SEASONAL VARIATIONS IN PHYSICO-CHEMICAL PARAMETERS OF RIVER GURARA AROUND THE FALL AND IZOM SETTLEMENT, NIGER STATE, NIGERIA

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ABSTRACT

Water samples were collected from River gurara once monthly for a period of twelve months (June 2004-May 2005). Physico-chemical parameters were carried out on the water samples. The parameters determined were statistically analyzed to reveal the presence or absence of any relationship among this parameters. The parameters monitored showed marked variations between different samples, stations, seasons and sub seasons. The mean value of temperature was (29.09°C), Biological oxygen demand (0.58mg/l), pH (6.72), Chemical oxygen demand (1.96mg/l), total suspended particles (0.01cm^3), Alkalinity (1.22mg/l) show no significant (p<0.05) variations between the stations, seasons and sub seasons. However significant difference (p>0.05) were observed in dissolved oxygen, electrical conductivity (19.04ohms/cm) and hardness (0.60mg/l) as regard to the mean value of the stations. The electrical conductivity range (4.4-80.98µohms/cm) and total hardness range (0.8-0.82mg/l) fall below recommended value. Low Dissolved oxygen and high BOD, COD and low hardness recorded in stations 3, 4, and 5 where human activities are highly concentrated indicated that Izom environ populace have some impact on the quality of river Gurara. Water temperature, Dissolved Oxygen, Biological Oxygen demand, Chemical Oxygen demand, Total dissolved solids and Alkalinity show significant difference (P>0.05) between wet and dry season means while air temperature, pH, conductivity and hardness showed no significant difference (P<0.05) between wet and dry season.

INTRODUCTION

The study of limnology is becoming more established in Nigeria due to the increasing awareness of the usefulness of water resources as a free gift of nature to man and aquatic lives. The great drive toward water resources for fisheries, irrigation, animal rearing, recreation, domestic and industrial water supply, tourism attraction and public health hazard and conservation of fresh water ecosystem prompt the need for scientific information on the inland water bodies. This involves assessing the physico-chemical parameters of water to determines it potentials productivity for future uses, and hazards to aquatic and human lives. The quantity and quality are important, it is quality that determines and support it biological composition (Kolo and Oladimeji, 2003)).

In Nigeria, limnological studies began in twentieth century with the works of Pioneers like Onabamiro (1952). Holden and Green in 1960) who work on some Nigeria rivers. The biodiversity, usefulness (portability) and characteristics of a river depend on its physico-chemical prospective which inturn gives clear reasons why some water bodies are much more productive than others (Adebisi, 1981, Stirling and Philips, 1990). These physico-chemical parameters which have effect on the fish's behavior are those which characterized it habitat, which provide optimal conditions for eating and for reproduction (Jean Luc, 1997). This field of aquatic resource management provides information to develop new management strategies for the preservation of biodiversity in tropical aquatic ecosystem (Donald, 1995).

STUDY AREA

River Gurara is located in South-Eastern part of Niger state, Longitude 9".30N and Latitude 7".00E under Gurara local government area in Suleja emirate. River Gurara is one of the tributaries of river Niger, which form confluence at Abugi, in Kogi state. The premier Gurara water falls, discovered in 1928, has international tourism potential status. The river took it sources from North-central of Nigeria high land with catchments around Jere (Southern Kaduna), it flows down South-ward, it flows within its course around the study area, characterized by U-shaped valley, being in it middle course, the bed are underlayed with rough-rocky boulders and pebbles, this makes the flowing river swift, having high velocity and produce audible drumming sound especially during the rainy season.

The Gurara water fall attracts visitor's from international, national and local communities especially during national festivals, i.e. Christmas, Sallah, New Year, public holidays, and students on excursion. The objective of the study is to monitor the physico-chemical parameter of the river Gurara around the water fall area and Izom environs and also assess the seasonal and sub-seasonal variations in the water quality parameter within the study area.

MATERIALS AND METHOD

River Gurara was used for studies with 5 sampling stations between Gurara water falls and Izom settlement. Station (1) was located up stream of Gurara water falls around Bonu village, station (2) at the foot of the water falls, 3.5km down stream of station 1, station (3) is at the confluences of rivers Gurara and Tata, about 10km away from water fall Station (4) was located at Izom township bridge about 3km from station (3). Station (5) is at the outskirt of Izom settlement about 3km away from station (4). The sampling of surface water was carried out once every month from June 2004 - May 2005 (12 months). The samples were immediately transported with ice block to the laboratory of Water resources, Aquaculture and Fisheries Federal University of Technology Minna for water quality parameters analysis.

