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AN ASSESSMENT OF THE PHYSICO – CHEMICAL PROPERTIES OF MORO LAKE, KWARA STATE, NIGERIA

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ABSTRACT

Sampling of the physico-chemical factors from two stations on the surface water of Moro Lake in Kwara State, Nigeria was carried out biweekly over a period of 8 months spanning both wet and dry seasons. The aims were to determine the water quality, productivity, assess nature or man's impact on the physico-chemistry of the lake water with a view to effective utilization, better management, conservation and sustainable exploitation of the lake resources. Temperature was measured using mercury in glass thermometer & ranged between 22^{0}C and 28^{0}C. Transparency was determined by a standard secchi disc and varied between 17cm and 55cm, while current was determined by flotation method and ranged between 14cm/s and 60cm/s. Dissolved oxygen was measured by modified Winkler – azide method and ranged between 3.2 mg/l and 6.2 mg/l while carbondioxide was determined by phenophtalein titration method. Calcium, magnesium, nitrate, phosphate, silica, & sulphate were measured using a Hach multichemical analysis spectrophotometer model DREL 5. All these ions showed variation in their concentrations with time. Conductivity and pH were measured with meters. Nitrate & phosphate were high showing a case of cultural eutrophication occurring from washing of nitrophophate fertilizer from nearby farmlands into the lake. In general, the surface water quality of the lake is good and the lake is productive and eutrophic.

Key words: Physico-chemical factors, Moro lake, Eutrophication, Water quality, Productivity.

INTRODUCTION

Water is known to contain a large numbers of chemical elements (Hutchinson, 1957). Physical parameters such as temperature, turbidity and current are also known to operate in lake ecosystem (Schowerbel, 1972). The interaction of both the physical and chemical properties of water play a significant role in the composition, distribution and abundance of aquatic organisms. Apart form this, it also gives an insight into the relationships between the organism and their environment and can be used in determining water quality, and productivity of the lake. The Physico-chemical study could also help in understanding of the structure and function of a particular water body in relation to its inhabitants. The chemical elements found in water especially those studied in this work have effect on biological processes which lead to interconversion of energy, production of organic material and ultimately to production of aquatic resources such as fisheries and other biological components found in lake ecosystem.

The proper balance of physical, chemical and biological properties of water in ponds, lakes and reservoirs is an essential ingredient for successful production of fish and other aquatic resources. The presence or absence of chemical elements in a water body might be a limiting factor in the productivity of such water body. Also the abundance of a particular element might suggest the types of organism that may be found as well as indication of ecologically unstable or unfavorable ecosystem which can have negative or positive impact on the population. Studies have shown that water rich in silica will contain a high population of diatoms (Pasche, 1980), while high species diversity of snail could be explained by high concentration of calcium (Williams, 1990a). Also high concentration nitrogen and phosphate is indicative of eutrophication that may lead to Algal bloom and consequently deoxygenation and fish kill. Physical properties such as light penetration, temperature and water movements have been shown to play important roles in plankton's distribution and Lake Stratification.

The physical and chemical limnology of a lake is characterized by hydrologic impact, autogenic nutrient dynamics and biological aspects. These factors combine with each other determine the water quality and consequently community of the lake (Sidneit *et al* 1992). Though some works have been done on the Physico-chemical characteristics of some man-made lakes in Nigeria, these include the works of Adeniji (1990), on Jakara reservoir, Adeniyi (1978) on Kainji lake, Mustapha (2003) on Oyun lake, Adebisi (1981), on upper Ogun river, Kolo (1996) on Shiroro lake. No published information or data exist for this important lake in Kwara State, Nigeria.

The physico-chemical characteristics of a lake can be significantly altered by human activities such as various agricultural practices and irrigation as well as natural dynamics which consequently affect the water quality and quantity, species distribution and diversity, production capacity, and even disruption in the balance of ecological system operating in the lake.

The goal of this paper is to determine the Physico-chemical properties of Moro Lake with a view to revealing information about its water quality, productivity, development and management. It will also serve as a baseline data and reference point when assessing changes caused by nature or man overtime in the lake. Such data will be of high importance for fisheries management and environmental impact assessment for the lake. It will also help in conservation, effective utilization, and sustainable exploitation of the vast aquatic resources that abound in the lake.

