PRINT ISSN 1119-8362
Electronic ISSN 2659-1499

Full-text Available Online at
https://www.ajol.info/index.php/jasem
https://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 29 (3) 761-766 Mar. 2025

Concentrations and Seasonal Variations of Physicochemical Parameters in Gubi Reservoir, Bauchi, Bauchi State, Nigeria

[1*]MUHAMMAD, F; [1]EZRA, AG; [1]NAYAYA, AJ; [2]SABO, IB; [1]AHMAD, A

*[1]*Department of Ecology, Faculty of Science, Abubakar Tafawa Balewa University Bauchi, Bauchi State, Nigeria*
[2]Department of Civil Engineering, Abubakar Tafawa Balewa University Bauchi, Bauchi State Nigeria

**Corresponding Author Email: fatymtym12@gmail.com*
**ORCID: https://orcid.org/0000-0002-2557-863x*
**Tel: +2348034661179*

Co-Authors Email: ezragaya294@gmail.com; ajnayaya@atbu.edu.ng; sbindo@atbu.edu.ng; gesunnam@yahoo.com

ABSTRACT: Physicochemical parameters of a river give fairly detailed information about the quality of the river or reservoir and also depict the suitability of the body of water for both humans that consume such water and survival of the living biota within water body. Therefore, the objective of this paper was to examine the concentrations and seasonal variations of physicochemical parameters in Gubi reservoir, Bauchi, Bauchi State, Nigeria using appropriate standard techniques. The mean values of temperature was (24±0.2^{0}C), pH (7.3±0.0), turbidity (16.4±0.5NTU), TDS (98.4±1.2mg/L), EC (180.8±2.9µc/cm), DO (6.9±0.1mg/L), BOD (3.3±0.1mg/L), water hardness (60.4±1.9mg/L($CaCO_3$), NO3-N (4.5±0.2mg/L) and PO4-P (1.3±0.0mg/L). The parameters were within the permissible levels except PO4-P which was lower than the permissible limits. Monthly and seasonal variations were also recorded. Physicochemical parameters should be constantly monitored in the reservoir and the state environmental protection agency should enforce appropriate measures concerning disposal of waste into the reservoir.

DOI: DOI: https://dx.doi.org/10.4314/jasem.v29i3.10

Cite this Article as: MUHAMMAD, F; EZRA, A. G; NAYAYA, A. J; SABO, I. B; AHMAD, A (2025) Concentrations and Seasonal Variations of Physicochemical Parameters in Gubi Reservoir, Bauchi, Bauchi State, Nigeria. *J. Appl. Sci. Environ. Manage.* 29 (3) 761-766

Dates: Received: 12 August 2024; Revised: 31 January 2025; Accepted: 08 March 2025; Published: 31 March 2025

Keywords: Parameters; Physicochemical; Reservoir; Seasonal Variations

Physicochemical parameters of a water body are informative on the quality and suitability of the water body for the survival of both humans and living biota within the water body. Palleyi *et al*., (2011) documented that environmental variables such as nutrients and physicochemical parameters are responsible for successional shift, distribution as well as overall abundance of phytoplankton community within the environment. Studies on physicochemical parameters of a water body provide information as to why problems on species diversity, quality of water and distribution occur and help to reveal the trends as well as assess the potentials of the water body (Danlami, 2015).

Assessment of physicochemical parameters help in determination and assessment of environmental pollutants in water bodies, especially reservoirs. Water pollution due to industrial activities, agricultural activities and to a larger extent, urbanization has adverse effects on the physicochemical properties of receiving water Dadi Mamud *et al*., (2012). Reservoirs are often used for agricultural and domestic purposes therefore the quality of water for such purposes may be described according to physicochemical characteristics of the water body Abdullahi *et al*., (2017). Therefore, the objective of this paper was to examine the concentrations and seasonal variations of

**Corresponding Author Email: fatymtym12@gmail.com*
**ORCID: https://orcid.org/0000-0002-2557-863x*
**Tel: +2348034661179*

physicochemical parameters in Gubi reservoir, Bauchi, Bauchi State, Nigeria

MATERIALS AND METHODS

The study site, Gubi reservoir is located 8km along Bauchi Maiduguri road 12 kilometers north-east of Bauchi metropolis, in Ganjuwa local government area. It is located at latitude 10^0 50' 0E and 9^0 '52' 0'E and longitude 10^0 ' 0' 24 '0' N and 10^0 '26' '0'N.