The air and water temperature were measured at each station using the centigrade mercury in glass bulb thermometer (0-110°c). Dissolved oxygen and BOD of the water were determined by Winklers Azide's method.

The pH of water samples were determine using Kent Eil 7045/46 pH meter in the laboratory room temperature. The conductivity was determined by using model W.PA CMD 400 conductivity meter. The readings were expressed in µhoms/cm. Total suspended particles were determined by evaporation of water samples while hardness and alkalinity were determined following the procedure as described by APHA (1992), (Lind, 1979).

RESULTS

Water temperature, Dissolved oxygen, Biological oxygen demand, Chemical oxygen demand, Total suspended solids and alkalinity shows significant difference (P>0.05) between wet and dry season means while air temperature, pH, conductivity and hardness showed no significant difference (P<0.05) between wet and dry season (Table 1). Figures 1 and 2 shows the monthly variation in air and water temperature at different stations. Analysis of variance for air temperature shows no significant difference between seasons and stations (p<0.05) (Tables: 2and 3) while seasonal variations in stations show higher mean value in dry season than the wet seasons (figure: 16)

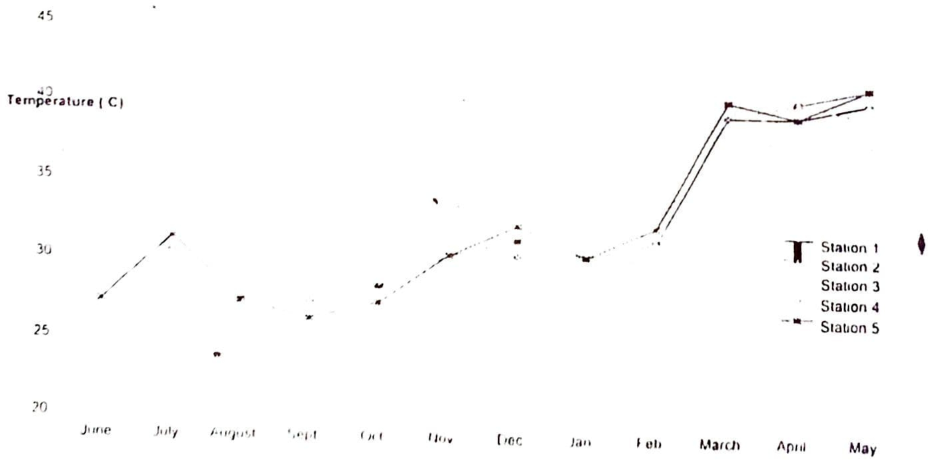

Figure 1: Mean Monthly Air Temperature Variation at Different Stations along River Gurara

Table 1: Result of t-tests for comparison Between Wet and Dry Seasons for physico-chemical parameters of River Gurara

95% Confidence interval of the Difference	Lower	Upper	t	df	Sig. (2-tailed)
Air Temperature (°C)	-5.049	-2.071	-4.936	24.000	0.000
Water Temperature (°C)	-2.761	0.601	-1.326	24.000	0.197
Dissolved Oxygen (mg/l)	-0.428	0.168	-0.900	24.000	0.377
Biochemical Oxygen Demand (mg/l)	-0.129	0.214	0.515	24.000	0.283
Chemical Oxygen Demand (mg/l)	0.535	1.754	1.098	24.000	0.283
pH	-0.593	-0.231	-4.701	24.000	0.000
Electrical Conductivity (µmhos/cm)	-44.999	-19.674	-5.271	24.000	0.000

Total Suspended Particles (g/ml)	-0.011	0.006	-0.575	24.000	0.571
Hardness (mg/l)	0.078	0.377	3.139	24.000	0.004
Alkalinity (mg/l)	-0.157	1.155	1.570	24.000	0.129

(P> 0.05) show significant difference.

