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Assessment of some aspects of the physico-chemical parameters of surface water at Karshi reservoir (Dam Site), Federal Capital Territory, Abuja, Nigeria

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ABSTRACT

Assessment of some aspects of the physicochemical parameters of surface water in Karshi Dam Site, Federal Capital Territory, Abuja, Nigeria was evaluated from January 2018 to December 2019. The aim of this study was to determine some aspects of physicochemical parameters in order to determine the water quality condition of the reservoirs for conservation, management, and sustainable use. Water samples were collected from three sampling stations and analyzed using standard methods, procedures, and instruments. The results of the physico-chemical parameters in Karshi reservoir are recorded. The mean values of physicochemical parameters were all within the recommended WHO limits except turbidity and nitrate. Analysis of Variance (ANOVA) indicated that transparency, turbidity, nitrate, phosphate, and iron were strongly influenced by seasonal variation. Pearson's correlation analysis indicated a positive significant relationship was observed between turbidity-EC ($r = 0.576$), turbidity-Fe^{2+} ($r = 0.832$), transparency-Fe^{2+} ($r = -0.799$), DO-BOD ($r = 0.922$), DO-Nitrate ($r = 0.594$), EC-Fe^{2+} ($r = 0.624$), while a negative significant relationship was observed between transparency-turbidity ($r = -0.941$), transparency-EC ($r = -0.616$) and turbidity-Nitrate ($r = -0.941$). This study has shown that the reservoirs fall within "good/average" water quality, with a class II level of pollution, which is indicative of moderate pollution, especially during the rainy season. Effective monitoring of the reservoir and regulation of activities in and around the reservoir are recommended. Also, water from the reservoir should be treated before consumption.

Keywords: Physicochemical parameter, water quality index, reservoir, Karshi Dam, Nigeria

1. INTRODUCTION

Nigeria has enormous water resources with about 256 billion cubic meters of surface water and 51.6 billion cubic meters of subsurface water [1]. However, Nigeria's inland water resources face several issues, including degrading watersheds and water courses, fragmented and uncoordinated water resource development, poor data, poor watershed management, deteriorating water quality, drought, and desertification in urban and rural areas [2]. Over fifty small and large natural and man-made water-bodies exist in the Federal Capital Territory (FCT), and these water resources have attracted economic, technological, and social growth [3]. According to Nwosah G. C. (2013), the National Water Resources Master Plan (NWRMP) proposed that for a 20-year plan, Nigeria would require at least 264 medium and 820 small dams to meet the developmental needs [1]. Consequently, over 200 dams and reservoirs have been built specifically to meet the water demand.

In the Federal Capital Territory (FCT) Nigeria, several reservoirs have been created. Some of the prominent amongst the lentic water resources are the Jabi Lake, Usuma Reservoir, Pandam Reservoir, and a host of discrete ones, including Karshi Reservoir. Karshi reservoir would serve as a water scheme project to provide portable water for the people of Karshi and environs. Karshi reservoirs require special attention considering their importance in the water supply chain in FCT. Therefore, assessment of physicochemical parameters and water quality status of reservoirs is important to provide data that describes the water quality condition of the reservoir for proper monitoring of the reservoir.

According to Echoke *et al.,* (2018), scientists and water quality operators generate huge amounts of water quality data daily in the form of physical, chemical, and biological variables [4]. Individually, this data does not give us an indication of trends in water quality over time and across geographic areas. Water quality indices provide a way to distill thousands of records of environmental data into meaningful values that indicate the health of water resources and create a yardstick for measuring and assessing water quality.

There is no published data on the physicochemical parameters and water quality status of these reservoirs. Furthermore, studies have previously and currently been carried out on prominent and large reservoirs in FCT. Considering the importance and lacunae in knowledge that exist for the selected reservoir, this study was initiated to provide baseline data that describes the physicochemical parameters, water quality conditions, and even pollution in the reservoir. Hence, this study was understudied. The specific objectives of this study, therefore, are to determine some aspects of the physico-chemical parameters and water quality condition of the reservoir.

