Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 2, No. 6, p. 12-19, 2012
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Limnological features of Ikere Gorge Reservoir, Iseyin south-western Nigeria: Physico-chemical parameters

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Received: 24 May 2012
Revised: 16 June 2012
Accepted: 17 June 2012

Key words: Physico-chemical parameters, tropical lake, Nigeria.

Abstract

A study of physico-chemical parameters of Ikere gorge reservoir Iseyin, South Western Nigeria was conducted from July to December 2007. The mean of the physico-chemicals parameters were; temperature (28.1 ± 0.73°C), transparency (1.82 ± 0.66m), hydrogen ion concentration (7.26 ± 0.15), dissolved oxygen (7.07 ± 0.59 mg/l), biochemical oxygen demand (2.71 ± 0.66 mg/l), conductivity (344.44 ± 184.04 µΩ/cm), phosphate (1.68 ± 1.32mg/l), nitrate (0.74±1.01 mg/l), total suspended solid (34.66 ± 23.03 mg/l), and total dissolved solid (223.35 ± 80.44 mg/l). Significant differences were observed in the mean dissolved oxygen, conductivity and phosphate concentration between the stations. Only total dissolved solids differed significantly between seasons. The physico-chemical parameters obtained fall within the range for drinking water except for total suspended solid which exceeded the Federal Ministry of Environment's (FME) recommendation for drinking water. Further purification of the water to remove excess total suspended solid will make the water fit for drinking. The reservoir is suitable for aquatic life.

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Introduction

Reservoirs of water held in natural or artificially created basins contain water for various periods of time. These bodies of water function in a multiplicity of ways in human activities as source of water, source of biota, for nutrition, and a source of aesthetic value to human well-being. These bodies of water are also used as purification systems, intentionally or fortuitously, for various waste products of human activities (Wetzel, 1990). The impoundment of rivers to form lakes brings about structural and physico-chemical changes, which affect the biota in a number of ways (Egborge, 1979 and 1981). The most obvious effect is the disappearance of source riverine species and the establishment of a lake community.

It has been observed by past workers that physico-chemical parameters have a great effect on the biotic component of aquatic environment (Holden and Green, 1960; Okogwu and Ugwumba, 2006). There are vast literatures on the physico-chemical parameters of freshwater bodies in Nigeria, Adebisi (1981), Umehan (1989), Adeniji, and Mbagwu (1990), Udousoro (1997), Idowu and Ugwumba, (2005), Ayoade et al., (2006), Adesalu and Nwankwo (2008). This work provides baseline data on the physico-chemical parameters of a man-made lake, Ikere gorge reservoir.

Materials and methods

Study area

Ikere gorge reservoir is a man-made lake, located in upper Ogun River 8 Km east of Ikere village and 40 Km North East of Iseyin in Oyo State, Nigeria. Ikere gorge reservoir takes its source between longitude 8^{o} 10^{1} and 8^{o} 20^{1} and latitude3^{o} 40^{1} and 3^{o} 50^{1} N (Figs 1). Toward the Southern part of the reservoir were hills primarily made of rock and gravels. The rivers that run down to the dam have gravels and sand as their major substrate (Adebisi, 1981). The water bed comprised mainly of fine and coarse sand particles and gravels. Along the bank of the reservoir are distributed forest and savanna trees and aquatic grasses and shrubs. There were several pieces of dead wood projecting out of the water. July and September are the period of heavy rainfall and November is the onset of dry season in the western part of Nigeria. The reservoir experienced frequent current as a result of wind that blows on it from time to time. Some times, the current results to wave action which frequently spread across the reservoir and sometime it could be violent particularly during the raining season. The reservoir was formed by damming River Ogun (main source) and Rivers Owu and Amaka which are minor tributaries. River Ogun is part of the dense network of inland water course that flows southwards into Lagos Lagoon. The reservoir has a storage capacity of 565 x $10^{6}m^{3}$. The reservoir was constructed by Ogun-Osun River Basin Development Authority in 1990. It was constructed primarily for the following purposes: Provide water to Iseyin, Okeho, and Iganna and environ, supplement out water supplies to Abeokuta and Lagos, provide irrigation water for 12,000ha and to generate 6 megawatt of hydro-electricity. Aside these, about 90% of the people comprising of people from seven villages around the reservoir have fishing as their primary occupation.

