International Journal of Biological Research Advancement

OPEN ACCESS

Abbreviated Key Title: IIARP IJBRA
ISSN 2736-0016 (Online)
Published by International Institute of Academic Research and Practice, Nigeria

Volume-1 | Issue-1 | Jan-Jun-2024 |

Original IJBRA Article

A Comparative Quality Assessment of Water Quality Index using Physicochemical Parameters of Selected Rivers in Rivers State, Nigeria

Okere, S.G.[1,2], Nduka, F.O.[1] and Otokunefor, K.[3]

[1]Department of Animal and Environmental Biology, University of Port Harcourt, Rivers State, Nigeria.[2]Department of Environmental Health Sciences, Federal University of Technology Owerri, Imo State, Nigeria. [3]Department of Microbiology, University of Port Harcourt, Rivers State, Nigeria. Email: ***sandra_okere@uniport.edu.ng***

Article History
Received: 12.01.2024
Accepted: 24.01.2024
Published: 30.01.2024

Journal homepage:

https://www.iiarpub.org

Abstract

Water is essential for life and people need water to survive, because it plays an important role in every aspect of life, especially for physiological activities such as the balance of body fluids. This study was aimed at assessing the quality of water collected from selected rivers using weighted arithmetic water quality index (WAWQI), to check for portability and purity of water. The water samples were collected from 5 rivers: Omuchi Aluu river, Choba river, Chokocho river, Oyigbo river, and Agbonchia river in the respective communities, in Rivers State, Nigeria. These rivers are located at coordinates between N 4.81971 / E 7.14131 and N 4.99586 / E 7.06179, and locals use water from these rivers for activities such as washing, bathing, fishing, and dredging. Water samples were collected every month from various sampling stations (of each community for 6 months) between March, 2021 and September, 2021 and, transported to the laboratory, to analyze ex-situ physicochemical parameters, while in-situ parameters were measured during sampling. Nine parameters were evaluated which included pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), salinity, turbidity, dissolved oxygen (DO), total suspended solids (TSS), and biochemical oxygen demand (BOD_5). The results showed that the WAWQI of water from stations 1, 2, 3, 4, and 5 were 199.4, 358.8, 121.6, 2838.6, and 555.0 respectively; and categorized as unfit for consumption because these values exceeded the acceptable standard limit set by WHO. It was concluded that water from these rivers is unsuitable for drinking and there will be advocacy visits to the community to sensitize community locals on good water sanitary and hygiene (WASH) practices, for a healthy and sustainable environment.

Keywords: Water quality, ground water, WASH, physicochemical parameters, WHO

INTRODUCTION

Water is an essential resource of life and people need water to survive, because it plays an important role in almost every aspect of life, especially for physiological activities such as in the maintenance of balance of body fluids (Omarova *et al.*, 2018). Water is considered to be the most important resource for sustaining ecosystems, which provide life supporting services for people, animals and plants (Adegboyega *et al.*, 2015). Drinking water or potable water also known as improved drinking water is said to be any water that is free from physical, chemical, biological or radiological form of contamination (Gyang *et al.*, 2017). Absent, inadequate, or inappropriately managed water and sanitation services expose individuals to preventable health risks (Pam *et al.*, 2018).

Surface water is sourced mostly from rivers, lakes, streams and lagoons (Okey – Wokey *et al.*, 2020). Most community locals source their water supply used for domestic, agricultural and industrial purpose from rivers and ground water. The environment is always impacted by man, for his sustenance and development, but anthropogenic activities have posed a threat to the environment as noticed in the recent environmental problems such as climate change, global warming, ozone layer depletion, and so on (Raimi *et al.*, 2019). Man is responsible for environmental degradation and pollution, hence, the establishment of an agency in Nigeria, National Environmental Standards and regulations Enforcement Agency (NESREA) to monitor human activities that negatively affect the environment (NESREA, 2011).

The national environmental regulations, S. I. No. 22 of 2011 by NESREA regulate and protect surface and groundwater quality, by protecting the physicochemical and biological characteristics of the nation's surface water from pollutants, for sustainability of the resources and protection of aquatic ecosystems (Raimi *et al*., 2019). The regulation act, also protects ground water sources by regulating the disposal of underground hazardous wastes and fossil fuel that can contaminate ground water (Olalekan *et al*., 2018). The quality and characteristics of water bodies greatly affects the species abundance and physiological conditions of the aquatic organisms that strive in it (Xiong *et al*., 2016). Regular monitoring of river water quality is required, because the river is a dynamic ecosystem, influenced by various activities in the river bank (Efendi, 2016).

