# Physico-Chemical Parameters of Oguta Lake, Imo State, Nigeria.

**Agorua, Uchenna Nwabata[1]; Sikoki, Francis David [2]; Ijeoma Vincent-Akpu [3]**

[1]Department of Fisheries and Marine Technology, Imo State Polytechnic, Umuagwo, e-mail:agoruauchenna@yahoo.com.

[2]Department of Animal and Environmental Biology, University of Port Harcourt, Port Harcourt; E-mail: francis.sikoki@uniport.edu.ng

[3]Department of Animal and Environmental Biology, University of Port Harcourt, Port Harcourt; E-mail: ijeoma.vincent-akpu@uniport.edu.ng

## ABSTRACT
The physico-chemical parameters of Oguta Lake, Imo State, Nigeria were studied for 18 months (May 2016 – October 2018) on monthly basis. The physico-chemical parameters (temperature, pH, colour, conductivity, turbidity, dissolved oxygen, Biochemical Oxygen Demand, Nitrate, Nitrate-nitrogen, Phosphate, Phosphorus, Total Dissolved Solids and Total Suspended Solids) were determined using standard methods. Temperature was ranged 23.41±0.50 – 30.90±1.24$^{o}$C, pH (5.08±0.47 – 8.31±0.37), Conductivity (5.67±3.32 – 47.78±4.60µs/cm), Turbidity 2.12±1.88-18.91±14.08 NTU, Total Dissolved Solids (4.33±0.75 – 31.06±3.27 mg/l, Dissolved Oxygen (3.00±0.93 – 9.70±0.00mg/l), Biological Oxygen Demand (1.21±0.43- 9.47±0.07mg/l), Nitrate (0.93±0.56 – 41.67±32.76mg/l), Nitrate-Nitrogen (0.29±0.18 – 9.43±7.42mg/l), Phosphate (0.22±0.07 – 9.06±3.43mg/l), Phosphorus (0.07±0.01 – 3.02±1.14). The result shows that the parameters were within the acceptable level except nitrate, phosphorus and turbidity which were higher. This may be caused by the defecation in the lake by the populace, the use of the lake for agricultural processing and sand dredging. Therefore, there should be proper regulation to reduce the input of inorganic materials by providing an alternative source for the populace of the community.

## INTRODUCTION
The accepted quality of rivers and streams at any point reflects the quality of upstream contributions of surface run-off and ground water discharge. The different aquatic bodies in the country are used for various purposes such as fishing, transportation, sand mining, irrigation, recreation, abstraction for industrial and household purposes as well as electricity generation. Urbanization, intensive agriculture, recreation, and the manufacturing industry are affecting water quality throughout the world. Reports available on environmental monitoring of surface water indicated that streams and rivers in the country are showing increasing trend of water pollution due to increase population, industrialization and urbanization. Waste generations by the industries and households have continued to increase. These wastes are arbitrarily disposed-off into the water bodies. This has led to pollution of inland water bodies and coastal water and subsequently increased water quality parameters such as heavy metal, nutrients and organic matter, soluble ions, oil and grease, and organic chemicals such as pesticides and Polynuclear Aromatic Hydrocarbons (PAHs) (Esoka and Umaru, 2006; Adebayo *et al*., 2007; Jaji *et al*., 2007; Mashi and Alhassan, 2007; Solomon, 2009) . Urgent attention is therefore required to

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alleviate water pollution problems in Nigeria in the course monitoring as well as enforcement of emission standards for industries (Ekiye and Zejiao, 2010).

According to National Bureau of Statistics (2009), at least 27% Nigerians depend entirely on streams, pond, river and rainwater for their drinking water source. Research has revealed high occurrence of waterborne diseases such as cholera, diarrhoea, dysentery, hepatitis, etc. among Nigerians (Oguntoke *et al*., 2009; Raji and Ibrahim, 2011). The need for water quality monitoring is paramount to safeguard the public health and also to protect the water resource in Nigeria. It had being reported that some of the water quality parameters of both ground and surface waters often rise up during raining season with high values in turbidity, solids and anionic species (Jaji *et al*., 2007; Mustapha, 2008;Taiwo *et al*.,2011) .

Water pollution through surface run-off has been reported to have subsequent effects on nutrient enrichment, water quality impairment, marine lives spawning ground destruction and fish mortality (Martin *et al*., 1998; Izonfuo and Bariweni, 2001). A report had been made on the significant increase of water indices such as pH, BOD, Nitrate, Phosphate and TSS on Studies on the impact of point source pollution from sewage treatment oxidation pond on a receiving stream by Ogunfowokan *et al.* (2005).

## Description of Study Area

Oguta Lake also known as Ohamiri is one of the inland drainage basins of non-marine habitat located on a low – lying continental platform in Imo State, Oguta Local Government Area in South-eastern Nigeria. It lies within approximately Latitudes $5^0 41^1$ and $5^0 44^1$ North and Longitudes $6^0 50^1$ and $6^0 45^1$ East. The Lake is linear in shape and is fed mainly from the water of Rivers Njaba, Awbana and Orashi, while the third river, Utu flows in during the rainy season (April to November).

It is relatively small, shallow freshwater body with flood season maximum surface area of 2.48km$^2$ and maximum depth of 9.30m (Ogidi and Nwadiaro, 1988). The Lake is of immense value to the people of Oguta, Orsu, Nkwesi and Awo. Infact, the Lake is the identity and pride of the Oguta man because it is the largest natural Lake in South-eastern Nigeria, source of navigation and transportation, sightseeing and tourism, and they obtain 80% of their protein from the lake.

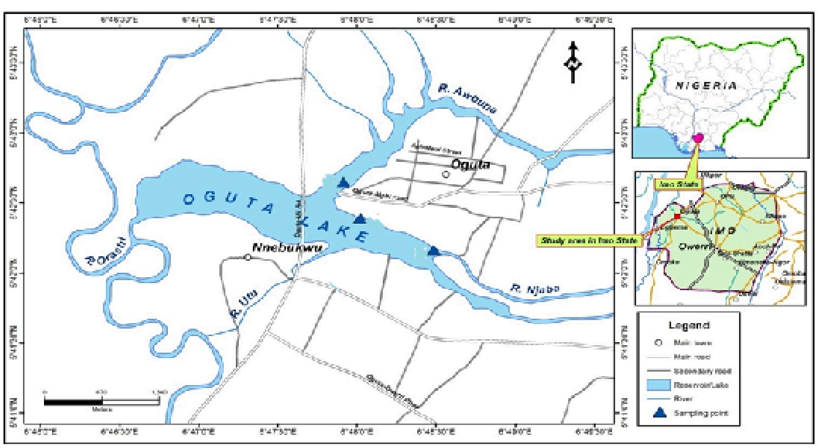


**Fig. 1:** Map of Oguta Lake showing the sampling points
**Source:** Ministry of Lands and Survey, Imo State.

**Sample Collection**

Water sample for physico-chemical analysis were collected on monthly basis with the sampling stations established along the Lake. The containers were washed, dried and corked, fully labeled and stored under laboratory conditions to avoid contamination. Water samples were collected at the sub-surface from the entire stations with washed and rinsed amber colour 250ml glass bottles at 10-20cm depth. The bottles were further rinsed three times with Lake Water at each sampling station for the analysis.

