

## Effects of Environmental Variables on Some Aquatic Biota of Jabi Lake, Federal Capital Territory, Abuja

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**ABSTRACT:** The presence of environmental variables above regulatory permissible limit especially, high levels of toxic substances and heavy metals in freshwater bodies represents a global public health issue. Aquatic ecosystems are critical components of the global environment and essential contributors to biodiversity and ecological productivity. The effects of environmental variables on some aquatic biota of Jabi Lake was studied from January, 2022 to December, 2023 using a combination of insitu and laboratory analyses. Seven stations were selected; the tributaries (3 stations), the confluent station and 3 stations within the Lake, to determine the physico-chemical, nutrients and biological characteristics based on the activities in and around the various stations. Physico-Chemical parameters measured were: Atmospheric temperature, Water temperature, pH, Dissolved Oxygen (DO), Turbidity, Water Electrical Conductivity (WEC), Water current, Biological Oxygen Demand (BOD), Total Dissolved Solid (TDS), Alkalinity, Chemical Oxygen Demand (COD) and Nitrite. Nutrients: Phosphate and Nitrate. Metals: Copper (Cu), Iron (Fe), Lead (Pb), Zinc, Chromium and Cadmium. Some of the parameters were within the regulatory permissible limit while few above the standard. There were significant differences ( $P < 0.05$ ) between these parameters, within the months, stations and seasons. The result of biotic fauna recorded shows composition and abundance of 4 phyla, 9 classes, 25 families and 45 species. Temperature has the most pronounced effect on the distribution and abundance of aquatic fauna, followed by DO in the CCA analysis. The Shannon Weiner species diversity index is 1.14. Pearson correlation @between fauna family and hydro-chemical parameters shows that phosphate was significant at  $P < 0.05$  followed by COD, EC and BOD.

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### INTRODUCTION

Environmental variables are determinants of water quality which is essential for ecological balance and economic development. Aquatic biota are the most threatened large taxon in the world as reported by Carrizo, Smith and Darwall, 2013. Lake are of significant importance because they hold populations of diverse species as reported by Idowu, 2004. World Health Organization, (2019) and Makpo, (2020) reported that the quality of Lake is being threatened by a large number of water pollutants and it mainly occurs in urban areas and areas that have become centers of intensive agriculture. Hence the need for proper planning, monitoring and management of water body as a natural resource as observed by Bamgbose and Arowolo, 2007. Some contaminants that have become important to comply with regulators' guidelines are microorganisms (bacteria, viruses, and parasites), nitrates and nitrites through chemical fertilizers, human sewage, and animal waste; heavy metals like copper, chromium, arsenic, lead, antimony, cadmium, selenium, organic chemical; radionuclides; and fluoride as reported by USEPA, 2010; Al-bahry and Mahmoud, 2014. Thus, continuous monitoring is essential for detecting and assessing effect of environmental variables at Jabi Lake, Federal Capital Territory (FCT), and in this case, physical, chemical, nutrients and heavy metal level has been monitored. Therefore, this research work provided information on the status of environmental parameters in relations to the aquatic biota of the Lake and its tributaries.

### MATERIALS AND METHODS

**Study Area:** This study was carried out at Jabi Lake and its tributaries in Abuja, Federal Capital Territory of Nigeria. Jabi Lake is located between the Jabi and Kado Districts of Abuja. It is located within Latitude  $9^{\circ}4'38''N$  and Longitude  $7^{\circ}25'18''E$ . The

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coordinate of the sampling stations are as shown in table 1 and figure 1, the goggle map of Jabi Lake and the tributaries showing sampling stations.

**Materials Used:** Material used includes sampling container (bottle and plastic), distilled water, conical flask, paper table, Aluminium fuel. Seven different sampling stations (stream and lake), A long-calibrated fabricated stick, float cork and fabricated Grab.

**Equipment used:** Insitu: Hand-held humidity & temperature meter AR837, Multipurpose Hanna Instrument – HI 9813-6, AZ 8403 Dissolved Oxygen Meter.

### Methods

**Laboratory Analysis:** Atomic Absorption Spectrophotometer (AAS) was used to determine heavy metal concentrations. The instrument settings and operational conditions were in accordance with the manufacturer's specifications. Colorimetric spectrometric method was used for determining both phosphate and nitrate concentration.

### Sample collection and Pre-treatment

#### Water collection and analysis

Some of the water parameters were determined at the field (in-situ) using hand-held multipurpose probe while surface water samples collection were also carried out separately at the seven stations for Laboratory analysis using appropriate containers (Amber bottle, high-density polyethylene plastic and conical flask) and they were preserved in ice-chest, then, transported to Fisas Laboratory at Lugbe extension, off Airport Road, Abuja, for further analysis.