Some indices have been developed over time, to monitor and assess the quality of water in water bodies, such as, Water Quality Index (WQI), which was used in this study. WQI gives a numeric value that represents the water quality, using several water quality parameters based on the time and location (Otene and Nnadi, 2019), and it is one of the most efficient ways to determine the level of purity of the water body sampled, which can be reported to the appropriate monitoring agencies and the general public (Boah *et al*., 2015). The aim of this study was to evaluate a comparative qualitative assessment of water quality index using physicochemical parameters of selected rivers in Rivers State, Nigeria.

MATERIALS AND METHOD

Description of the Study Areas

The study areas comprised of freshwater rivers surrounded by forest vegetation in these communities; Omuchi Aluu, Choba, Chokocho, Oyigbo, and Agbonchia in the following respective local government areas; Ikwerre, Obio-Akpor, Etche, Oyigbo and Eleme in Rivers State, Nigeria.

Station 1: Omuchi Aluu river is located in Omuchi Aluu community, Ikwerre local government area, as shown in Plate 1. Water samples were collected from the river, between latitudes 4.91260 and 4.91264 N and longitudes 6.89691 and 6.89695 E, close to a Man O' War base near the University of Port Harcourt. The river is polluted due to oil bunkering and nearby farming activities; people who live by the river, mainly locals from the community have their bath in the river, while others defecate in it. The sampling station is surrounded by deserted buildings and dilapidated structures where the less privileged reside.

Station 2: Choba river, in Choba community is located in Obio/Akpor local government area. Water samples were collected from the center of the river, between latitudes 4.88859 and 4.88863 N and longitudes 6.89816 and 6.89820 E, which is located behind the Choba community market, as shown in Plate 2. The river is disturbed by oil bunkering activities, slaughtering of herds and rearing of cows, and recreational activities such as swimming by the locals who live by the river side. The sampling station is surrounded by non-functional ships parked by the side of the river and small shops used for business purposes.

Station 3: Chokocho river in Chokocho community in Etche local government area, between latitudes 4.99582 and 4.99586 N and longitudes 7.06175 and 7.06179 E, near Otamiri river, as shown in Plate 3. Locals living by the river side carry out activities such as dredging and domestic activities such as laundering, washing of dishes, and having their baths in the river.

Station 4: Oyigbo river in Oyigbo local government area is between the boundary of Rivers state and Abia state, between latitudes 4.8859 and 4.8880 N and longitudes 7.1417 and 7.1452 E, and flows beneath a bridge (Plate 4). Water is highly disturbed by dredging activities, washing of slaughtered animals, and recreational activities such as swimming. Locals from the community carry out fish farming in the river and also have a fish market near the river.

Station 5: Abonchia river is in Abonchia community, Eleme local government area. Water samples were collected, between latitudes 4.81971 and 4.81975 N and longitudes 7.14131 and 7.14135 E, and river flows beneath a bridge, and is contaminated by oil spillage due to pipeline vandalization and breakage, recreational, domestic and sanitary activities (Plate 5).

