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Pysico-chemical Parameters of the Upper and Lower Reach of the New Calabar River Niger Delta

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Abstract

The physico-chemical parameters of the upper and lower reach of the New Calabar River across five stations in relation to season were investigated from December 2013 to May 2014.The result showed that the water was slightly acidic across months with pH range of 6.18 to7.08 and across Stations. Relatively high Do levels were observed during the study with higher value at the upstream sampled stations than downstream sampled stations. There was no significant variation in Temperature and BOD across Stations and season. Further results revealed that there were variation in salinity values, lowest salinity was recorded in station 5 (5.93 mg/l) and lowest in station 2 (1.08 mg/l) while the highest salinity in December (6.01).Dissolved Oxygen decreased across Stations (6.45 to 4.49 mg/l) but showed variation across season.

Keywords: New Calabar River; Physico-chemical parameters; Seasonal variation

Introduction

In recent years, a number of events affecting water quality have resulted in increased public concern about surface water quality [1]. Macer [2] postulated that the presence of impurities, reduces the quality and uses to which water may be deployed as well serve as a major factor controlling the state of health in both cultured and wild fishes.

The New Calabar River is one of the most stressed rivers in the Niger delta.it is presently not the focus of any systematic periodic water quality investigation. The New Calabar River is also connected to the Bonny River which is one of the most stressed rivers in the Niger Delta region [3]. The importance of periodic water quality monitoring of the New Calabar River cannot therefore be over emphasized. Although series of work have been carried out in different reaches of the river, but this study therefore is focused on the upper and lower reach of the New Calabar River covering both (fresh and brackish) and this will complement the existing knowledge on the pysico-chemical parameters of the river.

Materials and Method

Study area

The study area is the stretch of the New Calabar River as shown in Figure 1. The New Calabar River lies between longitude 006°53 53086'E and latitude 04°53' 19.020'N in Choba, Rivers State, Nigeria. The entire river course is situated between longitude 7°60'E and latitude 5°45'N in the coastal area of the Niger Delta and empties into the Atlantic Ocean. The New Calabar River region has an annual rainfall between 2000-3000 mm [4].

The new Calabar River is a black water type [5] located in Rivers State, Nigeria lies on the Eastern arm of the Niger Delta and empties into some creeks and coastal lagoon bordering the Atlantic Ocean. At the source at Elele-Alimini, the water is fresh and acidic but brackish and tidal at the mouth. Aluu is the upstream part of the river where the river is fresh and tidal [6]. The New Calabar River is among the important water resources in the Niger Delta region of Southern Nigeria; it is in the vicinity of the rapidly expanding oil city of Port Harcourt in Rivers State, Southern Nigeria. Most communities within this area are directly dependent on the river for their agricultural, recreational, and sometimes, domestic water supplies. The river is subjected to effluent discharge from Industries sited along its banks. Also, surface run-off resulting from soil erosion, lumbering activities, forestry operations, dredging activities, and domestic sewage inputs may lead to wide scale contamination of the river. A total of five different stations which includes: Rumuokparali, Choba bridge, Aluu (Arac Center), Ogbodo (Isiokpo), Elibrada (Emuoha) and were established as shown in Figure 1.

Sampling stations of the New Calabar River

Station 1: Rumuokparali Station 1 lies between longitude 6°54.17E and latitude 4°52.37N, with a distance of 551.09meters to Choba Bridge the river harbor pipes layed for dredging and domestic effluents is emptied into the river .A market is located close to the river which houses an abattoir where in which all waste goes into the river.

Station 2: Choba Bridge Station 2 lies between longitude 6°53.95E and latitude 4°53.78N is in Choba village and close to it is an extension base of Wilbros Nigeria Limited (WNL) oil serving industry. The distance from form this station to Aluu is 224.25meters and the activities here include the building and repair of oil pipelines as well as dredging activities as well as fishing activities.

Station 3: Aluu (ARAC) Station 3 lies on longitude 6°53.79E and latitude 4°54.73N with a distance of 213.53meters to Ogbodo in Isiokpo. The Station is also used mainly for dredging activities as well as for domestic and recreational; activities. It is also a narrow creek linking the discharge point of the farming activities within the African Regional Aquaculture Center in the river.

