PRINT ISSN 1119-8362
Electronic ISSN 2659-1502

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

J. Appl. Sci. Environ. Manage.
Vol. 27 (6) 1141-1146 June 2023

Water Quality Assessment of the Man-Made Jabi Lake, Federal Capital Territory, Abuja, Nigeria

***[1]DANIEL, M; [1]SAWYERR, HO; [1]OPASOLA, OA; [1]EKUNDAYO, DE; [2]ATIMIWOAYE, AD; [3]MUSA, O; [4]SULE, R**

**[1]Department of Environmental Health Science, Kwara State University, WASU, Malete, Kwara State, Nigeria,*
[2]Departmennt of Statistics, Kwara State University, WASU, Malete, Kwara State, Nigeria
[3]Nigerian Police Force, Lagos, Nigeria.
[4]Abuja Municipal Area Council, Abuja.

**Corresponding Author Email: danielmusa56@gmail.com*
Co-Authors Emails: hsawyerr@gmail.com; opasolaafolabi@gmail.com; eunicedayo3584@gmail.com; atimiwoayeadetunji@gmail.com; musaokaigreat6@gmail.com; ilayisule@gmail.com

ABSTRACT: The quality of the water needs to be evaluated in order to guarantee that everyone has access to clean water which is both sustainable and available. The objective of this research is to evaluate the water quality in-terms of physicochemical characteristics of the Man-made Jabi Lake in the Federal Capital Territory, Abuja, Nigeria using standard methods. Water samples were collected from three sites along the lake, and their pH, alkalinity, conductivity, total hardness, biological oxygen demand, chemical oxygen demand, phosphate, and nitrate concentrations were analyzed. The ANOVA results showed that there was no significant difference (0.089 p-value for physical parameters, 0.135 p-value for chemical parameters and 0.530 p-value for metals) in the physicochemical characteristics among the three sites. The Pearson correlation coefficient revealed a high positive correlation ($r = 0.999$) among the sample points, indicating that a change in the concentration of these parameters in one site would lead to a similar change in the other locations. These findings suggest that pollutants in one part of the lake may impact the entire ecosystem, and management strategies should consider the interconnectedness of the lake's water quality. The study concludes that the stream has a moderate level of pollution and is not suitable for direct consumption or use in the home.

DOI: **https://dx.doi.org/10.4314/jasem.v27i6.12**

Cite this paper as: DANIEL, M; SAWYERR, HO; OPASOLA, OA; EKUNDAYO, DE; ATIMIWOAYE, AD; MUSA, O; SULE, R (2023). Water Quality Assessment of the Man-Made Jabi Lake, Federal Capital Territory, Abuja, Nigeria. *J. Appl. Sci. Environ. Manage.* 27 (6) 1141-1146

Dates: Received: 19 February 2023; Revised: 22 April 2023; Accepted: 16 June 2023; Published: 30 June 2023

Keywords: water quality, metals, suitability; man-made Lake

It has been mentioned by Joana *et al*. (2021) that freshwater ecosystems are crucial to human life since human life depends heavily on the many services that are supplied by freshwater. These services could involve supplying, regulating, cultural, or supporting services, among others. Access to clean water for drinking is another factor that is critical to maintaining good health (Agneta *et al.*, 2021). It is estimated that more than 30 percent of the world's population is currently living with water scarcity, and that number will continue to climb if appropriate measures are not put into place to regulate it (United Nations, 2018). The nations of Sub-Saharan Africa, Central Asia, Southern Asia, Eastern Asia, and South-Eastern Asia are currently dealing with the most severe forms of water scarcity (SDG Baseline update, 2017). According to the United Nations Sustainable Development Goals (UNSDG) for 2018, it was reported that 71 percent of the world's population has access to drinking water services that are safely maintained. This would imply that three out of every ten people across the world do not have access to drinking water services that are safely managed (Polma, 2018). The percentage of people in Sub-Saharan Africa who have access to clean water is fairly low (46 out of 54 African countries), and only

