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WATER QUALITY ASSESSMENT OF ABAKPA RIVER, OGOJA, SOUTH-SOUTH, NIGERIA.

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ABSTRACT

Water quality assessment of Abakpa River in Ogoja Local Government Area of Cross River State, Nigeria was undertaken. The assessment was based on some key selected water quality parameters. The parameters were Temperature, Turbidity, Total Suspended Solids, Total Dissolved Solids, pH, alkalinity, Dissolved Oxygen, Chemical Oxygen Demand, Biochemical Oxygen Demand, Total Coliform Count, Total Heterotrophic Count, Ammonium, Nitrate, Nitrite, Conductivity, Iron and free chlorine. The work was aimed at assessing the river for potability and its ability to dissipate wastes. The concentration of the assessed parameters was determined experimentally by obtaining 5 different samples at different points from the river for two sampling periods. From the assessed parameters, 47.37% passed in the first sampling and 52.63% passed in the second sampling when compared with WHO (2011) standards. The variability of the results of the water quality parameters for the two seasons is indicative of the irregular pattern and varied trend of activities that take place in and around the river. From the field observations, laboratory results and findings of this study, it is pertinent that the indigenes should be sensitized on the health hazards associated with the direct or indirect pollution of the river.

KEYWORDS: Water quality; assessment; river; Abakpa.

1.0 INTRODUCTION

1.1 Background of Study

The paramount reason for drinking water quality guidelines is public health protection (WHO, 2006). Water is essential for life sustenance; its supply must be adequate, safe and accessible. The major challenges to human health are the diseases that relate to drinking water-quality contamination.

According to WHO (2006) guidelines, safe drinking water does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may arise at different stages of life. The guidelines however are intended to support the development and implementation of risk management strategies that will ensure the safety of drinking-water supplies through the control of hazardous constituents of water.

Acceptable guidelines include parameters that may not have any direct health effects but result in objectionable taste or odour in the water.

With the advent of industrialization, the range of requirements for water has increased, together with greater demand for higher quality of water overtime. Water requirements have emerged for drinking and personal hygiene, fisheries, agriculture (irrigation and livestock supply), navigation, for the transportation of goods and services, industrial production, cooling in fossil fuel and also in nuclear power plants, hydropower generation and recreational activities.

Fortunately, the largest demands for water quality, such as for agricultural irrigation and industrial cooling, requires the least in terms of water quality (i.e. critical concentration may only be set for one or two variables). Drinking water supplies and specialized industrial manufacturing exert the most sophisticated demand on water quality but its quantitative need is relatively moderate. From time, water has been considered the most suitable medium to clean, disperse, transport and dispose wastes.

There are also several human activities which have indirect and undesirable, if not devastating effects on aquatic environment and organisms such as accidental or unauthorized release of chemical substances, discharge of untreated wastes or leaching of noxious substances from solid waste deposits as well as excessive use of fertilizers and pesticides.

To curb the effect of these introduced wastes in water and to make it potable, a thorough assessment of the quality of water is needed which generally entails the overall process of evaluation of the physical, chemical and bacteriological nature of water in relation to natural quality, human effects and intended uses that affect human health and the health of aquatic organisms (Chapman, 1996).

The objectives of this work therefore are to assess the water quality of Abakpa river, identify the causes of observed conditions and pollution trends, proffer palliative and remedial measures, provide the accumulated information and assessments in a form that resource management and regulatory agencies can use to evaluate alternatives and make necessary decisions as well as determine and establish the ability of the river to dissipate waste.

