ASSESSMENT OF THE WATER QUALITY OF WATARI DAM, KANO STATE USING SELECTED PHYSICOCHEMICAL PARAMETERS

[1]RABIU, H. D., [2]UMAR, L. M; [4]SULAIMAN, I; [5]MADINA, M; and [3]ABUBAKAR, A.I

[1]Department of Biology, Federal College of Education (Technical) Bichi, Kano State.
[2]School of General Studies, Kano State Polytechnic
[4, 5]Department of Science Laboratory Technology, Kano State Polytechnic, Kano State.
[3]College of Administrative and Business Studies, Potiskum, Yobe State.

ABSTRACT

The physicochemical parameters of Watari Dam were investigated for a period of ten months between October, 2014 and September, 2015. Water samples for physicochemical parameters were collected and analyzed fortnightly between 8:00 – 10:00 am using standard methods. Four sampling sites (A, B, C and D) were chosen on the Dam based on the ecological setting. The mean range of physicochemical parameters studied were water temperature (21.5 – 29.5 °C), pH (7.3 – 8.9), DO (7.4 – 8.4mg/L), BOD (2.6 – 3.9mg/L), turbidity (0.10 – 0.25 m), electrical conductivity (156 – 245µS/cm), TDS (167 - 389mg/L), phosphate (0.5- 2.9mg/L) and nitrate (13.5 – 23.2mg/L). Physicochemical parameters showed some degree of variations between the two season in which total dissolved solids, electrical conductivity, turbidity and nitraterecorded significant difference between wet and dry season ($P<0.05$) while no significant difference was observed in DO, BOD, phosphate, temperature and pH. However, the phosphate concentration of 13.5 – 23.2mg/L and nitrate concentration of 0.5mg/l to 2.89mg/L raised concern on accumulation of these elements that can posed threat of pollution to the dam thus indicating anthropogenic influence. It is therefore recommended that proper attention need to be given to the water body by appropriate authorities due to its possible health implication on the consumers through continuous monitoring so as to track any adverse environmental changes in the dam.

Keywords: Physicochemical parameters, Water quality, Seasonal variation, Watari Dam

INTRODUCTION

The quality of water is of vital concern for mankind because it directly linked with human health (Abdulazeez, 2015). Freshwater has become a scare commodity due to over exploitation and pollution (Muhammad and Saminu, 2012). Pollution is caused when a change in the physical, chemical or biological condition in the environment harmfully affect quality of human life including other animals and plants' life (Oketola *et al.,* 2006). Industrial, sewage municipal wastes are been continuously added to water bodies hence affect the physiochemical quality of water making them unfit for use of livestock and other organism (Abubakar and Abdullahi, 2015). According to Ibrahim (2009) Water resources are of critical importance to both natural ecosystem and human development. It is essential for agriculture, industry and human existence. The healthy aquatic ecosystem is depended on the physico-chemical and biological characteristics (Verma *et al.,* 2012). The quality of water in any ecosystem provides significantinformation about the available resources for supporting life in that ecosystem (Ibrahim, 2008). Good quality of water resources depends on a large number of physic- chemical parameters and biological characteristics to assess the monitoring of these parameters is essential to identify magnitude and source of any pollution load (Adesalu*et al.*,2010). Due to increased population and use of fertilizers in agriculture and man-made activities, the natural aquatic environment is increasingly polluted leading to depletion of aquatic biota and water quality (Adakole *et al*., 2008 and Kawo *et al*., 2008). Impairment of water quality in reservoirs arises largely from anthropogenic contamination and natural mineralization (APHA, 1995 and Adamu *et al.,* 2014).The physical and chemical parameters serve as pollution indicators in water quality monitoring which is a fundamental tool in the management of fresh water resources (Balarabe 2001). The monitoring of physicochemical characteristics of a water body is vital for both long term and short analysis (Wood, 1995). Distribution and productivity levels of organisms in any waterbody are largely determined by physicochemical factors (Adakole *et al.,* 2008). In developing countries, industrial effluents and domestic sewage are indiscriminately discharged into adjoining rivers and water bodies without any pretreatment (Tiseer *et al*., 2008). In view of forgoing this research aimed at investigating physico-chemical parameters and ecological implications of Watari Dam, Kano.

MATERIALS AND METHODS

Materials

All reagents used were of analytical grades and purchased from Ado Jones Scientific Supply and General Enterprise, Ibrahim Taiwo Road, Kano State, Nigeria.Determination of physicochemical parameters was carried out at soil Science Laboratory of Bayero University Kano.

Study Area

Watari Dam is a manmade lake built in 1977. It was situated 2 km from Bagwai town and 8km south west of Bichi, Kano, Nigeria. It has 1,959 hectares surface area with active storage capacity of 92.74million litres. The dam is located between latitude 12°9'24''N and 8°8'12''Ewith two distinct seasons (wet and dry). The rainy season which last from May to

October and the dry season last from November to April. The mean annual temperature is between 16 – 41^{0}Cand the mean annual rainfall range from 700 – 813mm. (Adamu*et al.*, 2014).

