Nigerian Journal of Science and Environment 2025 Volume 23 (2) 188 – 201 ISSN: 3043 – 4440
https://doi.org/10.61448/njse2322515

WATER QUALITY STATUS OF OKURA RIVER, KOGI STATE, NIGERIA.

[1*]Anayeokwu, S.N., [1]Ogidiaka-Obende, E., [2]Okpanachi, M.A., [1]Omoarebun, E.J., [3]Okadi, D. [1]Ugegeh, D.O. and [1]Nwaiku, F.

[1]Department of Marine Science, University of Delta Agbor, Nigeria.

[2]Department of Animal and Environmental Biology, Prince Abubakar Audu University, Anyigba, Nigeria

[3]Department of Agricultural Education, Federal College of Education (Technical), Omoku, Rivers State.

*Corresponding Author's Email: samuelanayeokwu@gmail.com

ABSTRACT

Okura River is the major source of water supply to the communities and neighbouring villages within and outside the Dekina Local Government Area (LGA) in Kogi State. As a result of anthropogenic activities such as bathing with soap and washing farm produce, this study was conducted to investigate certain aspects of the physicochemical parameters of the river. The study covers four sampling sites: Okura-olafia (control), Ofejiji, Greater Ochaja and Ochaja (Cocoa Research Institute of Nigeria) (impacted). Samples were taken based on human activities around the river, which covers a span of six months from August 2019 to January 2020. The samples were analysed using standard methods. The results obtained were subjected to descriptive analysis and analysis of variance (ANOVA) to test for significant differences ($p < 0.05$) between the physicochemical parameters in months. The findings of the study show that the temperature ranged from 24.05 - 25.50 ℃ while the overall average pH value was 6.16. The average turbidity ranged between 141.44 to 152.21 NTU. The overall average dissolved oxygen level of the river is 6.52 mg/l. The average monthly sulphate ranged from 0.77 to 7.65 mg/l, while the average phosphate level ranged between 0.76 to 5.89 mg/l. The results of the physicochemical parameters analysed during the study period show varying levels of turbidity, dissolved oxygen, sulphate, and phosphate across the different sites associated with various human activities. Based on the findings, periodic assessments of physicochemical parameters should be made, recorded, and archived for future reference.

Keywords: Anthropogenic activities, Water quality, Okura River, Physicochemical parameters, Aquatic ecosystem pollution.

INTRODUCTION

Water resources are of critical importance to both natural ecosystems and human development (Ogidiaka-Obende *et al*., 2025). It is essential for industry, agriculture, and human existence. A healthy aquatic ecosystem is dependent on its physicochemical and biological characteristics (Ventatesharaju *et al*., 2010; Ogidiaka *et al*., 2012). Industrial, sewage and municipal wastes have been continuously added to water bodies and hence affect the physicochemical quality of water, making it unfit for use by livestock and other organisms (Dwivedi and Pandey, 2002).

It was noted by Ezealor *et al*. (1999) that extensive human activities, including agricultural practices, fertiliser application, and overgrazing, around the catchment areas of aquatic habitats result in marked fluctuations in the physicochemical parameters of aquatic ecosystems.

The good quality of water resources depends on a large number of physico-chemical and biological characteristics (Ogidiaka *et al*., 2012; Kaine and Ogidiaka, 2022). Monitoring of these parameters is essential to identify the magnitude and source of any pollution load. These characteristics can identify certain conditions for the ecology of living organisms and suggest appropriate conservation and management strategies. Notable contributions on water quality monitoring from various water bodies in Nigeria include works from researchers such as Ogidiaka *et al*. (2012) who studied the physicochemical parameters of Ogunpa River; Edegbene *et al*. (2012) reported on the chemical and physical characteristics of Atakpo River; Gideon *et al*. (2013) explored the quality assessment of water quality characteristics of Okura Rive; Ejeomo *et al*. (2022) analyzed the water quality index of ground water samples from Opete community; Ogbeibu and Oriabure (2023) worked on the water quality of the Benin River, Ukabiala *et al*. (2025) assessed the suitability of water from Okura river for irrigation while Ogidiaka-Obende *et al*. (2025) determined the water quality index of Akassa Creek.

Okura River has its roots in Ojaji hill, which flows through the Ogodu and other neighbouring villages within and outside the Dekina Local Government Area (LGA) in Kogi State. In rural communities like Okura-Olafia, Ofejiji, Greater Ochaja, and Ochaja (Cocoa Research Institute of Nigeria) the river is the major source of water supply for human activities such as bathing, washing with soap, washing and processing of farm produce, etc (Emurotu *et al*., 2016). As the human population within the catchments of the river continues to grow, there is a consequential increase in demand for water for agricultural and domestic uses (Emurotu *et al*., 2016). These activities could impair or contaminate the river. This study was conducted to assess the current status of River Okura by evaluating some physical and chemical parameters..

MATERIALS AND METHODS

Study Area

Okura River cuts across several communities in the Dekina Local Government Area (LGA), Kogi State. It lies between Latitudes 7˚00´N to 7˚30´N and longitudes 7˚00´E to 7˚30´E of the Greenwich meridian, stretching over a distance of about 81.5km (Fig. 1). The river has its source from Igbobe and Olla in Omala Local Government Area of Kogi State and empties into the Anambra River (Onimisi and Ogbe, 2018).

