Journal of Academia and Industrial Research (JAIR)
Volume 2, Issue 11 April 2014



ISSN: 2278-5213

RESEARCH ARTICLE

# Some Physical and Chemical Characteristics of Akpa Yafe River, Bakassi, Cross River State, Nigeria

**Udofia Udeme Uyom, Okorafor Kalu Ama* and Ntekim Immaculata Ephraim**
Dept. of Zoology and Environmental Biology, University of Calabar, Calabar, Nigeria
okoraforka@yahoo.com*; +2348037930542

## Abstract

Evaluation of some physical and chemical parameters of Akpa Yafe River was carried out in four locations: location 1 (Ikang), location 2 (Esuokon), location 3 (Ifiang Ayong) and location 4 (Archibong). The sampling was done over a period of three months (August-October 2012). The study was carried out to determine the pollution status of the river water using physico-chemical parameters with a view of effective utilization, better management, conservation and sustainable exploitation of the river resources. The results of the physical and chemical parameters showed some variations. pH ranged from 7.22-8.63, temperature ranged from 28.4-29.3°C, conductivity ranged from 10.5-26.6 NSCM, DO ranged from 0.94-1.39 mg/L, TDS ranged from 0.010-0.040 mg/L, TSS ranged from 0.01-0.016 mg/L, turbidity ranged from 0.018-0.030 mg/L, alkalinity ranged from 29-42 mg/L, Phosphate ranged from 0.232-0.326 mg/L, Nitrate ranged from 0.184-0.579 mg/L, Iron ranged from 0.12-0.48 mg/L, Manganese ranged from 0.063-0.114 mg/L, Lead ranged from 0.007-0.024 mg/L and Zink ranged from 0.007-0.021 mg/L. From the findings, all the parameters examined were lower than the compliance limit of the Federal Ministry of Environment (FMENV) and World Health Organization (WHO) tolerance limit for domestic uses except for Lead (Pb) which exceeded the FMENV and WHO limit. Iron (Fe), Nitrate ($NO_3$) and Phosphate ($PO_4$) were within the tolerance limit. The levels of Nitrate and Phosphate within the tolerance limit indicated a gradual threat of cultural eutrophication probably arising from washing of nitrophosphate fertilizer from nearby farm lands into the river. This together with the slightly high levels of Lead raises some concern on the pollution status of the river and demands a pragmatic effort to control and effectively manage the water resources for the health of the people and sustainable development of the community.

**Keywords:** Physico-chemical parameters, Akpa Yafe River, compliance limit, eutrophication, water resources.

## Introduction

The deterioration of water quality, its fast depletion and general loss of biodiversity are some of the major environmental challenges requiring urgent global attention. It is well known that water bodies have played a crucial role in the growth and development of the society. All settlements across the globe have started along water bodies and rivers. However, it is true that urban growth, increased industrial activities, intensive farming and over use of fertilizers in agricultural production are identified as drivers responsible for degradation. Increased urbanization coupled with industrialization during the past few years have resulted into depleting water ecosystem of major cities.

The interaction of both physical and chemical properties of water plays a significant role in the distribution and abundance of water organisms. The availability of good quality water is an indispensable feature for preventing disease and improving quality of life (Oluduro and Adewoye, 2007). Natural water contains some types of impurities whose nature and amount varies with source of water.

Worldwide, water bodies are the primary dump site for disposal of waste, especially the effluents from industries that are near them. These effluents from industries have great toxic influence on the pollution of the water body, as they can alter the physical, chemical and biological nature of the receiving water (Sandoyin 1991; Adekunle and Eniola, 2008). The initial effect of waste is to degrade the physical quality of water; later biological degradation becomes evident in terms of number, variety and organization of the living organisms in the water (Gray, 1989). Often the water bodies readily assimilate waste materials they receive without significant deterioration of some quality criteria; the extent of this is referred to as its assimilative capacity (Adekunle and Eniola, 2008). The aquatic ecosystem is upset by human activities resulting in pollution which is manifested dramatically as fish kill, offensive taste, colour and unchecked aquatic weed. The chemical element found in water will have an effect on biological processes which leads to inter-conversion of energy production of organic material and ultimately to production of aquatic resources such as fisheries and other biological component found in the river ecosystem.

Fig. 1. Map showing sampling locations.


