Fagbenro, O.A.; Ajani, E.K.; Magawata, I.; Shinkafi, B.A.; Ayoola, S.O. and Orisasona, O. (Eds.) (2018) Proceedings of 1st Conference of Association of Nigerian Fisheries Scientists. "Science, Innovation and Aquabusiness: A Tripod for Sustainable Fisheries and Aquaculture Development in Nigeria" July 10-12, 2018 in the University of Ibadan, Ibadan, Nigeria

Spatial and Temporal Variation of Limnological Features of Eleyele Lake, Ibadan, Nigeria

Sunday, Y. A. and Jenyo-Oni, A.
Department of Aquaculture and Fisheries Management,
University of Ibadan, Ibadan, Nigeria

Abstract

Lakes and reservoirs have significant impacts on inland water resources owing to their productivity level globally. The variations in physico-chemical parameters of a freshwater lake (Eleyele) in Oyo State were investigated in this study. This is to ascertain how the variability in physico-chemical parameters along the space and between seasons influences the productivity capacity of the lake. The physico-chemical parameters evaluated were pH, alkalinity, conductivity, temperature, dissolved oxygen, total dissolved oxygen, total hardness, transparency, nitrate, ammonia and biochemical oxygen demand. These parameters were assessed spatially as the lake was divided into five zones (Zone A to E) based on its hydrological features and temporally (seasons: wet and dry). The pH was highest during the wet season (7.23), zone C (7.15); alkalinity highest in dry season (104.66), zone B (7.15); temperature (23.30) in the dry season, zone E (25.40); conductivity (357) highest during the dry season, zone D (292.87); dissolved oxygen(4.51) highest in the wet season, zone E(4.65); total dissolved oxygen (158.28) highest in the wet season, zone B (162.54);biochemical oxygen demand (9.22) highest in the dry season, zone E(8.25); transparency (1.63) in the dry season, zone C (1.71); nitrate (4.22) wet zone season, zone B(4.03); ammonia (1.17) dry season, zone B(1.69). Most of these parameters were not significant spatially but significant differences existed between the seasons. The differences were attributed to variability recorded in fish productivity across seasons and along the space in Eleyele Lake.

Keywords:
Eleyele Lakes, physico-chemical parameters, Hydrological features

Introduction

Water is an elixir of life with functions and evolution of the whole universe. Water is very important for agriculture, farming, human existence and industry. An healthy environment for aquatic ecosystem depends largely on its physico-chemical parameters (Venkatesh-araju *et al*.,2010) .

Inland waters consist of different water bodies of vast range of diverse biodiversity that provide livelihood and various opportunities for man. Most of these aquatic biodiversity of inland waters which comprises of the plants, fish, reptiles and other aquatic resources are of great importance to human and its existence. Inland waters are used for different activities which is a threat to the fisheries sector (Cowx and Welcomme, 1998). Some of these activities include agriculture, power generation, tourism, navigation and recreation use, as well as urbanization, land use practices (forest use, charging run-off and sedimentation), domestic waste disposal and discharge of effluents by industries. All these practices compete and alter the environmental structure of the inland fisheries which greatly affect the quantity and quality of the water. The degradation of the natural habitat affects the aquatic environment, hence the water quality. With rapid urbanization and industrialization going on in most of the major cities in Nigeria with Ibadan as a good example of such cities in Nigeria, there is therefore a need for proper documentation of the consequence of these on the quality of freshwater system especially as it relates to

their productive capacity, due to the fact that these water bodies such as Eleyele Lake are the major recipient of the pollutants emanating as outputs of urbanization and industrialization. This study provided updated information on Eleyele Lake as regards the spatial and temporal variation of water quality parameters.

Materials and Methods

Eleyele Lake

Eleyele reservoir was constructed by the Water Corporation of the old Western Region in1939, primarily to supply water to Ibadan city by daming of the River Ona (Jeje *et al.* 1997). The dam is located along Eleyele wetland in the north-eastern part of Ibadan (Ido Local Government Area), south-western Nigeria within longitude N07°25'00" and N07°27'00" and latitude E03°50'00" and E03°53'00". The catchment of Eleyele wetland is relatively well-drained, with network of River Ona and its tributaries (such as Ogbere, Alapata and Ogunpa) (Tijani *et al.*, 2011) and is part of a network of inland waters draining into Lagos lagoon. The control of the fisheries of Eleyele Reservoir resides in the Oyo State Ministry of Agriculture and Natural Resources acting through its Department of Fisheries.