Water samples were collected for physicochemical parameters forth-nightly between 6am to 8am every sampling day for 12 months covering both rainy and dry seasons. Two liters sample bottles were used for sampling. The sample bottles were kept in dark container with ice blocks and transported to the laboratory for analysis.

Surface temperature of water was determined in the field by using Mercury in glass thermometer by dipping it into the water and allowed to equilibrate for three minutes. Readings were taken and recorded in the nearest degree Celcius. The pH was determined by placing a calibrated pH probe (HANNA HI 96107) in to the samples and allowed to equilibrate for three minutes. The pH readings were taken and recorded.

Turbidity was determined using HACH DR/890 Colorimeter. Ten mls of distilled water was poured into a sample cell and inserted in the colorimeter to charge the colorimeter to zero. Then, ten mls of the water sample was poured in to a test sample cell and inserted in the colorimeter and press 'read'. The turbidity was then measured in NTU and recorded.

Electrical conductivity was determined by dipping the conductivity probe (HANNA HI 9813/5) in to the samples and allowed to equilibrate for three minutes. The electrical conductance was taken twice and an average calculated and recorded in micro siemens/cm (µs/cm).

Total dissolved solids of the water was determined by dipping probe (HANNA HI 9813/5) in to the samples and allowed to equilibrate for three minutes. Readings were taken, the average calculated and recorded in parts per million (ppm) and converted to milligram per liter. The reading taken twice and an average calculated and recorded in mg/L.

Dissolved oxygen was determined by dipping the probe (JPB-70A) in the water sample in a 300mL BOD bottle and allowed to equilibrate over 3-5 minutes. Readings were taken twice and an average calculated and recorded in mg/L.

Biological Oxygen Demand was determine by pouring 300 mLs of water samples in to a 300mL standard BOD bottle and covered carefully to exude air bubbles. The bottle was then kept in an incubator for five days. The BOD was determined by dipping the probe (jpb-70A) in the water sample and allowed to equilibrate over 3-5 minutes. BOD was then be calculated using the formula: $(BOD)_5$ in mg/L = $DO_1 - DO_5$.

Ethyl Diamine Tetra Acetic Acid (EDTA) titration method was used to determine the total hardness by transferring 2mLs of water samples collected in to a conical flask, diluted to 500mLs with distilled water, then 2mLs of buffer solution of pH 10.4 was then added, followed by addition 0.1g of Errochrome black T dye. The resultant solution was titrated with EDTA titrant (0.01M) until there is a pale yellow colour. Total hardness was calculated as: Total hardness in $CaCO_3$/L = ml of titrant x 40.

Phenoldisulphonic acid method was used to determine Nitrate – Nitrogen by evaporating100mLs of the sample to dryness using a clean dry metallic crucible. The residue was kept in an oven set at 102^0C till dryness. 2mls of Phenoldisulphonic acid was added to the residue and the resultant solution swirled uniformly. The swirled sample was left to stand for 10 minutes, then 10 mls of distilled water was added. 5mls of concentrated NH_3 solution was then added to the solution and allowed to cool. HACH spectrophotometer at 430nm wavelength was used to assess the absorbance of the sample where colour change was observed. The nitrate / nitrogen concentration was determined in mg/L from a standard calibration.

To determine the phosphate-phosphorus, 100mLs of water sample was poured in to a conical flask, 1mL of ammonium molybdate reagent was then added to make up to 50mL mark. The resultant was allowed to stand for 10 minutes until change in colour was observed. Absorbance was then determined from the resultant with the use of HACH spectrophotometer at 600nm wavelength. A calibration curve was then used to determine the phosphate - phosphorus concentration in mg/L. mg PO_4/L = mg PO_4 in 50mL volume flask x 1000mL of sample used.

RESULTS AND DISCUSSIONS

At the end of the 12 months of sampling, the physicochemical parameters of the reservoir evaluated are presented in table 1 below.

Table 1: Physicochemical Parameters of Gubi Reservoir Bauchi, November 2019 –October 2020.