2. MATERIALS AND METHODS

2.1. Study Area and Sampling Stations

Karshi reservoir lies between latitude 8049´50´´N-8050´10´´N and between Longitude 7033´50´´E-7034´0´´E and located close to Karshi dam site. Three (3) sampling stations were chosen in the reservoir based on accessibility, depth, volume of water and the various activities taking place in and around the reservoir. Station I is the inlet point where water flow into the reservoir. Station II is mid-section of the reservoirs which represented the area of lentic water between the inlet and outlet, Station III is the outlet i.e the receiving end/outflow of water (figure 1).

2.2. Sample Collection

Water samples were collected monthly for a period of twenty-four months (January 2018 – December, 2019). The samples were collected between the morning hours of 6:00am - 10:00am randomly at intervals then a composite sample was made at each station. Samples were labeled accordingly while water samples for plankton studies were fixed immediately. Water samples was transported and analyzed in Biology laboratory, University of Abuja and Labchemjan Abuja, Nigeria.

2.3. Determination of Physicochemical Parameters

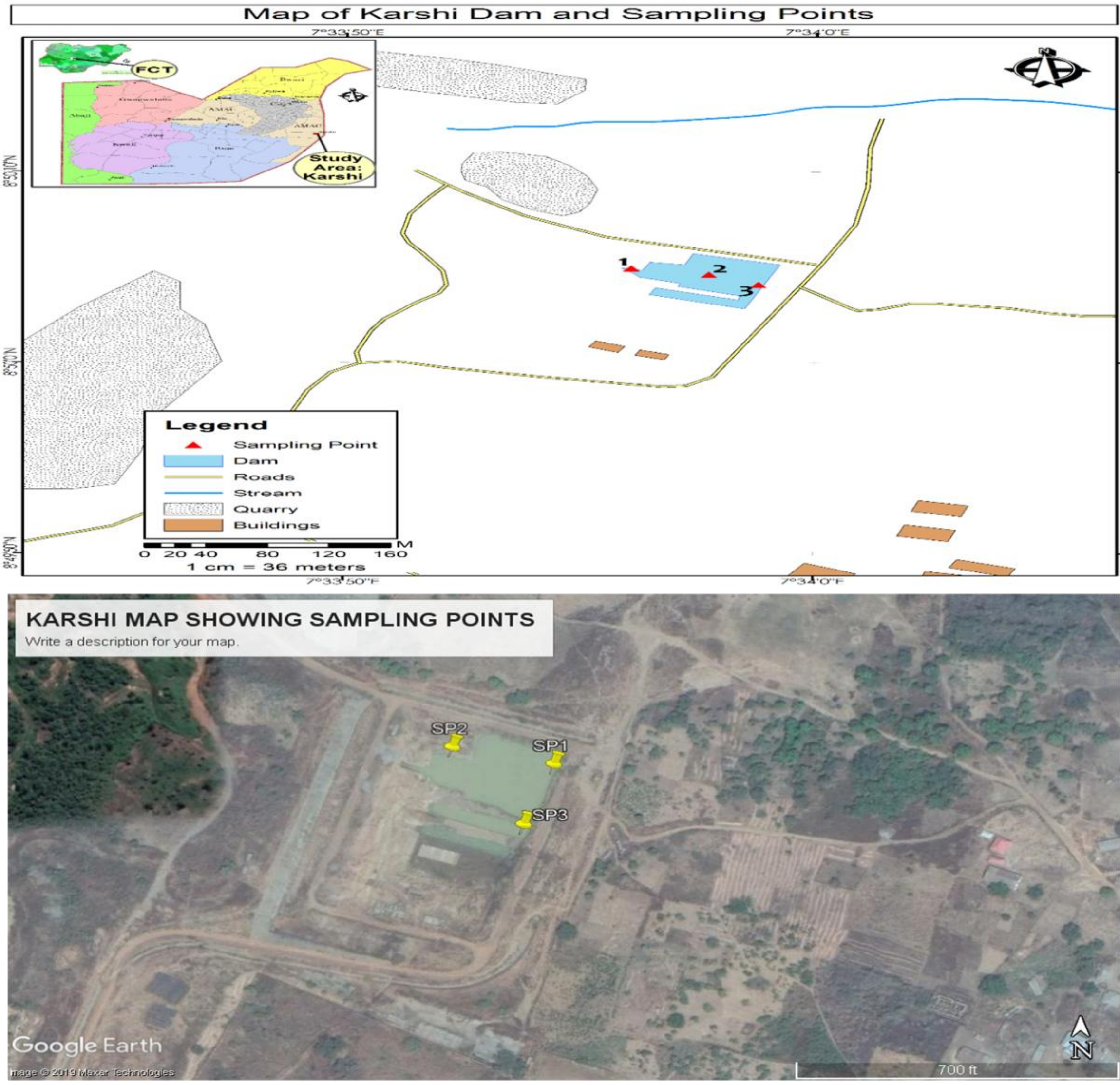

Image 1. Map of Karshi Dam site
Source of Map. http://geospatiallinks.com.ng

Temperature, pH, Electrical Conductivity and Dissolved Oxygen were measured in-situ using a portable Hanna instrument (Model Hi9198) multi parameter meter. The probe was inserted directly into the water for about 2-3 minutes while the readings in the meter were recorded. Transparency was measured using a secchi disc.

2.4. Laboratory analysis

2.4.1. Biochemical oxygen demand, nitrate, phosphate

Biochemical oxygen demand was determined using the 5-day BOD method [5]. Nitrate, phosphate, iron and lead were determined using Spectrophotometric method. 10 ml of the replicate samples were prepared by adding the appropriate recommended reagents described by American Public Health Association (APHA) (2012) [5].

Calculation of WQI

This was carried out using the Horton's method. This is expressed as:

$$WQI = \Sigma q_n W_n / \Sigma W_n \quad \text{....eq 1}$$

Where,
qn = Quality rating of nth water quality parameter.
Wn= Unit weight of nth water quality parameter.