The proper balance of physical, chemical and biological properties of water in ponds, lakes and reservoir is an essential ingredient for successful production of fish and other aquatic resources. The presence or absence of chemical element in a water body might be a limiting factor in the productivity of such water body. Also the abundance of a particular element might suggest the types of organism that can be found as well as indication of ecologically unstable or unfavourable ecosystem which can have negative or positive impact on the population. Studies have shown that water rich in silica will contain a high population of diatoms (Pasche, 1980) while high species diversity of snail could be explained by high concentration of  nitrogen and phosphate which is indicative of eutrophication that may lead to algal bloom and consequently deoxygenation and fish kill. Physical properties such as light penetration and water movement have shown to play important role in distribution and stratification.

The physico-chemical characteristic of a river can be significantly altered such as natural dynamics which consequently affect the water quality and quantity, species distribution and diversity, production capacity and even disruption in the in the balance of ecological system operating in the lake. The physico-chemical study could also help in understanding the structure and function of particular water in relation to its inhabitants. The physical and chemical limnology of a river is characterized by hydrological impact, autogenic nutrients dynamic and biological aspects. These factors combine with each other to determine the water quality and consequently community of the river (Sidnei *et al.,* 1992). In Cross River State, Nigeria, Akpa Yafe River is a good example of site where contribution of pollutants from natural (lithogenic) sources and anthropogenic activities is aggregated.

This work presents the results of the field study which assessed the physico-chemical parameters of Akpa Yafe River-water, Bakassi Local Government Area of Cross River State, Nigeria. The findings of this study will facilitate the effective management of water quality of the river and surrounding water bodies and also form the basis for further studies since this work is the first research on the pollution status of the river.

## Materials and methods

*Study area:* Akpa Yafe River lies approximately between latitude 4.683°N and longitude 8.517°E. It is a tributary of Cross River and forms a natural boundary between Nigeria and Cameroon by the Eastern flanks of Akpabuyo/Bakassi Local Government Areas of Cross River State. The river basin covers an area of 54,000 km$^3$ with 14,000 km$^3$ in the Cameroon and 40,000 km$^3$ in Southern Nigeria. It takes its rise from the Atlantic Ocean.

*Sampling locations:* Four sampling locations were identified and named as A, B, C, and D. The sampling locations were: location 1(Ikang), location 2 (Esuokon), location 3 (Ifiang Ayong) and location 4 (Archibong) respectively (Fig. 1). Human activities here include small scale farming, trading and artisanal fisheries. The total distance from A to D is 23.01 km. Individual distances between A to B is 5.92 km, B to C is 6.19 km and C to D is 10.9 km. The sampling locations were not evenly demarcated rather choice of sampling locations were based on accessibility to the river.

*Field sampling:* Triplicate water samples were collected from each of the four (4) sampling locations, using plastic sampling bottles of 150cl by dipping the bottles 15 cm below the water level at designated sampling locations.

All the sampling bottles were thoroughly washed and sun dried after which the sampling bottles were labeled with dates and collection stations. Until analysis, collected water samples were stored in a cool box containing ice blocks. Physico-chemical parameters, such as temperature, pH, conductivity as well as dissolved oxygen were measured *in situ* during sampling. Metal analysis of the water samples was also carried out; all analysis was done at Chemistry Department, University of Calabar, Nigeria.

*In situ measurement of some parameters in water:* The physico-chemical parameters were assessed using standard methods for examination of water and wastewater (APHA, 1998). The temperature of the water samples were taken at the sampling sites immediately after collection. A standard Celsius thermometer calibrated to 100°C was used to record the temperature at each sampling location. Conductivity was also measured at the sampling sites. The electrode or probe was dipped into the sample after rinsing with deionized water. The value was read and recorded in µs/cm. Hydrogen ion concentration (pH) was also measured *in situ*. The pH meter was calibrated with buffer 6.9 and 4.01. The probe was dipped into the pH buffer 6.9 solution and was allowed to adjust to 5.01 after switching the equipment to the pH scale; the same was repeated with pH buffer 4.01. Dissolved Oxygen (DO) was carried out with the aid of Dissolved oxygen meter. The equipment was placed in such a way that it was not exposed to direct heat radiation from the sun. The switch was turned to the percentage saturation position; the display was allowed to show a stable value. It was then adjusted by turning the small crew in the upper right corner until the display showed 002. The probe was dipped into the water sample to cover the probe to about 2/3, its length. The switch was turned to the ppm/mg/L position, the display was allowed to show a stable value and the result was recorded in mg/L.