MATERIALS AND METHODS

DESCRIPTION OF THE STUDY SITE

Moro Lake is a man-made lake constructed on the Moro River in Ilorin, Kwara State, Nigeria. It is located on latitude 9^0 58'N Longitude 8^0 25'E, it is the second largest dam in Ilorin. The Kwara state capital. It was constructed primarily for the supply of portable water to soldiers of Sobi Army barrack and the surrounding towns such as Shao, and part of Ilorin metropolis. The lake is located in the Guinea Savannah. Characterized by a high evaporation rate with mean annual temperature and rainfall of 27^0C and 2000mm respectively.

Two sampling stations were chosen within the lake. The first station designated as station 1, was at the down stream section of the dam site (lentic section of the river), while the second station, station 2, was at the river course, (the lotic flowing water section of the river) about 1000m from station 1. The choice of the stations is to reflect the lentic ad lotic nature of the lake as well as influence of human activities such as washing, fish landing, etc on the lake ecosystem which is common on station 1.

SAMPLINGS

Samplings for the Physico-chemical parameters were randomly done on each station for 8 months between June 2002, and January 2003 spanning both rainy and dry seasons. Temperature was measured using mercury in glass thermometer accurate to 0.1^0 C, transparency was determined by a standard Secchi disc having a diameter of 20cm with black and white quarters. Water velocity was measured by recording the time it took a float to cover a known distance (100cm) using a stopwatch on the water surface. Dissolved oxygen was determined by modified Winkler azide method, while carbon dioxide was determined using phenophtalein titration method. Measurements of calcium and magnesium (Total hardness), nitrate, phosphate, sulphate, and silica were done using a Hach spectrophotometer model DREL 5, a modern multichemical analysis apparatus. pH was measured using Hanna portable pH digital meter model type PW 9418 and conductivity was measured using Hanna multirange conductivity meter model H1 8033.

RESULTS

The results of the Physico-chemical parameters of the two stations are presented in tables 1 and 2 respectively. Temperature ranged between 22°C and 28^0 C, higher values were obtained at station 1 during dry season. The lowest temperature of 22^0 C was obtained at station 2 in January (Dry season). Secchi disc transparency varied between 17cm and 55cm. Lower transparency values were obtained in station 1. The lowest value of 17cm was obtained in station 1 in October (at peak of the rains) while highest value of 55cm was obtained at station 2 at the beginning of the rains. In general, the water was more transparent during the dry season at both stations and more turbid at the peak of the rains also at both stations. The highest water velocity was obtained in station 2 in Oct at the peak of the rain (60cm/s) while the lowest value of (14cm/s) was obtained at station 1 in June. Water current was more pronounced at station 2.

Dissolved oxygen concentration showed a gradual decrease with time in both stations. Station 2 has a higher value with maximum concentration of 6.8mg/l recorded in June, while lowest value of 3.2mg/l was obtained at station 1 in January. Carbon dioxide concentration varied between 2.0mg/l and 4.6mg/l. Lower values of Co_2 was obtained in station 2. The carbon dioxide concentration was also found to reduce with time. Calcium and Magnesium ions showed gradual reduction in their concentration from June to December with a slight increase in January. The highest calcium concentrations of 28.1mg/l (station 2) and 20.6mg/l (station 1) and magnesium concentration of 16.1mg/l (station 2) and 13.8mg/l (station 1) were obtained in June. Station 2 has more concentrations of these ions than station 1. Total hardness of the water followed the same pattern of calcium and magnesium ions, since the addition of these two makes the total hardness of

the water. Of all the ions studied in the lake, phosphate has the lowest concentration. It ranged between 0.2mg/l and 0.5mg/l in both stations. In contrast to phosphate, nitrate concentration in the lake was higher. The concentration varied between 16.4mg/l and 22.4mg/ in station 1and 5.2 to 8.6mg/l in station 2. Fluctuations in concentrations of the two ions were observed with time.

