



Assessment of The Water Quality Parameters of Lapai – Agaie Reservoir, Niger State, Nigeria

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ABSTRACT

Assessment of the water quality parameters of Lapai – Agaie reservoir was conducted from July – December, 2014. The water quality parameters; the physico – chemical parameters studied and analysed include: Dissolved Oxygen (DO₂), pH, Alkalinity, Transparency, Electrical conductivity, Total Water Hardness, Temperature, Phosphate – phosphorus and depth. The results revealed that the condition of this reservoir vary in different months, and for sampling stations showed seasonal fluctuations in the water quality parameters. Values of the water quality parameters observed ranged: Dissolved Oxygen (DO₂), 1.5 – 2.5mg/l, pH, 4.5 – 7.1, Alkalinity, 14.9 – 19.1mg/l, Transparency, 0.5 – 1.7m, Electrical conductivity, 36.4 – 46.8µs/cm, Total Hardness, 20.1 – 23.5mg/l, Temperature, 20.4 – 26.7°C, Phosphate – phosphorus, 0.3 – 1.7mg/l and Depth 4.5 – 6.4m. There were significant differences in the values of the water quality parameters result obtained between the two mean values recorded during the period of study. The differences may be as a result of the influx or organic waste deposit from surface water run – offs, and fertilizer deposited by man in the advent of farming. The water quality parameters recorded revealed close agreement with the international recommended range and Federal Ministry of Environment (FMENV) standard for domestic and aquaculture usage..

Keywords: Lapai – Agaie Reservoir, Dissolved Oxygen, Turbidity,

INTRODUCTION

Reservoirs are constructed to provide water for domestic use, irrigation and hydroelectric power generation, for the communities. According to Visser, (1970) and Wetzel, (1983) man made reservoirs are constructed during their early stage of occupation because the new communities undergo series of ecological changes immediately after construction, before it gradually approaches a relatively stable state. The pressure from human activities on the reservoir may have a series of negative consequence on water quality, which may limit its use and constitute an ecological hazard to the environment (Dokilili, 2003).

Water quality analysis is important to preserve and protect the natural ecosystem. Various physico – chemical and biological methods have been reported. The studies of the different water parameters are very important for understanding of the metabolic events in aquatic ecosystem. The parameters influenced each other, and also the sediment parameters, are governed by the abundance and the distribution of flora and fauna (Pawar and Shebekar, 2012). Such studies when conducted

from time to time indicate the state of the ecosystem. The quality of the surface occurring water, rivers and reservoirs, lakes depends on their physical, chemical and biological properties (Shinde, 2011). Portable water must be of international standard that is free of contamination in terms of physico - chemical parameters and microorganism. According to Boyd and Froshbish, (1990) water contamination could be caused by chemical, physical and biological processes, which also serve as factors controlling the composition of natural water. A good water quality for fish culture must not be of high acidic or alkaline value, it must contain optimum dissolved oxygen, and it must be muddy or turbid, not offensive to organs of smell and sight, and must be free from pollutants such as industrial wastes or effluents including detergents and pesticides.

Received 27 October, 2016

Accepted 02 December, 2016

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In Nigeria studies have been conducted on some major reservoirs, which include the works of Ibrahim *et al.* (2009) on Kontagora reservoir in Niger state, Nigeria, Shiroro reservoirs on the Kaduna River, a tributary of the Upper Niger (Kolo and Oladimeji, 2004), Goronyo and Bakolori reservoir on the Rima and Sokoto Rivers, respectively, both out of confluence

with the Kaduna River (Ita *et al.* 1982), Tiga Reservoir located on Tiga plain in Kano State, which flows into the Hadejia River valley, which joins up with the Jama' are River to form the Yobe River that empties in to Lake Chad (Adeniji and Ita, 1977) and Kainji reservoir on the main River Niger (Balogun, 1986; Adeniji, 1983).