2.0: MATERIALS AND METHOD

Description of Area of Study

Ogoja Local Government is one of the 18 Local Government Areas in Cross River State, South-South Nigeria. It is located between latitudes $6^0$20’ 0”E and $6^0$40’0”N, and longitudes $8^0$30’0 and $9^0$0’0”E. The capital of Ogoja is Igoli. The local government is located in the northern senatorial district of Cross River State. It is bounded by Yala Local Government Area in the West, Bekwarra Local Government Area in the South-West, Obudu Local Government in the East and Boki Local Government in the South-East. The Local Government Area has ten (10) political wards which are: Ekajuk I, Ekajuk II, Mbube East I, Mbube East II, Mbube West I, Mbube West II, Nkum Ibor, Nkum Irede, Urban I and Urban II ward. According to 2006 Nigerian census, Ogoja has a population of about 171,901. The projected population as at 2012 is 188,700 persons. According to Cross River State Geographic Information System (GIS) department, it has a total land mass of more than 472km^2. Ogoja is an urban setting with few riverine areas. It has different topography ranging from lowland in some parts, to rocky topography in others.

The Abakpa River located in Abakpa community, is a free-flowing surface water (fresh water).

2.1.1 Hydrological Characteristics

Rivers are complex systems of flowing water draining specific land surfaces which are defined as drainage basin of watersheds. The characteristics of the river(s) within the total basin system are related to a number of features. These features include size, form and geological characteristics of the basin and climatic conditions which determine the quantities of water to be drained by the river network.

The discharge of a river is the single most important measurement that can be made because;

- It provides a direct measurement of the water quality and hence the availability of water for specific uses.
- It allows for calculation of loads of specific water quality variables.
- It characterizes the origins of many water quality variables by the relationship between concentration and discharge.
- It provides the basis for understanding river basin processes and is essential for interpreting and understanding water quality.

3.0 Data Collection

The samples were taken from five (5) different locations within the study area into 75ml plastic containers at an interval of 150m. A total of 5 containers were used for both bacteriological and physicochemical analyses. Twenty four (24) containers of 50ml were used to collect samples at every 5 minute intervals downstream in one point after injecting the tracer elements at a distance of 300m upstream for tracer studies. After each sample was collected, the containers were well closed immediately to guard against external contaminant. The samples were conveyed to the laboratory in a cooler and kept at a temperature of 4^0C and the analysis were conducted within 48 hours from time of collection.

3.2 Data Analysis

Precise and appropriate procedures was strictly followed for the qualitative and quantitative assessment the parameters. The qualitative involved the detection of various substances of interest while the quantitative assessment involved the measurement of their concentrations in milligrams per liter (mg/l). The UV 7310 spectrophotometer was used. All the laboratory analyses were carried out using appropriate water testing meters and in accordance with the standard methods (APHA, 1998)

4.0 RESULTS AND DISCUSSION

4.1 Field Observations

Abakpa River in Ogoja Local Government Area is a perennial stream with its characteristic meanders. The major activities in and around the river include fishing, sand dredging, pumping water for artificial irrigation, industrial and constructional purposes. Other activities include nursing of improved palm seeds, farming, making of vegetable gardens, laundry activities, domestic waste disposal and washing of automobiles. There is also an abattoir at some point upstream. Observation showed that there is direct defecation into the river at all seasons but becomes more obvious during the dry season as a result of drop in river stage.

4.2 Water Sample Assessment

The WHO (2011) standard was used as the reference for the assessment of the quality of water in Abakpa River. The various water parameters used for the assessment are shown in Table 1. The variability of the water quality parameters collected at the various sampling points during the rainy and dry seasons are shown in Figures 1 and 2.

