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Full Length Research Paper

Water quality analysis of Digil Dam Mubi, North-eastern Nigeria

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A study of water quality condition of Digil Dam Mubi North-eastern Nigeria was carried out for the period of July to September 2008. Five sampling sites were selected for the research. The stations included the inlet site towards the eucalyptus trees; station (A), the entrance gate; station (B), opposite to the second station; station (C), the spill way channel; station (D), the middle of the Dam; station (E). Data were collected in triplicate for temperature, pH, conductivity, dissolved oxygen, total dissolved solids, alkalinity, salinity, and phosphate concentration using standard methods. The result showed variations in the monthly and station to station values of all the water quality parameters tested. Despite this variation the values were tolerable range of the majority of tropical fresh water fish species.

Key words: pH, conductivity, dissolved oxygen, alkalinity, salinity.

INTRODUCTION

The increasing level of using herbicide and pesticide, improper domestic and sewage disposal and global warming in Nigeria, has created a growing awareness of rational management of aquatic resources and control of waste discharged from the environment (Egborge, 1991). Global warming and environmental contamination with herbicide and pesticide commonly result in exposing aquatic organisms to pollution and hence affect their growth and productivity (Lamai et al., 1999).

Lakes and Dams are invaluable ecological resources. It serves many mankind in many ways providing a lot of opportunities. A large proportion of Nigerian population lives near small water bodies such as Lakes, Reservoirs, Rivers, swamp and coastal Lagoons. Many depend heavily on the resources of such water bodies as their main source of animal protein and family income. In general however, the controlling authorities do not render sufficient assistance to develop these water resources.

Nigeria is naturally endowed with large bodies of natural water (both fresh and marine) in the form of flood plains, rivers, lakes, and lagoons. Attention on water contamination and its management has become a need of the hour because of far reaching impact on human health (Sinha and Srivastava, 1995). Continuous assessment of physical, chemical and biological parameters of water is an essential part of current water quality control programmes.

Water is a vital resource for fish. It is the medium in which the fish lives, therefore the growth of any fish is directly related to the water quality (Ajana et al., 2006). Okram et al. (2003) maintained that physico-chemical features of water and sediment play important role in the structure and functioning of lake and Dams ecosystem.

The increasing emphasis on the improvement of the quality of aquatic systems and the monitoring of the surface water, has highlighted the need to know what factors causes environmental deterioration (Ozean et al., 2006). Digil Dam serves many purposes including irrigation farming, cattle watering, public water source and fish culture. A number of supplies and miscellaneous water users also participate in this value chain. The great commercial and food value of this Dam has brought an impact to the community. Information on water quality analysis of this Dam particularly physical and chemical property was not documented in literature though degradation every year was notice through inflows of water with many effluents during the rainy season. Against this background, this study was designed to investigate the water temperature, pH, dissolved oxygen (DO), conductivity, phosphate, total dissolved solids (TDS), salinity and turbidity of the Dam.

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Table 1. Temperature (^{0}C) value of Digil Dam.

Month	Sampling station					Monthly mean (X)
	A	B	C	D	E	
July	23.70±0.11^c	23.50±0.11^c	23.20±0.11^c	23.10±0.11^c	23.00±0.11^c	23.30±0.11
August	25.20±0.14^a	25.00±0.14^a	25.20±0.14^a	25.10±0.14^a	25.10±0.14^a	25.10±0.14
September	25.70±0.14^a	25.60±0.14^a	24.53±0.14^a	25.30±0.14^a	25.60±0.14^a	25.48±0.14
Station mean	24.87±0.13^b	24.70±0.13^b	24.53±0.13^b	24.50±0.13^b	24.57±0.13^b	

Where: station (A) = the site towards the eucalyptus trees; station (B) = the entrance gate; station (C) = opposite station (B); station (D) = the spill way channel; station (E) = middle of the Dam*F- value (monthly) = 8.72, (P< 0.05) *F- value (station) = 7.32 (P<0.05). Numbers in the same raw and followed by the same superscript do not differ significantly, P (>0.05). Number in the same raw and followed by different superscript differ significantly P (<0.05).

Table 5. Dissolved oxygen (DO) (mg/l) value of Digil Dam.