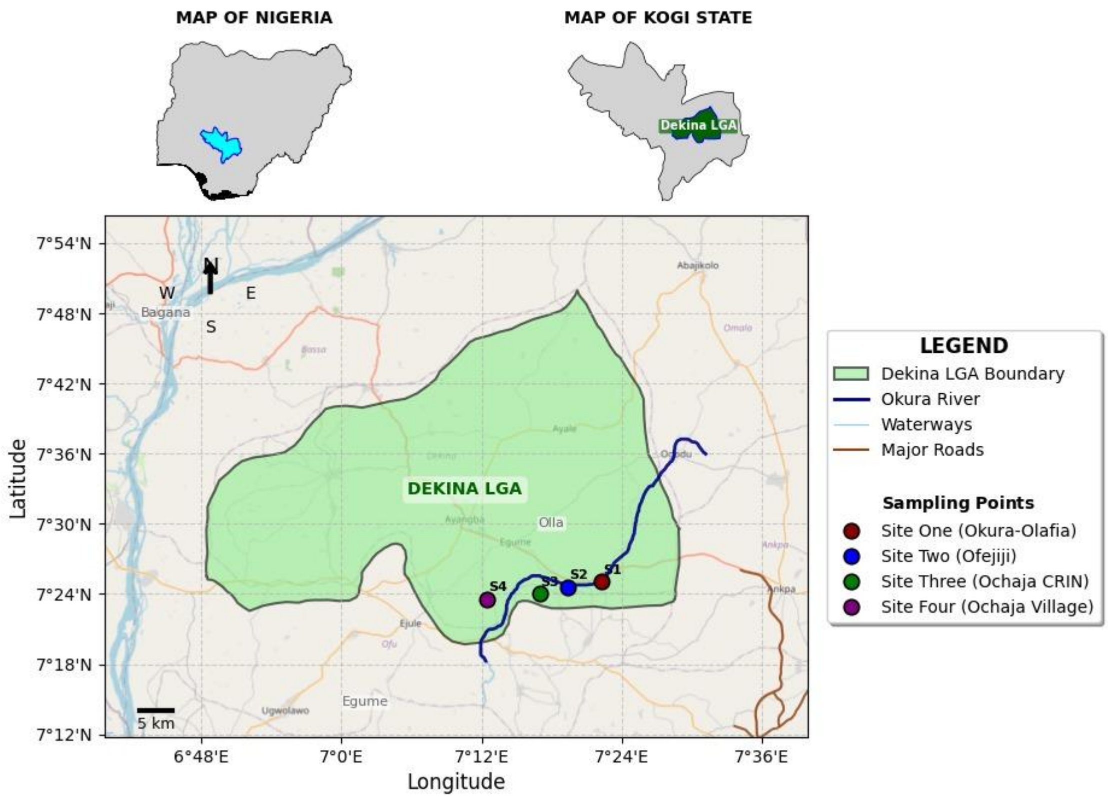

Figure 1: Map of Nigeria, showing Kogi State and the sampling stations

Geology and geomorphic of the Study Area

The study area is situated in the Anambra sedimentary basin, and dates back to the Cretaceous period (Gideon and Fatoye, 2012). Anambra Basin is a triangular-shaped embayment which covers approximately 30,000 square kilometres. The geological formations present includes; Ajali, Nkporo and Mamu formations (Gideon and Fatoye, 2012).

Climatic factors of the study area

The study area is located in Nigeria's humid tropical rainforest zone which is characterized by high annual rainfall (>200mm) with two distinct seasons: wet (May-October) and dry (November-April) (Gideon and Fatoye, 2012).

Vegetation

The study area's vegetation is classified as guinea savannah, featuring tall to short trees and shrubs, with evidence of anthropogenic impact such as deforestation and bush burning (Gideon and Fatoye, 2012). Four aquatic plants (lettuce (*Lactuca sativa*), water lily (*Nymphaea lotus*) pistia (*Pistia stratiotes*) and *Dryopteris* species were encountered in Okura River (Anayeokwu *et al*., 2025).

Human activities

Water from this river is used for many purposes such as drinking, washing, swimming and fishing. Furthermore, around the river banks are small farmlands used for subsistence farming (Emurotu *et al*., 2016).

Sampling locations

Water was sampled from four distinct sites (Fig. 1). Table 1 below shows the description of the sampling sites.

Table 1: Description of the sampling sites.

Serial no	Sites name	Latitude and Longitude	Human Activitie
1	Okura-Olafia (control)	7°25.03´N, 07°22.30´E	Fishing
2	Ofejiji (impacted)	07°24.55´N, 07°19.39´E	Fishing, bathing and laundry
3	Ochaja (Cocoa Research Institute of Nigeria) (impacted)	07°24.03´N, 07°17.00´E	Fishing and washing of different farm produce
4	Ochaja village (impacted)	07°23.55´N, 07°12.50´E	Fishing, washing of cassava, bathing and laundry

Sampling method

The water samples were taken twice monthly from August 2019 to January 2020. The water samples for the four sites were taken to the laboratory and analysed for various physicochemical parameters using standard methods (APHA, 1999).

Determination of Physicochemical Parameters

The temperature (°C) of the water was measured by using a mercury-in-glass thermometer. pH was measured with a Hanna 420 pH meter. A dissolved oxygen microprocessor HI 98186, was used to determine the dissolved oxygen. The phosphorus concentration of the samples was determined using the Deniges method (APHA, 1999). Sulphate was determined by reading the absorbance on the spectrophotometer at a wavelength of 420 nm.

Quality Assurance

Distilled water blank was used as a correcting factor when reading the absorbance of phosphorus and sulphate from the Gallenkamp Bausch and spectrophotometer respectively.

Statistical Analysis

The results obtained were subjected to descriptive analysis and analysis of variance (ANOVA) to test for significance at a probability level of 0.05 between the physicochemical parameters in months, seasons and stations.

