the organic waste in the River. This waste may depreciate the dissolved oxygen from the activities of microorganisms on the brake down of the wastes.

CONCLUSION

In this present study the low level of dissolved oxygen was due to the organic waste dumped into the river without control and not the surface water temperature. This is because the surface water temperature showed very weak relationship and association with dissolved oxygen.

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