



ENVIRONMENTAL HEALTH DETERMINATION AND ASSESSMENT OF PHYSICO-CHEMICAL CHARACTERISTICS IN OLOSHI RIVER, NIGERIA



Jacinta A. Opara¹ and Nicholas E. Okwodu²

¹Department of Biological & Environmental Sciences, Kampala International University, Uganda

²Department of Integrated Science, Federal College of Education (Technical), Omoku, Rivers State, Nigeria

*Corresponding author: jaopara@yahoo.com

Received: December 15, 2017

Accepted: March 20, 2017

Abstract: The Physico-chemical characteristics of the surface waters and sediment in Oloshi River, non-tidal fresh water were studied between July and December 2015. The Oloshi River drains and receives effluents from cassava mill treatment (starch mill) factory and oil companies in the area. The inhabitants are predominantly farmers and fishermen. All parameters were analyzed using standard methods for examination of water and waste water (ALPHA 1998). The results of water and sediment physico-chemical parameter lies between a mean range of 4.2-4.4 for pH, 28.5°C for temperature, 1.4-4.8 NTU for conductivity, 1.4 – 4.9 NTU for turbidity, 3.9 – 4.4 ppm for Po₄, 0.2 – 1.2 for No₃, BOD= 1.1 ppm. The results showed low physico-chemical levels which do not pose serious health risk except for phosphate levels with a range of 3.89 to 4.4 ppm. With regard to seasonal variation, dry season recorded higher values than rainy season except for pH and No₃ of the sediment parameter in which the rainy season recorded higher than dry season. Increased level of pollutants in the Oloshi River may have significant effect on the ecological balance of the River.

Keywords: Anthropogenic, assessment, environmental health, eutrophication, parameter

Introduction

Water is one of the most important natural resources. They are site for many human settlements on their shore resulting in growing population pressures and conflicts arising out of multiple demand and uses. Skilful management of water bodies is required if they are to be used for such diverse purposes as domestic, industrial, transport, recreation, fisheries and waste disposal. The modern world is aware of the relationship between water and water-borne diseases as a vital public health issue. Water bodies can be fully characterized by three major components- hydrology, physico-chemistry and biology. A complete assessment of the quality of any water body is based on appropriate monitoring of these components (Meybeck and Helmer, 1996). All fresh water bodies are interconnected from the atmosphere to the sea, via the hydrologic cycle. The part of the hydrologic cycle which is considered is the inland fresh water which appears in the form of River.

Rivers are characterized by unidirectional current with a relatively high, average flow velocity ranging from 0.1 to 1 ms⁻¹. Each fresh water body has an individual pattern of physical and chemical characteristics which are determined largely by the climatic geomorphologic and geochemical conditions prevailing in the drainage basin and the underlying aquifer. Such physico-chemical characteristics as total dissolve solids, conductivity and redox potential; provide a general classification of water bodies of similar nature.

Mineral content determined by the total dissolved solids present, is an essential feature of the quality of any water body resulting from the balance between dissolution and precipitation (Meybeck and Helmer, 1996). Oxygen content is another vital feature of any water body because it greatly influences the solubility of metal and is essential for all forms of biological life. Water quality simply refers to the overall quality of aquatic environment. Once maximum acceptable concentrations for selected variables in relation to water use have been exceeded, or the aquatic habitat and biota have been markedly modified, the water quality is usually defined as polluted.

Description of the water quality of the aquatic environment can be carried out in a variety of ways. It can be achieved either through quantitative measurement such as physico-chemical determination (in the water particulate material or biological tissues) and biochemical/biological tests (BOD

measurement, toxicity test, etc.) or through semi-quantitative and qualitative descriptions such as biotic indices, visual aspects, species inventories, odour, etc. (Meybeck *et al.*, 1980). Water quality monitoring can be defined as the actual collections of information at set locations and at regular intervals in order to provide data which may be used to define current conditions, establish trends, etc. (Bartram and Ballance, 1996).

Bartram and Ballance (1996) also defined water quality assessment as the overall process of evaluation of the physical, chemical and biological nature of water in relation to natural quality, human effects and intended uses, particular uses which may affect human health and the health of the aquatic system itself. Water quality assessment includes the use of monitoring to define the condition of the water, to provide the basis for detecting trends and to provide the information enabling the establishment of cause-effect relationships. There are several human activities which have indirect and undesirable, if not devastating effects on the aquatic environment. Examples are uncontrolled land use for urbanization or deforestation, accidental (or unauthorized) release of chemical substances, discharge of untreated waste, leaching of noxious liquids from solid waste deposits, uncontrolled and excessive use of fertilizer and pesticide, constant and regular gas-flaring in the area. The most important anthropogenic impacts on water quality, on a global scale are pathogens, suspended solids, decomposable organic matters, eutrophication, nitrate as a pollutant, salinization, trace elements, organic micro-pollutants, acidification and modification of hydrological regimes (Meybeck *et al.*, 1980).

Materials and Methods

Study area

The Oloshi River of Ohaji/Egbema Local Government Area in Imo State of Nigeria flows through Obokofia, Ekugba and Etekwuru communities (Fig. 1a,b,c)." The River is a fresh-water swamp forest. It is non-tidal and a tributary that originate from Orashi River and empties into Sambreiro River in Ahoada Local Government Area of Rivers State. The people of the area are fishermen and farmers and so the River experiences activities such as fishing, bathing, washing of clothes and household utensils, cassava fermentation, input of Agricultural fertilizers as run off during rain and oil

exploration/exploitation also take place within and near the river.