Table:2 The mean values of the parameters measured at different sub-seasons of River Gurara. (June 2004- May 2005)

Parameters	Sub-season 1	Sub-season 2	Sub-season 3	Sub-season 4
Air Temp.	28.56 ± 0.51^{a}	28.20 ± 0.42^{a}	29.87 ± 1.08^{a}	39.80 ± 0.17^{b}
Water Temp.	26.30 ± 0.17^{ab}	28.13 ± 0.88^{b}	24.27 ± 0.42^{a}	35.60 ± 0.23^{c}
DO	0.66 ± 0.09^{a}	0.40 ± 0.08^{a}	0.86 ± 0.18^{a}	0.59 ± 0.16^{a}
BOD.	0.36 ± 0.04^{a}	0.17 ± 0.06^{a}	0.52 ± 0.09^{a}	0.56 ± 0.14^{a}
COD	3.96 ± 1.56^{b}	0.91 ± 0.19^{a}	2.28 ± 0.25^{ab}	0.60 ± 0.41^{a}
pH	6.46 ± 0.05^{a}	6.86 ± 0.10b	7.02 ± 0.11^{b}	7.03 ± 0.02^{b}
EC.	4.93 ± 0.24^{a}	10.34 ± 0.10^{ab}	36.79 ± 8.52^{bc}	57.49 ± 7.96^{c}
T.S.P.	0.01 ± 0.00^{a}	0.02 ± 0.00^{a}	0.02 ± 0.00^{a}	0.02 ± 0.00^{a}
Hardness	0.53 ± 0.06^{a}	0.57 ± 0.80^{a}	0.29 ± 0.05^{a}	0.55 ± 0.11^{a}
Alkal.	0.59 ± 0.05^{a}	1.87 ± 0.53^{a}	0.89 ± 0.16^{a}	0.8 ± 0.07^{a}

The mean values with the superscript on the same row are not significantly different from each other at P< 0.05.

<u>**Sub season**</u> 1. warm rainy season 2. cold Rainy season 3. dry cold season 4. hot dry season

Table 3: The mean value of the parameters measured at different station of river Gurara and their standard errors.

Parameters	Station 1	Station 2	Station 3	Station 4	Station 5
Air Temp.	30.54 ± 2.15^{a}	32.27 ± 1.62^{a}	32.25 ± 1.62^{a}	31.50 ± 1.46^{a}	31.83 ± 1.54^{a}
Water Temp.	28.45 ± 1.39^{a}	29.00 ± 1.55^{a}	28.50 ± 1.35^{a}	28.67 ± 1.43^{a}	28.67 ± 1.53^{a}
DO.	0.71 ± 0.16^{a}	0.53 ± 0.19^{a}	0.79 ± 0.13^{a}	0.52 ± 0.18^{a}	0.58a ± 0.15^{a}
BOD.	0.48 ± 0.07^{a}	0.72 ± 0.12^{a}	0.57 ± 0.13^{a}	0.52 ± 0.11^{a}	0.44 ± 0.10^{a}
COD.	1.61 ± 0.45^{a}	1.76 ± 0.49^{a}	2.00 ± 0.55^{a}	1.92 ± 0.50^{a}	1.94 ± 0.54^{a}
pH	6.82 ± 0.07^{a}	6.91 ± 0.08^{a}	6.91 ± 0.11^{a}	6.88 ± 0.11^{a}	6.81 ± 0.17^{a}
EC	26.46 ± 8.53^{a}	27.17 ± 8.35^{a}	29.46 ± 9.77^{a}	28.11 ± 9.99^{a}	29.37 ± 9.90^{a}
TSP	0.02 ± 0.01^{a}	0.02 ± 0.00^{a}	0.02 ± 0.00^{a}	0.02 ± 0.00^{a}	0.02 ± 0.00^{a}
Hardness	0.50 ± 0.07^{a}	0.39 ± 0.06^{a}	0.54 ± 0.09^{a}	0.45 ± 0.10^{a}	0.54 ± 0.12^{a}
Alkal.	1:26 ± 0.14^{a}	0.93 ± 0.20^{a}	1.10 ± 0.32^{a}	1.18 ± 0.49^{a}	0.90 ± 0.29^{a}

The mean values with the same superscript on the same row are not different from each other at P< 0.05.