Experimental procedures

The water samples were collected bimonthly for a period of 24 months covering two wet seasons and two dry seasons. The physico-chemical parameters that were measured include dissolved oxygen, temperature, transparency, depth, pH, nitrite, alkalinity, conductivity, total dissolved solid, total solids, total hardness, chemical oxygen demand, biochemical oxygen demand, ammonia, nitrate, macro-nutrient compositions (sodium, chloride, magnesium, calcium, potassium and phosphate).

Sampling techniques

The sampling methods were time and space stratified. Time stratification covers two dry (May -Nov) and two wet (Dec-April) seasons. Space stratification were based on the method of Muhammed *et al.,* (2008), ISO (2006) and Southwood and Henderson, (2000) in which the entire lake were divided into five zones (Z1-Z5; Z1-Oluseyi, Z2-Apapa ijokodo, Z3-Oniyere, Z4-Dam, Z5-Fisheries) and three sampling stations were chosen in each of the five zones, giving a total of fifteen sampling stations within the lake. The sampling points were randomly selected in each zone using hydrological features (PA-Inshore, PB-open water, PC- offshore). The sampling stations were located using GPS to get the coordinates of the sites.

Rainfall data

Monthly rainfall data measured in mm of the study area for the study periods were obtained from the GIS Unit, Geography Department, University of Ibadan.