**Corresponding Author Email: danielmusa56@gmail.com*

approximately 24 percent of the region's population has access to drinking water services that are adequately managed. This is a problem in many African countries (United Nations, 2018). The quickening of the pace of industrialisation, which has become an absolute necessity in today's wo ld for any developing nation, is by itself a significant contributor to the contamination of groundwater. According to various studies, as disclosed by Kagiso (2016), these studies have given evidence that the effects of human activities such as agricultural runoffs, sewage, and industrial effluents damage freshwater resources. Kagiso's findings are based on the findings of these studies. The amount of the impact that human activities have on the quality of the water can vary greatly from one location to the next. Alterations in the physical, chemical, and biological features of water have a deleterious impact, not only on human health but also on the health of ecosystems (Wagner *et al*., 2013). In the process of penetrating the subterranean aquifer, effluents from industry, home waste, dump sites, and fertilizers all contribute to the contamination of groundwater and constitute a possible threat to the receptors (Zacchaeus *et al*., 2020). According to Essien and Bassey (2012), "pollution of ground water stems from a variety of sources that include insanitary conditions during borehole construction, splashing of runoff into wells, and if left uncovered, flooding at borehole site, leachate from old burned waste pit or latrine into the hole through cracks in aquifer, and annular of the hole." All of these factors can contribute to the contamination of ground water. Prior to consumption, the quality of the water must be evaluated, and in order to accomplish this, the physicochemical characteristics of the water or its conformance with specific physical, chemical, and microbiological requirements must be monitored (Sadiya *et al*., 2018). Researchers have utilized a variety of techniques in order to investigate the physicochemical properties of water. Some of these techniques include in-vitro bioassays (Brunner et al., 2020 and Kakaley *et al*., 2020), chlorination, ozonation, and UV-treatment (Tak and Vellanki, 2018). There have been a number of studies that have been carried out to ensure that these parameters are present in a variety of drinking water sources, including well water (Ezeribe *et al*., 2012; Mile et al., 2012; Aboh *et al*., 2015; Gambo *et al*., 2015; Allamin *et al*., 2015), borehole water (Onwughara *et al*., 2013; Isa *et al*., 2013; (Lawal and Lohdip, 2015). Using water that has been tainted in any way not only has an immediate negative impact on the health of the person doing so, but it also has the potential to have a fatal impact in the long run (Taruna and Alankrita, 2013). The United Nations Children's Fund (UNICEF) said in 2018 that each year, millions of people, including children, lose their lives to diseases that are linked to insufficient or contaminated water. According to Pal *et al*. (2018), humans are more susceptible to water-borne diseases like diarrhea, cholera, typhoid fever, hepatitis A and E, fluorosis, salmonellosis, shigellosis, leptospirosis, and schistomiasis as these diseases continue to spread throughout the world. Ezeh *et al*. (2020) evaluated the well water quality in the Gaba and Zuma communities in Abuja and found that it did not comply with the standards. According to the findings of Sadiya and colleagues (2018), who investigated the physicochemical and bacteriological properties of various sources of drinking water, the sachet/packaged water is the safest drinking water source in the Idu district of Jabi, Abuja, while the river water is the least safe due to the presence of opportunistic pathogens. Simply said, very little research has been done to investigate the water quality of Jabbi Lake. Therefore, the objective of this research is to evaluate the water quality in terms of physicochemical characteristics of the Man-made Jabi Lake in the Federal Capital Territory, Abuja, Nigeria.

MATERIALS AND METHODS

Study Area: The research was conducted on Jabbi Lake, which is located in the Idu industrial community. Jabbi Lake is a body of water that was created when an earth dam was constructed by humans. Its primary purpose when it was first established was to provide water to the people living in Abuja.