RESULT

Temperature

November had the highest average monthly temperature of 25.26 °C (Table 2). The temperature of the river ranged from 24.05 to 25.50 °C (Fig. 2). The highest temperature of 25.50 °C was observed in December in site one, while the lowest temperature of 24.05 °C was observed in January in site four.

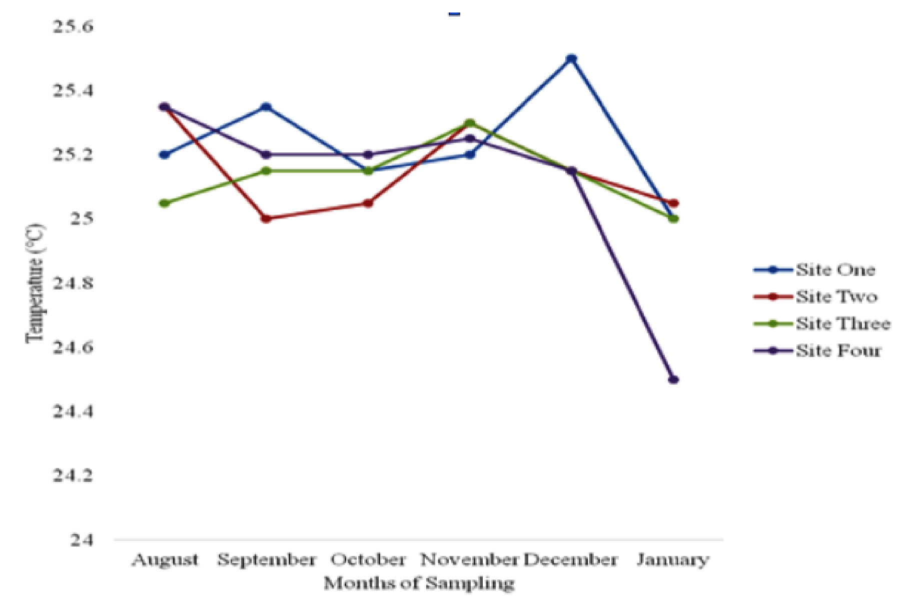

Fig. 2: Monthly Temperature Profile of Okura River, Kogi State

pH

The average monthly pH was not significantly different ($p > 0.05$) across the month, with the highest observed in January (6.33) while the lowest in August (6.05) (Table 2). pH of River Okura ranges from 5.5 in August in site four to 7.6 in November and December site one (Fig. 3) with an overall average pH value of 6.16.

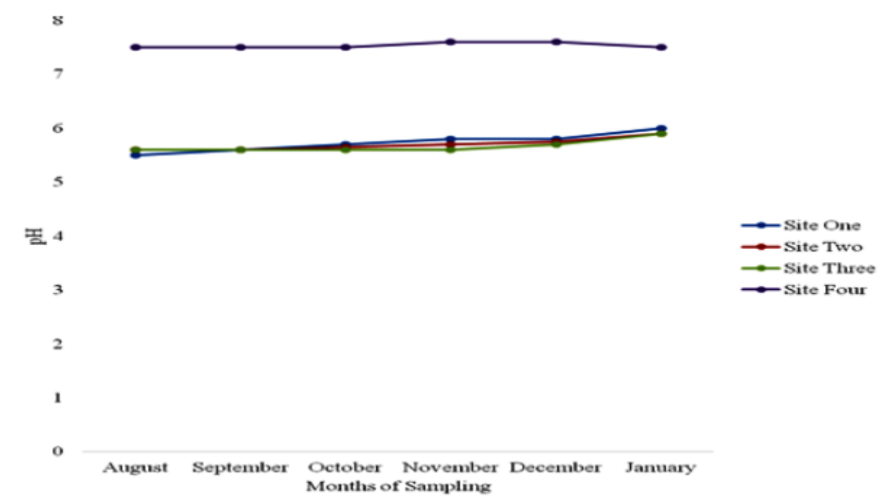

Fig. 3: Monthly pH Profile of Okura River, Kogi State

Turbidity

The turbidity was highest in September and lowest in January (Table 2). Turbidity of the water differs significantly ($p \leq 0.05$) across the stations and months of sampling. The turbidity of Okura River ranges from 139.15

in site one to 154.50 NTU in site two (Fig. 4) with an average monthly turbidity range of 141.44 to 152.21 NTU.

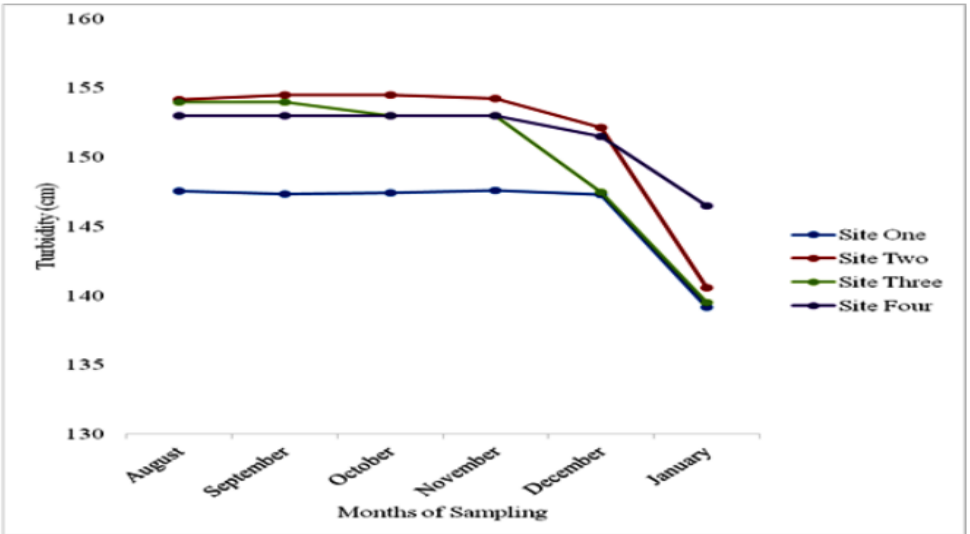

Fig. 4: Monthly Turbidity Profile of Okura River, Kogi State

Dissolved Oxygen (DO)