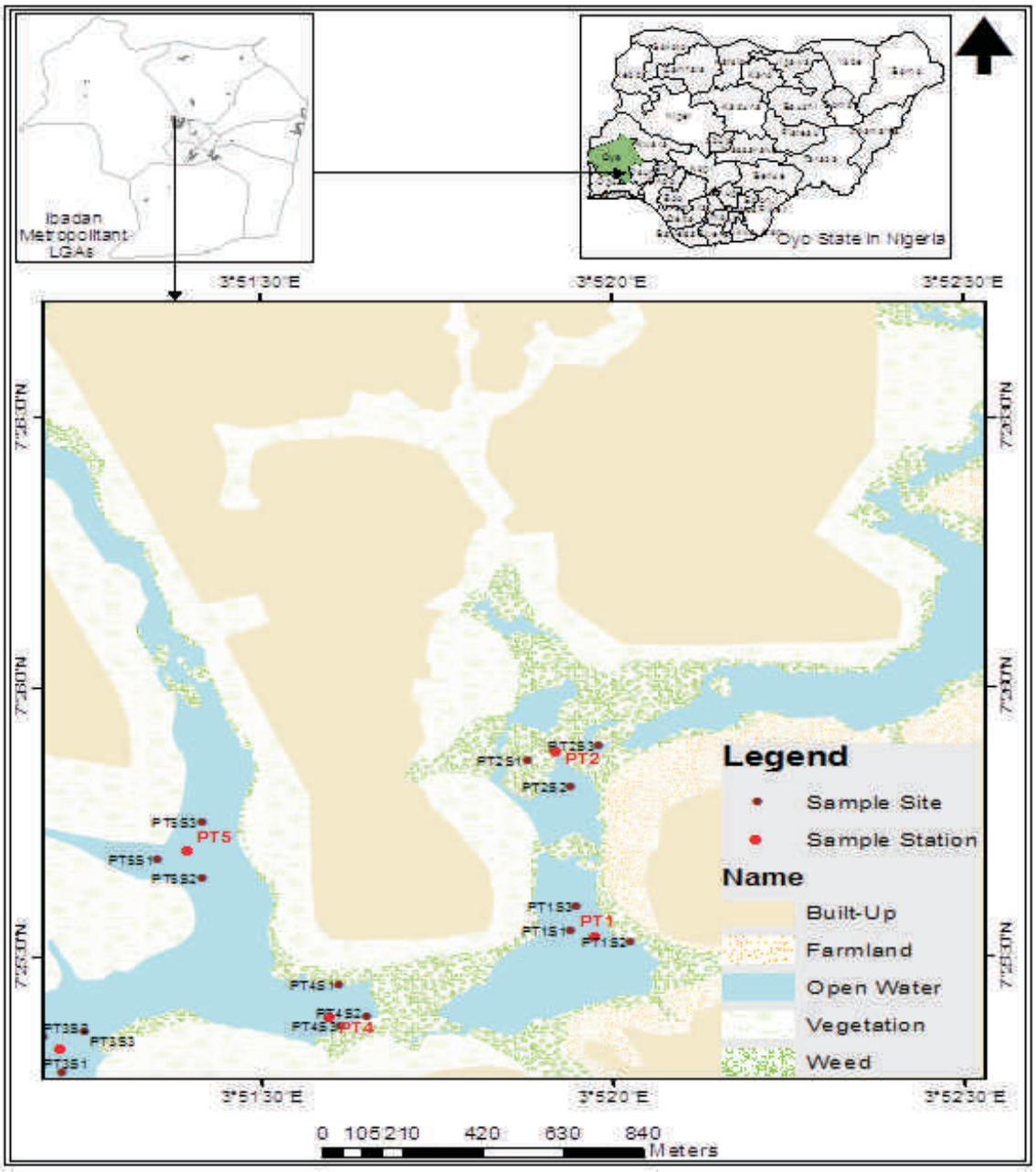

Figure 1: Map of Eleyele Lake

Collection of Water Samples

Water samples for physico-chemical parameters determination were collected just below the surface at each station with a 75cl bottle which was washed previously with dilute nitric acid and rinsed with distilled water. Water samples were taken at sub-surface level of about 50cm depth. The samples were fixed with 5ml/L of concentrated nitric acid (APHA, 2005) and stored at low temperatures. A separate water sample was collected in 250ml dissolved Oxygen glass bottle with glass stopper at each station and fixed according to Winkler's method using Manganese Sulphate solution and Alkaline Potassium iodide reagents which was later analysed in the wet laboratory of Aquaculture and Fisheries Management.

Conductivity and total dissolved solid were analysed with AD 33915- Intelligent metre, alkalinity and chloride were analysed using the HANNA metre (H13811), water temperature were measured with the Celsius thermometer *in-situ* and also the transparency by Secchi disc and depth with calibrated rope tied with iron rod while other parameters were analysed in accordance with APHA (2005).

The acid pre-treatment was to ensure that the mineral elements are not absorbed to the surface of the container during transportation.

Statistical analysis

The data generated for spatial and temporal variation in the physico-chemical parameter were subjected to both descriptive and inferential statistical tools. Descriptive statistics such as mean and standard deviation were used to describe each of the water quality parameters as well as macro-nutrient composition in water samples. The inferential statistical tool such as Analysis of Variance (ANOVA), t-test, Correlation using excel (2010) were used to test for significant differences in water nutrient composition content among the five sampling stations and the three sampling units, as well as significant relationship that may exist among the sampling units and the level of significance on seasonal variation. Data were pooled and presented as seasonal and spatial mean variance. Data were subjected to Analysis of variance (ANOVA-one way; SPSS version 20) to examine differences at $P < 0.05$ with regards to zones.

Results

Table 1: Temporal variation of physico-chemical parameters of water of Eleyele Lake