Table 1 The correlation matrix values for the physico-chemical parameters measured at different stations of River Gurara

	Air Temp.	Water Temp	DO.	BOD	COD.	pH	EC	T.S.P	Hard	Alk
Air Temp.										
Water Temp.	0.76*									
DO.	0.05	-0.17								
BOD.	0.05	0.10	0.11							
COD.	-0.15	-0.30	0.16	-0.14						
pH	0.39*	0.27*	0.19	0.10	-0.30					
EC.	0.16*	0.36*	0.49*	-0.03	-0.03	-0.52*				
T.S.P.	0.10	0.28*	-0.25	0.03	-0.32*	0.25	-0.20			
Hardness	0.04	0.13	1.14	0.53	-0.14	-0.20	-0.04	-0.25		
Alk.	-0.18	-0.22	0.005	0.16	-0.15	-0.33*	-0.03	-0.25	1.00	

* Shows significant at (P>0 05)

Dissolved oxygen showed marked difference in February in all stations (Fig 3). Seasonal variation shows higher value in dry season than wet season in all the stations except in station 5 with higher wet season value (fig 16).

Analysis of variance of mean values of stations and sub-season do not differ significantly (p<0.05) (Table: 2 & 3)

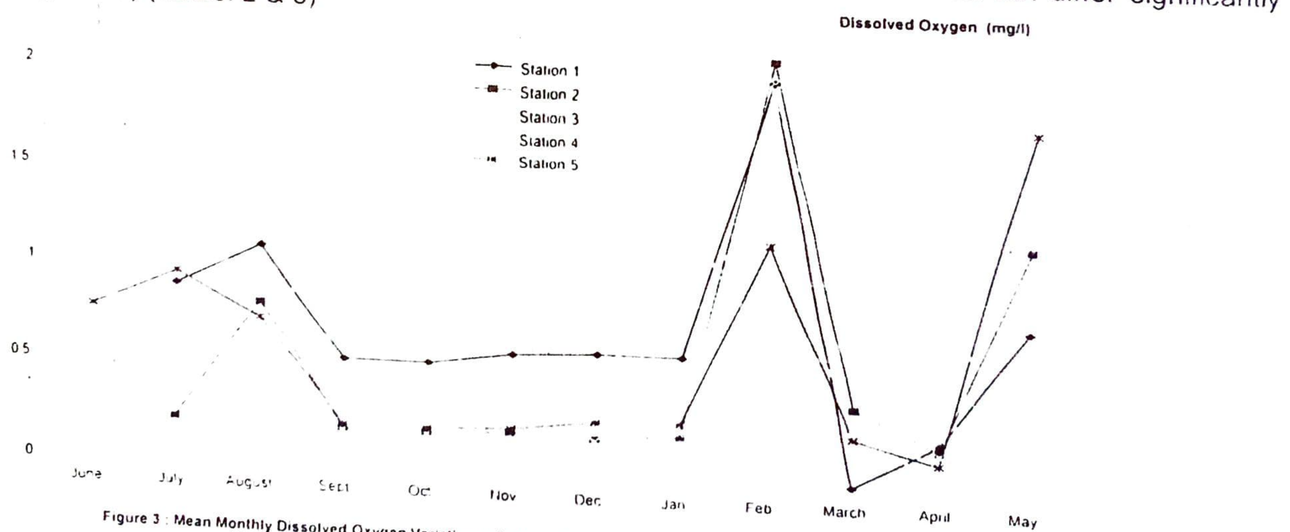

Figure 3 : Mean Monthly Dissolved Oxygen Variation at Different Stations along River Gurara

Mean monthly variations of BOD is shown in Fig 4. Biochemical oxygen demand show fluctuating ranges in mean value within sub-seasons. Low value was recorded in warm rainy sub-season (June-August). Wet season mean value was higher than dry season in all the stations. Analysis of variance show no significant difference in all the stations and sub-seasons (p< 0.05) (Tables 2 and 3) Wet season show slight higher mean value than dry seasons (Fig 6).