*Laboratory studies:* Total Dissolved Solids (TDS) was determined using the Probe method. The equipment used was total dissolved solids meter. The probe was held in air and the equipment was on by pressing the power button. The display on the screen showed 00.0 µs/cm which indicated that the meter was calibrated. The probe was dipped in beaker containing the water sample (100 mL) of water and the power on button of the meter was switched on and also the TDS button was also switched on which gave the value of TDS, the water sample in mg/L. This was done after a time lapse of about 30 sec. Total Suspended Solids (TSS) was determined through Photometric method using spectrophotometer (810 nm). The equipment was warmed up for 15 min, calibrated and zeroed. The original sample containers were shaken and the sample filled the chambers. The lid was covered and the sample was filled into a 25 mL burette and placed in the cell chamber, the lid was covered and the concentration was read on the screen and recorded in mg/L. Turbidity was measured as soon as the samples were taken to the laboratory using absorptiometric method (450 nm). The equipment was warmed up for 15 min, calibrated and zeroed. The original sample container was shaken and the sample was filled in a 25 mL clean curette and placed in the cell chamber. The lid was covered and the concentration was read on the screen and recorded in Nephelometric Turbidity Unit (NTU).

Alkalinity was determined by titration. Hundred mL of the samples were placed in the porcelain basin and few drops of methyl orange indicator were added, the resulting solution was filtrated with 0.1 M HCl with continuous stirring until colour change from yellow to faint orange pink. Phosphate was determined by Molybdenum blue method using Mixed reagent (mixture of Ammonium molybdate solution, sulphuric acid solution and ascorbic acid solution). Sample obtained was mixed with the reagent and shaken immediately. After some min, the concentration of blue colour was measured at 885 nm. For the determination of nitrates, 50 $cm^3$ of filtered samples was measured and 1 $cm^3$ in HCl solution was added and mixed thoroughly. It was then transferred to the curette and the spectrophotometer was adjusted to 220 nm to take the concentration reading of the samples. Also the wavelength of the equipment was adjusted to 275 nm to determine the reading due to interference of some dissolved organic matter. It was then subtracted to obtain the actual concentration.

Iron determination was done by Stored programmed 510 wavelength. A clean cell was filled to 25 mL mask with pH adjusted sample ($pH_2$). The content of the ferrovet iron reagent-powder pillow was added and swirled to mix (An orange colour developed to show the present of iron). A reaction period of 3 mixtures was timed. A second sample was filled with the original sample of the 35 mL mark. The equipment was zeroed with the original sample without reagent. The sample cell containing the heated sample was placed into the cell holder. The mg/L (ppm) iron was read from the screen. Manganese was determined by stored programme (525 nm). The sample cell was filled with 25 mL water with contents of a buffer powder pillow; citrate type for manganese was added; one powder pillow-sodium periodate for manganese was added. The content was swirled to mix. (Violet colour developed to show present of manganese). A reduction period of 2 min was timed. Another sample cell was filled with the original water sample and placed in the cell holder. This sample was used to set the zero conception point pressed to give 0.0 at the display. The sample cell containing the prepared sample was placed in the cell holder. The sample compartment door was closed and the reading taken in mg/L manganese (Mn) from the display. Total ion was read from screen. Zinc (Zn) and Lead (Pb) were determined by a flame atomic absorption spectrophotometer (AAS).

Table 1. Physical and chemical parameters of Akpa Yafe River, Bakassi, Cross River State, Nigeria.

