

ASSESSMENT OF PHYSICO-CHEMICAL PARAMETERS OF MAYO INNE RIVER, ADAMAWA STATE, NIGERIA.

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Abstract

This study assessed the physico-chemical parameters of River Mayo Inne, Fufore Local Government, Adamawa state, Northeast Nigeria. Four locations were chosen spatially along the water course to reflect a consideration of all possible human activities that are capable of changing the water quality of the river. Water samples were collected monthly for six consecutive months (July-Dec. 2014) at the four sampling stations. pH, water temperature ($^{\circ}\text{C}$), conductivity ($\mu\text{s}/\text{cm}$) were analyzed in-situ while dissolved oxygen (mg/L), nitrate (mg/L), phosphate (mg/L), alkalinity (mg/L) were determined ex-situ using standard methods. Physico-chemical parameters Result showed that dissolved oxygen, temperature, transparency, hydrogen ion, free CO_2 , Phosphorus, Ammonia, Alkalinity concentration fall within the permissible limit of WHO for drinking water and fish production. The physico-chemical parameters in river Mayo Inne generally fall within acceptable limits.

Keyword: Physico-chemical parameters, River water, Assessment.

Introduction

Water, is a universal solvent with its unique characteristics serves as a haven for most living organism on earth. Water is one of the abundantly available substances in nature which man has exploited more than any other resources for the sustenance of life (Patil, 2012).

Rivers are important multi usage components, such as source of drinking water, irrigation, fishery and energy production (Hacioglu and Basaran 2009). In recent years human impact on the environment such as urban, industrial and agricultural activities have increased exploitation of water resources as well as natural process such as precipitation inputs, erosion, weathering of crustal material, degradation of surface water and rendering the water bodies unsuitable for both primary and secondary use (Najoufpour *et al.*, 2008; Agbaire and Obi, 2009).

However, water contaminated by effluent from various sources is associated with heavy disease burden (Okoh, 2007), and this could influence the current shorter life expectancy in the developing countries compared with developed nation (World Health Organization, WHO, 2002). The Quality of water is described by its physical, chemical and microbiological characteristics (Rajeshwari and Sarawath, 2009).

Ramanathan *et al.* (2005) stated that Hydrogen ion concentration or pH as one of the vital environmental characteristics that decides the survival, metabolism, physiology and growth of aquatic organisms, and recommended optimum range of pH 6.8-8.7 for maximum growth and production of

shrimp and carp. Alkalinity of a water body is a measure of its capacity to neutralize acids to a designated pH (Edokpayi, 2005). Alkalinity between 30 and 500 mg/L is generally acceptable to fish and shrimp production (Abowei and George 2009). Water temperature is an important environmental variable that affects metabolic activities, growth, feeding, reproduction distribution and migratory behavior of, aquatic organisms (suski *et al.*, 2006). Conductivity is a good and rapid method to measure the total dissolved ions and is directly related to total solids (Bhatt *et al.*, 1999). The desirable range of water conductivity is 100-2,000($\mu\text{s}/\text{cm}$) while high conductivity is an indication of the presence of large amount of dissolved salts, which may be detrimental to fish (Stone and Thomforde, 2006).

Oxygen concentration is an indication of water health as most aquatic organisms acquire oxygen directly from the water rather than breathing air at the surface (Australian Center for Tropical Freshwater Research, ACTFR, 2002). Most aquatic organism thrive in water that has high dissolved oxygen level, but a drop below 3mg/l causes death in many species (Bramley and Roth 2002). Turbidity is the measure of water clarity; the more the material suspended in the water the less the light can pass through the water column, higher turbidity increases water temperature which reduces the concentration of dissolved oxygen (DO) because warm water holds more DO than cold water (Abubakar, 2006).

World Health Organization (2004) reported that human activities related to agriculture are major causes of the presence of nitrates and nitrites in

surface water. These two substances are responsible for many environmental problems. The required standard for nitrite is 50mg/l. Phosphorus is limited in supply in most tropical water bodies. Even modest increase can under the right conditions, set off a whole chain of plants growth, algal blooms, low dissolved oxygen and the death of certain fish, invertebrates and other aquatic animals (Margaleff, 1996, Chapman, 1997). Ammonia is an important nutrient of phytoplankton; it is also the major end-product of protein catabolism excreted by aquatic animals and also unionized ammonia can be toxic to fish and other animals and is therefore of considerable aqua-cultural significance (Stirling, 1985).

River Mayo Inne receives a wide variety of waste from human activities. These are mostly domestic waste, sewage and agricultural waste. These wastes generated flows into thrives and may contaminate the water with a variety of contaminants. Such contamination might accumulate to a certain level, and will affect the distribution and abundance of fish species. This has prompted the need to investigate the physico- chemical parameters in the river. The information obtained from this study will

serve base guideline for limnological, ecological, studies of this water body.

Study Area:

Mayo Inne River is located at Fufore Local Government Area of Adamawa State within the North Eastern region of Nigeria. It lies between latitude 9° 13' 00" ON 9.2167 and longitude 12° 39' 00" OE 12.6500. and a total land cover of about 5078.14 (sq km) and it is situated in the Northern guinea savannah vegetation zone of the country with mean annual rainfall ranging 700mm-1000mm(Adebayo, 1999).

River Mayo Inne is the main source of water for irrigation, domestic, fishing activities for the people of Mayo Inne and a tributary of river Benue; It is major river in the state, which rises from the highlands of Cameroon and flows southward to join the Niger at Lokoja

Material and Methods

Sampling Procedure water sample were collected from station A (Dingali), B (Limi),C (Wuro Abdu)and D (Wuru Ishaku) areas covering the upper reach, middle reach and the lower reach of the river{figure1}. The following parameter were determined at the site; Temperature, PH, turbidity, and conductivity

