Physico-chemical parameters of Iwofe and Bakana Rivers, tributaries of the New Calabar River, Niger Delta, Nigeria

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Abstract
The physico-chemical parameters and seasonal variations of water in Iwofe and Bakana Rivers, tributraries of the New Calabar River were sampled and studied from January, 2017 to June, 2017 for a period of five months. Water samples were collected and analyzed using standard methods. This study revealed some seasonal variations in the parameters measured, temperature, conductivity, Total dissolved solids (TDS), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), pH, turbidity and salinity. The mean values of conductivity and TDS were higher during dry seasons than wet seasons in both stations. However, the mean values of turbidity and salinity were higher during the wet and dry seasons in Bakana than in Iwofe River. The results obtained indicates significant differences (P<0.05) between the parameters investigated.

Key words*: Physico-chemical parameters, Iwofe, Bakana, New Calabar River, Niger Delta.*

Introduction

The New Calabar River is one of the Rivers in the Niger Delta region of Nigeria, with exposure to a high degree of anthropogenic activities that has led to the stress of this River (Dienye, 2011). It has tributries which lies between the coordinates; 4°29'54"N 6°59'46"E / 4.498393°N 6.996231°E / 4.498393; 6.996231.This River is also connected to the Bonny River (Dublin-Green, 1990). The periodic study and monitoring of the water quality of the New Calabar River will not be over emphasized in this work because series of work has been carried out on different reaches of the New Calabar River. This study is focused on the Iwofe and the Bakana reaches of the New Calabar River and will add to the existing knowledge of the physiochemical parameters of the River.

Iwofe River is located at the coordinates 4.089361° N and 6.928667° E in Degema LGA of Rivers State. This site is characterized by red mangrove – *Rhizophora mangle* and other species. The mangrove forest is usually flooded by water during the rainy season. This River is stressed by heavy anthropogenic activities like oil drilling and other bunkering activities.
The Bakana community is located at 4.740°N and 6.968°E along the new calabar River. It is characterized by mangrove swamp forest with mangrove species like *Avicima* species, *Rhizophora*, Nepa palm and host of other plant species and animal species. The main human activities here are artisanal fishing with canoes, drift nets and the use of hook and lines. The means of transportation within this community is mainly by the use of speed boats and canoes. Other activities include lumbering, hunting in the mangrove forest and sometimes bunkering activities.

Materials and methods

Sampling was for a period of five months, from January, 2017 to June, 2017. Water samples were collected from both Rivers (Iwofe and Bakana Rivers) with a one liter jerrican respectively, for the ex- situ analysis of the physiocochemical parameters.

Water quality parameters such as Temperature, DO (dissolved oxygen), and pH were measured in-situ with an Extech meter probe which was directly dipped into the water body. Other parameters such as BOD (Biochemical Oxygen Demand), Salinity, Turbidity, Total dissolved solids and conductivity were measured ex-situ, in the laboratory.

Temperature, DO, salinity, TDS, pH and conductivity were measured with an Extech multi parameter digital meter. The meter was first caliberated with Extech standard solution and rinsed with Extech distilled water at the sampling sites (Iwofe and Bakana Rivers). The Extech multi parameter had an external probe which was dipped into the waterbody and then readings were taken and recorded

Biological Oxygen demand was measured at the laboratory, using the dilution method which is a standard method of the American Public Health Association (APHA, 1992). The dilution method includes measuring some portions of water samples and placing them into bottles with the dilution water (which contains some inorganic nutrients and pH buffer). These bottles are filled, air tight and allowed to stand for a period of five days in a dark place at a controlled temperature of 20^{o}c. The bacteria present in the sample bottles oxidize the organic matter using up the dissolved oxygen, at the end of the fifth day, the dissolved oxygen left in the sample bottle is measured. The amount of oxygen consumed by the bacteria within the five days and the volume of the sample increment is used to calculate the BOD which is expressed in mg/L.