| Parameters | Location 1 (Ikang) | Location 2 (Esuokon) | Location 3 (Ifiang Ayong) | Location 4 (Archibong) | Mean value±SD |
|---|---|---|---|---|---|
| pH | 7.22± 0.011 | 7.05±0.05 | 7.16±0.08 | 8.63±0.04 | 7.51±0.05 |
| Temperature (°C) | 28.4±0.53 | 28.5±0.17 | 29.3±0.61 | 29.3±0.44 | 28.9±0.31 |
| Conductivity (NS/CM) | 26.6±2.51 | 18.20±3.26 | 10.57±3.28 | 16.43±1.45 | 19±2.63 |
| Dissolved Oxygen (mg/L) | 0.94±0.08 | 1.14±0.12 | 1.26±0.01 | 1.39±0.02 | 1.2±0.04 |
| Total Dissolved Solids (mg/L) | 0.014±0.003 | 0.040±0.004 | 0.018±0.004 | 0.010±0.002 | 0.07±0.003 |
| Total Suspended Solids (TSS) | 0.012±0.004 | 0.014±0.002 | 0.011±0.003 | 0.016±0.003 | 0.014±0.003 |
| Turbidity (mg/L) | 0.025±0.005 | 0.021±0.002 | 0.030±0.006 | 0.018±0.002 | 0.025±0.004 |
| Alkalinity (mg/L) | 37.0±2.00 | 29.3±1.73 | 31.0±2.00 | 42.0±6.08 | 35±2.9 |
| $PO_4$ (mg/L) | 0.271±0.004 | 0.232±0.005 | 0.254±0.003 | 0.546±0.003 | 0.326±0.003 |
| $NO_3$ (mg/L) | 0.579±0.004 | 0.184±0.004 | 0.282±0.003 | 0.185±0.005 | 0.29±0.004 |
| Fe (mg/L) | 0.37±0.002 | 0.14±0.002 | 0.12±0.003 | 0.48±0.003 | 0.03±0.002 |
| Mn (mg/L) | 0.105±0.005 | 0.147±0.005 | 0.063±0.004 | 0.114±0.003 | 0.03±0.004 |
| Pb (mg/L) | 0.024±0.005 | 0.007±0.003 | 0.009±0.004 | 0.008±0.003 | 0.107±0.003 |
| Zn (mg/L) | 0.021±0.003 | 0.020±0.001 | 0.008±0.003 | 0.007±0.002 | 0.012±0.002 |

*Statistical analysis:* Data obtained were subjected to descriptive statistics. The values were computed and presented as mean ± standard deviation. Levels of significant differences in the values of the parameters were assessed using coefficient of variance.

## Results

The results of the physical and chemical parameters of water are presented in Table 1, while Table 2 shows the range values of the physico-chemical parameters of the surface water. The pH values of the water were observed to have variations at each sampling locations. The pH value recorded ranged from slightly alkaline to alkaline. In all water samples, the lowest pH value recorded was 7.16 at location 3 (Ifiang Ayong) while the highest pH value was 8.63 recorded at location 4 (Archibong) and the mean value from location 1 to 4 is 7.5±0.005. Temperature is an important water quality parameter and is relatively easy to measure. Water bodies will show changes in temperature seasonally. The temperature of the study ranged between 28.4-29.3°C with a mean value of 28.9±0.31°C. The lowest value was recorded at location 1 (Ikang) while the highest temperature value was recorded at location 3 and 4 (Ifiang Ayong and Archibong) respectively.

Conductivity in natural waters is the normalized measure of the water ability to conduct electric current. The values for conductivity ranged from 10.5-26.6 with a mean value of 19±2.63. The highest value was recorded at Ikang while the lowest value was recorded at Ifiang Ayong. Dissolved oxygen results ranged from 0.94-1.39 mg/L with a mean value of 1.2±0.04 mg/L. The highest value of dissolved oxygen was recorded at Archibong while the lowest value was recorded at Ikang. Total Dissolved Solids (TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid; molecular ionized or micro granular suspended form. The mean value of TDS was 0.07±0.003 mg/L with highest value recorded at location 2 (Esuokon) and lowest at Archibong. Total Suspended Solids (TSS) is the material in water that affects the transparency or light scattering of the water. TSS is typically composed of fine clay or slit particles, plankton, organic compounds or other microorganisms. The mean value of TSS recorded for all the water samples is 0.014±0.003 mg/L with highest value recorded at Archibong and lowest value at Ifiang Ayong. The turbidity as obtained in this study ranged from 0.018-0.03 ONTU with a mean value of 0.025±0.04 mg/L. The lowest value was recorded at Archibong and the highest at Ifiang Ayong.