For Dissolved Oxygen, the water sample was carefully collected using Winkler's bottle. The Winkler's bottle was covered inside the water body without air bubbles and placed in the cooler with ice block and transported to the laboratory.

The physico-chemical parameters tested were Temperature, pH, Colour, Conductivity, Turbidity, Dissolved Oxygen, Biochemical Oxygen Demand (BOD), Nitrate, Nitrate- Nitrogen, Phosphate, Phosphorus, Total Dissolved Solids (TDS), Total Suspended Solid (TSS).

**Temperature**

The water temperature and pH was measured in-situ using "Suntex temperature meter" (model JPB-607A PORTABLE).

The temperature of the water was determined with the probe of the meter inserted in the lake 10-15cm below the water surface and the readings recorded in $^0$C (degree celsius).

**Hydrogen Ion Concentration (pH)**

The pH meter (Suntex pH meter, model HI-98107) was used. The pH meter was switched on 30 minutes before the test and was calibrated with buffer solution of 7.00 pH for alkalinity, 9.00 and 4.00pH for acidity. The probe of the meter was inserted at each sampling station of the lake 10-15cm below the water surface.

**Conductivity and Total Dissolved Solids (TDS)**

The combined Conductivity/ Total Dissolved Solid meter (Model HI98303) which consists of a probe and meter was used to measure the conductivity and Total Dissolved Solid (TDS) of the Lake respectively. Conductivity (G), which is the inverse of resistivity (R) was determined from the voltage and the current values according to Ohm's law, that is; R= V/I then, G= I/R= I/V. With 0.1 M potassium chloride prepared, the conductivity meter was calibrated to 14.12 mhos using the standard 0.1M potassium chloride by adjusting the calibration knob. The probe of the meter was inserted in the water at each sampling station of the Lake and the readings were recorded in microsiemens (μs/cm) for conductivity while the Total Dissolved Solid (TDS) readings were recorded in milligram per litre (mg/l).

**Turbidity**

Turbidity was determined by Photometric method, using HACH DR/2010 spectrometer at a wavelength of 860nm and programme number 750. 250l of filtered ionized water was poured into a 25ml cuvette as blank. The blank was used to zero the spectrophotometer. The sample was then shaken vigorously and 25ml was poured into another 25ml cuvette. The sample was put in the light shied and closed after the blank was removed. The "Read Button" was pressed and the value digitally displayed and recorded in Nephelometric Turbidity Unit (NTU).

**Dissolved Oxygen (DO)**

Dissolved Oxygen (DO) was measured with DO meter (JPB-607A PORTABLE DO ANALYZER). The DO meter was put ON and allowed to stabilize for 15 minutes and calibration was done following manufacturer's procedure by inserting the probe in 5% Sodium Sulphate solution. The probe was inserted at each sampling station of the Lake and values/readings recorded in mg/l.

**Biochemical Oxygen Demand (BOD)**

The Biochemical Oxygen Demand (BOD) of the water was determined using DO meter calibrated in 5% Sodium Sulphate solution. The probe was inserted into the sampling stations of the lake and the readings were taken and recorded in mg/l. The water sample was then incubated in a 250ml Wrinkle's bottle for 5 days at $20^0$C. On the fifth day, the probe of the DO meter was inserted again and the value was recorded as $DO_5$. The difference between the DO of the first and DO of the fifth day was recorded as BOD in mg/l.

$BOD_5 = DO_2 (1) – DO_2 (5)$.

**Nitrate**

Nitrate was determined by Cadmium Reduction method using HI83200 multi-parameter bench photometer at a wavelength of 525nm. 10ml of the sample was poured into separate cuvette, using one of them as blank to 'zero' the photometer and the second bottle of 10ml of water sample was added a sachet of Nitrate reagent powder pillow and was inserted in the cell bottle compartment for 4 minutes and 30 seconds. The READ button was pressed to display the result in mg/l of Nitrate and Nitrate – Nitrogen.

**Phosphate**

Phosphate was determined by Amino Acid method using HI83200 multiparameter bench photometer at a wavelength of 525nm. 10ml of the sample was poured into separate cuvettes, using one of them as blank to 'zero' the photometer and the second cuvette of 10ml of the water sample was added 10 drops of HI93717A- 0 molybdate reagent, then the content of one packet of HI93717B – 0 phosphate HR reagent B was added to the cuvette. It was shaken gently to dissolve and was inserted in the cell bottle comportment and timed for 5 minutes. At the countdown of 5 minutes, the READ button was pressed to display the result in mg/l of phosphate and phosphorous.

**Sulphate**

Sulphate was determined by turbid meter method using HI83200 multiparameter bench photometer at a wavelength of 466nm. 10ml of the sample was poured into separate cuvettes, using one of them as blank to 'zero' the photometer and the second bottle of 10ml of water sample was added a sachet of Sulphate reagent powder pillow and was swirled to mix. It is then inserted in the cell bottle compartment and timed for 5 minutes. At the end of countdown of the time, READ button was pressed to display the result in mg/l of sulphate.

**Results**

The monthly variation in temperature from May, 2016 to October, 2017 with a range of 23.41±0.50 – 30.90±1.24 ($^O$C) is shown in **Figure 2.** The highest temperature (30.90±1.24 $^O$C) was recorded in the month of October, 2016, while the lowest (23.41±0.50) was recorded in October, 2017.

**Figure 3** shows the pH variation from May, 2016 – October 2017 with the values ranging from 5.08±0.47 – 8.31±0.37 with the highest pH value (8.31±0.37 been recorded innthe month of December, 2016 and the lowest pH value (5.08±0.47) was recorded in the month of June, 2017.

**Figure 4** shows that colour has a range value of 0.00-53.89±8.96 (PCU), with the highest value (53.89±8.96 PCU) recorded in the month of September and the lowest recorded in April as 0.00.

**Figure 5** shows that the range value of Conductivity was 5.67±3.32 – 47.78±4.60µcm, with the highest (47.78±4.60) recorded in June, the lost was observed in October, 2017 as 5.67±3.32.

**Figure 6** shows the Total Dissolved Solid (mg/l), with the range value recorded as 4.33±0.75 – 31.06±3.27 mg/l, with the highest value (31.06±3.27mg/l) recorded in the month of August, 2017 and the lowest value (4.33±0.75mg/l) was recorded in the month of December, 2017. The mean value of 7.55±1.46mg/l was recorded as shown in Table 4.1.

**Figure 7** shows Dissolved Oxygen (DO), with the value ranged 3.00±0.93 – 9.70±0.00mg/l, the highest value (9.70±0.00mg/l) was recorded in November, 2016, and the lowest (3.00±0.93mg/l) recorded in September.

**Figure 8** shows that Total Suspended Solid (mg/l) has a range value of 5.00±8.14 – 93.30±7.67, with the highest value (93.30±7.67) recorded in August, 2016 and the lowest (5.00±8.14) was recorded in July, 2017. The mean value was 51±18.86mg/l (Table 4.1).