Month	Sampling station					Monthly mean(X)
	A	B	C	D	E	
July	6.00±0.02^a	6.0±0.02^a	6.00±0.02^a	6.00±0.02^a	7.00±0.03^a	6.20±0.02
August	5.00±0.01^b	5.00±0.01^b	5.10±0.01^b	5.12±0.01^b	4.98±0.01^b	5.04±0.01
September	4.00±0.01^b	4.10±0.01^b	4.00±0.01^b	4.12±0.01^b	4.78±0.01^b	4.02±0.01
Station mean	5.00±0.01^b	5.00±0.01^b	5.00±0.01^b	5.08.±0.01^b	5.59±0.02^a	

Where: station (A) = the site towards the eucalyptus trees; station (B) = the entrance gate; station (C) = opposite station (B); station (D) = the spill way channel; station (E) = middle of the Dam.*F- value (monthly) = 2.30, (P< 0.05) *F- value (station) = 1.32 (P<0.05). Numbers in the same raw and followed by the same superscript do not differ significantly, P (>0.05). Number in the same raw and followed by different superscript differ significantly, P (<0.05).

MATERIALS AND METHODS

The study area was located between (Latitude 10^o 45´ North and Longitude 13^o 40´ East). The Dam covers about 120,000 m^2 and 4 m deep containing different species of fishes such as *Clarias garapinus, Tilapia zilli, Grass carp, Marmyrus rume* and *Heterobranchus* spp. and other aquatic organisms. The sampling stations include the inlet site towards the eucalyptus trees; station (A), the entrance gate; station (B), opposite to the second station; station (C), the spill way channel; station (D), the middle of the Dam; station (E). Water sampling was done in July, August and September 2008 corresponding with the peak of rainfall in the area.

The samples were collected in triplicate for each of the water parameters (electrical conductivity, pH, salinity, temperature, transparency, dissolved oxygen, total dissolved solids and phosphate). Clean 1 L dry wide- mounted transparent glass bottle with Teflon covers were used, to collect samples. The samples from each station were collected at a depth of 30 cm. The glass bottles were labeled with sample location, date and time of collection.

The electrical conductivity values of the water sample were determined in the laboratory with the aids of Hatch conductivity meter model, EC500. The total dissolved solids (TDS) were determined with TDS meter model EC500. Air and water temperature was measured with the Mercury bulb thermometer. The thermometer was placed in the sample immediately after collection and temperature was read after equilibration for 2 min. The hydrogen ion concentration (pH) of the water sample was determined within 2 h of collection in the laboratory using combined pH and conductivity meter (Jenway model 3540). The sediment pH was determined by direct Potentiometry using 1:1 (soil distilled water) ratio as described by (Boyd, 1981).

Dissolved oxygen (DO) of the sample water was determined directly using Jenway DO meter model 9500 (range 0.2 to 20 mgL^{-1}. Phosphate contents of the sample water were determined using Hack kit model PO 19A that measures from 0-50 mg/l.

Statistical analysis

All the data obtained were subjected to analysis of variance (ANOVA) to test level of significance (p<0.05) among station and monthly means (Steel and Torries, 1990). The Duncan 1995 multiple range test was employed to distinguish the differences between treatment means.

RESULTS AND DISCUSSION

Temperature of the surface waters of Digil Dam generally followed a similar pattern throughout the monitoring period. Temperatures increased throughout the period and peaked in August and September at about 25.1-25.5ºC (Table 1). Temperatures throughout the stations in all months were somewhat uniform. In July, the temperature of the water was observed to be low with monthly mean of 23.3°C.

Dissolved oxygen (DO) in the Dam followed a decreasing pattern during the study period. Concentrations among all stations generally averaged 5 mg/L over the monitoring period and ranged from 4 to 7 mg/L (Table 5). The dissolved oxygen content of the Dam is within the range recommended for fish production according to (Viveen et al., 1985).

Table 3. pH value of Digil Dam.

Month	Sampling station					Monthly mean(X)
	A	B	C	D	E	
July	6.10±0.03[c]	6.18±0.02[c]	6.98±0.01[c]	6.87±0.12[c]	6.08±0.11[c]	6.45±0.06
August	7.10±0.14[a]	7.18±0.13[b]	6.98±0.01[c]	6.87±0.12[c]	7.08±0.13[b]	7.10±0.11
September	6.90±0.12[c]	6.91±0.21[a]	6.89±0.01[c]	6.90±0.11[c]	6.91±0.12[c]	6.90±0.12
Station mean	6.70±0.09[c]	6.76±0.12[c]	6.95±0.01[c]	6.88±0.11[c]	6.69±0.12[c]	

Where: station (A) = the site towards the eucalyptus trees; station (B) = the entrance gate; station (C) = opposite station (B); station (D) = the spill way channel; station (E) = middle of the Dam F- value (monthly) = 2.70, (P< 0.05) *F- value (station) = 6.20 (P<0.05). Numbers in the same raw and followed by the same superscript do not differ significantly, P (>0.05). Number in the same raw and followed by different superscript differ significantly, P (<0.05).