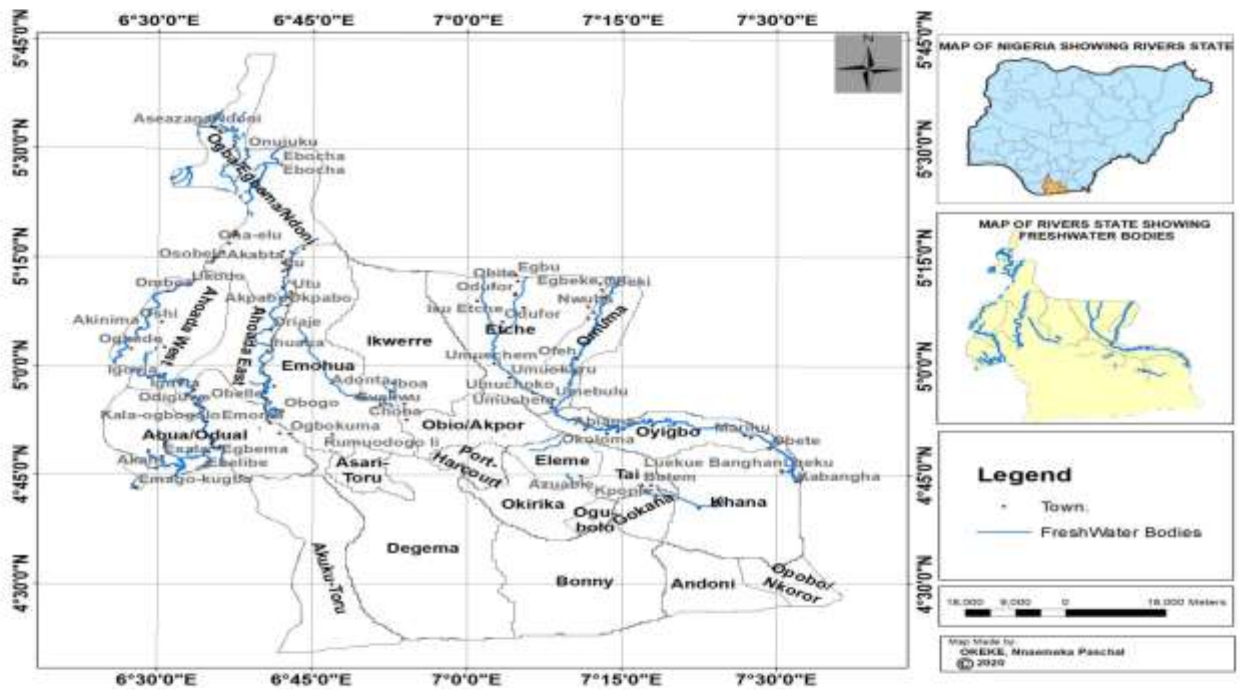

Fig. 1. Map of the study areas showing sampling stations in Rivers State, Nigeria.

Plate 1: Omuchi Aluu River - Station 1

Plate 2: Choba River - Station 2

Plate 3: Chokocho River - Station 3

Plate 4: Oyigbo River - Station 4

Plate 5: Abonchia River - Station 5

Sample Collection and Analysis

A four liter can of water was collected every month from all sampling stations (Figure 1) for 6 months between March, 2021 and September, 2021. Water samples were stored in sterile bottles and plastic coolers with ice blocks, and transported to the laboratory, Aegis One Consultant Limited, Port Harcourt, Rivers State for water analysis.

Water Quality Analysis

Water samples were collected for physicochemical parameters (such as biochemical oxygen demand (BOD_5), salinity, turbidity, total dissolved solids, total suspended solids, and conductivity) for ex-situ analysis in the laboratory. While temperature, pH and dissolved oxygen were measured in-situ at all sampling stations for 6 months.

Calculation of Water Quality Index

Water quality index

The weighted Arithmetic index method as described by Tyagi *et al.* (2013) was used for the calculation of WQI in this study. Nine parameters were evaluated and World Health Organization (WHO) Drinking Water Quality guideline (WHO, 2010) was used as the recommended standard. The Weighted arithmetic water quality index (WAWQI) method is used in the classification of the water quality based on the level of purity; using the most commonly measured water quality parameters (Table 1). The method has been widely used by the various scientists (Etim *et al.*, 2013) and the calculation of WQI was made using the equation:

$$WQI = \frac{\sum Q_i W_i}{\sum W_i}$$ (Al Obaidy *et al*., 2015)

The quality rating scale (Qi) for each parameter is calculated by using this expression:

$$Qi = 100 \frac{[v_i - v_o]}{[s_i - v_o]}$$ (Bustanmante *et al*., 2004)

Where,

V_i is estimated concentration of ith parameter in the analysed water, V_o is the ideal value of this parameter in pure water. V_o = 0 (except pH = 7.0 and Dissolved Oxygen = 14.6 mg/l), S_i is recommended standard value of ith parameter.

The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

Wi = K/Si (Ani *et al*., 2016) Where,
K = proportionality constant

Table 1: Water Quality Rating as per Weight Arithmetic Water Quality Index (WQI) Method

WQI value	Rating of water quality	Grading
0-25	**Excellent Water Quality**	**A**
26– 50	**Good water Quality**	**B**
51– 75	**Poor Water Quality**	**C**
76 – 100	**Very Poor Water Quality**	**D**
>100	**Unsuitable for Drinking Purpose**	**E**

Source: Tyagi *et al.* 2013

Statistical Analysis

Microsoft Excel was used to calculate the descriptive statistics and the water quality index (WQI), using the physicochemical parameters of the water samples collected from the sampled stations.

RESULTS

Physicochemical Parameters

The physicochemical parameters which reflect the environmental chemistry of the studied rivers are presented in Table 2. The pH values were between the ranges of 5.10 and 7.40, some of the pH values were not within the acceptable limits set by

