

Seasonal Variations in Some Physico-chemical Parameters of the Upper Reach of the New Calabar River

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Abstract: The aim of the study is to evaluate the seasonal variations of physico-chemical parameters of the New Calabar River at Aluu in order to ascertain its productivity. Physico-chemical parameters of the upper reach of the New Calabar River at Aluu were investigated during dry and rainy seasons for 17 months. The water was acidic most of the period pH was between 5.12 to 7.43 with low total hardness values ranging from 11.5 to 51.2 mg CaCO₃/L which indicate that the water is soft. There was an obvious significant seasonal variation in temperature (23.1 to 31.7°C), transparency (9.30 to 19.00 cm) and total hardness with dry season values higher than the wet season values. Hydrogen ion concentration (pH), dissolved oxygen (5.20 to 7.50 mg/L) and dissolved oxygen deficits (0.02 to 2.95 mg/L) however, exhibited insignificant seasonal variations. These results are useful for several stake holders who use the river as a sink for trade wastes, as source of water for fish farming and water treatment plants and as means of transportation of industrial materials.

Keywords: New Calabar River, physico-chemical parameters, seasonal variation

INTRODUCTION

The New Calabar River is one of the most stressed rivers in the Niger Delta river system. It is presently not the focus of any systematic periodic water quality investigation. This should not be because the river is of great economic importance to several stakeholders who use it either as receiving water for discharge of point and non-point trade wastes or as means of transport of industrial materials. Several oil wells, flow stations, oil pipelines, oil servicing companies, food processing companies, agricultural farms, hydraulic sand mining sites, fish farms, etc., are located within the catchment area of the river. Prominent users of the river water include William Brothers at Choba, Agbada flow station at Mbodo, African Regional Aquaculture Centre (ARAC) at Omuihuehi, Aluu to mention but a few. The New Calabar River is also dynamically connected to the Bonny River which is one of the most stressed rivers in the Niger Delta region (Dublin-Green, 1990). The importance of periodic water quality monitoring of the New Calabar River cannot therefore be overstressed.

Apart from the work carried out by Erondu and Chindah (1991), no other work on the effect of oil exploration and exploitation and tidal and seasonal influence on the physico-chemical features of the upper

reaches of the river have been reported. This study will complement existing knowledge on some physico-chemical parameters of the upper reaches of the river.

MATERIALS AND METHODS

The study area: The New Calabar River is located on the eastern flank of the Niger Delta River System (Fig. 1). It is a black water type (RPI, 1985; Ubong and Gobo, 2001) and empties into some creeks and lagoon bordering the Atlantic Ocean. At Aluu, the river is fresh and tidal, whereas at a little distance down stream (Choba and Ogbogoro) it is brackish (Fig. 2). The study area is inundated by tidal waters during floodtides. The climate is tropical with a dry season during November to March and wet season during April to October. The vegetation is thick swamp forest with gentle sloping topography. The mean tidal range at Aluu is 2.50 m (Uzukwu, 2000). The tidal nature of river presupposes adequate mixing. The New Calabar River basin experiences an annual rainfall of 254 mm (Erondu and Chindah, 1991).

Measurement of water quality parameters: Water quality parameters of New Calabar River were measured at the mouth of the earth canal supplying