Turbidity was measured with a separate Extech meter, which was also standardized with the Extech solution. Water sample was contained in a small 30ml vial bottle. The sample bottle was fixed into the instrument cell and properly aligned in a cell, the cover was closed and readings taken as soon as the value stabilized.

Statistical Analysis

Microsoft excel was used for the graphical presentation of data obtained from the laboratory analysis of the physico-chemical parameters of the water samples.

Results

Temperature (^{o}C): Temperature was recorded as 30.1^{o}C in Bakana River (Station one) on the 23rd of January, 2017 and in Iwofe River (Station Two) it was recorded as 29.9^{o}C on the 25th of January, 2017 during the dry season. While Temperature was recorded as 29.9^{o}C in Bakana River (Station one) on the 26th of June, 2017 and in Iwofe River (Station Two), temperature was recorded as 27.7^{o}C on the 26th of June, 2017 during the wet season. The mean temperature of both water bodies during the wet and dry seasons are shown in Figure 1.

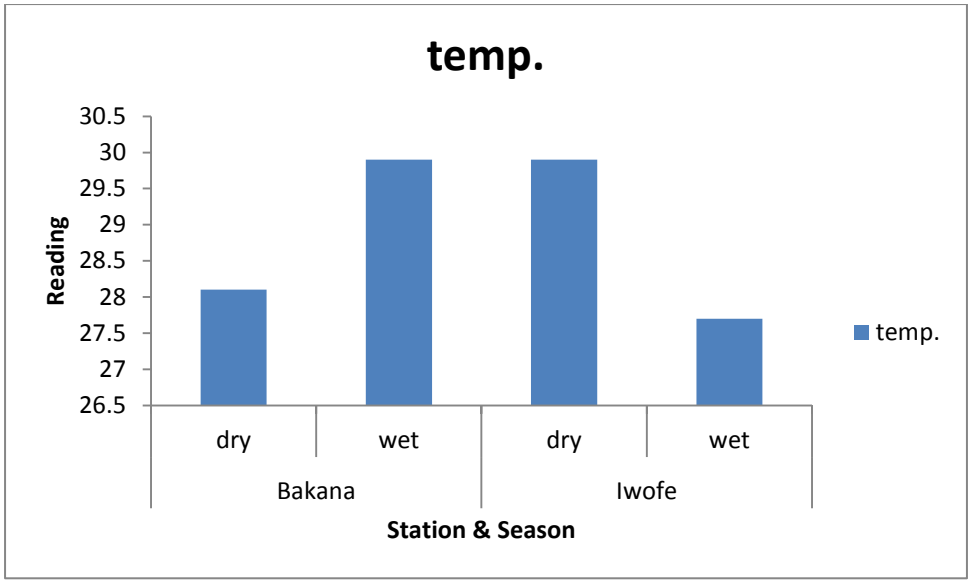

Fig. 1: Mean Temperature (^{o}C) readings of both water bodies during the wet and dry seasons

Conductivity (µʃ): The conductivity of the water sample in Bakana River was recorded as 38,200µʃ on the 23rdJanuary, 2017 and in Iwofe River, conductivity was recorded as 36,100µʃ on the 23th of January, 2017 during the dry season. The conductivity of the water sample in Bakana River was recorded as 2,360µʃ on the 26th of June, 2017. In Iwofe River, conductivity was recorded as 1,060µʃ on the 26th of June, 2017 during the wet season.

Total Dissolved Solid (TDS)(Mg/l): Total dissolved solids was measured in Bakana River as 15,500mg/l on the 23rd of January,2017, while in Iwofe River, total dissolved solids was measured as 15,300 mg/l on the 25th of January, 2017 during the dry season. Total dissolved solid was measured in Bakana River as 986mg/l on the 26th of June, 2017, while in Iwofe River, total dissolved solids was measured as 734mg/l on the 26th of June, 2017 during the wet season. Figure 2 is the graphical presentation of the mean values of conductivity and TDS during the wet and dry seasons of the study period.