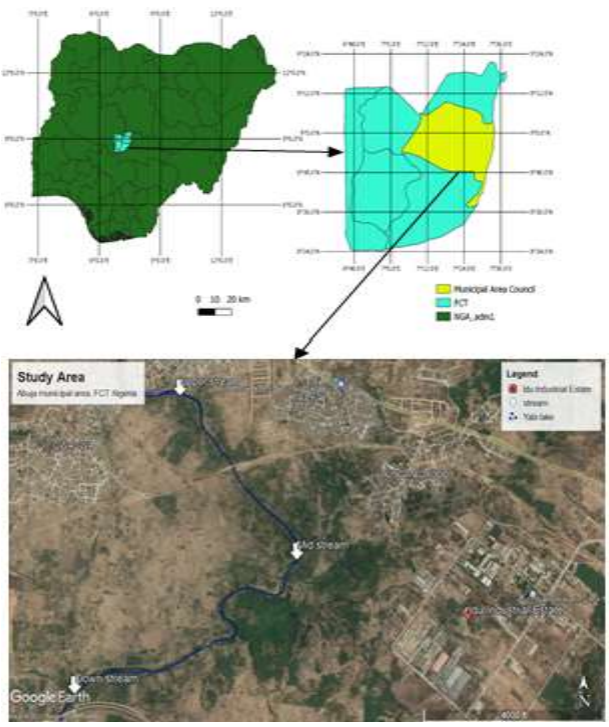

Fig 1: Map of Idu Industrial Area in Abuja Metropolis (Google Map, 2021)

The lake has an approximate surface area of 1,300 hectares across its entirety. The coordinates for Jabbi Lake in Abuja's Idu industrial district, Nigeria are 9.0740 degrees North and 7.4210 degrees East.

Sample Collection: The research design used in this study was an experimental one. It includes taking samples from a selection of sites in the Jabbi Lake in Idu industrial region, specifically the upper reach (Station A), the midpoint (Station B), and the lower reach (Station C). A sample of water is taken from each station and then analyzed to determine its pH, alkalinity, conductivity, total hardness, biological oxygen demand (BOD), and chemical oxygen demand (COD), as well as its phosphate and nitrate concentrations.

Determination of Temperature: 50ml of water sample was poured inside the beaker and sensor of temperature meter deep into beaker and reading was the taken for the three water samples.

Determination of conductivity: Spectrophotometer, method was used to determine conductivity of the water sample, 50ml of water was poured into the beaker and sensor of conductivity meter was deep into it, conductivity meter (CDM83 Conductivity meter Denmark product) was switch on and reading was taken, conductivity meter was calibrated to 0.00 before reading was taken.

Determination of Turbidity: 50ml of water sample was also poured into beaker and sensor of turbidity meter was deep into the beaker, turbidity meter was switch on and then reading was taken.

Determination of Dissolved Oxygen: Titration method was used. The solutions of Manganese peroxide and sodium hydroxide were added to sample water. The resulting precipitate of manganese hydroxide reacts with dissolved oxygen to form brown precipitate. Measurements are taken for each water sample.

Determination of Total Dissolved Solid: In order to calculate the total dissolved solids (TDS), a handheld digital portable meter with 4 parameters was used. After inserting the probe into the water sample, the results for total dissolved solids (TDS) were compared across the three samples.

Determination of pH: Spectrophotometric method was used with Wagtech Kit instrument. 50ml of water sample was poured into beaker. The sensor of pH meter was deep into it. pH meter was switch on and reading was taken.

Determination of Total Hardness: Titration method was adopted in determination of total hardness. Reagent used was EDTA i.e. Ethylene Diamine Tetral Acetic Acid). Indicator used was Black T (i.e. Ericromic Black T). 50ml of water sample was also poured into conical flask. 2 drops of buffer were added to water sample. A drop of black T powder was also added (i.e. indicator). It was then titrated until it changed from initial color (i.e. black) to faint blue.