This research work investigate some aspects of the water quality parameters (i.e. physico - chemical parameters) in Lapai - Agaie Reservoir, Niger state, Nigeria with the objective of determining the water quality status of the reservoir, and its conformity with the national and international standard limits.

METHODOLOGY

Study Area

Agaie - Lapai reservoir is situated on longitude 6°34'E and Latitude 9°13'N on River Jatau. River Jatau joins River Chanchaga at Ebba which is one of the major tributaries of River Gbako that drains into River Niger, south of Badegi. The reservoir is located near Bakajeba village about 20km north from Lapai, the headquarter of Lapai local government area and about 25km south of Paiko, the headquarter of Paiko local government area of Niger State. Both towns and the reservoir are located south of Minna, the capital of Niger state. The study area is characterized by climatic conditions that prevail in the tropical hinter land climate belt of Nigeria, where the annual rainfall ranges between 100 and 150cm, and the relative humidity is about 70% on the average (Iloeje,1976). The area lies within the guinea savanna belt of Nigeria. The reservoir supplies the nearby villages with drinking water, and also used for irrigation activities. Five sampling stations were established on the reservoir for the purpose of the study: - Bakajeba I, Gana II, Gidan Alhaji III, Quarters IV and Water Board V (Figure 1).

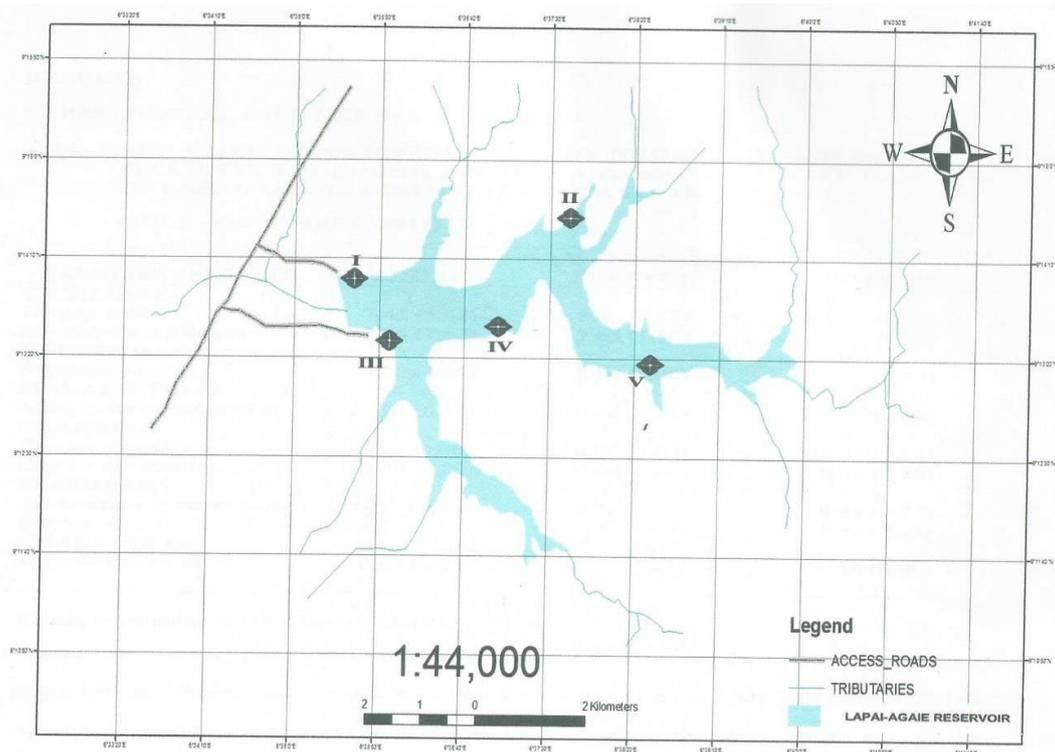


Figure 1: Map of Lapai – Agaie Reservoir, Niger State, Nigeria

Source: Niger State Water Board, Minna.