**Figure 9** shows that Turbidity has a range of 2.12±1.88 – 18.91±14.08NTU with the highest value (18.91±14.08NTU) been recorded in the month of March, 2017 and the lowest value (2.12±1.88NTU) recorded in April, 2017.

**Figure 10**. It was recorded that the range value of Biological Oxygen Demand (BOD) was 1.21±0.43 – 9.47±0.07 mg/l with the highest value (9.47±0.07 mg/l) recorded in November, 2016 and the lowest value (1.21±0.43 mg/l) was recorded in August, 2016

**Figure 11** shows that range Nitrate was ranged 0.93±0.56 – 41.67±32.76mg/l with the highest value (41.67±32.76mg/l) recorded in December, 2016 and the lowest value (0.93±0.56 mg/l) recorded in October, 2017.

Nitrate – Nitrogen ranged 0.29±0.18 – 9.43±7.42 mg/l with the highest value (9.43±7.42 mg/l) recorded in December, 2016 and the lowest value (0.29±0.18mg/l) was recorded in October, 2017 (**Figure 12**).

Phosphate ranged of 0.22±0.07 – 9.06±3.43mg/l with the highest value (9.06±3.43 mg/l) recorded in August, 2017 and lowest value (0.22±0.07 mg/l) recorded in June, 2017 (**Figure 13**).

Phosphorous ranged 0.07±0.01 – 3.02±1.14 mg/l with the highest value (3.02±1.14 mg/l) recorded in August, 2017 and the lowest value recorded (3.02±1.14mg/l) in the month of June, 2017 (**Figure 14**).