The average monthly dissolved oxygen was highest in January with 8.13 mg/l, which was significantly different ($p \leq 0.05$) from the average monthly ($p \leq 0.05$) dissolved oxygen in it other months. August had the lowest dissolved oxygen level of 5.10 mg/l (Table 3). The dissolved oxygen of the Okura River ranges from 4.23 in site one to 8.48 mg/l in site three (Fig. 5). The overall average dissolved oxygen level of the Okura River was 6.52 mg/l.

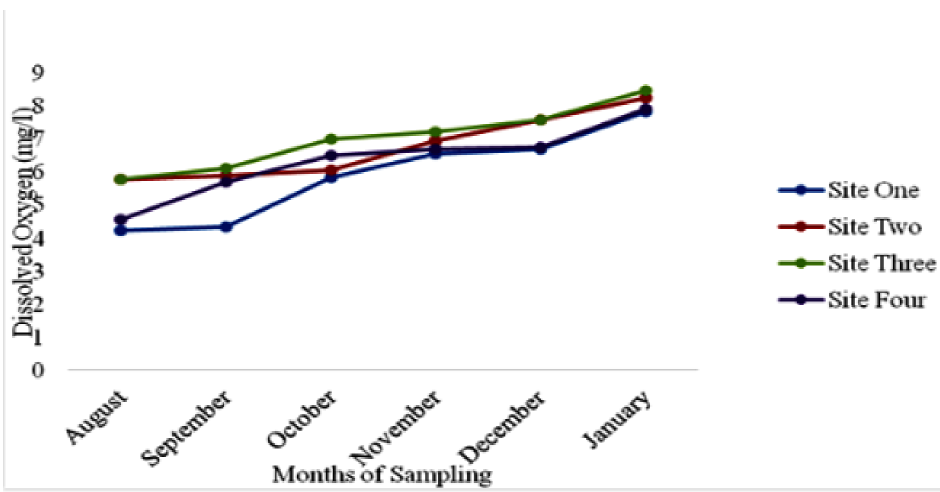

Fig. 5: Monthly Dissolved Oxygen Profile of Okura River, Kogi

The Anions

Significant difference ($p \leq 0.05$) was observed in the sulphate levels across the months of sampling (Table 2). The sulphate level ranges from 0.77 to 7.65 mg/l (Fig. 6). The monthly average sulphate was highest in January and December, with 6.72 mg/l and 5.83 mg/l, respectively in site two.

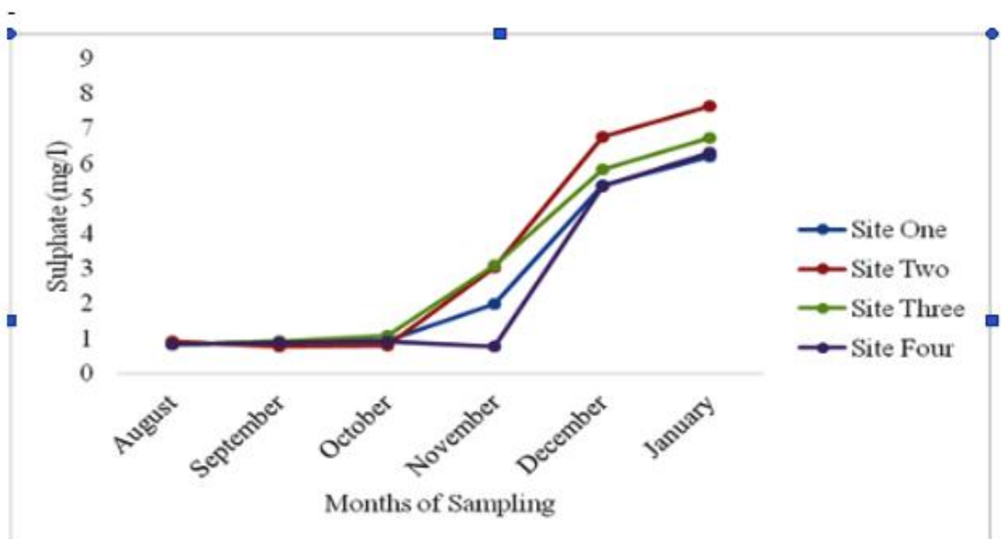

Fig. 6: Monthly Sulphate Profile of Okura River, Kogi

Phosphate level ranges from 0.76 to 5.89 mg/l with an overall level of 3.74 mg/l in River Okura (Fig. 7). The monthly average phosphate level revealed that September had the highest level of 5.18 mg/l in site three (Fig. 7) which was not significant with October (5.08 mg/l), August (5.06 mg/l) and November (4.46 mg/l) but significantly different ($p \leq 0.05$) from December (1.53 mg/l) and January (1.11 mg/l) (Table 3)