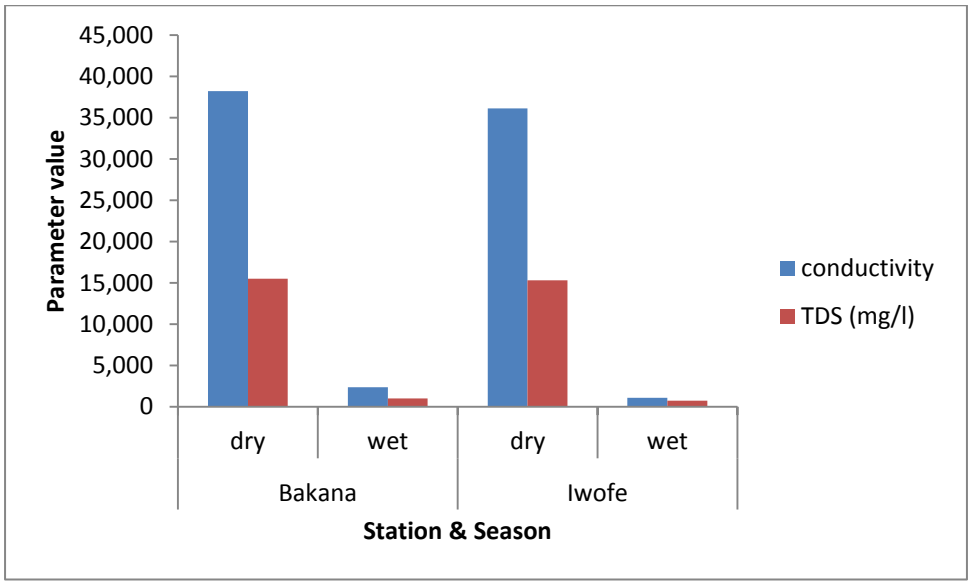

Fig. 2: Mean conductivity and TDS values during the wet and dry seasons

Biochemical Oxygen Demand (BOD) (mg/l): In Bakana the BOD was recorded as 3.05mg/l on the fifth day after the collection of water sample on the 23rd of January, 2017 andin Iwofe, BOD was recorded as 2.22mg/l on the fifth day after the water sample were collected on the 25th of January, 2017 during the dry season. While in Bakana the BOD was recorded as 3.82mg/l on the fifth day after the collection of water sample on the 26th of June, 2017 and in Iwofe, BOD was recorded as 2.22mg/l on the fifth day after the water sample were collected on the 26th of June, 2017 during the wet season.

Dissolved Oxygen (DO) (mg/l): Dissolved oxygen was recorded as 5.34 mg/l in Bakana River on the 23rd of January, 2017 and in Iwofe River, DO was recorded as 5.21mg/l on the 25th of January, 2017 during the dry season. While Dissolved oxygen was recorded as 5.17mg/l in Bakana River on the 26th of June, 2017 and in Iwofe River, DO was recorded as 5.78mg/l on the 26th of June, 2017 during the wet season.

pH: In Bakana River, the pH was recorded as 6.51 on the 23rd of January, 2017 and in Iwofe River, the pH was recorded as 7.34 on the 25th of January, 2017 during the dry season. Whereas in Bakana River, the pH was recorded as 5.63 on the 26th of June, 2017 and in Iwofe River, the pH was recorded as 6.40 on the 26th of June, 2017 during the wet season. The mean values of BOD, DO and pH during the wet and dry seasons over the study period are presented in Figure 3.

