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ASSESSMENT OF PHYSICO-CHEMICAL QUALITY OF WATER IN ALIERO DAM (KEBBI STATE, NIGERIA)

Godwin Abuh E[1]† --- Abdullah Adil Ansari[2]
[1]*Department of Biological Sciences, Kebbi State University of Science and Technology, Aliero, Kebbi State, Nigeria*
[2]*Department of Biology, University of Guyana, Georgetown, Guyana*

ABSTRACT
Aleiro dam in Aleiro Local Government of Kebbi state (Nigeria) constructed in 2010 is not only used for irrigation purposes but also serves the ecological needs of the local communities. This study was carried out during the year 2010-11, in order to assess the physico-chemical quality of water in the dam reservoir. The water samples were collected for a period of 6 months (monthly basis), from the three marked channels and were subjected to physico-chemical analysis. The results indicated that water quality is up to the standards accepted by WHO and FAO. The water is suitable for irrigation as required values for the concentration of sodium, magnesium, calcium and other elements are within the approved range suggested by FAO.

Keywords: Ecology, Aquatic biology, Ecosystem services, Eutrophication, Irrigation.

Contribution/ Originality
This research contributes towards the assessment of freshwater bodies in Nigeria. The contribution is highly significant in the area of basic climate change impact.

1. INTRODUCTION
Water is the basis of life, and development of water resource is an important component in the integration of an area [1]. Reservoirs are essential for good water supply for irrigation, fish production, recreation and sustainable ecological biodiversity system within the regions of their locations [2]. There is continuous increase in the demand for water in many parts of the world for various uses such as domestic, industrial and irrigation purposes. Due to impounding impact of expanding human population such water bodies are stressed by unsustainable human activities with serious implication on physical and chemical properties of water with functional effect on aquatic biology [2, 3]. Several man-made reservoirs in northern Nigeria have been studied by researchers in terms of physico-chemical parameters [4-9]. These studies have indicated that some of the physico-chemical variables were within standard limits whereas others such as nitrogen and phosphates were in a higher concentration range compared to established freshwater bodies. The reasons attributed to the problem were the runoff containing nitrogen and sulphates from agricultural fields and washings from animal herds visiting adjoining areas, into the reservoirs that cause eutrophication. Such human directed activities affect the water quality and fish production. Eutrophication is becoming a serious threat to water reservoirs in many countries especially African countries where it is an essential source for livelihood [2, 3].

Aliero dam was constructed in the year 2010 to irrigate an area of about 6000 hectares during the dry season. It was aimed to ensure adequate water supply for inhabitant of this area apart from providing essential ecological services in the adjoining areas of Aliero. Therefore assessment of water quality was important to monitor the changes taking place in reservoirs like Aliero Dam that may aid in developing strategic plan to prevent ecological

† Corresponding author

degradation. The present research work was conducted as the water quality of Aliero dam has not been studied in the recent past.

2. MATERIALS AND METHODS

The study of water quality in Aleiro dam (12^{0} 16' 42N 4^{0} 27' 6" E) in Aleiro Local government of Kebbi state was carried out during the year 2010-11. The study area has a population of about 200,000 of which most of them are farmers and fishermen. The climatic condition of Aliero is the wet and dry season and is characterized by an e average amount of rainfall (800 mm), which is between 4 to 5 months ranging from May to September. The maximum temperature that increases from January onwards reaching a peak of 35 ^{0}C to over 37 ^{0}C in April that is between the arrival of planting season, and the minimum temperature is about 25 ^{0}C. Tropical continental type of climate prevails with two air masses blowing from Atlantic (tropical maritime) and Sahara desert (tropical continental), respectively, creating wet and dry seasons in the region. The relative humidity is generally low (40 %) for most of the year except during wet season (reaches up to 80 %). One of the major problems associated with the physical environment in this region is desertification that causes serious constraint in the development. Some of the factors responsible for ecological problems are attributed to limited rainfall, indigenous method of cultivation, excessive sources for fuel wood and indigenous grazing techniques [10, 11].

The water samples were collected from the three marked channels "SITE A, B and C", which measured about 20 m intervals between the channels. The water samples were collected for six months and collection was done once in each month, starting from December 2010 to May 2011. The determination of physico-chemical parameters (temperature, dissolved oxygen, pH, electrical conductivity (EC), sodium, potassium, calcium, magnesium, phosphates, ammonium, nitrates, bicarbonates and chlorides) of the water was carried out using standard methods [12-14] at the Agricultural Laboratory at the Faculty of science, Usman Danfodio University, Sokoto.

Surface water temperature, pH and electrical conductivity (EC) were measured *in situ* using Hanna portable pH/EC/TDS/temperature combined water proof tester model HI 98129. Dissolved oxygen was determined by Azide modification of the Winkler method. Nitrate and phosphate were measured according to APHA [14] Standard procedures using Hach spectrophotometer model DR-EL/2.