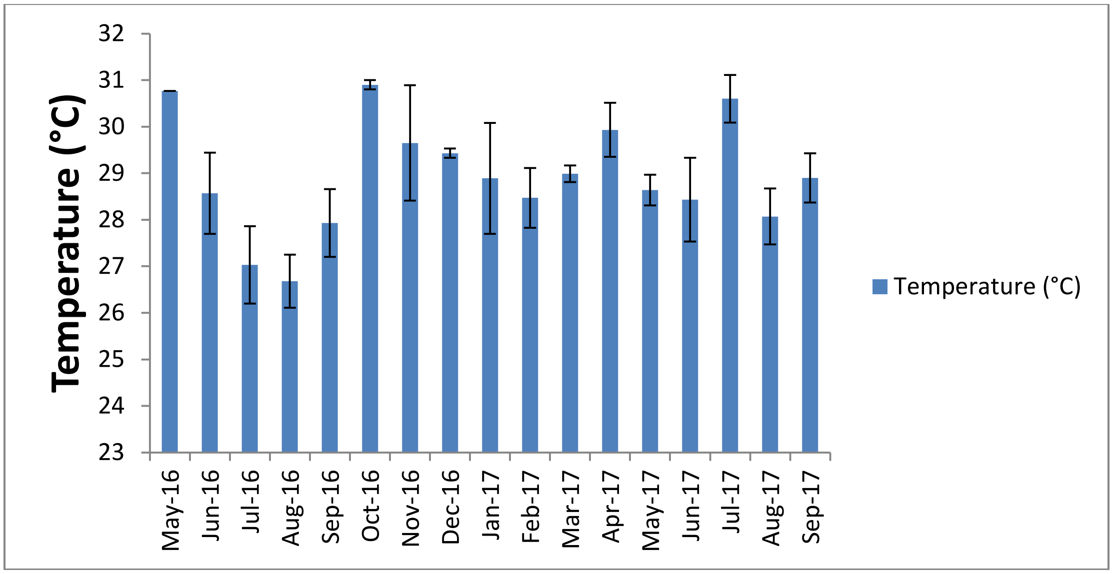


**Figure 2: Temperature variation within the sampled months (May,2016-October, 2017)**

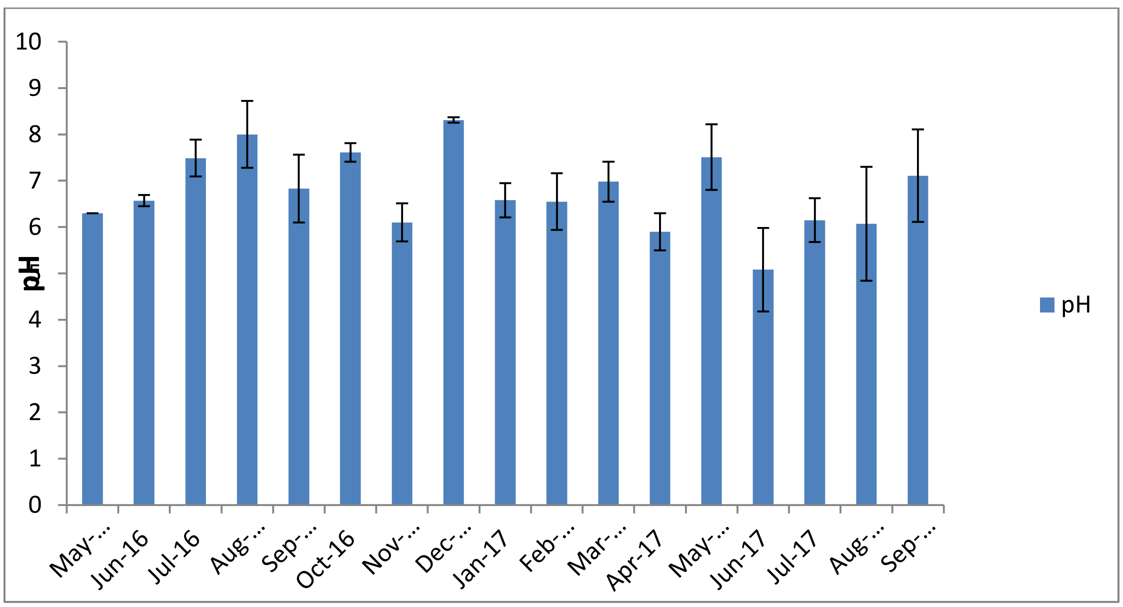


**Figure 3: The pH variation within the sampled months (May, 2016-October, 2017)**

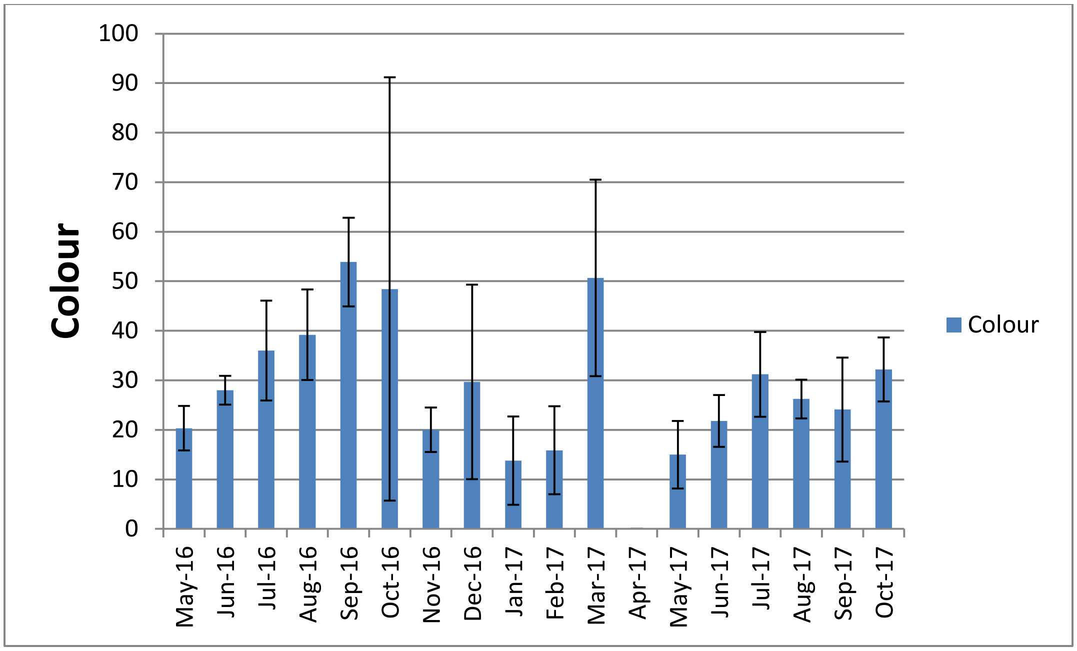


**Figure 4: The colour value variation within the sampled months (May, 2016-October, 2017)**

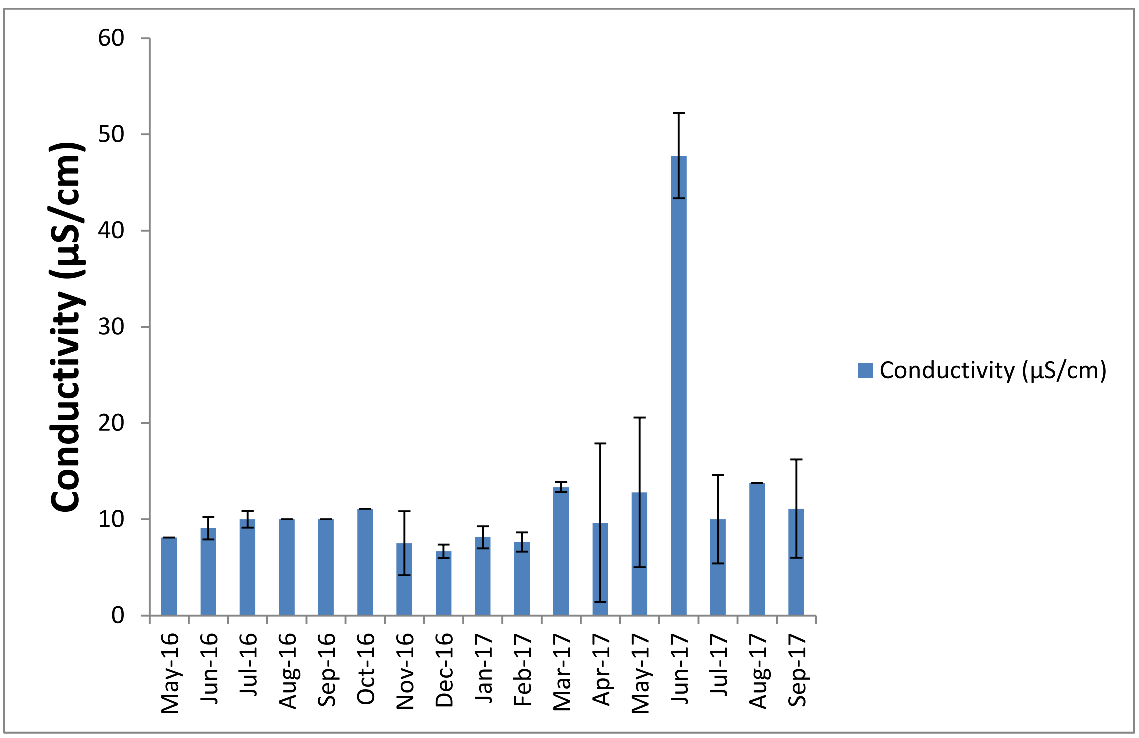


**Figure 5: The conductivity variation within the sampled months (May, 2016-October, 2017)**

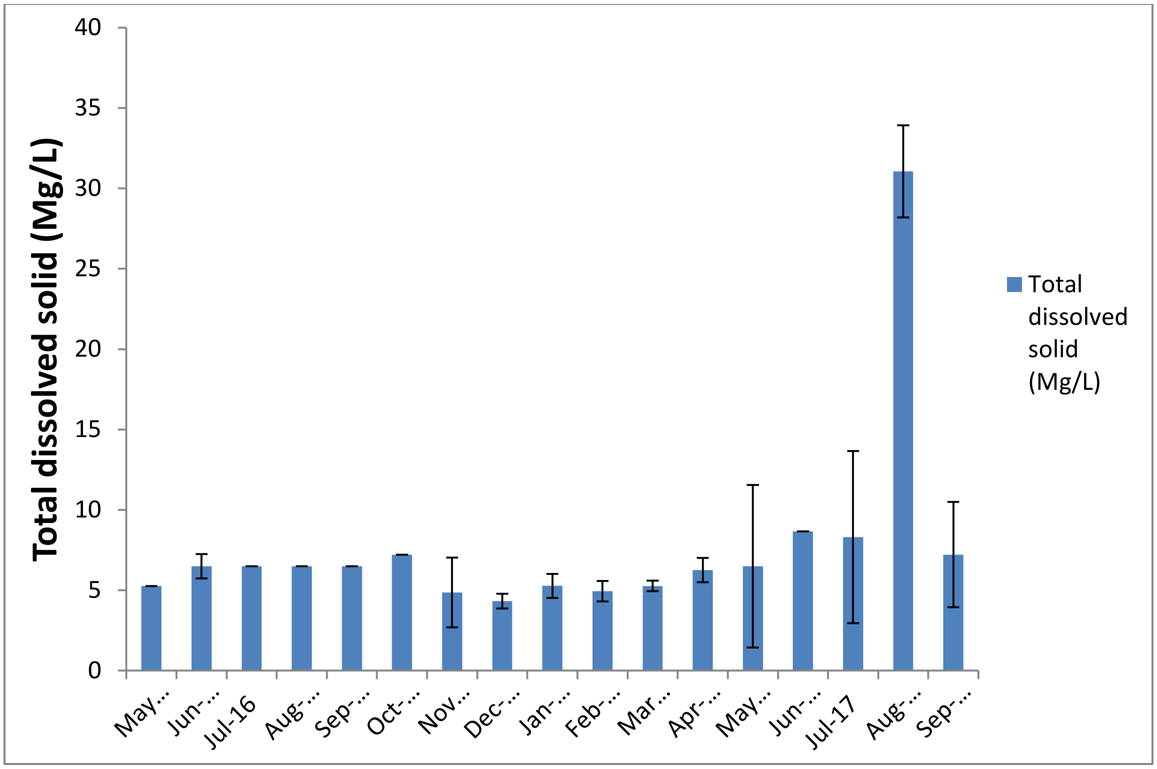


**Figure 6: The Total Dissolved Solid variation within the sampled months (May, 2016-October, 2017)**

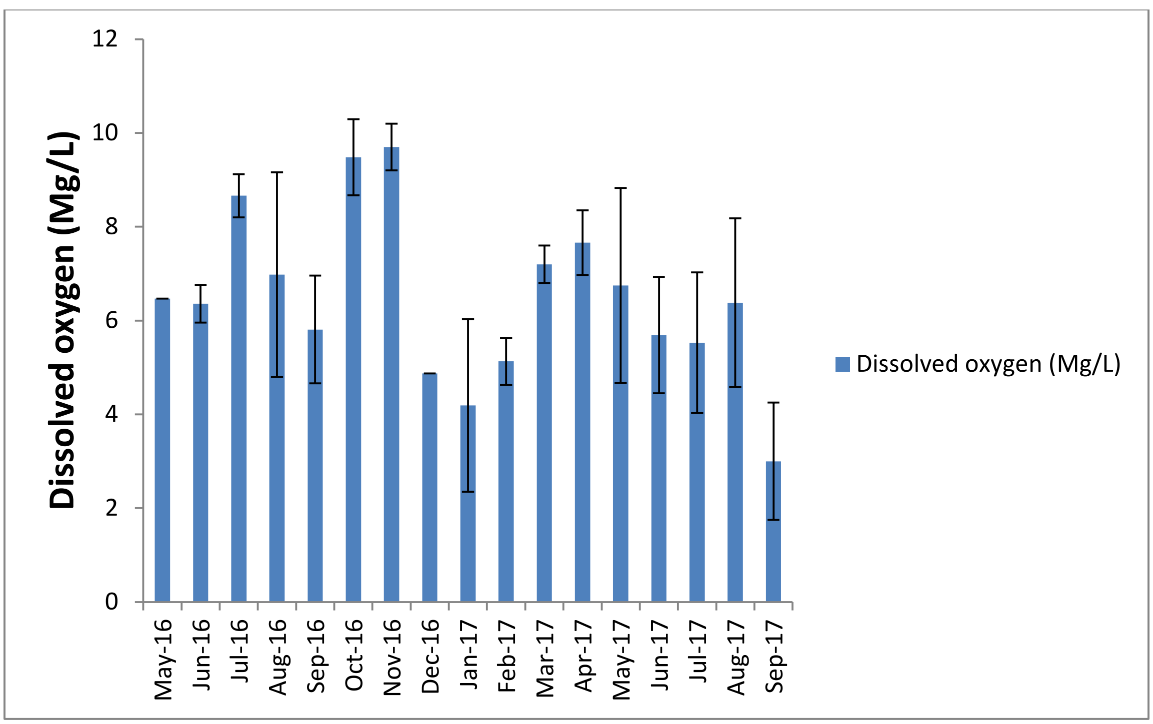


**Figure 7: The Dissolved Oxygen variation within the sampled months (May, 2016-October, 2017)**

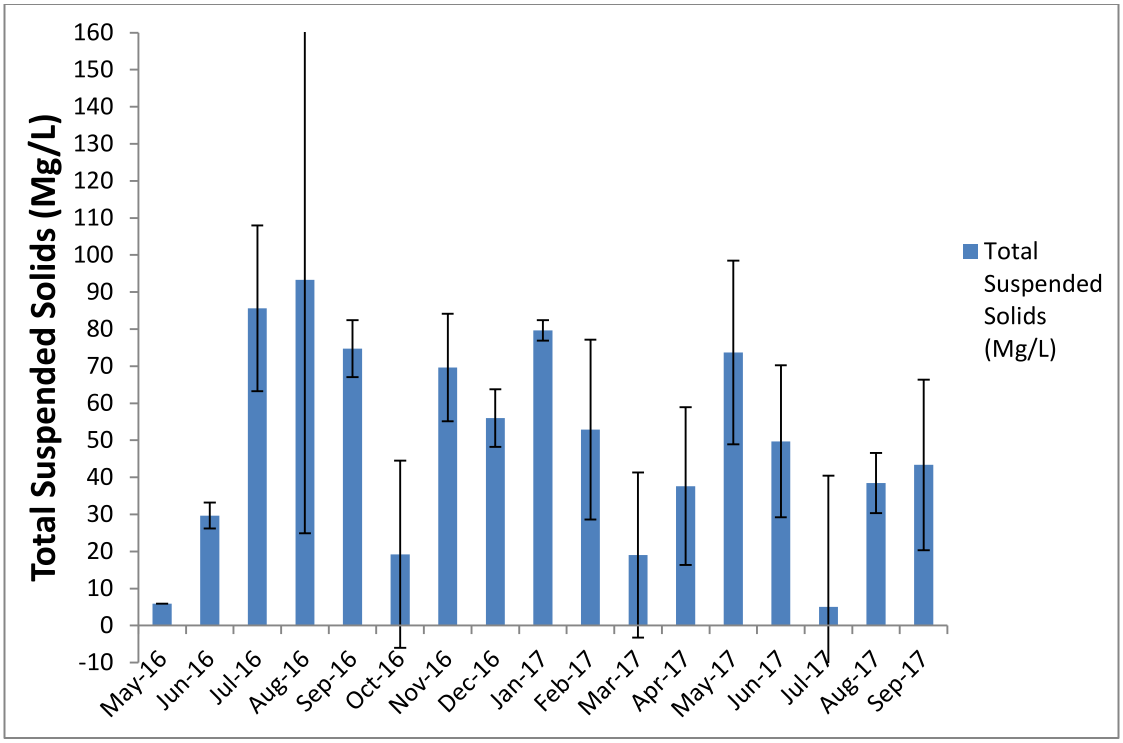


**Figure 8: The Total Suspended Solids variation within the sampled months (May, 2016-October, 2017)**

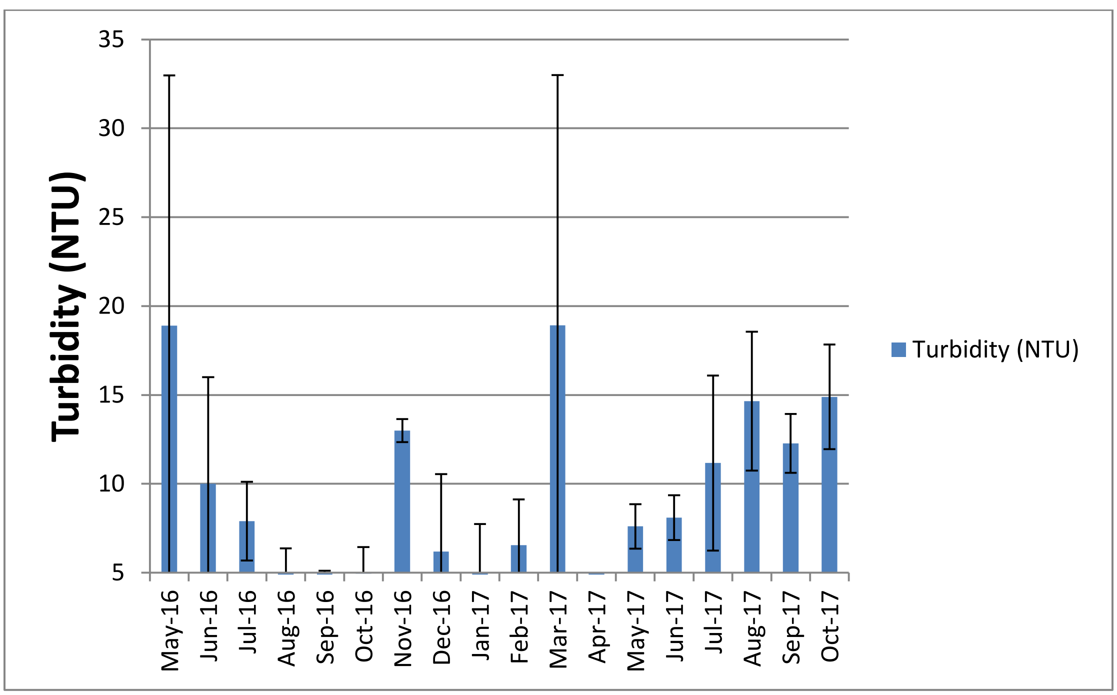


**Figure 9: The Turbidity variation within the sampled months (May, 2016-October, 2017)**

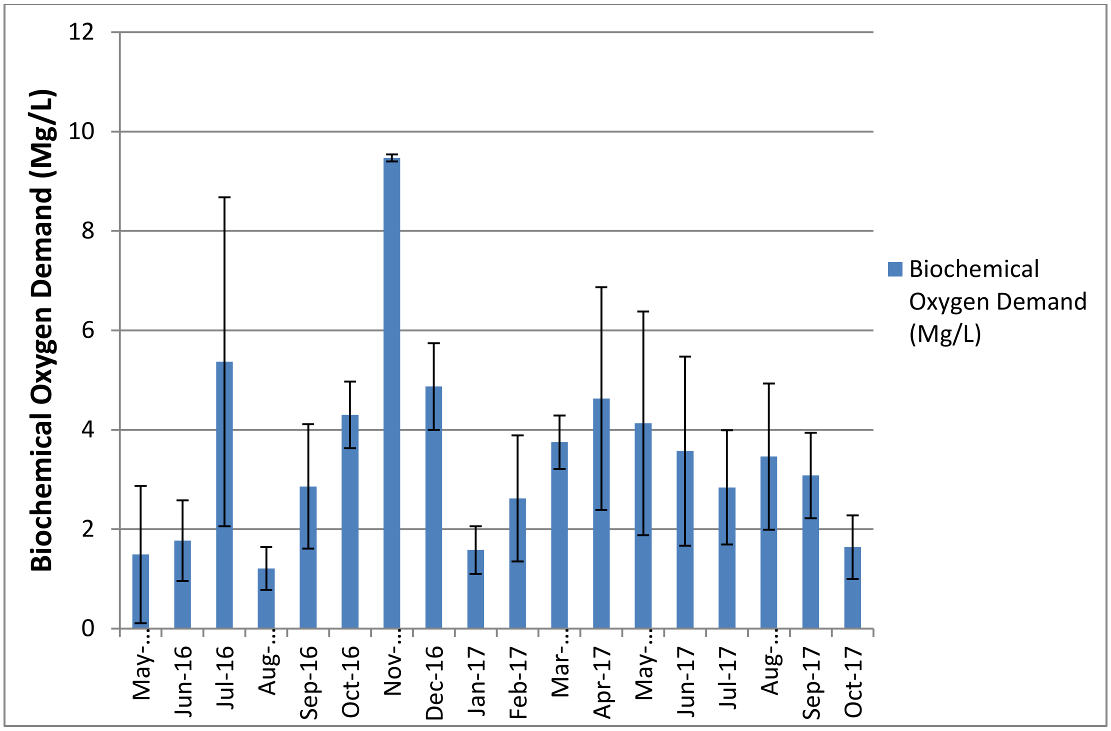


**Figure 10: The Biochemical Oxygen Demand variation within the sampled months (May, 2016-October, 2017)**

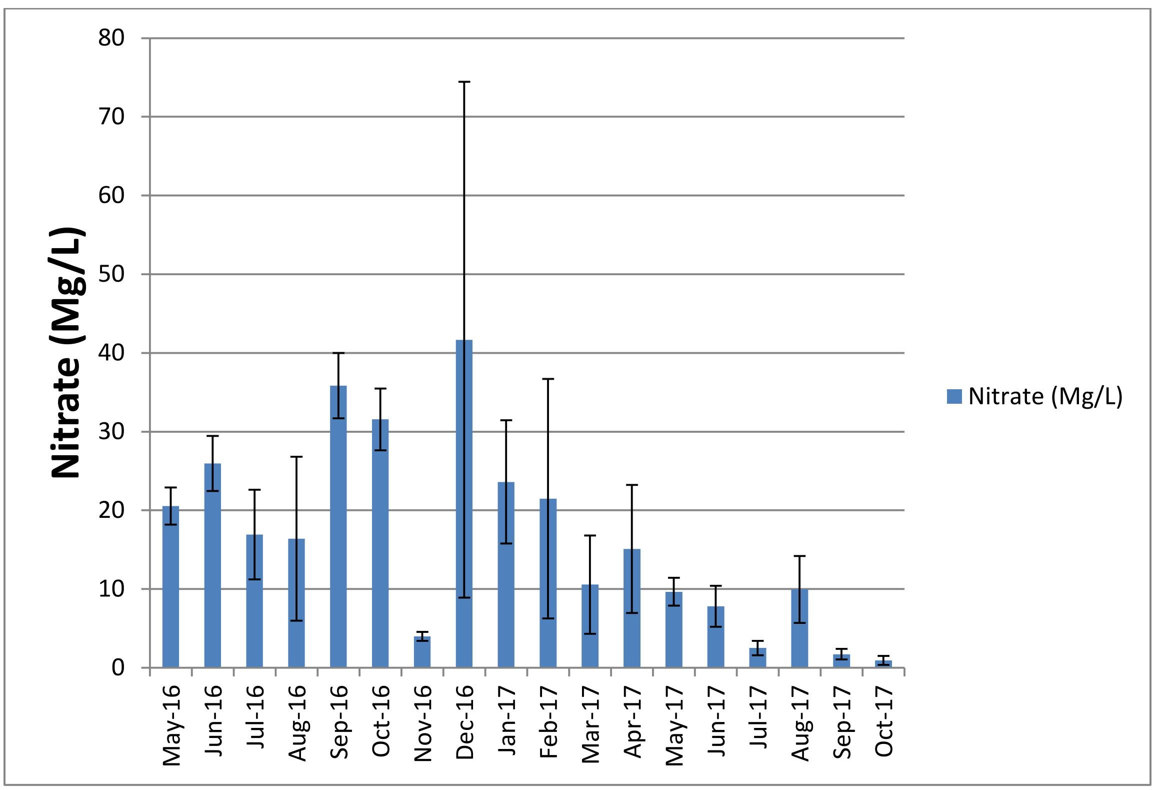


**Figure 11: The Nitrate variation within the sampled months (May, 2016-October, 2017)**

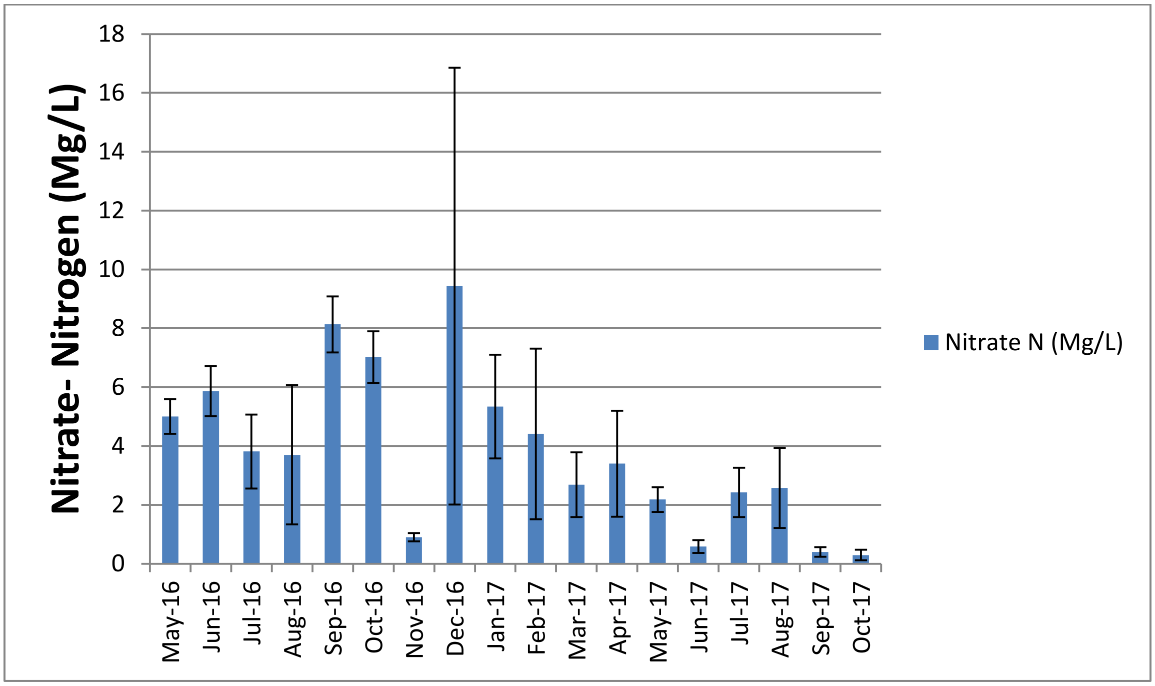