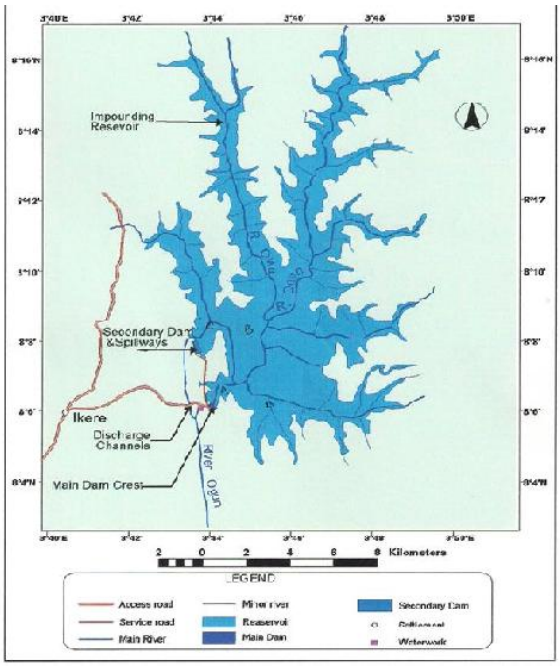

Fig. 1. Map Showing Ikere Gorge Reservoir.

Sampling stations

Four sampling stations were selected along the length of the reservoir for the present study;

Station A: this is located at the core of the reservoir around the workshop (a 50m tower built at the core of the reservoir) toward the embankment of the reservoir.

Station B: this is located at the region where River Owu, one of the Ogun river tributaries, entered into the reservoir. It is about 3.5 kilometers away from station A. Fishing is the only noticeable human activity in Stations A and B.

Station C: this site is located very close to the spillway and the landing centre of the fishermen. It is about five hundred meters away from station B.

Station D: this is at the eastern part of the reservoir and very close to the landing centre of the fishermen at a village called Bendel. It is about two kilometers east of station A. Domestic activities like bathing, fetching of water, washing of cloth and fishing nets takes place in Stations C and D.

Sampling was carried out monthly from July 2007 to December 2007 except in September because the road was not motorable and Station D was included in August. Sampling was done between 8am and 11am during each trip.

Table 1. Monthly variation in Physico-chemical Parameters of Ikere Gorge Reservoir, Iseyin.

PARAMETERS	Temperature(°C)	Transparency(m)	pH	DO(mg/l)	BOD(mg/l)	Conductivity(µΩ/cm)	Phosphate (mg/l)	TSS(mg/l)	TDS(mg/l)	Nitrate (mg/l)
July	27.80	2.67	7.52	7.53	3.72	60.18	4.02	28.22	277.71	2.54
August	27.60	2.38	7.17	7.73	2.87	506.00	1.23	37.8	331.70	0.23
October	28.90	1.24	7.26	6.28	1.93	507.50	1.22	34.69	256.23	0.28
November	28.86	1.30	7.21	7.06	2.42	300.00	0.85	14.80	148.03	0.22
December	27.35	1.50	7.16	6.74	2.62	348.50	1.08	41.28	153.10	0.41
Mean	28.10	1.82	7.26	7.07	2.71	344.44	1.68	34.66	233.35	0.74
SD	0.73	0.66	0.15	0.59	0.66	184.04	1.32	23.03	80.44	1.01

Table 2. Correlation coefficient (r) values between physico-chemical parameters of Ikere gorge reservoier, Iseyin.