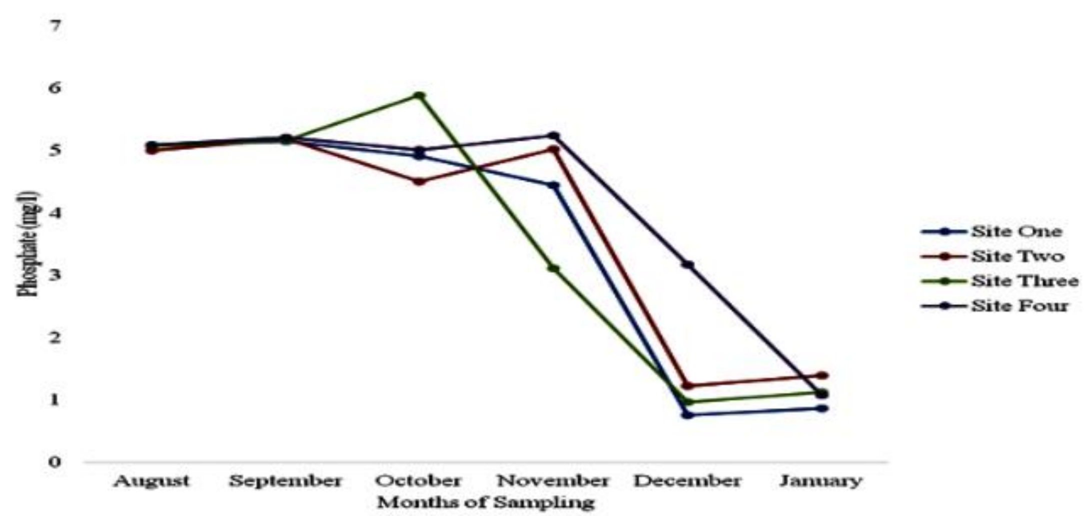

Fig. 7: Monthly Phosphate Profile of Okura River, Kogi

Table 2: Mean Monthly Values of Physicochemical Parameters of Okura River, Kogi State

Months	Temperature (°C)	pH	Turbidity (NTU)
August	25.24±0.06 (25.05 – 25.35)	6.05±0.32 (5.5 – 7.5)	152.18±1.02 (147.55 – 154.15)
September	25.18±0.06 (25.15 – 25.35)	6.08±0.31 (5.6 – 7.5)	152.21±1.08 (147.35 – 154.50)
October	25.14±0.03 (25.05 – 25.20)	6.11±0.30 (5.6 – 7.5)	151.99±1.02 (147.45 – 154.50)
November	25.26±0.04 (25.20 – 25.30)	6.18±0.31 (5.6 – 7.6)	151.96±0.97 (147.60 – 154.25)
December	25.24±0.07 (25.15 – 25.50)	6.21±0.30 (5.7 – 7.6)	149.61±1.40 (147.30 – 152.15)
January	24.89±0.13 (24.50 – 25.05)	6.33±0.26 (5.9 – 7.5)	141.44±1.37 (139.15 – 146.50)

Table 3: Mean Monthly of Physicochemical Parameters of Okura River, Kogi State

Months	DO (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)
August	5.10±0.27 (4.23 – 5.80)	0.84±0.03 (0.81 – 0.91)	5.06±0.07 (5.00 – 5.09)
September	5.52±0.26 (4.35 – 6.13)	0.86±0.02 (0.78 – 0.91)	5.18±0.02 (5.15 – 5.21)
October	6.36±0.26 (5.85 – 7.00)	0.92±0.05 (0.79 – 1.07)	5.08±0.27 (4.51 – 5.89)
November	6.86±0.10 (6.55 – 7.23)	2.22±0.71 (0.77 – 3.10)	4.46±0.59 (3.12 – 5.24)
December	7.16±0.20 (6.75 – 7.60)	5.83±0.24 (5.35 – 6.77)	1.53±0.57 (0.76 – 3.18)
January	8.13±0.10 (7.85 – 8.48)	6.72±0.22 (6.19 – 7.65)	1.11±0.07 (0.87 – 1.40)

DISCUSSION

Monitoring physico-chemical parameters of a water body is very important for studying the influence of these parameters on the distribution of various biodiversity components (Sharma *et al.*, 2007). Water quality is influenced by geological, hydrological, climatic and anthropogenic factors (Balance, 1996). In this study, the physical and chemical parameters evaluated were temperature, pH, turbidity, dissolved oxygen, sulphate and phosphate.

Temperature

Temperature is an important factor that influences primary production in rivers and depends on the climate, sunlight and depth (Ayoade, 2009). It also affects the amount of nutrients, organic/inorganic pollutants, microbacterial concentrations, dissolved matter, invertebrates and fish behaviour in aquatic ecosystems (Bonacina *et al.*, 2023). Temperature is a key driving force for the survival and growth of aquatic organisms since it directly affects their metabolic rate, immunity, and oxygen demand (Muziri *et al.*, 2022). Changes in the environmental temperature above the organism's thermal threshold will not only increase the oxygen demand coupled with metabolic shifts but also reduce the feed intake (FI) and suppress their immunity (Muziri *et al*., 2022). This is because increasing water temperatures affect the solubility and availability of oxygen which negatively affects aerobic metabolism (Zhao, *et al*., 2019; Wang *et al*., 2020).