#### Fauna collection and analysis

**Fish Species:** Fishes were collected from fishermen; artisanal fishery survey at the lake on every sampling day, and were preserved with 70% alcohol and transported to the Biological Science Department Laboratory, Nasarawa State University for further examination and identification.

**Benthos:** Sediment samples were collected from each sampling station with a fabricated grab sampler using the combination of the Travelling-Kick-and Sweep-Transect method and near shore Lake sampling methods called Sampling Reaches (Ontario, 2007) for shoreline substrate. Sediments were collected into labelled polyethylene bags. Samples were preserved and stored in ice-chest – 4°C and transported to the Biological Science Department Laboratory of Nasarawa State University, Keffi (NSUK). In the laboratory, sediment samples were washed under tap water and filtered through Seven (7) standard-sized sieves in descending order (6mm, 4mm, 2mm, 1mm, 0.5mm, 0.25mm mesh size with the bottom receiver) and then, the sieved samples (specimens) were preserved in 70% Ethanol. Macroorganisms were further sorted and identified to the lowest possible taxonomic level as described by Mezquita (1996) and Meisch (2000) using identification guide.

**Table 1: Characteristics of sampling stations and their coordinates**

Station	Predominant activity	Coordinates	
		Latitude	Longitude
1.	Nicon Junction (tributary)	9.096598	7.473435
2.	Katampe (tributary)	9.118115	7.426540
3.	Garinpa Ex. (tributary)	9.098758	7.428326
4.	KadoGishiri (confluent)	9.089126	7.429520
5.	Recreational Area (Jabi Lake)	9.073763	7.418126
6.	Carnival Ground (Jabi Lake)	9.076248	7.420039
7.	Fruit Garden (Jabi Lake)	9.077503	7.418150