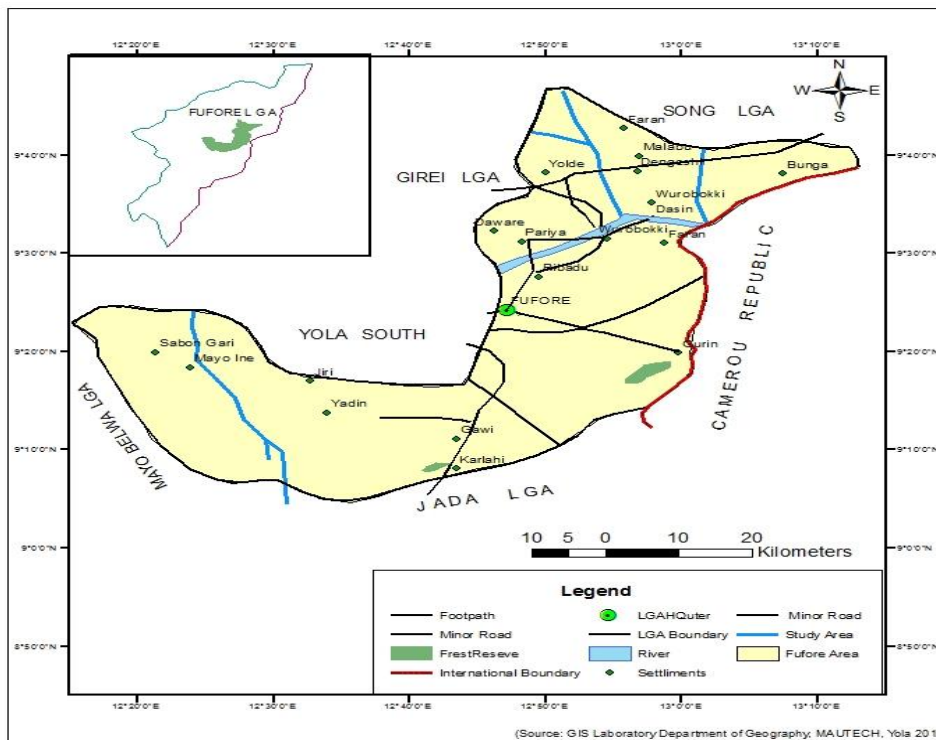


Figure 1: Map of Fufore L.G A Showing the study Area

While water sample were collected in labeled and fixed sampling bottles of 250ml glass for dissolve oxygen, free carbon dioxide, Phosphorus, Ammonia, Alkalinity, Nitrogen at the different sampling station. Before sampling the bottles were rinsed three times with sample water before being filled with the sample. The actual sampling was done midstream by dipping each sample bottle at approximately 20-30cm below the water surface, projecting the mouth of the container against the flow direction. The bottle was filled to the brim and covered immediately to avoid air bubbles inside. Samples were then transported from the field to the laboratory where physico-chemical analysis was carried out.

Determination of Temperature

Temperature reading was determined directly at the sampling site using a mercury bulb thermometer (GlasweKwer tein model). The bulb was placed in the water and allowed for about two minutes for equilibration before taking the reading (Boyd, 1981).

Determination of Transparency

The transparency was measured as described by Stirling, (1985) using Sechi disc depth. The disc was lowered until it disappeared from view and the depth recorded. The disc was then raised until it just appears and the depth recorded. The disc visibility was estimated by taking the average two reading i.e. $(L_1+L_2)/2$. The average depth readings were taken while viewing the disc directly from above and backing the sun.

Determination of Dissolved Oxygen

Dissolved oxygen was determined as described by Saxena, (1990). In the field a sample bottled was filled and a stopper to avoid air bubbles. The bottle was opened and 1ml of each magnanous sulphate and alkaline reagents (potassium iodide plus potassium hydroxide) using separate pipette was poured in it. A precipitate appears. The stopper was placed and the bottle was shaken thoroughly. 2ml of sodium H_2SO_4 (reagent) was added and shaken thoroughly to dissolve precipitate. 50ml of content was transferred gently avoiding bubbling in a conical flask. Four (4) drops of starch indicator was added. Tritation was done against sodium thiosulphate solution and the end point was noted when initial blue colour turned to colourless. 50ml of content was used for titration

Determination of Free Carbon dioxide

Carbondioxide was determined tritrimetically in the laboratory as described by

Saxena (1990). 50ml of water sample was put into a flask and 3 drops of phenolphthalin indicator (reagent) was added. If the colour turned pink free CO_2 was absent in the sample. If the sample remained colourless, it was titrated against sodium hydroxide solution (reagent) until a pink colour appeared (end points).

Calculation

$$\text{Free } CO_2 \text{ (mg/l or PPM)} = \frac{V_T \times 100}{V_S}$$

V_S

Where

V_T = volume of titrant (ml)

V_S = volume of sample (ml)

Determination of Hydrogen Ion (pH)

The pH of the water body was determined at the site using pH meter (model: Hanna instruments model No H18915ATC). The electrode of the meter was standardized using a buffer solution, which have the same temperature as the water. It was washed in distilled water before placing deep into the water sample for about 2 minutes for equilibration. The electrode was always standardized with a buffer solution before measurement was taken (Abubakar, 2006).

Determination of Total Phosphorus

Phosphate was determined as described by the Association of official Analytical chemistry, (1990). 5ml of the sample was measured into a test tube. 1ml ammonium molybdate solution was added and allowed to stand for 20 seconds. 1ml of hydroquinone solution was added, that flask was rotated to mix and 1 ml of Na_2SO_3 was added. 2ml of distilled H_2O was added. The test tube was stopped by thumb and was shaken to mix thoroughly. The mixture was allowed to stand for 30 minutes and then measured with spectrophotometer (model spectronic 20:722-2000) set at 650nm, alongside blank.

Determination of Total Ammonia

Ammonia was determined according to Philips, (1985). Samples collected were immediately filtered through pre-rinsed whatman GF/C filter paper. The phenol - hypochloride method was adopted for fresh water sample. 1.0ml of phenol-nitropruside reagent was added to 25ml of sample. It was mixed and 1.5ml of alkaline hypochloride reagent was added. The flask was covered and the mixture was left to stand in the dark for 1 hour at room temperature. The absorbance of standards of ammonia stock was serially diluted with the same procedure used for sample and reagent.