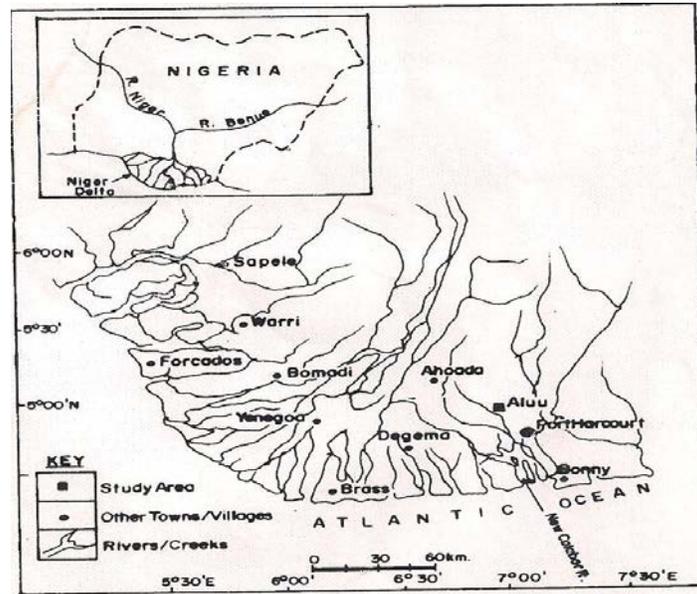


Fig. 1: Map of the lower Niger Delta showing the position of the study area

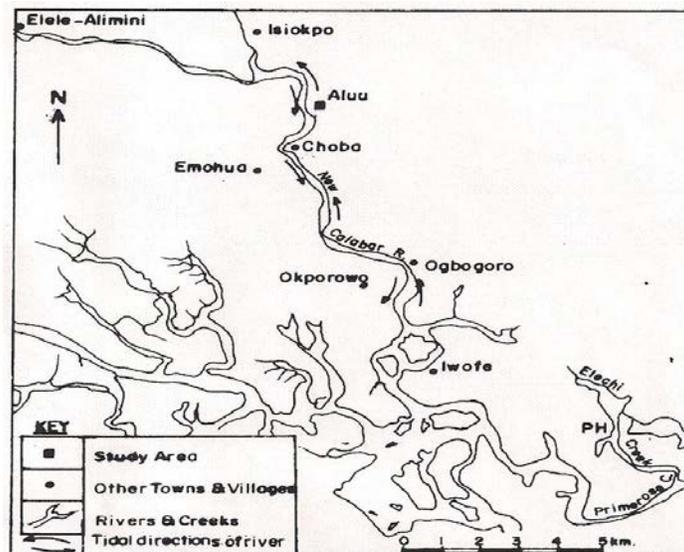


Fig. 2: Map of the new Calabar River showing the location of Aluu as study area

African Regional Aquaculture Centre fish farm at Aluu, Rivers State for 17 months. Surface Water samples were collected bimonthly during high tide and the samples immediately taken to the laboratory for analysis. Surface water temperature ($^{\circ}\text{C}$) was measured using a Celsius thermometer; transparency was measured in-situ using a weighted white secchi disc of 12 cm diameter (Boyd and Lichtkoppler, 1979) while Dissolved Oxygen (DO) was measured using Winkler's method (Boyd, 1979; APHA, 1995). Dissolved Oxygen Deficits (DOD) values were computed by subtracting the DO values from the saturated DO value at measured temperature values. The hydrogen ion concentration (pH) was determined with a glass electrode pH meter

(model 191) while total hardness was measured using EDTA titrimetric method (Boyd, 1979). Rainfall data for the period was obtained from International Institution of Tropical Agriculture (IITA), Onne, Rivers State.

RESULTS

Result of the physico-chemical parameters are presented in Table 1. Values of the parameters measured indicated seasonal variation. The mean surface water temperature for the period was $25.99 \pm 1.89^{\circ}\text{C}$ (mean, S.D.). Dry season temperatures ranged from 23.10 to 30.20°C with a mean of

Table 1: Monthly means of physico-chemical parameters of New Calabar River

Months	pH	Transparency (cm)	DO (mg)	Total hardness (mg CaCO ₃ /L)	Temp (°C)	DOD (mg/L)	Rainfall (cm/month)
Aug	6.00	12.00	6.00	14.20	26.20	2.00	35.80
Sep	6.50	10.80	6.20	14.50	24.50	2.30	39.00
Oct	6.20	11.70	5.90	13.90	24.00	2.60	26.60
Nov	6.70	13.30	6.30	14.30	25.70	1.90	5.20
Dec	6.80	14.80	6.50	14.20	26.10	1.70	1.50
Jan	6.95	18.50	6.80	14.60	25.10	1.50	8.30
Feb	6.97	16.70	5.50	28.50	27.50	1.50	0.820
Mar	6.50	19.00	6.90	49.60	28.90	1.00	8.60
April	5.90	16.50	7.40	50.20	29.90	0.20	11.60
May	6.80	14.50	6.90	24.20	28.20	1.10	31.40
June	6.05	13.00	6.20	14.10	26.50	2.00	34.10
July	6.08	13.00	6.00	15.80	24.80	2.30	42.30
Aug	6.20	11.00	5.80	14.40	25.10	2.50	32.10
Sep	6.10	10.50	5.80	13.20	24.50	2.50	19.80
Oct	6.15	9.50	6.20	13.00	25.60	2.00	42.30
Nov	6.40	12.00	5.90	12.90	26.20	2.30	12.00
Dec	6.55	13.50	6.30	13.60	23.50	2.40	2.90

