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# ASSESSMENT OF SEASONAL PHYSICO-CHEMICAL PARAMETERS OF OGUTA LAKE, NIGERIA.

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## ABSTRACT

Seasonal variation of physico-chemical variables of Oguta Lake, Nigeria was studied. Results obtained using standard analytical methods indicated that in the rainy and dry seasons (July and August) and (October and November), 2014, iron (Fe; 1.401 mg/l in November) was the overall metal observed in the lake, while mercury (Hg) was not detected throughout the period of study. Heavy metals concentrations observed were higher (not significantly) during the dry than the rainy season. The values observed for dissolved oxygen (DO), biological and chemical oxygen demand (BOD and COD) were within WHO permissible limits. The above evidence revealed that there was signs of heavy metal (Fe) pollution of the lake, and steps must be taken for constant monitoring of anthropogenic inputs into the lake.

## Indexing terms/Keywords

Analytical; characteristics; discharge; domestic; ecosystem; industrial; quality; runoff.

## Academic Discipline And Sub-Disciplines

Environmental chemistry

## SUBJECT CLASSIFICATION

Chemistry

## TYPE (METHOD/APPROACH)

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## 1.0 INTRODUCTION

Lakes and rivers are abundant natural resourses of water. Water is necessary to sustain the system. Both urban and rural populations depend on lakes and rivers for their sources of water. However, the quality of these water bodies is not guaranteed due to contamination by heavy metals (HMs).

Heavy metals pollution of lakes and river environments have been researched extensively by scientist all over the world. Heavy metals are mostly toxic, resistant to decomposition, and have the ability to bioaccumulate and affect the ecosystem adversely. Hence, there is need to always monitor environment systems where these metals are present.

Water pollution by HMs occur from effluents of daily domestic and industrial activities which could considerably alter the physical and chemical quality of the water body. Goher et al. (1) noted that water quality monitoring indexing is one of the ways by which the quality of a water system could be assessed. It is important to regularly monitor the water body since this action helps to reveal how healthy and hygienic the water is for use for domestic, industrial and agricultural purposes (2).

Water quality refers to the physico-chemical and biological characteristics of water. Water quality also represents a measure of the condition of the water system relative to end use (3). The quality of water is the most important factor affecting live in the ecosystem. Lakes and rivers being important fresh water sources are polluted by natural and anthropogenic sources (4). Heavy metals are present in these natural and anthropogenic sources, and estimation of the HMs in these systems is essential to ease the burden of pollution (5).

Several authors have documented concerns and main threats posed by HMs in the ecosystem, especially with respect to lakes and rivers in Nigeria. In one study, Salawu et al. (6) investigated seasonal variation of selected HMs in river Maru, Nigeria, and observed that compared to other HMs, zinc (Zn; 1.136 mg/l) was the most HMs contaminant observed in the river. The study also noted that the levels of cadmium (Cd) and lead (Pb) exceeded standard permissible limits. The high levels of Cd and Pb in the river was attributed to industrial and agricultural discharge into the river through the use of fertilizers. However, Nsofor et al. (7) had earlier in their study revealed that HMs could alter the histopathology of aquatic species in the rivers. The researchers demonstrated that the high levels of Pb in the Niger river, Nigeria was linked to dust emanating from combustion of petrol in automobile cars. The dust is washed off into the river as runoff during heavy precipitation.

A recent study to assess the water quality of Oguta lake, Nigeria, revealed that the levels of turbidity, nitrate, iron (Fe), nickel (Ni) and Cd slightly exceeded maximum permissible limits (8). However, the study concluded that given the levels of nutrients detected in the lake, the problem of pollution of the lake was not severe, and the lake was healthy to sustain aquatic life, since the values observed for other variables such as dissolved oxygen, biological and chemical oxygen demand were within standard permissible limits.