Two oil companies namely Shell Petroleum Development Company (SPDC) and Nigeria Agip Oil Company (NAOC) are located within the study area with their oil field close to Obokofia and Etekwuru communities, respectively. Their activities along the River and within its immediate surrounding are capable of producing toxic effluents and affluent with transformed product capable of causing harm to the aquatic environment and human population around it. There is constant and regular gas flaring at one of the stations by SPDC (Plate 1a,b,c). The gas flaring introduces a lot of carbon into the atmosphere which later fall back as acid rain in the area. This is also capable of causing global warming which will eventually bring about temperature fluctuation, Increase pH and turbidity in the Oloshi River. Forest reserve mainly Gmelina species and cassava farm span the area for almost five kilometer distance along the river bank. The secondary rainforest in the area has been, subjected to extensive land clearing and farming activities. Hence the importance of monitoring Physico-chemical Parameter of the area who depend on the river for their livelihood.



Plate 1a: NAOC oil well head at Etekwuru



Plate 1b: Gas flaring at Obokofia



Plate 1c: SPDC oil well head near Obokofia

Sampling technique

Three locations were established along the river using Global positioning system navigator as shown in Table 1.

Table 1: Geographical locations of the area sampled

Location (Stations)	Co-ordinates	Elevation
1. Obokofia	N 05° 32' 37.6" E 006° 47' 0.2"	21 m
2. Ekugba	N 05° 29' 11.4" E 006° 46' 39.9"	24 m
3. Etekwuru	N05° 27' 31.8" E 006° 45' 36.7"	12 m

GPS - Geographical positioning system; Model - Garmin Geko 201

Collection of water sample

The water samples were collected at a depth of 15 – 25 cm, with pre-rinsed container. One litre plastic container was used for the collection of samples for physicochemical analysis. The samples were collected by lowering the container by hand to be completely immersed, allowed to filled and were corked underwater. Dark coloured reagent glass bottle measuring 125 ml were used in collecting water sample for biological oxygen demand (BOD) and Dissolve oxygen (Do) analysis. The BOD₅ samples were carefully filled without trapping air with bottles wrapped with dark polyethylene bags. This was to exclude all light.

Collection of sediment sample

Sediment samples were collected during the dry and rainy seasons at each sampling station. The samples were wrapped with aluminum foil to avoid contamination and taken to the laboratory. The samples were air dried at room temperature for five days and ground into powdery form.

Determination of water physico-chemical parameter

All parameters were analyzed using standard method for examination of water and waste water (APHA, 1998).

Phosphate determination in water

To 25 ml of the water sample was added 0.5 ml of ammonium molybdate and 2 drops of stannous chloride and mixed by swirling. A blue colour was developed within an hour. The intensity of the colour was measured using a spectrophotometer.

The concentration of phosphate was determined thus, phosphate mg/l = A - B x C

Where: A = absorbance of sample B = absorbance of blank sample C = volume of standard phosphate

Nitrate (NO₃) determination in water

The determination of nitrate in the sample was carried out calorimetrically at a wave length of 470 nm using fisher Electro-photometer. 10 cm³ of the samples were transferred into 25 ml volumetric flasks. Brucine reagent (2 ml) was added, followed by 10 ml of concentrated H₂SO₄. The content was mixed and allowed to stand for 30 min. The flask was air cooled for 15 minutes made up to mark and absorbances taken at 470 nm.

Standard nitrate solution was prepared by dissolving 0.18 g of KNO₃ in 500 cm³ of distilled water.

Chloroform (0.5 cm³) was added as a preservative. Aliquots having concentration (0.00 - 8.00 mg/l) were prepared from the stock solution and used in obtaining a calibration curve. From the absorbencies obtained for the samples and the calibration curve, the concentration of nitrate in the samples was determined.

