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Flood and Post-flood Water Quality of Imonitea Freshwater Stream in Ndoni, Ogba Egbema Local Government Area, Rivers State, Nigeria

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ABSTRACT: Imonitea freshwater stream serves as a major source of water for domestic and agricultural applications for the inhabitants of Imonitea, in Ndoni of Ogba-Egbema Local Government Area of Rivers State, Nigeria. This research was conducted to investigate the physicochemical characteristics and microbial loads of the flood and post-flood water quality of the Imonitea fresh water stream using standard methods. Water samples were collected at both flood and post flood periods using standard methods. The properties of the freshwater at both flood and post flood periods were respectively: pH (6.41±0.15; 6.88±0.15); total dissolved solids (88.87± 20.07 mg/l; 103.13 ±16.76 mg/l), total hydrocarbon (4.20±0.77 mg/l; 4.94±0.86 mg/l), electrical conductivity(126.6±17.59 µS/cm; 140.53±33.99 µS/cm), nitrate(0.11±0.08 mg/l; 1.26;±1.45 mg/l), turbidity(51.88±7.67 NTU; 20.39±16.76 NTU), sulphate(3.52±1.25 mg/l; 2.44±0.41mg/l). The levels of heavy metals were: iron (1.20±0.50 mg/l; 110.98±9.94 mg/l), lead (0.30±0.20mg/l; 1.25±0.51 mg/l), cadmium (0.12±0.01 mg/l; 0.07±0.03 mg/l). On the other hand microbiological loads at flood and post flood periods were 1.84±0.92 cfu/ml; 3.56 ± 1.36 cfu/ml and 1.72 ±1.92 cfu/ml; 3.56 ±.1.20 cfu/ml respectively. At both periods, turbidity and total dissolved solids exceeded national standards. Although lead levels were within permissible limits, iron and chromium exceeded their permissible limits. The microbiological loads at both periods also exceeded national limits. The Water Quality Index was very high (3,192.81; 3,838.13), implying that the freshwater body was not fit for human consumption.

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Streams generally serve as a means of transport of metals partly dissolved or partly adsorbed on suspended materials as well as other water pollutants. Water pollution increases the threshold of heavy metals that poses serious threat to human and animal health, as well as natural and semi-natural ecosystems (Irima et al., 2020). Heavy metals such as lead (Pb) and cadmium (Cd) are discharged and globally distributed mainly via the activities of humans such as fossil fuel exploration and consumption. It has now become a common knowledge that exposures to lead poisoning in humans and animals have been a concern for more than a century (Kelvin, E.C, 2015). Cadmium has been reported to be one of the most dangerous trace elements in food and the environment because of its high toxicity and high persistence in the environment (Oluyemi.; *et al.*;2010). Heavy metals such as zinc and iron are required in biological processes, however, when their environmental concentrations exceed acceptable limits they

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constitute serious toxicological problems (Kelvin, 2015). Water quality index (WQI) is one of the most reliable tools to communicate information on the quality of water to concerned citizens, researchers, assessors and policy makers (Irima et al., 2020, Vincent-Akpu, and Yanadi, 2014, Nwankwoala, and Ogbonna, 2017). Water quality index provides a comprehensive picture of the quality of surface/ground water for most domestic uses (Vincent-Akpu, and Yanadi, 2014). For example, WQI has been used to determine the quality of a Fresh Water Stream (Mini-Whuo) (Irima *et al.*, 2020). Floods can potentially lead to high microbial loads, increase the transmission of water- and vector-borne diseases and results in water quality contamination. Therefore, this study investigated the physicochemical characteristics and microbial loads of flood and post-post water quality of Imonitea Freshwater Stream in Ndoni, Ogba Egbema Local Government Area, Rivers State, Nigeria

MATERIALS AND METHODS

Description of study area: Imonitea stream is a freshwater stream, located in Ndoni in Ogba, Egbema local government area of Rivers State. It is a tributary of the River Niger and it serves as a major source of drinking waterfor the inhabitants. In 2019, there was an unusual flooding of the stream, which greatly impacted on the community and thus necessitated the assessment of the quality of water at both flood and post flood periods. The map of the study area is shown in Fig. 1.

