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ASSESSMENT OF PHYSICO-CHEMICAL PARAMETERS OF WATER FROM IWOFE RIVER, RIVERS STATE, NIGERIA

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ABSTRACT: *This study is aimed at assessing the physico-chemical parameters of water from the Iwofe River which is heavily stressed by extensive anthropogenic activities like bunkering. Two stations were established and surface water samples were collected bi-monthly at each station for one year. All the parameters were determined in-situ except biochemical oxygen demand (BOD) which was analyzed in the laboratory on the fifth day of sample collection. The results obtained show that pH varied from 5.66 and 6.87, dissolved oxygen (DO) ranged between 3.51 and 5.16 mg/l. Temperature had values ranging between 27.85 and 31.25 oC; salinity ranged between 5.96 and 11.54 ppt; conductivity ranged between 9.55 and 10.46 us/cm. The total dissolved solid (TDS) ranged between 7.15 and 13.63 mg/l and biochemical oxygen demand (BOD) was between 0.85 and 2.84 mg/l. Seasonal fluctuations revealed that mean values of DO, TDS, salinity and temperature were higher during the dry season while pH and BOD were higher in the wet season, but mean conductivity values were uniform for both seasons. The study has shown that despite the visible anthropogenic perturbations in the study area, the surface water is still relatively clean.*

KEYWORDS: Assessment, Physico-Chemical Parameter, Surface water, Iwofe River.

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INTRODUCTION

Water is an essential element needed for survival of life on earth. All organisms depend on water for their survival. However, the constant increase in population has resulted in an enormous consumption of the world's water reserves (Ho *et al*., 2003). Natural contamination of water resources mainly results from normal geological phenomena such as ore formation (Al Fraij *et al*., 1999); nevertheless, it is observed that human activities are a major factor in determining the quality of both surface and groundwater through atmospheric pollution, effluent discharges, use of agricultural chemicals, eroded soils and land use (Sillanpa *et al*., 2004). Temperature, turbidity, nutrients, hardness, alkalinity and dissolved oxygen are some of the important factors that play a vital role for the growth of living organisms in the water body. Hence, water quality assessment involves analysis of physico-chemical, biological, and microbiological parameters that reflect the biotic abiotic status of the ecosystem (Smitha & Shivashankar, 2013). Therefore, any change in the physical, chemical and biological properties of water leads to a serious problem in the biotic component and disturbs the equilibrium of an ecosystem. The present study deals with the assessment of physico-chemical characteristics of water along the Iwofe Creek.

MATERIALS AND METHODS

Study Area

The study area is a brackish water tidal river located at 4.089361^0N and 6.928667^0E, along the Iwofe creek, which may have been stressed by extensive anthropogenic activities like bunkering. The study area plays host to several organizations, such as Saipem, Masters Energy, Aveon Oil Servicing, etc., sand dredging firms and also receives discharges from sewage contractors who evacuate domestic sewage tanks. The mud flats are populated with the characteristic mangrove vegetation.

Field Procedures

Two sampling stations which were geo-referenced with a GPS were established along the creek. Surface water samples were collected from each of these stations bimonthly (6 times) from July 2018 – June 2019. All the physicochemical parameters investigated in this study were determined in-situ except for biochemical oxygen demand (BOD) which was taken to the laboratory for further analysis. Water samples for BOD determination were collected at a depth of 10–20 cm by pre-cleaned and labeled dark narrow neck 250ml reagent bottle which was first rinsed with river water. The reagent bottle when filled was corked underwater to avoid trapping air bubbles, and covered with aluminum foil before transporting to the laboratory for further analysis.

Determination of In-situ Parameters

The physico-chemical parameters determined in-situ at each station and period of sampling are pH, temperature, conductivity, total dissolved solids, DO, and salinity.

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Water Temperature (^{0}C)

Surface water temperature was measured at each station (in-situ) using the Hanna instrument pH/EC/TDS meter (Model; HI 1992 301) and Horiba water checker (UIO). For the reading, the probe of the meter was dipped into the river water. Readings were taken on the screen of the meter when stable.

