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Original article

Some physical parameters of the sokoto-rima river system in north western Nigeria

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A B S T R A C T

Some physical parameters of water samples from Sokoto-Rima River system at the fishing site for Argungu International Fishing and Cultural Festival (AIFCF) were assessed to determine how they influence the water productivity via titrations and instrumentation methods. Data generated were analyzed statistically based on months, wet and dry seasons and five sub-seasons (early, flood, early dry, mid dry and late dry sub-seasons). The annual mean for water temperature was 27.06 ± 1.93oC, transparency was maximum (4.67 ±0.25 cm) in late dry sub-season. The annual mean of water depth was 3.40 ±2.00 m. Total Dissolved Solid recorded annual mean of 0.45 ±0.20 mg/L. The results provide baseline data for further productivity studies.

1. Introduction

Nigeria is blessed with vast expanse of fresh water bodies constituting about 12.4% of its surface area and is dominated by two major river systems namely rivers Niger and Benue (Raji and Babatunde, 1998). Good quality water supply relates to the web of physical, chemical and biological factors that constitute aquatic environment and influence the beneficial uses of water (Tchobanoglous and Schroeder, 1987). It has been estimated that the quality of water for human and livestock consumption, as well as for fish performance, depends on three major factors which interrelate to produce some specific quality parameters that make the water to have good or bad qualities (Beadle, 1974). These factors are physical, chemical and biological factors. Temperature and turbidity are the major physical quality determinants, dissolved oxygen, hydrogen ion concentration and hardness influence the chemical quality while plankton contributes immensely to the formation of the biological water characteristics (Delince, 1992).

The major pathway of water quality properties is an inter-change between the earth surface and the atmosphere through the precipitation and evaporation (Beadle, 1974). Delince (1992) reported that the quality of waters depend on the kind of soils they travel over in addition to physical, chemical and biological factors. These water quality characteristics influence the principal and vital activities of survival, nutrient utilization and general performance of aquatic life, and regulates the suitability of water for living organisms. Inland fresh water bodies are often subjected to intensive human and industrial activities which influence the quality of water. Sewages from domestic, agricultural and industrial activities pollute fresh water and adversely affect the quality of water. Water is said to be of good quality if its physical, chemical and biotic characteristics are within the recommended values.

Sokoto Rima- River is in the North Western part of Nigeria. It developed as a result of amalgamation of River Bunsuru and River Gagare (Katsina State) at Shinkafi in Zamfara State in Nigeria. On reaching Goronyo via Sabon Birni, it was harnessed as Goronyo Dam, it then runs southwest and joins the Sokoto River near Sokoto to form the Sokoto-Rima river system. The river system pass through Argungu town (Kebbi State) and drains into River Niger at about 120km south of Birnin Kebbi. In addition to fishing, the communities residing in the catchment areas of this River use the water for drinking, washing and irrigation of crops in the dry season.

The study assesed some aspects of the limnology of Sokoto-Rima River system at the site where the Argungu lnternational Fishing and Cultural Festival (AIFCF) is hosted. Specifically the study determined the physical properties in relation to seasons.

2. Materials and methods

2.1. Study Area

The study was conducted on the Sokoto-Rima River system at the traditional fishing site for Argungu International Fishing and Cultural Festival (AIFCF) in Kebbi State in North -Western Nigeria .The site is situated in Sudan Savanna Zone. Some multipurpose reservoirs such as Goronyo reservoir have been built by harnessing Sokoto- Rima River. At Argungu, there is the site for fishing festival along the Sokoto-Rima River. The littoral margin of this site is lined with patches of aquatic vegetation mostly Polygonum, Echinochloa and Nymphaea species (Ita, 1993). The shore line is steepy sloping with limited breeding areas. The Rima River. At Argungu is located on flat river bed with the flow almost at ground level with extensive flood plains along the valley. Scattered across the plain are small natural flood ponds and pools such as Mashe pond near Argungu.

2.2. Water sampling

Water samples were collected at five sampling points denoted as A, B, C, D and E. Sampling points B, C and D were within the main fishing area of AIFCF, known in the local area as matan fada, while A and E were 500m each upstream and downstream fishing area, respectively.

Water samples were collected from each of the sampling point monthly for twelve months. Each sample was replicated three times. A total of fifteen 1 litre capacity plastic containers were used at each sampling.