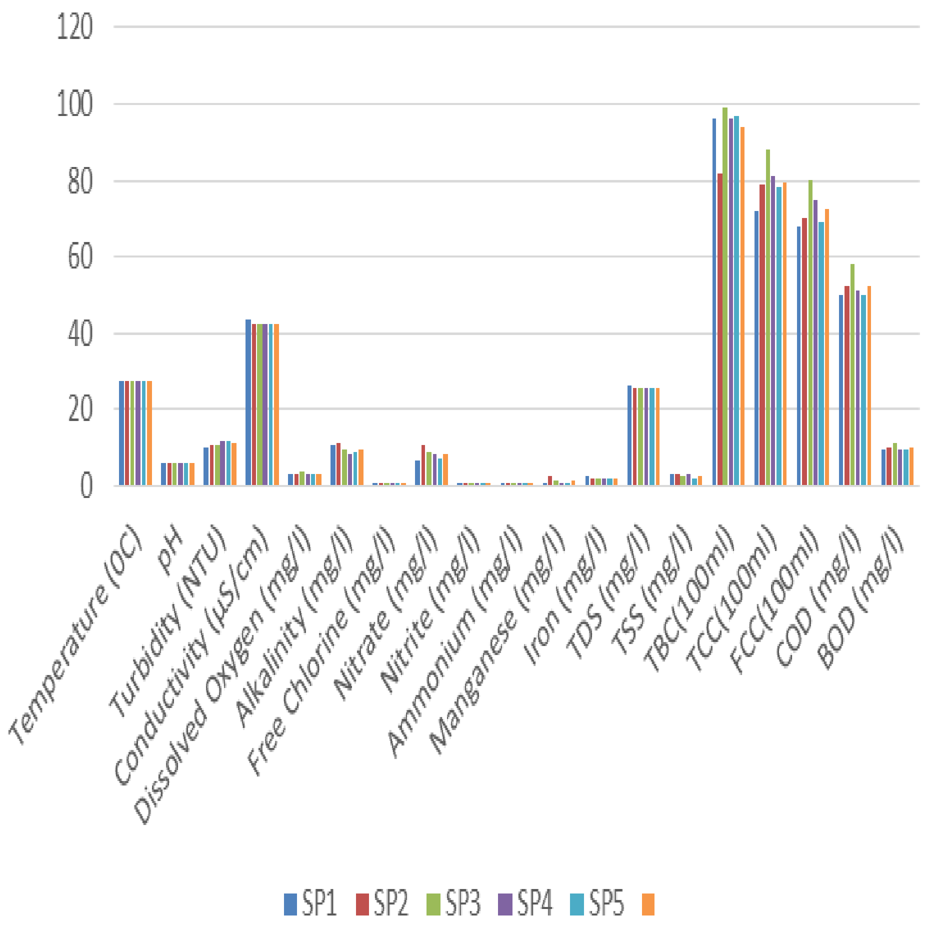

Figure 1: Variability of water quality parameters collected at the various sampling points during the rainy season.

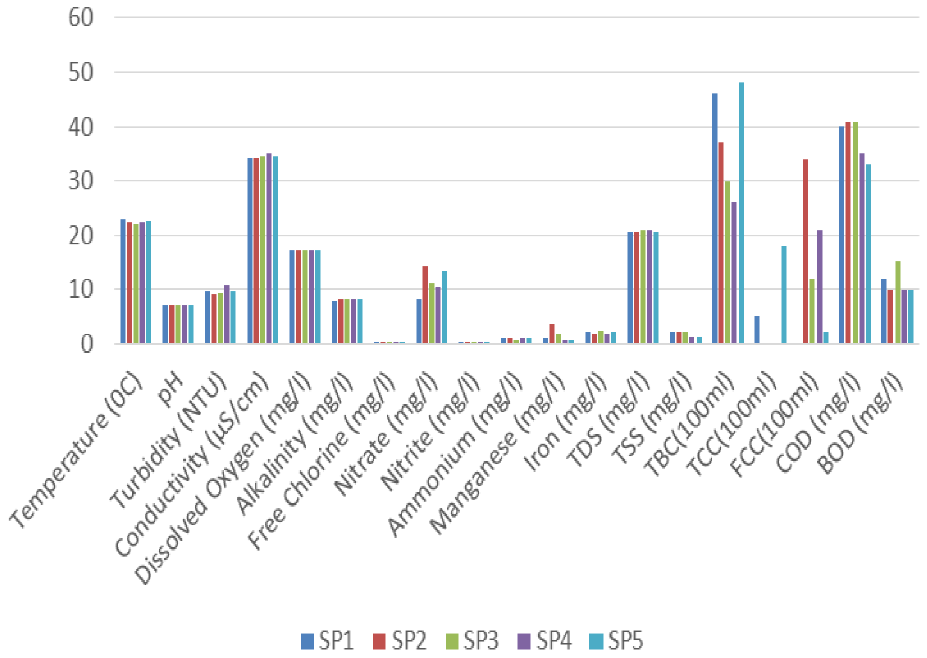

Figure 2: Variability of water quality parameters collected at the various sampling points during the dry season.