Data recorded were analyzed using Microsoft Excel 2007. ANOVA and LSD were used to calculate the significance at 95% confidence level for the changes in physico-chemical parameters of Aliero Dam.

3. RESULTS AND DISCUSSION

Table 1 shows the physico-chemical analysis recorded during the study period. Statistical tool [Least Significant Difference (LSD)] was employed for data analysis (Table 1). The established standards [15-17] used for the comparison of water quality are as follows:

pH- 6.5-8.5, EC- <600 µs/cm, Na- >200 mg/l, K- <20 mg/l, Ca- <100 mg/l, Mg- <30 mg/l, Nitrate- <10 mg/l, Chloride- <250 mg/l and DO- <6 mg/l.

During the study period the air temperature fluctuation ranged between 20^{0}C and 24^{0}C. The temperature was higher in May with a mean value of 24 ^{0}C and lower (20^{0}C) in December and showed no significant difference from December to January but significantly differed from the other months (Table 1). There was a decrease trend of temperature from December. The temperature of the water was within the approved standard of WHO, with mean value of 21.9 ^{0}C. The water temperature is attributed to weather condition prevailing during the period of study. The increase in temperature during the later month was as a result of dry season with higher intensity of solar radiation absorption by shallow reservoir [2, 18]. The surface water temperature recorded collates with earlier studies done on African water bodies [2, 19].

Dissolved oxygen (DO) is an important indicator of water quality and ecological productivity of a reservoir [2]. The highest level of dissolved oxygen (6.3 mg/l) was observed in December and it showed significant difference from other months. The lowest mean value was observed in May and deflects no significant difference from April but differs significantly from other months (Table 1). The dissolved oxygen was higher in December due to prevalence of cool weather condition facilitating mixing of water [2]. There was seasonal variation of DO which is attributed to temperature regime in conjunction with greater rate of decomposition [2]. The mean value of 5.15 mg/l is closer to the finding of Adeniji [5] and Ita [20] who reported DO concentration between 5.80 – 6.60 mg/l in Bakolori reservoir in the semi-arid land in the North–Western part of Nigeria. The range of DO recorded indicates that the water quality is good for aquatic productivity [2, 21].

The pH is an indication of buffering capacity of aquatic water body [22]. From December to May, the highest pH was observed in January with a mean value of 7.1 (Table 1) but there was no statistical difference observed when compared to December 2010 (7.0). The lowest pH value was observed in May (6.0) which gives a significant difference when compared to the other months. The trend indicated gradual decrease in pH. According to WHO and FAO standard, the pH was within the limit (near neutral) with the mean value of 6.7. The observed decrease in pH of the water could be as a result of increase intensity radiation and lack of rain during the dry months. The recorded value of pH was near neutral because Aliero Dam was going through early formative stage. Prabhavathy and Sreenivasan [22] reported that the total alkalinity of confined water are classified as those with low, moderately high and total alkalinity. The highest electrical conductivity was observed in May with mean value of 1329.0 µS/cm (Table 1). This showed a great difference when compared with the previous months, the lowest being December 2010 with mean value 894.9 µS/cm. Between January and March, the values obtained showed no significant difference but between March and May, there was a drastic increase in Electrical Conductivity (Fig. 1). The drastic increase observed in electrical conductivity could be as a result of low volume of water and the rise in temperature [3].

May was observed to be the peak for Sodium with the mean value of 1.1 mg/l (Table 1) and this show a significant difference when compared with all other months, with minimum value reached in December 2010 and January 2011 with mean value of 0.9 mg/l, respectively. Thus, there was significant difference in the value obtained from the month of December 2010 to April 2011, thereby showing an increase in the trend of sodium. There was a gradual increase in Potassium from December to May. The highest mean value was observed to be 5.4 mg/l (Table 1) in May and the lowest was observed in December (0.6 mg/l). Statistically there was significant difference between December and the other months. The mean value of sodium and potassium are 0.97 mg/l and 3.07 mg/l, respectively. Water with low sodium concentration can be used for irrigation on almost all kinds of soil [3].

The highest mean value of calcium 0.97 mg/l, was observed in December 2010 (Table 1), while the lowest Ca content was observed at April with mean value of 0.57 mg/l. There was no significant difference between March, April, and May. The calcium concentration according to FAO standards is 0.005 mg/l [23] and mean value of calcium obtained (0.75 mg/l) was higher than FAO standards. The mean value of Magnesium of 1.35 mg/l (Table 1) was observed to be the highest in February. There was no significant difference between the February and the other months, the lowest was December with mean value of 0.62 mg/l which showed a significant difference when compared with the subsequent months. Magnesium mean value observed was 1.1 mg/l, which is lower than the FAO standard for magnesium. The result may be caused by the fluctuation in environmental condition as seen in the general trend of magnesium [24].