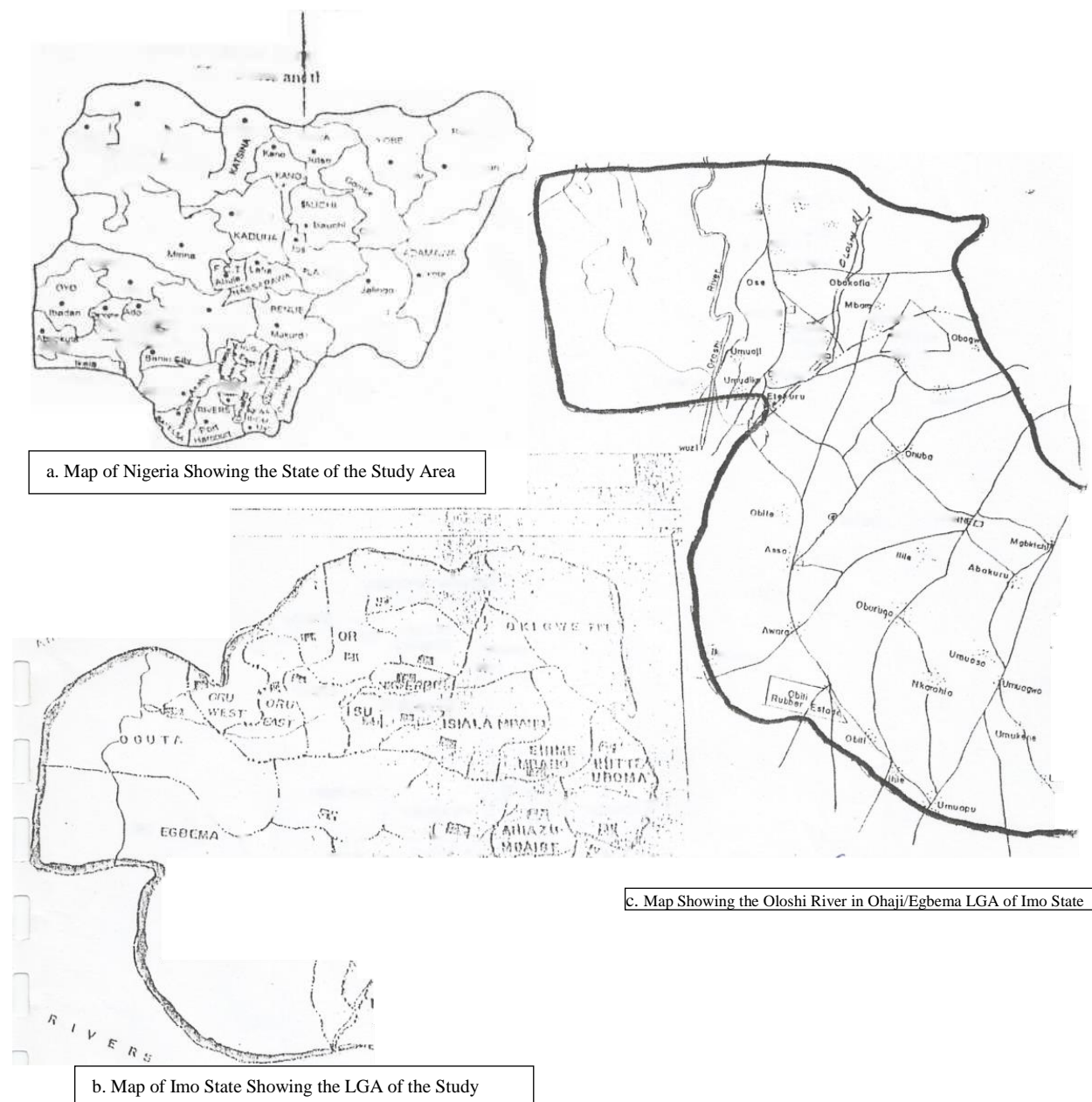


Fig. 1(a,b,c): A geographical map showing the study areas

Determination of electrical conductivity in water

The dip type cell conductivity meter (CM - 21 type) was used. The dip type cell instrument was immersed into the sample in a clean beaker connected to a bridge. The range switch was set to the desired conductance range and the potentiometer knob rotated until the magic eye indicator showed balance. This indicated that the florescent area was a minimum. The reading under the cursor on the outer scale (i.e. the dial reading) was noted and then multiplied by a factor indicated by the position of the range switch. To obtain true conductivity of the sample, the conductance was multiplied by the cell constant and the value expressed in μscm^{-1} .

Determination of temperature in surface water

Water temperatures were measured in-situ at the respective sampling stations. The measurements were carried out using mercury in glass thermometer graduated in centigrade

(°C). The procedure was done by allowing the thermometer first to equilibrate in air before lowering the sensitive (i.e. bulb) end into the water. The thermometer remains $\frac{3}{4}$ immersed for 5 min to stabilize and the thermometric reading were then recorded.

Determination of turbidity in water

Turbidity readings were measured for the water samples using the Horiba Model (N- 70) water quality checker. The unit of measurement is NTU.

Dissolved oxygen (Do) - idometric (Winkler) method

Dissolved oxygen was determined based on the method known as Winker's method. To water sample in 25 ml brown bottle, 1 ml, each of winker I and II reagents were added. One millilitre of starch solution was added to the solution to produce a deep blue solution. It was then titrated against standard silver nitrate (AgNO_3) to produce colourless end point and volume was recorded.

Biological oxygen demand (BOD) in water

The water sample was first incubated in the dark for five days at the end of which precipitation of the sample following the addition of Winkler I and II reagents were carried out. In other words, two Do determinations were carried out, that is one before incubation and the other, after incubation. The BOD was then calculated from the difference between the two Do.

Determination of pH in Water

The water pH was determined in-situ using a digital pH meter calibrated with pH 7.0 and 10.0 buffer solutions according to manufacturer instruction. pH was measured by inserting the pH probe directly into the sample and the readings taken from the digital display.

Sediment analysis

Determination of phosphate

Phosphorus in the sediment samples was determined by weighing 1 g of the sample into a clean extractant flask. This was followed by the addition of 10 ml of Bay P-1 extracting solution (0.25N HCl & 0.03N NH₄F) and shaking immediately for a minute and filtered. Five millilitres of the filtrate was then pipetted into a 25 ml volumetric flask and diluted to about 20 ml which is followed by 4 ml of ascorbic acid solution (1.056 g Ascorbic acid in 200 ml Molybdate-tartrate solution) and diluted to volume. This was then allowed for at least 30 min for full colour development before reading from the spectrophotometer at 730 nm. Phosphate concentrations were then calculated

after reference to a standard curve.

