ASSESSMENT OF NJABA RIVER QUALITY USING PHYSICO-CHEMICAL PARAMETERS.

Abstract

The study analyzed the physico-chemical parameters of Njaba River Awo-Omamma, Imo State. Samples of water were collected in May, 2023 at five different sampling points for physico-chemical analysis. The physico-chemical parameters were analyzed in the laboratory using Standard methods and statistically using descriptive statistics. The laboratory results were compared with regulatory standard. The mean concentrations of turbidity (15.60±2.86) NTU, TSS (83.48±7.26) mg/L, Pb (0.078±0.030) mg/L, Zn (0.225±0.054) mg/L and Ni (0.254±0.012) mg/L exceeded the Federal Ministry of Environment's maximum permissible limits. Mean separation result with the Duncan Multiple Range test revealed the difference in concentrations of Zn and Ni across the sampling points. Narrow variation was recorded for temperature while wide variations were recorded for turbidity, TS, TSS and Pb. The study recorded high values in turbidity and Nickel across all the sampling points when compared to the set standard. These were a clear indication of human activities such as sand excavation runoff, agricultural runoff as well as effluent discharge from a brewery into the river. Therefore, Government Agencies should put in place stringent measures to tackle discharges of effluents from industries as well as other anthropogenic activities into water bodies.

KEYWORDS: Quality, anthropogenic, effluent, excavation, statistical

1.0 INTRODUCTION

The major resource required by all creatures for their survival is water and the desire of quality water has been reduced due to anthropogenic activities. However, these activities (such as bathing and washing of clothes, sand excavation and agricultural runoffs) when discharged into water bodies contributes significantly to water pollution which in turn makes clean water a scarce commodity. Singh and Deepika, (2015) classified all these activities as point and non-point sources of pollution which deteriorates the quality of water sources through nutrient enrichment, destruction of spawning grounds for aquatic and marine life and eventually, killing of aquatic lives[ref]. The study area Njaba River is a major river of economic, agricultural and environmental significance in Awo-Omamma, Osu Local Government Area of Imo State, Nigeria. It is believed that Njaba River receives effluents from the Nigerian Breweries Plc, as well as contaminants from agricultural runoff and other sources that could contribute to its pollution[ref]. Somestudies (Whitehead *et al*., 2018; Hasan *et al*., 2019) revealed that untreated effluent from factories which are directly or indirectly discharged into rivers causes pollution of surface water. On the other hand, effluents from the food (brewery) industry are not particularly toxic but their organic content and large volume can exert a considerable oxygen demand on the environment in the region where they are discharged[ref]. These organic contents together with agricultural runoff, sand excavation runoff etc., when combined, alters the ecological niche resulting in stressors like increasedturbidity which limits light penetration and prohibits healthy plant growth on the river bed[ref]. The quality of water is usually influenced by myriads of parameters such as temperature, power of the concentration of hydrogen ion (pH), Electrical conductivity, turbidity, dissolved oxygen, chemical oxygen demand, biological oxygen demand, total dissolved solids, total suspended solid, and some heavy metals[ref]. Thus, a regular monitoring of some of them not only prevents diseases and hazards but also checks the water resources from further pollution (Nayar, 2020). Sequel to the above, the present study assessed the water quality of Njaba River by analyzing some physico-chemical parameters of the water.

2.0 MATERIALS AND METHODS

Njaba River in Awo-Omamma community originated from the north-western part of Isu at Isunjaba, flows south-westwards through Njaba and Oguta territories towards Oguta lake, passing through the southern parts of Ukworji, Umunnoha and Oguta Local Government Areas in Imo State of Nigeria (figure 1). The river is located between latitude N 5°44' longitude 6°49' E and latitude 5°47' longitude 7°03'. The climate around the river area has a mean rainfall season that falls between the month of May and October and the river is adequately recharged by precipitation during rainy season[ref]. The region is a rainforest belt. The river is the primary source of water for drinking and other domestic activities by the villagers. The primary human activity in this community is farming, fishing and sand excavation[ref].