The water temperature ranged from 24.05 to 25.5 ℃ indicating a relatively narrow temperature range. The normal range to which fish are adapted in the tropics is between 8 and 30 ℃. The temperature observed in this study is within the recommended range by Mustapha (2008). This result is similar to Fafioye *et al*. (2005) who reported a range of 26.5 – 31.5 ℃ in Omi water body, Ago Iwoye, Ogun State, Nigeria, and agrees with previous reports for temperatures in the tropics (Ayoade *et al*., 2006; Atobatele and Ugwumba, 2008; Ogbeibu and Oriabure, 2023; Adelakun *et al*., 2023) in the Sombreiro river; Olopade and Dieyne, 2023 in coastal waters of Rivers State. This value also conforms with the range of 29.30± 0.60 – 29.8± 0.3 0c for Douglas creeks in Akwa Ibom State (23) and 27.30 – 32.1 ℃) reported for stumps creeks (Ideriah, 2010) in Amadi creek in Rivers state. However, Ayoade *et al*. (2006) recommended a temperature range of 20^0C-30^0C for optimum fish growth.

pH

The overall average pH value of 6.16 suggests that the river water is slightly acidic. This pH range can support a diverse range of aquatic life. Although the monthly average pH values didn't show significant differences, the range of pH values throughout the year (5.5 - 7.6) indicates potential fluctuations that could impact aquatic life.

The pH range observed during the period of this study was below the acceptable range for inland waters (pH 6.5 - 8.5) as reported by Mahar (2003) and in contrast with reports by Emurotu *et al.* (2016). Although the pH was within the range reported by Adelakun *et al*., (2023); Olopade and Dieyne 2023 in coastal waters of Rivers State and Ogbeibu and Oriabure (2023). Boyd and Tucker (1998) recommended a pH range of 6.09 - 8.45 as ideal for supporting aquatic life, including fish. The combined effects of run-off from adjoining agricultural lands and photosynthetic activity of macrophytes could be responsible for the high mean value of pH recorded during the study. A downward decrease in pH seems to be a common limnological phenomenon in water bodies and probably because the top levels of the water column usually comprise the photosynthetic zone, while the bottom column is trophic and characterised by relatively high organic matter decomposition and the release of carbon dioxide. A decrease in pH often implies a decrease in photosynthetic activities, and this is usually coupled with increased concentration of carbon dioxide and other by-products of organic matter decomposition at the bottom (Akinbuwa, 1988). The increase in acidic conditions with depth could also be attributed to the build-up of carbon dioxide from respiring organisms in the water column, as respiration often exceeds production of oxygen by primary producers at these depths. The carbon dioxide produced by respiring organisms combines with water molecules to produce carbonic acid, leading to an increase in acidic conditions.

Turbidity

This study revealed significant spatial and temporal variations in turbidity levels in the Okura River. The results showed that turbidity was highest in September and lowest in January. Okeke and Adinna (2013) opined that soil particles, waste materials are transported by run offs from anthropogenic activities in rivers, thereby increasing their turbidity levels. According to Onyegeme-Okerenta *et al*., (2016), turbidity affects aquatic life by limiting sunlight penetration. The significant difference ($p \leq 0.05$) in turbidity across stations and months points to the fact that both spatial and temporal factors affects water clarity. The turbidity range of 139.15 to 154.50 cm indicates moderate to high turbidity levels. The average monthly turbidity range of 141.44 to 152.21 NTU further buttresses the variability in water clarity. The highest turbidity in September could be attributed to seasonal factors such as increased runoff or anthropogenic activities during this period. Significant differences in turbidity across stations indicate varying sources of pollution or natural factors impacting water clarity.

Dissolved Oxygen

The dissolved oxygen (DO) levels in Okura River showed significant monthly variations, with the highest average monthly DO observed in January (8.13 mg/l) and the lowest in August (5.10 mg/l). This result is in line with reports by Keke *et al.* (2015) who recorded a DO range of 3.5 - 8.2 mg/l in Kaduna River, Niger state, Nigeria and Odo *et al*., (2004) who recorded DO range of 4.23 mg/l to 8.48 mg/l within River Idye Makurdi, Benue State, Nigeria. Furthermore, in River Wanzum, Niger state, Nigeria, Mohammed *et al*., 2024 reported that dissolved oxygen varied between 5.80±0.19 mg/L and 6.45 ± 0.12 mg/l while Olopade and Dieyne 2023 in coastal waters of Rivers State reported a range of 5.32 to 8.58 mg/l for dissolved oxygen. The overall average DO level was 6.52 mg/l and adequate to support aquatic life (Boyd, 1979). These results align with reports by Inyang and Anozie (1987) in Adada River and Odo (2004) in Anambra River. Seasonal variations observed in this study are also consistent with previous reports by Huet (1972. Factors influencing changes in DO levels include changes in temperature, excessive plant and algae growth, rainfall, river flow, organic matter from industrial wastewater, agricultural runoff sewage discharges, and as well as photosynthesis by aquatic plants.

Anions

Phosphate levels in River Okura varied between 0.76 to 5.89 mg/l, with an overall mean level of 3.74 mg/l. This result was higher than reports from Jebba Upper Basin by Adelakun *et al*., 2023 and Olopade and Dieyne 2023 in coastal waters of Rivers State. In aquatic ecosystems, phosphate levels can impact the growth of algae and aquatic plants. While there isn't a specific "normal" range for river water phosphate, levels above 0.1 mg/l can contribute to algal blooms and eutrophication. Several factors could contribute to the observed phosphate levels in River Okura, such as agricultural runoff, sewage and wastewater and the geological characteristics of the river (Boyd, 2015).

The sulphate levels in Okura River showed significant differences across the months of sampling, with a range of 0.77 to 7.65 mg/l. Notably, January and December had the highest monthly average sulphate levels at 6.72 mg/l and 5.83 mg/l, respectively. Possible factors that could influence the observed variations in sulphate levels are seasonal changes, anthropogenic activities and geological characteristics. This result was higher than reports from Olopade and Dieyne 2023 in coastal waters of Rivers State. Run-off from agricultural land is suspected to be the chief contributor to solids and dissolved ions in lakes and rivers, which in turn usually brings about a corresponding increase in the conductivity values.