Parameters	Units	Mean	SD	Minimum	Maximum
Surface Water Temperature	^0C	24±0.2	3.7	20.0	30.7
pH		7.3±0.0	3.7	6.2	9.7
Turbidity	NTU	16.4±0.5	9.4	2.0	58.0
Total Dissolved Solids	Mg/L	98.4±1.2	20.9	44.0	183.0
Electrical Conductivity	µs/cm	180.8±2.9	49.4	60.0	348.0
Dissolved Oxygen	Mg/L	6.9±0.1	1.9	2.3	10.6
BOD	Mg/L	3.3±0.1	1.6	0.0	7.2
Total Hardness	Mg/L ($CaCO_3$)	60.4±1.9	31.5	15.0	250.0
NO_3-N	Mg/L	4.5±0.2	2.7	0.1	15.8
PO_4-P	Mg/L	1.3±0.0	0.5	0.0	3.6
SiO_3	Mg/L	4.9±0.1	1.9	0.4	8.6

Key: BOD (Biological Oxygen Demand),

The mean temperature was 24.1±0.2^{0}C with a standard deviation of 3.7^{0}C. The highest temperature of 30.7^{0}C was recorded in June whereas the lowest value of 20.0^{0}C was recorded in November and December. Low temperature was recorded between November, December, January to February, this was followed by an appreciable decrease in October. The temperature thereafter became raised from March to September. The mean pH was 7.5±0.1 with a standard deviation of 3.7. The surface water pH values recorded during the period of study varied between 6.2 and 9.7. The lowest value of 6.2 was recorded in the month of May at station 4 whereas the highest value of 9.7 was recorded in the month of December at station 3. The pH was relatively high (9.7) in the month of December. pH values decrease from April to June and increase from November, December and January. The pH was neutral in the months of February, March, July, August and September. It became alkaline in the months of November and December. The mean turbidity was 16.4±0.5 NTU with a standard deviation of 9.4. The highest turbidity value of 58.0 NTU was recorded in the month of September while the lowest value was recorded in the months of January and March. There was little variation in values between February to July followed by an increase from August to October followed by appreciable decrease from November to December. The mean TDS during the study period was 98.4±1.2 ppm with a standard deviation of 20.9. TDS reached its maxima at 183.0 ppm in the month of March and minimal of 44.0 ppm was recorded in November. TDS was relatively high in the months of January to August while low in the months of November and December.

The mean value for EC was 180.8±2.9µs/cm with a standard deviation 49.42.9µs/cm. The highest value of 3482.9µs/cm was recorded in the month of August while the lowest value of 602.9µs/cm was observed in the month of December. Higher values of EC were mostly observed in the months of March, April, May, June, July and August. There was appreciable decrease of the values of EC in the months of November and December. The mean value for water hardness was 60.4±1.9mg/L with a standard deviation of 31.5mg/L. Water hardness varied between 15.0 in the month of December and 250mg/L in the month of August. Higher values of water hardness were mostly observed in the months of August and September. Lower values of water hardness were mostly observed during the dry season.

The mean valued for DO was 6.9±0.1mg/L with a standard deviation of 1.9mg/L. Higher values of DO, 10.6, was observed in the month of April while lower value of 2.3mg/L was observed in the month of February. Lower value of 2.5mg/L was also observed in the month of January. The mean value for BOD was 3.3±0.1mg/L with a standard deviation of 1.6mg/L. Low value of 0.0mg/L was observed in the month of January while high value of BOD of 7.2mg/L was observed in the months of March and October. Higher values of BOD were mostly observed from the months of August to October. The mean value for Nitrate-nitrogen was 4.5±0.2mg/L with a standard deviation of 2.7mg/L. Highest value of 15.8mg/L was recorded in the month of August while lowest value of 0.1mg/L was recorded in the month of January. Higher values of Nitrate-nitrogen were mostly observed during the wet season. The mean value for Phosphate-phosphorus was 1.3±0.0mg/L with a standard deviation of 0.5mg/L. PO_4 varied between 3.6mg/L in the month of June at station 3 to 0.0mg/L in the month of February. Generally, lower values of phosphate-phosphorus were recorded during the study period. Phosphate-phosphorus values were relatively low between November to April ranging between 0.0mg/L to 2.5mg/L while it was relatively higher between May and June ranging from 0.9mg/L to3.6mg/L. Appreciable higher values were obtained in wet season than the dry season. From the study carried out, the physicochemical parameters of Gubi reservoir, the mean water temperature was within the range of 20.0^0c to 30.7^0C. Lower values of temperature recorded from the months of November to January could be attributed to the cold harmattan wind experienced during the period. Similar observations were also recorded by (Ezra, 2006). Higher values observed from the months of March to September could be due to increased solar radiation. Temperature is one of the most important and essential physical parameter of aquatic habitats which varies throughout the year with seasonal changes in air temperature, day length and solar radiations Roy *et al*., (2006). Seasonal variations in temperature of water body directly affects its productivity. It is pertinent to note that all organisms possess limits of temperature tolerance Suzie et al., (2018).