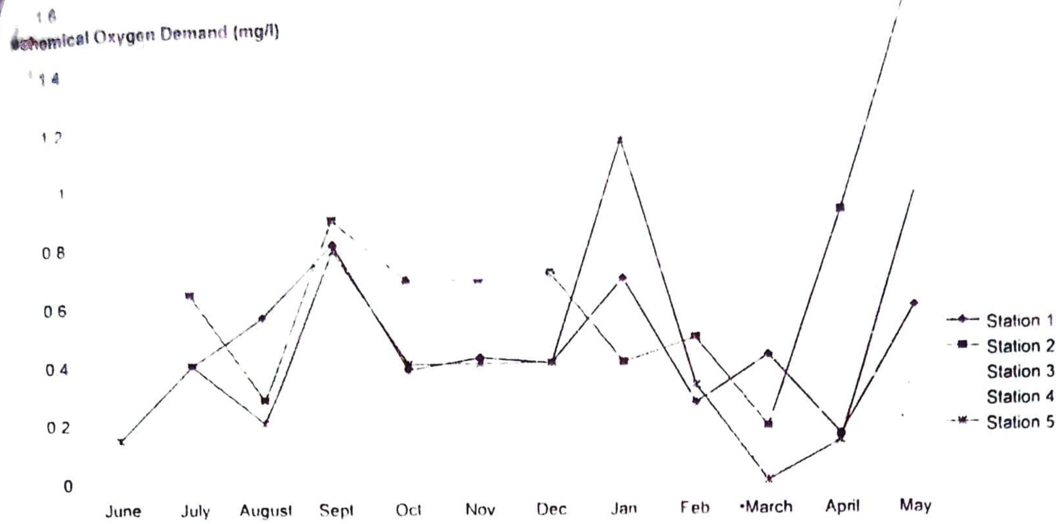

Figure 4 : Mean Monthly Biochemical Oxygen Demands Variation at Different Stations along River Gurara

Highest chemical oxygen demand mean value was recorded in warm rainy sub-season (June-August) followed by a very sharp decrease, which rises in cold rainy sub-season (September-November) it increases further in cold dry season (December-February) and decreases down in hot dry season (March-May) (fig: 5). Analysis of variance showed no significant difference in all the stations ($p<0.05$) while significant difference was recorded in stations 3 and 4 with sub-seasons respectively ($p>0.05$) (Tables 2 and 3). There was slight higher wet season mean value than dry season (fig. 6).

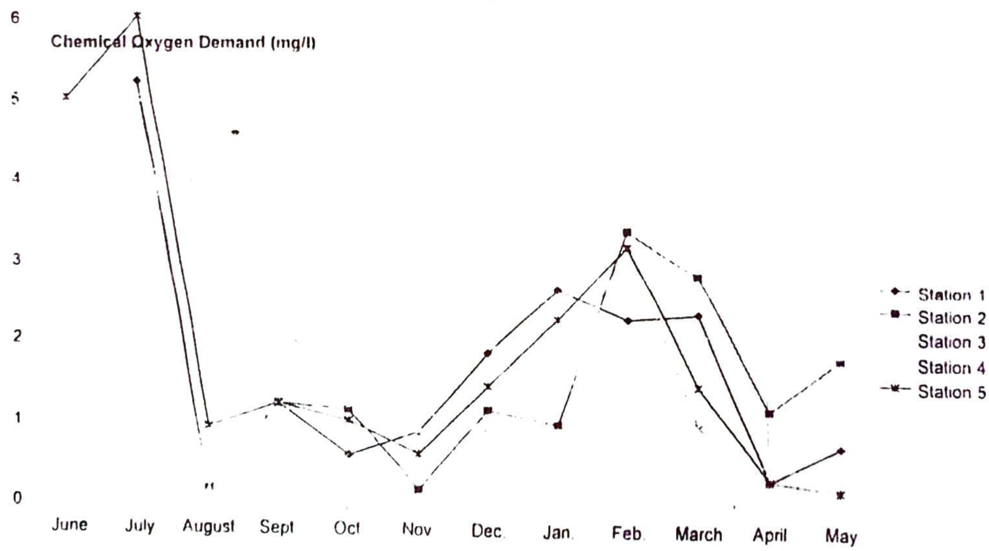

Figure 5 : Mean Monthly Chemical Oxygen Demands Variation at Different Stations along River Gurara

P^{H} range was between 6.4 – 7.3 (figure: 6). Seasonal variations shows higher mean value in dry season than wet seasons (figure 17). Analysis of variance show no significant difference between the stations ($p<0.05$) but significant difference was recorded in the sub-season, 2, 3 and 4 (cold rainy, cold dry and hot dry sub-season)
respectively ($p>0.05$) (Tables2 and 3).