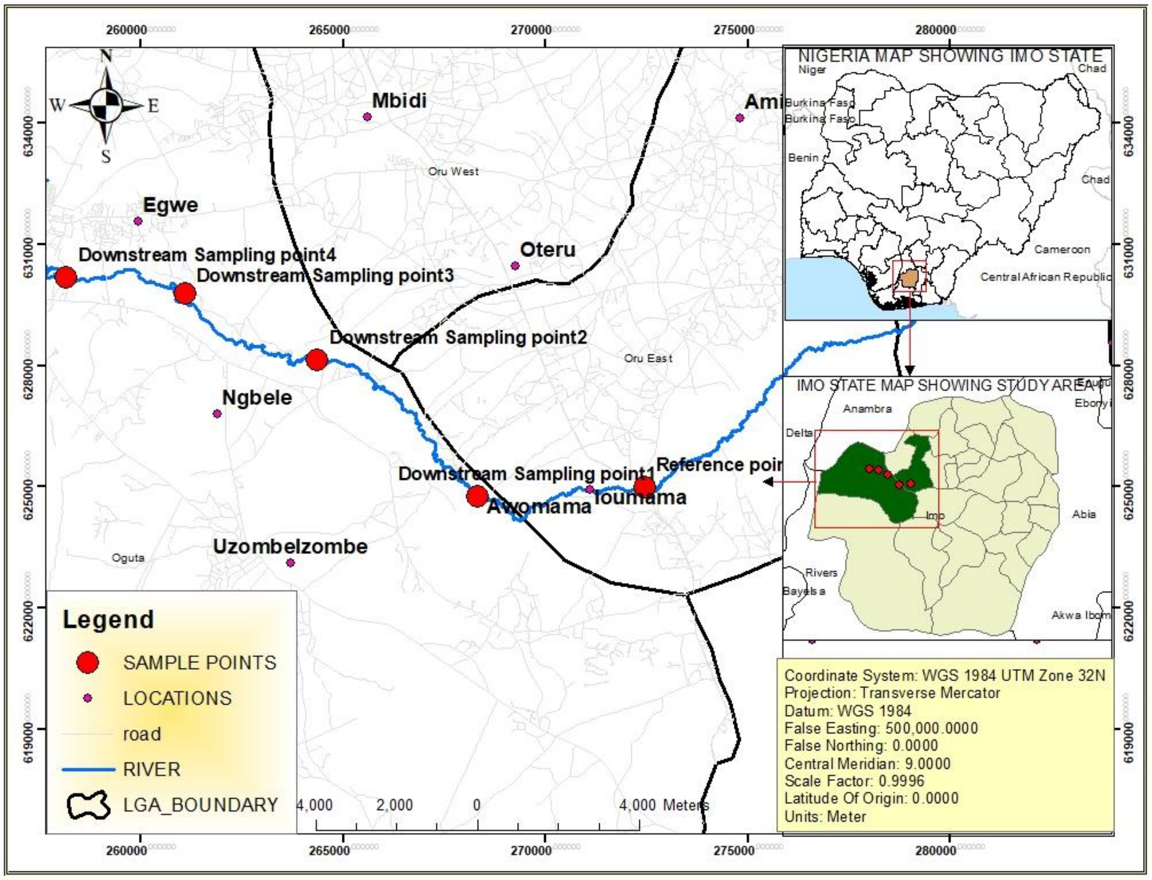

Figure 1:The study area showing the sampling points along Njaba River as well as map of Nigeria (Source: GIS coordinates from field trip).

The study was carried out during the month of May, 2023. At each sampling point, the sample container was dipped inside the river counter current to the flow of the river in collection of the sample. The in-situ parameters such as pH, Temperature, Conductivity, Dissolved Oxygen (DO) and Total Dissolved Solids(TDS) were measured using the following equipments: pH meter, Temperature Probe, Conductivity meter, DO meter and TDS meter respectively and their readings recorded accordingly.

Biological Oxygen Demand (BOD) samples were also collected immediately after the in-situ measurement of the DO at each sampling location. The water sample was fixed in the 250ml Winklers bottle at each sampling location and corked. Afterwards, it was placed in an ice chest alongside the water samples and transported to the laboratory for further analysis. The physico-chemical parameters of the water samples were analysed in the laboratory using standard methods.