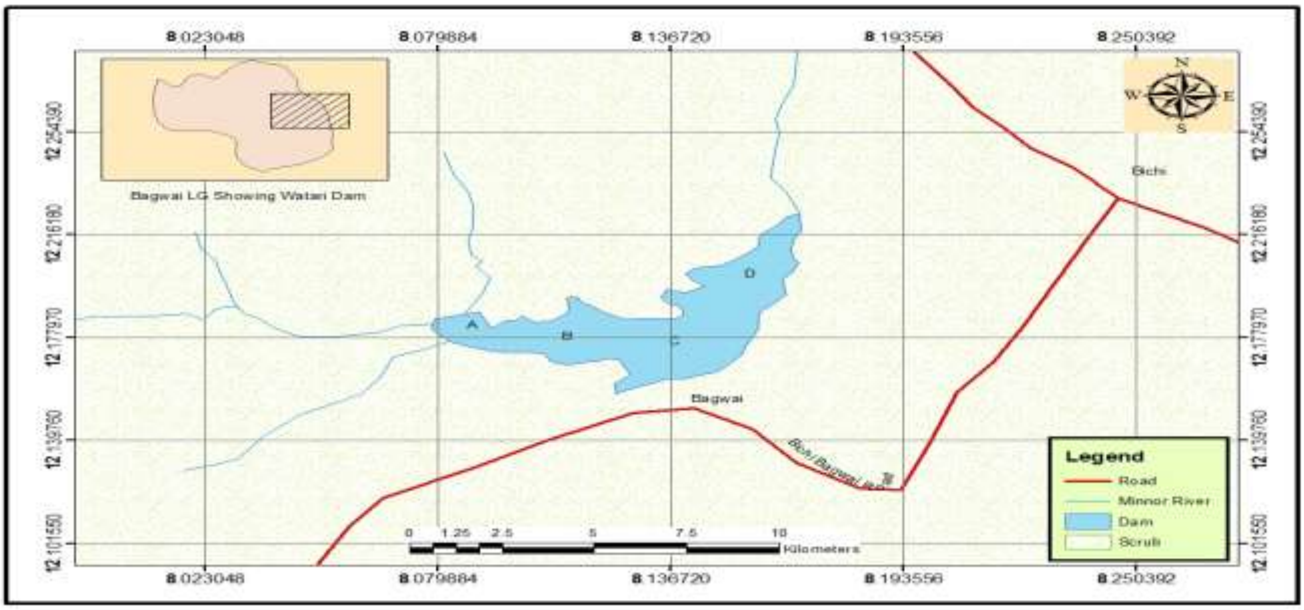

Fig. I: Map of Watari Reservoir Showing the Sampling Sites (Source: Cartography Lab. Bayero University Kano, 2017).

Sampling Sites

Five sampling sites designated as A, B, C, D and E were selected for the purposes of this research based

Site A: Is at the upper site of the dam where irrigation activities take place during dry season.

Site B: Is at the lower point of the dam where there is less human activities.

Site C: The reservoir tanks use at Federal college of Education (Tech.) Bichi.

Site D: The outlet point of the reservoir tank where there is a lot of human activities like washing of clothes among other activities.

Site E: Is at the upper point of the dam where there are less human activities.

Sample Collection

Samples were collected on monthly basis between the hours of 7am – 8am from October, 2014 – September, 2015 from five sampling stations that cut across two season of the year.

Determination of Physico-chemical parameters

Determination of Temperature (^{0}C)

Digital thermometer (Jenway 100 model) was used to measure the water temperature *in situ*, by immersing the thermometer into the water surface for about 30 seconds and allowed until stabilized readings was taken twice as described by APHA (2005).

Determination of pH

This was determined using pH meter (Jenway 3320) the pH reading was recorded according to APHA (1995).

Dissolved Oxygen (DO)

It will be measured using DO meter (HANNA model HI9146) in which the probe was inserted into the water until DO reading in mg/L is recorded as described by the manufacturers.

Biochemical Oxygen Demand (BOD_5)

It was be measured after collecting the samples at each sites into a labeled 250mL dark bottle, kept in an incubator in the laboratory at 21^0C for 5 days, the DO will be measured again. BOD_5 was obtained by subtracting the 5-day DO reading from the 0 – day DO reading (APHA, 2005).

Turbidity

The transparency of the water was measured using 20cm diameter Secchi disk, which was dipped into the water until the disk disappeared and the depth was recorded. It was dipped further and then withdrawn carefully and the depth at which it becomes visible was also recoded. Actual measurement was obtained by taking the average of two reading (APHA, 2005).

Determination of Electrical Conductivity

This was measured using Conductivity meter (SUNTEX 9649 Model) by dipping the probes into the water until the screen show a stable reading as described by the manufacturers.

Determination of Nitrate- nitrogen concentration

It was determined using phenol disulphuric acid method described by APHA (1995). The method involves nitrate determination by phenol disulphuric acid using spectrophotometer (1L 25lmodel). About 30mls of the water sample were placed in a porcelain dish and evaporated in an oven. It was later allowed to cool. Two (2) ml of phenol of disulpheric acid was added to the content of the porcelain dish. Thereafter, 20ml of distilled water and 7mls of concentrated ammonia was added and thoroughly mixed with the content of the porcelain dish. A yellow colour was later developed which indicate the present of nitrate. The intensity of the colour was measured with a spectrophotometer set at a wavelength of 410nm in the biochemistry laboratory Bayero University, Kano. A nitrate calibration curve was plotted from the instrument reading using a known nitrate calibration standard curve to obtained nitrate concentration in mg/L

Determination of phosphate- phosphorus concentration

Phosphorus was determined by the procedure described by Boyd (1981).The procedure is as follows, 50ml of the filtrated water sample, 4ml of ammonium molybdate reagent was added and mixed. After 10minute a yellow colour developed. It was measured using spectrophotometer (1L25l model) at 690nm and standard calibration curve was prepared. The value of phosphate was obtained by comparing absorbance of sample with the standard curve and expressed as mg/l.

RESULTS

The mean values of 54.32µS/cm and 113.18µS/cm were recorded in December and October 2014 respectively for electrical conductivity during the exercise (Figure 2). The mean monthly values for surface water temperature determined during this research period ranged from 19.80°C to 27.80°C figure 4, which was in January and September respectively. The mean monthly range of pH values were from 6.54 to 7.47 in the June and February 2015 respectively figure 3.The mean values of 54.32µS/cm and 113.18µS/cm were recorded in December and October 2014 respectively for electrical conductivity during the exercise. Moreover, mean monthly values of 1.50 to 7.99mg/l were recorded in September and January of 2015 respectively for dissolved oxygen (Figure 5). The mean monthly values for BOD_5 rangedbetween 0.54 to 3.60mg/l (Figure 6) recorded in September and February 2015. The mean monthly values for Nitrate ranged between 0.03 to 3.99mg/l in the months of July and October (Figure 8). The mean monthly phosphate values ranged between 0.43 to 5.27mg/l in the months of September and November in the year 2014 and 2015 respectively (Figure 7). However, the mean range of temperature value was between 23.61°C recorded at B and 25. 83°C recorded at site C, while, the range of 6.51 to 7.81 were recorded, with the lowest at site C and the highest at site B. The range of mean values of electrical conductivity (Figure 2) recorded along sites was 61.28 to 93.57µs/cm (Table 2) with the least and highest values recorded at sites A and E respectively.The dissolved oxygen (DO) mean values ranged between 5.07 to 6.57mg/l with the lowest value recorded at site D and the highest recorded at site E, alsoThe range of the BOD_5 was 2.09 to 2.81mg/l with the least value recorded at site B and highest at site E. The values of Nitrate sampled along sites ranged between 1.68 to 2.53mg/l (Figure 8). The lowest value was recorded at site A and the highest at site E. Concentrations of Phosphate ranged between 1.92 to 2.67mg/l the lowest value was recorded at site A and the highest recorded at site E.