Determination of sediment nitrate

One ml aliquot of the soil extract was thoroughly mixed, then 0.5 ml of brucine reagent was added quickly; 2 ml of sulphuric acid was thereafter added. The solution was mixed and allowed to stand for 5 min. Two millilitres of distilled water was added and mixing continued for about 30 seconds. Tubes were set in cold water for about 5 min or air cool for 15 min. Transmittance was measured at 470 nm.

Determination of sediment pH

The sediment pH was determined according to APHA (1998). According to this procedure, air-dried and sieved sediments were mixed in a ratio of 1:1 to the water. Twenty grammes that resulted was washed into a 100 ml beaker. To it was added 20- 30 ml distilled water and stirred, then allowed for 30 min, stir with glass rod and allow to stand. Electrode was inserted and pH reading was taken.

Determination of electrical conductivity

The electrical conductivity of soil sediment samples was determined using the filtrate obtained after filtering the suspension. The conductivity bridge used for the measurement was the chandos conductivity model A19 Bridges.

Statistical data analysis

A two way Analysis variance (ANOVA) with replication was carried out on the raw data Table 2 using MINITAB.

Table 2: Raw data

a) Water sample result																		
Parameter	July			August			Sept.			Oct.			Nov.			Dec.		
	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3
pH	3.0	3.3	4.1	4.0	4.4	4.5	4.2	4.8	4.1	4.4	4.8	4.3	4.5	4.9	4.1	4.6	4.3	4.8
Conductivity Ms/Cm	10	10	10	10	10	20	20	10	10	20	20	30	20	20	30	10	20	10
Turbidity (NTU)	4.0	4.2	4.1	4.9	4.0	4.8	4.0	2.9	2.7	2.6	2.6	3.1	1.4	4.1	2.4	0.3	3.4	1.8
Phosphate (PPM)	5.0	5.3	5.1	4.0	4.7	4.6	5.0	5.6	4.9	3.0	3.0	3.7	3.0	3.8	3.6	3.0	3.3	2.8
Nitrate(PPM)	1.0	1.2	1.0	0.9	0.3	0.6	0.4	0.7	0.4	0.6	0.2	0.9	0.6	0.6	0.4	0.3	0.3	0.2
DissolveOxygen (PPM)	4.4	3.1	2.0	4.7	5.0	4.1	5.8	5.8	5.6	4.7	4.4	3.9	2.1	2.9	1.6	2.9	3.1	0.5
BOD (PPM)	0.7	0.4	0.6	1.6	1.7	1.7	1.8	1.0	1.6	1.1	1.1	1.3	<1.0	0.7	1.3	<1.0	0.7	1.5
Temp (°C)	27	28	27	27	28	28	28	27	27	28	27	28	30	32	30	33	30	31

b) Sediment result																		
Parameter	July			August			Sept.			Oct.			Nov.			Dec.		
	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3	Stat 1	Stat 2	Stat 3
pH	2.7	3.1	2.1	2.1	2.05	2.0	3.6	4.1	2.6	3.0	3.7	2.7	2.1	2.0	2.4	2.6	2.4	1.0
Conductivity (Ms/Cm)	100	700	18,000	150	900	8000	160	800	24,000	190	900	22,000	200	780	20,000	180	890	28,800
Turbidity	NOT ANALYSED																	
Phosphate(PPM)	7.0	4.0	20.5	6.0	11.0	16.8	9.0	12.7	22.1	8.6	7.7	35.0	8.9	12.6	30.3	8.1	10.5	33.9
Nitrate(PPM)	0.5	1.0	1.2	0.6	0.8	0.7	0.3	0.6	0.9	0.8	0.4	0.5	0.4	0.4	0.6	0.4	0.6	0.9
DissolvedO ₂ (PPM)	NOT ANALYSED																	
BOD (PPM)	NOT ANALYSED																	

Results and Discussion

Physico-chemical parameters in water pH

The result of the analysis of pH in surface water range from 3.01 to 4.86 at the three stations sampled. Fig. 1 also reveals the seasonal variation which showed that the dry season is slightly higher than rainy season. This implies that a normal biological activities would be improved during the dry season as the study indicated that the pH of Oloshi river

were all below the acceptable level (Tebbutt, 1992). The analysis of variance (ANOVA) results show that there is no significant difference in the pH values of surface water during the study period.

Temperature

This investigation showed that the water temperature of Oloshi River range from 27°C to 33°C. The dry season recorded higher mean value of 30°C when compared with

rainy season (27°C). The temperatures of the Oloshi River were within the mesophilic range of temperature for Nigerian Rivers, stream and water ways (Asonye *et al.*, 2007). At the prevailing temperature high biochemical reactions are possible and hence oxidation of waste which is oxygen demanding is expected to progress rapidly. During the dry season there is long hours of sunshine, less precipitation including the gas flaring, bush clearing/burning and less turbidity of the surface water.

Conductivity

The result of analysis obtained for conductivity is presented in Fig. 3 and revealed that all the station recorded low level of conductivity throughout the sampling period. It ranges from 10 to 30 ppm. This indicated that salinity was more prevalent in the study area. This could be attributed to nutrient load due to pollution from the Oil Company and fertilizer from Agricultural farms. The low values make the water suitable for irrigation (Wilcox, 1955). The dry season recorded a higher mean value of 20 μscm^{-1} compared to 12.22 μscm^{-1} recorded for the rainy season.