4.2.1 Physical characteristics of Assessment parameter

The physical characteristics are the properties of water sample that can be determined through physical observation and inspection. The physical properties are turbidity, TSS, TDS and temperature.

Temperature

The result of the analysis showed mean temperature value of 27.32^{0}C and 22.46^{0}C for the first and second sampling, respectively. The temperature of 27.29^{0}C for the first sampling was within WHO (2011) standard while the second was below the standard. According to Missouri Department of Natural Resources and Environmental Service Programme, water temperature can fluctuate hourly, daily and seasonally due to spring discharge, the quantity and velocity of stream flow and over hanging canopy of stream vegetation providing shades that help buffer the effect of temperature changes.

Turbidity

Turbidity makes water cloudy and prevents visibility of the bottom of the container carrying the water due to suspended matter (Agunwamba, 2008). From Table 1, for both sampling periods, the turbidity of the river was 10.84 (NTU) and 9.72 (NTU), respectively, which is higher than WHO's standard of below 5.0 NTU. The increase in turbidity of the river is caused by suspended solids (soil particles) and plankton (microscopic plants and animals) through sediment bearing runoff that enters the river bank, erosion and the farming activities that go on around the river.

Total Suspended Solid (TSS)

The result obtained from the analysis for both first and second sampling gave a mean result of 2.71mg/l and 1.71mg/l respectively. The WHO (2011) standard is 0.2mg/l, implying that the parameter did not meet the standard. Erosion, agricultural activities as well as constructional sites contribute to the recorded amount of TSS in the river.

Total Dissolved Solid (TDS)

The value obtained from the analysis gave a mean value of 25.46 and 20.7mg/l respectively for first and second sampling. The result showed that the TDS value was far below the WHO (2011) standard which is 500mg/l. This means the water is very okay in the number of dissolved solids. The palatability of drinking water depends on the amount of TDS present in it, the less the TDS, the more palatable the water and vice versa.

4.3 Chemical Characteristics of Assessment Parameters

The chemical characteristics are the properties of water quality assessment parameters that cannot be assessed by mere physical observations and inspection but by detailed assessment procedure.

pH

pH which measures the intensity of acidity or alkalinity of a solution was 5.9 and 7.10 for the first and second sampling respectively. From Table 1, the mean value of 5.9 in the first sampling did not meet WHO (2011) standard of 6.5 – 8.5 while the mean value of the second sample was within the range. This result shows that the river was acidic at the time of first sampling and slightly alkaline at the time of second sampling showing a better water quality in a drier season. The acidic property of the first sample is due to municipal runoff that carries some elements that can readily react with water to form acid. Streams generally have pH values ranging from 6 – 9 depending upon the presence of dissolved substances that comes from bedrocks, soils and other materials in the watershed (Missouri Department of Natural Resources). Changes in pH can change the aspect of water chemistry. For instance, as pH increases, smaller amount of ammonia added into the water makes the water toxic to fishes. As pH decreases, the concentration of metals may increase because higher acidity increases their ability to be dissolved from sediments into the water.

Alkalinity

Table 1 shows the mean value of alkalinity as 9.55mg/l and 8.02mg/l respectively for the two sampling periods. The WHO (2011) standard for alkalinity is given as 400mg/l. The obtained values were far lower than the given standard. Alkalinity or the buffering capacity of a stream refers to how well it can neutralize acidic pollution and resist changes in pH.