Parameters	Dry season	Wet season	P – value	Optimum range (Boyd,1998)
pH	6.85±0.36	7.23±0.51	.000*	6.5-8.5
Temp(^{O}C)	25.30±1.12	25.29±1.19	.945	25.0-32.0
Trans(cm)	1.63±1.25	1.53±0.28	.100	0.3-0.4
Depth(m)	6.93±1.40	7.23±1.53	.014	-
Alk(mgL^{-1})	104.66±27.95	100.69±19.81	.035	50.0-300.0
Chl(mgL^{-1})	2.51±1.71	7.10±6.58	.000*	31-50
TH(mgL^{-1})	76.48±24.24	93.59±36.61	.000*	30-180
Ca(mgL^{-1})	32.71±17.34	30.65±15.46	.000*	75-200
Mg(mgL^{-1})	3.04±1.72	4.04±2.16	.000*	<150
Na(mgL^{-1})	0.31±0.35	0.24±0.37	.018	<500
K(mgL^{-1})	0.60±0.41	0.43±0.33	.000*	0.5-10
TDS(mgL^{-1})	157.23±19.61	158.28±27.23	.599	30-200
TS (mgL^{-1})	247.07±121.49	311.92±148.03	.000*	<500
DO(mgL^{-1})	4.07±1.22	4.51±1.08	.000*	5.0-10.0
BOD(mgL^{-1})	9.22±5.85	6.88±3.56	.000*	<10.0
COD(mgL^{-1})	93.03±18.72	114.83±55.69	.000*	<50.0
Nitrate(µm)	3.12±0.72	4.22±1.60	.000*	0.1-3.0
Phosphate(µm)	1.41±0.63	1.61±0.62	.000*	6.5-8.5
Sulphate(µm)	7.0±6.99	8.16±3.68	.005	<400
Ammonia(µm)	1.17±0.32	1.58±1.14	.000*	0.0-1.0

Legend: pH, Temperature, Transparency, Depth, Alk- Alkalinity, CHL- Chloride, TH- Total Hardness, Ca-Calcium,Mg-Magnesium, Na-Sodium, K-Potassium, TDS- Total dissolved solid, DO-Dissolved Oxygen, BOD-Biochemical Oxygen Demand,COD- Chemical Oxygen Demand, Nitrate, Phos- Phosphate, Sul- Sulphate, Ammonia.

Table 2: Spatial variation of physico chemical parameters of Eleyele Lake

Parameter / Zones	A	B	C	D	E	Optimum range (Boyd, 1998)
Ph	7.08±0.49^{ab}	7.10±0.48^{ab}	7.15±0.53^{b}	7.01±0.51^{a}	7.12±0.49^{ab}	6.5-8.5
Temp	25.10±1.17^{a}	25.30±1.21^{a}	25.31±1.19^{a}	25.38±1.33^{a}	25.40±1.15^{a}	25.0-32.0
Trans	1.48±0.25^{a}	1.55±0.23^{ab}	1.71±1.67^{b}	1.56±0.30^{ab}	1.50±0.27^{a}	0.3-0.4
Depth	6.51±0.92^{a}	6.53±0.85^{a}	6.85±1.18^{b}	8.73±1.84^{c}	6.96±1.31^{b}	-
Alk	102.40±23.3^{a}	104.65±21.13^{a}	102.77±22.31^{a}	99.36±22.38^{a}	103.71±27.21^{a}	50.0-300.0
Chl	6.33±7.65^{b}	6.94±10.21^{b}	3.05±1.46^{a}	7.31±11.65^{b}	3.43±1.78^{a}	31-50
TH	89.42±32.88^{a}	87.02±33.65^{a}	83.66±34.69^{a}	87.69±33.48^{a}	86.01±34.74^{a}	30-180
Ca	30.89±15.43^{a}	30.59±16.15^{a}	30.05±15.07^{a}	30.04±14.65^{a}	30.6±14.92^{a}	75-200
Mg	3.77±1.92^{a}	3.72±2.02^{a}	3.55±2.01^{a}	3.66±2.05^{a}	3.51±2.04^{a}	<150
Na	0.24±0.30^{a}	0.23±0.3^{a}	0.30±0.44^{a}	0.31±0.45^{a}	0.25±0.31^{a}	<500
K	0.46±0.36^{a}	0.49±0.36^{a}	0.46±0.35^{a}	0.47±0.37^{a}	0.45±0.33^{a}	0.5-10
TDS	160.78±22.62^{ab}	162.54±28.69^{b}	158.33±22.50^{ab}	155.19±20.30^{a}	155.56±27.10^{a}	30-200
TS	289.89±119.41^{a}	290.98±106.06^{a}	341.33±151.02^{b}	302.04±149.11^{a}	273.82±139.5^{a}	<500
DO	4.34±1.04^{a}	4.25±0.93^{a}	4.33±1.31^{a}	4.39±1.09^{ab}	4.65±1.14^{b}	5.0-10.0
BOD	7.48±4.27^{a}	7.41±4.02^{a}	7.53±4.44^{a}	7.41±4.30^{a}	8.52±5.39^{b}	<10.0
COD	107.88±49.03^{a}	109.45±49.50^{a}	102.05±44.44^{a}	107.49±44.24^{a}	102.49±48.22^{a}	<50.0
Nitrate	3.83±1.64^{ab}	4.03±2.06^{b}	3.83±1.35^{ab}	3.56±1.10^{a}	3.94±1.07^{ab}	0.1-3.0
Phos	1.51±0.62^{a}	1.54±0.74^{a}	1.49±0.68^{a}	1.51±0.71^{a}	1.44±0.68^{a}	6.5-8.5
Sulp	8.05±5.40^{a}	8.12±5.49^{a}	8.40±5.71^{a}	7.51±4.95^{a}	7.04±3.55^{a}	<400
Amm	1.66±1.25^{b}	1.69±1.40^{b}	1.36±0.61^{a}	1.31±0.52^{a}	1.21±0.41^{a}	0.0-1.0
Cond	288.37±69.15^{a}	292.87±69.85^{a}	291.15±67.04^{a}	292.21±69.35^{a}	288.91±69.1a	