TABLE 1: THE MONTHLY MEAN VALUES OF PHYSICO – CHEMICAL PARAMETERS AT STATION 1 IN MORO LAKE

Parameters	Wet periods					Dry periods		
	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.
Temperature °C	23	25	26	26	26	27	28	28
Transparency cm	29.8	27.6	20.4	18.0	17.0	24.2	26.1	27.8
Water Velocity cm/S	14	16	19	24	38	36	20	18
Dissolved oxygen mg/l	5.2	4.7	4.2	4.0	3.8	3.6	3.2	3.2
Carbon dioxide mg/l	3.0	3.0	3.5	4.2	4.6	4.0	3.6	3.2
Calcium mg/l	20.6	18.0	17.5	16.2	15.5	14.2	16.0	18.0
Magnesium mg/l	13.8		12.6	10.4	10.0	12.1	13.9	14.0
Total hardness mg/l	34.4	30.6	29.9	26.2	26.3	26.3	29.9	32.0
Sulphate mg/l	15.2	14.8	13.6	13.0	12.2	10.9	11.8	12.6
Phosphate mg/l	0.2	0.3	0.4	0.4	0.5	0.4	0.3	0.3
Nitrate mg/l	16.4	16.8	20.6	21.9	22.4	19.0	18.6	18.0
Silica mg/l	48.0	52.0	47.6	44.2	38.4	30.0	49.6	51.5
PH	7.2	7.2	7.1	6.9	6.8	7.0	7.2	7.1
Conductivity µS/cm	78.8	70.2	66.8	62.4	62.8	63.0	69.6	74.0

TABLE 2: THE MONTHLY MEANS VALUES OF PHYSICO –CHEMICAL PARAMETERS AT STATION 2 IN MORO LAKE

Parameters	Wet periods					Dry periods		
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Temperature °C	22	23	25	25	26	26	27	27
Transparency cm	55.0	46.8	40.2	32.4	28.4	36.0	42.8	44.6
Water Velocity cm/S	26	32	48	54	60	58	42	30
Dissolved oxygen mg/l	6.8	6.5	6.0	5.6	4.8	4.4	4.0	4.2
Carbon dioxide mg/l	2.6	2.4	2.0	2.0	2.1	2.2	2.2	2.4
Calcium mg/l	28.1	26.4	24.2	22.0	23.0	23.0	24.4	26.2
Magnesium mg/l	16.1	14.2	14.6	13.4	12.0	12.0	12.2	14.0
Total hardness mg/l	44.2	40.6	38.8	35.0	35.0	35.0	36.6	40.2
Sulphate mg/l	12.0	10.6	10.2	8.4	8.0	9.6	10.8	10.8
Phosphate mg/l	0.2	0.2	0.3	0.4	0.5	0.3	0.2	0.2
Nitrate mg/l	6.2	6.4	7.8	8.6	8.0	6.6	5.8	5.2
Silica mg/l	36.0	42.4	38.6	30.0	25.1	18.6	24.5	32.8
PH	7.4	7.3	7.2	7.0	7.1	7.4	7.4	7.2
Conductivity µS/cm	88.5	82.4	76.6	70.8	70.6	70.6	72.1	80.4

Silica was the most abundant ion in the lake. The concentration varied between 30.0mg and 52.0mg/L in station 1 and 18.60mg/L to 42.40mg/L in station 2. Fluctuation in the concentration was recorded with time with highest value in July and lowest value in November at both stations. Sulphate values in station 1 was higher (10.90mg/L – 15.20mg/L) than in station 2 (8.0mg 11-12mg/L). The concentration of sulphate was found to decrease from June to October. Electrical conductivity showed relative variations with time, gradual decrease in conductivity was observed. Highest values of 88.5µS/cm and 78.8 µS/cm were obtained in June while lowest value of 70.6µS/cm and 30.0 µS/cm were obtained in November at stations 2 and 1 respectively. The lake water was slightly alkaline at station 2 with surface pH ranging between 7.2 in August and 7.4 in December. A neutral value of 7.0 was obtained in September. Fluctuations in surface pH were observed at station 1. The pH was acidic (6.8) in October, Neutral (7.0) in November and alkaline (7.2) in December. Generally, the lake water tends to move more into alkalinity.

