HYDROGRAPHIC PROPERTIES OF SOME BUSY STRETCHES OF THE CALABAR RIVER, CALABAR, CROSS RIVER STATE, NIGERIA.

Abstract
A study on the hydrographic (tidal range, speed of flow and Physicochemical parameters) characteristics of the Calabar River was carried out for three months at three sampling points. The result obtained for the tidal range of the Calabar River from the three sampling points ranged between 0.2m to 0.98m. Statistical analysis revealed that the difference in the tidal range between the sampling stations was not significant ($P > 0.05$). The speed of flow ranged between 0.72m/s and 1.15m/s. The difference in the speed of flow values between the three stations was found to be statistically significant ($P < 0.05$). Physicochemical parameters showed that the pH of water from the three sampling points ranged between 4.90 to 6.55 ($P > 0.05$). Conductivity values ranged between 194 µm/S and 955 µm/S. ($P < 0.05$). Dissolved Oxygen ranged from a minimum of 2.5 mg/l to 5.1 mg/l ($P < 0.05$). Salinity (mg/l) ranged from 0.13 mg/l to 0.63 mg/l in the study ($P < 0.05$). Nitrate concentration ranged from 0.32 mg/l to 0.57 mg/l ($P > 0.05$). Nitrite concentration ranged from 0.030 mg/l to 0.2 mg/l ($P >0.05$). Alkalinity concentration ranged from 9.0 mg/l to 55.10 mg/l. ($P < 0.05$). Turbidity concentration ranged between 5.2 mg/l and 65.6 mg/l ($P < 0.05$). Temperature ranged from 25^{o}C to 28^{o}C ($P < 0.05$). Total dissolve solute (TDS) concentration ranged between 132.66 mg/l and 668.5 mg/l ($P >0.05$).
Keywords: hydrographic properties**,** physicochemical parameters, tidal range and speed of flow,

Introduction
The system of permanent and temporary watercourse (rivers, streams and brooks) forms a hydrographic network on the land surface (Shiklomanov, 2003). Hydrography is the measurement of the physical features of oceans, seas, coastal areas and rivers, as well as the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities including economic development, security and defense, scientific research and environmental protection (IHO, 2018). The productivity of a given body of water is determined by its physical, chemical and biological properties (Agbugui & Deekae, 2014). For successful management to keep watersheds clean, research should be conducted through comparative analysis between past and present health conditions of aquatic environments and also predict the future (Lee, *et al.*, 2018). Series of activities or disturbances at one location, within a body of water, affect processes and organisms downstream, complicating the management of these systems (Bere & Tundisi, 2010). There are varieties of lives like fishes, plants, animals, and numerous microorganisms that survive in the aquatic ecosystem. In addition to these, along the river banks, trees and shrubs grow as shelter belts for birds and mammals. Increasing anthropogenic influence on aquatic environments that parallels civilization has captured public interest because of the consequent deterioration of water quality, health problems, pest plants and animals, and other problems. Hence, it is necessary to study the freshwater ecosystems and the parameters controlling its habitat such as temperature, light, pH, dissolved gases, dissolved salts in water, turbidity, alkalinity, depth, water current/flow rate and areal distribution. This study is aimed at measuring the hydrographic properties of some busy stretches of the Calabar River and ascertain the water quality of the River, by measuring the temperature, pH, Dissolved gases (O_2), Dissolve salts (Nitrates, Nitrites), alkalinity, turbidity, (suspended solids) and dissolve solids at the designated stretches.

MATERIALS AND METHODS

Description of study area

The study area is situated between longitude $8^{o}15^{'}$ and $8^{o}20^{'}$E and latitude 5^{o} and $5^{o}10^{'}$N. The climate of the study area is defined by dry season and wet season. The wet season (April-October) is characterized by high precipitation "3050 mm ± 230 mm", while the dry season (November-March) is marked by low precipitation "300 mm ± 23 mm" (Akpan & Offem, 1993). There is usually a cold, dry and dusty period between December and January, referred to as harmattan season. According to Ama-Abasi *et al.,* (2004), temperatures generally range from 22^{o}C in the wet season to 35^{o}C in the dry seasons. The major activities of the people living along the stretches of the Calabar River are fishing and sand mining.

Sampling period and Data collection

Sampling was done once a month for 3 months (November, December and January). The hydrographic properties of the designated stretches of the Calabar River were measured in the first week of each month for a period of three months at three (3) stations indicated as A, B and C. Those samples that could not be measured in-situ were collected using one (1) liter plastic container and taken to the laboratory for analysis.

Measurement of hydrographic properties

Tide (m) / water level (cm/m): The lowest and highest tide (tidal range) was measured on site using the tidal pole, which was tied strong in a fixed position inside the river at the near shore zone. The reading of elation of water and tide was made intermittently, 30minutes interval for at least 10 hours. And the readings converted from centimeters to meters.

Speed of flow (m/s): A drifter (floater) was allowed to float and travel a measured distance, the time and direction of travel regarding the initial point was used to calculate the currents speed and direction. The time of travel was measured using a stop watch; ***Speed = Distance / Time (m/s)***

Temperature (^{0}C): The temperature was measured in-situ using mercury-in-glass thermometer.

pH: This is the acidity or alkalinity of a water-based solution. This was measured in-situ with a pH meter.

Conductivity: Water samples for conductivity was collected in a 1L sterile bottle and taken to the laboratory for analysis.

Turbidity: This is the measure of clarity of surface water to the human eye. Water sample was collected in 1L sterile bottle and taken to the laboratory for analysis.