2.3. Water analyses

The collected samples were analyzed for physical property (TDS) in the Physical Laboratory of the Faculty of Agriculture, Usmanu Danfodiyo University, Sokoto, Nigeria. Air and water temperatures were measured in the field using mercury in glass thermometer while transparency was determined using Secchi disc. Water depth measured in metre was measured with measuring tape attached to heavy chain that was connected to a heavy metal object.

Total Dissolved Solid (TDS) was determined by measuring 100ml of water sample using graduated cylinder. The amount was poured into Petri- dish whose weight had already been measured as W1. The Petri dish was placed on the racks of the Gallenhamp oven and evaporated to dryness. It was then removed from the oven, cooled and weighted again. This weight was denoted as W2.The total dissolved solids was calculated following the formular.

$$TDS\left(mg / L\right) = \frac{W_2 - W_1}{V} \times 1000$$

(Stirling, 1985)

Where

W1= initial weight of Petri- dish

W2= final weight of Petri- dish

V = volume of water sample (100ml in this case).

2.4. Data analysis

The data collected were analyses on monthly bases, two seasons (wet and dry) and five sub-seasons, namely: early rainy (June and July), flood (August and September), early dry (October, November and December), mid-dry (January and February) and late dry (March, April and May) sub-seasons. The parameters were analyzed following analysis of variance (ANOVA) (Steel and Torrie, 1980) and mean separation was by Duncan Multiple Range Test at 5% probability. The computer analysis was carried out using Statistical Package for Social Science (SPSS) software version 19.

3. Results

The results of the sub-seasonal and seasonal physical parameters are contained in Tables 1 and 2, respectively. The air temperature in the sampling points ranged from a minimum of 26.00C in January to a maximum of 40.00 0C in April and May. However, the sub-seasonal air temperatures were not significantly (P >0.05) different (Table 1). The mean values for rainy and dry seasons were 30.500C ±0.000C and 31.36 ± 9.04, respectively, while the annual mean was 31.02 ± 6.92 0C (Table 2). The trends in air temperatures across the sampling points were similar, showing gradual decrease from September to January and peaked in March to May (Figure 1). The water temperatures in the sampling points ranged from a minimum of 20.00C in January to a maximum of 30.00C in September, April and May. The results of sub-seasonal analysis show that water temperatures of the five sampling points were not significantly (P>0.05) different (Table 1). The water temperatures at the sampling points were the same and they followed similar trend throughout the study period showing gradual decrease from September to January with the peak in April and May (Figure 1).

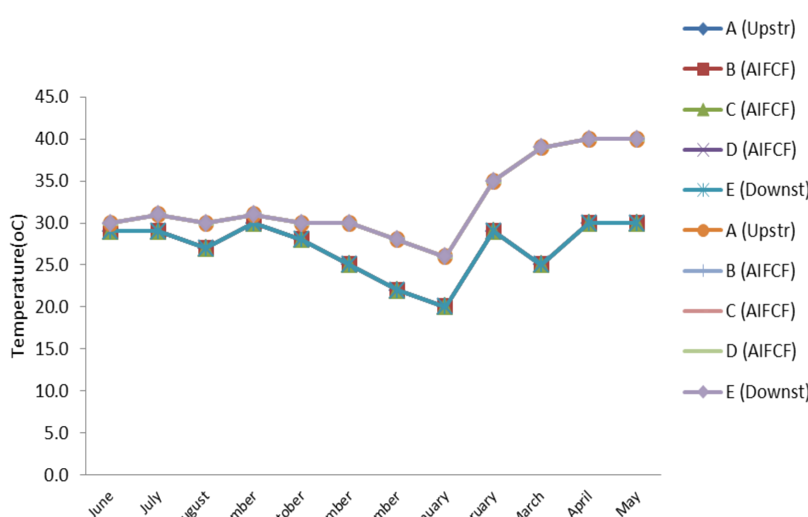

Figure 1: Mean monthly variation of air and water temperatures at the sampling points. Like air temperatures (●) water temperatures (■) at sampling points were the same, hence single graph in each case.

The water levels fluctuated between minimum of 0.70 m in December at A in the upstream to a maximum of 8.60 m in September at the C in the AIFCF fishing area. Similarly, the peak of water level (7.8 ± 0.82 m) occurred in flood sub-season at the point C in the restricted fishing area and lowest (0.93 ± 0.18 m) in mid dry sub-season at A in the upstream (Figure 1). The water depth at the sampling points differed significantly ($p < 0.05$) during the early rainy and early dry sub-seasons, but not significantly different during the late dry sub-season. During the flood sub-season it was significantly deeper at sampling points B to D within AIFCF fishing area. The mean value for rainy season was 5.20 ± 1.92 m while that of dry season was 2.20 ± 0.50 m and the annual mean was 3.40 ± 1.96 m (Table 2). The trends in water level at the five sampling points were similar, with the gradual increase from June to September and subsequently decreased (Figure 2).