Total alkalinities measured ranged from 29-42 mg/L with a mean value of 55±2.9 mg/L. The lowest value of alkalinity was recorded at location 2 (Esuokon) while the highest value was recorded at Archibong. Nitrate concentration ranged from 1.84-0.579 mg/L with the lowest concentration value (0.579±0.004 mg/L) recorded at station 1 and the highest concentration value (0.282±0.003 mg/L) recorded at station 3. The main environmental impact associated with phosphate pollution is eutrophication. Inorganic phosphate fluctuated between 0.23-0.546 mg/L with the maximum concentration at Archibong and a mean value of 0.326 mg/L. The ranges and distribution pattern of metal concentration in water are included in Table 1. Total iron concentration varied from 0.12-0.48 mg/L with highest concentration at Archibong with mean value of 0.03±0.002 mg/L. Manganese ranged from 0.063-0.147 mg/L with a mean value of 0.003±0.002 mg/L and highest concentration found at Esuokon. Lead (Pb) and zinc (Zn) had ranges of 0.007-0.024 mg/L and 0.007-0.021 mg/L with mean values of 0.107±0.003 mg/L and 0.012±0.002 mg/L respectively. The highest concentrations of Pb and Zn were recorded at Ikang.

Table 2. Physical and chemical parameters of Akpa Yafe River with FMENV and WHO Standards.

| Parameters | Range values | Standards | |
|---|---|---|---|
| | | FMENV | WHO |
| pH | 7.22–8.63 | 6–9 | 6.5-9, 8.0 (P) |
| Temperature (°C) | 28.4–29.3 | 27 | <35 |
| Conductivity (NS/CM) | 10.5–26.6 | 70 | 20 |
| Dissolved Oxygen (mg/L) | 0.94–1.39 | 8–10 | 5.0 |
| Total Dissolved Solids (mg/L) | 0.010–0.040 | NI | NI |
| Total Suspended Solids (TSS) | 0.011–0.016 | >10 | 710 |
| Turbidity (mg/L) | 0.018–0.030 | 0–1 | 5.0 |
| Alkalinity (mg/L) | 29–42 | <120 | 30–500 |
| $PO_4$ (mg/L) | 0.232–0.326 | NI | <1 |
| $NO_3$ (mg/L) | 0.184–0.579 | NI | <1 |
| Fe (mg/L) | 0.12–0.48 | 0.3 | <1 |
| Mn (mg/L) | 0.063–0.114 | 1.0 | 1.0 |
| Pb (mg/L) | 0.007–0.024 | 0.001 | 0.001 |
| Zn (mg/L) | 0.007–0.021 | 3.0 | 3.0 |

P = Health based provisional value, NI = Not indicated, WHO = World Health Organization and FMENV = Federal Ministry of Environment.

## Discussion

Optimal pH range for sustainable aquatic life is pH 6.5-8.5 and the principal components regulating pH in natural waters is the carbonate which comprises $CO_2$, $H_2CO_3$ and $HCO_3$ (APHA, 1998). Water pH which is an indicator of acidic or alkaline condition of water status was within FMENV's permissible limit (6-9) but slightly higher than WHO permissible limit of 6.5-8.5 as recorded at location 4 (8.63). The pH was slightly alkaline in locations 1-3 throughout the period of study; this could be attributed to the dilution of saline mangrove water by fresh water inflow. High pH recorded at station 4, could be due to the removal of $CO_2$ by photosynthetic organism. The results obtained for pH are similar to the results obtained by Adefemi *et al.* (2007) in water samples from Ureje, Egbe, Ero and Itapaj dams, all in Ekiti State. Varunprasath and Nicholas (2010) also obtained similar result in water samples from India. High or low pH values in a river have been reported to affect aquatic life and the toxicity of other pollutant in one form or the other (Morrison *et al.,* 2001).

There was slight progressive temperature increase across each sampling area. This could be due to the fact the ambient temperature increased as sampling progressed in each sampling day. Generally, the temperature was above FMENV's permissible limit in all the stations. The increase in temperature could be attributed to high solar radiation in the tropical region. Temperature difference could be also due to the increase in the rate of chemical reaction and nature of biological activities, since temperature is one of the factors that govern the assimilative capacity of the aquatic system (EPA, 1976). The temperature results were higher when compared with results from water samples in Ona River (Adefemi *et al.,* 2007; Andem *et al.,* 2012) but similar with the results obtained in Calabar River by Okorafor *et al*. (2013). Conductivity obtained in all cases was found to be below FMENV and WHO acceptable limit.