Station 4: Ogbodo (Isiokpo) Station 4 is the upper part of the river which lies between longitude 6°52.01E and latitude 4°54.80N. The Station is mainly used for dredging activities as well as for domestic purposes like fishing by the inhabitants, recreational activities are sometimes carried out. It has a short distance of 71.8 meters to Elibrada in Emuoha.

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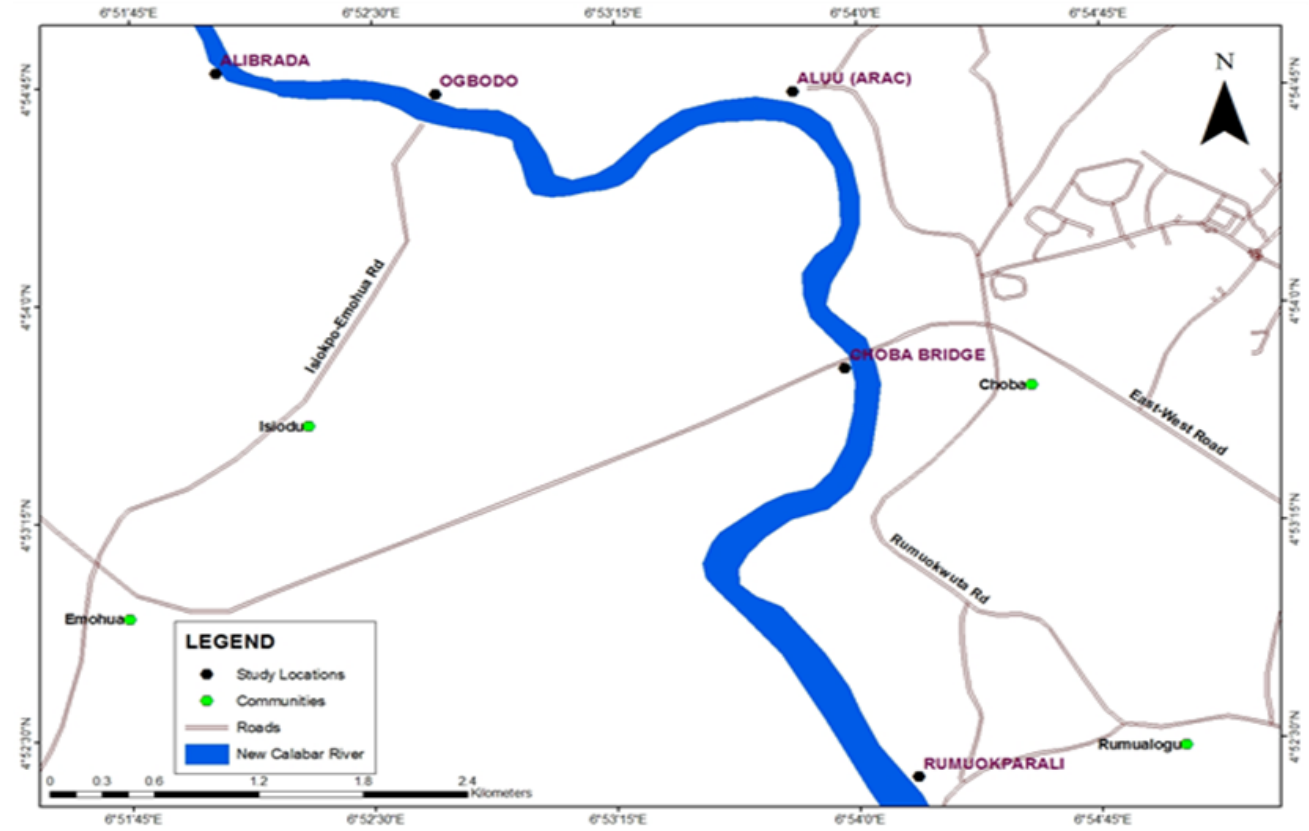

Figure 1: Map the study area showing the different sampling stations of the New Calabar River.