Determination of the physico - chemical parameters

Data were collected for the physico – chemical parameters during the period of the study July - December, 2014.

Temperature

The temperature of the air, water surface and depth was measured using a thermometer calibrated in degree centigrade (°C) (APHA, 1992).

Transparency

A Secchi – disc of 25cm in diameter were used to determine the transparency of the water sample. This was done by lowering the Secchi - disc into the water, until it ceased to be visible. The depth of the disappearance and reappearance was measured to the nearest centimeter (cm) and the average taken (APHA, 1992).

pH

The pH of the water was determined with the use of a pH meter (Pye Unicam model 392) at 25 (°C). The meter was standardized with a buffer solution at pH 4.0,7.0 and 9.0 before the readings were taken (APHA, 1992).

Dissolved Oxygen

The dissolved oxygen of the sample water was determined by using the modified winkler azide method (Lind,1979; APHA,1992).

Total Alkalinity

Total alkalinity was determined by measuring 100ml of water sample in 250ml Elenmeyer flask, three drops of phenolphthalein indicator was added and the pink was titrated with 0.02N H₂SO₄, until the pink colour just disappear and the millilitre(s) (ml.) of acid used recorded for alkalinity calculation (APHA, 1992).

Calculation :-

Phenolphthalein Alkalinity =

$$\frac{A \times N \times 50,000 \text{ (mg/l CaCO}_3\text{)}}{\text{ml. of Sample}}$$

Where A = ml. Of titration for sample to reach phenolphthalein end point (i.e. pH 8.3)

Where B = ml. Of titration for sample to reach methyl orange endpoint (i.e. pH 4.5)

N = Normality of acid (0.02N) (APHA, 1992).

Total Water Hardness

This was done using EDTA titration method (APHA,1992). The calculation was based on the equation given by Lind (1979), and APHA (1992).

EDTA Hardness ($\text{mg l}^{-1} \text{CaCO}_3$) = ml. Titration
x 40

Electrical Conductivity

The electrical conductivity of the water sample collected from the five sampling station was measured in the laboratory using a conductivity meter (Model Unicam pye 292).

Phosphate – Phosphorus

Phosphate – phosphorus was determined using the Denigen (Lind, 1979 and APHA, 1992). One millilitre (1ml.) of Denigens reagent and 5 drops of stannous chloride was added to 100ml. Of water sample, Spectrophotometer – S101 was used to measured the absorbance at 690nm.

Depth

The depth of the water was determined with a simple graduated line made of suitable wire, weighted at one end with an heavy object (Lind, 1979).

RESULTS

Table 1: Mean values of some physico-chemical parameters

Sampling Stations	Air Temp. °C	Water Temp. °C	Depth (m)	Transparency (m)	pH	Dissolved Oxygen (DO ₂) mg/l	Alkalinity (mg/l)	Total Hardness (mg/l)	Conductivity (µhoms/S)	Phosphate - Phosphorus (mg of CaCO ₃ /l)
Bakajeba	23.5	26.7	3.9	0.5	5.5	1.9	16.4	20.1	45.7	0.3
Gana	23.5	21.2	4.5	1.6	6.8	2.5	15.1	21.7	36.4	1.2
Gidan Alhaji	23.5	21.2	5.5	1.4	4.5	1.6	14.9	20.4	46.8	0.8
Quarters	27	28	5.6	0.4	6.5	1.7	18	22	38.3	1.8
Water board	24.3	27.1	6	1.5	7.1	2.1	17.1	21.5	40	0.9