Quality rating:

Quality rating (qn) = [(Vn – Vid) x 100(Sn- Vid)] ….*eq 2*

Where,
Vn = Estimated value of n^{th} water quality parameter at a given sample location.
Vid = ideal value for n^{th} parameter in pure water (Vid for pH = 7 and 0 for all other parameters)
Sn = Standard permissible value of nth water quality parameter

Unit weight

Wn = K /Sn …*eq 3*

Where,
Sn = Standard permissible value of n^{th} water quality parameter.
k = Constant of proportionality[1 / (Σ 1/ Sn=1,2,..n)]

3. RESULTS AND DISCUSSION

Karshi Reservoir is a project of Federal Capital Territory Administration (FCTA) but is supervised by Satellite Town Development Department (STDD). The entire Karshi water project when completed shall be made up of a dam with 64.1 Ha reservoirs area, a balancing reservoir, a spillway and a treatment plan which shall provide about 19.6 million cubic liters of 2500 cubic liters per hour for the residents. The dam is feed from surface water (surroundings in the hill about 2km from the project area) which flows through a channeled pipe and from surface- run off, water inflow is ephemeral. As at the time of visit the water project is still under construction, with an estimated dam area to be approximately 11,888m2 and water capacity of about 6,000,000L3 as at the time of construction (STDD, Archives). The water body is standing and has a T-shape with an elongated arms, it is used for swimming, feeding of livestock and for agricultural purposes (Satellite town development department (STDD Archives).

3.1. Physico-Chemical Parameters of Surface water

3.1.1. Temperature

Temperature values ranged from 23.8–32.3 °C with a mean value of 26.0±1.9 °C, in the sampling stations, station 2 recorded the lowest value of 25.8±0.2 °C while the highest value was recorded in Station 3 (26.1±0.1°C). Monthly mean temperature values as shown in table 3 fluctuated steadily such that monthly temperature values were not significantly different throughout the months (24.3±0.10 - 26.1±0.4 °C) except in the month of March and April (28.0±0.1 - 31.4±0.9 °C) when temperature values were elevated. Monthly mean temperature was lowest in the month of January (24.3±0.10 °C) while the highest monthly mean temperature was recorded in the month of March (31.4±0.9 °C).