WHO (WHO, 2011). The lowest pH value was recorded in station 5 in March, 2021 while the highest pH value was recorded in station 4 in August 2021. The temperature values ranged between 25.60 and 31.70 °C; the lowest temperature value was recorded in station 1 in August, 2021, while the highest temperature was recorded in station 3 in March, 2021. These values recorded were within the acceptable limits by WHO. The Electrical conductivity (EC) values were between the ranges of 15.00 and 21180.00 µS/cm, the lowest EC value was recorded in station 3 in April, 2021, while the highest EC was recorded in station 5 in April, 2021, its high value tends towards brackish water due to tidal fluctuations and salinity. Total dissolved solids (TDS) values ranged between 11.00 and 14800.00 Mg/l, the lowest TDS values were recorded in stations 3 and 4 in April, 2021, while the highest TDS was recorded in station 5 in April, 2021; its high value tends towards brackish water due to tidal fluctuations and salinity. The salinity values were between the ranges of 0.01 and 13.57 PSU, its lowest salinity values of 0.01 were recorded in stations 3, 4 and 5 in March, April, May, 2021, while the highest salinity was recorded in station 5 in April, 2021. The turbidity values ranged between 0.80 and 107.40 NTU, with the lowest turbidity value been recorded in station 5 in March, 2021, and the highest turbidity was recorded in station 2 in June, 2021. Dissolved oxygen (DO) values were between the ranges of 3.40 and 15.30 Mg/l, the lowest and highest DO values were recorded in station 5 in the months of March and April, 2021, respectively. Total suspended solids (TSS) values ranged between 0.10 and 266.70 Mg/l, lowest value of TSS was recorded in station 3 in August, 2021, and the highest TSS was recorded in station 4 in June 2021. Biochemical oxygen demand (BOD) values were between the ranges of 0.10 and 4.80 Mg/l, with the lowest BOD value being recorded in station 2 in August, 2021, and the highest BOD was recorded in station 4 in March, 2021.

The water quality index (WQI) evaluation: The result of WQI evaluation for stations 1, 2, 3, 4, and 5 were recorded as 199.40, 358.82, 121.62, 2838.61, 555.02 respectively, which is above the required standard quality of water fit for consumption, which has the WQI value of 50 by WHO as seen in Figure 3 (WHO, 2011). Hence, categorized as unfit for consumption because these values exceeded the acceptable standard limit as seen in Table 3.

DISCUSSION

Most of the parameters (dissolved oxygen, electrical conductivity, total dissolved solids, total suspended solids, turbidity and salinity) evaluated were generally above acceptable limits, except salinity, total dissolved solids and electrical conductivity which were lower in stations 3 and 4, while pH, temperature, and biochemical oxygen demand were below acceptable limits. The electrical conductivity and total dissolved solids observed in this study were high in stations 1, 2, and 5 because the water tends towards brackish water due to tidal fluctuations and salinity. The high turbidity in station 4 was due to oil sheen as a result of oil pipeline vandalization. The water quality index (WQI) values are presented in Table 2, and were recorded was a reflection of the nature and intensity of the anthropogenic activities going on in the river.

pH: The pH test was done to measure the alkalinity and acidity of the river water to check the influence of chemical and biochemical reactions (Taskeena *et al*., 2017). Low values of pH lead to a bitter taste of the water, which can affect aquatic organisms negatively, health problems like acidosis, hence, cancer in humans (Narasimha, *et al*., 2011). Seiyaboh *et al*., (2013) reported that sand mining lowers the pH of water bodies. Some of the pH values recorded in this study were slightly acidic, while others where within the WHO acceptable limit, and were not similar to the reports by Anyanwu and Umeham (2020).

Temperature: The temperature values recorded in this study were within the acceptable limits by WHO. Cooler temperatures of water bodies reduce the possibilities of microbial growth and corrosion issues (WHO, 2011).

Electrical Conductivity (EC): This is very important as an indirect indicator of pollution in the water, its usually associated with the presence of sewage disposal in the waterbody (Taskeena *et al*., 2017). The values recorded in this study were higher than the acceptable limits by WHO standards, except permissible range for drinking water (WHO, 2011). High values of EC could be due to industrial waste, agricultural runoff and domestic discharges, which makes the water unfit for drinking (Otene and Nnadi, 2019).

Table 2. Physicochemical parameters and water quality index of Sampled stations and WHO Standards