Table 2: Mean monthly values of some physico-chemical parameters

Month	Air Temp. °C	Water Temp. °C	Depth (m)	Transparency (m)	pH	Dissolved Oxygen (DO ₂) mg/l	Alkalinity (mg/l)	Total Hardness (mg/l)	Conductivity (µhoms/S)	Phosphate - Phosphorus (mg of CaCO ₃ /l)
July	20.4	25.2	6.4	1.7	7.1	1.5	17.2	23.5	36.9	1.5
August	23.5	26.7	3.9	0.5	5.5	1.9	16.4	20.1	45.7	0.3
September	23.5	21.2	5.5	1.4	4.5	1.6	14.9	20.4	46.8	0.8
October	21.6	23.6	5.1	0.9	6.5	2	19.1	22.2	40.7	1.7
November	21.3	20.4	4.5	1.6	6.8	2.5	15.1	21.7	36.4	0.9

Table 1, indicate the mean value of the physico-chemical parameters for the sampling stations during the study period (July - November, 2014). Water temperature has the mean value range of 21.2°C – 28°C. The mean water depth ranged between 3.9m – 6m, with water board sampling station of the reservoir having the highest mean depth. Transparency has the lowest mean value (1.6m) at Gana sampling station of the reservoir. The mean value for dissolved oxygen ranged between 1.6 mg/l – 2.5 mg/l, with water board sampling station of the reservoir having the highest mean value. Sampling station near the building quarters of the reservoir recorded the high mean value for alkalinity (18mg/l), while Gidan Alhaji sampling station recorded the lowest value (14.9mg/l). The mean value for water hardness ranged between 20.1 – 21.7 with Gana sampling station having the highest value. The mean value of pH for the sampling stations ranged between 4.5 – 7.1. Electrical conductivity mean value during the sampling period ranged between 36.4µs/cm – 46.8 µhos/S. The highest mean value for phosphate – phosphorus (1.8 mg of CaCO₃/l) was recorded by sampling station near the building quarters of the reservoir.

Table 2, indicates the monthly mean value of the physico-chemical parameters during the study period (July - November, 2014). Water temperature has the mean value range of 21.2°C – 26.7°C. The mean water depth ranged between 3.9m – 6.4m, with water board sampling station of the reservoir having the highest mean depth. Transparency has the highest mean value (1.7m) in the month of July. The monthly mean value for dissolved oxygen ranged between 1.5 mg/l – 2.5 mg/l, with November having the highest mean value. The month of October recorded the highest mean value for alkalinity (18mg/l), while September recorded the lowest value (14.9mg/l). The mean value for water hardness ranged between 20.1 – 23.5 with the month of July having the highest value. The monthly mean value of pH for the sampling stations ranged between 4.5 – 7.1. Electrical conductivity mean value during the sampling period ranged between 36.4µs/cm – 46.8 µhos/S. The highest mean value for phosphate – phosphorus (1.7 mg of CaCO₃/l) was recorded in the month of October.

DISCUSSION

There were some marked variations in the physico – chemical parameters observed for the sampling stations with respect to months and the seasons of the study. Favourable temperature increases devoid of thermal pollution, according to Klapper (2001) tend to augment the productivity of a water body, increasing algal growth, bacterial metabolism and nutrient cycling rates. The temperature recorded for Lapai- Agaie reservoir during the study period lies between 20.4°C to 26.7°C, this agreed with the temperature range recorded by Indabawa (2009), in the studies on limnological parameters and phytoplankton dynamics of Nguru Lake, Yobe state, Nigeria. The water temperature range for the entire reservoir compare well with the ranges recorded in other tropical lakes (Adebisi; 1981, Ovie and Adeniji, 1993; Adakole *et al.* 2003). The normal range of which fish is adapted in the tropics is between 8°C - 30°C (Alabaster and Lloyd, 1982). The relatively high temperature observed on the Agaie - Lapai reservoir during the period of the study could be as a result of seasonal effect (Sitaramiah, 1996). This temperature range was also within the optimum range suitable for alga growth (Indabawa, 2009), and also within the tolerable limit for aquatic environment in accordance with national water quality criteria (EPA, 2002). Transparency was observed to be generally low in the present study, a characteristic of reverine area. The highest value of transparency was recorded in Bakajeba sampling station and the least in Gana station. The result agreed with the work of Iloeje, (1976) in the study of Lake Chad. Low Seechi disc transparency recorded during the rainy season which agreed with the observation of Wade (1985), who observed that onset of rain, decreased the Seechi – disc visibility in two mines Lakes around Jos, Nigeria. Lower transparency recorded during the rainy season, when there was turbulence and high turbidity, has a corresponding low primary productivity, because turbidity reduces the amount of light penetration, which reduces photosynthesis, and hence primary productivity (APHA, 1992). The higher conductivity value obtained for the reservoir 36.4 – 46.8µ/cm could be due to concentration effect as a result of reduce water volume from their main tributary channels. Ovie and Adeniji (1993) and Kolo and Oladimeji (2004) observed a similar