The reservoir's water temperature was comparatively

Table 1. Range, Mean, P-value of Physicochemical Parameters of Surface water in Karshi reservoir

Parameters	Range	Mean ±S. E	p-value (stations)	p-value (months)	p-value (season)	WHO LIMITS
Temperature (°C)	23.8-32.3	26.0±0.19	0.849	0.597	0.016	< 40°C
pH	6.3-7.9	7.1 ± 0.3	0.951	0.944	0.152	6.0-9.0
Secchi depth (m)	0.4-1.8	1.2± 0.4	0.795	0.485	0.0048*	
Turbidity (NTU)	10.5-85.0	26.0±13.4	0.967	0.637	0.0001*	<25 NTU
EC (µS/cm)	59.8-257.0	105.4±31.9	0.978	0.611	0.0003*	<1000 µS/cm)
DO (mg/l)	4.9-7.1	6.2±0.4	0.888	0.481	0.518	5.0-9.0mg/L
BOD (mg/l)	5.0-8.0	5.7 ± 0.6	0.510	0.320	0.090	3.0-6.0mg/L
Nitrate (mg/l)	3.9-8.5	6.7±0.9	0.995	0.458	0.090	5mg/L
Phosphate (mg/l)	0.0 - 0.2	0.1 ± 0.0	0.976	0.227	0.002*	0.1mg/L
Iron (mg/l)	0.0-1.6	0.1 ± 0.0	0.997	0.998	0.0006*	0.3mg/L
Lead (mg/l)	0.0-bdl	0.0-bdl	-	-	-	0.1mg/L

Table 2. Mean ± SD Variation of physicochemical Parameters in all stations sampled in Karshi Reservoir

Parameters	STATION 1	STATION 2	STATION 3
Temperature (ºC)	26.0 ± 0.2	25.8 ± 0.2	26.1 ± 0.1
pH	7.1± 0.1	7.1 ± 0.0	7.1 ± 0.1
Secchi depth (m)	1.2 ± 0.1	1.2 ± 0.1	1.2± 0.1
Turbidity (NTU)	20.0 ± 1.2	18.7 ± 1.0	20.6 ± 1.3
EC (µS/cm)	99.9 ± 3.2	111.1±1.4	105.3±1.3
DO (mg/l)	6.2 ± 0.1	6.3 ± 0.1	6.2± 0.1
BOD (mg/l)	5.6 ± 0.1	5.6 ± 0.1	5.8 ± 0.1
Nitrate (mg/l)	6.7 ± 0.1	6.8 ± 0.1	6.6 ± 0.1
Phosphate (mg/l)	0.1 ± 0.1	0.1 ± 0.0	0.1 ± 0.0
Iron (mg/l)	0.3 ± 0.0	0.3 ± 0.0	0.3 ± 0.0

low during the rainy seasons and during the harmattan period, while seasonal mean temperatures were higher during the dry season. Although seasonal mean temperatures were greater during the dry season. Low water temperatures reported during this time might be ascribed to seasonal temperature variations brought about by the chilly harmattan winds and to the rainy season. These findings were lower than those in the Usuma reservoir, the Jabi lake, the Doma reservoir, and the Nassarawa reservoir, Kastina [4, 6-8]. The reservoir's temperature measurements were within the WHO's recommended range for aquatic life growth.

3.1.2. pH value

pH values ranged from 6.3–7.9 with a mean value of 7.1±0.3, in the sampling stations, pH values was steady in all stations (7.1±0.0). Monthly mean pH values in the months of February-March and August-September (6.8 ±0.1-6.9 ±0.0) were not significantly different compared to other months. Monthly mean pH was lowest in the month of February and August (6.8±0.1) while the highest monthly mean temperature was recorded in the

Table 3. Monthly and Seasonal Mean ± (SE) of Physicochemical Parameters in Karshi Reservoir