Electrical conductivity had his highest mean value recorded in cold dry season (February-March) and early hot dry sub-season (March) followed by very sharp drop in April and high increased in late hot dry season (May) and relatively uniform low mean between (June-November) (Fig 7) Analysis of variance show no significant difference between the stations ($p<0.05$) but show a significant difference in the sub-seasons except (1)(Tables 2 and 3)

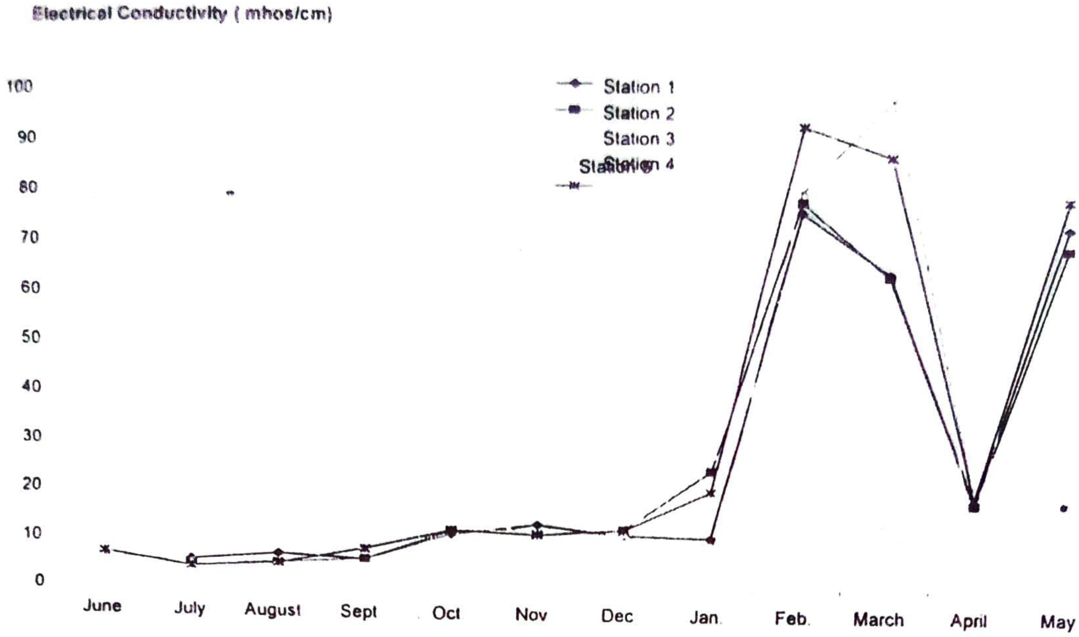

Figure 7 : Mean Monthly Electrical Conductivity Variation at Different Stations along River Gurara

Total suspended mean value was low generally with two peak value recorded in (October) and (April) (figure 8). Analysis of variance do not show significant difference from stations and sub-seasons ($p<0.05$) (Tables 2 and 3). Seasonal variation between wet season and dry season was very low and do not differs. (Figure: 6).

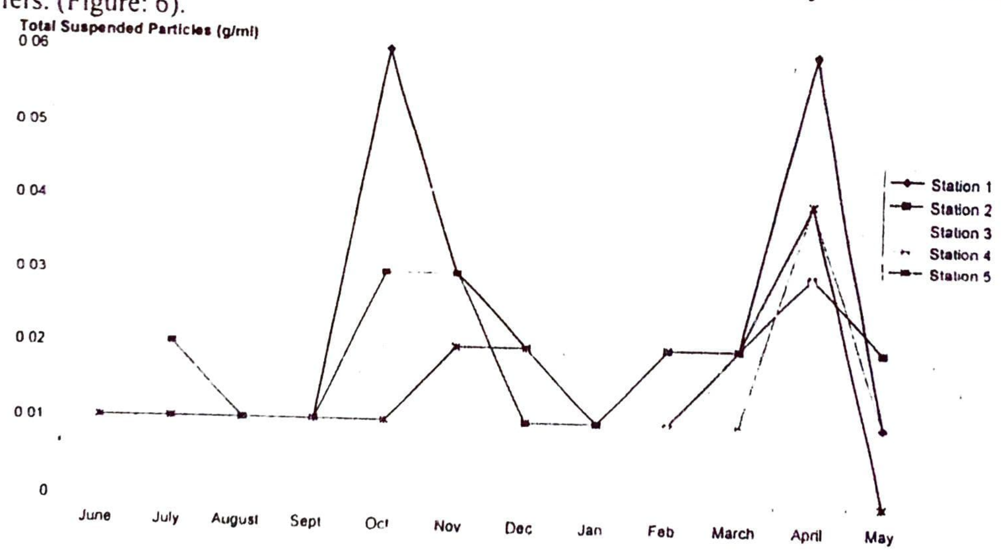

Fig. 8: Mean Monthly Total Suspended Particles Variation at Different Stations along River Gurara