Dissolved Oxygen (mg/l)

A pre-calibrated hand-held HANNA (9142) portable dissolved oxygen meter was used in situ to measure dissolved oxygen. This was achieved by dipping the probe into the river water and taking readings on the scale with the eye piece at the other end of the cylindrical tube in %o (parts per thousand). Readings were taken on the screen of the meter when stable. Readings were recorded in mg/l.

Salinity (%o)

A hand-held salinity refractometer (AGRO Master Refractometer) was used to measure salinity in situ (Cat no 2491). This was done by placing a drop of water on the glass side of the refractometer prism and this was covered with the inbuilt plate. The salinity was then read from the in-built scale using the eyepiece at the other end of the cylindrical tube in %o (parts per thousand).

Hydrogen Ion Concentration (pH), Conductivity (µs/cm) and TDS (mg/l):

Surface water pH and conductivity were measured in-situ in sampling stations using the Hanna instrument, pH/EC/TDS meter (model; HI 191 301). This was done by inserting the probe into the river water and readings were taken on the screen of the meter when stable.

Laboratory Procedures

In the laboratory, samples were stored in a dark cupboard for five (5) days after which they were and fixed using 2 ml of prepared Winkler 1 and 3 reagents. A uniform solution was obtained by mixing thoroughly. Concentrated tetraoxosulphate six acid (H_2SO_4) was then added and mixed thoroughly by shaking, giving the resulting solution a pale yellow colouration. 50 ml of the solution (sample) was then transferred into a 100 ml Erlenmeyer flask and 2 drops of prepared potato starch solution (as indicator) added into it. This changed the colour from pale yellow to blue-black. It was then titrated against a 0.025N Sodium thiosulphate solution until a colourless solution was formed. The final volume of the thiosulphate was used for the calculation of DO after 5 days. BOD was then calculated using the formula:

$$BOD = DO - DO_5$$

where DO = value of dissolved oxygen determined in-situ in the field

DO_5 = value of dissolved oxygen determined in the laboratory after 5 days.

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Biochemical Oxygen Demand (mg/l)

An appropriate volume of the sample, depending on the nature and level of envisaged pollution, was diluted to 1 – litre with oxygen rich nutrient water containing 1 ml each of phosphate buffer, magnesium sulphate, calcium of phosphate buffer, magnesium sulphate, calcium chloride and ferric chloride solutions per litre of the nutrient water.

The diluted sample and ordinary diluent (blank) were incubated for 5 days at 20^0C, after having determined the dissolved oxygen of individual dilution and blank for the first day.

The BOD was calculated using the formula:

BOD_5 (mg/l) = $(S_1 – S_2) – (B_1 – B_2)$ x % dilution

S_1 = DO for the first sample

S_2 = DO after the incubation of sample

B_1 = DO for the first day of blank

B_2 = DO after the incubation of blank

Map showing Iwofe Creek and Sampling Stations

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RESULTS

Mean, ANOVA and Tukey Test by Month for Each Physicochemical Parameter

Month	pH	DO (mg/l)	Water Temp (ºC)	Salinity (ppt)	Conductivity (µs/cm)	TDS (mg/l)	BOD (mg/l)
May	6.87[a]	4.08 [a]	29.80[ab]	6.54[cd]	10.10 [a]	9.05[b]	2.84[a]
July	6.53[a]	4.74 [a]	27.85[b]	6.11[d]	10.17 [a]	8.35[b]	1.90[ab]
Sept	6.66[a]	4.64 [a]	28.05[b]	7.75[c]	10.00 [a]	9.65[b]	0.94[c]
Nov	6.67[a]	3.51 [a]	29.55[ab]	5.96[d]	10.20 [a]	7.15[b]	1.65[bc]
Jan	5.66[a]	5.16[a]	30.10[ab]	11.54[a]	9.55[a]	13.63[a]	1.13[bc]
March	6.50[a]	4.89 [a]	31.25[a]	9.45[b]	10.46[a]	8.45[b]	0.85[c]
P-value	0.1383	0.3721	0.0166	<0.0001	0.9562	0.0008	0.0012