Months	Temperature (ºC)	pH	Secchi depth (m)	Turbidity (NTU)	EC (µS/cm)	DO (mg/l)	BOD (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	Iron (mg/l)
JAN	24.3±0.10^{a}	7.1 ±0.1^{b}	0.9±0.1^{b}	11.0±0.0^{a}	91.6±7.3^{b}	6.0 ±0.2^{b}	5.5±0.8^{a}	6.4±0.2^{b}	0.1±0.0^{a}	0.3±0.0^{b}
FEB	25.6±0.12^{a}	6.8 ±0.1^{a}	1.1±0.0^{ab}	09.6±0.9^{a}	74.6 ±4.1^{a}	6.0 ±0.0^{b}	5.5±0.4^{a}	7.8±0.6^{ab}	0.1±0.0^{a}	0.1±0.0^{a}
MAR	31.4±0.9^{b}	6.9 ±0.0^{a}	1.0±0.0^{ab}	10.5±0.5^{a}	89.8 ±8.8^{a}	6.1 ±0.1^{ab}	5.1±0.1^{a}	6.2±0.0^{b}	0.1±0.0^{a}	0.1±0.0^{a}
APR	28.0±0.1^{b}	7.2 ±0.1^{b}	1.0±0.0^{ab}	11.0±0.0^{a}	102.2±5.4^{b}	7.0 ±0.0^{ab}	6.8±0.6^{b}	7.2±0.0^{ab}	0.1±0.0^{a}	0.3±0.0^{b}
MAY	26.1±0.4^{a}	7.1 ±0.1^{b}	0.9±0.1^{b}	12.0±1.0^{a}	103.2 ±6.9^{b}	6.4 ±0.4^{b}	5.7±0.7^{a}	7.1±0.1^{ab}	0.1 ±0.0^{a}	0.2±0.0^{a}
JUN	25.6±0.2^{a}	7.4 ±0.1^{b}	0.4±0.10^{a}	32.8±2.0^{b}	132.8 ±58.2^{ab}	5.4 ±0.2^{a}	5.1±0.2^{a}	4.8±0.6^{a}	0.1±0.0^{a}	0.3±0.0^{b}
JUL	25.0±0.3^{a}	7.6 ±0.4^{b}	0.5±0.00^{a}	21.1±4.6^{b}	135.6 ±91.0^{ab}	5.3 ±0.5^{a}	5.0±0.0^{a}	4.8±0.6^{a}	0.1±0.0^{a}	0.5±0.0^{ab}
AUG	25.2±0.3^{a}	6.8 ±0.3^{a}	0.3±0.00^{a}	95.0±3.6^{ab}	233.2 ±48.7^{c}	5.9 ±0.1^{a}	7.3±0.6^{ab}	7.2±0.2^{ab}	0.2±0.0^{a}	0.3±0.1^{b}
SEPT	24.9±0.1^{a}	6.9±0.0^{a}	1.0±0.0^{ab}	71.1±16.0^{ab}	152.1±35.1^{ab}	6.7 ±0.2^{b}	5.1±0.1^{a}	7.0±1.8^{ab}	0.1±0.0^{a}	0.1±0.0^{a}
OCT	25.3±0.2^{a}	7.4 ±0.2^{b}	0.6±0.00^{b}	40.1±5.0^{b}	110.8±10.2^{b}	6.1 ±0.1^{b}	5.0±0.0^{a}	6.1±0.1^{b}	<0.01	0.2±0.0^{a}
NOV	25.2±0.4^{a}	7.1 ±0.3^{b}	0.9±0.0^{b}	11.8±0.3^{a}	83.9±5.2^{a}	6.1 ±0.1^{b}	5.1±0.1^{a}	7.1±0.1^{ab}	<0.01	0.3±0.0^{b}
DEC	25.1±0.1^{a}	7.2 ±0.1^{b}	0.9±0.0^{b}	12.0±1.0^{a}	78.0±16.3^{a}	6.0 ±0.2^{b}	5.4±0.5^{a}	7.1±0.0^{ab}	0.1±0.0^{a}	0.3±0.0^{b}
WET SEASON	25.4 ± 0.1	7.2 ±0.1	0.8 ± 0.3	28.1±17.3	122.0±42.8	6.3 ± 0.5	5.9± 0.8	6.7 ± 1.0	0.1±0.1	0.3 ±0.1
DRY SEASON	26.3 ± 2.4	7.0 ±0.3	1.0 ± 0.1	11.0±0.0	83.6±9.2	6.0 ± 0.4	5.3± 0.6	6.9 ± 0.5	0.1±0.0	0.2 ±0.1