PARAMETERS	Temperature	Transparency	pH	DO	BOD	Conductivity	Phosphate	TSS	Nitrate
Temperature (°C)	1								
Transparency(m)	-0.52*	1							
pH	0.15	0.36	1						
BOD(mg/l)	-0.49*	0.67**	0.42	0.47*	1				
Conductivity(µΩ/cm)	0.23	-0.27	0.06	0.55*	-0.25	1			
Phosphate(mg/l)	-0.37	0.15	-0.23	-0.59**	0.11	0.52*	1		
TSS(mg/l)	-0.08	-0.01	-0.20	0.18	0.27	0.11	0.02	1	
TDS(mg/l)	-0.22	0.53*	0.18	0.11	0.34	0.01	0.03	-0.20	
Nitrate(mg/l)	-0.26	0.63**	0.52*	0.30	0.70**	-0.50*	0.05	-0.04	1

*- significant at 0.05; **- significant at 0.01

Field sampling

The temperature of the surface water was measured with mercury in glass thermometer graduated in degree Celsius (°C). The thermometer was placed horizontally for 5 minutes in surface water and then read. Transparency of the water values were measured in situ with Secchi disc. Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) were analyzed following the procedure of Mackereth (1963). Hydrogen ion concentration (pH), conductivity, nitrate, phosphate, total suspended solid (TSS) and total dissolved solid (TDS) were determined using standard methods by APHA (1992).

Table 3. Spatial Variation in Physico-Chemical Parameters of Ikere Gorge Reservoir, Iseyin.

PARAMETERS	STATIONS				ANOVA
	A	B	C	D	F-Value
Temperature (°C)	28.14±0.89	28.14±0.62	28.11±0.71	28.08±0.92	0.02
Transparency(m)	2.05±0.64	1.7±0.69	1.66±0.73	1.65±0.65	0.323
Nitrate(mg/l)	0.6±0.77	0.82±1.15	0.762±1.13	0.31±0.15	0.044
pH	7.36±0.23	7.32±0.18	7.22±0.31	7.05±0.22	0.745
DO(mg/l)	7.24±0.60	6.94±0.45	7.19±1.01	6.73±0.55	9.713**
BOD(mg/l)	2.84±0.46	2.59±0.82	2.796±1.06	2.34±0.65	0.117
Conductivity(μΩ/cm)	348.79±184.33	342.16±195.83	348.56±181.27	407.75±139.77	5.257*
Phosphate(mg/l)	1.63±1.23	1.7±1.44	1.7±1.28	1.09±0.32	3.785*
TDS(mg/l)	216.26±75.41	249.77±93.86	222.2±88.57	237.05±102.28	0.180
TSS(mg/l)	26.63±17.83	24.35±19.03	63.73±90.50	22.85±20.78	0.820

**Significant at 1%, *Significant at 5%,

Table 4. Seasonal variation in mean Physico-Chemical parameter of Ikere gorge reservoir, Iseyin using student t-test.

PARAMETERS	RAINY SEASON	DRY SEASON	ST.ERR	T-Value
Temperature(°C)	28.13±0.7	28.11±15.43	0.77	-0.007
Transparency(m)	2.04±0.76	1.40±3.34	0.57	1.226
pH	7.30±0.18	7.18±0.21	0.14	0.963
DO(mg/l)	7.30±0.78	7.18±2.53	0.60	0.464
BOD(mg/l)	2.76±0.90	2.52±62.58	0.67	0.481
Conductivity (μΩ/cm)	384.96±257.83	324.25±187.70	193.02	0.174
TSS(mg/l)	21.89±18.97	53.03±57.16	16.63	-1.841
TDS(mg/l)	289.53±38.89	150.56±86.77	29.04	4.751*
Phosphate(mg/l)	1.99±1.61	0.96±31.55	1.21	0.988
Nitrate(mg/l)	1.00±0.28	0.31±0.13	0.99	0.712

*- Significant at 1%

Data analysis

Analysis of variance (ANOVA) was used to test for statistical difference between the mean of the physico-chemical parameters of the four stations (Ogbeibu, 2005). The correlation coefficent between physico-chemical parameters was determined. Student t-test was used to determine the difference between the physico-chemical parameters in raining season and in dry season.

