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Full Length Research Paper

The seasonal variation of pH and dissolved oxygen (DO_2) concentration in Asa lake Ilorin, Nigeria

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The vertical and surface water variations of pH and dissolve oxygen (DO_2) concentration were studied for 12 months (March 2005 to February 2006) in Asa lake Ilorin, Nigeria. The mean surface pH values ranged between 7.30 and 8.10, with lower values (7.30 - 7.70) obtained October to December while higher values (8.0/8.10) were obtained in January to July. Vertical distribution of mean pH also ranged from 8.1 (Surface) to 5.20 (Bottom). Similarly the monthly variations of mean DO_2 concentration at the surface waters were between 7.60 - 8.20 mg/l, with lower values in October/November and higher values in March/April. Vertical distribution of DO_2 concentration also ranged from 8.20 (surface) to 2.50 (bottom) mg/l. A fairly defined pH and DO_2 stratification were noted from March to September and also in January/ February, while destratification was noted for these parameters in November and December. However a sharp drop in DO_2 concentration usually occurred at the thermocline zone of 5 m depth. This sharp drop also became shifted to 7 m depth in October and November due to thermal mixing condition of the lake around this season, and DO_2 concentration were almost uniform from the surface to 5 m depth (mean = 7.60 mg/l). The effects of this on some of the fish fauna of this water body were discussed. The pH and dissolved DO_2 concentration were positively correlated (0.54). There were no marked variations of the pH and dissolved oxygen concentration along the 3 sampling sites across the lake hence fish species composition along the water body is likely to be less varied.

Key words: Dissolve oxygen, pH, fishes, Asa lake, stratification.

INTRODUCTION

Dissolved oxygen concentration and the pH of water bodies are important parameters that determine the spatial and temporal distribution of aquatic organisms particularly the fish fauna. Dissolved oxygen is required for respiration by most aquatic animals. Apart from this, dissolved oxygen combined with other important elements such as Carbon, Sulphur, Nitrogen and Phosphorous that could have been toxicants in the absence of oxygen in the water bodies to form carbonate, sulphate, nitrate and phosphate respectively that constitute the required compounds for aquatic organisms for survival. There is a direct variation of phytoplankton with oxygen (Biswas, 1973). The diffusion of oxygen into natural waters is slow, except under conditions of strong turbulence hence the most important source of oxygen is through the process of photosynthesis by the aquatic plants (Boyd, 1979). Factors controlling the rate of photosynthesis and the amount of oxygen evolved include light, species and abundance of plant (Adeniji, 1991), temperature and turbulence (Welch, 1968; Araoye, 2007). Dissolved oxygen and pH affects directly or indirectly other limnological parameters such as transparency, viscosity, total dissolved solids and conductivity (Whitney, 1942); all of which constitute the very important physical and chemical parameters that form the basis for an enlightened fisheries and water resources management (Araoye et al., 2007).

Photosynthesis by aquatic plants during the daylight removes carbon dioxide (CO_2) from the medium hence pH would increase. At night, respiratory processes of aquatic organisms release CO_2 into the medium and pH declines. Similarly warm waters develop increased pH levels due to conversion of CO_2 to organic carbon by photosynthesis and the rate may exceed the rate of the release of CO_2 from organic carbon by the process of respiration (King, 1970).

There are reports on the physico-chemical parameters of many tropical lakes. Some of these include the work of Adeniji et al. (1984), Adeniji (1991) on Jebba lake Nigeria, Egborge (1977) on Asejire lake Nigeria, Imevbore (1975) on Kainji lake Nigeria, Biswas (1973) on Volta lake

Table 1. Features of Asa dam.

Features	Measurement
Overall length	596 m
Storage capacity	43 million cm^3
Extent of lake	18 km
Earth Embankments:	
Length	402 m
Crest width	6 m
Maximum height	27 m
Upstream slope	1:3
Down stream slope	1:2.5
Earth fills	250,000 cm^3
Non-overflow concrete gravity section:	
Length	130 m
Crest width	6 m
Maximum height	11 m
Spill way:	
Length	65 m
Height	14 m
Maximum discharge	79,000 cm^3s^{-1}
Total volume of concrete:	49,000 cm^3