3.0 RESULTS

Table 1: Descriptive of the physico-chemical parameters of Njaba River in Imo State

Parameters	Concentrations				
	Minimum	Maximum	Mean	SE	FMEnv
pH	3.00	5.80	5.02	0.26	6.50-8.50
Temp. (°C)	27.00	29.60	28.35	0.21	30.00
EC (µS/cm)	11.00	14.00	12.73	0.22	1000.00
DO (mg/L)	7.40	8.70	8.31	0.12	>7.50
BOD (mg/L)	3.50	5.70	4.61	0.18	NS
COD (mg/L)	560.00	704.00	651.20	13.54	NS
Turbidity (NTU)	5.80	34.60	15.60	2.86	10.00
TS (mg/L)	50.00	128.00	91.87	7.41	500-1000
TDS (mg/L)	8.30	9.10	8.55	0.07	500.00
TSS (mg/L)	43.00	118.90	83.48	7.26	<10.00
NO_3^- (mg/L)	0.40	3.74	1.16	0.34	50.00
PO_4^{3-} (mg/L)	0.40	0.56	0.47	0.01	5.00
Pb (mg/L)	0.008	0.305	0.078	0.030	0.05
Zn (mg/L)	0.040	0.598	0.225	0.054	0.01
Ni (mg/L)	0.180	0.308	0.254	0.012	0.02

NS=Not Specified, FMEnv=Federal Ministry of Environment, SE=Standard error of mean, Temp=Temperature, EC=Electrical Conductivity, DO=Dissolved oxygen, BOD=Biological oxygen demand, COD=Chemical oxygen demand, TS=Total solids, TDS=Total dissolved solids, TSS=Total suspended solids, NO_3^-=Nitrate, PO_4^{3-}=Phosphate, Pb=Lead, Zn=Zinc, Ni=Nickel

Spatial variations in physico-chemical parameters of Njaba River

Numerical variations were observed in concentrations of the physico-chemical parameters measured across the control sampling point in the Njaba River during the study period, Mean ±SE values of EC, temperature, COD, Turbidity, TS and TSS were 12.33±0.66 µS/cm, 29.50±0.05 °C, 627.33±9.82 mg/L, 7.77±0.08 NTU, 51.33±0.66 mg/L and 43.37±0.18 mg/L. At sampling points (SP 1) their respective mean ±SE concentrations were 13.67±0.33 µS/cm, 28.73±0.28 °C, 694.00±5.03 mg/L, 22.33±1.51 NTU, 123.33±2.40 mg/L and 113.93±2.50 mg/L. At SP 2, their mean concentrations were 12.67±0.33 µS/cm, 28.10±0.05°C, 567.33±4.66 mg/L, 7.83±0.38 NTU, 81.33±0.66 mg/L and 73.37±0.18 mg/L and at SP 3 they were 12.33±0.66 µS/cm, 27.63±0.28 °C, 686.67±15.37 mg/L, 33.47±0.56 NTU, 122.67±1.76 mg/L and 113.70±1.92 mg/L. However, SP 4 the respective parameter mean concentrations were 12.67±0.33 µS/cm, 27.77±0.43 °C, 680.00±16.01 mg/L, 6.60±0.70 NTU, 80.67±1.76 mg/L, 73.03±1.79 mg/L

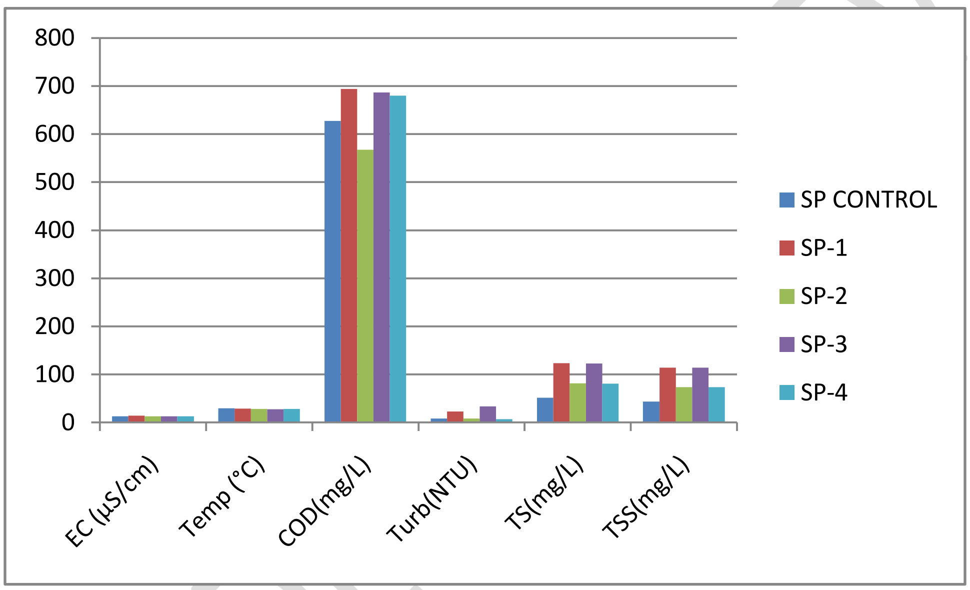

Fig. 2: spatial variations in mean physical and chemical parameters.