SUMMARY OF PHYSICO-CHEMICAL PARAMETERS OF THE SAMPLING STATIONS							
Parameters	**Units**	**Station 1 X ± S.E**	**Station 2 X ± S.E**	**Station 3 X ± S.E**	**Station 4 X ± S.E**	**Station 5 X ± S.E**	**WHO**
pH		6.07 ± 0.08 (5.90 - 6.40)	6.15 ± 0.12 (5.80 - 6.50)	5.73 ± 0.11 (5.50 – 6.20)	6.55 ± 0.21 (6.00 – 7.40)	6.32 ± 0.25 (5.10 – 6.80)	6.5
Temperature	ºC	27.68 ± 0.63 (25.60 - 29.70)	28.75 ± 0.67 (26.50 - 30.20)	28.65 ± 0.92 (26.00 –31.70)	27.88 ± 0.42 (26.90 - 29.50)	28.58 ± 0.63 (26.60 -30.60)	40
Electrical conductivity (EC)	µS/cm	2722.00 ± 866.74 (125.00- 5549.00)	1545.00 ± 1253.71 (411.00 - 7671.00)	26.67 ± 5.47 (15.00 - 46.00)	26.83 ± 4.76 (19.00- 50.00)	13322.50 ±3206.08 (29.00 – 21180.00)	1000
Total Dissolved Solids (TDS)	Mg/l	1821.83 ± 619.72 (89.00 - 3890.00)	3225.83 ± 854.08 (290.00 - 5370.00)	18.67 ± 3.80 (11.00 - 32.00)	17.67 ± 3.62 (11.00 – 35.00)	9396.00 ± 2266.70 (20.00 – 14800.00)	500
Salinity	PSU	1.52 ± 0.52 (0.06 - 3.28)	2.80 ± 0.76 (0.22 - 4.61)	0.01 ± 0.00 (0.01 – 0.02)	0.01 ± 0.00 (0.01 – 0.02)	8.59 ± 2.11 (0.01 – 13.57)	1
Turbidity	NTU	12.02 ± 5.16 (4.00 - 37.00)	25.18 ± 16.30 (4.30 - 107.40)	15.31 ± 4.11 (6.80 – 30.80)	51.87 ± 15.91 (16.80 - 97.60)	10.26 ± 3.25 (0.80 - 24.50)	5
Dissolved Oxygen	Mg/l	7.43 ± 0.53 (6.20 - 9.60)	7.18 ± 0.71 (4.10 - 9.10)	7.35 ± 0.42 (5.70 – 8.90)	8.45 ± 0.40 (7.60 – 10.40)	8.28 ± 1.58 (3.40 – 15.30)	5
Total Suspended Solids (TSS)	Mg/l	41.88 ± 5.12 (33.30 - 38.00)	81.42 ± 19.58 (20.00 - 166.70)	35.30 ± 9.68 (0.10 – 66.70)	105.68 ± 34.50 (53.30 –266.70)	43.00 ± 0.22 (33.30 – 66.70)	5.5
Biochemical Oxygen demand (BOD5)	Mg/l	1.23 ± 0.23 (0.70 - 2.20)	1.45 ± 0.41 (0.10 - 3.00)	1.05 ± 0.10 (0.70 – 1.30)	2.42 ± 0.58 0.70 – 4.80	1.77 ± 0.22 (0.80 – 2.30)	5
WQI		**199.40**	**358.82**	**121.62**	**2838.61**	**555.02**	**50**

X = Mean, S.E = Standard Error, WHO = World Health Organization standard (WHO, 2011)

Table 3: Index Value of the WQI of the Sampled Stations and its Water quality Status

Location	Index value	Water quality Status
Station 1	199.40	Unfit for Consumption
Station 2	358.82	Unfit for Consumption
Station 3	121.62	Unfit for Consumption
Station 4	2838.61	Unfit for Consumption
Station 5	555.02	Unfit for Consumption