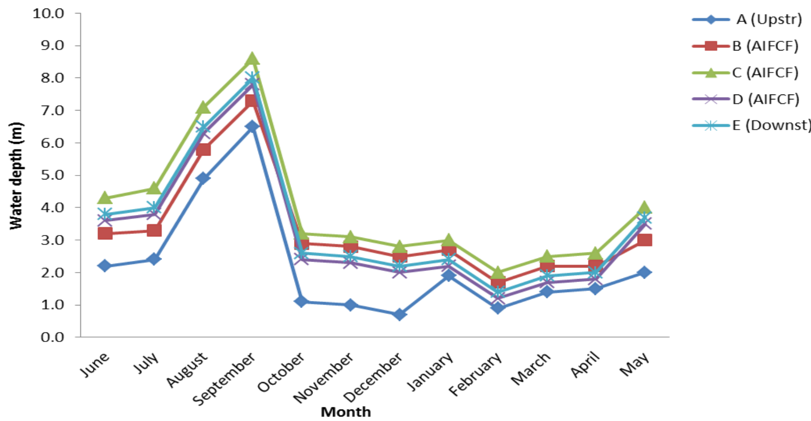

Figure 2: Mean monthly variation of water depth at the sampling points

The transparency of water at the sampling points ranged from a minimum value of 1.50 cm in September to a maximum value of 5.0 cm in June. The lowest sub-seasonal mean transparency of 1.75 ± 0.27 cm occurred in the flood sub-season while the highest value of 4.67 ± 0.25 cm was in the late dry sub-season (Table 1). The results of seasonal analysis (Table 2) revealed mean value of 2.88 ± 1.19 cm for rainy season and 4.39 ± 0.29 cm for dry season and the annual mean of 3.78 ± 1.07 cm. The transparency at five sampling points exhibited similar trends throughout the period of the study. They decreased from June to September and subsequently increased with the peaks in December to January and March (Figure 3).

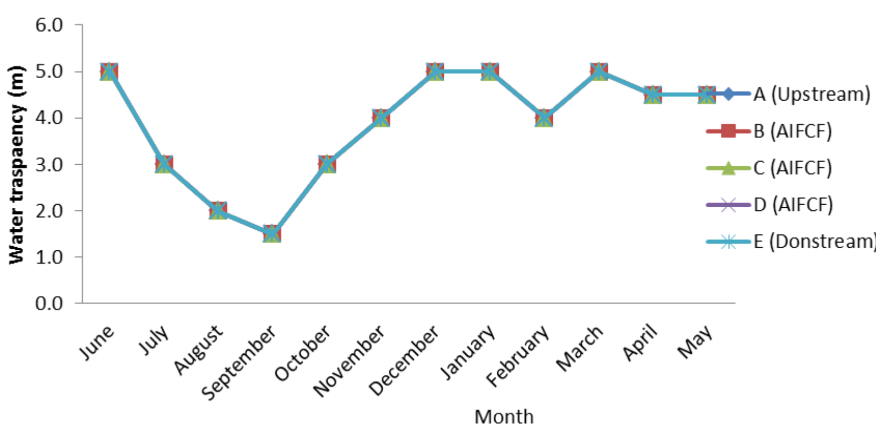

Figure 3 : Mean monthly variation of water tranparency at the sampling points

Note: Single curve because the sampling points recorded same water transpareny.

The Total Dissolved Solid (TDS) ranged between the minimum value of 0.10 mg/L and a maximum of 1.37 ± 0.06 mg/L both in sampling point D (within AIFCF area) in June and April, respectively. The sub-seasonally results (Table 1) showed no significant ($P>0.05$) difference between the values recorded in the early rainy and mid dry sub-seasons. TDS of the sampling points were not significantly different (P>0.05) during the early rainy and mid dry sub-seasons. However, it was significantly higher at sampling point B than the other sampling points while, in the early and the late dry sub-seasons the variations showed no clear pattern. The lowest mean TDS (0.22 ± 0.08 mg/L) was in the flood sub-season while the late dry sub-season obtained the highest value of 0.98 ± 0.54 mg/L, both at the sampling point D within the AIFCF area (Table 1). The mean values in the rainy and dry seasons were 0.37 ± 0.13mg/L and 0.53 ± 0.22mg/L, respectively, while the annual mean was 0.47 ± 0.20mg/L (Table 2). The total dissolved solids at the five sampling points exhibited similar trends over the study period, they increased gradually from June to July and remained low until March after which it increased to high level in April and May (Figure 4).