pH is a measure of the acidity or alkalinity of an aqueous solution. Optimal pH range that can sustain aquatic life is 6.5 to 8.2. The pH range observed in this study falls within the range of 6.2 to 9.7. The variation in pH could be as a result of the presence or absence of free carbon di oxide, carbonate and planktonic density during the various months Lashari *et al*., (2009). The significant difference in the mean pH values between the months of the dry season and those of the wet season is similar with the observations of Ali *et al*., (2013), Suzie *et al*., (2018) and Fadimatu *et al*., (2020). Low pH values observed in the wet season could be due to increase of effluents and rainfall which lead to reduction in pH values. High pH values however, is indicating the enrichment of alkaline chemicals from agricultural and industrial waste as well as increase in algal population by their photosynthetic activity in water Priyanka *et al*., (2013). Turbidity is a measure of the ability of water to absorb light and is caused by small particles. The turbidity in water is mainly caused by suspended matter such as clay, silt, organic and inorganic matter, plankton and other microscopic organisms in water. Higher values of turbidity were recorded during the wet season which could be due to the presence of flood water, surface runoffs and settling effects of suspended materials that followed the cessation of rainfall. Higher values of turbidity in the rainy season also coincide with low count of phytoplankton abundance. Higher values of turbidity during the rainy season in this study is also in agreement with the work of Suzie et al., (2018) and Fadimatu *et al*., (2020). Low values of turbidity observed during the dry season showed that the reservoir had some suspended particles which still allowed light penetration in to the water body to sustain aquatic life. This observation is similar to that of Ekhator *et al*., (2015). The findings in this study are not in agreement with the report of Abubakar (2015) on high turbidity values recorded during the dry season along selected locations of river Kaduna. The difference in the findings of the two studies regarding values of turbidity could be attributed to the fact that river Kaduna traverses through many communities hence domestic waste domestic wastes are being discharged in to the river whereas Gubi reservoir did not traverse through communities and therefore low domestic wastes are being discharged in to the reservoir.

Total dissolved solids increase the density of water thereby retarding the palatability of water. Seasonal variations showed maximum values of TDS during the dry season which could be due to decaying of vegetation, high rate of evaporation cause by increase in air temperature and winds during the dry season. Increased concentration of TDS increases the nutrient status of water body leading to eutrophication Priyanka *et al*., (2013) and Katherbee *et al*., (2015). Higher values of TDS recorded reflects the effects of domestic and agricultural discharges at the reservoir. Similar observation was also found in the work of Fadimatu et al., (2020). Low values of TDS were recorded during the dry season. The findings in this study are not in agreement with the report of Abubakar (2015) and Suzie et al., (2018) on high TDS values recorded during the rainy season. The studies by Suzie and Abubakar were conducted in river Kaduna, which receives effluents from the Kaduna Refinery and Petroleum Company as well as domestic waste from the tributaries of the river, hence having high values of TDS.

EC values observed during the study period were within the range of 60.0µs/cm to 348.0 µs/cm. Low conductivity showed paucity of most dissolved ions and high concentration of EC could be as a result of evaporation and high concentration of salt in the water body (Imoobe and Oboh, 2003). Higher values of EC recorded during the study period could be due to high ionic concentration, pollution status, some domestic effluents and other organic matter in water. The level of conductivity in water gives a good indication of the amount of substances such as phosphates, nitrates and nitrites that dissolve in it. Higher values of EC observed during the rainy season were also observed in the work of Bagalwa (2006) and Ezra *et al*.,(2008) which could be as a result of eroded sediments of silts and debris from surface runoff that raise the water table and ionic composition of the river.