Source: Kwara State Utility Board, Ilorin

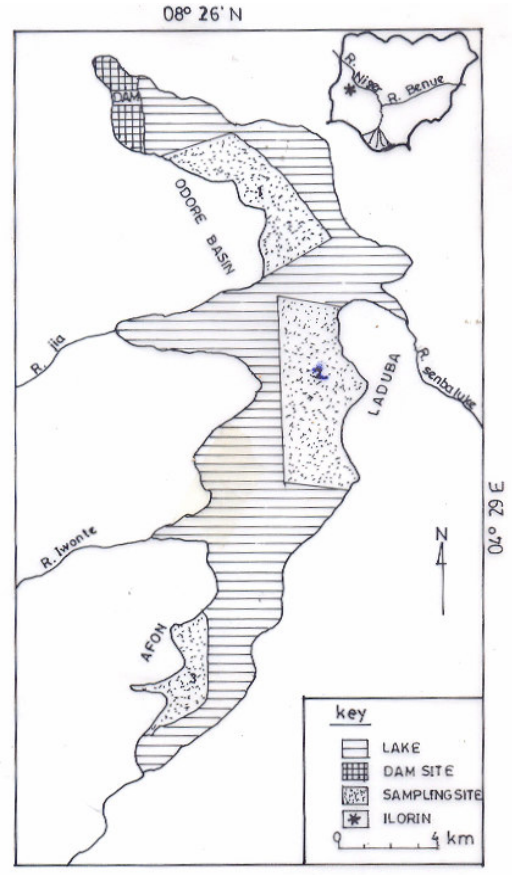

Figure 1. Sketch map of Asa Lake showing the sampling sites.

lake Ghana and Raheja (1973) on Lake Nasser. Most of these reports were on large water bodies. Apart from the work of Araoye, 1997 and 2007 on bio-ecology and the temperature regime of Asa lake respectively, there has been no recent report on the pH and dissolved oxygen of this water body that supplies fish to the people of Ilorin and environ. Hence this work shall constitute a baseline report for subsequent studies on other physico-chemical features of this water body while also complementing the recent work of Araoye, 2007.

MATERIALS AND METHODS

Asa dam was constructed in 1977 primarily for domestic water supply to Ilorin town by the Kwara State Government of Nigeria. The dam is located at about 5 km south of Ilorin the Kwara State capital across river Asa at a latitude 08°26' north and a longitude 04°29'. The dam is 597 m in length and 27 m height with a crest width of 6 m (Table 1).

Surface area of the reservoir is 302 hectares (Ita et al., 1985) and the reservoir is fed by four river tributaries with river Asa being the major river as shown in Figure 1. The sampling sites extended from the dam site to Odore, Laduba and Afon basins (Figure 1). The periods of maximum water levels associated with floods around the lake usually commenced as from June to middle of October corresponding with the rainy season starting from May to the early October (Araoye et al., 2007). Water samples were collected by-monthly from March 2005 to February 2006 between 07.00 and 09.00 h at depth intervals of 2 m up to a depth of 13 m around the dam site using Kemmer water sampler. Dissolved oxygen of the water samples was determined using a dissolved oxygen test kit (Cole Parmer - Model 5946-75), while the pH was determined using the corning portable meter, model PS 15. Transparency was determined using a secchi disc with a calibrated nylon rope attached. Readings were

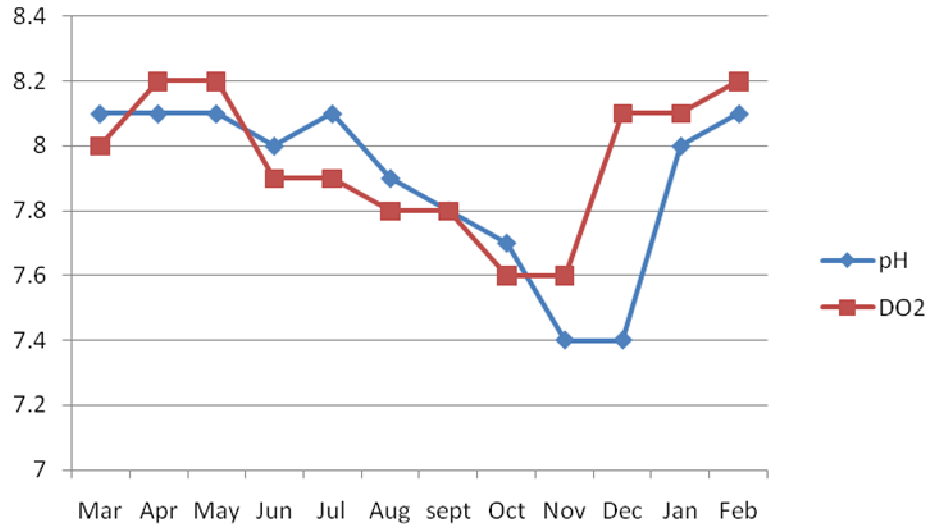

Figure 2. Monthly variations of pH and Dissolved oxygen in Asa lake

were recorded and graphs were plotted for each parameter to describe seasonal variations. Correlations coefficient between these parameters were also determined.