There was a sharp increase in phosphate in December and January and a decline in the other month. The highest mean value (0.05 mg/l) in January (Table 1) with a statistical difference when compared with other months. The least mean value was observed in March to be 0.03 mg/l. Phosphate has a mean value of 0.03 mg/l. The presence of phosphate in the water was because most of the resident around the dam and farmers around usually do their laundries around the water body and most laundry detergents contain phosphates [24].

Mean value of ammonium was 0.01 mg/l. The highest value of NH_4 was obtained in the month of February, March and May with mean value of 0.005 mg/l (Table 1), respectively. It showed no significant difference with the other months. December with mean value of 0.004 mg/l is the lower one. There was no significant difference observed in the six month mean values of nitrate (Table 1). The low concentration of nitrates may be an indication of low primary productivity. In terms of HCO_3^- values, stability was observed between February and April and a fall in the month of May. December showed the highest mean value (1.2 mg/l) (Table 1). February, March and April had no significant difference when compared to each other. The mean value of bicarbonate was 0.9 mg/l, a lower value. The peak of chlorine concentration was observed in March with a mean value of 3.6 mg/l, while the lowest was 2.1 mg/l (Table 1) in the month of May. There was significant difference between all the month exception of December and January where mean value was the same (2.9 mg/l).

From the result of the analysis, most of the physico-chemical parameters of water from Aliero dam are within the range approved by the World Health Organization (WHO) and Food and Agricultural Organization (FAO). The concentration of salts (sodium, potassium, calcium and magnesium) was observed to be low in Aliero Dam with restrictive seasonal fluctuation. This could be attributed to ionic utilization by organisms in dry seasons [2, 3]. Slight increase in potassium could be as a result of runoff from chemically fertilized farmlands [2, 3, 25].

4. CONCLUSION

The results of this research work indicated that physico-chemical parameters of water from Aliero Dam are within the standard values accepted by WHO and FAO. The water is thereby suitable for irrigation as required values for the concentration of sodium, magnesium, calcium and other elements are within the approved range suggested by FAO.

Table-1. Physico-chemical analysis of water reservoir (Aliero dam) (Mean ± SD)

Parameters/ Months	Dec 2010	Jan 2011	Feb 2011	Mar 2011	April 2011	May 2011	LSD
Temp (°C)	20.4±0.6 d	20.0±0.9 d	22.3±0.3 c	22.1±0.4 c	23.1±0.4 b	24.0±0.7 a	0.7
DO (mg/l)	6.3±0.2 a	5.7±0.2 b	5.4±0.1 c	4.3±0.2 de	4.7±0.2 d	4.5±0.2 d	0.2
pH	7.0±0.4ab	7.1±0.4a	7.0±0.4 b	7.0±0.4 ab	6.5±0.4 c	6.0±0.4 d	0.1
EC (µS/cm)	894.9±197.9d	902.4±197.9 c	904.5±197.9 c	908.8±197.9 c	1233.7±197.9 b	1329.0±197.9 a	6.7
Na^+ (mg/l)	0.9±0.1b	0.9±0.1 b	1.0±0.1 ab	0.9 ±0.1 b	1.0±0.1 ab	1.1±0.1 a	0.2
K^+ (mg/l)	0.6±1.9 f	0.8±1.9 e	3.4±1.9 d	3.6±1.90 c	4.5±1.9 b	5.4±1.9 a	0.2
Ca^+ (mg/l)	0.97±0.3 a	0.83±0.3 ab	0.77±0.3 bc	0.75±0.3 bcd	0.57±0.3d	0.59±0.3cd	0.1
Mg^{+2} (mg/l)	0.62±0.3 c	0.88±0.3b	1.35±0.3 a	1.22±0.3 a	1.32±0.3 a	1.25±0.3 a	0.1
PO_4^{-3} (mg/l)	0.03±0.0 b	0.05±0.0 a	0.03±0.0 b	0.03±0.0 b	0.03±0.0 b	0.03±0.0 b	0.01
NH_4^+ (mg/l)	0.004±0.0 a	0.004±0.0 a	0.005±0.0 a	0.005±0.0 a	0.030±0.0 a	0.005±0.0 a	0.01
NO_3^- (mg/l)	0.01±0.0 a	0.01±0.0 a	0.01±0.0 a	0.01±0.0 a	0.01±0.0 a	0.01±0.0 a	0.008
HCO_3^- (mg/l)	1.2±0.2 a	1.1±0.2 b	0.9±0.2 c	0.8±0.2 a	0.9±0.2 c	0.7±0.2 d	0.1
Cl^- (mg/l)	2.9±0.5 c	2.9±0.5 c	3.3±0.5 b	3.6±0.5 a	2.6±0.5 d	2.1±0.5 e	0.3

($p \leq 0.05$)

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