CONCLUSION

This study sheds light on the impact of anthropogenic activities on the water quality of Okura River, Kogi State. The result of the physicochemical parameters analysed during the period of the study shows varying levels of turbidity, dissolved oxygen, sulphate and phosphate across the different sites. Site one recorded the highest values in temperature, pH with site four recording the lowest in both parameters. Site two recorded the highest turbidity and sulphate values while site four recorded the lowest turbidity value. Dissolved oxygen and phosphate level had highest values in site three. The parameters values were within acceptable limits, there is need for continuous pollution monitoring of physicochemical parameters to ensure a healthy aquatic ecosystem.

Conflict of Interest

The authors declare that there is no conflict of interest

REFERENCES

Adelakun, K. M., Idowu, A. A, Alegbeleye, W. O, Arowolo, T. A. and Akinde, A. O. (2023). Assessment of Physical and Chemical Characteristics of Jebba Upper Basin on River Niger, North Central Nigeria. J. Appl. Sci. Environ. Manage. 27 (11): 2515-2523

Akinbuwa, O. (1988). The study of the physico-chemical factors and rotifera fauna of Opa Reservoir, Ile-Ife, Nigeria. Zoology Department, University of Ife, Ile-Ife, Nigeria. 261.

Anayeokwu, S.N., Ogidiaka-Obende, E., Chinjindu, C.P.; Ugegeh, D., Nwaiku, F. and Omoarebun, E. J. (2025). Aquatic plants as ecological indicator for assessing the health of Okura River. Scientia Africana. 24 (No. 2): 319-328

APHA (1999). Standard methods for the examination of water and wastewater, 18th ed. American Public Health Association, Washington, DC. .127

Arumugam P. T. and Furtado, J. I. (1980). Physico-chemistry, destratification and nutrient budget of a lowland eutrophicated Malaysian reservoir and its limnological implications. Hydrobiologia. 70: 11-24.

Atobatele, O. E. and Ugwumba, O. A. (2008). Seasonal Variation in the Physico-chemistry of a Small Tropical Reservoir (Aiba Reservoir, Iwo, Osun, Nigeria). African Journal of Biotechnology. 7(12): 62-171.

Ayoade, A. A. (2009). Changes in Physico-chemical Features and Plankton of Two Regulated High Altitude Rivers Garhwal Himalaya, India. European Journal of Scientific Research. 27(1): 77-92.

Ayoade, A. A., Fagade, S. O. and Adebisi, A. A. (2006). Dynamics of Limnological Features of Two Man-Made Lakes in Relation to Fish Production. African Journal of Biotechnology. 5(10): 1013-1021.

Balance, J. R. (1996). Water quality monitoring, a practical guide to the design and implementation of freshwater quality studies and monitoring programmes. UNEP and WHO, Geneva.

Bonacina, L., Fasano, F., Mezzanotte, V. and Fornaroli, R. (2022). Effects of water temperature on freshwater macroinvertebrates: a systematic review. Biol Rev Camb Philos Soc. 98(1): 191-221. doi: 10.1111/brv.12903. Epub PMID: 36173002; PMCID: PMC10088029.

Boyd, C.E. (2015). Phosphorus. In: Water Quality. Springer,Cham. https://doi.org/10.1007/978-3-319-17446-4_12

Dwivedi, B. K. and Pandey, G. C. (2002). Physico chemical factor and algal diversity of two ponds in faizabad. India Pollution Research. 21(3): 361-370.

Edegbene, A. O., Arimoro, F. O., Nwaka, K. H., Omovoh G. O., Ogidiaka, E. and Abolagba, O. J. (2012). The physical and chemical characteristics of Atakpo River, Niger Delta, Nigeria. Journal of Aquatic Sciences. 27 (2): 159 –172.

Ejeomo, C., Oghoje, S. U. and Obayagbona, N. O. (2022). Water Quality Index classification of ground water samples collected from Opete, community, Delta State, Southern Nigeria. Dutse Journal of Pure and Applied Sciences (DUJOPAS), 8(3b): 25-33.

Emurotu, J. E., Ipeaiyeda A. R. and John P. A. (2016). Baseline Studies of Okura River in Kogi State, Nigeria. Scientia Africana. 15 (1): 87-96

Ezealor, A.U., Gbem, T.T., Kwande, W.S., Auta, J. and Bako, S.P. (1999). Sedimentation: A threat to man-made reservoirs in the savanna (A case study of Kubani reservoir, Zaria, Nigeria). A paper presented at the International Seminar on the Performance of Large and Small-scale Irrigation Schemes in Africa, Abuja, Nigeria, pp 18-31.

Fatioye, O. O., Fagbohun, T. R. and Olubanjo, O. O. (2005). Fungal infestation and nutrient quality of traditionally smoked dried freshwater fish. Turkish Journal of Fisheries and Aquatic Sciences, 8: 7-13.

Gideon, Y. B., Fatoye, F. B. and Omada, J. (20I3). Quality Assessment of Physico-Chemical Characteristics of Okura River, Kogi State, Nigeria. International Journal of Science and Technology (IJST). 2 (12): 891-899

Huet, M. (1972). Textbook of fish culture: Breeding and cultivation of fish. Fishing news Books Ltd., Farnham, Surrey, England. 436. Pp.