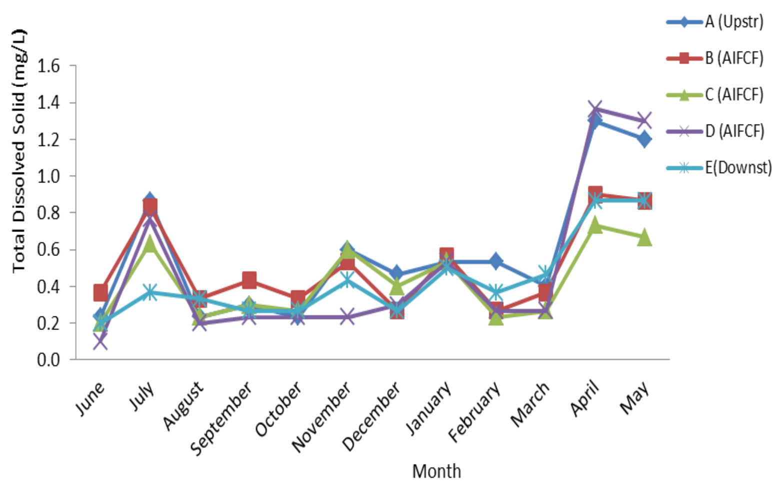

Figure 4: Mean monthly variation of Total Dissolved Solid at the sampling points

4. Discussion

The air temperatures across the sampling points were the same throughout the twelve months study period. However, the lowest value was recorded during the early dry sub-season (29.33oC) and highest (39.67oC) in the late dry sub-season, this could be attributed to the prevalence of harmattan period during the former while the latter encompasses the hottest months in the study area. The overall mean air temperature (31.02 ±6.920C) was obtained. Similarly, the lowest water temperature recorded in the mid- dry sub-season (Table 1) could be attributed to the influence of the cold dry season or hamattan (Abohweyere, 1990) while the highest (29.00oC) in early rainy sub-season may be due to hot weather usually associated with the beginning of the rainy season. This is in line with the finding of Onaji et al. (2005) who found that the mean water temperature of Kware Lake in Sokoto State in North- western Nigeria was lowest in mid- dry sub-season. The results of this study on the sub-seasonal mean water temperature range (24.50 ±4.93 to 29.0 ±0.00) and overall mean(27.07 ± 1.95 0C) are within the recommended range of 25 to 35oC for aquatic life in the tropic. The transparency was lowest during the flood sub-season probably because of the flooded water which might have contained a lot of organic and inorganic matters fhat rendered the water less transparent. Also, Agricultural activities, resulted to release of particulate matters and thus reduced the transparency (increased turbidity) (Okayi et al., 2001). The highest transparency recorded during late dry season may be due to high concentration of calcium and sodium ions which caused coagulation of aggregates and sedimentation of suspended particulate matters (Delince, 1992).

Table 1
Sub-seasonal means of some physical parameters of water samples from Sokoto-Rima River at the AIFCF fishing site.