Studies have shown that elevated levels of HMs in lakes and rivers in Nigeria have carcinogenic effects (9),(10); consequently, such water courses should not be used for domestic, industrial and agricultural purposes. Further studies have revealed the presence of large concentration of Fe over other HMs such as chromium (Cr), Pb and Ni in a river. Nontheless, these studies also demonstrated that the concentrations of these HMs in the water body was significantly lower than that in fish tissues habitating in the river (11).

Source protection has been proposed as a way of maintaining the quality of water systems to benefit the ecosystem (12). Reporting on investigations on point and non-point source pollution of Oramiriukwa, Nworie and Otamiri rivers Nigeria, Egereonu et al. (13) noted that source point protection methods such as sewage treatment prevention and industrial effluent off-load monitoring of lakes and rivers are effective approaches that has been applied to manage water quality. In a related study, Obunwo et al. (14) observed that much of the estimated 200,000 tonnes of municipal wastes generated annually in Port Harcourt City, Nigeria is discharged into the city's water courses. This wastes discharge, the authors allege, is responsible for HMs pollution of the Minichida river. Hence, the researchers recommended proper monitoring of discharge of municipal wastes effluents into rivers as a source protection measure. Further studies on physico-chemical variations and HMs pollution of lakes and rivers in Nigeria have been reported by (15),(16),(17) and (18).

In other regions of the world, scientific findings tend to support the generally held belief that the major limitation to usage of water from lakes and rivers is the presence of HMs in these water bodies. In Egypt, it has emerged that the Nile River which has been one of the traditional water sources for the country's economic development is being contaminated by uncontrolled wastewater discharge from the Ismaila Canal (1). Studies on pollution index to assess the levels of contamination of the canal's water revealed the presence of high concentrations of aluminium (Al), manganese (Mn) and Fe. The study further observed that these elements were introduced into the canal by activities of industrial water treatment plants located upstream of the canal (1). In their contributions, the following authors (19),(20) and (21) collaborated the study of (1).

According to Skordas et al. (22), high nutrients and HMs concentrations in Lake Karla, Greece was a manifestation of high loadings of local parent rock materials with anthropogenic origin. Ni and Cr were estimated as potential pollutants of the lake, and compared to labile metal fractions, these to trace metals were less bioavailable. The authors concluded that potential risk arising from high concentrations of HMs in lakes does not solely depend on the overall metal concentrations, but also on bioavailable fractions. The findings by these researchers has been used as baseline evidence for successful management of lakes and rivers, reinterating the early recommendations for close monitoring and control of nutrient loads into water systems to ensure their sustained quality.

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It is important to undertstand the probable source of pollutants of water courses since these water systems have been shown to be residential areas of many unique life forms (23). In some rivers in Tunceli, Turkey, copper (Cu) was distinguished as the highest metal contaminant of the rivers. Copper contamination was observed to be highest during the spring and summer seasons, and human activities such as mining and settlements were implicated for introducing such high concentrations of Cu in the rivers.

The coast of Bengal also host many lakes and rivers, including the Karnaphuli River. This river has been reported to be heavily polluted in areas close to the Chittagong port channel by discharges of oil and chemical wastes leaking from ships, as well as anthropogenic inputs of phosphate fertilizers into the estuarine zone of the river (24). It was evident from published data that considerable concentrations of Zn, Pb, Cu, Fe and magnesium (Mg) were present in sediment found in the river and the levels of these metals were relatively higher than standard permissible limits. The investigators recommended proper industrial planning, safe disposal of ship oil and adequate industrial and urban waste management as source protection approaches that when applied could turn the tide against high levels of HMs poisoning of coastal aquatic ecosystem.

Aquatic ecosystems in eastern China have been reported to be in danger of HMs pollution due to rapid economic development and urbanization (25). A recent effort by Tang et al. (25) observed that in five different aquatic ecosystems (river, reservoir, estuary, lake, wetland) studied, higher HMs (Cd, Cr, Cu, Ni, Pb, Zn) concentrations were mainly found in sediments samples from river ecosystem. Cadmium was shown to be the most anthropogenically enriched pollutant followed by Zn and Pb, and the metal (Cd) was also noted as the most serious pollutant in all five ecosystems. It was hoped, the authors cautiously noted, that if concern of Cd contamination is fundamental in developing management strategies for protecting aquatic environments, better procedures for controlling and managing the pollutant could be achieved. Recent advances in HMs contamination of lakes and rivers around the world have been published in several recognized studies including (26).(27) and (28).