The conductivity was low when compared to values obtained from Okpoka Creek, Niger Delta, Nigeria by Abowei and George (2009). Reduction of conductivity in the area might be due to fresh water input from rain or it may be due to the uptake of the ions by the organism for their metabolism. Low conductivity is also possible due to organic detritus, weed growth and biomass degradation in the benthic layer. Similar observation has been reported by Aluji *et al.* (2003). Dissolved oxygen is indicative of health of an aquatic system, the vital metabolism of aerobic organisms and respiration depends on the amount of oxygen dissolved in the water. There is a strong line of relationship between DO and many toxic existences. The range of DO (0.94-1.39 mg/L), across the river is below the permissible limit. Dissolved oxygen concentration in unpolluted water normally range between 8 and 10 mg/L and concentration below 5 mg/L adversely affect aquatic life (DFID, 1999; Rao 2005). The dissolved oxygen value from this study is low and its mean value is similar to the one reported by Muhibbu-Din *et al.* (2011). Depending on the water temperature requirement for a particular aquatic species at various stages, the DO criteria values ranges from 5 to 9.5 mg/L for warm water biota and 6.5-9.5 mg/L for cold-water biota (NEMA, 2003). Low concentration of DO as obtained from the four sampling locations (Ikang, Esuokon, Ifiang Ayong, Archibong) when combined with the presence of toxic substances may lead to stress response in aquatic ecosystem because the toxicity of certain element such as Zn, Pb and Cu, is measured by low concentration of DO. Primary sources of TDS in receiving waters are agricultural, residential runoff, leaching soil contamination etc. The mean value of TDS was 0.07±0.003 mg/L. Kataria *et al.* (1996) reported that increase in values of TDS indicated pollution by extraneous material. However, the values gotten were in low concentration, on the average TDS contributes to the palatability of drinking water.

Total Suspended Solids (TSS) determines the depth of a photosynthetic organism or the photozone of a river. The mean value is higher than the one reported for Ona River (0.04±0.03 mg/L) by Adefemi *et al*. (2007). The quality of wastes in different phases of natural aquatic systems is reflected by TSS and other physico-chemical parameters (EPA, 1992). The higher values obtained could be as a result of washing away of fertilizers into the river (Ipinmoroti and Oshodi, 1993). Turbidity is associated with suspended solids concentration and this generally affects the general condition of water and aquatic life. Suspended solids in the runoff pollutants greatly influence the turbidity of the receiving water which in turn affects light penetration resulting in reduced photosynthesis (Patel *et al.,* 1983). The values of turbidity was below WHO set limit. Total alkalinities measured in mg/L $CaCO_3$ were found to fall within the set limit and similar results was reported for Karmana River by Sujitha *et al.* (2010). Alkalinity is imparted more by the presence of $CO_2$ suggesting the decay of organic matter and is the prominent activity elevating alkalinity in natural waters.

Unpolluted natural water usually contains only minute amount of nitrate (Jaji *et al.,* 2007). Nitrate concentration was highest at station 1. Moro Lake has the highest concentration of nitrate (22.4 mg/L) in Nigeria (Mustapha and Omotosho, 2005). Other works reported include 0.5 mg/L in Shiroro Lake (Kolo, 1996), 4.0 mg/L in Jebba (Adeniji *et al.,* 1994) and 5.1 mg/L in Ogun. The level of nitrate concentration within the tolerance limit of FMENV and WHO could be due to leaching and surface runoff of nitro-phosphate fertilizers from nearby farmlands. Nitrate can exist naturally in ground water but can increase drastically on irrigated lands. They are various sources of phosphate to rivers, such as firm deposit, runoff from surface catchments, interaction between water and sediment from dead plant and animal remains at the bottom of rivers and detergents which get accumulated in the river. The fluctuation in nitrate and phosphate values observed in the present study reveals localized mode of contamination in the river. Similar result of the localized influence in the water quality of Bharathpuzha River has been reported by Bahu *et al.* (2005). Phosphate is considered to be the most significant among the nutrient responsible for eutrophication of rivers, as it is the primary initiating factor. The result reveals that the rivers can therefore result in nutrient enrichment, productivity, decay and sedimentation (Adeyomo, 2003). The high concentration could also be traced to leaching of phosphate fertilizer into the river. Kolo (1996) has reported this on Shiroro. Total iron concentration was within the acceptance limit of FEPA and WHO. Similar investigation has been carried out by some authors (Sreejith *et al.,* 1998; Krishnakumar, 1998). For Pb, the levels recorded across the rivers were higher than the WHO recommended limit of 0.001. Chronic exposure to Pb has been linked to growth retardation in children (Schwartz *et al.,* 1986). Lead toxicity studies conducted on female animals revealed mortality miscarriages, premature delivery and potential mortality (Tapieau *et al.,* 2000). On the average, the concentration of Mn and Zn were found in low concentrations. Oluwande *et al.* (1983) reported generally on the level of some metals in Nigerian rivers. The contamination of metals in the aquatic environment has been a serious problem. They have high level of persistence and toxicity in most aquatic biota including microorganisms.