**Figure 12: The Nitrate-Nitrogen variation within the sampled months (May, 2016-October, 2017)**

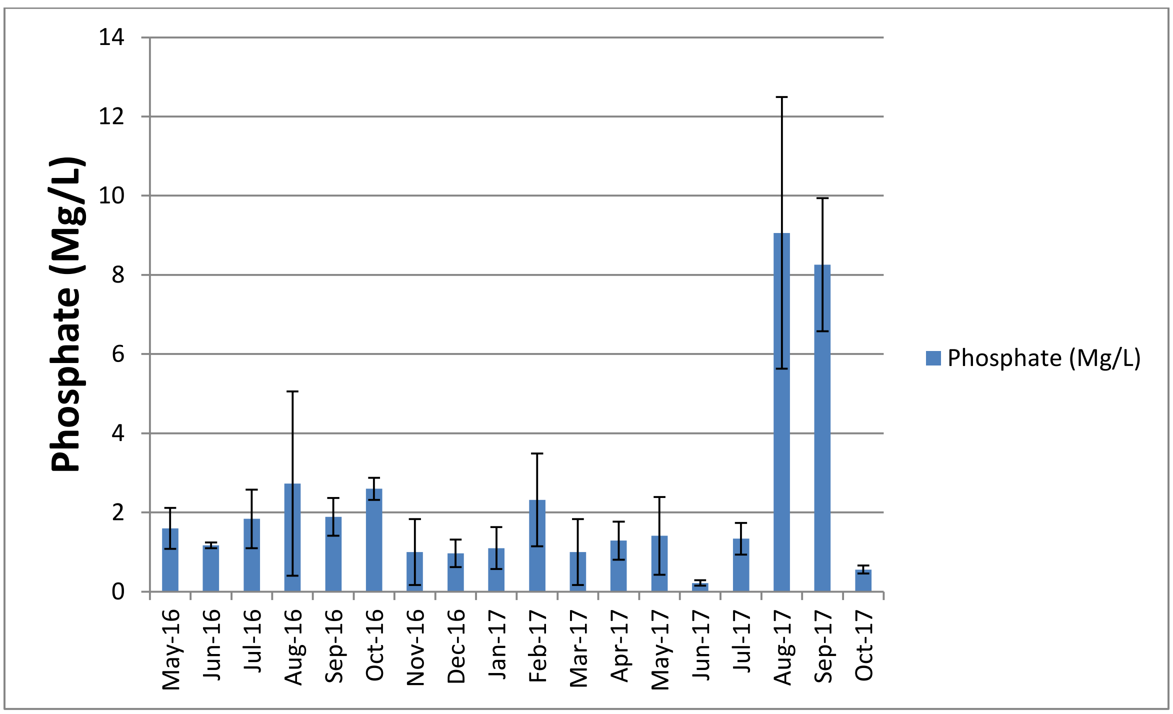


**Figure 13: The Phosphate variation within the sampled months (May, 2016-October, 2017)**

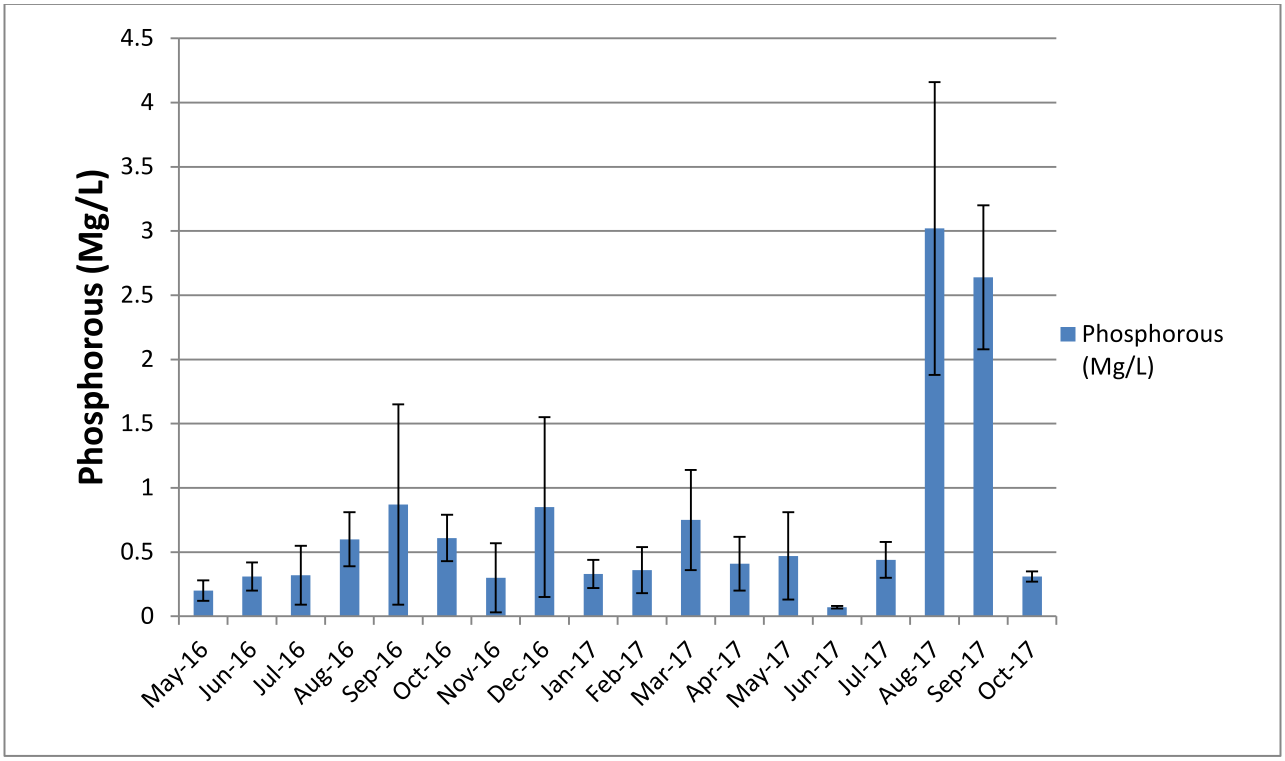


**Figure 14: The Phosphorous variation within the sampled months (May, 2016-October, 2017)**

## Discussion

The temperature of the Lake was ranged between 23.41±0.50-30.90±1.24°C and this agrees with Lawal and Ahmed (2014) who reported a temperature range between 25.8-30.8°C from their studies on physico-chemical parameters in relation to fish abundance in Daberam Reservoir, Katsina State, Nigeria and Adedeji *et al*. (2019) who reported temperature variation from 22°C to 28°C from their studies on seasonal variations in the Physico-chemical parameters of Lake Ribadu, Adamawa State, Nigeria. The result contradicts the reports of Dimowo (2013) who reported temperature range between 26.9±1.1 and 32.1±0.5°C from River Ogun, Abeokuta, Ogun State, Southwestern Nigeria and Fafioye *et al.* (2005), who reported 26.5-31.5°C for the temperature of Omi water body of Ago-Iwoye, Nigeria.