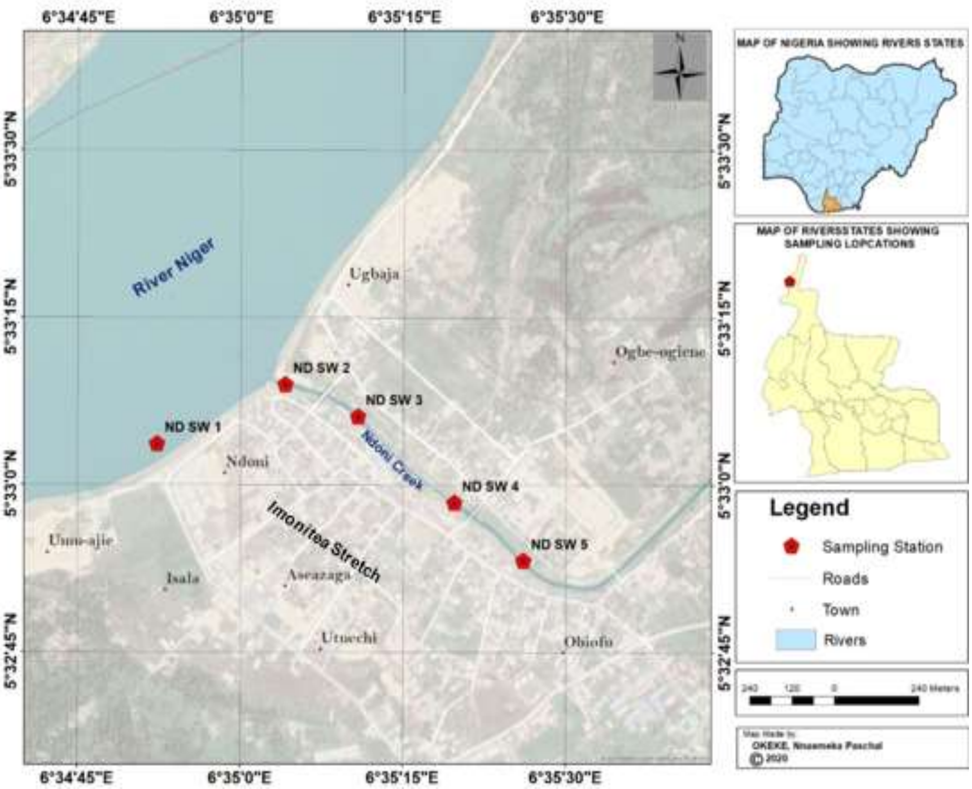

Fig. 1: Map of the Study Area

All chemicals and reagents used in this work were commercially sourced and used without further purification except otherwise stated.

The study was carried out in the fresh water stretch of Imonitea Stream Ndoni, Ogba, Egbema, Ndoni Local government area of Rivers State. The Imonitea stream is a tributary of the River Niger that empties into the Orashi River. A global positioning system receiver was used to geo-reference the sampling points of the water body.

Collection of sample and Analysis: Samples were collected in two seasons (Flood and Post Flood). The samples were collected at different points. Temperature and pH measurements were done in situ by the use of mercury-in-glass thermometer and electric digital pH meter respectively. Furthermore, electrical conductivity (EC) and total dissolved solids

(TDS) levels were also determined in situ by the use of the handheld Hanna portable conductivity meter. Levels of other physicochemical parameters such as Total Hydrocarbon Content (THC), Sulphate, Phosphate and Nitrates were done following standard laboratory procedures described by APHA (2005).

Determination of Water Quality Index (WQI): Calculations for the determination of the water quality index was done using the weighted arithmetic method (Okey-Wokeh et al., 2021). The mean values of pH, DO, BOD, Total Hardness, Nitrate, Phosphate, Chloride, TDS and EC were used for the (WQI). The standard values set by WHO for drinking water was followed in the calculation using the general equation:

$$QWI = \frac{\Sigma QnWn}{\Sigma Wn}$$

Where: Qn = Quality Rating; Wn = Unit Weight

$$Qn = \frac{100(Vn - Vio)}{(Sn - Vio)}$$

Where: Vn = Estimated value for nth water quality parameters of collected samples, Sn = Standard permissible value of the nth water quality parameters, Vio - Ideal value of the nth water quality parameter in pure water (it is 0 for all other parameters except for pH, which is 7 and DO which is 14.6).

The unit weight (Wn) was obtained by calculating a value inversely proportional to the recommended standard value (Sn) of the corresponding parameter, (ie Wn = 1/Sn).