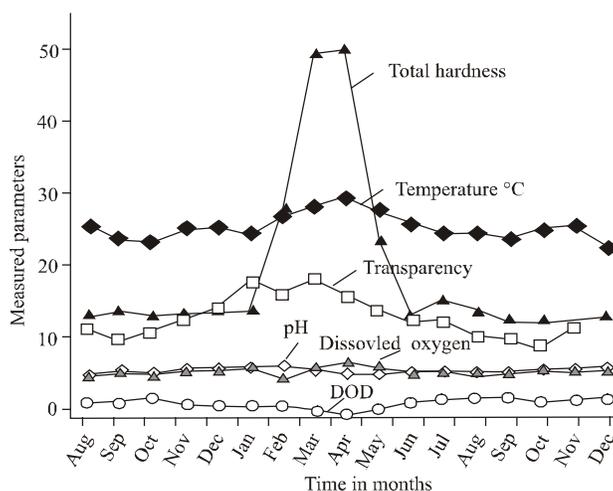


Fig. 3: Mean values of physico-chemical parameters

26.10±1.76°C. The records for rainy season ranged from 23.80 to 31.70°C with a mean of 25.93±2.00°C. The Lowest value of 23.10°C was recorded in December which is usually dry season. The mean secchi disc readings (transparency) for the period was 13.65±2.73 cm. Dry season values ranged from 11.00 to 19.00 cm with a mean of 15.45±2.65 cm while the rainy season records ranged from 9.30 to 17.00 cm with a mean of 12.44±2.10 cm. Rainy season secchi transparency values were generally lower relative to the dry season values.

Data on dissolved oxygen for the period are presented also in Table 1. The mean DO value for the period was 6.27±0.61 mg/L. The dry season values ranged from 5.20 to 7.70 mg/L with a mean of 6.31±0.64 mg/L while that of rainy season ranged from 5.30 to 7.50 mg/L with a mean of 6.24±0.61 mg/L. The mean Dissolved Oxygen Deficit (DOD) was 1.72±0.74 mg/L. Dry season DOD ranged from 0.05 to 2.65 mg/L with mean of 1.64±0.67 mg/L while that of rainy season ranged from 0.02 to 2.95 mg/L with a mean of 1.78±0.79 mg/L. The lowest value of 0.02 mg/L was recorded in April.

Data on hydrogen ion concentration (pH) indicate that the New Calabar River was slightly acidic throughout the period with a mean pH of 6.34±0.48.

Dry season pH ranged from 6.12 to 7.43 having a mean value of 6.69±0.44 while in the rainy season pH ranged from 5.12 to 6.88 with a mean of 6.12±0.35. The mean total hardness for the period was 19.67±11.96 mg CaCO₃/L. Dry season hardness ranged from 11.80 to 50.60 mg CaCO₃/L, while that of rainy season ranged from 12.50 to 51.20 mg CaCO₃/L. The peaks (50.60 mg CaCO₃/L and 51.20 mg CaCO₃/L) were recorded in March and April respectively. Rainfall data varied between 0.82 and 42.3 cm with the lowest value (0.82 cm) recorded in February while the maximum (42.3 cm) was recorded in October (Table 1).

DISCUSSION

Records of surface water temperature indicated slight seasonal variation (Fig. 3). This was expected. The lowest value of 23.5°C which was obtained during December (Dry season) is attributed to the cooling effect of the harmattan which is caused by the south bound cold North-East trade winds (Horsfall and Spiff, 2001). The insignificant difference in the Standard Deviation (S.D.) for dry season (±2.00) and rainy season (±1.76) is also attributable to cooling effect of the harmattan.

Transparency varied between the seasons (Fig. 3). The difference in the value of standard deviation for rainy season (± 2.1) and dry season (± 2.65) records lends credence to this view. The marked low secchi transparency recorded during the rainy season could be attributed to increased clay and silt load due to the erosion of soils by runoff and from within the catchment area of the river. Heavy influx of silt and clay particles does smother fish eggs when settled on the substrate being used as fish spawning ground (Boyd, 1979; Boyd and Lichtkoppler, 1979). Seasonal variation of secchi transparency was reported by Dublin-Green (1990) for the upper reaches of the Bonny estuary.