The pH was ranged between 5.08±0.47-8.31±0.37 and this is in agreement with Okorie and Nwosu (2014) who reported 5.15-6.95 as the pH range on their studies on seasonal variations in physico-chemical of Imo River and Adedeji *et al.* (2019) who reported the mean pH value of Lake Ribadu, Adamawa State, Nigeria as 6.89-8.08 but disagreed with Dimowo (2013) who reported a pH range between 7.7±0.15 and 9.1±0.13 from River Ogun, Abeokuta, Ogun State, South-western Nigeria.

According to Chapman (1992) and Boyd (1981) who stated that a change in water pH indicates the presence of certain agricultural and domestic effluents. Haruna (2003) also reported that decay and decomposition of aquatic weeds can cause accumulation of acidic gases in a lake and may affect the water pH.

From the result, conductivity range is between 5.67±3.32-47.78±4.60µs/cm and this contradicts the report of Lawal and Ahmed (2014), who reported conductivity range between 0.02-0.13µs/cm; Dimowo (2013), who reported range between 99.0±7.84 and 180.5±6.64 µs/cm and Adedeji *et al* (2019) who reported 391µmhos/cm as the lowest mean conductivity value and 480µmhos/cm as the highest.

Sikoki and Venn (2003) observed that the conductivity range of Shiroro Lake in Niger State was 3.8-10 µs/cm and suggested that since fishes differ in their ability to maintain osmotic pressure, therefore the optimum conductivity for fish production also differ from one species to another. According to Boyd (1979), conductivity of freshwater varies between 50 to 1500 µs/cm.