## Conclusion

The findings of the assessment of physico-chemical parameters of water in the river studied above could be used as a baseline and reference point for assessing further changes caused by nature or man in this river, since there has not been published information on this important river. Although most of the water parameters fall within the acceptable range by FMENV and WHO, the DO is low and Pb is above the permissible limit. This indicates that Akpa Yafe River is under pollution threat. Therefore, good management measures should be employed to make sure that the river regains its fitness for the support of aquatic life and also for other domestic uses. Adequate waste disposal facilities that will prevent the indiscriminate dumping of wastes into Akpa Yafe River should be provided to the inhabitants of the area. There is also the need for public enlightenment campaigns to raise the level of awareness and reorienting the attitude of large and small scale industries as well as individuals with respect to environmental pollution problems which may result from discharge of untreated wastes/effluents into the natural water bodies.

The villagers should also be enlightened through public awareness programmes on the effects of polluted water on their health and the health of their children. Maintaining adequate in-stream flow is critical to protecting water quality and preserving aquatic habitat. Use of best management practices can also help villages, utilities and landowners avoid harm to aquatic systems. This includes cautious use of pesticides and herbicides. Farmers should be taught how to apply the right amount of the right fertilizers at the right moment, and know that it would go directly into their crops and not into the river. Dumping of refuse into the aquatic systems should be avoided. Sewage and effluents should be treated to detoxify them because they will end up in our aquatic ecosystems.

## References

1. Abowei, J.F.N. and George, A.D.I. 2009. Some physical and chemical characteristics in Okpoka Creek, Niger Delta, Nigeria. *Res. J. Environ. Earth Sci*. 1(2): 45-53.
2. Adefemi, O.S., Asaolu, S.S. and Olaofe, O. 2007. Assessment of the physico-chemical status of water samples from major dams in Ekiti State, Nigeria. *Pak. Nut.* 6(6): 657-659.