Station 5: Elibrada (Emuoha) Station 5 lies on longitude 6°52.01E and latitude 4°54.80N in Emuoha village where Ogbodo rivers empties into, there is dredging activities in this river and villagers around carry out fishing activities. It is also used for recreational activities by neighboring villages. The distance of this Station to Rumuokparali is 510.97 meters.

The sampling was done twice in a month from December 2013 to May 2014 which covers a period of six months (three months of dry season and three months of wet season).

Sample collection and laboratory analysis

At each of the Stations a set of water samples were collected in a pre-cleaned 50 cl poly propylene container and transported to the laboratory for further analysis. The physico-chemical parameters that were analyzed are: pH, Temperature measured in °C, Salinity measured in mg/l, Chemical Oxygen Demand measured in mg/l, Biological Oxygen Demand measured in mg/l and Dissolved Oxygen measured in mg/l.

The physico-chemical parameters were determined according to the procedure s outlined in the Standard Methods for the examination of water and waste water [7].

Statistical analysis

Analysis of Variance (ANOVA) was done by computer software. It was used to ascertain significant variations of parameters within different sites of the New Calabar River. Pearson's Correlation coefficient (r) was used to identify the relationship between season and Stations and physico-chemical parameters of the New Calabar River. Probability was set at ($P<0.05$) and ($P<0.01$).

Results and Discussion

A summary of the results of the physico-chemical parameter of the sampled sites along the New Calabar River is shown in Tables 1 and 2. The pH of the river ranged between 6.72 at Station 5 and 6.37 at Station1.The EU sets protection limits of pH from 6 to 9 for fisheries and aquatic life [8].Water temperatures ranged from 26.02°C recorded in Station 5 to 26.53°C recorded in Station1.The slight variations in water temperature could be due to different times of sampling as the ambient temperature influenced the temperature of the samples. Dissolved Oxygen (DO) decreased across the Stations with highest value of 6.45 mg/l in Station 1 and 4.49 mg/l in Station 5.The mean value for salinity ranged from 5.93 mg/l Station 5 to 1.08 mg/l in Station 3.The Chemical Oxygen Demand (COD) had highest value of 2.67 mg/l in Station 1 and the lowest value of 1.74 mg/l recorded in Station 5. Biological Oxygen Demand (BOD) also decreased across Station 1 to 5 with the range of 0.23 mg/l in Station 1 to 0.17 mg/l in Stations 4 and 5.

The mean values of the physico-chemical parameters in relation to month as shown in Table 2. The highest pH value of 7.08 was recorded in January while the lowest mean value 6.18 was recorded in May. The pH values in the sampling Stations increased across the Stations, the generally low pH value at the upstream Station 1 to 3, 6.37 mg/l-6.46 mg/l may have resulted from decaying of the domestic and industrial waste littered in the area contributing to the acidic nature of the water, however pH values recorded in this study area were well within the preferred pH of 6.5 to 9.0 recommended for optimal fish and aquatic

Station	pH	Temp.	DO.	Salinity	COD	BOD
Rumuokparali	6.37d	26.53a	6.45a	5.50a	2.67a	0.23a
Choba bridge	6.41c	26.25b	5.50b	4.07b	2.20c	0.18b
Aluu (ARAC)	6.46b	26.15c	4.89c	1.08c	2.25b	0.18b
Ogbodo (Isiokpo)	6.69a	26.12c	4.62d	7.18b	1.93d	0.17c
Elibrada	6.72a	26.02d	4.49e	5.93e	1.74e	0.17d
SEM	0.013	0.029	0.014	0.029	0.003	0.002

*Superscripts of the same alphabet are not significantly different (P<0.05)

**Superscripts of different alphabets are significantly different (P<0.05)

Table 1: The physico-chemical parameters at the different stations in New Calabar River.