Table 2. Conductivity (µcms^{-1}) value of Digil Dam.

Month	Sampling station					Monthly mean(X)
	A	B	C	D	E	
July	54.50±0.14[a]	54.80±0.15[a]	54.10±0.13[b]	54.91±0.14[a]	54.62±0.14[a]	54.14±0.14
August	53.50±0.12[c]	53.80±0.12[c]	55.60±0.15[a]	54.10±0.14[a]	53.60±0.13[b]	54.21±0.13
September	53.60±0.12[c]	53.20±0.12[c]	53.60±0.12[c]	53.60±0.12[c]	52.60±0.11[c]	53.28±0.12
Station mean	53.87±0.12[b]	53.93±0.13[b]	54.37±0.13[b]	54.20±0.13[b]	53.61±0.13[b]	

Where: station (A) = the site towards the eucalyptus trees; station (B) = the entrance gate; station (C) = opposite station (B); station (D) = the spill way channel; station (E) = middle of the Dam*F- value (monthly) = 2.30, (P< 0.05) *F- value (station) = 2.78 (P<0.05). Numbers in the same raw and followed by the same superscript do not differ significantly, P (>0.05). Number in the same raw and followed by different superscript differ significantly, P (<0.05).

Measures of pH generally followed a similar pattern during period of study. Among all stations, pH generally averaged about 6.7- 6.95 throughout the monitoring period and monthly ranged from 6.45 to 7.1 (Table 3). On most monitoring dates, measures of pH were relatively uniform throughout the stations. In August, pH was highest and averaged about 7.1 In July, pH was lowest averaging 6.45 and ranged from 6.1 to 6.98. The water quality standard for pH is a range of acceptable measures between 6 and 9. Throughout the monitoring period, measures of pH at all stations were within the limits of the water quality standard. This is in agreement with the report of Ugwu and Mgbenka (2006).

For the most part, conductivity among the stations followed a consistent pattern. Conductivity at most stations averaged about 54 µcms^{-1}, throughout the monitoring period and ranged from 53 to 54 µcms^{-1} monthly mean (Table 2). Conductivity was typically higher in August opposite the entrance gate of the Dam at station C. At these locations, conductivity averaged 54.37 µcms^{-1}. In most months, measures were generally uniform throughout, but followed a slight increasing trend as the season progressed. This is in corroboration with the report of other workers (Obhahie et al., 2007).

The turbidity of the Dam was notice to be high especially during the peak of the raining season around August and September. While the lowest value of 0.15 cm was recorded in July at station A (Table 4). In a previous study by Ajayi (2006), he observed that the favourable range of secchi-disc reading for aquaculture in the tropics is within the range of 0.30 to 0.60 m.

Phosphate concentrations in the Dam were observed to be high in the month of July but followed a decreasing pattern in the months of August and September (Table 8). EPA guidance for nutrient criteria in lakes and reservoirs suggests a minimum concentration of 0.01 mg/L (EPA 2000). Lakes and reservoirs exceeding this concentration are more likely to experience algal bloom problems during the growing season. While in freshwater environments, dissolved phosphate is usually a limiting nutrient and is readily taken up by freshwater plants and algae.

Total dissolved solids (TDS) of the stations throughout followed a similar pattern. Concentrations at all stations averaged 22 mg/L over the monitoring period while ranging from 21.6 to 24.5 mg/L (Table 7). Higher concentrations were measured at station D in September. In that month, the concentration of TDS in the spill way channel was 26.2 mg/L. The water quality standard is a maximum concentration of 500-mg/L. Throughout the monitoring period, concentrations measured at all stations were always less than the standard (APHA, 1992)

Salinity of Digil Dam was low during the period of the research. Concentrations measured at all stations averaged 6.14 to 7.46 mg/L and ranged less than 18 mg/L throughout the monitoring period (Table 6). The PADEP standard is a minimum concentration of 20 mg/L

Table 8. Phosphate concentration of Digil Dam.

Month	Sampling station					Monthly mean(X)
	A	B	C	D	E	
July	0.08±0.02[a]	0.08±0.02[a]	0.08±0.02[a]	0.08±0.02[a]	0.08±0.02a	0.08±0.02
August	0.06±0.01[b]	0.06±0.01[b]	0.06±0.01[b]	0.06±0.01[b]	0.06±0.01[b]	0.06±0.01
September	0.05±0.01[b]	0.05±0.01[b]	0.05±0.01[b]	0.05±0.01[b]	0.08±0.01[b]	0.08±0.01
Station mean	0.06±0.01[b]	0.06±0.01[b]	0.06±0.01[b]	0.06±0.01[b]	0.06±0.0s1[b]	

Where: station (A) = the site towards the eucalyptus trees; station (B) = the entrance gate; station (C) = opposite station (B); station (D) = the spill way channel; station (E) = middle of the Dam.*F- value (monthly) = 3.44, (P< 0.05) *F- value (station) = 1.22 (P<0.05). Numbers in the same raw and followed by the same superscript do not differ significantly, P (>0.05). Number in the same raw and followed by different superscript differ significantly, P (<0.05).