Pair of means not connected with the same letter are significantly different along the column

Seasonal Average of Physico-chemical Parameters of the Area and T-Test of between Season's Variations

Season	pH	DO (mg/l)	Water Temperature (ºC)	Salinity (ppt)	Conductivity (µs/cm)	TDS (mg/l)	BOD (mg/l)
Wet	6.69±0.14	4.49±0.75	28.57±0.88	6.80±0.78	10.1±0.34	9.02±0.53	1.89±0.87
Dry	6.28±0.44	4.52±0.92	30.3±0.71	8.98±2.53	10.1±1.11	9.74±2.8	1.21±0.40
P-value	0.1577	0.9491	0.0147*	0.0717	0.9781	0.5913	0.1120

Significantly different at p<0.05

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DISCUSSION

The use of water is greatly influenced by its physical and chemical properties, which to a large extent is used to assess the condition of water (Courtney & Clement, 1998). The initial signs of pollution in any aquatic environment can be detected from the deterioration of surface water quality. Hence, the importance of assessment of surface water quality cannot be overemphasized in any environmental study, as it is very necessary to ascertain its quality and the capability to sustain aquatic life and by extension the productivity of the aquatic ecosystem.

Temperature

In this study, water temperature was relatively uniform throughout the period with measurable differences across the seasons. Temperature ranged between 27.8 and 31.25ºC all through the study period. This was within the acceptable range of 20ºC–33ºC as recommended by the Nigerian Federal Ministry of Environment for aquatic life in the tropical region (FMEnv., 2001). The highest temperature of 31.2ºC was recorded in the dry season while the lowest temperature was recorded in the wet season. The results were in agreement with previous work done in the same study site by Vincent-Akpu and Nwachukwu (2016), where 28ºC was recorded as the mean temperature. Higher temperature values in the dry season were also observed by Wokoma and Umesi (2017) and Ogolo *et al*. (2017). Sikoki and Zabbey (2006) and Jamabo (2008) also recorded a drop in temperature during the wet season which they attributed to heavy rainfall, which is quite common in the Niger Delta.

Dissolved Oxygen (DO)

Dissolved oxygen values in this study ranged between 3.51 and 5.16 mg/l; this is consistent with the earlier observation of Wokoma and Umesi (2017) who reported a range of 3.69–5.44 mg/l as well as the 3.61±1.44 – 5.83±2.16 recorded by Wokoma and Friday (2016). It is however relatively lower than the reported range of 6.84–7.13 mg/l by Ezekiel *et al*. (2011) from the Sombreiro River. The higher wet season values of DO recorded by Wokoma and Umesi (2017) and Ngah *et al*. (2017) is at variance with that of the present study where higher concentrations of DO were recorded during the dry season. However, Ogolo *et al*. (2017) and Vincent-Akpu *et al*. (2015), working in the same environment, also reported higher dry season values of DO. It thus seems that seasonal fluctuations of DO might be a function of variations in both natural and anthropogenic activities in the study sites.

The DO values recorded in this study showed no significant difference across seasons as opposed to significant seasonal variation reported by Wokoma and Umesi (2017). Notwithstanding, the values of DO record in this investigation were all within the acceptable limits of the Federal Ministry of Environment (2001).

Salinity

Rainfall, evaporation and tides have combined effects on the variations in salinity (Nwankwo, 2004). This statement was reflected in the results recorded for salinity in this study. Seasonal or temporal variability was observed with high values recorded in the dry months of January (11.54 mg/l) and March (9.45 mg/l) respectively. Higher salinities in the dry season could be attributed to high sunlight intensity which increased evaporation rate. Ogolo *et al*. (2017) and Makinde *et al.* (2015) both reported higher salinity values in the dry season compared to the wet season. Mclusky (1989) reported that rainfall could cause dilution of estuarine water, thus

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reducing the saline content and this may account for the higher salinities recorded in the dry season. Salinity values showed seasonal variability, with significant difference across seasons, with a p-value of 0.0001. Salinity had a positive correlation with TDS and BOD and a negative correlation with pH.