On the other hand, values of temperature recorded ($P<0.05$) during the month are significantly different with one another (Figure 4). However, there was no significant variation ($P<0.05$) in values of temperature at all the sites sample. There were no significant variations between values of pH recorded in the months of sampling and along the sites respectively.Moreover, the values recorded for EC during the months were significantly different ($P<0.05$), likewise the values recorded along the sites of collection. Between the values of secchi disc transparency obtained, there was no significant variation at $P<0.05$, while the values obtained along the sites of sample are significantly variable. There was a significant variation at ($P<0.05$) between the values of dissolved oxygen (DO) obtained during the months of sampling (Table 6). While values obtained along the sites are not significantly different ($P<0.05$). The values obtained for BOD_5 was significantly different ($P<0.05$) in the months (Table 6). But the result showed no significant difference ($P<0.05$) along all sites of sample.The values obtained for Nitrate are significantly different ($p<0.05$) from each other during the months, but they are not significantly different ($p<0.05$) along the sites of sample collection (Table 7). More so, the obtained values for Phosphate throughout the research period are not significantly different ($p<0.05$) (Table 6) and as well, along the sites of samples.

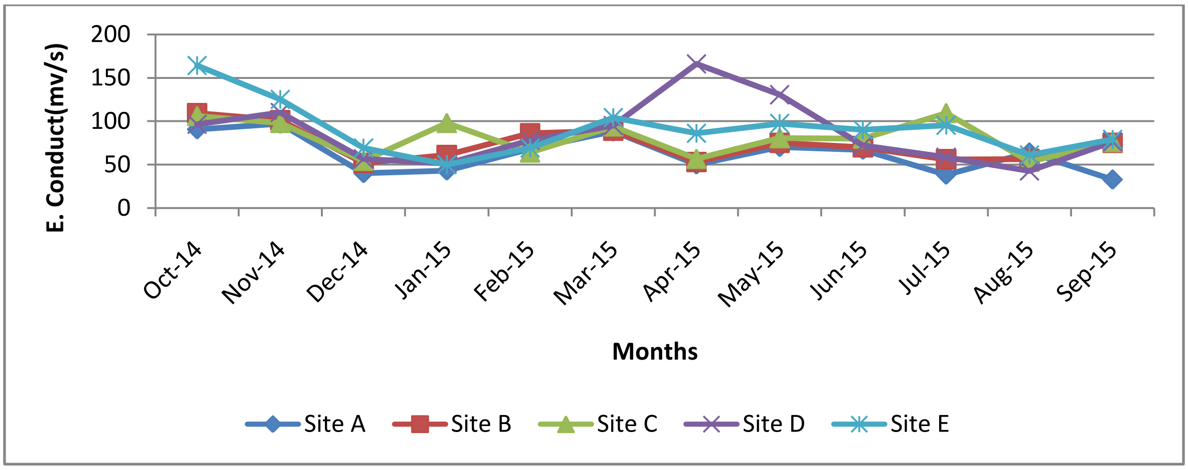

Figure 2. Monthly variation of Electrical Conductivity in each sampling site at Watari Dam Kano