Inyang, N. M. and Anozie, G. N. (1987). Some aspects of the biology of Epiplatys sexfasciatus (Pisces: Cyprinodontidae) in Adada River, Southeastern Nigeria. Nigeria Journal of Applied Fisheries and Hydrobiology. 2: 59 - 63

Kaine, E. A. and Ogidiaka, E. (2022). Water quality assessment of Ogbese River, Ekiti State using biological approaches. Journal of Applied Science. 22: 342-350. DOI: 10.3923/jas.2022.342.350

Keke, U. N., Arimoro, F. O., Ayanwale, A. V. and Aliyu, S. M. (2015). Physicochemical parameters and heavy metals content of surface water in downstream Kaduna River, Zungeru, Niger State, Nigeria. Applied Science Research Journal. 3 (2): 49-57

Mahar, M. A. (2003). Ecology and Taxonomy of Plankton of Manchhar Lake (Distt. Dadu), Sindh, Pakistan. Unpublished PhD. Thesis University of Sindh, Pakistan. Retrieved from: http://usindh.edu.pk.mukhatiar.ahmadlDessertation_mukhatiar

Muhammed, H. A., Yahaya, A., Abdullahi, S. S., Jagaba, A. H. and Birniwa, A. H. (2023). Mitigating water contamination by controlling anthropogenic activities of organochlorine pesticides (OCPs) for surface water quality assurance. Case Studies in Chemical and Environmental Engineering, 8: 100474 https://doi.org/10.1016/j.cscee.2023.100474

Mustapha, M.K. (2008). Assessment of the Water Quality of Oyun Reservoir, Offa, Nigeria, using Selected Physico-chemical Parameters. *Turkish Journal of Fisheries and Aquatic Sciences,* 8, 309-3 19.

Muziri, M., Mahmood, A.O., Dawood, F. K. and Hani, S. (2022). Anthropogenic temperature fluctuations and their effect on aquaculture: A comprehensive review. Aquaculture and Fisheries. 7 (3): 223 - 243. https://doi.org/10.1016/j.aaf.2021.12.005.

Odo, G. E. (2004). Studies on the Ecology of Macroinvertebrate Fauna as Fish Food in Anambra River Basin, Nigeria. Ph.D , Thesis, University of Nigeria, Nsukk, 172 pp.

Ogbeibu, A. E. and Oriabure, P. A. (2023). Assessment of the Water Quality of the Benin River, Southern Nigeria, Prior to the Seaport Development Project. Journal of Water Resource and Protection. 15: 597-610. https://doi.org/10.4236/jwarp.2023.1511033

Ogidiaka, E**.,** Esenowo, I. K. and Ugwumba, A. A. A. (2012)**.** Physico-chemical parameters and Benthic Macroinvertebrates of Ogunpa River at Bodija, Ibadan, Oyo State. European Journal of Scientific Research. 85(1): 89-97.

Ogidìaka-Obende, E., Anayeokwu, S. N., Omoarebun, E. O., Atadiose, J. and Oyem, I. M. (2025). Water Quality Index (WQI) of Akassa Creek, Southern Nigeria. International Journal of Biological Innovations. 7(1): 36-40. https://doi.org/10.46505/IJBI.2025.7105

Olopade, O. A. and Dieyne, H. E. (2023). Assessment of water quality parameters of the coastal waters of Rivers State, Nigeria. Advance Journal of Agriculture and Ecology. 8 (4): 10-20.

Okeke, P. N. and Adinna, E. N. (2013). Water Quality study of Otamiri Otamiri-oche River in Owerri, Nigeria. Universal Journal of Environmental Research and Technology. 3 (6): 641-649.

Onimisi, M. O. and Ogbe, G. F. (2018). A study of the variation of physico-chemical parameters along the course of river Okura, Confluence Journal of Environmental Studies. 12(1): 35-43.

Onyegeme-Okerenta, B. M., Obia, C. and Wegwu, M. O. (2016). Physicochemical properties of water quality of Imeh, Edegelem and Chokocho communities located along Otamiri-oche River in Etche Ethnic Nationality of Rivers State, Nigeria. Journal of Applied Sciences and Environmental Management. 20 (1): 113 -119.

Sharma, A., Sharma, R. C. and Anthwal, A. (2007). Monitoring phytoplankton diversity in the hill stream Chandrabhaga in Garhwal Himalayas. Life Science Journal. 4: 80–84.

Sun,J.L., Zhao, L.L. Wu, H., Lian, W.Q., Cui, C. and Du, Z.J. ((2019). Analysis of miRNA-seq in the liver of common carp (*Cyprinus carpio* L.) in response to different environmental temperatures. Functional & Integrative Genomics. 19 (2): 265-280. 10.1007/s10142-018-0643-7.

Ukabiala, M. E., Omatule, L. and Kolo, J. (2025), Assessment of Irrigation Water Quality of River Okura in Dekina Local Government Area of Kogi State, Nigeria. African Journal of Environment and Natural Science Research. 8(2): 1-9. DOI: 10.52589/AJENSRSZM8OIEM

Ventatesharaju, K., Ravikumar, P., Somashekar, R. K. and Prakash, K. L. (2010). Physicochemical and Bacteriological Investigation on the River Cauvery of Kollegal Stretch in Karnataka. Journal of Science Engineering and Technology. 6 (1): 50-59.

Wang, J., Lu, D.Q., Jiang, B.,. Mo, X.B., Du, J. J. and Li, A.X. (2020). Influence of temperature on the vaccine efficacy against *Streptococcus agalactiae* in Nile tilapia (*Oreochromis niloticus*).
Aquaculture. 521: 734943, 10.1016 /j.aquaculture.2020.734943