The months of October and November generally showed higher value in the analysis of variance, indicating that there was significant difference between time (month) at ($P < .05$) for the conductivity value obtained during the monitoring period ($P = 0.046$).

Turbidity

Spatial and seasonal changes in turbidity are shown in figure 4. Turbidity values ranged from 1.4-4.8 NTU during the monitoring period. The mean value are 2.87 NTU (station I), 3.53 NTU (station 2) and 3.15 NTU (station 3). The result revealed that all the samples were below the World Health Organization (WHO) and European Economic Community (EEC) drinking water standard which is 5NTU. The result of the variation, showed that rainy season has higher mean value (3.96 NTU) than dry season (2.41 NTU). The higher value in rainy season was caused by erosion of the farmland, suspended silt and clay, organic matter and plankton (Philip *et al.*, 2006).

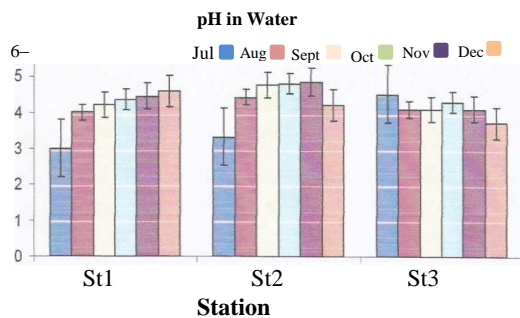


Fig. 1: pH in water sample

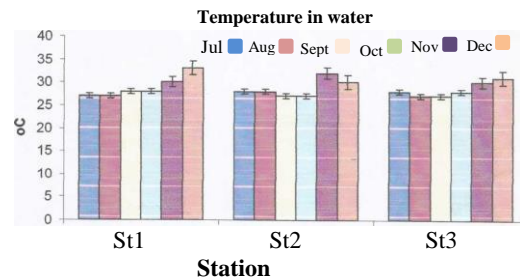


Fig. 2: Temperature in water

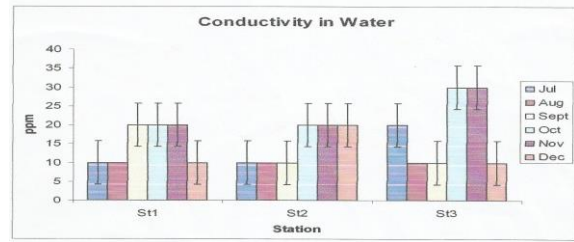


Fig. 3: Conductivity in water

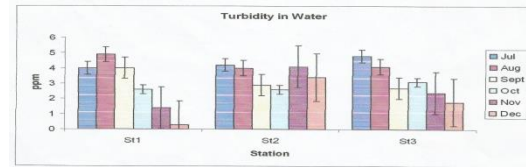


Fig. 4: Turbidity in water

Phosphate (PO₄)

Seasonal and spatial variations in phosphate concentration are presented in Fig. 5. Which revealed that phosphate value obtained in this study were generally above the permissible limit of 0.1 mgL^{-1} (Moore, 1991). Station 2 has the highest mean value of 4.35 ppm for phosphate followed by station 3 (4.11 ppm) and station I (3.85 ppm). Seasonally, phosphate was observed throughout the monitoring period but the rainy season has higher mean value of 4.93 ppm compared to 3.29 ppm for dry season. The gradual increase in the concentration of phosphate with the rainy months would be associated with inputs from upland during rain storm. The communities along the rivers are typically farmers hence application of fertilization is commonly practiced. Other anthropogenic sources such as human waste, cow dung and blood from abattoir serves as sources of input of waste containing phosphate into the river. There is significant difference ($P < .05$) in phosphate concentration of the river over the monitoring period.

Nitrate (NO₃)

The result of the analysis obtained for nitrate in water is presented in Fig. 6. Nitrate value ranged from 0.2 ppm to 1.2 ppm. This showed that nitrate input into the river was low (below 10 mg/L according to WHO (1984) for nitrate) despite the agricultural activities. This means that fertilizer application within the farmlands is minimal. Seasonally, the rainy season recorded a higher mean value of 0.72 ppm compared to 0.46 recorded for dry season. The high concentration of nitrate in the rainy season could be as a result of run offs from agricultural land and combination with human or animal waste. There was no significant difference in nitrate (NO_3) values of water samples during the study period. ($P = 0.229$).

Dissolve oxygen

The seasonal and spatial variations in dissolved oxygen (Do) are shown in Fig. 7. The mean values were 4.1 ppm, 4.05 ppm and 2.95 ppm for station 1, 2 and 3, respectively. Seasonally, a higher mean value of 4.5 ppm was recorded for the rainy season while 2.9 ppm was recorded for dry season. The highest value for dissolved oxygen was observed in the month of September for the three stations. This is due to turbulence and mixing of water during the rainy season. The low DO value during the dry season may be attributed to the corresponding high water temperature due to sunshine. DO level falls with increase in temperature because heating evaporates water and hence Oxygen into

the atmosphere and also there is increase metabolic activities of fishes which make an increase demand on the already limiting oxygen supply in the water (Ademorotti, 1996). It was observed that there was significant difference between sampling periods at ($P < .05$).