Determination of Chloride: Titration method was used**.** Reagent used was silver nitrate**.** Indicator used was Potassium Dichromate ($K_2Cr_2O_7$)**.** Silver nitrate (i.e. reagent) was poured into burette**.** 50ml of water sample was also poured into conical flask**.** 2drops of Potassium Dichromate ($K_2Cr_2O_7$) (I.e. indicator) was added to water sample inside conical flask (initial color was yellow). It was titrated until it changed from yellow to deep orange

Determination of Alkalinity: Titration method was used. 50ml of water sample was poured into clean Erlenmeyer flask. A drop of sodium thiosulphate solution and two drops of phenolphthalein indicator. The solution was titrated against standard sulphuric acid in the burette, till the color disappears. Two drops of methyl orange indicator, the color turns yellow. Titration is done against acid, until the color turns to orange yellow. The resulting volume is note.

Determination of Sulphate and Phosphate: This was done for all the water samples following APHA method.

Determination of Iron: 50ml of water sample was poured into burette. Iron reagent was added (Hanna product). It was left for (3) minutes. Photo meter was calibrated to blank i.e. 0.00 reading. Reading was taken with photometer. The same procedures were followed for all the 3 water samples.

Determination of Fluoride: Ion-selective electrode method was used to quantify fluoride. Lanthanum fluoride-selective membrane is used to measure the concentration of fluoride ions in the water sample. The membrane generates a potential difference between the fluoride ion and the reference electrode, which is proportional to the fluoride ion concentration.

Statistical Analysis: Data were analyzed using Analysis of Variance (ANOVA), and the relationship between heavy metals in the sample points will be tested using spearman rank correlation.

RESULT AND DISCUSSION

According to the results from the ANOVA table, the p-value for testing significance difference of physical parameters, chemical parameters and metals are 0.089, 0.135 and 0.530 respectively. These values are greater than 0.05 which demonstrates that the concentration of physicochemical characteristics detected in the top stream, the middle stream, and the lower stream are not significantly different from one another.

Correlation matrix for physicochemical water quality parameters: According to the results of the ANOVA test presented earlier, the physico-chemical parameters that were observed in the upper stream, the mid stream, and the lower stream are not significantly different from one another. Because of this outcome, it is possible that the pollutants in the upper stream, the mid stream, and the lower stream are impacting one another. The Pearson correlation is used to investigate the nature of this connection. The table that follows presents this information in a format called a correlation matrix.

Table 1: Physical parameters of water in the sampled water

Parameters	Down stream	Mid-stream	Up stream
Temperature (0^C)	23	19	23
Conductivity (Us/cm)	289	284	295
Turbidity (Mg/l)	8.92	9.11	8.62

Table 2: Metals in the sampled water

Parameters	Down stream	Mid-stream	Up stream
Iron (Mg/l)	0.56	0.59	0.6
Fluoride (Mg/l)	0.3	0.2	0.2
Sodium (Mg/l)	24.7	22.4	26.6
Sulphate (Mg/l)	15.7	16.2	15.7

Table 3: Chemical parameters of water in the sampled water

Parameters	Down stream	Mid-stream	Up stream
Dissolved Oxygen (Mg/l)	3.2	8.4	11.6
Biological Oxygen Demand (Mg/l)	1.6	0.8	6.0
Total Dissolved Solid (Ppm)	142	141	146
pH	7.45	7.25	7.50
Total hardness (Mg/l)	257	260	262
Calcium hardness (Mg/l)	115	113	110
Magnesium hardness (Mg/l)	155	157	152
Chloride (Mg/l)	43.4	44.3	48.7
Alkalinity (Mg/l)	110	118	113
Phosphate (Mg/l)	0.87	0.89	0.91
Chemical Oxygen Demand (Mg/l)	2.0	4.0	4.0

According to the results of the association analysis presented earlier, the Pearson correlation coefficient among the points in the sample is 99 percent (Upper stream, mid-stream, and downstream). This correlation value demonstrates that there is a high positive correlation between the points in the sample. This suggests that the physico-chemical parameters in the sample points are closely connected to one another, which translates to the fact that a rise in the concentration of these parameters in one site will lead to the similar increase in the concentration of these parameters in the other locations.