Table 4. Pearson's correlation coefficient between various Physicochemical parameters

	pH	Temp	Transparency	Turbidity	EC	DO	BOD	NO_3^-	PO_4^-	Fe^{2+}
pH	1									
Temp (⁰C)	-0.265	1								
Transparency (m)	-0.39	0.420	1							
Turbidity (NTU)	0.147	-0.404	-0.941	1						
EC (µS/cm)	-0.123	-0.418	-0.616*	0.576*	1					
DO(mg/l)	-0.111	0.017	0.376	-0.456	0.103	1				
BOD (mg/l)	-0.05	-0.255	0.313	-0.391	0.178	0.922	1			
NO_3^- (mg/l)	-0.397	0.213	0.527*	-0.590*	0.24	0.594*	0.493	1		
PO_4^- (mg/l)	0.535*	-0.273	-0.118	0.245	0.541*	0.018	0.054	0.176	1	
Fe2+ (mg/l)	-0.006	-0.396	-0.799*	0.832*	0.624*	-0.288	-0.147	-0.414	0.194	1

month of July (7.6±0.4).

pH is a critical water quality characteristic since it is involved in all metabolic activities. The pH levels in Karshi reservoir are compatible with those seen in natural waters (6.5-8.5), while lower values are possible in dilute waters with a high concentration of dissolved organic compounds and higher values in eutrophic waters. The reservoir's mean pH value was circumneutral, however it was somewhat acidic. [9] and [10] revealed comparable results in other Nigerian bodies of water. Additionally, pH readings were under the WHO range, which was advantageous for aquatic life development.

3.1.3. Secchi Depth (transparency)

Secchi Depth (transparency) recorded a range of 0.4–1.8m with a mean value of 1.2±0.4m, in the sampling stations, secchi depth values was also steady in all stations in Karshi (1.2±0.1m). Monthly mean secchi depth in the months of January, May, October -December (0.6±0.0 - 0.9±0.0) and in the month of February-April (1.0±0.0-1.1±0.0) were not significantly different but was different compared to other months. Decreased secchi depth was recorded the month of June-August (0.3±0.0 - 0.5±0.0), the secchi depth was not significantly different but was different compared to other months. Monthly mean secchi depth was lowest in the month of August (0.3±0.0) while the highest monthly mean secchi depth was recorded in the month of February (1.1±0.).

Turbidity values fluctuated between 10.5–85.0 NTU with a mean value of 26.0±13.4NTU, in the sampling stations, station 2 recorded the lowest value of 18.7±1.0NTU while the highest value was recorded in Station 3(20.6 ±1.3NTU). Monthly mean turbidity values in the months of June, July and October (21.1±4.6- 40.1±5.0) was not significantly different, but where significantly different from other months. Turbidity values in the months of August and September (71.1±16 - 95.0±3.6) were elevated and significantly different from other months. Monthly mean turbidity values were lowest in the month of February in Kurudu (9.6±0.9) while the highest values were recorded in the month of August (95.0±3.6) reservoir.

Turbidity and transparency are both used to describe the clarity of a body of water, yet they are assessed

Table 5. Computed water quality Index (Horton's method) of Karshi Reservoir

Parameters	Estimated value of parameter (Vn)	Parameters of Std values (Sn)	Ideal value of parameter (Vid)	k value	Unit Weight (Wn)	qn	qnWn
pH	7.1	7.5	7.00	0.04	0.01	500.00	2.76
Temp (°C)	26	40	0.00	0.04	0.00	153.85	0.16
Transparency(m)	0.9	0	0.00	0.04	0.00	0.00	0.00
Turbidity (NTU)	26	25	0.00	0.04	0.00	96.15	0.16
EC (µS/cm)	105.4	1000	0.00	0.04	0.00	948.77	0.04
DO (mg/l)	6.2	4.5	14.60	0.04	0.01	120.24	1.11
BOD (mg/l)	5.7	3	0.00	0.04	0.01	52.63	0.73
N-N03 (mg/l)	6.7	5	0.00	0.04	0.01	74.63	0.62
P-P04(mg/l)	0.2	0.1	0.00	0.04	0.41	50.00	20.72
Fe2+ (mg/l)	0.1	0.3	0.00	0.04	0.14	300.00	41.44
Pb2+ (mg/l)	0	0.1	0.00	0.04	0.41	0.00	0.00