Results

Monthly variation in physico-chemical parameters

Table 1 shows the monthly variation in physico-chemical parameters of Ikere reservoir and table 2 shows the correlation coefficient value (r) between the parameters. The mean temperature recorded was 28.10 ± 0.73°C. The highest temperature was recorded in October (28.9°C) and the least in December (27.35°C). Temperature is significantly and negatively correlated to transparency and BOD (P> 0.05). The mean transparency of study area was 1.82 ± 0.66m. The highest transparency was recorded in July (2.67m) and the least in October (1.24m). Transparency is significantly and positively correlated to BOD (P> 0.05), Nitrate (P>0.05) and TDS (P>0.01). The mean dissolved oxygen was 7.07 ± 0.59 mg/l. The highest dissolved oxygen was recorded in August (7.73mg/l) and the least in October (6.28 mg/l). Dissolved oxygen is significantly and positively correlated to BOD (P> 0.01) and Conductivity (P>0.01), and negatively correlated to phosphate (P>0.05) (Table 2). The mean pH of Ikere gorge reservoir was 7.26 ± 0.15. The highest pH was recorded in July (7.5) and the least in December (7.16). pH is significantly and positively correlated to DO (P> 0.01) and nitrate (P>0.01). The mean BOD of the study area was 2.71 ± 0.66 mg/l. The highest BOD was recorded in July (3.72mg/l) and the least in October (1.93mg/l). BOD is significantly and positively correlated to nitrate (P>0.05). The mean phosphate concentration of Ikere gorge reservoir was 1.68 ± 1.32mg/l. The highest phosphate was recorded in July (4.02mg/l) and the least in November (0.85mg/l). Phosphate is significantly and positively correlated to conductivity (P>0.0) and negatively correlated to DO (P>0.05). The mean nitrate concentration was 0.74 ± 1.01 mg/l. The highest nitrate was recorded in July (2.54mg/l) and the least in November (0.22mg/l). The mean TSS was 34.66 ± 23.03 mg/l. The highest TSS was recorded in December (41.28mg/l) and the least in November (14.80mg/l). The mean value of the TDS was 233.35 ± 80.44mg/l with the highest value recorded in August (331.70mg/l) and the least in November (148.03mg/l).

Spatial and seasonal variation in physico-chemical Parameters

Table 3 shows the spatial variation of the physico-chemical parameters of Ikere reservoir. The Analysis of variance (ANOVA) for the physico-chemical parameters showed a significant difference in the mean level of DO (7.03), Conductivity (361.82) and phosphate (1.53). Table 4 shows Seasonal variation in mean physico-chemical parameter of Ikere reservoir using student t-test. There was no marked differrence except for the TDS.

Discussion

The temperature of water body has a great impact upon its productivity in general. All organisms including fish in water possess well defined limits of temperature tolerance, with optimum lying between 22°C to 32°C (Akinyemi, 1988). The mean temperature obtained (28.1 ± 0.73°C) fall within the optimum range for the survival of aquatic life. The highest temperature recorded in October coincided with the period of least oxygen. Aguigwo (1997) also reported high temperature in October in a stream at Awka, Anambra State. Temperature correlated negatively with dissolved oxygen indicating that temperature has a negative effect on dissolved oxygen. Increase in water temperature more than necessary lead to decrease in the dissolved oxygen level in the water (Boyd, 1979). The decrease in transparency from July to October is as a result of influx of flood water into the reservoir during these raining season months. The least transparency