Determination of Total Alkalinity

Total alkalinity was determined as described by Stirling (1985). 50ml of the water sample was measured and transferred into conical flask. Three (3) drops of methyl orange indicator was added. The sample was titrated with standard 0.0/m H₂SO₄ from a 10ml burette with continuous shaking, until the colour changed from blue to pale pink. The total alkalinity was calculated from the equation;

$$\text{Alkalinity in mg/l} = \frac{n \times V_2 \times 1000}{V_1}$$

Where

n =normal of standard H₂SO₄

V₁= volume of sample

V₂= volume of acid used

Determination of Conductivity

Conductivity was determined at the site using conductivity meter (model: PHYTE 65667.00). The unit of measurement was expressed in us/cm which is the SI units. All measurement was corrected by multiplying by a factor given in a standard table of conversion.

$$\text{Conductivity (K)} = C \times 1/R$$

Where

C=cell constant

R =resistance

Determination of Nitrogen

Nitrogen was evaluated as described by Philips, (1985). Sample of water collected was immediately filtered through pre-rinsed What-man GF/C filter paper. 25ml of sample was measured in a 150ml conical flask and 1ml concentration H₂SO₄ and a dozen anti-bumping granules were added. The sample procedure was carried out on standard and distilled water as blank. The sample was boiled a hot plate until the white fumes of sulphur-trioxide appeared. The flask was then removed from the hot plate. 1g of potassium per sulphate was added to the flask. The mixture was strongly heated at fuming temperature for exactly 10 minutes. Sufficient time was allowed for cooling and 15ml distilled water was added and transferred to 50ml volumetric flask. The mixture was gently heated to dissolve the digest in the

water. The conical flask was rinsed 3 times with fresh distilled water to ensure that the sample is completely transferred. 1 drop of methyl red solution and 10M sodium hydroxide was added until the solution turned clear. The solution was back titrated by adding 4M H₂SO₄ drop by drop until the solution turned red. The sample was made up to 50 ml distilled water. 1.0ml of phenol-nitropruside and 1.5ml of alkaline hypochloride was added to the sample and blank. Samples were allowed to stand for 24 hours before the absorbance of stand and samples was taken against a reagent blank at 635nm.

Statistical Analysis.

The data obtained in this study was analyzed statistically using analysis of variance (ANOVA) graph (bar-chart). Means and standard deviations were calculated following established statistical procedure (graph pad 2003 and Excel window, 2003. Data was presented in the form of graphs (Bar charts).

Results

The lowest mean water temperature value of 24.8°C was recorded at sample station B in the month of August. While the highest value of 29°C was recorded at sample station B,C, D in the month of October (Figure 2). The monthly mean variation of water temperature ranged from 25.45°C in the month August to 28.75°C in the month of October. The result therefore, revealed that there was no significant difference in month of September, November, December (P>0.05). The result shows that the lowest mean water transparency value of 10cm was recorded at sample station A in the month of August. While the highest value of 12.7cm was recorded at sample station C in the month of October (Figure 3). The result mean value of dissolved oxygen (DO) is 7.3mg/l was recorded at sample station A in August and November. While the highest value of 10.3mg/l was recorded at sample station D in the month of July (Figure 4). The result shows that the lowest mean value of free carbon dioxide is 1.4mg/l was recorded at sample station A in the month of July, while the highest value of 3.61mg/l was recorded at sample station C in the

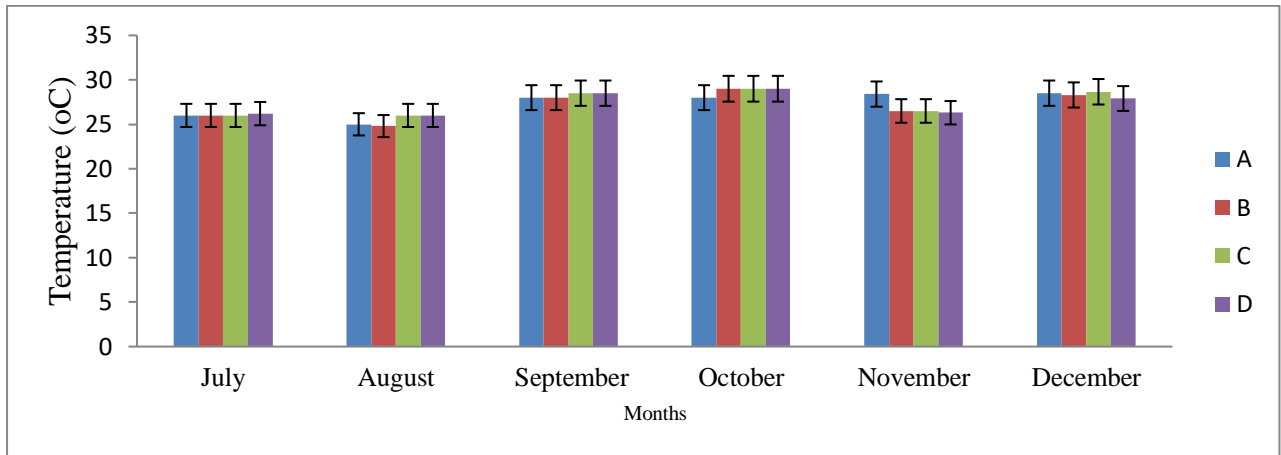


Figure 2: Monthly Mean Variation of Temperature in River Mayo Inne during the Rainy and Dry Season 2014

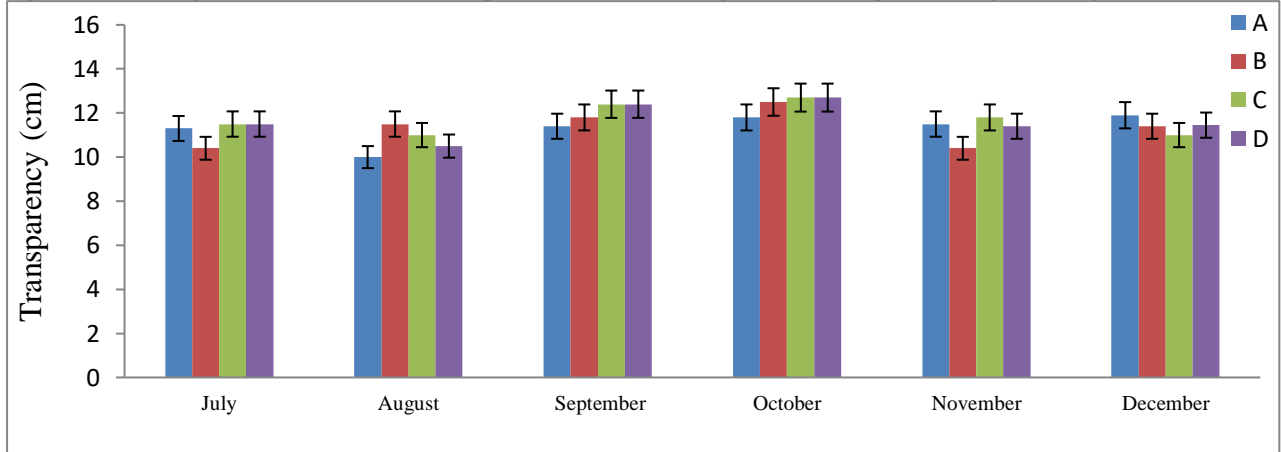


Figure 3: Monthly Mean Variation of Transparency in River Mayo Inne during the Rainy and Dry Season 2014