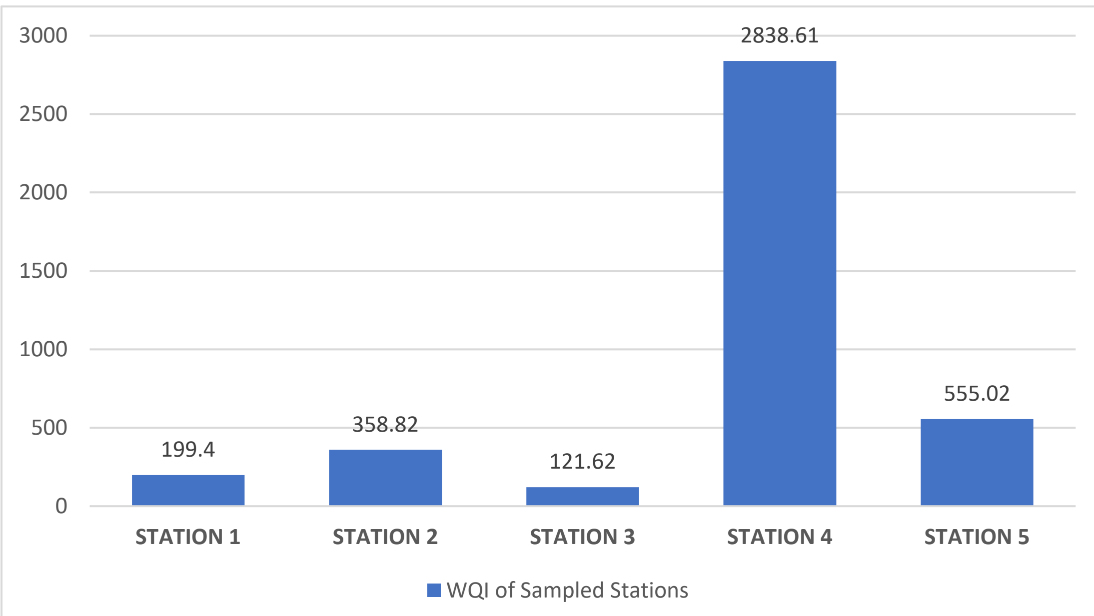

Fig. 2: Index values of the water quality of the sampled stations

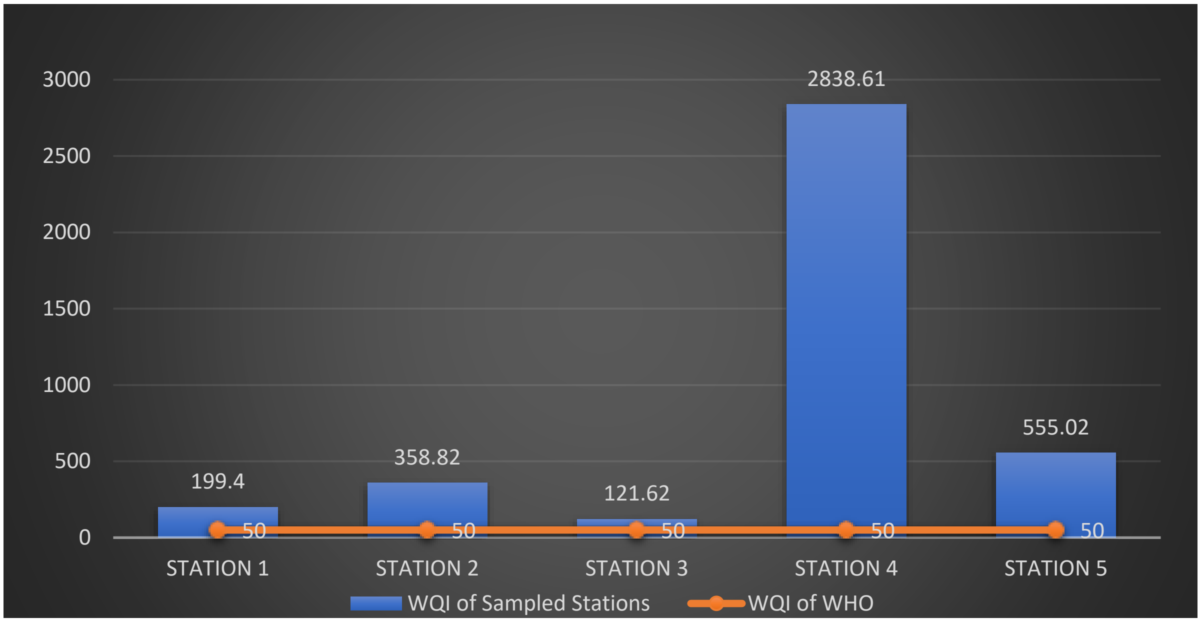

Fig. 3: Index values of the water quality of the sampled stations and the index value of 50 for water quality of clean water, set by WHO standard (WHO, 2011).

Total Dissolved Solids (TDS): This parameter measures the presence of dissolved solids in the waterbody as a result of salinity and it affects the density of water, especially when it is high in concentration, thereby affecting the fresh water organisms, due to the reduction in the solubility of gases such as oxygen (Ogundele and Makuleyi, 2018). The values recorded in this study were higher than the acceptable limits set by WHO standards, except in stations 3 and 4 which were within the 500 mg/l permissible range for drinking water (WHO, 2011).

Salinity: Saline water is unsuitable for drinking, food production, and it causes harm to the biodiversity of freshwater bodies. The consumption of water with excess salt concentrations poses a threat to human health and can cause imbalance of sodium and potassium levels in the body, as well as kidney failure in extreme cases. The salinity values in the study were between the ranges of 0.01 and 13.57 PSU, and were above the acceptable limit set by WHO, especially in stations 1, 2, and 5, the salinity values were high due to tidal fluctuations, and salt concentrations were tending towards brackish water in these stations.

Turbidity: Turbidity is derived from the presence of suspended materials such as sand, organic and inorganic materials, mud and other organisms (Efendi, 2016) which hinders the penetration of light into a waterbody, thus preventing photosynthesis. Most of the turbidity values recorded in this study were higher the acceptable limits by WHO standards, which was as a result of the anthropogenic activities in the river, by the indigenes of the communities.

Dissolved Oxygen (DO): DO is the measure of oxygen dissolved in water. DO is used in the aerobic decomposition of organic matter in the water body, respiration of aquatic organisms and oxidation of minerals (Kale, 2016). The values of DO from this study were greater than 5 mg/l, irrespective of the activities that take place in the river, indicating a high tidal fluctuation.