Key:pH,Temp-Temperature(^{0}C),Trans-Transparency(cm),Depth(m),Alk-Alkalinity(mgL^{-1}),Chl-Chloride(mgL^{-1}),TH-Total Hardness (mgL^{-1}),Ca-Calcium(mgL^{-1}),Mg-Magnesium(mgL^{-1}),Na-Sodium(mgL^{-1}),K-Potassium(mgL^{-1}),TDS-Total dissolved oxygen(mgL^{-1}),TS-Total solid(mgL^{-1}),BOD-Biochemical oxygen demand (mgL^{-1}),COD-Chemical oxygen demand(mgL^{-1}),Nitrate(µm),Phos-Phosphate(µm),Sulp-Sulphate(µm),Amm-Ammonia(µm),Conductivity.

Table 3: Correlations coefficient of physico-chemical parameters

	pH	Alk	Cl	TH	Ca	Mg	Na	K	TDS	TS	Do	BOD	COD	N	Phos	Sulp	NH3	Tem	Depth	Cond
pH	1																			
Alk	-.198	1																		
Cl	-.171	.136	1																	
TH	.188	.186	.153	1																
Ca	.253	.156	.034	.810**	1															
Mg	.067	.048	.185	.675**	.637**	1														
Na	-.511*	.130	.463*	.022	-.028	-.138	1													
K	-.305	.015	-.147	.092	-.016	.301	-.115	1												
TDS	-.355	.147	.132	-.172	-.387	-.347	.212	.224	1											
TS	-.108	.470	.563**	-.174	-.287	-.279	.393	-.325	.554**	1										
Do	.066	.262	.137	-.190	-.244	-.493*	.029	-.699**	.287	.516*	1									
BOD	-.277	.015	-.257	.008	.124	.239	.065	.789**	.035	-.474*	-.777**	1								
COD	-.041	.132	.734**	-.135	-.214	-.353	.338	-.082	.405	.628**	.316	-.261	1							
N	-.150	.529	.750**	.024	-.017	.242	.568**	-.134	.178	.551**	.068	-.117	.536*	1						
Phos	-.120	.262	.105	-.169	-.348	-.308	.144	-.252	.621**	.811**	.521*	-.374	.252	.253	1					
Sulp	-.123	.596	.169	.009	-.159	-.106	.051	-.314	.444*	.654**	.539**	-.609**	.169	.167	.696**	1				
NH3	-.263	.279	.902**	-.142	-.199	-.005	.545**	-.157	.180	.615**	.153	-.164	.737**	.832**	.239	.096	1			
Temp	-.146	.173	.492*	-.289	-.098	-.180	-.010	-.127	.126	.422	.233	-.093	.521*	.218	.225	.039	.527*	1		
Depth	.385	.957	.063	.556**	.538**	.478*	-.294	.048	-.591**	-.475*	-.220	.108	-.154	-.169	-.568**	-.482*	-.140	-.039	1	
Cond	-.162	.085	-.024	-.049	-.074	.025	-.268	.214	.202	.062	-.119	.149	.020	-.150	.159	.088	-.012	.117	-.071	1