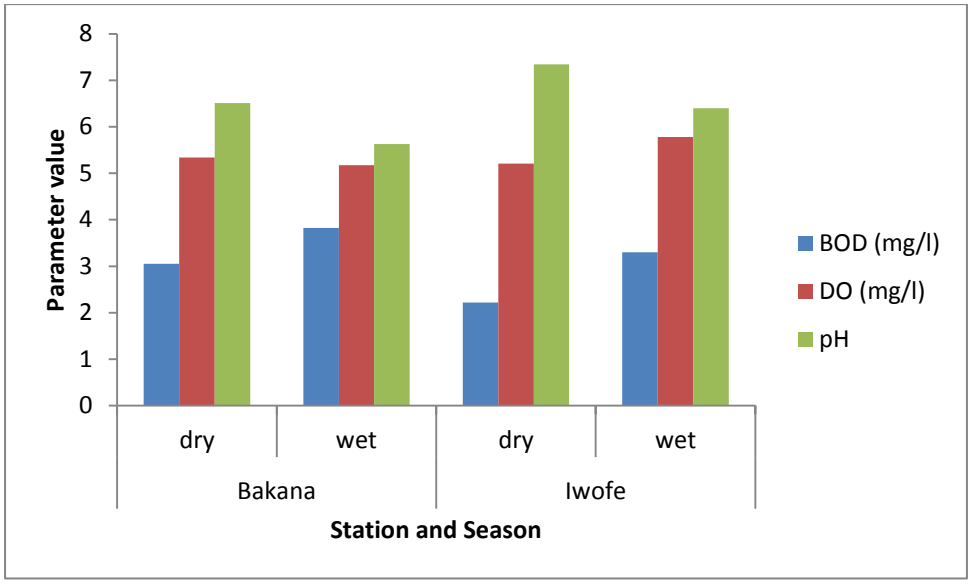

Fig. 3: BOD, DO and pH values during the wet and dry seasons

Turbidity (NTU): The turbidity value of Bakana River was recorded as 88.9 NTU in the 23rd of January, 2017 andthat of Iwofe River was recorded 15.4 NTU on the 25th of January, 2017 during dry season. The turbidity value of Bakana River was recorded as 58.0 NTU in the 26th of June, 2017 while that of Iwofe River was recorded 7.2 NTU on the 26th of June, 2017 during the wet season.

Salinity (‰): In Bakana River, the salinity of the water sample was recorded as 20.5‰ on the 23rd of January, 2017 and in Iwofe River, the salinity was recorded as 21.3‰ on the 25th of January, 2017 during the dry season. While in Bakana River, the salinity of the water sample was recorded as 13.6‰ on the 26th of June, 2017 and in Iwofe River, the salinity was

recorded as 5.78‰ on the 26th of June, 2017 during the wet season. The mean values for turbidity and salinity are presented in Figure 4.

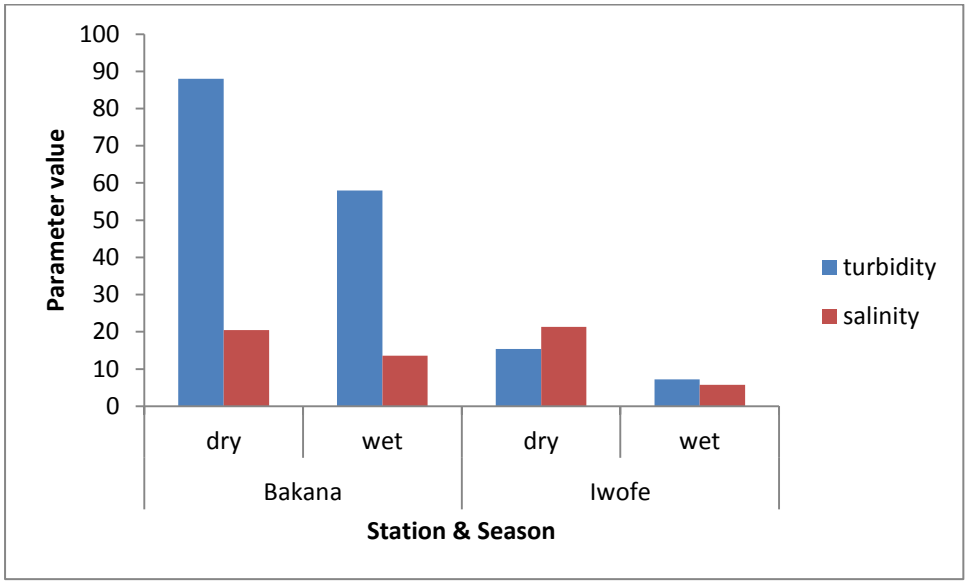

Fig. 4: Mean turbidity and salinity values during the wet and dry seasons

Discussion

The results indicated that a preferable rate of BOD, temperature, pH, conductivity, tubidity, salinity and TDS were measured in the wet season than in dry season. These parameters were more favourable for fish species to thrive and proliferate.