Conductivity

The conductivity (9.55–10.46 µS/cm) recorded in this study did not show obvious seasonality. Values across months and seasons were all within the same range except March which had the highest value of 10.46 µS/cm. Oben (2000) attributed increase in the magnitude of conductivity during the dry season to evaporation, and decrease in value during the wet season to dilution by rainfall. Values observed in this study are higher than the values recorded by Vincent-Akpu *et al.* (2015), who recorded a mean value of 8.75 µS/cm in the same study environment. Lower conductivity values in the wet season were also recorded by Alame *et al*. (2020), Oniye *et al*. (2002). However, Odulate (2010) and Adeosun (2007) had a contrary result with higher conductivity observations in the wet season. Values of conductivity recorded in this study showed no significant difference across seasons and are within the permissible limit for FEPA (1991) which is 200–1000 µS/cm.

pH

The hydrogen ion concentration (pH) in this study ranged from 5.66–6.87. The lowest value was recorded in January while the highest value of 6.87 was recorded in May. This slightly falls below the Federal Environmental Protection Agency (FEPA, 1991) limit of 6–9. However, Boyd (1979) opined that to support aquatic life for optimum fish production, pH values should be within 5.0–9.0. Nevertheless, the result is indicative of a stressed environment going by the earlier assertion of Wetzel and Likens (2000) that pH values that are outside the range of 6.5–8.5 indicate pollution. Similarly, pH tending towards neutrality, as in this study, suggests the presence of increased human activity which results in a corresponding increase in waste. This can be related to this study site which is high in anthropogenic activities. Results from this study were similar to those of Ekpo *et al*. (2012), who reported a pH of 6.80–6.86 in their study in Ikpa River but is lower than that recorded by Nkwoji *et al.* (2010).

Total Dissolved Solids

Total dissolved solids in this investigation ranged from 7.15–13.63 mg/l; this is relatively higher than the 5.8mg/l observed by Vincent-Akpu (2016) in the same study area, but grossly lower than the range of 6785±3.5 – 17098±2.0 reported by Wokoma and Njoku (2017) in the Sombreiro River. The mean dry season value is higher than that of the wet season. This, according to Bamidele and Fasakin (2016), could be due to excessive evaporation in the dry season and reduction in rate of river runoffs. Adeosun (2012) also recorded higher TDS in the dry season. However, higher values of TDS in the wet season were reported by Tonye *et al*. (2018) and Marcus and Edori, (2017), which they attributed to increased turbulence of river flow that may have caused re-suspension of sediments. TDS had a positive correlation with salinity ($r = 0.77$) and was negatively correlated with pH ($r = -0.77$).

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Biochemical Oxygen Demand

BOD values ranged between 0.85–2.84 mg/l. The values were much less than 10 mg/l recommended by DPR (2002) and within the FEPA (2003) recommended limits of 0–6 mg/l. Ngah *et al*. (2017) recorded values between 0.45–7.50 mg/l. The low BOD value may be due to tidal influence, indicating a cleansing effect, flushing and diluting organic matter and other stressors. This result is similar to that of Onojake *et al*. (2017) in their study of Bonny/New Calabar River Estuary. BOD values recorded were between 0.42–2.83 mg/l with the highest value recorded in February. The high BOD was attributed to the culmination of salinity, higher temperature, and breakdown of substances deposited in the river. Mean value of BOD was higher in the wet season in this present study. Hart and Zabbey (2005) also recorded higher BOD values in the rainy season which was attributed to demand by organisms to support life processes. BOD values recorded in this study showed a negative correlation with salinity.

CONCLUSION

Water is an important life supporting system; the entire biotic components depend on water for their physiological processes. Therefore, any change in the physical, chemical and biological properties of water leads to serious problems in the biotic component as it may alter the equilibrium of an ecosystem. Seasonal fluctuations revealed that mean values of DO, TDS, salinity and temperature were higher during the dry season while pH and BOD were higher in the wet season, but mean conductivity values were uniform for both seasons. The study has shown that the visible human activities in the study area have not adversely impacted on the surface water which may be as a result of the tidal movement of water.

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