Parameter	Location	Sub-season				
		Early Rainy	**Flood**	**Early Dry**	**Mid Dry**	**Late Dry**
Air Temperature	A (Upstream	30.50 ± 0.55	30.50 ± 0.55	29.33 ± 1.00	30.50 ± 4.93	39.67 ± 0.50
(0C)	B (AIFCF)	30.50 ± 0.55	30.50 ± 0.55	29.33 ± 1.00	30.50 ± 4.93	39.67 ± 0.50
	C (AIFCF)	30.50 ± 0.55	30.50 ± 0.55	29.33 ± 1.00	30.50 ± 4.93	39.67 ± 0.50
	D (AIFCF)	30.50 ± 0.55	30.50 ± 0.55	29.33 ± 1.00	30.50 ± 4.93	39.67 ± 0.50
	E (Downstream)	30.50 ± 0.55	30.50 ± 0.55	29.33 ± 1.00	30.50 ± 4.93	39.67 ± 0.50
Water Temperature (0C)	A (Upstream	29.00 ± 0.00	28.50 ± 1.64	25.00 ± 2.60	24.50 ± 4.93	28.33 ± 2.50
	B (AIFCF)	29.00 ± 0.00	28.50 ± 1.64	25.00 ± 2.60	24.50 ± 4.93	28.33 ± 2.50
	C (AIFCF)	29.00 ± 0.00	28.50 ± 1.64	25.00 ± 2.60	24.50 ± 4.93	28.33 ± 2.50
	D (AIFCF)	29.00 ± 0.00	28.50 ± 1.64	25.00 ± 2.60	24.50 ± 4.93	28.33 ± 2.50
	E (Downstream)	29.00 ± 0.00	28.50 ± 1.64	25.00 ± 2.60	24.50 ± 4.93	28.33 ± 2.50
Transparency (cm)	A (Upstream	4.00 ± 1.10	1.75 ± 0.27	4.00 ± 0.87	4.50 ± 0.55	4.67 ± 0.25
	B (AIFCF)	4.00 ± 1.10	1.75 ± 0.27	4.00 ± 0.87	4.50 ± 0.55	4.67 ± 0.25
	C (AIFCF)	4.00 ± 1.10	1.75 ± 0.27	4.00 ± 0.87	4.50 ± 0.55	4.67 ± 0.25
	D (AIFCF)	4.00 ± 1.10	1.75 ± 0.27	4.00 ± 0.87	4.50 ± 0.55	4.67 ± 0.25
	E (Downstream)	4.00 ± 1.10	1.75 ± 0.27	4.00 ± 0.87	4.50 ± 0.55	4.67 ± 0.25
Water Depth (m)	A (Upstream)	2.30 ± 0.11 ^{e}	5.70 ± 0.88 ^{c}	0.93 ± 0.18 ^{e}	1.40 ± 0.55 ^{c}	1.63 ± 0.28 ^{b}
	B (AIFCF)	3.25 ± 0.05 ^{d}	6.55 ± 0.8 ^{bc}	2.73 ± 0.18 ^{b}	2.20 ± 0.55 ^{ab}	2.47 ± 0.40 ^{a}
	C (AIFCF)	4.45 ± 0.16 ^{a}	7.85 ± 0.82 ^{a}	3.03 ± 0.18 ^{a}	2.50 ± 0.55 ^{a}	3.03 ± 0.73 ^{a}
	D (AIFCF)	3.70 ± 0.11 ^{c}	7.05 ± 0.82 ^{ab}	2.23 ± 0.18 ^{d}	1.70 ± 0.55 ^{bc}	2.33 ± 0.88 ^{a}
	E (Downstream)	3.90 ± 0.11 ^{b}	7.25 ± 0.82 ^{ab}	2.43 ± 0.18 ^{c}	1.90 ± 0.55 ^{abc}	2.53 ± 0.88 ^{a}
TDS (uS/cm)	A (Upstream)	0.55 ± 0.36	0.27± 0.05 ^{bc}	0.43 ± 0.17 ^{a}	0.53 ± 0.05	0.97 ± 0.45 ^{a}
	B (AIFCF)	0.60 ± 0.26	0.38 ± 0.08 ^{a}	0.38 ± 0.14 ^{ab}	0.42 ± 0.17	0.71 ± 0.26 ^{ab}
	C (AIFCF)	0.42 ± 0.38	0.27 ± 0.05 ^{bc}	0.42 ± 0.16 ^{a}	0.38 ± 0.17	0.56 ± 0.22 ^{b}
	D (AIFCF)	0.43 ± 0.37	0.22 ± 0.08 ^{c}	0.26 ± 0.13 ^{b}	0.40 ± 0.15	0.98 ± 0.54 ^{a}
	E (Downstream	0.28 ± 0.31	0.30 ± 0.06 ^{b}	0.32 ± 0.10 ^{ab}	0.43 ± 0.08	0.73 ± 0.21 ^{ab}

Values are mean ± standard deviation
Means of sampling points in a season with the same letter are not significantly different (P>0.05)
AIFCF: Argungu International Fishing and Cultural Festival.