RESULTS

Dissolved oxygen

Monthly variation of the mean dissolved oxygen concentration of the surface waters is presented in figure 2. DO_2 ranged from 7.6 mg/l in October/November to 8.2 mg/l in March/April for the surface waters. The pattern of vertical distribution of dissolved oxygen (Figure 3) followed similar trend as that of pH except that a sharp drop in DO_2 usually occurred at the thermocline zone (5 m depth). The range values from surface to bottom recorded was 8.2 - 2.5 mg/l respectively. A shift of the sharp drop zone was noticed in October and November as the usual drop in DO_2 occurred at 7 m depth while DO_2 recorded between surface to 5 m depth were almost uniform (7.6 mg/l). Dissolved oxygen and pH were positively correlated (0.54).

pH

The mean pH values of the surface waters are also presented in figure 2 ranging from 7.3 - 8.1. Lower values (7.3 - 7.7) were recorded in October to December while higher values (8.0 - 8.1) were recorded in as from January to July. The vertical distribution is also presented in figure 3 with values ranging from 8.1 (Surface) to 5.2 (bottom). There was a fairly define pH stratification from January to September while the pH became fairly uniform (7.3/7.4) in November and December from surface to 9 m depth. There were no marked variations in the pH and DO_2 values along the reservoir.

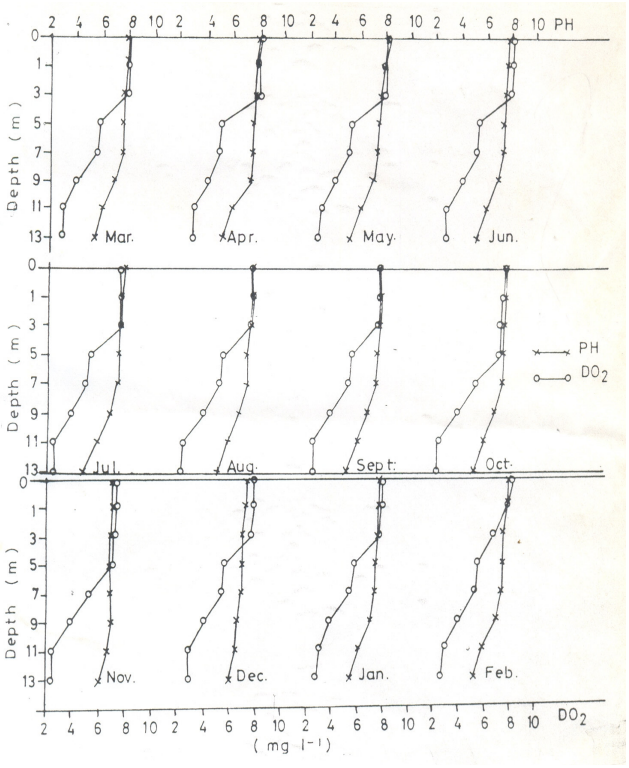

Figure 3. Vertical distribution of pH and DO_2 concentration in Asa lake.

DISCUSSION

The pH distribution of the surface waters showed that it was slightly alkaline. High pH values of 8.0/8.1 were recorded during the dry season while pH dropped during the rainy and harmattan seasons. This drop in pH from 8.1 - 7.3 was probably due to the stirring effect of the incoming flood from the rivers and streams that converged