Turbidity range value of the Lake was 2.12±1.88-18.91±14.08 which was greater than 5.0 NTU been the limit given by WHO (2008). This could be due to the run-off effects as well as domestic activities going on in the Lake.

The Total Dissolved Solid (TDS) recorded was ranged between 4.33±0.75 and 31.06±3.27mg/l and this contradict Dimowo (2013) who reported 48.8±3.68 -90.8±3.35mg/l as the range recorded for the physico-chemical parameters of River Ogun.

The Dissolved Oxygen (DO) of the lake ranged between 3.00±0.93 and 9.70±0.00mg/L. According to Boyd and Lichtokoppler (1979), Dissolved Oxygen concentration of 50mg/l and above is desirable for fish survival. Biney (1990) also stated that fresh and brackish waters have mean Dissolved Oxygen concentration of the range of 6-8mg/L. This report disagreed with Adedeji *et al* (2019) who reported 4.23mg/l-6.89mg/l from their studies on Lake Ribadu, Adamawa State, Nigeria. It also contradicts Okorie and Nwosu (2014) that reported 2.51-16mg/l from Imo River.

Biological Oxygen Demand of Oguta Lake was 1.21±0.43-9.47±0.07 with 9.47±0.07 been the highest value, was recorded in November 2016 (flood period). Okorie and Nwosu (2014) reported a BOD range of 2.50-7.45mg/l from Imo River, Lawal and Ahmed (2014) reported a range between 3.16-5.15mg/l from their study in Daberam Reservoir while Adedeji *et al* (2019) stated that the BOD of Lake Ribadu varied between 2.17mg/l and 3.91mg/l.

Chindah *et al*. (1991), BOD range of ≥2≤4 does not show pollution while level beyond 5mg/l is an indicator of pollution (Clerk, 1986). Water bodies with BOD between 1.0 and 2.0 mg/l are considered clean; 3.0 mg/l fairly clean; 5.0 mg/l doubtful and 10.0mg/l definitely bad and polluted. Therefore, Oguta Lake can be said to be fairly or slightly clean.

The range values of Phosphate and Phosphorous recorded was 0.22±0.07-9.06±3.43mg/l and 0.07±0.01-3.02±1.14mg/l respectively. This shows that Oguta Lake is likely not to be supporting the growth of phytoplankton. Abowei (2010) stated that Phosphorous is essential for growth of phytoplankton the total concentration of phosphorous in uncontaminated water is about 0.01mg/l.

**Conclusion**

The physico-chemical parameters varied with a significance difference ($p<0.05$) and are within acceptable level except nitrate, phosphorus and turbidity level of the lake which was high and this may be caused by the defecation in the lake by the populace, the use of the lake for agricultural processing and the sand dredging. Therefore, there should be proper regulation to reduce the input of inorganic materials by providing an alternative source for the populace of the community.

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