Mean concentrations of TDS, NO_3^-, PO_4^{3-}, Pb, Zn and Ni ions, DO, BOD, at control sampling point 8.60±0.05 mg/L, 0.49±0.01 mg/L, 0.52±0.01 mg/L, 0.0107±0.000 mg/L, 0.0407±0.000 mg/L, 0.2707±0.000 mg/L, 4.37±0.08 mg/L and 8.41±0.04 mg/L. At SP 1, they were 9.07±0.03, 0.53±0.01, 0.43±0.01, 0.3033±0.001, 0.5953±0.002, 0.2247±0.002 mg/L, 7.47±0.03 mg/L and 4.83±0.28 mg/L respectively. The mean spatial variations recorded for SP 2 were 8.43±0.01, 0.63±0.01, 0.54±0.01, 0.0527±0.001, 0.2820±0.001, 0.2847±0.002, 8.27±0.03, and 5.57±0.08 mg/L respectively. At SP 3, 8.40±0.05, 3.69±0.02, 0.45±0.02, 0.0147±0.002, 0.1453±0.002, 0.1847±0.002, 8.57±0.03 and 4.73±0.08 mg/L respectively and numerical variations in mean concentration observed at SP 4 were 8.43±0.01, 0.45±0.02, 0.41±0.01, 0.0087±0.000, 0.0633±0.001, 0.3053±0.002, 8.67±0.03 mg/L and 3.57±0.03 mg/L respectively.

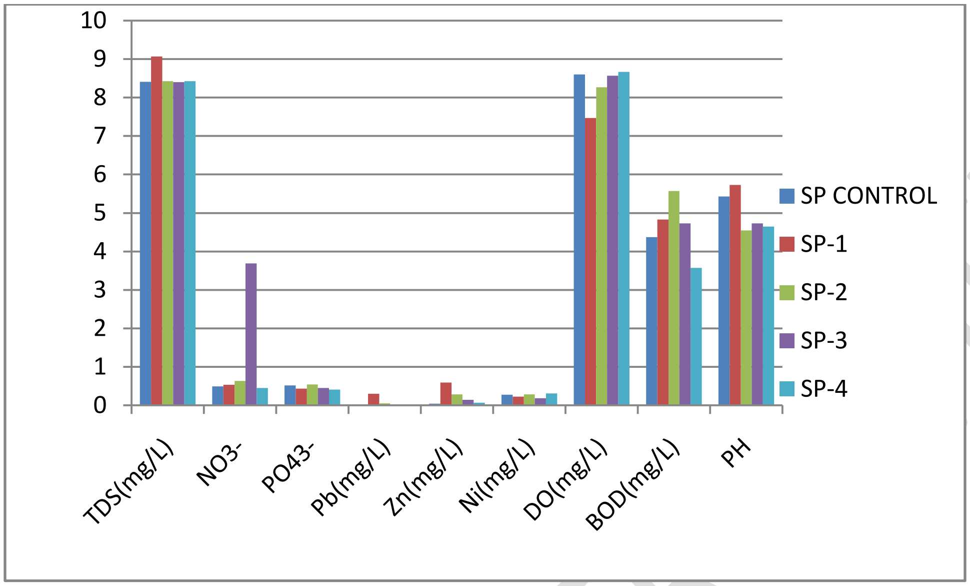

Fig.3: spatial variation in mean chemical and heavy metals parameters.

4.0 DISCUSSION

Temperature values reported in the current work were below the maximum permissible limit by Federal Ministry of Environment (FMEnv).Al-Janabi *et al.*, (2015) in their study stated that though, water bodies have the ability to buffer against atmospheric temperature extremes, even moderate changes in water temperature can have serious impacts on aquatic life.