trend for Shiroro reservoir. The low water hardness value range of 20.1 – 23.5mg/l for the reservoir could be due to dilution and low concentration of ions. This agreed with the result of Kolo and Oladimeji (2004) for Shiroro Reservoir and Ufodike *et. al.*, (2001) for Dokowa mine Lake. The mean alkalinity agreed with the range value documented by Boyd (1985) for natural water. The high level of alkalinity in the dry season agrees with the findings of Adebisi (1981), on the correlation of the seasonal fluctuation of water level and alkalinity. The dissolved oxygen in the reservoir was high during the dry season than the rainy season. The dry season high value coincides with the periods of low turbidity and temperature. In this study, the cool harmattan wind which increases wave action and decrease surface water temperature, might have contributed to the increased oxygen concentration during the dry season, while torrential rains created increase turbidity, and decrease oxygen concentration during the rainy season. Oniye *et al.* (2002) made similar observation on Zaria reservoir. The high value range 4.64 – 7.60mg/l of phosphate – phosphorus (PO₄-P) could be due to concentration effect because of reduced water volume. It could also be due to lower water hardness (House, 1990; Heleen *et al.* 1995). Akpan and John (1993) made similar findings in Cross River in Eastern Nigeria. The Hydrogen ion concentration (pH) for Lapai – Agaie reservoir was 4.5 – 7.5, and this was within the range for Inland waters (pH 6.5 – 8.5), as reported by Antoine and AL – Saadi (1982). The pH of the water samples were found to be in a narrow range *within* the neutral zone during the period of the research work. This agreed with the records of Mustapha (2002), who works in Oyun Lake in Ilorin, Kwara State of Nigeria, and obtained his result to be within the neutral zone.

Conclusion

The result of this research work provides an insight into the level of the water quality, at Lapai - Agaie reservoir, Niger State. The levels of the water quality parameters (i.e. physico - chemical parameters) determined were within the acceptable ranges for both domestic water purposes and fish production. However, the seasonal and monthly fluctuations in some of the physico – chemical parameters determined

were brought about by the torrential rains of the reservoir area, the characteristic trade winds of the dry season, effects of deforestation, fertilizer application, herbicides, insecticides and other chemical factors.

Recommendation

It could recommended that measure should be taken to protect the reservoir, so as to ensure its usage for a longer period of time. Regulatory authorities of Nigeria (e.g. Niger State Water Board, Federal Environmental Protection Agency and Federal Ministry of Environment) should be employed to monitor the activities of people around the reservoir, as well provide national guidelines and standards for water quality in Nigeria.

It could also be recommended that, the nutrient level that empty into the reservoir should be controlled by employing appropriate measures. Hence a direct restorative measures is required, and various Nigeria environmental laws should be enforced by appropriate authorizes to ensure the protection of the reservoir for long time use.

On these aspects, there is need for the creation of public awareness on the need for protection, sustainable and management of the reservoir, among villagers within the immediate catchment area of the reservoir.

Acknowledgement

The present research work was fully supported and sponsored by the pioneer **TETFund, Abuja, Nigeria** (2014 Intervention Batch) in **IBB University, Lapai, Niger State, Nigeria**.

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