Dissolved Oxygen concentration (DO)

It is seen from Table 1 that, the mean values for dissolved oxygen of the first and second sampling are 3.28mg/l and 18mg/l respectively. WHO (2011) stipulates that the depletion of dissolved oxygen poses adverse effects such as the discoloration of water among others. Also, very high levels of DO may exacerbate corrosion of metal pipes (WHO, 2011). It was observed from the first sampling that the decrease in DO was caused by the presence of organic pollutants while the increase in DO of the second sample showed lower level of organic pollutants present in the water.

Chemical Oxygen Demand (COD): Table 1 gives the mean values of COD in first and second sampling as 52.2mg/l and 38.0mg/l for respectively. Although there is no exact limit for COD, but from the assessment, it was higher than the value of DO showing that the water is a threat to lives. A high value of COD in water is indicative of inadequate DO in that water. COD is a measure of the total quantity of oxygen consuming substances in the complete chemical breakdown or organic substances in water. It is an important parameter in measuring quality and determining that organic load that is present in the water.

Biochemical Oxygen Demand (BOD)

This is the amount of oxygen consumed by bacteria in decomposition of organic material; including the oxygen required for the oxidation of various chemicals in the water. From Table 1, BOD's mean values for the first and second sampling are 9.92 and 11.6mg/l. There is no stated value for BOD by WHO. The BOD values can be empirically compared to COD, and if so, since the COD measures the total oxygen (O_2) depletion, in complete chemical breakdown, and BOD measures only the biological (bacteria) aspect of O_2 depletion, therefore, the BOD with value of 11.6mg/l is not out of proportion with COD value of 52.2mg/l.

Conductivity

Assessment analysis shows in Table 1 the mean values of conductivity for the first and second sampling as 42.46 and 34.5µS/cm, respectively. These values are within the WHO (2011) limit of 500µs/cm and as such cannot reduce DO nor pose any aquatic imbalance to aquatic organisms.

The measure of how well water can pass an electric current is called conductivity. It is measured in micro Siemens per centimeter (µs/cm) it indirectly measures the presence of organic dissolved solids such as sulphate, nitrate phosphate calcium, magnesium, sodium, aluminum and iron. The presence of the above ions shows high conductivity while the presence of organic oil, sugar and alcohol lowers conductivity

Free Chlorine

The concentration of free chlorine in water was 0.2mg/l in accordance with WHO (2011). The free chlorine for this analysis was found to be 0.1mg/l (Table 1) which is within the WHO standard.

Nitrate (NO_3)

The nitrate level for this analysis for first and second sampling is 8.20 and 11.46mg/l as shown in Table 1. These values and lower than 50mg/l WHO (2011) standard which means the river is free from eutrophication (natural or artificial addition a nutrient into water bodies) and associated algae bloom. Nitrate is a colourless, odourless and tasteless compound. It is a natural form of nitrogen found in the soil. It is formed when microorganisms breakdown fertilizer, decaying plants, manures or other organic residue.

Nitrite (NO_2)

WHO (2011) standard for NO_2 is 3mg/l. The obtained values in this assessment are 0.3 and 0.28 mg/l respectively. The increase value of NO_3 (8.21 to 11.36mg/l) is an indication of the river's ability to convert NO_2 to NO_3.

Nitrite is extremely toxic to aquatic life. However, it usually occurs in trace quantity in most freshwater systems because it is readily oxidized to nitrate. The conversion of NO_2 to NO_3 is affected by pH, temperature and DO (Antigha et al, 2003).

In water treatment, ammonia consists of NH_3^- + NH_4^+. If pH water increases naturally or by addition of a base, the concentration of unionized NH_3 increases. It hinders the conversion of nitrate, causing nitrate to accumulate when pH decreases, as NH^+_4 and NO_2 are oxidized such that increase in HNO_2 concentrations occurs. When there is no strong acid in the stomach to convert NO_2 to NO_3, bacteria that can convert NO_3 to NO_2 will increase thereby causing nitrate to be absorbed into the blood. This inefficiency may lead to reduction in oxygen supply to vital tissues such as the brain and may damage the brain (Antigha, 2002).