Total hardness of water mean range recorded during the study was between 15.0 (mg/L($CaCO_3$) – 250.0 (mg/L($CaCO_3$). Seasonally, highest value was recorded during the rainy season and lowest value during the dry season. Higher values during the rainy season could be due to influx of rain water in to aquatic systems. These observations were not in agreement with the work of Priyanka *et al*., (2013) where they recorded higher values of total hardness during the summer and lowest during the rainy season due to increase in water volume and increase in rate of evaporation at high temperature.

The mean range of DO during the study period was 2.3mg/L to 10.6mg/L. Highest value of DO of 10.6mg/L was recorded in the month of April which could be due to low amount of organic matter received in the reservoir. Low values of DO recorded in sites 3 and 4 could result from high levels of pollution by organic waste. Low values of DO were also reported in the work of Ezra (2000) due to the effect of pollution. Higher values were also observed in the work of Abubakar (2015) which coincides with periods of lowest turbidity and little flow of runoff. Higher DO values of 10.6mg/L in this study is also similar with the findings of Priyanka *et al*., (2013) where they recorded DO values of 10.5mg/L in the month of January.

The observation of present study showed highest BOD values of 7.2mg/L during the month of October and lowest value of 0.0mg/L in the month of January. This may be due to the presence of several microorganisms and input of decomposable organic matter in to the reservoir through surface runoff. Suzie *et al*., (2018), documented higher values of BOD during the rainy season and attributed it to input of organic waste and enhanced bacterial activities in Romi River, Kaduna.

The BOD of unpolluted water is less than 1.0mg/L, moderately polluted water 2.0mg/L to 9.0mg/L while heavily polluted water has more than 10.0mg/L (Adakole, 2000). The BOD values in this study fluctuated between 0.0mg/L to 7.2mg/L which shows that some of the stations can be reported to be unpolluted and some as moderately polluted.

Discharge of industrial waste, sewage and agricultural runoffs from nearby farmlands contribute nitrates to water bodies. Results of this work showed that Nitrate-nitrogen reached its peak during wet season with value of 15.8mg/L and lowest value of 0.1mg/L was recorded in the month of January during the dry season. Higher concentration may be due to influx of nitrogen-rich flood water. Variation in nitrate contents of Gubi reservoir could be attributed to irrigation practices close to the reservoir whereby, fertilizer from farms leach into the reservoir as reported by Ezra (2006) and Suzie *et al*., (2018). High values of nitrate could also be due to livestock and human waste from the catchment areas of the reservoir. Nitrogen could also be introduced in the form of urea and nitrate fertilizer. Increase in phosphate levels can be caused by sources such as phosphorus-rich bedrock, reduced water volume, industrial effluents and agricultural activities in the form of use of fertilizers and pesticides around the water body. Higher values of phosphate-phosphorus recorded during the wet season could be attributed to fish farming activities around the reservoir. Similar observations were also reported in the work of Ezra (2006), Dadi-Mahmud *et al*., (2012), where they recorded higher values in the wet season due to runoffs of nutrients from agricultural lands, livestock and domestic sewage from the catchment areas of human settlements. Low level of phosphate-phosphorus in water bodies were also observed by Olele and Ekelemu (2008) and Fadimatu *et al*., (2020). Phosphorus can also be introduced in to the environment in the form of phosphoric acid and phosphate fertilizers.

Conclusion: In conclusion, the physicochemical parameters of Gubi reservoir were within permissible limits except phosphate-phosphorus which was below the permissible limits.

Declaration of Conflict of Interest: The authors declare that there is no conflict of interest among them.

Data Availability: Data are available upon request from first author.

REFERENCES

Abdullahi, Y; Mustapha, Y; Indabawa, II; Sindama, A. (2017). The Relative Abundance, Distribution and Species Diversity of Phytoplanktons in Kanye Dam in Kano, North western Nigeria. *J. Env. Sci. Toxicol. Food Technol.* 11(4):20-31.