The results of the pH were between the ranges of 5.63 to 7.34. The pH value of Iwofe and Bakana was more alkaline in the dry season, having a higher level of pH which is similar to the Buguma creek obtained by Oribhabor *et al.*, (2012) and Makinde *et al*., (2015) and this may be due to the reduced rainfall in the dry season, hence also a reduced flow of acid sulphate from the soil into the River. This seasonal variation of pH values observed in this study is also in agreement with the results of previous studies in Bonny River by Dublin – Green (1990).

The temperature values of the sampling stations during the study was between the range of 27.7^0C to 29.9^0C which agrees with earlier reports on works in the Niger Delta water by Abowei (2010) who reported temperature range of between 27^0C – 31^0C.

Dissolved oxygen (DO) values was between the range of 5.17mg/l and 5.78mg/l which was in both wet seasons, at both sampling stations, this record in Iwofewas in agreement with the finding of Eborge (1971) who reported that DO is generally higher in wet season and in Bakana it was in agreement with the result of Abowei (2001) who recorded a higher mean value of DO in dry season.

Lower salinity values of 13.6‰ recorded in wet season than dry season value of 21.3‰ in contrast with the report by Dienye and Woke (2015) which reported lower salinity in dry season than the wet season. This could be as a result of the dredging activities and domestic activities which takes place in Iwofe River. The salinity records from this study is in agreement with the values of salinity measured at the study of the Buguma creek by Makinde *et al*. (2015) which had higher salinity values in dry season than wet season.

The values of Biochemical Oxygen Demand (BOD) from this study ranged from 2.22mg/l to 3.82 mg/l which agrees with the records observed from the study at Buguma creek by Makinde *et al.* (2015) during the dry season. The BOD values from both Rivers exceeded the

permissible limit according to the rankings of World Health Organization (2005), which emphasizes on water bodies with BOD levels between 1.0mg/l and 2.0mg/l as clean and unpolluted, 3.0 mg/l as fairly clean, 5.0mg/l is doubtful and 10.0mg/l as bad and polluted.
The BOD of a water body is responsible for its odour and taste.

The turbidity values from both Rivers recorded was between 7.2 NTU and 88.0 NTU. The turbidity levels were higher in the dry seasons than wet season at Bakana and Iwofe Rivers. These findings are contrary to the values of turbidity recoded by Makinde *et al.* (2015) in Ekerekana Creek, which was higher in the rainy season than the dry season. High turbidity could be associated with presence of colloidal particles arising from discharge of industrial waste and domestic waste (Asuquo and Etim, 2012).
The conductivity values recorded in this work was between 1,060µ∫ to 38,200 µ∫, indicating a higher conductivity level in the dry season than wet season in both Rivers. These records are in agreement with the seasonal change in variation recorded in Ekerekana creek by Makinde *et al.* (2015) showing that higher conductivity level was recorded in dry season than wet season. The variations in these Rivers are as a result of sea influence, while the seasonal variation is attributed to ionic distribution in both Rivers. The higher values of conductivity dry season may be due to low precipitation rate and high evaporation rate (Chindah and Pudo, 1991).
The Total dissolved solids (TDS) values recoded at the Bakana and Iwofe Rivers ranged from 734 mg/l to 15,500mg/l and higher values were recorded in dry seasons at both Rivers. High TDS loads may be due to the turbulence by dredging activities, anthropogenic activities and also wave currents which disturb the benthic dwellers hence upsetting the sediment (Nweke, 2000).

Conclusion

There were variations in the concentrations of the water quality parameters studied, due to seasonal differences and ecological variations of the sampling stations. Anthropogenic activities in the Niger Delta region has led to the stress of these Rivers and has also contributed to high concentrations of pollutants in the water bodies.

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