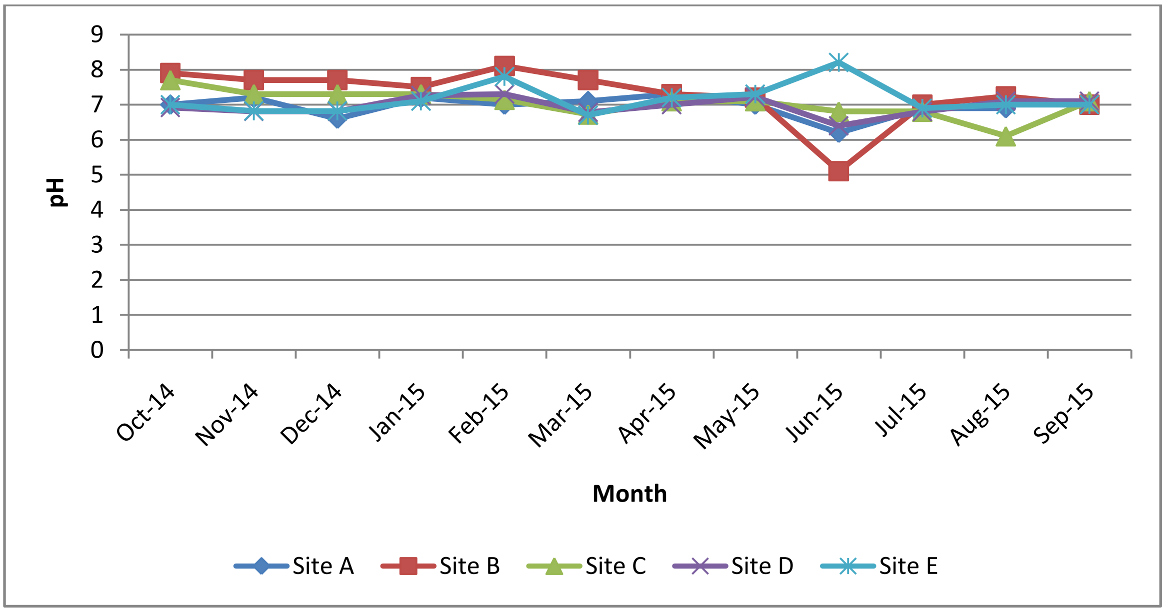

Figure 3. Monthly variation of pH in each sampling site at Watari Dam Kano

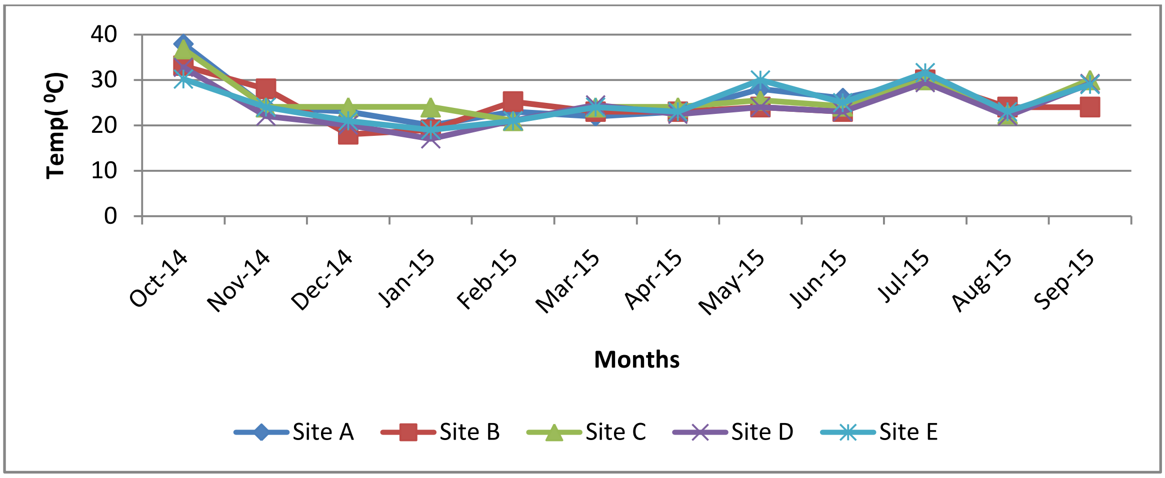

Figure 4. Monthly variation of Temperature in each sampling site at Watari Dam Kano

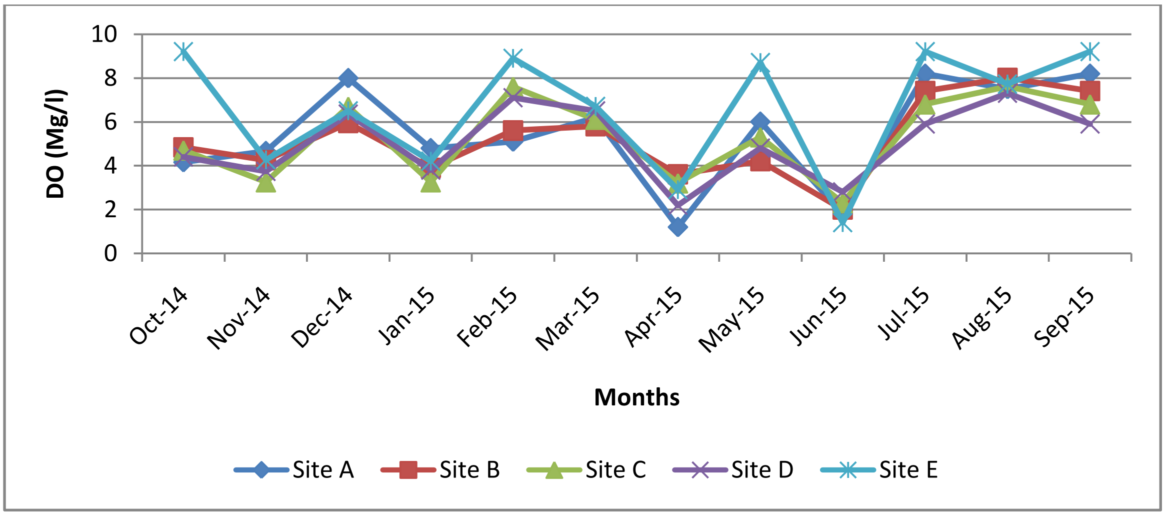

Figure 5. Monthly variation of Dissolved Oxygen in each sampling site at Watari Dam Kano

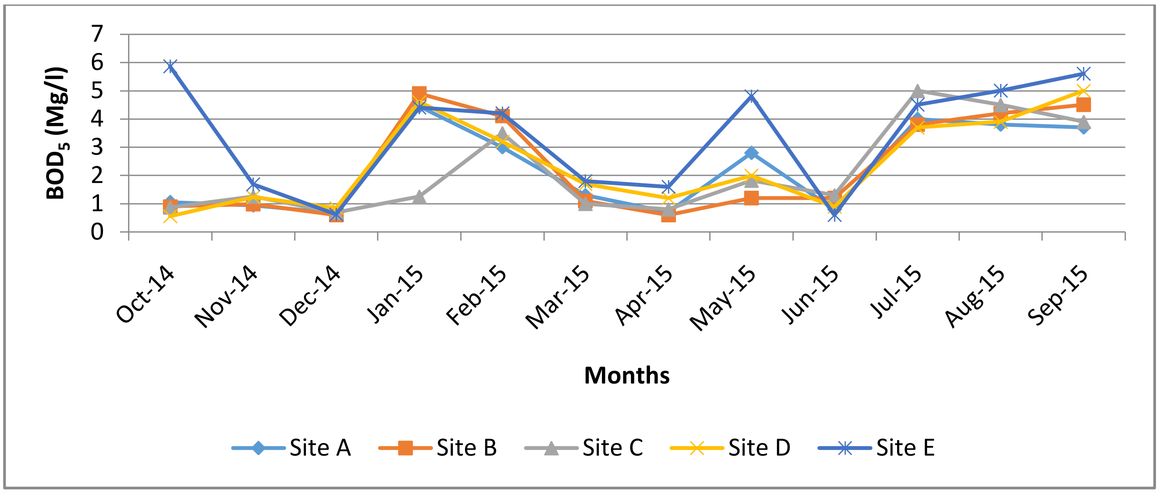

Figure 6. Monthly variation of Biochemical OxygenDemand in each sampling site at Watari Dam Kano