Key: pH, Alk- Alkalinity, Chl- Chloride, TH- Total Hardness, Ca- calcium, Mg- Magnessium, Na-Sodium, K- Potassium, TDS-Total dissolved solid, TS- Total solid, DO-Dissolved oxygen, BOD-Biochemical Oxygen Demand, COD-Chemical Oxygen Demand, N-Nitrate, Phos- Phosphate, Sulp- Sulphate, NH_3- Ammonia, Temp – Temperature, Depth, Trans- Transparency, Condu- Conductivity

The temporal variation of physico-chemical parameters of Eleyele Lake is presented in Table 1, the results revealed that the mean value of pH, Chl (mgl^{-1}), TH (mgl^{-1}), calcium (mgl^{-1}), magnesium (mgl^{-1}), potassium (mgl^{-1}), TS (mgl^{-1}), DO (mgl^{-1}), BOD (mgl^{-1}), COD (mgl^{-1}), nitrate (µm), phosphate (µm),sulphate (µm)and ammonia (µm) significantly varied within the season ($P<0.05$) while alkalinity, sodium, TDS, temp (^{O}C), transparency (m) and depth(m), had no significant difference between the season ($P>0.05$). The mean value (±SD) of the physico-chemical parameters of pH (7.23±0.51), chloride (7.10±9.58), TH (93.59±36.6mgl^{-1}), Mg (4.04±2.16), TDS (158.28±27.23mgl^{-1}), TS (311.92±148.03mgl^{-1}), DO (4.51±1.05), COD (114±55.69), Nitrate (4.22±1.60), phosphate (1.61±0.62), sulphate (8.16±3.68), ammonia (1.58±1.14) and depth (7.23±1.53m) were higher in the wet season than the parameters in the dry season, while the mean value for calcium (32.71±13.34), sodium (0.31±0.35), potassium (0.60±0.41), BOD (9.22±5.85), temperature (25.30±1.12), transparency(1.63±1.25) and conductivity (357±50.51) were higher in the dry season than the parameters in wet season.

The mean value of the spatial variation of the physico-chemical parameters are presented in Table 2. Zone C (7.15) had the highest mean value for pH and significant difference exist across the zones, for alkalinity, Zone B has higher (104.65), mean value which was also not significant across the zones, zone E (25.40) was the highest among the zones for temperature and no significance across the zones, for the transparency of the Lake, Zone C had the highest mean value (1.71) and there was significant difference across the zones, while in depth, Zone D had the highest mean value (8.73) with significant difference across the zones, and for ammonia, Zone B (1.69) had the highest mean value and significant difference exist across the zones.

The correlation analysis of the physico-chemical parameters is presented in Table 3.The Pearson Correlation showed that some parameters were significantly positive or negatively correlated between themselves while some showed no marked correlation. The pH was negatively correlated to sodium ($r = -.511$; $p<0.05$), chloride showed a positive correlation with NH_3 ($r = .902$), temperature ($r = 492$), sodium ($r = 453$), TS (.563), ($p>0.05$); COD (.734) and Nitrate (.760) . Magnesium exhibited positive correlation with depth ($r = .498$; $p >0.05$) and negatively correlated with dissolved oxygen ($r = -.493$, $p <0.05$); potassium is significantly correlated negatively with DO ($r = -.699$; $p<0.01$) and significantly correlated positively with BOD ($r = .789$, $p<0.01$). TDS indicated strong positive correlation with phosphate ($r = .621$, $p>0.01$) and correlated with sulphate ($r = .444$; $p>0.05$) and strongly correlated negatively with depth ($r = .591$, $p<0.01$). TS is positively correlated with DO ($r = .516$ $P>0.05$) and negatively correlated with BOD and depth ($r = -.474, -.475$, $P<0.05$). DO significantly correlated with COD ($r = .777$; $p<0.01$) and positively correlated with phosphate ($r = .521$; $p>0.05$) and significantly correlated positively with sulphate ($r = .539$, $p>0.01$) COD showed positive correlation between Nitrate and temperature ($r = .536, .521$, $p>0.05$) and significantly correlated positively with Ammonia ($r = .737$, $p>0.01$).