towards the lake resulting in the mixing of the poorly alkaline or acidic bottom waters with alkaline surface waters to reduce pH. Also the decrease in pH of the surface waters in November and December was due to decomposition of the inundated terrestrial vegetation of the littoral zone following increased water levels. Decomposition reduced the amount of oxygen, while increasing the amount of carbon dioxide in the affected environment. This accounted for the positive correlation between pH and DO_2. Similar observation was reported in Asejire lake Nigeria by Egborge (1977) and also in Jebba lake Nigeria by Adeniji (1991). Dissolved oxygen distribution followed a similar annual cycle with the pH. The high oxygen concentration (8.2 mg/l) recorded during the dry season was due to an enhanced photosynthetic activities and reduced turbidity during the dry season. The drop in DO_2 concentration in October / December was as a result of the vertical mixing due to low surface water temperatures that accompanied the harmattan at this season. The vertical mixing brought hypolimnetic deposits to the water surface resulting in turbidity and reduced oxygen concentration. Araoye (2007) reported the vertical mixing of this lake at this season due to temperature changes resulting in over turn. Similar observation was reported by Vander-Heide (1982) on lake. Brokopondo and Adeniji (1978, 1991) on Kainji and Jebba lakes respectively. Vertical mixing may be of advantage to some fishes inhabiting the surface habitat such as Osteglossidae, Schilbedae, Cyprinidae and Anabantidae (Araoye, 1997) because the need to migrate spatially to the bottom for detritus may not be required at this season. However vertical mixing resulting in depletion of oxygen or very low concentration of oxygen could be disastrous to fish species like the Tilapines that mat not cope well in this type of situation The flooding of the lake as from May to September came with suspended solids and dissolved salts which also resulted in the negative correlation of DO_2 concentration with Total Dissolved Solids (TDS) and conductivity (Araoye, 1997). High concentration of dissolve salts, suspended solids resulting in turbidity and reduced oxygen concentration was also confirmed by Imevbore (1975) in Kainji lake. High conductivity and sediments were reported in Jakara reservoir Nigeria by Adeniji and Mbagwu (1990). The result of this work has also shown that the fish species distribution are not likely to change due to the little or no variation of the pH and DO_2 concentration along the three sampling sites across the lake.

REFERENCES

Adeniji HA (1978). Diurnal vertical distribution of zooplankton during stratification in Kainji lake Nigeria. Verh. Int. Verin. Limnol. 20: 1677-1683.

Adeniji HA (1991). Limnology and biological production in the pelagic zone of Jebba lake, Nigeria. Ph.D Thesis, University of Ibadan. p. 292.

Adeniji HA, Mbagwu IG, Ibikunle F (1984). Study on some aspects of the water quality of the new Jebba lake and its effect on the lake fisheries. K. L. R. I. Annual report, pp. 25-32.

Adeniji HA, Mbagwu IG (1990). Studies of some physic-chemical factors and heavy metals in the Jakara reservoir in Kano State Nigeria. NIFFRI Annual Report, pp. 136- 140.

Araoye PA (1997). Bio-ecology of a Mochokid, Synodontis schall (Bloch and Schneider 1801) in Asa lake Ilorin, Nigeria. Ph.D. Thesis University of Ibadan. p. 201.

Araoye PA (2007). Aspect of meteorological factors and temperature regime of Asa lake, Ilorin Nigeria. The Zoologist. pp.39-46.

Araoye PA, Adedeji RA, Dada JO, Adebiyi GO (2007). Relationship between the rainfall water levels flooding and fish supply from Asa dam Ilorin, Nigeria. In: Proceedings of the Fisheries Society of Nigeria. Eds. Araoye PA, Adikwu IA, Banke ROK. Publ. Fisheries Society of Nigeria. pp. 236-239.

Biswas SO (1973). Limnological observations during the early formation of Volta lake in Ghana. Geophys. Monogr. 17: 121-128.

Boyd CE (1979). Water quality in warm water fish ponds. 1st Edition. Craftmaster Printers, Alabama. p. 353.

Egborge AB (1977). The hydrology and plankton of Asejire lake. Ph.D. Thesis, University of Ibadan, Nigeria. p. 278.

Imevbore AMA (1975). Ecology of the newly formed Kainji lake. In: The ecology of Lake Kainji. Transition from river to lake. University of Ife Press. p. 203.

Ita EO, Sado EK, Balogun JK, Pandogari A, Ibiwoye B (1985). Inventory survey of Nigerian inland waters and their fishery resources. A preliminary checklist of inland water bodies in Nigeria with special reference to ponds, lakes, reservoirs and major rivers. K.L.R.I. Tech. Report Series II. New.

King BDL (1970). The role of carbon in Eutrophication. J. Water Pollut. Control Fed. 42: 2035-2051.

Raheja PC (1973). Lake Nasser. Geophys. Monogr. 17: 234-245.

Vander-Heide J (1982). Lake Brokopondo: Filling phase limnology of a man-made lake in the human tropics. Alblasserdam Off sedrukkerij Katers. B.V. p. 427.

Whitney RJ (1942). Diurnal fluctuations of oxygen and pH in two small ponds and a stream. J. Expt. Biol. 19: 92-99.