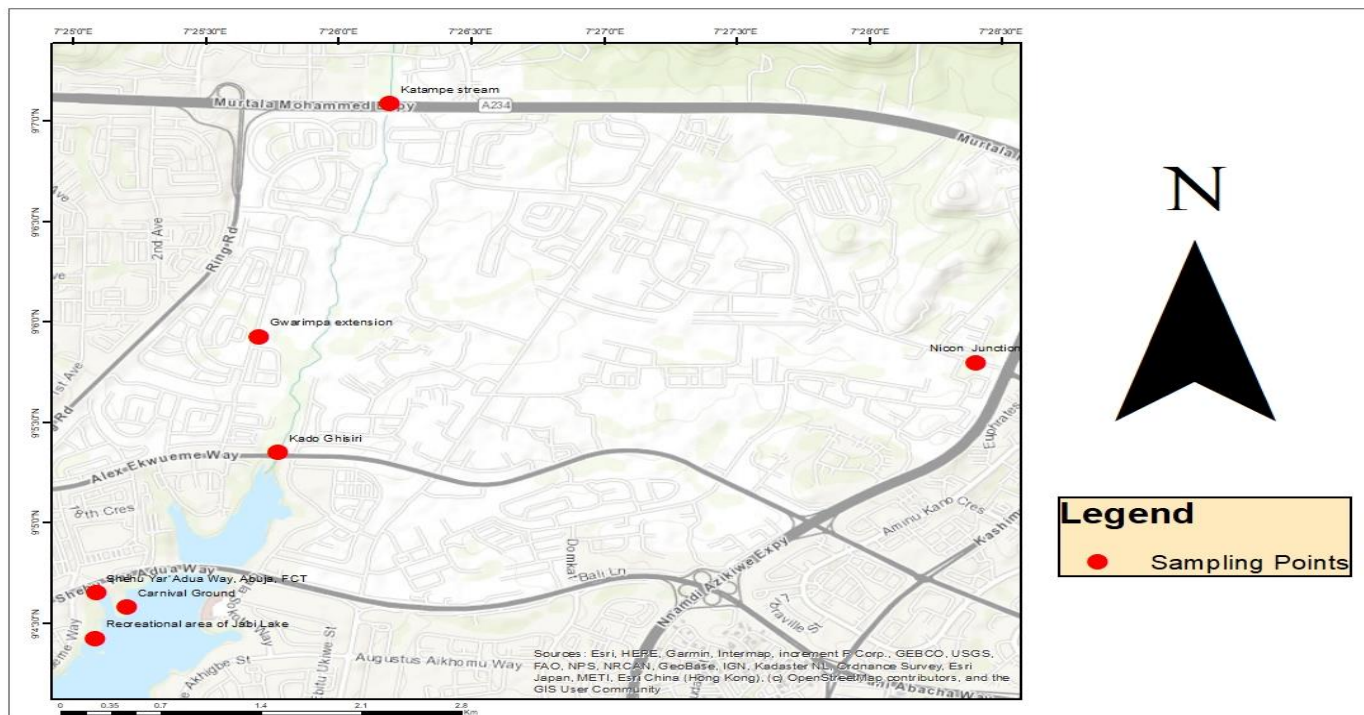


Fig 1: Goggle Map of Jabi Lake and the Tributaries showing sampling stations

**Statistical Analysis:** All data collected for the physic-chemical parameters over the period of studies was subjected to means using Simple Descriptive analysis. T-test was used to determine seasonal variation. Analysis of Variance (ANOVA) was used to test any significant different in physic-chemical parameters and heavy metals within the stations. Pearson correlation co-efficient was used to determine relationship between parameters and macrofauna. The data were tested at 95% level of significant (0.05). Statistical analyses for fauna was based on Shannon Wiener and Simpson diversity index, which is commonly used to characterize species diversity in a community plus Jaccard Index to calculate the Index values between species and between seasons. It accounts for both abundance and evenness of the species present. Canonical Corresponded Analysis (CCA) was used to determine environmental impact of parameters on macrofauna.

## RESULTS

Atmospheric temperature ranged from 23.3<sup>o</sup>C to 39.3<sup>o</sup>C but within the regulatory limit of >40<sup>o</sup>C while water temperature ranged from 23.25<sup>o</sup>C to 34.85<sup>o</sup>C and slightly above standard regulation of 20 - 33<sup>o</sup>C for aquatic environment. The pH value ranged from 5.50 to 7.60 (Limit 6 – 9), Dissolved Oxygen (DO) ranged from 3.10mg/L – 7.70mg/L which are within regulatory permissible limits, Turbidity ranged from 3.80 – 116NTU, Water Electric Conductivity (WEC) fluctuated between 150.00 – 354.00uS/cm, water current well recorded at tributaries while part of the Lake stagnates. Biological Oxygen Demand (BOD) ranged between 7.00mg/L to 26.50 mg/L, Total Dissolved Solid (TDS) ranged from 110.00 to 236.00mg/L, Alkalinity ranged from 40.00 to 116.00mg/L, Chemical Oxygen Demand (COD) ranged from 11.00 to 52.00 mg/L and the Nitrite value recorded ranged from 0.01 to 1.25mg/L. Nutrients: Phosphate ranged from 0.01 to 2.50 mg/ L and Nitrate ranged from 1.10 to 8.00mg/L. Metals: Copper (Cu) ranged from 0.01 to 0.58mg/L, Iron (Fe) ranged from 0.01 to 4.59mg/L, Lead (Pb) ranged from 0.01 to 0.35mg/L, Zinc ranged from 0.00 to 0.24mg/L, Chromium ranged from 0.00 to 0.07mg/L and Cadmium ranged from 0 – 0.4 mg/L.

### Fauna distribution at Jabi Lake and its tributaries

A total of 4 phyla (Chordata, Mollusca, Arthropoda and Annelida) were recorded throughout the sampling period, 10 classes, 26 families and 44 species. The total number of species encountered at station 1 throughout the sampling period were 20, station 2 were 15, Station 3 was 48, station 4 was 79, station 5 was 2,140, station 6 was 1,177 and station 7 was 780. The total number of species sampled were 4,259. Family Bithyniidae, *Ganiobasis livescens* were abundantly present during dry season but gradually drifted away at onset of rainy season.

Table 2 presented the Pearson correlation @ between ichthyofauna family and hydrochemical parameters as factors that influences fish abundance. The result shows that phosphate, Electrical conductivity and Air temperature has pronounced effect (P<0.05) on *Oreochromis niloticus*, *Gnathonemus petersil* was next with two parameters influencing it while *Pseudotolithus senegalenses* appears less delicate with only phosphate having influence on it. Table 3 shows the Pearson correlation @ between benthos family

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and environmental variables having influences on their abundance. Water current, BOD, Phosphate and COD has significant effect ( $P < 0.05$ ) on Arthropos (*Chironomus tentans*, *Argyroneta aquatic*, *Chironomous ripariusn* and *Dolomedes sp.*). Phosphate, BOD and Electrical conductivity has pronounced effect on Molluscs (*Lymnaetruncatula*, *Campeloma sp.* And *Viviporous sp.*). Annelids (*Naisbarbata*, *Nais simplex* and *Helobdella stagnalis*) appears as the delicate species as it was influenced by tree different environmental variables (Chromium, Alkalinity and COD) while Arachnid (*Progompus serenus*) appears less delicate with only cadmium having influence on it. Figure 2, Canonical Corresponded Analysis (CCA) shows environmental impact on macrofauna family. The CCA shows only torant organisms on positive axis i.e. representative of Annelida, Arthropoda, Chodata has affinity to variables while few representative of Arthropoda were sensitive to environmental condition.