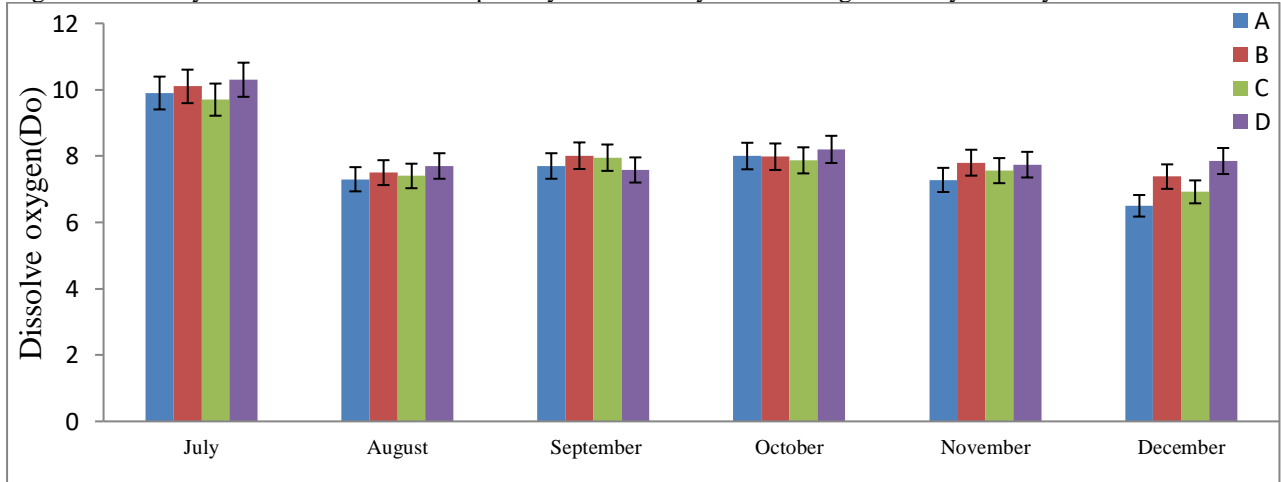


Figure 4: Monthly Mean Variation of Dissolve Oxygen in River Mayo Inne during the Rainy and Dry Season 2014

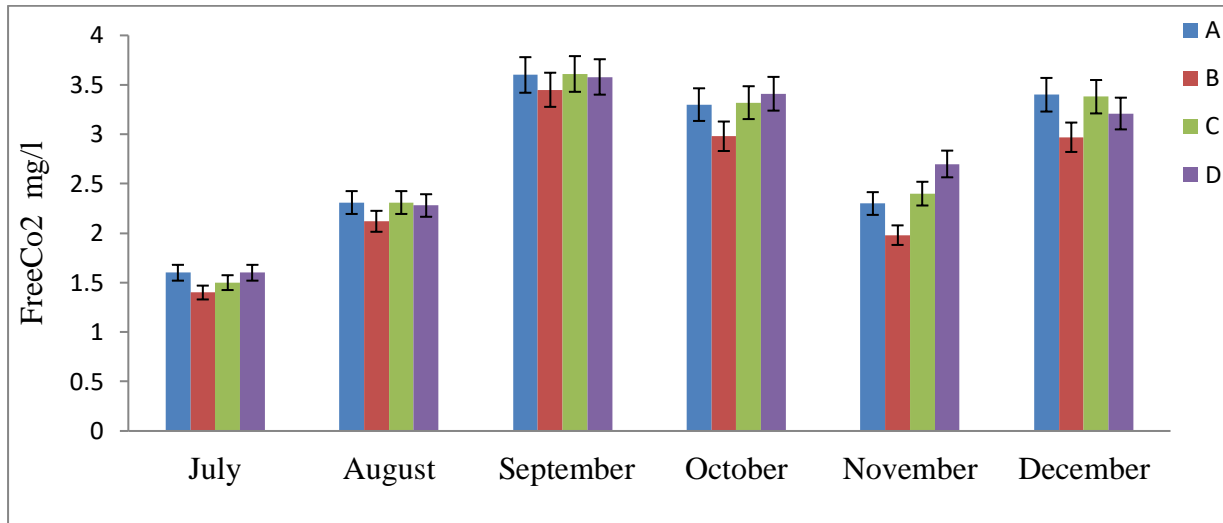


Figure 5: Monthly Mean Variation of FreeCO₂ in River Mayo Inne during the Rainy and Dry Season 2014

The result shows that the lowest mean water pH value of 6.5 was recorded at sample station A in the month of August. While the highest value of 8.5cm was recorded at sample station B in the month of November, September, November (Figure 6). The monthly mean variation of water pH ranged from 7.25 to 8.22 in the months August and November. The result therefore, revealed that there was no significant difference in month of July, August, September, October, December ($P>0.5$). In the month of November, there was a significant difference ($P<0.05$)

The result shows that the lowest mean value of phosphorus is 0.43mg/l which was recorded at sample station B in the month of October. While the highest value of phosphorus is 1.9mg/l was recorded at sample station A in the month of August (Figure

7). The result therefore, revealed that there was no significant difference in month of July, September and October ($P>0.5$). In the month of August-December there was a significant difference ($P<0.5$). The lowest mean total ammonia value of 0.18mg/l was recorded at sample station B in the month of September. While the highest value of 0.73mg/l was recorded at sample station D in the month of July (Figure 8) ranged from 0.20mg/l, it revealed that there was no significant difference in month of July-December ($P>0.5$).

The lowest mean Alkalinity value of 27.85mg/l was recorded at sample station B in the month of September. While the highest value of 42.13mg/l was recorded at sample station D in the month of August (Figure 9) ranged from 28.06mg/l to 41.462mg/l there was no significant difference in month of July-December ($P>0.5$).