Hardness mean value increases from warm rainy sub-season (June-August) which fluctuate and decreases sharply in hot dry sub-season (March-May) (figure 9). Analysis of variance do not differ significantly from each other in all the stations and sub-stations.($p<0.05$) (Tables 2 and 3). Higher mean value was recorded in wet season than dry season (figure 6).

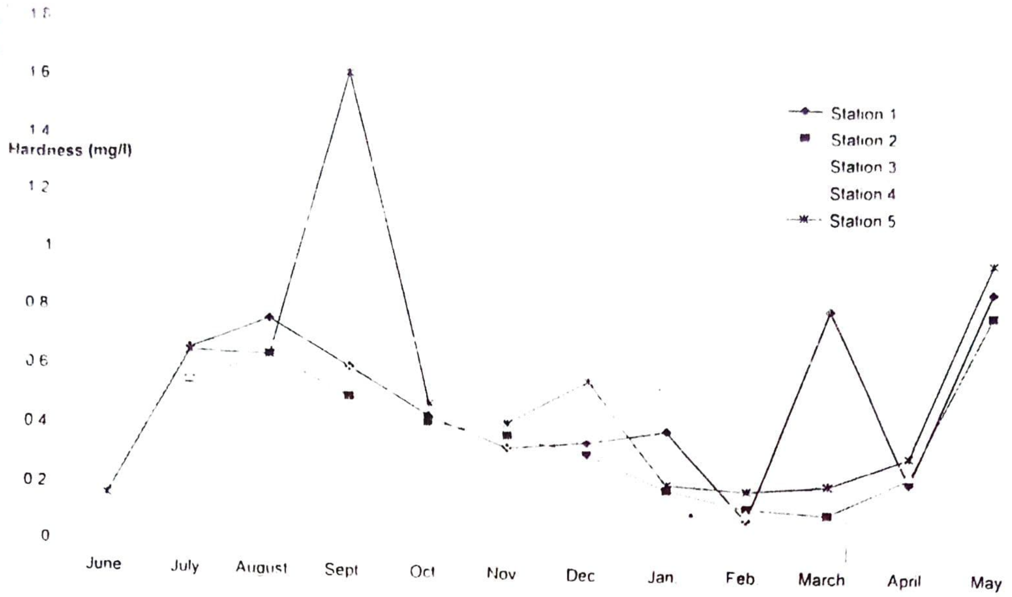

Figure 9 : Mean Monthly Water Hardness Variation at Different Stations along River Gurara

Alkalinity was at it peak in cold rainy sub-season (September- October), it dropped sharply in November and fluctuate within the same range to the month of May (warm rainy sub-season) recorded low mean value. Analysis of variance do not differ significantly in station and sub-seasons ($p<0.05$) (Tables 2 and 3). Alkalinity mean value was higher in wet season compare to dry season.

DICUSSION

The water quality parameters variation between the samples, stations, months and season observed during the study is characteristics of most tropical rivers. The positive correlations observed between air and water temperature for all the stations (Table 4) agrees with the findings of (Dickson, 2001) who indicated that a standard air data can be adopted to predict water temperature as there is a linear relationship between the two parameters. High temperature value recorded in the month of March (hot dry sub-season) in all the stations could be due to intensive sun rays that sub-season, which marks the preparation for rains. The low temperature value recorded in (December-February) may be due to the effect of dry cool harmattan weather brought about by North East trade wind. Late summer sun rays account for high peak temperature in September - November. Wade, (1985), observed that the temperature is an important physical factor influencing water quality, distribution and abundance of organisms. High temperature value recorded in stations 4 and 5 where a lot of human activities are concentrated using the river and discharging waste materials into the water agreed with what Dickson, (2001), observed in Gona river, Farin Gada Jos. The phenomenon of low temperature due to hamattan was also observed by some researchers in some African inland water bodies (Adeniji 1978, Ekom and John 1993,Kolo and Oladimiji, 2003). The positive and significant ($P>0.05$) correlation of temperature with total suspended particles agrees with work of Boyd and Frobish (1990) in which they observed that temperature of surface waters in turbid (pond) are greater than those of clear water.