Total Suspended Solids (TSS): Total solids are dissolved solids plus suspended and settleable solids in water. Suspended solids include silt and clay particles, plankton, algae, fine organic debris, and other particulate matter. Total solids also affect water clarity. Higher solids decrease the passage of light through water, thereby slowing photosynthesis by aquatic plants. Water will heat up more rapidly and hold more heat; this, in turn, might adversely affect aquatic life that has adapted to a lower temperature regime (APHA, 1992). The TSS values in this study ranged between 0.10 and 266.70 Mg/l, which was higher than the 5.5 Mg/l acceptable limit by WHO, and this was due to the anthropogenic activities that take place in these rivers.

Biochemical Oxygen Demand (BOD): BOD measurement is important to determine the health status of fresh water bodies. It is the oxygen required for micro-organisms to decompose dissolves solids in water (Qureshimatva *et al*., 2015). The BOD values recorded in this study were between the ranges of 0.10 and 4.80 Mg/l, which is within the ideal limit set by WHO for water bodies. At this limit, the BOD will not cause harm to human bodies and aquatic life.

CONCLUSION

Based on the water quality index values recorded in this study, it can be concluded that water collected from Omuchi Aluu, Choba, Chokocho, Oyigbo and Abonchia Rivers are unsuitable for human consumption especially in station 4 (Oyigbo river) with a WQI of 2838.6. It is not the only source of water in that area; hence it should not be used for drinking. Indigenes of these communities should embark on good water sanitary and hygiene (WASH) practices, for a healthy and sustainable environment. However, it is recommended that groundwater boreholes should be dug to the acceptable depth set by the Ministry of Environment, and used as a source of drinking water, to promote the good and healthier lives of the locals.

Acknowledgement

We sincerely appreciate Mr. Choko Onyinye of Department of Forestry and Wildlife Management, University of Port Harcourt, Nigeria, who assisted in the collection of the water samples from all sampling stations. We also appreciate Mr. Uzoma Okoroafor of Aegis One Consults laboratory, Nigeria, who assisted us with measuring the physicochemical parameters of the water samples.

REFERENCES

Adegboyega, A., Olalude, C., and Odunola, O. (2015). Physicochemical and bacteriological analysis of water samples used for domestic purposes in Idi Ayunre, Oyo State, Southwestern Nigeria. *IOSR J App Chem, 8*(10).

Al Obaidy, A.M., Talib, A.H. And Zaki, S.R. (2015). Application of Water Pollution Index for Assessment of Tigris River Ecosystem. *International Journal of Advanced Research*, 3(2):219-223.

American Public Health Association (APHA) (1992). *Standard methods for the examination of water and wastewater.* 18th ed. American Public Health Association, Washington, DC.

Ani, C., Okogwu, O.I., Nwonumara, G.N., Nwani, C.D. and Nwiniyimagu, A.J. (2016). Evaluation of Physicochemical parameters of Selected Rivers in Ebonyi State, Southeast, Nigeria. *Greener Journal of Biological Sciences,* 6(2):34-41. Doi: http://doi.org/10.15580/GJBS.2016.2.020216030.

Anyanwu, E. D. and Umeham, S. N. (2020). Identification of waterbody status in Nigeria using predictive index assessment tools: a case study of Eme River, Umuahia, Nigeria. *International Journal of Energy and Water Resources,* 4, 271-279. https://doi.org/10.1007/s42108-020-00066-5.

Boah, D.K, Twum, S. B, Pelig-Ba, K.B (2015). Mathematical Computation of Water Quality Index of Vea Dam in Upper East Region of Ghana. *Environ. Sci*. 3(1): 11 – 16.

Bustanmante., R, Butterworth, J., Flierman, M., Herbas, D., Hollander, M., Meer, S.V., Ravenstijn, P., Reynanga, M. and Zurita, G. (2004). Livelihoods in conflict: dispute over water for household level productivity uses in Tarata Bolivia [Online]. Available at www.irc.nl.

Efendi, H. (2016). River water quality preliminary rapid assessment using pollution Index. *Procedia Environmental Sciences*, 33, 562–567.

Etim, E.E., Odoh, R., Itodo, A.U., Umoh, S.D. and Lawal, U. (2013). Water Quality Index for the Assessment of Water Quality from Different Sources in the Niger Delta Region of Nigeria. *Frontiers in Science*, 3(3):89-95 Doi: 10.5923/j.fs.20130303.02.

Gyang, P., Uzoigwe, N., & Ayim, J. (2017). Evaluation of Local Drinking Water Sources to Determine their Possible Contamination with Parasite in Lafia Local Government Area Nasarawa State, Nigeria. *European Journal of Basic and Applied Sciences, 4* (1), 63-68. Retrieved from http://www.idpublications.org/

Kale, V. S. (2016). Consequence of temperature, pH, turbidity and dissolved oxygen water quality parameters. *International Advanced Research Journal in Science, Engineering and Technology,* 3(8), 186–190.