Table 7. Total dissolved solid (mg/l) value of Digil Dam.

Month	Sampling station					Monthly mean(X)
	A	B	C	D	E	
July	20.20±0.10[c]	20.20±0.10[c]	20.10±0.10[c]	23.10±0.10[c]	19.98ss±0.09[c]	20.72±0.10
August	21.00±0.11[c]	20.90±0.10[c]	20.80±0.10[c]	24.10±0.14[a]	21.10±0.11[c]	21.58±0.11
September	23.60±0.13[b]	24.75±0.14[a]	23.80±0.13[b]	26.20±0.16[a]	24.52±0.14[a]	24.57±0.14
Station mean	21.60±0.11[c]	21.95±0.13[b]	21.57±0.11[c]	24.47±0.14[a]	21.87±0.11[c]	

Where: station (A) = the site towards the eucalyptus trees; station (B) = the entrance gate; station (C) = opposite station (B); station (D) = the spill way channel; station (E) = middle of the Dam*F- value (monthly) = 8.23, (P< 0.05) *F- value (station) = 7.83 (P<0.05). Numbers in the same raw and followed by the same superscript do not differ significantly, P (>0.05). Number in the same raw and followed by different superscript differ significantly, P (<0.05).

Table 6. Salinity (mg/l) value of Digil Dam.

Month	Sampling station					Monthly mean(X)
	A	B	C	D	E	
July	7.10±0.14[a]	7.20±0.14[a]	7.99±0.14[a]	7.30±0.14[a]	7.70±0.14[a]	7.46±0.14
August	6.10±0.13[b]	6.20±0.13[b]	6.10±0.13[b]	6.30±0.13[b]	5.99±0.12[c]	6.14±0.13
September	6.10±0.13[b]	6.30±0.13[b]	6.10±0.13[b]	6.30±0.13[b]	6.40±0.13[b]	6.24±0.13
Station mean	6.43±0.13[b]	6.25±0.13[b]	6.73±0.13[b]	6.63±0.13[b]	6.69±0.13[b]	

Where: station (A) = the site towards the eucalyptus trees; station (B) = the entrance gate; station (C) = opposite station (B); station (D) = the spill way channel; station (E) = middle of the Dam.*F- value (monthly) = 4.20, (P< 0.05)*F- value (station) = 3.30 (P<0.05). Numbers in the same raw and followed by the same superscript do not differ significantly, P (>0.05). Number in the same raw and followed by different superscript differ significantly, P (<0.05).

Table 4. Turbidity (cm) value of Digil Dam.

Month	Sampling station					Monthly mean(X)
	A	B	C	D	E	
July	0.15±0.01[c]	0.19±0.02[b]	0.18±0.02[b]	0.19±0.02[b]	0.16±0.01[c]	0.17±0.02
August	2.13±0.23[a]	2.14±0.23[a]	2.18±0.24[a]	2.27±0.25[a]	2.30±0.23[a]	2.20±0.24
September	0.18±0.02[b]	0.20±0.02[b]	0.22±0.02[b]	0.23±0.02[b]	0.21±0.02[b]	0.21±0.02
Station mean	0.82±0.03[b]	0.84±0.03[b]	0.86±0.03[b]	0.89±0.03[b]	0.89±0.03[b]	

Where: station (A) = the site towards the eucalyptus trees; station (B) = the entrance gate; station (C) = opposite station (B); station (D) = the spill way channel; station (E) = middle of the Dam.*F- value (monthly) = 1.70, (P< 0.05) *F- value (station) = 0.70 (P<0.05). Numbers in the same raw and followed by the same superscript do not differ significantly, P (>0.05). Number in the same raw and followed by different superscript differ significantly, P (<0.05).

(Van Diver 1990).

The natural Salinity of water is largely dependent on the underlying geology and soils within the surrounding watershed. The low Salinity measured at Digil Dam probably results from the geology which is primarily sandstone

Conclusion

It is therefore concluded that despite the contamination of the Digil Dam with many effluent, its water is still amenable for aquaculture activities. Some aquatic and terrestrial fungi might be introduced into the Dam to make it more productive. Hence, the Dam could be used for fishing, irrigation, domestic water supply and other related water usage.

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