Biological oxygen demand (BOD)

The result of analysis obtained for biological oxygen demand (BOD) is presented in Fig. 8. The values ranged from < 1.0 ppm to 1.8 ppm with the mean levels obtained as < 1.0 ppm, 0.93 ppm and 1.33 ppm for station 1, 2 and 3, respectively. This shows that the overall quality of domestic water in the studied area of Oloshi River is clean as the values are between < 1.7 -1.8 ppm throughout the station according to Moore and Moore (1976). Seasonally, the mean value for rainy season is higher (1.23 ppm) than that (0.85 ppm) obtained for dry season. The high value recorded in rainy seasons may be attributed to organic matters which were washed into the receiving water bodies from the surrounding during the rainy season. There is no significant difference ($P < .05$) for biological oxygen demand (BOD) in the water during the study period. $P = 0.713$.

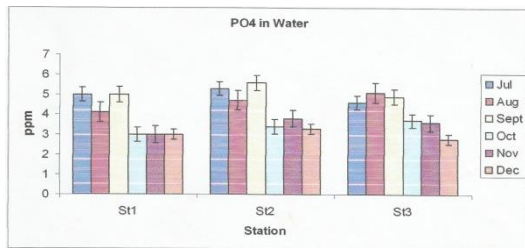


Fig. 5: Phosphate concentration in water

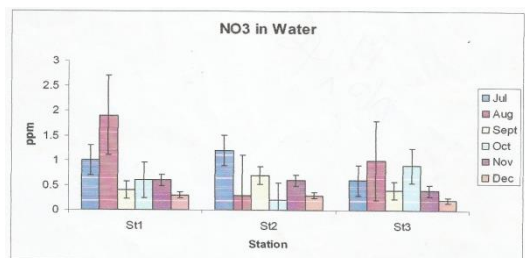


Fig. 6: Concentration of nitrate in water

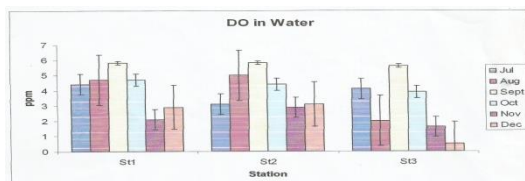


Fig. 7: Dissolve oxygen concentration in water

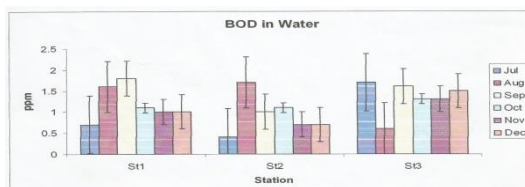


Fig. 8: Biological oxygen demand in water

Physico-chemical parameters in sediment
pH

The spatial and seasonal variation in pH are presented in Fig. 9. The PH value is 1.03 to 4.11. The mean values were 2.71, 2.75 and 2.06 for station 1, 2 and 3 respectively. Fig. 9 also shows seasonal variation with rainy season (2.72) higher than the dry season (2.44). The low level pH of the sediment could be attributed to anthropogenic activities around the study area. The result of the analysis of variance (ANOVA) showed that there was significant difference ($P < .05$) between locations (station) and time (months).

Conductivity

The result obtained for conductivity is presented in Fig. 10. The results range from 100 NTU to 28,800 NTU. Fig. 10 also show seasonal variation which indicates that a higher value (8,215.56 NTU) was recorded for dry season while a lower value (5,867.78 NTU) was recorded as a mean value for the rainy season. Statistically, there was significant difference ($P < .05$) between locations (station) in the conductivity values obtained during the monitoring period. The significant difference occurred between station 3 and 1 ($P = 0.0014$) and stations 3 and 2 ($P = 0.0018$)

Phosphate (PO4)

Figure 11 shows the result of phosphate (PO₄) level in the sediment, which ranged from 4.0 to 33.7 ppm. The phosphate concentration in the sediments was very high when compared to the standard guideline (EPA, 2002). There are various sources of phosphate to the rivers such as firm rock deposit, run off from surface catchments and interaction between water and sediment from dead plants and animal remains at the bottom of rivers (Adeyemo *et al.*, 2008). Phosphate is considered the most significant among the nutrients responsible for eutrophication of lakes, river etc. Seasonally, the dry season recorded a higher phosphate level (17.25 ppm) as compared to 12.22 ppm recorded during the rainy season because of accumulation of nutrient as against the water turbullance inherent in the rainy season.

Nitrate (NO3)

The results of nitrate levels in sediment are presented in Fig. 12 with the values ranging from 0.3 to 1.2 ppm. The mean values are 0.42 ppm (station 1), 0.63 ppm (station 2) and 0.8 ppm (station 3). Seasonally, the rainy seasons recorded the higher value (0.73 ppm) as compared to 0.6 ppm recorded for dry season. The result of analysis of variance (ANOVA) showed that there is significant difference ($P < .05$) between locations and time. The significant difference is between station 3 and 1 ($P = 0.0033$) also between October and August ($P = 0.0293$).