Strong positive correlation exist between Nitrate and ammonia ($r = .832$, $p>0.01$) and sulphate exhibited positive correlation with depth ($r = .482$, $p>0.05$). Ammonia is positively correlated with temperature ($r = .527$, $p>0.05$) .

Discussion

According to standard water limit recommended by Boyd (1998) for aquatic life survival, the mean values and ranges of physico-chemical parameters obtained fell within these ranges except for the electrical conductivity which was above the range. This was in agreement with the report of Atobatele and Ugwumba (2008) which suggested that decrease in conductivity values during rainy season might be due to dilution of rainfall while the higher values may be due to chemical fertilizers from irrigated

farmlands around the lake.

The low water temperature observed during the period of this study could be attributed to rainy season, extensive cloud cover and fluctuation in water temperature of the lake. These results agreed with the findings of Olarenwaju *et al*., (2017). Toma (2013), while the report contradicted that of Fafioye *et al*, (2005) which recorded higher value for temperature in wet season. The temperature range falls within the standard recommended limit by Boyd (1998) for metabolism, physiology and survival of aquatic life. The pH value recorded was high during the wet season but the ranges were within the acceptable limit reported by Boyd (1998) for fish production. This was in line with the report of Atobatele *et al*., (2005) and Hassan *et al*., (2014). Higher transparency occurred during the dry season which may be due to gradual settling of the suspended particles in the water; there was no rainfall and this slowed down the rate of water runoff. This is similar to the findings of Ibrahim *et al*., (2009). The report is also consistent with that of Inuwa (2007) and Mustapha (2003). The value of total dissolved solids obtained falls within the range set by Boyd (1998). Higher concentration of TDS was recorded during the wet season. This was similar to the report of Araoye (1997) Asa Lake in Ilorin, Kalwale and Sayale (2012) and Olarenwaju *et al.,* (2017) in Eleyele Lake. This study also reports a higher value for alkalinity during the dry season and low value during the wet season and is similar to the findings of Ibrahim *et al.,* (2009). The phosphate in the study was higher compared with previous studies by Akindele and Adeniyi (2013) in Opa Reservoir and Mustapha and Omotosho (2005) in Moro.

The relatively high values recorded for phosphate may be related to the inflow of effluent (agricultural run-off) and human activities around the lake. Nitrate and Ammonia reported fell outside the recommended limit set by Boyd (1998) but agreed with the findings of Ovie *et al,* (2011). The report coincides with the report of Ayoola and Ajani (2009) in wetland of Oyo State and contradicts the findings of Dimowo, (2013) in Ogun River. The ions composition observed during the study fall within the recommended limit while Calcium, Chloride and Potassium were relatively low (outside the recommended limit by Boyd (1998)). Chloride was higher during the wet season which could be attributed the discharge of sewage to the water which could be more during the wet season, this is similar to the report of Farombi *et al.* (2014). Only Chloride and magnesium were higher during the wet season while, sodium, calcium, potassium were higher during the dry season and lower during the wet season. These disagree with the findings of Akindele and Adeniyi (2013) that observed higher variation during the dry season in Oyun lakes but agrees with Golterman and Kouwe (1980) which observes similar result of calcium been predominantly dominated in the ionic composition of Eleyele Lake.

Conclusion

This study showed that Eleyele Lake is an eutrophic lake with acceptable water quality that fall within the set limit for aquatic ecosystem.

References

Akindele, E.O and Adeniyi, I.F. 2013. A study of the physico-chemical water quality, hydrology and zooplankton fauna of Opa Reservoir catchment area, Ile-Ife, Nigeria. *Afr J Environment Sci Technol* 7: 192-203.

Ali,S.S.1999. Freshwater fishery fe/o/ogy.Nasem Book Depot, Hyderabad,! 08-114.

Ali, M., Iqbal, I.F., Salam, I.A., Irani, I.S. and Athar, M. 2005. Comparative study of body composition of different fish species from brackish water pond. M. *International Journal of Environmental* American Public Health Association (APHA). 2005. *Standard methods of water and wastewater examination,* 21st Edition. Washington D.C. Joint publication of American Public Health Association, American Water Works Association and Water Pollution Control Federation approach: 179.