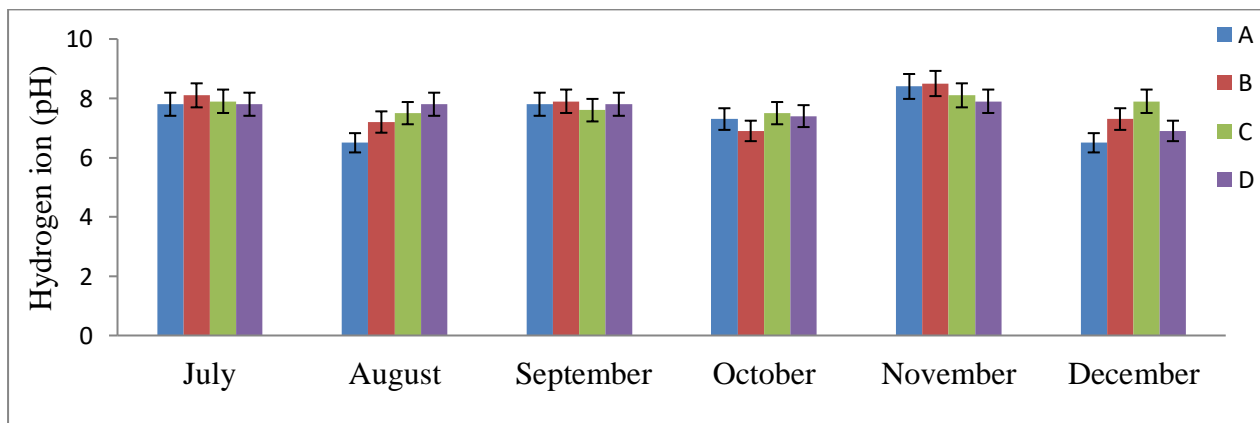


Figure 6: Monthly Mean Variation of Hydrogen in River Mayo Inne during Rainy and Dry Season 2014

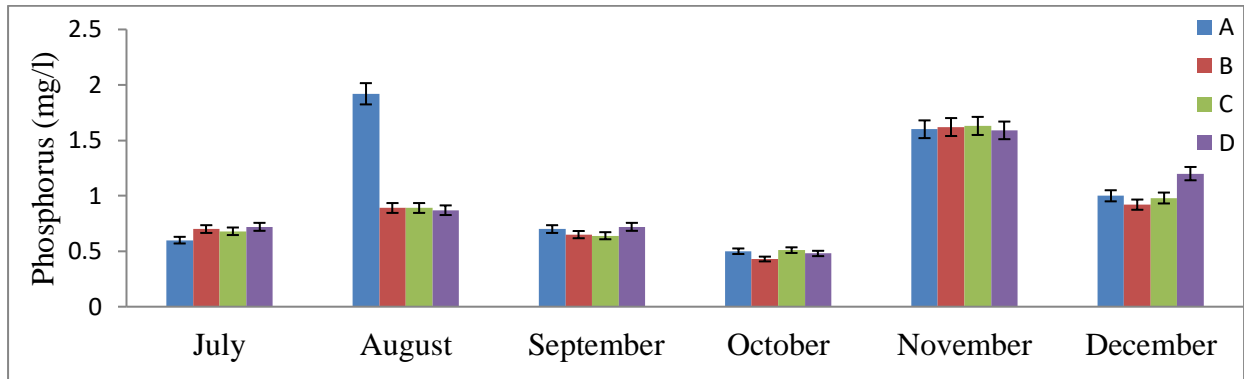


Figure 7: Monthly Mean Variation of Phosphorus in River Mayo Inne during the Rainy and Dry Season 2014

The result shows that the lowest mean value of water Conductivity is 1.3 ($\mu\text{s}/\text{cm}$) recorded at sample station B, in the month of October. While the highest value of water Conductivity 2.66($\mu\text{s}/\text{cm}$) was recorded at sample station C, D in the month of August (Figure 10). The monthly mean variation of

water Conductivity ranges from 1.33($\mu\text{s}/\text{cm}$)in the month October to 2.66 ($\mu\text{s}/\text{cm}$) in August. The lowest mean total nitrogen value of 0.92mg/l was recorded at sample station D (July), while the highest value of 1.84mg/l was recorded at sample station B in the month of December (Figure 11), ranged from 0.947mg/l in the month July to 1.812mg/l in the month of December.

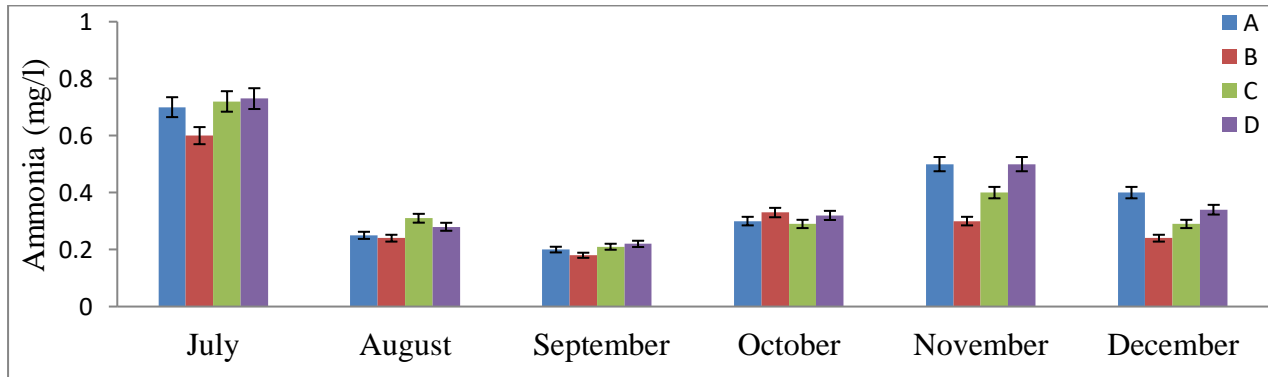


Figure 8: Monthly Mean Variation Ammonia in River Mayo Inne during the Rainy and Dry Season 2014

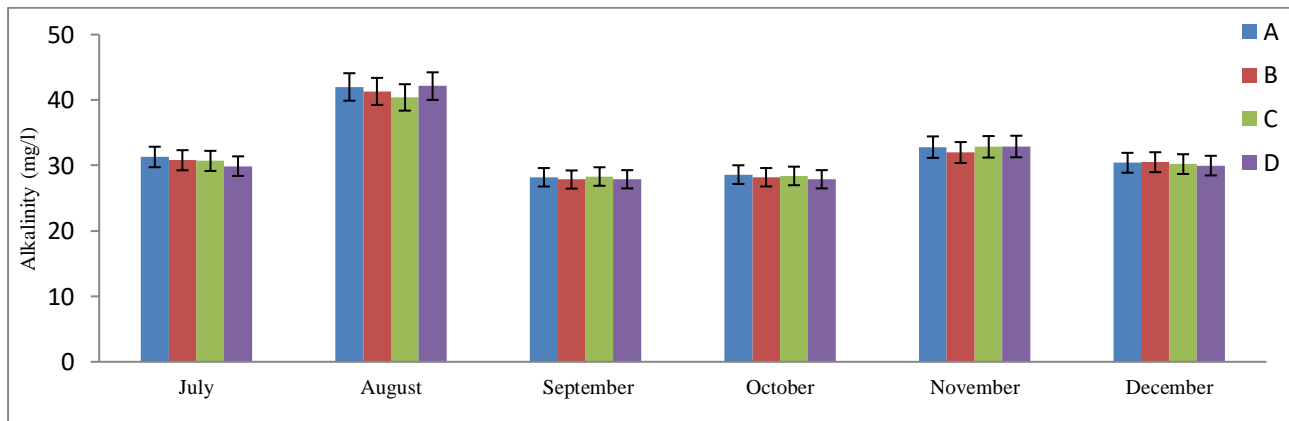


Figure 9: Monthly Mean Variation of Alkalinity in River Mayo Inne during the Rainy and Dry Season 2014