Electrical Conductivity (E.C), Total dissolved solid (TDS), Total Hydrocarbon Content (THC), Sulphate, Phosphate and Nitrates and others as shown in **Table 1** were done in the laboratory using the standard method for analysis

RESULTS AND DISCUSSION

Electrical Conductivity (E.C): this is an important indicator of the levels of pollution in the water body. A high EC indicates high dissolution of ions in the water. This may either be as a result sewage runoff, domestic runoff, agricultural waste discharge or industrial waste discharge into the water body (Iyama and Edori 2014). Table 1, shows that the EC during the flood was 126.67 ± 17.59, while in the post flood it was 140.53 ± 33.99 which was below World Health Organization (WHO) standards, but within the Federal Ministry of Environment (FMEnv) standards for fresh water. The results of the physicochemical and microbiological characteristics of the sampling stations are:

Table 1 Mean values of physicochemical characteristics of Water Sample from *Imonitea* Stream

Parameter	FMENV/DPR	Flood	Post Flood	T-Test
Temp	<40	29.76 ± 1.06	30.42 ± 0.84	0.200
Ph	8.0	6.41 ± 0.15	6.88 ± 0.15	0.009
E.C (µS/cm)	750	126.67 ± 17.59	140.53±33.99	0.194
Phosphate (mg/L)	5	0.1 ± 0.03	0.15 ± 0.10	0.196
Nitrate (mg/L)	50	0.11 ± 0.08	1.26 ± 1.46	0.077
THC (mg/L)	50	4.20 ± 0.77	4.94 ± 0.86	0.015
Sulphate (mg/L)	400	2.44 ± 0.41	3.52 ± 1.25	0.049
Chloride (mg/L)	250	3.47 ± 2.31	9.05 ± 2.40	0.019
Salinity (ppt)	0.00	0.04 ± 0.00	0.04 ± 0.01	0.449
TDS(mg/L	500	84.87 ± 20.07	103.13 ± 16.76	0.026
Turbidity (NTU)	1	20.39 ± 16.76	51.88 ± 6.67	0.021
Total Hardness (500 mg/L)	500	14.85 ±1.52	25.61 ± 10.85	0.043
Alkalinity	500	14.87± 0.87	59.43 ± 12.71	0.001
Iron (mg/L)	0.03	1.20 ± 0.50	110.98 ± 49.94	0.04
Chromium (mg/L)	0.01	0.01 ± 0.00	0.16 ± 0.19	0.08
Cadmium (mg/L)	0.01	0.07 ± 0.03	0.12 ± 0.01	0.01
Nickel (mg/L)	0.05	0.01 ± 0.00	0.48 ± 0.52	0.06
Lead (mg/L)	0.01	0.30 ± 0.20	1.26 ± 0.51	0.01
THB cfu/ml)		5.35 ± 2.20	5.46 ± 2.48	0.48
THF (cfu/ml)	0-200	2.02 ± 1.16	3.03 ± 0.84	0.12
HUB (cfu/100ml)	0.01	1.84± 0.92	3.56 ± 1.36	0.07
HUF (cfu/100ml)		0.10 ± 0.00	0.20 ± 0.20	0.16

Total Dissolved Solids (TDSs): The level of TDSs in water is an indirect indicator of the measure for salinity. High levels of TDSs affect the density of water, which in turn impacts on freshwater organisms as well as the solubility of gases such as oxygen (Okey-Wokeh., *et al.*2021). High levels of TDSs damages the central nervous system, dizziness and provoking paralysis of tongue (Ugbaja and

Otokunefor, 2015). The TDSs for the water studied as shown in Table 1 revealed that its values during the flood and post flood periods are 84.87 ± 20.07 (mg/L) and 103.13 ± 16.76 (mg/L) respectively. Although, the TDS values obtained in this study is within 500 mg/L WHO standard and FMEnv permissible limits for drinking water. However, the TDS values obtained in this study during the flood and post flood periods, were lower than 500 mg/L WHO standard and FMEnv permissible limits for drinking water.

Chloride (Cl^-): Chloride ions are reported to be present in all types of water bodies in varying concentrations (Amacha et al., 2019). However, excessive chloride in surface water gives a salty taste to water. The values of chloride as shown in Table 1 for water body under investigation revealed that the values for flood and post flood period were 3.47 ± 2.31 mg/L and 9.05 ± 2.40 respectively. These values are far below the permissible limits of 250 mg/L and 100 mg/L recommended by WHO and FMEnv respectively.