Table 2
Mean values of some physical parameters of water samples from Sokoto-Rima River at the AIFCF fishing site

Parameter	Location	Rainy Season	Dry Season	Annual mean
Air temperature	A (upstream)	30.5 ± 0.00	33.16 ± 5.66	32.10 ± 4.26
	B (AIFCF)	30.5 ± 0.00	33.16 ± 5.66	32.10 ± 4.26
	C (AIFCF)	30.5 ± 0.00	33.16 ± 5.66	32.10 ± 4.26
	D (AIFCF)	30.5 ± 0.00	33.16 ± 5.66	32.10 ± 4.26
	E (Downstream)	30.5 ± 0.00	33.16 ± 5.66	32.10 ± 4.26
	Mean	30.50 ± 0.00	31.36 ± 9.04	31.02 ±6.92
Water temperature (oC)	A (upstream)	28.75 ± 0.35	25.94 ± 2.08	27.07 ± 2.14
	B (AIFCF)	28.75 ± 0.35	25.94 ± 2.08	27.07 ± 2.14
	C (AIFCF)	28.75 ± 0.35	25.94 ± 2.08	27.07 ± 2.14
	D (AIFCF)	28.75 ± 0.35	25.94 ± 2.08	27.07 ± 2. 14
	E (Downstream)	28.75 ± 0.35	25.94 ± 2.08	27.07 ± 2.14
	Mean	28.75 ± 0.26	25.94 ± 1.80	27.07 ± 1.95
Transparency (cm)	A (upstream)	2.88 ± 1.59	4.39 ± 0.35	3. 78 ± 1.18
	B (AIFCF)	2.88 ± 1.59	4.39 ± 0.35	3.78 ± 1.18
	C (AIFCF)	2.88 ± 1.59	4.39 ± 0.35	3.78 ± 1.18
	D (AIFCF)	2.88 ± 1.59	4.39 ± 0.35	3.78 ± 1.18
	E (Downstream)	2.88 ± 1.59	4.39 ± 0.35	3.78 ± 1.18
	Mean	2.88 ±1.19	4.39 ± 0.29	3.78 ±1.07
Water depth (m)	A (upstream)	4.00 ± 2.40	1.32 ± 0.36	2.40 ± 1.91
	B (AIFCF)	4.90 ± 2.33	2.47 ± 0.27	3.44 ± 1.78
	C (AIFCF)	6.15 ± 2.40	2.85 ±0.31	4.17 ± 2.18
	D (AIFCF)	5.38 ± 2.37	2.09 ± 0.34	3.40 ± 2.17
	E (Downstream)	5.58 ± 2.37	2.29 ± 0.34	3.60 ± 2.17
	Mean	5.20 ±1.92	2.20 ±0.59	3.40 ± 1.96
TDS (uS/cm)	A (upstream)	0.41 ± 0.19	0.64 ±0.29	0.55 ± 0.26
	B (AIFCF)	0.49 ± 0.16	0.50 ± 0.18	0.50 ± 0.15
	C (AIFCF)	0.35 ± 0.11	0.45 ± 0-09	0.41 ± 0.10
	D (AIFCF)	0.33 ± 0.15	0.54 ± 0.38	0.46 ± 0.31
	E (Downstream)	0.29 ± 0.14	0.49 ± 0.21	0.41 ± 0.19
	Mean	0.37 ± 0.13	0.53 ± 0.22	0.47 ±0.20

Values are mean ± standard deviation; AIFCF: Argungu International Fishing and Cultural Festival

The significantly ($p<0.05$) higher water depth in the flood sub-season (7.85 ±0.82 m) at sampling point C within AIFCF fishing area due to increased water volume as a result of torrential rainfall and flood that caused run off into the Sokoto-Rima River. However, the overall mean (3.40 ± 1.96 m) indicated generally low water level at the site. Lower values of total dissolved solids were recorded in the flood sub-season and higher in the late dry sub-season. This, according to Golterman (1975), might be due to dilution of the water by rainfall and flood water. Higher TDS recorded in the late dry sub-season could be as a result of increase in the concentration of cations and anions in the water due to high rate of water evaporation. The annual mean (0.47 ± 0.20 mg/L) recorded was lower than the recommended water quality standard (500mg/L) for drinking (SON, 2007) and favourable (100 mg/L) for aquatic life (Vezeau, 1989).

5. Conclusion

Water temperatures were lower than air temperatures and were within the range of 250C to 350C for fresh water fishes. The temperatures were at smaller range in the wet season than in the dry season (140C). The water transparency was lowest in flood sub-season with the overall mean of 3.78 ± 1.07 m. Total dissolved solids were below the recorded water quality standard, thus the values increased from the low levels in the flood season to higher level in the late dry sub-season.

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