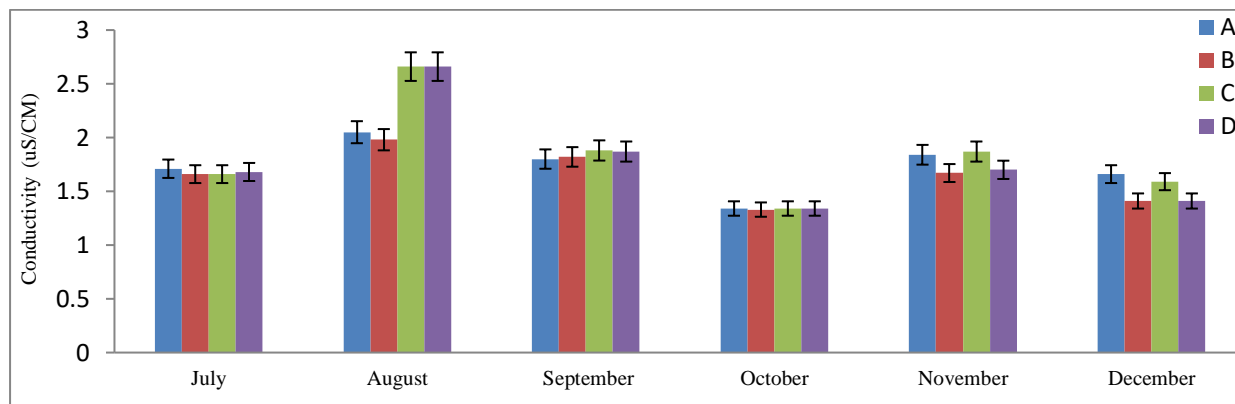


Figure 10: Monthly Mean Variation of Conductivity in River Mayo Inne during the Rainy and Dry Season 2014

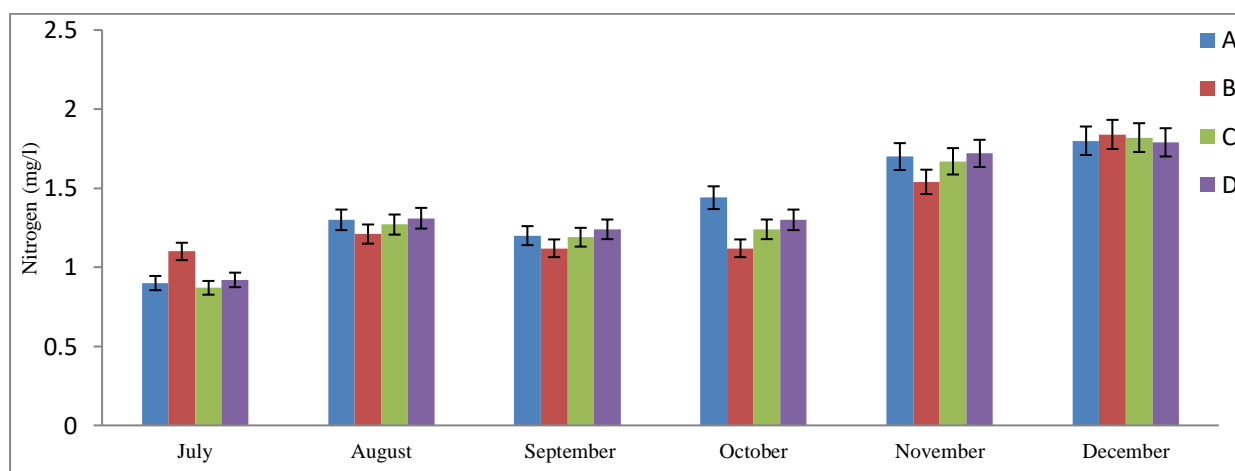


Figure 11: Monthly Mean Variation of Nitrogen in River Mayo Inne during the Rainy and Dry Season 2014

Discussion

There are some marked variations in the physico-chemical parameters observed for the sampling stations and the seasons. The monthly mean Water temperature value ranged from 25.45°C to 28.75°C for the river, compares well with the ranges recorded for other tropical Lakes (Adebisi, 1981; Ovie and Adeniji, 1973). Kolo and Oladimeji (2004) also observed low water temperature in Makwaye Lake, near Zaria, during this period made similar findings in Shiroro dam.

The monthly mean transparency value ranged from 10.75cm -12.425cm in October. August is at the peak of the raining season which comes with corresponding high turbidity which might be attributed to increase in debris load. Kemdirim (1990), reported low transparency recorded during rainy season, agrees with the findings of Wade (1985), who observed that onset of rain decreased the secchi-disc visibility in two mine lakes around Jos, Nigeria. The monthly mean dissolved oxygen

ranged from 7.16 mg/l (December) to 10.0 mg/l (July). The amount of dissolved oxygen in water has been reported as not constant, but fluctuates, depending on temperature, depth, wind and amount of biological activities such as degradation (Adeniji, 1973 ; Ibe, 1993). The monthly mean value of DO observed during the period of the researched is in close agreement with 12.02mg/l to 19.50mg/l as obtained by Abubakar (2006). The monthly mean variation of free CO₂ ranged between 1.52mg/l (July)-3.56mg/l (Sept). The lowest value of free CO₂ observed in July may be attributed to the utilization of free CO₂ by phytoplankton for primary productivity (Abubakar, 2006). Saxena (1990) observed that high alkaline (hard water) water bodies are characterized by negative value of free CO₂. Absalom and Hajek (2002) also states that high free CO₂ in water indicated low photosynthetic activities. Thus, the value obtained fall within the

recommended safety limit of 10mg/l as observed by Haruna (2003).