Total Hardness (TH): The levels of dissolved minerals such calcium and magnesium ions in a water body is an indicator of the water hardness. The water hardness levels determines the suitability of water for domestic and industrial purposes such as washing or drinking (Donald and Blessing 2019).). For the water studied, the TH values recorded during the flood and post flood periods were 14.85 ±1.52 mg/L and 25.61 ± 10.85 respectively. These values are below 500 mg/L guideline set by National and International organizations. This implies that this freshwater is soft.

Phosphate (PO_4^{3-}): High levels of phosphate ions in water enhances algal growth boom and therefore controls the primary productivity of a water body. Thus determination of phosphate levels in water serves as a good indicator for potential biological pollution that may lead eutrophication (Iyama and Edori 2014). The values of phosphate in this study during the flood period and the post flood period were 0.1 ± 0.03 and 0.15 ± 0.10 respectively. These values are below the Federal Ministry Environment as well as that of DPR for fresh surface water. However, these values are similar to values obtained for fresh water in other studies (Okey-Wokeh *et al*., 2021)

Nitrate (NO_3^-): Nitrate ions in surface water are indicators of the presence of oxidized matter (Donald and Blessing (2019)). Their sources maybe due to activities of man such as municipal sewage deposits, runoff water from agricultural lands as well as discharges from households. From the result in Table 1, the concentration of NO_3^- during the flood period was 0.11 ± 0.08 mg/L, while that of the post flood period was 1.26 ± 1.46 mg/L. The nitrate ion values obtained in this study were below Federal Ministry Environment as well as that of DPR for fresh surface water.

Turbidity: The turbidity of a water is an indicator of the levels of particles in the water that makes the water turbid such that organism may be able to see through or may not be able to see clearly in such water. For the water under study, the turbidity during the flood period was 20.39 ± 16.76 while 51.88 ± 6.67 was obtained for the post flood period. These values revealed that the turbidity exceeded those of the Federal Ministry Environment as well as that of DPR for fresh surface water.

Levels of heavy metal ions: The concentrations of heavy metal ions during the flood period and post flood period were respectively (1.20 ± 0.50 and 110.98 ± 49.94) mg/L for iron, (0.01 ± 0.00 and 0.16 ± 0.19) mg/L for chromium, (0.07 ± 0.03, and 0.12 ± 0.01) mg/L for cadmium, (0.01 ± 0.00 and 0.48 ± 0.52) mg/L for nickel, and (0.30 ± 0.20, and 1.26 ± 0.51) mg/L for lead. The results revealed that levels of these metal ions at post flood period exceeded the Federal Ministry Environment and DPR standard for fresh surface water.

Microbial Load in Sediment: Total heterotrophic bacteria ranged from 5.35 ± 2.20 mg/L during the flood and 5.46 ± 2.48 mg/L at post flood period. The total heterotrophic fungi (THF) value was 2.40 ± 2.05 mg/L during the flood period and 3.03 ± 0.84mg/L at post flood period. On the other hand human utilizing bacteria (HUB) value was 1.84± 0.92 mg /L during the flood and 3.56 ± 1.36 mg/L at the post flood period. Furthermore, the values recorded for human utilization fungi (HUF) during the flood period and the post flood periods were 0.10 ± 0.00 and 0.20 ± 0.20 respectively. The microbial load level in found for the water under study exceeded those recommended by Federal Ministry of environment as well as DPR.

Water Quality Index (WQI) during the flood: the WQI of the water during the flood period was $\frac{\Sigma Q1W1}{\Sigma W1} = \frac{1132627}{3547433} = 3{,}192.807$))

Water Quality Index (WQI) during the post flood: the WQI of the water during the post flood period was $\frac{\Sigma Q1W1}{\Sigma W1} = \frac{1161553117}{3547433} = 3{,}274.3483$.

These QWI values were higher than expected compared to standard values for fresh water. These values revealed that the water quality is very poor and thus not suitable for human consumption.

Conclusion: Though the *Imonitea* stream is a fresh water, the water quality index (WQI) values (3,192.81, 3,838.129) from the study is an indication of serious pollution of the stream stretch. The increase in heavy metal and bacteria are as a result of human activities around the water body. Based on the result obtained in this study, the freshwater is not suitable for consumption. The water should be treated if need for cooking and drinking.

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