Month	pH	Temp.	DO	Salinity	COD	BOD
December	6.88b	27.38a	4.58f	6.10f	2.85a	0.16d
January	7.08a	26.26c	5.23e	1.01e	1.82f	0.19b
February	6.46c	25.80e	5.12d	1.44d	1.91e	0.17c
March	6.35d	25.30f	4.92e	4.37a	1.99d	0.18b
April	6.22e	25.98d	5.45b	3.48b	2.16c	0.20a
May	6.18f	26.56b	5.81a	3.44c	2.21b	0.20a
SEM	0.014	0.032	0.015	0.032	0.003	0.003

*Superscripts of the same alphabet are not significantly different (P<0.05)

**Superscripts of different alphabets are significantly different (P<0.05)

Table 2: Effect of month on the physico-chemical parameters of the New Calabar River.

life [9].The seasonal variation of pH values observed in this study is in agreement with results of previous studies conducted by Dublin-green [3] in Bonny River , where the highest pH values were recorded in the dry season and lower values of pH in the wet season. Similar trend was reported by Ekeh and Sikoki [10] in the New Calabar River and also by Ansa [11] in Andoni flats of Niger Delta area.

Temperature value was at the highest in December 27.38°C and lowest in March 25.30°C. The mean temperature values in the study area ranged from 26.02°C to 26.53°C across the Stations and ranged between 26.26°C and 27.28°C across the months are observed normal with the reference to the location in Niger Delta region, Alabaster and Lloyd [12] reported that temperature on natural inland waters in the tropics generally varies between 25°C and 35°C. The findings agree with earlier reported works in the Niger Delta water by Abowei [13] who reported temperature range of between 27°C–31°C, Chinda [14] who reported temperature range between 26°C and 30.5°C, Zabbey [15] recorded between 26.3°C and 30.4°C, Braide [16] reported a range between 26.64°C and 30.83°C, Ansa [11] reported range between 25.9°C and 32.4°C, Uedema-Naa [17] reported range between 28.94°C and 29.72°C, Hart and Zabbey [18] reported range between 25.8°C and 30.4°C, Sikoki and Zabbey [19] recorded values between 26.0°C and 27.8°C and Jamabo [20]reported a temperature range between 27°C and 30°C in the upper Bonny River of Niger Delta. The temperature values are significantly higher in the dry season with 26.48°C and 25.95°C in the wet season. Similar trend was reported in the main Bonny River by Dublin-Green [3], 31.2°C dry season and 27.5°C wet seasons. Amakri [21] recorded 27.6°C wet season and 31.6°C in dry season but in the New Calabar River, Ekeh and Sikoki [10] reported lowest temperature of 25°C in wet season which corroborates with findings of this study and 30°C in the dry season .Temperature is positively correlated to pH and is significant at (P<0.01) and negatively correlated to Dissolved Oxygen (DO), Salinity, Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD).

Dissolved oxygen (DO) values ranged from 5.81 mg/l in May to 4.58 mg/l in December. The Dissolved Oxygen (DO) values in the Stations were higher at the upstream sampled Station than the downstream Station with the highest of 6.45 mg/l in Station 1 and lowest 4.49 mg/l in Station 5. Similar trend was also reported by Hart and Zabbey [18] for Woji Creek, Davies et al. [22] also made similar report for the Trans-Amadi (Woji) Creek Port Harcourt. They attributed it to the effect of higher temperature and abattoir waste. This is in agreement with the findings of the study. There is significant difference at (P<0.05) in the variation between dry and wet season, higher mean value for dissolved oxygen was recorded in the wet season agree with the findings of Eborge [23] who reported that Dissolved Oxygen is generally higher in the wet season in the tropics but this is contrary to the result of Abowei [4] who recorded a higher mean value of Dissolved Oxygen in the dry season. He attributed it to the effect of higher temperature and abattoir waste. In the study area there was significant difference in Dissolved Oxygen across the station at (P<0.05) and season which is in agreement with the result of [24,25] who reported that at higher temperature which is usually observed in dry season, the solubility of oxygen decreases while at lower temperature (wet season) it increases.