The monthly mean variation of the pH values ranged from 7.15 to 8.22. The hydrogen ion concentration (pH) was near neutral throughout the period of the research, and it was within the range (pH6.5-8.5), as similarly reported by Antoine and Al-Saadi (1982). Boyd and Lichtkoppler (1979), reported pH range of 6.09 -8.45 as being ideal for supporting aquatic life including fish. Thus, the pH range obtained in this study is within the acceptable level of 6.0 to 8.5 for culturing tropical fish species (Huett, 1977) and, for the recommended levels for drinking water (WHO, 1984). The monthly mean value of total phosphorus ranged from 0.48mg/l to 1.61mg/l. ACTFR (2002) states that artificial sources of phosphorus include fertilizers, detergent, waste water, and industrial effluent and animal excreta amongst others. Ajibade *et al* (2008) reported Phosphate level ranges between 0.1 and 1.00 mg/l in the dry seasons and between 0.4 and 1.7 mg/l in the wet season. High values of phosphate support algae growth and hence good plankton bloom (Boyd, 1979). Federal Environmental Protection Agency (1991) recommended a maximum of 20mg/litre.

Total ammonia ranged from 0.020mg/l to 0.68mg/l this agrees with 0.025mg/l recommended by Alabaster and Lloyd (1982). Stirling and Philips (1990) state that ammonia could originate where the farm water supply is polluted with sewage, silage or other organic rich water. Haruna (2003) reported that high ammonia cause poor growth, increase susceptibility to disease and eventually death.

Total alkalinity ranged from 28.06 to 41.46 mg/l which agreed with the range value documented by Moyle (1946) and Boyd (1981) for natural water. Alkalinity due to the presence of bicarbonate, carbonate and hydroxides of calcium, sodium and potassium (Murhekar, 2011; Lawson, 2011) is vital in neutralizing the acidity of water which increases with dissolved carbon dioxide (Lawson, 2011). Boyd (1982) recommended suitability of alkalinities between 20 and 50 mg/l for plankton production for fish culture. It is used in the classification of waters especially lakes according to nourishments (Kara *et al.*, 2005).

The conductivity values ranged from 1.34 μ s/cm and 2.66 μ s/cm which is less than 4.99-44.19 μ s/cm reported by Abubakar (2006). Stirling (1985) states that the very acidic (pH<4.5) or alkalinity (pH>10) of waters have appreciably higher conductivity values. Discharges could raise the conductivity because the presences of chloride, phosphorous and nitrate (United State Environmental Agency, 1991). Nitrogen is an important source of nutrients for aquatic plants and animals (Philips,

1985). The monthly mean value of Nitrogen ranged from 0.94 to 1.81mg/l The higher nitrate-nitrogen (N03-N) concentration during the rainy season could be due to surface run-offs as well as the decomposition of organic matter. Ufodike *et al.*, (2001), made similar observations for Dokowa Mine Lake. The levels of the Physico-chemical parameters determined were within the acceptable ranges for domestic water purposes and fish production.

Conclusion

The physico-chemical parameters in river mayo inne generally fall within acceptable limit. Temperature, transparency, dissolved oxygen (DO), pH, Free carbon dioxide ranges between 24.8°-29°C, 10cm - 12.7cm, 7.3mg/l-10.3mg/l, 6.5- 8.5, 1.4mg/l- 3.61m respectively while total phosphorus, total ammonia, total Alkalinity, Conductivity, nitrogen ranges between 0.43mg/l -1.9mg/l, 0.18mg/l - 0.73mg/l, 27.85mg/l -42.13mg/l, 1.34- 2.66 μ s/cm, 0.92mg/l -1.84mg/l. respectively. Therefore; proper management of these parameters will contribute immensely to fish production where tolerable limits have been established.

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Reference

- Absalom, M. and Hajek. J. (2006). Prosodic phonology and raddoppiamento sintattico: a re-evaluation. In K. Allan (ed.) Selected Papers from the 2005 Conference of the Australian Linguistic Society, Melbourne: Monash University.
- Abubakar, K.A. (2006). A Study of Aspects of Productivity and Stock Status of *Oreochromis niloticus* and *Clarias gariepinus* in lake Geriyo, Yola Adamawa State, Nigeria. PH.D Thesis Federal University of Technology, Yola, Nigeria. 212.
- Adebayo, A.A and Tukur A.L. (1999). Climate 'I and II' Adebayo, A.A and Tukur A.L (eds) Department of Geography, Federal University of Technology, Yola. 1st edition. 52:7 Paraclete Publisher, Yola ISBN 978-35157-0-5 a. Pp 20-26
- Adebisi, A.A. (1981). The Physicochemical Properties and Hydrology of a Tropical Seasonal River-Upper Ogun river. *Hydrobiology*. **79**:157-165.
- Adeniji, H.A. (1973). Preliminary Investigation into Composition and Seasonal Variation