DISCUSSION

The surface water temperature of the lake follows closely that of the air temperature. The temperature variation recorded during the study was optimal for normal growth and survival of aquatic organisms (Boyd, 1979). Lower Secchi disc transparency values, which were obtained during the rains, could be as a result of washing of suspended particles along with floodwater into the lake. Adeniji (1982) has reported this type of observation on Asa Lake. The high water velocity which carried suspended solids at that time (wet period) promoted the low transparency. The water velocity was found to increase with rainfall, this also washed organic fertilizer from nearby farmlands into the lake leading to the europhication observed in the lake. The high velocity especially at station 2 could have effect on distribution of aquatic organism. Jobin & Ippen (1964) have shown that at velocities greater than 0.33m/s, aquatic snails become dislodged and swept away. The absence of high water velocity, run-offs and sedimentation made transparency at station 1 to be high. This will likely concentrate aquatic organisms at that site. The lower values of dissolved oxygen observed in station 1 could be due to cumulative effect of human activities such as sewage disposal where oxygen is used in decomposing these organic water, eutrophication which causes Algal bloom and therefore inability of oxygen to adequately dissolved in the water or the lentic nature of the site where was no serious upturns. The higher Carbon dioxide could also be due to decomposition of these wastes or its production during respiration by organism, which is greater than its uptake by phytoplaktons and macrophytes during photosynthesis as reported by Boyd (1979). Calcium and magnesium ions in the lake form the total hardness of the water. The lake water could be classified as soft since its calcium and magnesium did no exceed 120mg/1 (Renn, 1968). Sulphate is the third most abundant ion in the lake. This agrees with Renn (1968) observation on the abundance of ions in freshwaters. The source of the sulphate could probably be from the mineral rocks that are present around the lake, which is usually mined. Silica is the most abundant ion in the lake. Its abundance could due to decomposition of aluminum silicate minerals in the rocks that are found around the lake. The presence of silica in the lake will promote the growth of diatoms-a major food producer of aquatic ecosystem.

The nitrate concentration maximum of 22.4mg/l in station 1 is higher than most other lakes in Nigeria. 0.54mg/l in Shiroro lake (Kolo 1996), 4.0mg/l in Jebba lake (Adeniji et al 1984), 5.1mg/l in Oyun lake (Mustapha, 2003). The high Nitrate concentration could be due to leaching and surface run off of Nitro-phosphate fertilizer from nearby farmlands into the lake as well as domestic sewage from the barracks being dumped into the lake. The barracks and farm site are located near station 1. This gave rise to cultural eutrophication and this could have serious ecological implications such as algal bloom, hypoxia and even fish kill in the lake. According to Rast et al (1989), increase in Nitrogen or phosphorous one or other of which tends to limit productivity will lead to eutrophication. Eutrophication could also lead to unpleasant taste and odour of the water when the algae die and decompose thus deteriorating the quality of the water. Like Nitrogen, the phosphate concentration is also higher (0.5mg/l maximum) compared to its concentration in most freshwater lakes (Talling and Talling 1965). The high concentration could also be traced to leaching of phosphate fertilizer into the lake. Kolo (1996) has reported this observation in Shiroro Lake. Electrical conductivity of the water was low has a direct relationship with the total hardness of the water. 1mg/l of hardness equals 2 µS/cm of conductivity. (Hanna, 2004). The gradual reduction in conductivity with time may be due to the uptake of the ions by organisms for their metabolism. Similar observation has been reported by Aluyi et al (2003). The pH of the water was normal as is still fell within the recommended range of 6.5-7 for the support of aquatic life (Boyd, 1979).

In conclusion, the surface water quality of Moro Lake could be classified as class 1 (excellent) according to Prati et al (1971) classification. The lake is also productive and will support diverse number of organism from planktons, benthos to fishes and macrophytes going by the abundance of chemical ions needed for interconversion of energy and production of organic materials present in the lake. The only threat to it productivity was the case of cultural eutrophcation, which was observed in the lake.

The results of the Physico-chemical examination of this lake could be helpful in the management of the lake for its water quality and fisheries. Marshal (1984), used Physico-chemical data to predict ecology and fish yield in African reservoirs, while Henderson (1971) and Adeniji et al (1983) have used Morpho-edaphic index based on Physico-chemical data to estimate potential fish yield in Kainji and Goronyo lakes respectively.

The Physico-chemical data obtained in this Lake could be used as a baseline and reference point when assessing further changes caused by nature or man in this lake, since there has not

been published information of data on this important lake.

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