### DISCUSSION

#### Macroorganisms distribution at Jabi Lake and its tributaries

Environmental factors have long been known to explain variation in distribution pattern of macrofauna and thus community structure at the global dependent taxa. An increase in temperature will probably further decreases breeding in the hot months but increases breeding in the rainy season months of major aquatic organisms according to Brook, Sodhi, and Bradshaw 2008. Although, this does not account for the high density recorded in the hot dry season for family Bithyniidae and Lymnaeiidae. The abundance of Gastropoda in Jabi Lake may be due to the types of aquatic macrophytes in and around the lake. It is also possible that gastropod abundance is a consequence of differences in protection and avoidance from the predators.

The overall composition and abundance of macrofauna in Jabi Lake and tributaries varied both spatially and temporally in response to physical, chemical nutrient and heavy metals factors of the aquatic environment. The overriding influence of the temperature, DO, pH, current, depth, conductivity in distribution and abundance of aquatic fauna can explain the significantly species numbers observed in all the station during the sampling period.

**Table 2. Environmental variable having significant influence on fish species (Using Person's Correlation)**

S/No.	Variables (Environmental)	Variables (Biological)	Pearson Correlation (r)	p (Sig.)
1.	Phosphate	<i>Oreochromisniloticus</i>	0.889	0.007**
2.	Electrical Conductivity	<i>Oreochromisniloticus</i>	0.763	0.046*
3.	Air temperature	<i>Oreochromisniloticus</i>	0.755	0.050*
4.	Nitrate	<i>Gnathonemuspeterisil</i>	0.849	0.016*
5.	Ph	<i>Gnathonemuspeterisil</i>	0.770	0.043*
6.	Phosphate	<i>Pseudotolithussenegalenses</i>	0.829	0.021*

\* Significant at  $p < 0.05$ , \*\* Significant at  $p < 0.01$

NARESCON, (1992) reported that the fresh water fishery resources in Nigeria comprised of over 200 species from inland waters, with Kainji having about 100 species of fish while Lake Chad had 87 species. Ita (1993) reported 101 species of fish in Lake Kainji and 52 species in Jebba, eighteen (18) species belonging to nine families were recorded in Zaria reservoir (Balogun, Auta, Balarebe, and Bako, 2000). Balogun and Auta (2001) reported 34 species of Fish in Ikere Gorge, 32 species was reported in Erinle Lake (Komolafe and Arawomo, 2011), 16 species reported in Ikwori Lake (Offem *et al.*, 2011) and 27 species in Asejire Lake (Ipinmoroti, 2013). Other works with a comparable results are Doma reservoir with eleven (11) species of fish belonging to six (6) families (Banyigy *et al.*, 2016), Dan-Kishiya, Olatunde and Balogun, (2013) reported low diversity of fish species in Lower Usuma Dam, Bwari, Abuja. Eleven (11) species of fish in Tagwai Lake Minna, while eight (8) species of fish were recorded in Egbe reservoir (Edward, 2013).

### CONCLUSION

The study revealed that Jabi lake is maintaining eutrophic status and is not really polluted nor adversely affected by environmental variables. The study also shows that most species in the Lake were relatively in good condition for human consumptions accept high concentration of few parameters such as COD, Nitrite and Iron that needs government intervention and further investigation.