- of the Plankton in Kainji lake, in Nigeria. In: Geophysical monograph series. Man-made lakes: their problems and environmental effects. W.C. Ackamuru, Apha G.F and E.B. Worthington (edu) 17:617-619.
- Agbaire P.O and Obi C, G.J. (2009) Applied Science of Environmental Management, 13(1):55.
- Ajibade, A.C., Anyanwu, N.P.C., Okoro, A.U., Nwajide, C.S., (2008). The geology of the Alabaster, J.S and Lloyd, R., (1982). Water quality criteria for fresh 'water fish 2nd edition Pp 325
- Antoine, S.E and Al-Saadi, H.A., (1982). Limnological studies on the polluted Ashar Canal at Basra (Iraq). In: *Reveges hydrobiology* **67**: 405-418
- Association of official Analytical Chemistry, AOAC (1990). The official method of analysis .Association of official Analytical chemistry 17th, Washington, D.C
- Australian Center for Tropical Freshwater Research, ACTFR, (2002). A Preliminary Assessment of the Impacts of Aquatic Weed Harvesting on the Physico-Chemical and Chemical Water Quality of Ross River. ACTFR Report No.02/09 for Maunsell Australia (Townsville) Pty. Ltd.
- Bhatt L.R, Lacoul, H.D Lakhak, and Jha P.K (1999). Physico-Chemical Characteristics and Phytoplanktons of Taudaha Lake, Kathmandu, Pollution Research, *Journal of Ecosystems* **18**(4) pp.353-358
- Boyd, C.E, Lichtkoppler, F. (1979). Water Quality Management in Fish Pond Culture. Research and Development Series No. 22. International Centre for Agriculture, Agricultural Experimental Station Auburn.
- Boyd, C.E., (1981). Water quality assessment. Agricultural Experiment Station. Auburn University, Craft master publ. Co. Alabama U.S.A 2nd Ed. pp359.
- Bramley, R.G and C. Roth (2002). Land use Effects on Water Quality in an Intensively Managed Catchments in Australia Tropics. *Marine and Fresh Water Research* **53**(5): 931-940.
- Chapman, D. (1997). Water Quality Assessment. A Guide to the use of Biota, Sediments and Water in Environ. Monitoring 2nd ED. & En. SPON. London. 210.
- Edokpayi, C.A., (2005). Variation of Chemical Constituents of a Brackish Water Prawn Habitat in Southern Nigeria. *Acta SATECH, Journal-aquatic science*, **2**(1): 11-18.
- Federal Environmental Protection Agency, FEPA, (1991). Guidelines and Standards for Environmental Pollution Control in Nigeria pp.15.
- Hacioglu N, Dulger Basaran. (2009). "Monthly Variation of Some Physico-chemical and Microbiological Parameters in Biga Stream (Biga, Canakkale, Turkey)". *African Journal of Biotechnology*, **8**(9), pp 1929-1937.
- Haruna, A. B. (2003). Aquaculture in the tropics Theory and Practice. Al-Hassan Kano. 432 Pp.
- Huett, M. (1977). Text Book of Fish Culture, Breeding and cultivation of fish. 2nd edition, News Book Publ. University Press, Cambridge, Pp438.
- Ibe, S. N. (1993): Growth performance of Normal, Frizzle and Naked neck chickens in tropical Environment. *Nigeria Journal Animal Production*. **20**:28-31.
- Kara, Y., I. Kara and D. Basaran, (2005). Investigation of Some Physical and Chemical Parameters of Water in the Lake Isikli in Denizli, Turkey. *International Journal Agriculture and Biology*. **6**(2): 275-277
- Kolo, R.J. and Oladimeji, A.A (2004) Water Quality and Some Nutrient Levels in Shiroro Lake Niger State. Nigeria. *Journals of aquactic science*. **19** (2): 99.
- Lawson, E.O. (2011), Physico-Chemical Parameters and Heavy Metal Contents of Water from the Mangrove Swamps of Lagos Lagoon, Lagos, Nigeria, *Advances in Biological Research*, **5**(1), 8-21.
- Margaleff, R. (1996). Limnology Now. A Paradigm of Planetay Problems. Elsevier, Amsterdam. 52-55.
- Murhekar G.H. (2011), Determination of Physico-Chemical Parameters of Surface Water Samples in and around Akot City, *International Journal of Research in Chemistry and Environment*, **1**(2), 183-187.
- Najafpour, S.H, Alkarkhi A.F.M, Kadir M.O.A, Najafpour G.D., (2008). "Evaluation of Spatial and Temporal Variation in River Water Quality." *Internal Journal Environment*. **2**(4):349-358.
- Okoh, A.I (2007) Waste water treatment plants as a source of microbial pathogens in the receiving watershed. *Africa Journal of Biotechnology* **6** (25): 2932-2944
- Patil J.G (2012). Assessment of Physico chemical parameter of Adan Dam reservoir Karanja (LAD) Dist. Washing (M.S). *Internal interdisciplinary research journal*. **1**(2): 15-20
- Philips, M.J. (1985). Analysis of Nutrients. In Stirling H.P. (ed) Chemical & Biological

- Methods of Water Analysis For Aquaculture. First edition Institute of Aqua. University of Stirling, Stirling Printed & made in Great Britain 110.
- Philips, M.J. (1985). Analysis of Nutrients. In Stirling H.P. (ed) Chemical & Biological Methods of Water Analysis For Aquaculture. First edition Institute of Aqua. University of Stirling, Stirling Printed & made in Great Britain 110.
- Rajeshwari, C.V and Sarawath B, (2009) Pollution Research 28 (3) 499.
- Ramanathan, N., P. Padmavathy, T. Francis, S. Athithian and N. Selvaranjitham, (2005). Manual on polyculture of tiger shrimp and carps in freshwater. Tamil Nadu Veterinary and Animal Sciences University, Fisheries College and Research Institute, Thothukudi, pp: 1-161.
- Saxena M.M (1990) Environmental analysis, Water, soil and air, Agro. Botanical publishers, New Delhi.
- Saxena M.M (1990) Environmental analysis, Water, soil and air, Agro. Botanical publishers, New Delhi.
- Stirling, H.P. and M.J. Phillips, (1990). Lecture Notes on Water Quality Management for Aquaculture and Fisheries. Institute of Aquaculture Publications, Scotland, UK., ISBN-13: 9780901636928, Pages: 49.
- Stirling, H.P. (1985). Chemical and Biological Methods of water Analysis for Aquaculture. University of Stirling. Printed and made in Great Britain.
- Stirling, H.P. (1985). Chemical and Biological Methods of water Analysis for Aquaculture. University of Stirling. Printed and made in Great Britain.
- Stone, N.M and Thomforde, H.K. (2006). Understanding your Fish Ponds. Water Cooperation Aqua/Fisheries Ext. prog. University of Akanas.
- Suski, C.D., S.S. Killen, J.D. Keiffer and B.L. Tufts, (2006). The influence of Environmental Temperature and Oxygen Concentration on the Recovery of Large Mouth bass from Exercise. Implications for live-release angling tournaments. *Journal of Fish Biology*. **68**: 120-136.
- Ufodike, E.B.C., Kwanasie, A.S. and Chude, L.A. (2001). On-set of rain and its Destabilizing Effect on Aquatic Physico-chemical Parameters. *Journal of aquatic sciences*, **16** (2) 91-94
- United State Environment Protection Agency (1991). Volunteer Lake Monitoring a Methods Manual, EPA 4404-91-002 office of Water Washington D.C.
- Wade, J.W. (1985). Limnology and Trace Element Studies in relation to primary production in two mine lakes unpublished M.S.C Thesis, University of Jos. Pp205
- WHO, (1984). Guidelines for Drinking – Water Quality. Vol 1. Geneva
- WHO, (2002) Water and health in Europe: A joint report from the European Environment Agency and the WHO Regional Office for Europe. World Health Organization, WHO regional publications, European, series No. 93
- WHO, (2004) .Guidelines for Drinking-water quality Recommendations, world Health Organization, Geneva, Switzerland, 3rd edition, vol. 1.
- World Health Organization, WHO (2006). Guidelines for Drinking – Water Quality. Vol 1. (Geneva:WHO)