WQI for Karshi Reservoir = 67.30, Status= Average quality.

differently. Inversely, greater the measured turbidity lesser the transparency of water (lower secchi depth). The increased turbidity levels seen during the rainy season may be due to silt, sediments, debris, and organic and inorganic suspended particles rushed into the reservoir by flood and surface run-off, particularly during the rainy season. High turbidity values result in a variety of water quality problems, including increased water temperatures (darker water absorbs more sunlight), decreased dissolved oxygen, and decreased light penetration, all of which reduce photosynthesis and thus primary productivity, as well as the numerous problems associated with erosion, storm water/runoff pollution, and excessive algal growth. This conclusion is consistent with the Usuma reservoir [4, 11], and in reservoir in Kastina [8].

3.1.4. Electrical Conductivity

Electrical Conductivity values indicated a range of 59.8-257.0µS/cm with a mean value of 105.4±31.9µS/cm, in the sampling stations, electrical conductivity was lowest in Station 1 (99.9±3.2µS/cm) and highest in station 2 (111.1±1.4µS/cm). Monthly mean EC fluctuated throughout the month however, in the months of February-March, November and December (74.6±4.1-89.8±8.8) and in the month of January, April and October, EC values were not significantly different but where significantly different from other months. Increased EC values were recorded in the month of June-August. Monthly mean EC was lowest in the month of February (74.6±4.1) while the highest monthly mean temperature was recorded in the month of August (233.2 ±48.7).

According to Anago I. J. *et al.,* (2013), conductivity values less than 50 µS/cm are considered low, those between 50 and 600 µS/cm are considered medium, and those more than 600 µS/cm are considered high [10]. Boyd, C. E. (1990) said, however, that natural water often has a conductivity of 20–1500 µS/cm [12]. Karshi's reservoir electrical conductivity suggests a medium degree of conductivity. Conductivity readings grew gradually until during the rainy season, when they surged dramatically. This might be a result of organic matter pollution, other effluents, run-off with a high concentration of suspended particles, or excessive rains. The dry season, on the other hand, had higher seasonal mean electrical conductivity values.

Table 6. WQI table of interpretation

WQI value	Water quality status	Indications
91-100	Excellent	Support high diversity of aquatic life, suitable for all forms of recreation
71-90	Good water	Support high diversity of aquatic life, suitable for all forms of recreation
51-70	Average	Less diversity of aquatic organisms, probability of frequent increase in algal growth, Conventional treatment required
26-50	Fair	Low diversity of aquatic life, probably experiencing problems with pollution
0-25	Poor	Support limited number of aquatic life, significant quality issues

3.1.5. Dissolved Oxygen

Dissolved Oxygen values ranged from 4.9–7.1mg/l with a mean value of 6.2±0.4mg/l, in the sampling stations, Dissolved Oxygen values was steady in all stations (6.2±0.1) except in Station 3 where dissolved Oxygen values varied slightly to 6.0±0.0. Monthly mean DO values as shown in table 3 fluctuated steadily such that monthly DO values were not significantly different throughout the months except in the month of June-August and April (5.3±0.5 - 5.9±0.1) when DO values were reduced. Monthly mean DO values were lowest in the month of July (5.3±0.10 mg/l)) while the highest monthly mean DO was recorded in the month of April (7.0±0.0 mg/l).

Dissolved oxygen is critical for aquatic life's existence, particularly for the bigger creatures in the aquatic food web. Dissolved oxygen implies a high-quality environment conducive to aquaculture development. However, DO levels decreased throughout the rainy season. The dry season's high oxygen content corresponds to times of low turbidity. The cold harmattan breeze, which promotes wave action and cools the surface water, may have contributed to the higher oxygen concentration during the dry season, while heavy rains increased turbidity and lowered oxygen concentration during the wet season. The results of this research were consistent with that of in Jabi lake, Doma reservoir [7] whereas a higher DO in Usuma reservoir [4, 11-12, 14].