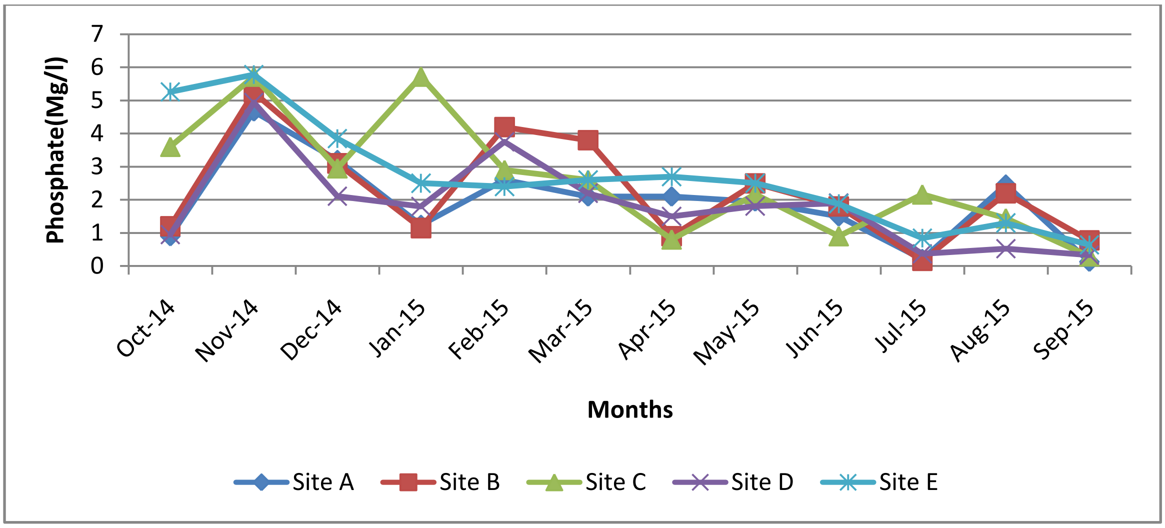

Figure 7. Monthly variation of Phosphate- Phosphorus concentration in each sampling site at Watari Dam Kano

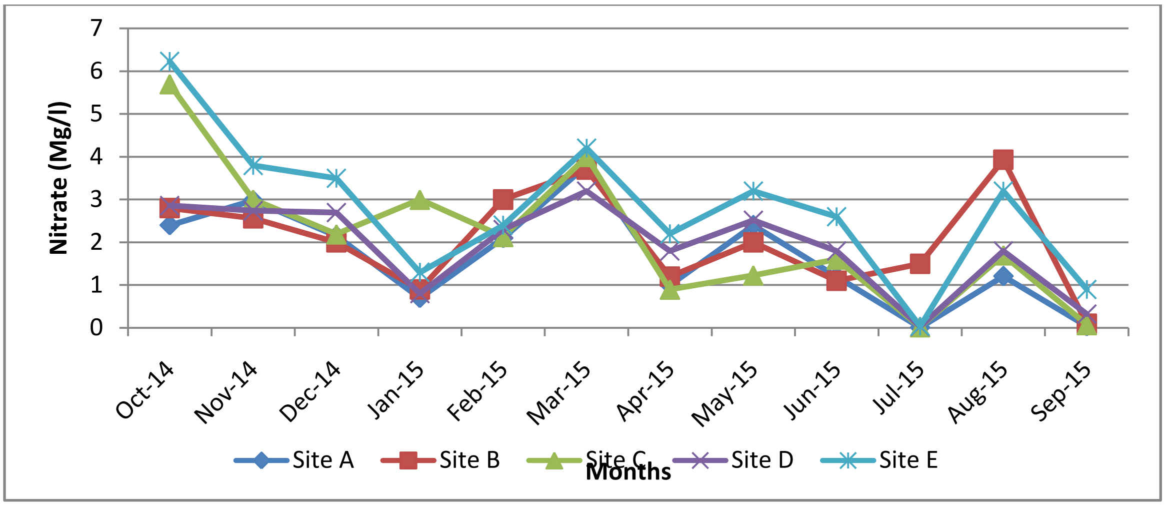

Figure 8. Monthly variation of Nitrate- Nitrogen Concentration in each sampling site at Watari Dam Kano

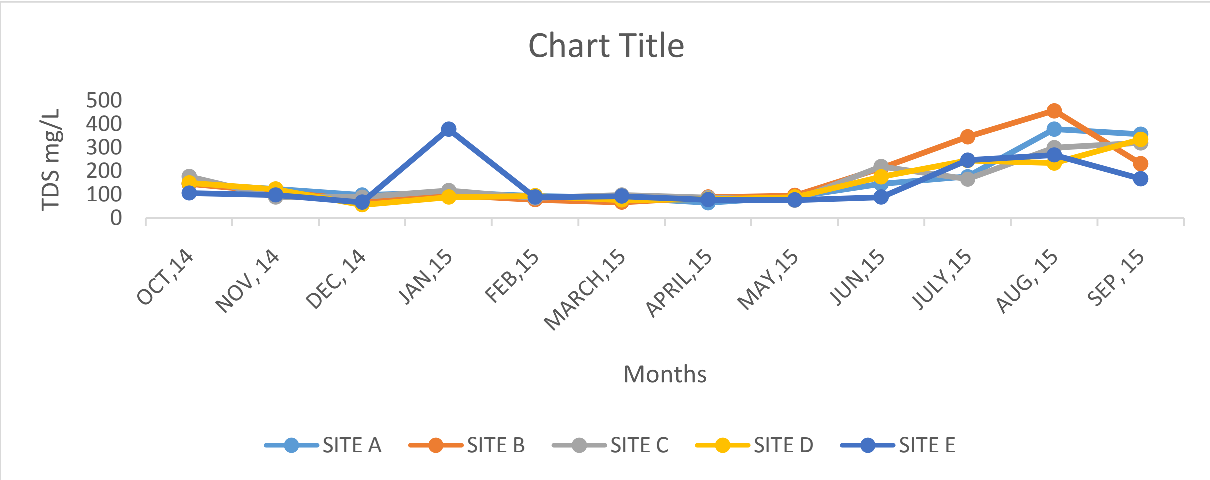

Figure 9. Monthly variation of Total Dissolved Solids in each sampling site at Watari Dam Kano