Dissolved Oxygen varied slightly between seasons having higher values in the dry season than wet season. The higher values obtained during the dry season is attributed to increased photosynthetic activities of phytoplankton due to increased light penetration occasioned by decreased turbidity in dry season. The seasonal variation in DO Deficits (DOD) reflects the trend and degree of pressure exerted on DO by oxidizable contaminants (BOD, COD and NOD) in the river arising from wastes routinely discharged into the river environment by industries located along the riverbanks. The DOD records are important in the design of treatment facility of effluent BOD discharged into the river.

According to Horsfall and Spiff (2001), the pH of natural waters determines the solubility and the also forms of most chemical substances in water. The low pH values recorded in this study is typical of black waters and rivers in the Niger Delta basin (RPI, 1985; Ubong and Gobo, 2001; Erondu and Chindah, 1991; Dublin-Green, 1990). Although pH values appear to be quite close, a seasonal pattern is however discernable. Lower value of standard deviation in dry season indicates that pH varied more in the dry season than the rainy season. This trend contrasts the report of Dublin-Green (1990) on the lower Bonny Estuary. This may be distributed to the distance between the upper reaches of New Calabar River and the latter.

Total hardness showed significant seasonal variations. High values were recorded in peak dry season (March and April), while lower values were recorded in the peak wet season (October). The decrease in total hardness value in the wet season is attributable to the dilution effect of rain. The low total hardness recorded in the New Calabar River system is indicative of its level of alkalinity and high buffering capacity. The months of July to September are characterized by heavy rainfall. These heavy rainfall events are associated with the disturbance lines, which are characterized by thunderstorms and squally winds. The observed pattern of rainfall variation is typical of the Niger Delta region of Nigeria, with March being the peak dry season and April being the transition between rainy and dry seasons.

CONCLUSION

The waters of the upper reach of the New Calabar River system exhibit temporal variation attributed to the mixing processes of freshwater and brackish water under varying tropical climatic conditions. The water was clear and coffee colored (humates) during the onset of the rains and turbid during peak rainy season. Total hardness, temperature and transparency data exhibited significant seasonal variable while pH, DO and DOD show slight seasonal variations.

The upper reach of the New Calabar River has been reported as RPI (1985) and Ubong and Gobo (2001). The results from this study relative to previous studies indicate that the upper reach of the river has not changed significantly overtime. This may be attributed to relatively high buffering capacity of the river despite the low total hardness values recorded in this study. These results are invaluable to several stake holders who use the River for diverse purposes.

REFERENCES

- APHA, 1995. Standard Methods for the Examination of Water and Wastewater. 19th Edn., American Public Health Association, Washington, D.C., pp: 1043.
- Boyd, C.E., 1979. Water Quality in Warm Water Fish Ponds. Agric. Exp. Sta. Auburn University Craftmaster Printers Inc., Opelika, Alabama, pp: 359.
- Boyd, C.E. and F. Lichtkoppler, 1979. Water quality management in pond fish culture Agric. Exp. Sta. Auburn University Res. Dev. Series No. 22, pp: 30.
- Dublin-Green, C.O., 1990. Seasonal Variations in Some Physicochemical Parameters of the Bonny Estuary, Niger Delta. NIOMR Technical Paper No. 59, pp: 28.
- Erondu, E.S. and A.C. Chindah, 1991. Variations in the Physico-chemical Features and Phytoplankton of the New Calabar River at Aluu, Rivers State Nigeria. NIOMR Technical Paper No. 75, Nigerian Institute for Oceanography and Marine Research, pp: 18.
- Horsfall, M. and A.I. Spiff, 2001. Principles of Environmental Pollution. Metroprints Ltd., Port Harcourt, pp: 317.
- RPI, 1985. Environmental baseline studies for the establishment of control criteria and standards against petroleum related pollution in Nigeria. Report No. RPI/84/15-7, Research Planning Institute Inc., Colombia, U.S.A.
- Ubong, I.U. and A.E. Gobo, 2001. Fundamental of Environmental Chemistry and Meteorology. Tom and Harry Publications Ltd., Port Harcourt, pp: 264.
- Uzokuwu, P.U., 2000. Baseline studies and design of water supply facilities for a fish farm. M. Eng. Thesis, University of Port Harcourt, pp: 81.