3.1.6. Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) fluctuated between 5.0–8.0mg/l with a mean value of 5.7±0.6 mg/l, in the sampling stations, Biochemical Oxygen Demand did not vary in all stations (5.6±0.1mg/l) except in Station 3 where BOD values varied slightly to 5.8±0.1 mg/l. Monthly mean BOD values as shown in table 3 varied steadily such that monthly BOD values were not significantly different throughout the months (5.0±0.0-5.7±0.7mg/l) except in the month of April and August when BOD values were elevated. Monthly mean BOD values was lowest in the month of July and October (5.0±0.0) while the highest monthly mean BOD was recorded in the month of August (7.3±0.6 mg/l).

In Karshi reservoir, biochemical oxygen demand levels varied between 2.0 mg/l and 8.0 mg/l at all sampling points. Increased sedimentation, a substantial input of organic materials, and subsequent biodegradation all contribute to high BOD concentrations. This rise in oxygen tension in the water results in an increase in BOD. The readings were much greater in both reservoirs during the wet season, owing to the huge volume of water flowing into the reservoir during the rainy season. As a result, the microbial population will use oxygen more rapidly; the seasonal mean BOD concentration was greater during the wet season.

3.1.7. Nitrate and Phosphate

Nitrate values ranged from 3.9–8.5mg/l with a mean value of 6.7±0.9 mg/l, in the sampling stations, Nitrate values was lowest in Station 3 (6.6±0.1mg/l) and highest in station 2 (6.8±0.1mg/l). Monthly mean Nitrate values as shown in table 3 fluctuated steadily that monthly Nitrate values were not significantly different throughout the months (6.1±0.1- 7.8±0.6mg/l) except in the month of June-July. Monthly mean nitrate values were lowest in the month of June-July (4.8±0.6) while the highest monthly mean Nitrate was recorded in the month of February (7.8±0.6 mg/l). Phosphate ranged from 0.0–0.2mg/l with a mean value of 0.1±0.0 mg/l Phosphate values was steady in all stations (0.1±0.0 mg/l).

Nitrate and phosphate levels were found to be over the WHO guideline. The comparatively high nitrate levels detected in this research may be attributable to runoff water including fertilizers and manure from agricultural land, industrial effluents, sewage, and wastewater, particularly at station 1. This result was greater than what observed in Usuma reservoir and observed in Karidna reservoir in Kaduna [4, 9].

3.1.8. Iron

Iron concentration ranged from 0.0–1.6mg/l with a mean value of 0.1±0.0mg/l, in the sampling stations, iron concentration was also steady in all stations (0.3±0.0m). Monthly mean iron values in the months of January, April, June, August, November-December (0.3±0.0) and in the month of February-March, May, September and October (0.1±0.0 - 0.2±0.0) were not significantly different but was different compared to other months. Increased iron value was recorded the month of June-July (0.5±0.0). Monthly mean iron value was lowest in the month of October and November (<0.01±0.0) while the highest monthly mean secchi depth was recorded in the month of July (0.5±0.0). During the rainy season, the iron content in Karshi reservoir exceeded the WHO guideline. Lead concentration was below the detection limit.

3.1.9. Water quality Index

According to Table 5, the Karshi Reservoir's determined water quality index (WQI) was 62.35. This indicates that the reservoirs have "average" water quality, with a pollution class II level suggestive of moderate contamination, particularly during the rainy season. Average water quality supports a limited variety of aquatic species (in comparison to what can be found in high and exceptional water quality; see table 6), which is almost certainly facing pollution concerns, if the water is to be recommended for drinking.

4. CONCLUSION

Physico-chemical parameters of Karshi reservoir were within the permissible limit of WHO. However, turbidity, nitrate phosphate values recorded elevated values during wet season. Water quality of Karshi reservoir was average suitable for irrigation and commercial purposes.

5. RECOMMENDATION

Adequate, effective and consistent monitoring of the reservoir and regulation of activities in and around the reservoir should be of utmost priority to detect early warning signs and forestall further deleterious deterioration of its WQI. Also, water from the reservoir should be treatment before consumption.

6. ACKNOWLEDGEMENT

NA

7. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

8. SOURCE/S OF FUNDING

NA

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