DISCUSSION

During the study period, mean water temperature of the dam fluctuates between 26.30 – 28.6. The low water temperature recorded in January might be due to the characteristic cool dry North-East trade wind (Harmattan) between December and February while the high water temperature in May was due to characteristic of hot weather in Kano. This trend of temperature variation is in tandem with findings of Ibrahim (2009) in Challawa, River Kano State, Kefas *et al.* (2015) in Lake Geriyo, Adamawa State, Ibrahim *et al*. (2009) in Kontogora reservoir and AdakoleC*et al*. (2008) in Kubanni Lake. The values of temperature observed are within the normal range of 8-30oC recommended for standard for surface waters by FEPA (1991). Seasonal variations indicated that during wet season (May- October) the temperature was more or less steady. The fluctuation in water temperature could be due to change in the weather especially during rainy season when cloud cover reduces the intensity of the solar radiation which limited light rays to the water surface (Abolude *et al*., 2013). The optimal temperature observed in this Lake could be due to the shallow nature of the Lake, which could be favourable to fish growth and other aquatic biota (Haruna and Abdullahi, 1999).

Nitrate - nitrogen ranged from 13.5 – 23.2mg/L. Nitrogen and phosphorus are important elements regulate biological productivity in aquatic ecosystem and may be applicable to Watari Dam (Mustapha, 2011). The mean total nitrate – nitrogen ranges between 12.6mg/l in December and 23.2mg/l in June which is higher than 0.44 to 1.21mg/l as reported by Abubakar (2006) and Kefas *et al*. (2015) in Lake Geriyo. The higher nitrogen observed in June could be due to surface run-offs as well as the decomposition of organic matter. This corroborates with the finding of Ufodike *et al*. (2001) in Dokowa Mine Lake. Ibrahim *et al*. (2009) stated that high nitrate concentration in the lake is related to inputs from agricultural lands. The values of nitrogen recorded in the present study were within the desirable limit of 20.0mg/l for drinking water recommended by (WHO, 2003). Variation of nitrate in the dam reflects the effect of watershed and anthropogenic contamination around the dam.

The monthly variation of phosphate – phosphorus range from 0.5mg/l to 2.89mg/l in Watari Dam is in agreement with what was observed by Kolo and Yisa (2002) in River Suka. The phosphate concentration could also be due to lower water hardness, thus less co-precipitation of phosphate with calcium carbonate, a phenomenon that has often been reported to occur in many fresh water lakes (Ibrahim *et al*., 2009). The monthly variations phosphate was as a result of significant seasonal and spatial variation in the weather and other human activities near the dam such as irrigation and other farming activities (Wetzel, 2000).

The range of pH recorded during the study period was 7.3-8.9, the pH in the water body is slightly alkaline. The highest of 8.9 was obtained in July. The present findings are tandem with the findings of Akindele *et al.* (2013). Therefore the recorded pH values are suitable for aquatic animals such as fish (Jahangir *et al*., 2000). The ph recorded also Fall within the EU recommended range of 6 to 9 for fisheries and aquatic life (Akindele *et al*., 2013) but above the WHO pH guideline for drinking water for effective disinfections with chlorine (WHO, 2003).The pH values obtained for this work are similar to the values obtained by Imam and Balarabe (2012) in Bompai- Jakara Catchment Basin, Kano State. Average pH values obtained in this study agree with those documented by Fakayode (2005) as values most suitable for maximum productivity of aquatic organisms.

Conductivity indicates presence of dissolved ions in water. The electrical conductivity values in the dam were typical of freshwater body of 1 – 1000uS/cm as described by FME (2001). Vajrapp and Singh (2005) reported that water with conductivity below 750 µS/cm is satisfactory for aquatic biota, as the highest recorded was 245 µs/cm in October. The higher mean conductivity values in wet season than dry season is an indication of the presence of

more ions in the wet season which could be due to influx of allochotonous and inorganic materials from the stream surroundings. Electrical Conductivity was maximum in the month of November (dry) while lowest was recorded in the month of August (wet). The high dry season value may be due to the reduction in the water level and increases in nutrient due to runoff of inorganic fertilizer from nearby farmland. Atobatele and Ugwumba (2008) suggested that decrease in conductivity values during raining season might be due to dilution of rainfall. The values obtained are in line with 4.99- 44.19 µS/cm reported by Abubakar (2006) in Lake Geriyo. The high conductivity values observed may be due to the fluctuation of monthly mean values of pH around the neutral point of 7 recorded in the Lake. Elleta (2005) pointed out that ions were lower in the rainy season than in the dry season since conductivity declines in the wet periods as the concentration of salts becomes more dilute. Therefore, discharges can change the conductivity of a water body because of their make-up.
The highest value for Dissolved Oxygen was obtained in the month of February (dry). This similar value for DO was observed by Ibrahim *et al.* (2009) in Kontagora reservoir who reported that the cool harmattan wind which increases wave action and decrease surface water temperature might have contributed to the increased oxygen concentration during the dry season. The high oxygen value for the dry season coincides with periods of lowest turbidity and temperature. The amount of dissolved oxygen in water has been reported not constant but fluctuates, depending on temperature, depth and wind and amount of biological activities such as degradation. In this study, the cool harmattan wind which increases wave action and decrease surface water temperature might have contributed to the increased oxygen concentration during the dry season, while the torrential rains, created increased turbidity and decreased oxygen concentration during wet season. Oniye *et al.* (2002) made similar observation in Zaria dam. The values of dissolved oxygen fell within the ranges (5.0-9.0 mg/l) documented by Alabaster (1980) for good water quality suitable for aquatic organisms. The monthly mean variation of the DO ranged from 3.15mg/l in the month of April to 13.20mg/l in December. The monthly mean value of Do observed during the period of study is lower than 12.02mg/l to 19.50mg/l as obtained by Abubakar (2006). The fluctuation of DO during the period of research might be due to decomposition of organic matter resulting in use of oxygen.

The BOD values recorded were less than 5 mg/l in all sites and seasons, indicating low level of organic matter pollution sources in the area (Patki, 2002). Biological Oxygen Demand (BOD) value was recorded during wet season (4.15 mg/L) could be as a result of massive amount of waste flowing into the river during wet season hence oxygen will be consumed faster by microbial population. The biodegradation of organic materials exerts oxygen tension in the water and increases the BOD (Adesalu *et al*., 2010).