Highest value of Salinity was recorded in December 6.10 mg/l and lowest value 1.01 mg/l in January. The salinity value ranging from 7.18 mg/l in Station 4 to 1.08 mg/l in Station 3 showed a slight fluctuation in salinity from the upstream to downstream Stations along the river. This trend could be attributed to effluent water discharge from several industrial establishment carrying out dredging activities, slaughter house operation and domestic activities which are prevalent along the upstream area of the river. Lower salinity value of 102.11 mg/l was recorded in the dry season than the wet season value of 376.29 mg/l which is in contrast with the report by Payne [26] and Abowei [4] reported higher salinity values during dry season than the wet season, this could be attributed to variation in the amount of rainfall during the year. Uedeme-Naa [17] reported that the mean value of salinity were the same in all the sampled Station in Nta –Wogba stream in Port-Harcourt which is in contrast with the findings of the study.

Chemical Oxygen Demand (COD) mean value ranged between 2.85 mg/l in December and 1.82 mg/l in January. Chemical Oxygen Demand (COD) mean values for the study ranged from 2.67 mg/l in Station 1 to 1.74 mg/l in Station 5,This is in contrary to the findings of Woke [27] who reported 20.80 mg/l in his findings in a Station in the New Calabar River, he stated that chemical Oxygen Demand (COD) was generally higher than standards allowed to be discharged into the Nigerian inland waters [28] comparing his result values with other findings made by Clerk [29] they were greater than 40 mg/l and therefore indicated higher degree of pollution in the water body but the result of this study fall within the accepted range.

Biological oxygen demand (BOD) value of 0.20 mg/l was recorded in April and May while 0.16 mg/l in December, mean values showed slight variation among the various Stations with the highest BOD recorded in Station 1 0.23 mg/l and lowest in Station 4 and 5 0.17 mg/l. This may be as a result of dead plants (organic matter) which will require higher amount of Dissolved Oxygen to decompose. This is in contrast with the result of Uedema-Naa [17] reported Biological Oxygen Demand (BOD) had the lowest value of 51.78 mg/l and highest 171.28 mg/l in Nta-Wogba Stream.

The Pearson correlation in Table 3 showed that pH, Temperature and Chemical Oxygen Demand (COD) correlated negatively to the month, but only pH and Temperature were significant at (P<0.01) while Dissolve Oxygen, Salinity and Biological Oxygen Demand (BOD) were positively correlated and were significantly different at(P<0.01). pH is positively correlated to Station and significant at (P<0.05) while other parameters were negatively correlated but DO, Salinity, COD and BOD were significant at (P<0.05). Temperature was found to be

Month	Station	pH	Temp.	DO	Salinity	COD	BOD
			ºC	(Mg/L)	(Mg/L)	(Mg/L)	(Mg/L)
Month	1						
Station	0	1					
pH	-0.772**	0.351**	1				
Temp.	-0.330**	-0.205	0.282**	1			
DO	0.360**	-0.758**	-0.443**	0.223**	1		
Salinity	0.424**	-0.660**	-0.673**	-0.209**	0.644**	1	
COD	-0.203	-0.584**	-0.17	0.576**	0.425**	0.350**	1
BOD	0.451**	-0.611**	-0.483**	0.039	0.770**	0.664**	0.303**

** Significant at p<0.01, * Significant at p<0.05

Table 3: Pearson's correlation matrix between physico-chemical parameters, month and station.

positively correlated to pH and is significant at (P<0.01) while other parameters were negatively correlated to pH but DO, Salinity and BOD were significant at (P<0.01). DO, COD and BOD were positively correlated to temperature but DO is significant at (P<0.05) while COD is significant at (P<0.01). Salinity, COD and BOD were positively correlated to DO and were significant at (P<0.01). Chemical oxygen demand (COD) and BOD were positively correlated to COD and are significant at (P<0.01).

Conclusion

The New Calabar River system exhibit temporal variation which could be attributed to the mixing process of the upper and lower reach of the water under varying tropical climatic conditions. The water across the season exhibited variation in the increase and decrease in the physico-chemical parameters and this could be attributed to the industrial activities going on in and around the river and level of discharge of domestic waste into the river which are prevalent along the upstream of the river.

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