The pH of the study area was lower than the minimum permissible limit of the FMEnv across all the sampling points. The slightly acidic pH condition recorded across the sampling points of this study is in consonance with the findings of Enuneku *et al*., (2017) in Obueyinomo River. They opined that this is typical of tropical aquatic bodies. However, the pH values across the stations did not fall within the FMEnv recommended range of 6.50–8.50 for surface water. According to Enuneku *et al*., (2017) and Rim-Rukeh *et al*., (2006), acidic conditions in an aquatic body could be attributable to humic acid formed from decaying organic matter.

The mean value of Electrical conductivity EC obtained were significantly below FMEnv guideline limit of 1000µS/cm. Okoye *et al.*, (2021) in their work reported that change in conductivity values during the rainy season might be due to dilution by rainfall which is in consonance with this study. EC is related to the concentration of TDS. In this study, the TDS value recorded across the sampling points were below recommended guideline of 500mg/l for drinking water and conforms to the findings obtained by Onwona *et al*., (2021) who reported that the low values of EC and TDS recorded in their work indicated low salt contents in the study area. However, this finding is not in tandem with the study of Keke *et al.*, (2015) who reported a high conductivity value range of 32.00-72.00 µS/cm in surface water of downstream Kaduna River, in Zungeru.

The FMEnv guideline for DO is greater than 7.50 mg/L. Other than in SP 1, all other SPs have DO values that were above this guideline limit. Low DOs may be attributed to the decomposition of organic matter, dissolved gases, and industrial wastes. The mean DO recorded for this study is in tandem with the findings of Dimowo (2013), who reported DO range of 2.9-7.7 mg/L in his work on River Ogun Southwestern Nigeria and Keke *et al*. (2015) also reported a DO range of 3.5-8.2 mg/L from surface water of Kaduna River Zungeru Niger state, Nigeria.The mean value of BOD recorded in this work conforms to values recorded by Okoye *et al*., (2021) and Ude (2012). On the other hand, high COD indicated presence of all forms of organic matter, biodegradable and non-biodegradables, and hence the degree of pollution in water. The COD of the study area were high across the sampling points. The mean COD value 651.20±13.54 mg/L was in consonance to the findings of Akaahan and Azua (2016) who obtained highest value of COD in river Benue. They observed that the seasonal variation of COD during their study was increasing during the rainy season and decreasing during the dry seasons. Thus, they opined that, reduced water quantity during the dry season decreases COD value. This result agreed with the high COD findings of earlier studies in River Benue by Eneji *et al*., (2012), Longe and Omole (2008) in River Illo, Ota Nigeria and Edokpayi *et al.*, (2010) in a coastal ecosystem impacted by land based activities.

There was a wide variation recorded for turbidity, TS, TSS, and Pb in this study. The wide variations in turbidity, TS and TSS reflected significant increases in levels of particulate materials constituting turbidity, especially after rainfalls. Aside reducing clarity; such water is often difficult to treat[ref]. Turbidity values of the present study were higher than FMEnv standard at SP1 and SP3. The observed high values were clear indication of the influence of human activities in such perturbations as sand excavation, as well as runoff from farm lands into the river. Consumption of water with high total suspended solids is harmful to the system (Akubugwo *et al.*, 2013). Low nitrate and phosphate were recorded during the study period. Phosphate and nitrate were one of the limiting factors of environmental variables because when used up, aquatic environment becomes unproductive (Arimoro *et al.*, 2015).

Suspended solid materials appeared to increase the concentrations of ions such as sulphate in our water bodies (Duru *et al.*, 2019).

The Pb did not exceed the set standard across most of the SPs, except SP1 that recorded a value far above the regulatory standard. High concentrations of Lead in the body can cause death or permanent damage to the central nervous system, the brain, and kidneys (Keke *et. al.*, 2015). Nickel was high across all the sampling points when compared to the set standard. This can be attributed to anthropogenic activities. In small quantities nickel is essential, but when the uptake is too high, it can be dangerous to human health[ref]. High concentrations in surface waters can diminish the growth rates of algae. The value of Zinc recorded in the study was far above FMEnv limit.

5.0 CONCLUSION

In conclusion it was observed that the water is slightly polluted mainly due to anthropogenic activities and the discharge of industrial effluent into the water body. Therefore, Government Agencies should put in place stringent measures to tackle discharges of effluents from industries as well as other anthropogenic activities.

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