Higher value for TDS is potentially unhealthy for aquatic life. The highest TDS obtained in the month of September (389mg/L) could be due to decaying of vegetation and wind effect at onset of rain during wet season leading to increase in water turbidity, this in turn decreases the light penetration, thus affects the photosynthesis, thereby suppressing the primary producers in the form of algae and macrophytes. Similar observation was made by Atobatele and Ugwuba (2008) when they reported increase in the values of total dissolved solids during the wet season which could be due to most of the vegetation was decaying so there was a rise in amount of dissolved solids. Similar values were reported by Mustapha (2009) in Oyun reservoir Offa, Nigeria. TDS concentrations at the range of 25-80mg/L represent moderatewater quality which serves as potential impairment of Dam (Tanimu *et al.*, 2011). Total dissolved solids mean range values of 167 to 278mg/L was within the standard limit set by FEPA (1991) for surface water 500mg/L.

Conclusion and recommendations

The physico-chemical parameters of Watari Dam during the study period were optimal for aquatic organisms within the study period, however the phosphate concentration of 13.5 – 23.2mg/L and nitrate concentration of 0.5mg/l to 2.89mg/L raised concern on accumulation of these elements that can posed threat of pollution to the dam. It is therefore recommended that regulatory and statutory agencies such as NAFDAC, NASREA and SON should strengthen their legislation against indiscriminate and improper waste disposal along water-ways, dams inclusive. This will ease inflow and check contamination to a large extent.

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CONFLICT OF INTEREST

The authors declared that they have no conflict of interest,

REFERENCES

Abubakar,K. A. (2006). A study of Aspect of Productivity and Stock Status of Orechromisniloticus and Clariasgariepinus inLake Geriyo, Yola, Adamawa State, Nig. Ph.D Theses Federal University of Tech. Yola, Nigeria pp. 212.

Abubakar, A. and Abdullahi, B.A (2015). Flora composition of phytoplankton as bioindicators of water Quality in jakara dam, kano state, nigeria. Bayero Journal of Pure and Applied Sciences, 8(2): 145 – 155.

Abdulazeez, M.T. (2015).Limnological studies of Karidna Reservoir, in Igabi Local Government area of Kaduna State, Nigeria, M.Sc. Thesis Ahmadu Bello University, Zaria. Pp 68.

Adamu, G.A; Sallau, M.S; Idris, S.O; and Agbaji, E.B. (2014). Seasonal variations of some physico-chemical parameters of watari reservoir, treated and potable water, in kano state nigeria. International Journal of Technical Research and Applications, 2(7): 98-104ISSN: 2320-8163, www.ijtra.com

Adesalu T, Bagbe M, Keyede D. (2010). Hydrochemistry and Phytoplankton Composition of Two Tidal Creeks in South-Western Nigeria. Revista de Biología Tropical. 58(3):827-840. Available: http://www.academicjournals.org/journal/JENE/article-full-text-pdf/0197CF011771

Abolude, D.S.,Chia,A.M., Yahaya,A.S and Okafor, D.C. (2012). Phytoplankton Diversity and Abundance as a function of Water Quality for Fish Production:a case study of two Manmade Reservoir in Zaria, Nigeria .*Tropical Fresh Water Biology*, 21(2):41-48.

Abolude, D.S., Barak,Z., Tanimu,Y., Bingari,M.S., Opabunmi,O.O and Okafor, D.C (2013). Assessment of the Concentration of Metals in Sewage Treatment Pond of the Ahmadu Bello University Zaria, Nigeria. *Journal of Aquatic Sciences,* 28(1):24-34.

Adakole, J.A., Abolude, D.S. and Balarabe, M.L. (2008). Assessment of Water Quality of a Man-Made Lake in Zaria, Nigeria. *Proceedings of Taal:* The 12th World Lake Conference: 1373-1382.

Akindele, E.O. Adeniyi,I. F. and Indabawa,I.I. (2013). "Spatio-temporal assessment and water quality characteristics of Lake Tiga, Kano, Nigeria," Research Journal of Environmental and Earth Sciences, 5(2):67–77.

Alabaster, J.S. and Lloyd, R. (1980). *Water quality for freshwater fish*. 1st edition.Butterworth publishers limited, London.283pp.

APHA(1995). *Standard methods for the examination of water and wastewater.16th edition* .American Public Health Association. New York, USA. 1268pp.

American Public Health Association (APHA, 1998). *Standard methods for theexamination of water and wastewaters*. 20th edition American Water works Association and Water Environment Federation, USA. Parts 1000-10,000. 10145pp.

APHA. (1999) Standard methods for the examination of water and wastewater. 18th ed. American Public Health Association, Washington, DC. Pg.127

APHA (2005). Standard methods for the examination of water and waste water.21st Edn., Washington, D. C.pg.126

Araoye, P.A. (2008). Physical factors and their Influence on Fish Species Composition in Asa Lake, Ilorin, Nigeria. *International Journal of Tropical Biology*,57(2): 167-175.

Asano, T. (2007). Water Reuse; *Issues, Technologies, and Applications.* New York, McGraw Hill.Pp. 23

Atobatele, O.E. and Ugwumba, O.A (2008). Seasonal Variation in the Physico-chemistry of a Small Tropical Reservoir (Aiba Reservoir, Iwo, Osun, Nigeria). *African Journal of Biotechnology,* 7 (12):62-171.

Ayodele, I. A., and Ajani, E. K. (1999). *Essentials of fish farming (Aquaculture)*. Odufuwa Press, Ibadan. 48pp.

Balarabe, M.L. (2001). Effect of Limnological Characteristic on Zooplankton Composition and distribution in Dumbi and Kwangila Ponds, Zaria, Nigeria. Ph.D. Thesis, Department of Biological Sciences, Ahmadu Bello University. Pp 65.

Boyd, C. E. (1981). Water Quality in Warm Water Fish Ponds. Agricultural Experimental Station; Aubum University Craft master Publication Co. Alabama USA 2nd edition, Pp 35- 39.

Elleta, O.A., F.A. Adekola,F.A and Aderanti,M.A. (2005). Assessment of Asa River: impact of water discharge from soft drink plant into Asa River, Ilorin. *Nigeria. J. Appl. Sci. Environ. Mgt.*, 9(1): 187-190.