Abubakar, H. (2015). Assessment of Physicochemical Parameters along Selected Locations of river Kaduna, Kaduna State, Nigeria. *Asian Res. Center J. Acad. Res.* 1(1):11-16.

Adakole, JA; Balogun, JK; Lawal, FA. (2002). Water Quality Impact Assessment Associated with an Urban stream in Zaria, Nigeria. *J. Nig. Soc. Exp. Bio.* 2(3):195-203.

Ali, MZ; Michael, AA; Yahuza, T. (2013). Physicochemical Characteristics and Phytoplankton abundance of lower Niger River, Kogi State. *Nig. J. Env. Sci. Toxicol. Food Technol.* 2(4):31-37.

Bagalwa, M.(2006). The Impact of Land Use on Water Quality of Lwiro River, Democratic Republic of Congo, Central Africa. *Afr. J. Aqua. Sci*.3(17):137-143.

Dadi-Mamud, NJ; Oniye, SJ; Auta, J; Kumar, N. (2012). Some Physicochemical Parameters of Makera Drain, Kaduna, Nigeria. *Ind. J. Lif. Sci.* 2(1):1-8.

Danlami, MK. (2015). Periphytic Diatom Composition and Diversity in relation to Physicochemical Parameters in a segment of river Galma, Zaria, Kaduna State. *M.Sc Thesis, Department of Biological Science, Faculty of Science, ABU Zaria*.

Ezra, AG. (2000). Study of Planktonic Algae in relation to the physicochemical parameters. J. Exp. Appl. Biol.5:102-112

Ezra, AG. (2006). Phyco-periphyton on Some Aquatic Macrophytes in a Stream Near ATBU, Bauchi, Nigeria. *J. Exp. Appl. Biol*. 7(2):16-25.

Ezra, AG. (2008). Studies on Diatoms from Gubi Reservoir Bauchi, Nigeria. *Afr. J. Nat. Sci*.10:7-10.

Fadimatu, M; Saidu, A; Auta, J. (2000). Correlation between Physicochemical Parameters of River Kaduna and its Phytoplankton Population: an Observational Study. *Int. J. Biol. Sci. Res.* 2(3): 189-197.

Imoobi, TOT; Oboh, IP. (2003). Physical and Chemical Hydrology of river Janvieson, Niger Delta, Nigeria. *Benin Sci. Dig.*1:105-119.

Katherbee, S; Chitra, J; Malini, E. (2015). Studies on Plankton Diversity and Water Quality of Ambattur Lake, Tamil Nadu. *Int. J. Pur. Appl. Zool*. 3(1):31-36.

Lashari, KH; Korai, AL; Sahato, GA; Kazi, TG. (2009). Limnological Studies of Keenghar Lake, District, Thatta, Sindh, Pakistan. *Pak. J. Analyt. Env. Chem*. 10(1-2):39-47.

Olele, NF; Ekelemu, JK. (2008). Physiochemical and Periphyton / Phytoplankton study of Onah Lake, Asaba Nigeria. *Afr. J. Gen. Agr*. 2(3): 183-193.

Palleyi, S; Kar, RN; Panda, CR. (2011). Influence of Water Quality on the biodiversity of phytoplankton in Dhamra River Estuary of Odisha Coast, Bay of Bengal. *J. Appl. Sci. Env. Manage.* 15(1):69-74.

Priyanka, Y; Yadav, VK; Yadav, AK; Khare, PK. (2013). Physicochemical Characteristics of a Freshwater Pond of Orai, U.P., Central India. *Octa J. Biosci*. 1(2):177-184.

Roy, S; Alam, S; Chattopadhyay, J. (2006). Competiting effects of toxin-producing phytoplankton on the overall plankton population in the Bay of Bengal. *Bull. Math. Biol*. 68 (8), 2303-2320.

Suzie, KZ; Ezra, AG; Abdulhameed, A; Nayaya, AJ; Yusuf, YO. (2018). Use of algae as a bio-friendly mean to determine water quality of Romi River in Kaduna, Nigeria. *Sci W. J.* 13(1): 65-69.

Ubwa, ST; Atoo, GH; Offem, J; Abah, JO; Asemave, K. (2013). An Assessment of Surface Water Pollution Status around Gboko Abbatoir. *Afr. J. Pur. Appl. Chem*. 7(3):131-138.