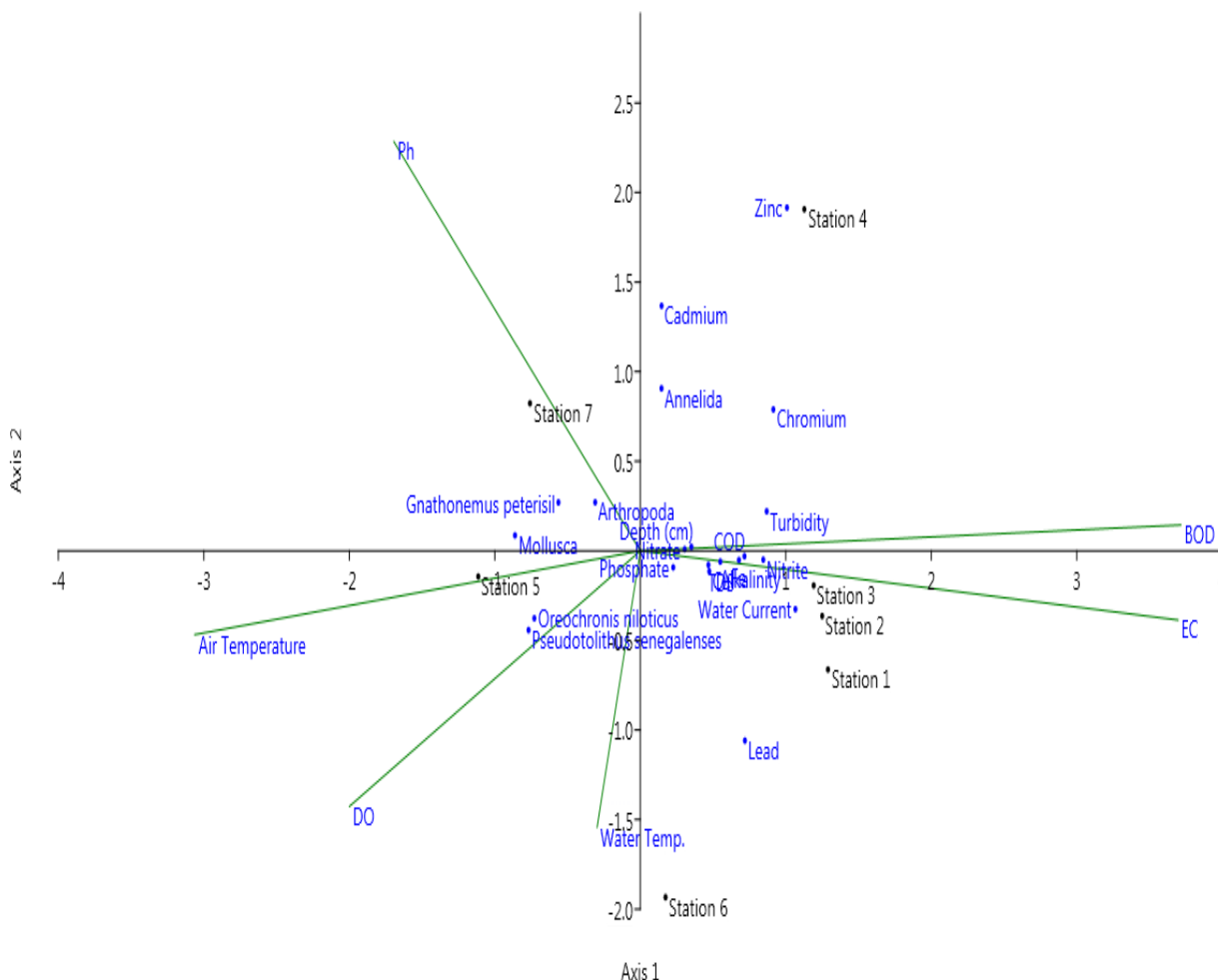
**Table 3. Environmental variable having significant influence on macro-invertebrates (Benthos) Using Person's Correlation**

S/No.	Variables (Environmental)	Variables (Biological)	Pearson Correlation (r)	p (Sig.)
1	Water Current	<i>Chironomustentans</i>	-0.846	0.017*
2	BOD	<i>Argyronetaaquatica</i>	-0.821	0.024*
3	Phosphate	<i>Chironomousriparius</i>	0.802	0.030*

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4	COD	<i>Dolomedes sp.</i>	0.758	0.048*
5	Phosphate	<i>Lymnaetruncatula</i>	0.935	0.002**
6	BOD	<i>Campeloma sp.</i>	-0.767	0.044*
7	Electrical conductivity	<i>Viviparous sp.</i>	-0.766	0.045*
8	Chromium	<i>Naisbarbata</i>	0.988	0.007*
9	Alkalinity	<i>Nais simplex</i>	0.961	0.023*
10	COD	<i>Helobdellastagnalis</i>	0.943	0.033*
11	Cadmium	<i>Progompusserenus</i>	0.939	0.036*

\* Significant at  $p < 0.05$ , \*\* Significant at  $p < 0.01$



**Fig 2: Canonical Corresponded Analysis (CCA) for Environmental variables on species**

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