Table 4: ANOVA of parameters among the sample stream points

Source of Variation	F	P-value	F crit.
Physical parameters	2.601	0.089	3.276
Chemical parameters	2.216	0.135	3.493
Metals	0.707	0.530	5.143

Table 5: Correlation matrix of physico-chemical parameters among the stream sample points

	Down stream	Mid-stream	Upper stream
Down stream	1	0.999	0.999
Mid-stream	0.999	1	0.999
Upper stream	0.999	0.999	1

Conclusion: The evaluation of the water quality showed that the physicochemical parameters that were observed from the upper stream, the mid stream, and the lower stream are not distinct from one another but are instead significantly positively associated with one another. This study reveals that although industrial activities such as industrial processes in the study area have a negative influence on the physicochemical characteristics of groundwater samples under consideration, the contamination is not statistically significant. This is the conclusion reached by the researcher after conducting this research. According to the findings of the study, the stream in Jabi has a level of pollution that is considered moderate, and it is not suitable for direct consumption or use in the home.

REFERENCES

Aboh, EA; Giwa, FJ; Giwa, A (2015). Microbiological assessment of well waters in Samaru, Zaria, Kaduna, State, Nigeria. *Ann African Med, 14*(32).

Agneta O; Anna KR; Geeta MAJ; Andrew H; Rikard T; Johan L. (2021). Assessment of source and treated water quality in seven drinking water treatment plants by in vitro bioassays – Oxidative stress and antiandrogenic effects after artificial infiltration. *Sci. of the Total Env. 758* (2021) 144001

Allamin, I; Borkoma, M; Joshua, R; Machina, I. (2015). Physicochemical and Bacteriological Analysis of Well Water in Kaduna Metropolis, Kaduna State. OA Lib, 2:1.

Brunner, AM; Bertelkamp, C; Dingemans, MML; Kolkman, A; Wols, B; Harmsen, D. (2020). Integration of target analyses, non-target screening and effect-based monitoring to assess OMP related water quality changes in drinking water treatment. *Sci. Total Env*. 705

Ehiowemwenguan, G; Iloma, A; Adetuwo, J. (2014). Physico-Chemical and Bacteriological Quality of Borehole Water in Eyaen Community Area of Edo State, Nigeria. IJBAS,3:60-68.

Essien OE and Bassey ED (2012). Spatial variation of borehole water quality with depth in Uyo Municipality, Nigeria. In: 21st Century Watershed Technology: Improving Water Quality and Environment Conference Proceedings, May 27-June 1, 2012, Bari, Italy, *American Society of Agric. and Bio Engrs*, p 1.

Ezeh, CC; Udourioh, GA; Echoke, JC; Matthews-Amune, OC (2020). Well Water Quality Assessment: A Case of Gaba and Zuma Communities, Bwari Area Council, Abuja, Nigeria. *J. Appl. Sci. Environ. Manage. Vol. 24* (6) 967-974 June 2020.

Ezeribe, A; Oshieke, K; Jauro, A (2012). Physico-chemical properties of well water samples from some villages in Nigeria with cases of stained and mottle teeth. *Sci World J, 7*:1-3.

Gambo, J; James, Y; Yakubu, M (2015). Physico–Chemical and Bacteriological Analysis of Well Water at Crescent Road Poly Quarters, Kaduna. *Int J Eng Sci*, *4* (11):11-17.

Halage, AA; Ssemugabo, C; Ssemwanga, DK; Musoke, D; Mugambe, RK; Guwatudde, D; Ssempebwa. JC (2015). Bacteriological and physical quality of locally packaged drinking water in Kampala, Uganda. *J Environ Pub. health*.

Isa, MA; Allamin, IA; Ismail, HY; Shettima, A (2013). Physicochemical and bacteriological analyses of drinking water from wash boreholes in Maiduguri Metropolis, Borno State, Nigeria. *Afrc. J. Food Sci, 7*:9-13.

Joana IS; Tania V; Fernando, GJM; Bruno, BC; Joana LP (2021). Challenges to water quality assessment in Europe – Is there scope for improvement of the current Water Framework Directive bio assessment scheme in rivers? Ecological Indicators 121 (2021) 107030

Kagiso Mosimanegape (2016). Integration of physicochemical assessment of water quality with Remote sensing techniques for the Dikgathong Dam in Botswana. University of Zimbabwe, facualty of engineering, department of civil engineering.