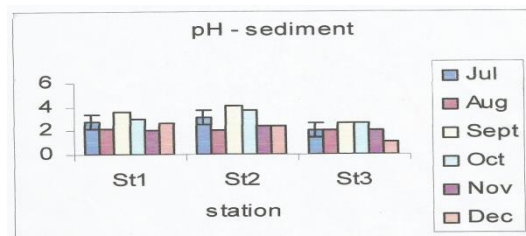


Fig. 9: pH of sediment

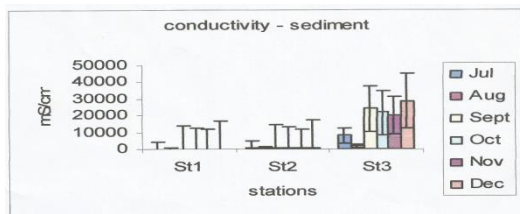


Fig. 10: Electrical conductivity in sediments

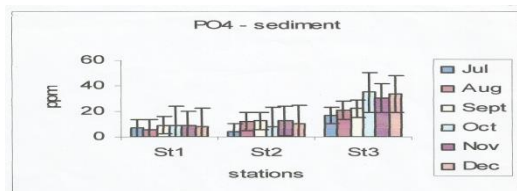


Fig. 11: Concentration of phosphorus in sediment

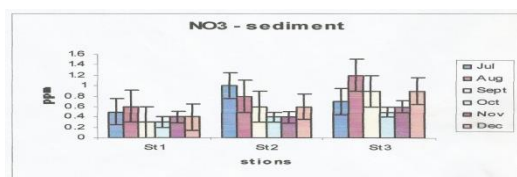


Fig. 12: Concentration of nitrate in sediment

Water and Sediment Physico-Chemical Parameter pH

The intensity of acidity or alkalinity of sample is measured on the PH scale which actually measures the concentration of hydrogen ions present (Tebutt, 1992). The PH range of Oloshi River and Sediment lies between 4.18-4.40 and 2.44-2.72, respectively which is acidic and far below accepted limit for natural water 6.8 and EEC guide limit of 6.5-8.5. The acidic nature may be associated with the effect of acid rains that are commonly related to gas flaring at flow station/oil field area (Ekweozor and Agbozu 2001). It may also be attributed to the geochemical characteristics of the soil where river drains (Balax, 1985) and anthropogenic activities around the study area. Generally higher levels of PH were observed in the dry season than in the rainy season for surface water while reverse is the case in the sediment analysis. This may be as a result of sedimentation. Efe *et al.* (2005) also stated that increased acidity may be attributed to the oxidation of reduced sulphur compounds in the soils of the catchment areas.

Temperature

The temperature values were within national and international standard. Temperature values tend to be slightly higher in dry season than in wet season. This variation may be associated with water depth and high intensity of the sun. The higher temperature level in station 1 is as a result of the gas flaring around the area. The temperatures of Oloshi River ranged from 28.5 - 28.8 and were within the Mesophilic range of temperature between 20 - 45°C).

Conductivity

The study revealed that all the stations recorded low level of conductivity throughout the sampling period. The mean levels of 10-30 Mscrrf^l recorded in this study were slightly lower than those of other freshwater environment in the Niger Delta area (Egborge, 1994). These low values make the water suitable for irrigation (Udom *et al.*, 2002). The electrical conductivity is a useful parameter of water quality for indicating salinity hazards (Begum *et al.*, 2009).

Seasonal value revealed that dry season recorded higher electrical conductivity value than the wet season. This is as a result of dilutions during rainy season.

Turbidity

Turbidity is a good indicator of the amount of materials suspended in water because it measures the amount of light that is scattered within the medium. Turbidity measurement of Oloshi River ranges from 1.4 NTU to 4.90 NTU revealing that all the samples were below the World Health Organization (WHO) and EEC drinking water standard which is 5 NTU.

Phosphate

The phosphate values obtained in this study were generally above the permissible limit of 0.1 mg/l^l (Moore 1991) and standard guideline (EPA, 2002). This is reflected across the three stations. The mean value ranged from 3.35-4.35 ppm for the waters. Rainy season recorded higher values than the dry season throughout the three stations sampled. Phosphate was exceptionally high during dry season in sediment analyzed compared to the dry season. The higher value of phosphate in the rainy months in the water analysis would be associated with inputs from upland during rain storm. Other anthropogenic sources such as human waste, cow dung and blood from abattoir serve as sources of input of waste containing phosphate into the River. The higher level of phosphate in sediment during dry season may be a result of depositions of dead plants and animal remains at the bottom of the river.

Nitrates

Nitrate was detected in all the stations but in levels below 10 mg/l according to WHO (1984) for Nitrate. The value ranged from 0.2-1.2 mg/l for surface water and 0.42 - 0.8 mg/l for sediment which showed that nitrate input into the river was low despite the agricultural activities of the host communities. This means that fertilizer application within the farm land was minimal. Generally, Nitrate concentration was higher in the rainy season months, with station 1 (Obokofia) and station 3 (Etekwuru) having the highest mean value of 0.63 and 0.8, respectively. This could be as a result of run offs from the fertilized agricultural farm of the starch mill and combination with human or animal wastes. Nitrate is a form of Nitrogen and a vital nutrient for growth, reproduction and survival of organism. High nitrate levels (>1 mg/l) are not good for aquatic life (Johnson *et al.*, 2002) and usually indicate the presence of organic pollution or waste which can originate from fertilizers, sewage disposal or pit latrine.