Hujare, M.S., (2008), Seasonal variation of physico-chemical parameters in the 93 perennial tank of Talsande, Maharashtra, *Ecotoxicology and Environmental Monitoring*, 18(3): 233-242.

Fakayode, S.O. (2005). Impact Assessment of Industrial effluent on Water Quality of the Receiving Alaro River in Ibadan, Nigeria, *Ajeam-Ragee*., 10:1-13.

FEPA (1991). National Environmental Protection (Effluent Limitation) Regulations of 1991. Federal Environmental Protection Agency, Lagos, Nigeria. pp1-8.

FME (Federal Ministry of Environment). (2001). Guidelines and Standard for Quality in Nigeria. *Published Federal. Ministry of Environment,* p.114.

Haruna, A.B. and Abdullahi, B.A. (1999). Observations on the Seasonal Variations in Water Quality and Some Ecological Implications of Jakara Lake, Kano, Nigeria. *African Journal of Material andNatural Sciences,* 1(1): 107-112.

Ibrahim, S. (2008). Effect of Lead on Zooplankton Dynamics in Challawa River, Kano State, Nigeria. *Bajopas*.,1(1): 88-94.

Ibrahim, S. (2009). A Survey of Zooplankton Diversity of Challawa River, Kano and Evaluation of Some of its Physico-chemical Conditions : *Bayero Journal of Pure and Applied Sciences*, 2(1) : 19-26.

Ibrahim, B. U., Auta, J. and Balogun, J. K. (2009). An assessment of the Physicochemical Parameters of Kontagora Reservoir, Niger State, Nigeria. *Bayero Journal of Pure and Applied Sciences*, 2(1): 64 – 69.

Jahangir, T.M. Khuhawar, M.Y., Legahri, S.M., Balouch, W.A. and leghari, A.A. (2000), Some Studies onWater Quality and Biological Life at Kinjhar andKaleji Lakes of District Thatta, Sindh, Pakistan.*Pakistan Journal of Biological Siences.3(11):1965-1972*

Kawo, A.H; Abdullahi, B.A; Saminu, M.Y; AbdulHadi, S.K and Sha'aya'u, A.G. (2008). Seasonal and Spatial Variations in Water Quality and Its Ecological Implications on Challawa River, Nigeria. *Nigerian Journal of Basic and Applied Sciences*, 16(2): 129 – 135.

Kefas. M, Abubakar. K.AandAli.J. (2015). The Assessment of Water Quality via Physicochemical Parameters and Macro Invertebrates in Lake Geriyo, Yola, Adamawa State, Nigeria. *The International Journal Of Science &Technoledge,* 3 (3): 284- 290.

Kolo, R.J. and M. Yisa (2002). Preliminary Baseline assessment of the water quality of river Suka, Nigeria State Journal of Fisheries Technology Federal College of Fresh Water Fisheries Technology New Bussa and Alau-Nigeria Vol.2: pp 99-106

Mohammed, M. A. and Saminu M.Y. (2012). Water Quality and Phytoplankton of Salanta River Kano, Nigeria. *Journal of Biological Science and Bioconservation,* (4):65-73.

Mustapha, A. (2008): Environmental Pollution inKano: The Contribution of wastewater Discharge from Kano Old City and BompaiIndustrial Estate to Jakara River Basin system, *Techno Science J*., 2(1): 83-88.

Mustapha, M.K. (2011). Perspectives in the Limnology of Shallow Tropical African Reservoirs in Relation to Their Fish and Fisheries. *Journal of Transdisciplinary Environmental Studies*,10(1):16-23

Oketola A. A., Osibanjo O., Ejelonu B. C., Oladimeji Y. B., and Damazio O. A., (2006). Water Quality Assessment of River Ogun around the Cattle Market of Isheri, Nigeria, Journal of Applied Sciences, 6(3): 511-517.

Oniye, S-L, Ega, R.A., Ajanusi, O.J. and Agbede, R.I.S. (2002). Some Aspects of the Physicochemical Parameters of Zaria Dam, Nigeria. *Journal of Agriculture and Environment*,11(2): 367- 379.

Patki, S. F. (2002). *Hydrobiological studies of Banshelki dam at Ugdi*. PhD Thesis Marawathda University. Pp. 89

Tanimu, Y., Bako, S.P., Adakole, J.A. and Tanimu, J. (2011). Phytoplankton as Bioindicators of Water Quality in Saminaka Reservoir, Northern-Nigeria. *Proceeding of the 2011 International Symposium on Environmental Science and Technology*. Dongguan, Guandong province, China. Published by Science press USA: 318-322.

Tiseer, F. A., Yarimu, Y. and Chia, A. M. (2008). Survey of Macrovegetation and physico-chemical parameters of Samaru stream, Zaria, Nigeria. *Research Journal of Environmental Science,* 2(5): 393-400.

Ufodike, E.B.C., Kwanasie, A.S. and Chude, L.A (2001). On-set of rain and its Destabilizing effect on aquatic Physicochcmical Parameters. *Journal of Qquatic Sciences* 16(2)91-94.

Verma, P.U; Purohit, A and Patel, N.J. (2012). Pollution Status of Chandlodia Lake Located in Ahmedbad Gujarat. *IJERA*., 2(1) : 1600- 1606.

Vajrappa, H.C. and Singh, N.R. (2005). Hydrochemical studies of Suvarnamukhi*Sub-basin of ArkavathiRiver, Bangalore district, Karnataka. In: Fundamentals of Limnology*. S.B. Nangia for APHpublishing corporation 5, Ansari road, Darya Ganj,New Delhi.Pp.171-18

Wetzel, R.G and Liken,s G.E. (2000). Limnological Analyses, Third Edition Springer, New York p.429.

Wood, A. (1995). Constructed Wetland in Water Pollution Control Fundamental to their Understanding. *Water science and Technology*, 32(3): 21 -29.

World Health Organization (2003). *Guidelines for Safe Recreational Water Environment* Volume 1:Coastal and Fresh Waters, Geneva, pp 1-33.

WHO (1999). *Limits for Effluents Discharge into Surface Waters.* World Health Organization, Geneva, Pp 456