Kakaley EKM; Blackwell BR; Cardon MC; Conley, JM; Evans, N; Feifarek DJ (2020). De facto water reuse: bioassay suite approach delivers depth and breadth in endocrine active compound detection. *Sci. Total Environ*. 699.

Lawal, R. and Lohdip, Y., (2015). Physicochemical and Microbial Analysis of Water from Mimyak River in Kanke LGA of Plateau State, Nigeria. *Afr J Nat Sci*, 1119-1104.

Mile, I; Jande, J; Dagba, B (2012). Bacteriological contamination of well water in Makurdi town, Benue State, Nigeria. *Pakistan J. of Bio. Sci.: PJBS 15* (21):1048-1051.

Okorondu, S and Anyadoh-Nwadike, S (2015). Bacteriological and Physiochemical Analysis of Oguta Lake Water, Imo State, Nigeria. 3 (5-1).

Onwughara, NI; Ajiwe, VE; Nnabuenyi, HO; Chima, CH (2013). Bacteriological Assessment of Selected Borehole Water Samples in Umuahia North Local Government Area, Abia State, Nigeria. *J. of Env. Trt. Techniques 1* (2):117-121.

Pal, M; Ayele, Y; Hadush, M; Panigrahi, S; Jadhav, VJ (2018) Public health hazards due to unsafe drinking water. *Air Water Borne Dis, 7*(1000138), 2.

Polman, P. (2018) Scale and Speed Needed to Make Water, Sanitation and Hygiene a Reality for all: SDG Perspective. *Retrieved from www.un.org on September 15, 2019*

Sadiya, A; Chukwuma, CO; Olatunbosun, OA; Onyinye, F.N. (2018). Comparative Study of the Physicochemical and Bacteriological Qualities of some drinking water sources in Abuja, Nigeria. *GJPAS, Vol. 24,* 2018: 91-98

Sa'eed, M and Mahmoud, A (2014). Determination of Some Physicochemical Parameters and Some Heavy Metals in Boreholes from Fagge L.G.A of Kano Metropholis Kano State- Nigeria. World J Anal Chem, 2:42-46.

Sustainable Development Goal (SDG) (2017) Baseline Report on Progress on Drinking Water, Sanitation and Hygiene. Retrieved from www.un.org on September 15, 2019

Tak S and Vellanki, BP (2018). Natural organic matter as precursor to disinfection byproducts and its removal using conventional and advanced processes: state of the art review. *J. Water Health* 16, 681–703.

Taruna J and Alankrita C (2013). Assessment of water quality and its effects on the health of residents of Jhunjhunu district, Rajasthan: A cross sectional study. Journal of Public Health and Epidemiology. Vol. 5(4), pp. 186-191, April 2013 DOI: 10.5897/JPHE12.096

Ugochukwu, S; Giwa, F; Giwa, A., (2015). Bacteriological evaluation of sampled sachet water sold in Samaru-Zaria, Kaduna-State, Nigeria. *Nig J Basic Clin Sci, 12*(6).

Ukpong, E and Okon, B (2013). Comparative analysis of public and private borehole water supply sources in Uruan Local Government Area of Akwa Ibom State. *IJAST*, 3.

United Nations (UN) (2018) Sustainable Development Goals (SDG) Report. Retrieved from www.un.org on September 15, 2019

Wagner, PD; Kumar, S; Schneider, K. (2013). An assessment of land use change impacts on the water resources of the Mula and Mutha Rivers catchment upstream of Pune, India. *Hydrology and Earth System Sciences, 17*(1), 2233–2246.

Zacchaeus OO; Azeem AA; Adewale MT; Saheed AG; Mujeeb AB; (2020) Assessment of physicochemical characteristics of groundwater within selected industrial areas in Ogun State, Nigeria, *EPB*, 32:1, 100-113.