Atobatele O.E, and Ugwumba O.A 2008. Seasonal variation in the physico-chemistry of a small tropical reservoir Aiba Reservoir, Iwo, Osun State, Nigeria. *Afr J Biotechnol* 7:1962-1971.

Atobatele, O.E, Morenikeji, O.A, Ugwumba, O.A 2005. Spatial variation in physical and chemical parameters of benthic macro invertebrate fauna of River Ogunpa, Ibadan. *Zoologist* 3: 58-67.

Ayoade A.A, Fagade S.O and Adebisi A.A 2006. Dynamics of limnological features of two man- made lakes in relation to fish production. *Afr J Biotechnol* 510: 1013-1021.

Bolaji G.A. 2010. Hydrological assessment of water resources and environmental impact on an urban lake: a case study of Eleyele Lake catchment, Ibadan, Nigeria. *J Nat Sci Engineering*^ Technol 9: 90-98.

Boyd, C.E 1998. Water quality for pond aquaculture. Research and Development Series No. 43.1 international Center for Aquaculture and Aquatic Environments, Alabama. Agricultural Experiment Station, Auburn University Publisher, Alabama:183.

Fafioye, O.O., Olurin, K.B., Sowunmi, A.A. 2005. Studies on the physico-chemical parameters of Omi water body of Ago-Iwoye, Nigeria. Afr J Biotechnol 4: 1022-1024.

Hassan, A.A, Jenyo-Oni, A, Dauda. A.B. 2014. Assessment of water quality, Ichthyofauna and Macroflora Diversity of Lower Ogun River Wetlands. *World Journal of Fish and Marine Sciences* 6:1: 101-108, 2014.

Ibrahim, S. 2009. A survey of Zooplankton diversity of Challawa River, Kano and evaluation of some of its physicochemical conditions. *Bayero J Pure Appl Sci* 2: 19-26

Inuwa B.2007. Studies on aspects of physicochemical conditions and fish biology in Jakarta Dam, Kano, Nigeria. A M.Sc. Dissertation Submitted to the Biological Sciences Department, Bayero University, Kano (Unpublished).

Kalwale, A.M., Savale, P.A. 2012. Determination of physico-chemical parameters of Deoli Bhorus Dam water. Adv Appl Sci Res 3: 273-279.

Kareem, O.K. 2016. Ecological evaluation and sustainable fish production in Erelu reservoir, Oyo, Nigeria. PhD Thesis submitted to Department of Aquaculture and Fisheries Management .Pp 202+Xviii.

Mustapha M.K. and Omotosho J.S. 2005. An assessment of the physico-chemical properties of Moro Lake, Ilorin, Nigeria. *Afr J Appl Zoology Environ Biol.*

Mustapha M.K 2009. Limnology and fish assemblages of Oyun reservoir, Offa, Nigeria. Ph.D Thesis submitted to the Department of Zoology, Faculty of Science, University of Ilorin, lorin, Nigeria.

Olanrewaju, A.N, Ajani, E.K and Kareem, O.K., 2017. Physico-Chemical Status of Eleyele Reservoir, Ibadan, Nigeria. *J Aqua Res Development* 8: 512.

Oniye, S.I.; 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.

Ovie SI, Bwala RL, Ajayi O 2011. A preliminary study on limnological stock assessment, productivity and potential fish yield of Omi Dam, Nigeria. *Afr J Environmental SciTechnol* 5: 956-963

Tetsuro Agusa A., Takashi KunitoB., Genta Yasunaga A., Hisato Iwata .A, Annamalai Subramanian A., Ahmad Ismail C., Shinsuke Tanabe A.2005. Concentrations of trace elements in marine fish and its risk assessment in Malaysia. *Mar. Pollut. Bull*. 51: 896-911.

Tijani, M.N., A.O. Olaleye and O.O. Olubanjo, 2011. Impact of urbanization on wetland degradations Case study of Eleyele Wetland, Ibadan, South West, Nigeria. *Proceedings of the Environmental Management Conference, Federal University of Agriculture, Abeokuta, Nigeria*,: 435-457.

Toma, J.J. 2013. Limnological study of Dokan, Derbendikhan and Duhok lakes, Kurdistan region of Iraq. *Open Journal of Ecology* 3: 23-29.