recorded in October coincided with the period the reservoir reached its peak water level due to flooding. Decrease in transparency was reported also by Umehan (1989) during the period of high water level. Factors affecting transparency of water are silting, microscopic organism and suspended organic matter (McCombie, 1953 and Micheal, 1969). There was no marked difference between the transparencies of the stations and this indicate some level of uniformity in the transparency across the stations and this may be as a result of current which frequently occurred across the reservoir. The period of lowest transparency (October) coincided with the period of least dissolved oxygen concentration. This is supported by Boyd (1979) who reported that high turbidity implies low transparency which reduces primary production and oxygen levels in pond and often increase susceptibility of fish to fungal disease. The mean pH obtained (7.26 ± 0.15) is optimum for fish culture as recommended by Umeham (1989) who suggested a range 5.5 - 10 for tropical fish culture, and Boyd (1979) recomended a range between 6.5 and 9.0 for fish culture. At a pH below 5.5 fish develop hypersensitivity to bacterial parasites. Adebisi (1981) in Upper Ogun River also recorded pH range (6.9-7.9). The reservoir is homogenous in terms of pH showing no significant different in the stations. The absence of drastic fluctuation was indicative of stability at all stations as indicated by Sowunmi, 2001. This condition was also attributed to the fact that the water is well buffered probably due to the unconfirmed presence of carbonates, bicarbonates and hydroxide (Boyd, 1979). The conductivity level below 50 are regarded as low, those between 50 and 600 are medium while those about 600 are high (Adeleke, 1988 cited by Oben (2000). The conductivity ranges (60.18 - 507.7μΩ/cm) in this study fall to the medium level. Boyd (1979) affirmed that natural water normally has conductivities ranges from 20-15007μΩ/cm. Adebisi (1981) observed a range of 31-131 μΩ/cm in upper Ogun River. The higher conductivity observed in Ikere reservoir may be as a result of rocky basement of the reservoir as well as the settlement of influx organic and co-organic compound. Stirling (1985) recorded that conductivity depends on location, geological history of the basin, drainage, rainfall, bottom diploids, presence or absence of inflowing water and the character of the biota. The conductivity of reservoir and manmade lakes depend largely on that of flowing river, turn over rate and the soil of the catchment area (Akin-Oriola 2003b). In view of this, ionic concentration in Nigeria reservoir and lakes are highly variable. In Opi lake, Enugu state, Hare and Carter, (1984) reported the range of 15-24 μΩ/cm; in Jakara reservoir, Kano state, Adeniji and Mbagwu, (1990) reported the range of 2,400-8,200 μΩ/cm. The conductivity of the study area is in line with the range (48-954 μΩ/cm) obtained in Awba reservoir, Ibadan, Oyo state (Akin-Oriola, 2003b) probably because they fall within the same geographIcal location. The DO concentration obtained (7.07 ± 0.59 mg/l) is optimal for aquatic life. DO concentration below 5.0mg/l is considered undesirable for fish pond (Boyd, 1979). The peak dissolved oxygen concentration recorded in August may be as a result of rigorous aeration of the water due to the rapidity of the water flow concomitant with the high flood (Holden and Green, 1960; Egborge, 1970). Other factors identified affecting DO concentrations in water are temperature, salinity, turbulence, and atmospheric pressure (Sowunmi, 2001), strong wind due to harmattan was recorded in Sokoto river (Holden and Green 1960), and Larkin (1976) noted that the speed at which water flows helps in regular replenishment of oxygen. However, Adebisi (1981) reported that the harmattan does not have any effect in the aeration of River Osun and River Ogun. The higher BOD level during the raining season months coincided with the period of input of allochthonous organic matter from the catchments area during the raining season and this had been recorded to increase BOD of the water body (Akin-Oriola 2003a, and. Oben, 2000). The biochemical oxygen demand was generally low during this study. Water with BOD level less than 4 mg/l are term reasonably clean and unpolluted while water with level greater than 10mg/l are considered polluted since they contain

large amount of degradable organic materials (Udousoro, 1997). The range obtained (1.93 – 3.72 mg/l) was considerably good for drinking and acceptable as good water quality. In the research conducted by Idowu and Ugwumba (2005) at Eleiyele reservoir the biochemical oxygen demand was in the range of 3.1 – 4.3 mg/L which was said to support low organic enrichment of the reservoir. Higher level of TSS obtained during the raining season months could be explained in term of influx of allochthonous matter from the catchments area into the reservoir through run off. This is true of most of Nigeria inland water as recorded by many authors (Egborge, 1972, 1994, Imevbore and Adeniyi, 1977). TSS exceeded the Federal Ministry of Environment's (FME) recommendation for drinking water.

Water nutrient

Higher phosphate and nitrate recorded during the raining season may be associated with washing of some of the nutrients from the drainage area by run-off created by rain. Kemdirim (1990) also observed higher concentration of phosphate during the raining season than the dry season in Pankshin reservoir in Plateau State, Nigeria. The reduction in nutrient concentration in August was attributed to phytoplankton consumption of the phosphates for growth and reproduction (Michael, 1969). The sudden decline in the level of phosphate in this month may also be as result of sedimentation of the nutrient.

Conclusion

The physico-chemical parameters obtained fall within the range for drinking water except for Total suspended solid which exceeded the FME recommended for drinking water. The reservoir is suitable for aquatic life.

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