The low dissolved oxygen recorded in all the station was least expected due to the nature of river course full of rapids and falls causing the river to flow- fast and swift which is expected to have been highly aerated however reverse was the findings. The low dissolved oxygen may likely be due to high discharge of organic and inorganic waste into the river, through surface-run-off and human activities. The reason for low dissolved oxygen in this finding is open for further research. The relatively higher value of dissolved oxygen recorded in all the stations between December – February may be due to cool weather, cool water contains more dissolved oxygen than warm water (APHA, 1992).

The higher biochemical oxygen demand mean value recorded at station 2 could be as a result of deep pool at the foot of the water falls, which might accumulate organic sediments and high temperature causing the decay of organic matters using up the dissolved oxygen leading to lower dissolved oxygen content and high biochemical oxygen demand value. Similar effect was observed in two contrasting mine lakes in Jos (Obioha, 1984). The least means value recorded in stations 3, 4, and 5 in the month of (January-

February) might be due to cool weather (harmattan) which might inhibited the decomposition of organic matters by microbes at that period.

Higher chemical oxygen demand recorded in station 1 during dry season could be due to shallowness of water that easily get heated up resulting into relatively higher water temperature which in turn encourage chemical weathering of the bed rock. Discharges due to human activities who depend greatly on the river at this the hot dry sub season for water might be responsible for the higher chemical oxygen demand at this sub-season.

The pH range (6.3-7.1) recorded in this study agreed with recommended range of (6.5-7.5) that will support aquatic life including fish (Boyd, 1979). The hydrogen ions of Gurara River varied in all the stations with slight increase in wet season. This could be due to dilution effect of rain fall on the river. The slightly lower pH value recorded from stations 5 and 4 could be due to the effluent inflow from N.N.P.C sub-pump station and other human activities such as car washing and domestic sewage disposal into the river at that point.

The conductivity value recorded was low in wet season, this might be due to dilution factor and the increase in dry season could be due to concentration effect of solute and high temperatμre, the warmer the water, the higher the conductivity. The low value recorded in the month of (June – July) could be due to the nature of river bed rock of the river course .APHA, (1992) said conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. The higher dry season mean value was also observed by Ovie and Adeniji (1993) and Kolo, (1996) in Shiroro dam reservoir. The conductivity value recorded in this study fall below the range of 150 and 500μohms/cm which is recommended to be suitable for survival of fish and macro invertebrates (APHA 1992) and this might accounted for few fish species composition and low catch per effort from this river.

The total suspended particles values recorded were generally low in all the stations. This may be due to nature of this river at this section, being confined to it deep course.

The water hardness higher mean value recorded at station 5 and 4 may be due to decay process as a result of less water movement and moderate temperature, while higher value in station 1 may be due to swifter water movement which aerates the water and encourage decay processes which in turn enhance acidic condition.

The low water hardness in all the stations suggest that the water is soft and have low level of calcium and magnesium, carbonate minerals thus less productive than hard water (Thurston et. al. 1979)

Alkalinity higher mean value recorded in all the stations in the month of (August-October) may be due to the dilution effect, less water movement, lower temperature, less weathering and decomposition processes, while lowest mean value recorded at station 5 in the month of April-May, might result from acidic nature resulting from concentration effect during this period as a result of decay of organic matters, higher temperature and lower dissolved oxygen. Low water alkalinity is associated to a consequent low productivity in aquatic ecosystem (Khan and Ejike, 1984).However a trend of lower wet season mean value was observed in some Nigeria water bodies (wright,1985 and Kolo,1996). This does not agreed with the finding of this study which recorded higher wet season mean values than dry season mean value.

In conclusion physico-chemical analysis shows that all the water quality parameters considered in this research fell within the tolerant level recommend by the World Health Organization (WHO, 1988). Except for dissolved oxygen, electrical conductivity and hardness which were below recommended range for fish production.

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