3. Adekunle, A.S. and Eniola, I.J.K. 2008. Impact of industrial effluents on quality of segment of Asa River within an Industrial Estate in Ilorin, Nigeria. *New York Sci. J.* 1(1): 17-21.
4. Adeyomo, O.K. 2003. Consequences of pollution and degradation of Nigerian Aquatic
5. American Public Health Association (APHA). 1998. Standard methods for examination of water and waste water. 20th edn., American Public Health Association, Washington, D.C. New York, USA. p.1268.
6. Andem, A.B., Udofia, U., Okorafor, K.A., Okete, J.A. and Ugwumba, A.A.A. 2012. A study on some physical and chemical characteristics of Ona River, Apata, Ibadan South-west, Oyo State, Nigeria. *Euro. J. Zool. Res*. 1(2): 37-46.
7. Bahu, A.R., Classen, J.J., Williams, B. And Starvely, J. 2005. Emerging environmental contaminants and antibiotic resistance; science and policy concerns. Animal Waste Management Symp. pp.246-259.
8. DFID. 1999. A simple methodology for water quality. G.R. Pearce, M.R. Chaudhry and S. Ghulum (Eds.). Department for International Development, Walingford. p.100.
9. Environment on Fisheries Resources. *Environmental.* 23(4): 297-306.
10. Environmental Protection Agency (EPA) Act. 1992. Quality criteria for water Use.
11. Environmental Protection Agency (EPA). 1976. Quality criteria for water Use. E.P.A, 440, 1a-76-023, Environ. Agency, Wash.
12. Gray, A.V. 1989. Case study on water quality modelling of Dianchi Lake, Yunnan province, southwest China. *Water Sci. Technol*. 40: 35-43.
13. Ipinmoroti, K. and Oshodi. 1993. Determination of trace metals in fish, associated wanted and soil sediment fresh fish ponds. *Discovery*. 5: 138.
14. Kataria, H.C., Quereshi, H.A., Iqbal, S.A. and Shandilya, A.K.1996.Assessment ofwater quality of Kolar Reservoir in Bhopal (MP). *Pollut. Res*. 15: 191-193.
15. Kolo, R. 1996. The assessment of physicochemical parameters of Shiroro Lake and its major tributaries in Eyo A.A. (ed). Proc. of the Annual Conference of Fisheries of Nigeria. pp.260-268.
16. Krishnakumar, A. 1998. Hydro geochemistry of Vellayani, fresh water lake with special reference to drinking water quality. M.Phil., Thesis, University of Kerala, India.
17. Morrison, G., Fatoki, O.S., Persson, L. and Ekberg, A. 2001. Assessment of the impact of point source pollution from the Keiskammahoek Sewage Treatment Plant on the Keiskamma River–pH, electrical conductivity, oxygen demanding substance (COD) and nutrients. *Water SA*. 27(4): 475-480.
18. Muhibbu-Din, O.I., Aduwo, A.O. and Adedeji, A.A. 2011. Study of Physicochemical Parameter of effluent impacted stream in Obafemi Awolowo University, Ile-Ife, Nigeria. B.Sc (Hons) degree in Zoology Dissertation, Obafemi Awolowo University.
19. Mustapha, M.K. and Omotosho, J.S. 2005. An assessment of the physico-chemical properties of Moro Lake. *AJAZEB.* 7: 73-77.
20. Natural Environmental Agency (NEMA). 2003. Environmental standards and preliminary environmental impact assessment. Natural resources for Water Quality and Discharge of Effluents into Water. Vol. 1. Prepared for the Ministry of Environment, Nigeria.
21. Okorafor, K.A., Effanga, E.O., Andem, A.B., George, U.U. and Amos, D.I. 2013. Spatial variation in physical and chemical parameters and macro-invertebrates in the intertidal regions of Calabar River, Nigeria. *Greener J. Geol. Earth Sci.* 1(2): 63-72.
22. Oluduro, A.O. and Adewoye, B.I. 2007. Efficiency of *Moringa oleifera* seed extract on the Microflora of surface and ground water. *J. Plant Sci*. 6: 463-538.
23. Oluwande, P.A., Sridhar, M.K.C., Bammeke, O.A. and Okubadejo. 1983. Pollution levels in some Nigerians Rivers. Water Res. 17(9): 863-957.
24. Pasche, E. 1980. Silicon, in the physiological ecology of phyto planktons. Studies in the Ecology J. (ed. I. Morris), Oxford. Blacwells. pp.259-284.
25. Patel, S.G., Singh, D.D. and Harshey, D.K. 1983. Pamitae (Jabalpur) Sewage polluted water body, as evidenced by chemical and biological indi cators of pollution. *J. Environ. Biol.* 4: 437-449.
26. Rao, P.V. 2005. Textbook of environmental engineering. Eastern Economy Ed., Prentice-Hall of India Private Limited, New Delhi, Chapter 3. p.280.
27. Sandoyin. 1991. Eutrophication trends in the water quality of the Rhode River. *J. Mar. Biol. Assoc*. 54: 825-855.
28. Schwartz, L., Angie, C. And Pitcher, H. 1986. Relationship between childhood blood lead levels and stature. *Pediatr*. 77: 281-288.
29. Sidnei, M.T., Fakio, A.L., Maria, T., Francises, A.E. and Adaunto, F. 1992. Seasonal variation of some limnological factors of Lagoa do Guarana, a Varzea Lake of Rio Parana State of Mato Groso do sul, Brazil. *Rev. Hydrobiol.* 25(4): 269-276.
30. Sreejith, S., Mani, R. And Padamalal, D. 1998. Granulometric of the sediments of Sasthamkotta and Vellur Lakes, Kerala: Implication of hydrodynamic responses on lacustrine sediments. *J. Indian Assoc. Ediment*. 17: 251-262.
31. Tapieau, C., Poupou, J., None, P. and Leferie, B. 2000. Lead accumulation in the mouse ovary after treatment with induced follicular atresia. *Reprod. Toxicol*. 15(4): 385-391.
32. Varunprasath, K. and Nicholas, A.D. 2010. Physico-chemical parameters of river bhavani in three stations, Tamil Nadu, India. *Iran. J. Energy Environ.* 1(4): 321-325.