Ammonium

Table 1 gives the value of ammonium as 0.66 and 0.6mg/l for first and second sampling. It deduces that the values are less that WHO (2006) limit of 1mg/l indicating that the water is potable.

Iron

The mean value for iron was 1.98 and 2.21mg/l in the first and second sampling, respectively. The result shows that the obtained values exceeded WHO (2011), 0.3mg/l making the water unfit for drinking. This iron is from dissolve mineral in the soil and enters the river through percolation and underground flow.

4.2.3 Biological Characteristics

Fecal Coliform Count (FCC)

Table 1 shows the FCC values of 68 – 80/100ml with a mean value of 72.4/100ml in first sampling and in the second sampling, the values fluctuates from 2-TNTC. With the standard of 0/100ml count, by WHO (2011), the first and second sampling failed. The investigation shows TNTC in the second sampling in the drier season where the river is healthier because of direct defecation into the river.

The presence of FCC in water indicates the presence of virus and pathogenic bacteria like fecal coliform bacteria, enterococci and Escherichia or E-coli. Although these bacteria are non-disease causing agent themselves at low count but high concentration suggest the presence or disease causing organisms.

Total coliform

Table1 shows the total coliform count values 72 – 88/100ml with a mean of 79.6/100ml in the first sampling and 0 – TNTC in the seconds sampling. These values exceeded the 0/100ml limit by WHO (2011) indicating the presence of bacteria in the water resulting from animal and human feces.

Total Bacteria Count (TBC)

Table 1 gave the mean value of TBC for first and second sampling as 94 and 37.4/100ml respectively. The WHO standard (2011) is nil/100ml. This result revealed that the river is highly polluted. The high pollution is because of direct deification into the river. Increase in TBC indicates ideal condition for bacteria growth which can cause foul-taste in the water.

Table 1: Mean values for dry and rainy seasons sampling.

Parameter	Mean Values (Rainy Season)	Mean Values (Dry Season)	WHO Guideline value
Temperature (^{0}C)	27.32	22.46	27 – 29
pH	5.90	7.1	6.5 -8.5
Turbidity (NTU)	9.72	10.848	5
Conductivity (µS/cm)	42.46	34.5	500
Dissolved Oxygen (mg/l)	3.18	17.00	5≥14
Alkalinity (mg/l)	9.55	8.02	400
Free Chlorine (mg/l)	0.10	0.10	0.20
Nitrate (mg/l)	8.21	11.47	50
Nitrite (mg/l)	0.13	0.28	3
Ammonium (mg/l)	0.66	0.80	1
Iron (mg/l)	1.98	2.06	1
TDS (mg/l)	25.46	20.70	600-1000
TSS (mg/l)	2.72	1.71	
TBC(100ml)	94.00	37.40	NIL
TCC(100ml)	79.60	11.50	1
FCC(100ml)	72.40	17.25	0
COD (mg/l)	52.20	38.00	
BOD (mg/l)	9.92	11.40	

5.0 CONCLUSION AND RECOMMENDATIONS

The quality of Abakpa River was assessed. This was achieved by collecting samples from the river and analyzing them to ascertain the concentration of pollutant. A total of 19 water quality parameters were determined in this research work. The research revealed that 47.37% in first sampling and 52.63% in the second sampling of the analyzed parameters met WHO (2011) limit. The variability of the results of the water quality parameters for the two seasons is indicative of the irregular pattern and varied trend of activities that take place in and around the river.

It was noticed that in the first sampling temperature, conductivity, alkalinity, pH, free chlorine, nitrate, nitrite, ammonium, and TDS passed the assessment while other parameters failed, in the second sampling temperature, conductivity, alkalinity, pH, free chlorine, nitrate, nitrite, ammonium, TDS and DO passes while other parameters failed the assessment. Also TCC and FCC were found to be too numerous to count in the second sampling.

From the field observations, laboratory results and finding of this study, it is pertinent that the indigenes should be sensitized on the health hazards associated with the direct or indirect pollution of the river.

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