Dissolved oxygen (DO)

The result of dissolved oxygen (Do) shows that there is a general increase of the parameters during the wet seasons (4.5) than the dry months (2.9). This is because the concentration of oxygen in most surface water is high due to turbulence and mixing especially during the rainy seasons. The low dissolved oxygen (Do) value during the dry season may be attributed to the corresponding high water temperature due to sunshine. Higher temperature causes evaporation of water and hence oxygen into the atmosphere. It may also set in motion certain processes such as increase in metabolic activities of fishes which make an increasing demand on the already limiting oxygen supply in the water. In addition, the micro-organisms that cause decay on organic materials also become more active when temperature of the water is increased and so they accelerate their oxygen uptake to decompose the organic materials thereby depleting the already reduced oxygen supply (Pelezar *et al.*, 1995).

The biological oxygen demand (BOD) is reported by (Moore and Moore, 1996) to be a fair measure of cleanliness of any water on the basis that values less than 1-2 mg/l are considered clean, above 2 - 3 mg/l fairly clean, 5mg/l doubtful and 10 mg/l definitely bad and polluted. This shows that the overall quality of domestic water in the study area of Oloshi River is clean as the values are between 1.7 - 1.8 ppm through the stations. The rainy season recorded higher values. This may be attributed to organic matters which were washed into the receiving water bodies from the surrounding during the rainy season. The low value recorded during the dry season is due to drastic reduction in oxygen demand. The difference in the values recorded with season were however not significantly different as confirmed by the ANOVA result at 95% confidence level.

Conclusion

The results from this study have provided information on the physicochemical characteristics of the water and sediments of Oloshi River. The average mean concentrations of the parameters, studied were low when compared with the World Health Organization (WHO) and FMENV standards for drinking water.

Generally, higher values were recorded for the analyzed parameter during the dry season. This indicated that the quality of the water may be poor at certain times of the year. A close look at the observation in this non-tidal freshwater revealed that pollution events in the study area are likely to have severe but localized effects except during the rainy season when the pollutants are spread by the flood into wider areas.

Recommendation

The need for physico-chemical analysis of water and sediment to determine the level of pollution of the aquatic system cannot be over emphasized. Since the host communities rely on the Oloshi River for both their domestic, economic and nutritional needs, the following recommendations are important in order to obtain and maintain good water quality.

1. There is the need to develop management plan to ensure that contamination that would result from eutrophication of the area is prevented or reduced.
2. The local communities should also be enlightened about the adverse effects of anthropogenic activities and the excessive use of fertilizers near the Oloshi River.
3. Periodic monitoring and preventive measures are required to save the aquatic system from eutrophication which would increase algae growth and ultimately reduced dissolve oxygen levels in the water.

References

- Ademoroti CMA 1996. *Environmental Chemistry and Technology*. 1st Edition, Foludex Press Limited, pp. 2003-224.
- Adeyemo OK, Adedokun AO, Yusuf RK & Adeleye EA 2008. Seasonal change in Physico- Chemical Parameters and Nutrient load of River sediment in Ibadan city, Nigeria. *Global NEST Journal*, 10(3): 326-336.
- Asonye CC, Okolie NP, Okenwa EE & Iwuanwu UG 2000. Some Physico- chemical characterises and leavy metal profiles of Nigerian rivers, Streams and water ways. *Afr. J. Biotech.*, 6(5): 617-624.
- Bertram J & Ballance R (Eds) 1996. Water quality monitoring. A practical Guide to the Design and Implementation of freshwater quality studies and monitoring programme. *Chapman and Hall, London*, p. 400.
- Begum A, Ramaiah M, Harikrishna K & Verena K 2009. Heavy metal pollution and chemical profile of Convery, River Water. *E. Journal of Chemistry*, 6(1): 47-55.
- Egborge AB 1994. *Biodiversity and Chemistry of Warri River*. Ben Miller Books. Nigeria Limited, Warri, p. 331.
- European Economic Community (ECC) 1976. EC Standards for surface water use for portable abstraction. Directive 76/464/EEC; EEC Brussels.
- Federal Ministry of Environment (FMENV) 1992. Environmental Impact Assessment Decree 86, 1992 (Procedural Guidelines) published by the Federal Government Press, Lagos, Nigeria.
- Meybeck M & Helmer N 1996. An introduction to water quality. In: *Water Quality Assessment - A Guide to use Biota, Sediments and Water in Environmental Monitoring 2nd edition*, Chapman, (ed) UNESCO/WHO/UNEP, p. 651.
- Moore JW 1991. Inorganic contaminants of surface water. *Research & Monitoring Priorities*, Springer City, p. 368.
- Pelezar MJ, Chan ECS & Krieg NR 1993 Microbiology concepts and application, first edition. McGraw-Hill publishing Company Limited, New York, pp. 806-833.
- Philp L, Shanmugam P, Neelamanis Ahn Y & Hong G 2006. Assessment of the level of coastal marine pollution of Chema city southern India. Springer Science +Bussines Media, pp. 1-17.
- Tebuth THY 1992. *Principles of Water Quality Control 4th Edition*. Pergamon Press, Oxford, p. 235.
- Udom GJ, Ushie FA & Esu EO 2002. A geochemical Survey of ground water in Khana and Gokana Local Government Area of River State, Nigeria. *J. Appl. Sci. & Envntal. Mgt.*, 6(1): 53-59.
- Wilcox, LV 1955 Classification and use of irrigation waters. United State Department of Agriculture. Circular 969, p. 19.
- World Health Organization (WHO) 1994 *Guidelines for Drinking Water Quality* in WHO, Geneva.