Salinity: The values for conductivity were converted to salinity and vice versa using the formula: $\text{Salinity} = 0.65 \times conductivity/1{,}000$

Statistical analysis

Statistical analysis was carried out with the aid of Microsoft Excel (2016 version). Analysis of variance (ANOVA) was used to test for significant differences. Descriptive statistics provided the means and standard deviations of the hydrographic properties measured.

RESULTS

Tidal range and Speed of flow of Calabar River

Result obtained from the determination of Tidal range and Speed of flow of the Calabar River are presented in Table 1.

TABLE 1: Tidal range and Speed of flow of the Calabar River

Parameter	Month	Station A	Station B	Station C

Tidal range	Nov	0.22	0.2	0.28
	Dec	0.68	0.97	0.56
	January	0.98	0.79	0.66
	Mean±SD	**0.63±0.38**	**0.65±0.40**	**0.50±0.19**
Speed of flow	Nov	0.86	0.72	1.15
	Dec	0.99	1.03	1.14
	January	1.22	1.02	1.11
	Mean±SD	**1.02±0.18**	**0.92±0.18**	**1.13±0.02**

Physicochemical parameter of water quality

Result obtained from the determination of Physico-chemical parameters of the Calabar River are presented in Table 2.

TABLE 2: Physicochemical Parameters of Water Quality

Parameter	Month	Tinapa	Adiabor	Marina
pH	Nov	6.55	5.74	5.49
	Dec	6.00	5.4	5.0
	January	5.89	4.90	5.52
	Mean±SD	**5.73±0.83**	**5.35±0.42**	**5.34±0.29**
Conductivity	Nov	955	194	200
	Dec	740	382	198
	Mean±SD	**858.33±109.13**	**262.00±104.23**	**227.33±49.08**
Dissolved	Nov	4.9	4.1	2.5
Oxygen	Dec	5.1	4.9	3.5
	January	5.0	4.7	3.1
	Mean±SD	**5.00±0.10**	**4.57±0.42**	**3.03±0.50**
Salinity	Nov	0.63	0.13	0.13
	Dec	0.48	0.24	0.13
	January	0.57	0.14	0.17
	Mean±SD	**0.56±0.76**	**0.17±0.06**	**0.14±0.23**
Nitrate(NO_3)	Nov	0.058	0.032	0.042
	Dec	0.054	0.57	0.48
	January	0.052	0.036	0.053
	Mean±SD	**0.55±0.00**	**0.21±0.31**	**0.19±0.24**
Nitrite (NO_2)	Nov	0.069	0.058	0.065
	Dec	0.050	0.030	0.051
	January	0.2	0.048	0.070
	Mean±SD	**0.12±0.08**	**0.06±0.01**	**0.06±0.01**
Alkalinity	Nov	10.0	30.0	55.10
	Dec	9.0	25	30.0
	January	12.0	35	45.0
	Mean±SD	**0.727±0.04**	**0.045±0.00**	**0.035±0.00**
Turbidity	Nov	37.16	8.20	10.9
	Dec	45.0	10.2	5.2
	January	65.6	6.6	17.4
	Mean±SD	**49.25±14.68**	**8.33±1.80**	**11.17±6.10**

	Nov	25	26	26
Temperature	Dec	27	28	26
	January	26	27	26
	Mean±SD	**26.00±1.00**	**27.00±1.00**	**26.00±0.00**
	Nov	668.5	135.8	140.0
TDS	Dec	495.8	255.94	132.6
	January	589.6	140.7	170.2
	Mean±SD	**584.63± 86.46**	**177.48 ± 67.99**	**147.62±19.89**

Discussion

Although not definitive, pH of aquatic system is an important indicator of the water quality and the extent of its pollution. pH has profound effect on water quality as it affects the solubility of metals, alkalinity and hardness of water. The survival of aquatic organisms is also greatly influenced by the pH of the water bodies in which they are found. This is because most of their metabolic activities are pH dependent (Osibanjo *et al.*, 2011). If the surface water pH shifts too far either away from the acceptable range (6.5-8.5), highly mobile aquatic organism tends to migrate to safer environments while the life of sedentary organisms is susceptible to loss. The pH of water samples (4.90- 6.55) in the study was found to be slightly acidic and below W.H.O. stipulated standards for drinking water quality of 6.5 -8.5 mg/l.

Conductivity of water is a measure of the ability of the water to conduct electricity due to the presence of ionic solutes. The magnitude of the conductivity therefore is a useful indication of the total concentration of the ionic solute. According to the study made on Lake Mattamuskeet by Anne (2015), it was observed that increase in conductivity results in decrease in Zooplankton population. She proposed that since zooplankton naturally predate phytoplankton. It is possible that the reduction in zooplankton could result in an increase phytoplankton population, perhaps compensating for the phytoplankton that may have been unable to tolerate a conductivity increase.

Oxygen molecules are dissolved in water and measured as dissolved oxygen. The presence of dissolved oxygen in lakes and rivers is good because the survival of most aquatic plants and depends on a sufficient level of oxygen dissolved in water. Dissolved oxygen (DO) is therefore a good indicator of healthy water quality (Neighborhood Water Quality 2000). Dissolved Oxygen content in the present study fluctuated from 2.5 mg/l to 5.1 mg/l. The W.H.O. permissible limit for DO is 5.00mg/l -7.00mg/l (Singh *et al.*, 2010). The findings of this study are in agreement with Osibanjo *et al.*, (2011) who reported a range of 4.86-6.37 mg/l for River Ona in Ibadan, Nigeria. Evaluation of DO is crucial to the survival of aquatic organisms and ultimately in establishing the degree of freshness of a river (Fakayode, 2005). Total dissolve solids (TDS) and temperature (^{o}C) were observed to be within the accepted limit for fish production, which is in line with the findings of Ezekiel, (2018) who observed same characteristics in Goro-Dong Lake.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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