Narasimha, R.C., Dorairaju, S.V., Bujagendra, R.M. and Chalapathi, P.V. (2011). Statistical Analysis of Drinking Water Quality and its impact on Human Health in Chandragiri, near Tirupati, India [Online]. *ECO Services International*.

National Environmental Standards and Regulations Enforcement agency (NESREA) (2011). NESREA Act, No. 11, 2011. The Act prescribes the powers and functions of the NESREA.

Ogundele, O. and Mekuleyi, G. (2018). Physicochemical properties and heavy metal concentration in waste water discharged from two industries in Agbara, Lagos State Nigeria. *Int. Res. J. Pub. Environ. Health*. 5(3) 32-37.

Okey-Wokeh, C.G, Obunwo, C.C, Boisa, N. (2020). Assessment of Physicochemical Characteristics of Mini-Ezi Stream in Elele-Alimini, Emohua Local Government Area of Rivers State, Nigeria. *Int.J.Adv. Sci. Res. Eng. (IJASRE)*, 6 (1): 1 – 8.

Olalekan, R.M., A.O. Omidiji, D. Nimisngha, O.E. Odipe and A.S. Olalekan (2018). Health risk assessment on heavy metals ingestion through groundwater drinking pathway for residents in an oil and gas producing area of Rivers State, Nigeria. *Open J. Yangtze Gas Oil*, 3: 191-206.

Omarova, A., Tussupova, K., Berndtsson, R., Kalishev, M., & Sharapatova, K. (2018). Protozoan parasites in drinking water: A system approach for improved water, sanitation and hygiene in developing countries. *International journal of environmental research and public health, 15*(3), 495.

Otene, B.B. and Nnadi, P.C. (2019). Water Quality Index and Status of Minichindah Stream, Port Harcourt, Nigeria. *Int. J. Geo. Environ. Manage*. 5(1): 1 - 9.

Pam, V., Ombugadu, A., Adejoh, V., Idris, A., Pam, D., Rwang, P.G., Kumbak, D. and Dogo, S.K. (2018). Evaluation of parasitic contamination of local potable water sources in Doma Local Government Area of Nasarawa State, Nigeria. *Tropical Freshwater Biology, 27*(2): 31-41.

Qureshimatva, U. M., Maverya, R. R., Gamit, S. B., Patel, R. D. and Solanki, H. A. (2015). Determination of Physicochemical Parameters and Water Quality Index (WQI) of Chanlodia Lake, Ahmedabad Gujarat, India. *J. Environ. Anal. Toxicol*. 5 (4): 288.

Raimi, M.O., Omidiji, A.O., Adedotun, A.T., Emmanuel, O.O. and Anu, B. (2019a). An analysis of Bayelsa state water challenges on the rise and its possible solutions. *Acta Sci. Agric*., 3: 110-125.

Raimi, M.O., Abdulraheem, A.F., Iteimowei, M., Odipe, O.E., Isa, H.M., and Chinwendu, O. (2019b). The sources of water supply, sanitation facilities and hygiene practices in an island community: Amassoma, Bayelsa State, Nigeria. *Public Health Open Access*, 3: 1-13.

Seiyaboh, E., Ogamba, E., and Utibe, D. (2013). Impact of Dredging on the water quality of Igbedi Creek, Upper Nun River, Niger Delta, Nigeria. *IOSR Journal of Environmental Science, Toxicology and Food Technology,* 7(5), 51–56.

Taskeena, H., Saltanat, P., Bilal, N. and Uzma, A. (2017). Seasonal Variations in Water Quality Parameters of River Yamuna, India. *Int. J. Curr. Appl*. *Sci*. 6(5):694.

Tyagi, S., Sharma, B., Singh, P. and Dobhal, R. (2013). Water Quality Assessment in Terms of Water Quality Index. *American Journal of Water Resources*, 1(3):34-38. Doi:10.12691/ajwr-1-3-3.

World Health Organization (WHO) (2010). Guidelines for Drinking-water Quality. *World Health Organisation Publication*, Geneva, Switzerland. 595pp.

World Health Organization (WHO) (2011). Guidelines for Drinking-water Quality. 4th ed. *World Health Organization Publication*, Geneva, Switzerland. 564pp.

Xiong, W., Li, J., Chen, Y., Shan, B., Wang, W. and Zhan, A. (2016). Determinants of community structure of zooplankton in heavily polluted river ecosystems. *Scientific Reports*, 6, 22043. https:// doi.org/10.1038/srep22043.

Cite This Article: Okere, S.G., Nduka, F.O. and Otokunefor, K. (2024). **A comparative quality assessment of water quality index using physicochemical parameters of selected rivers in Rivers State, Nigeria.** IJBRA*,* 1(1), 20-30.