The aim of the present study was to examined seasonal variations of physico-chemical variables of Oguta Lake, Nigeria.

## 2.0 Materials and Method

### 2.1 Description of study area

The fishes were bought from commercial fishermen at the daily market in Oguta, Nigeria. Oguta is a town on the East bank of Oguta lake in Imo State, Nigeria; and its geographical coordinates are latitude 5°42' O" North and longitude 6°48' O" East, (Fig. 1).

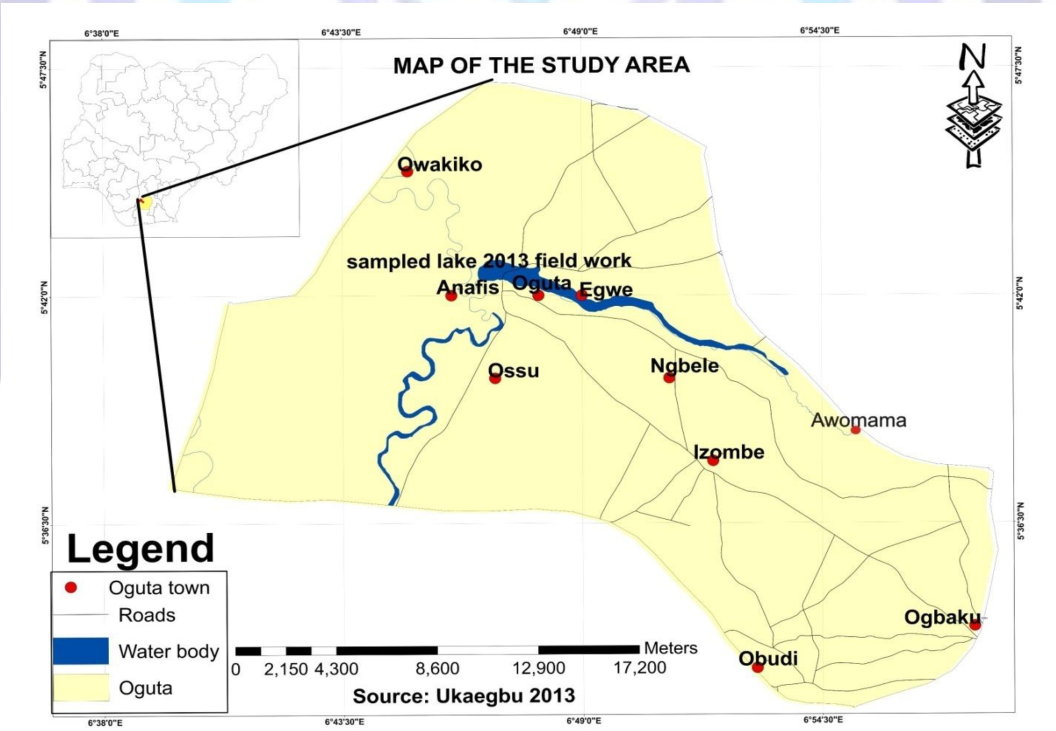


Fig. 1: Map of Oguta lake showing sampling stations (Adopted from Umunnakwe Johnbosco E, and Aharanwa Bibian C (8))

## 2.2 Water sample collection, preparation and analyses

Composite sampling method was applied to obtain water samples. Three water samples each collected 1km apart from each other in the sampling site were stored in 750 ml plastic bottle previously soaked in 10% $HNO_3$ for two days and thoroughly rinsed with deionised water. A few drops (about 2 ml conc. $HNO_3$) were added to the plastic bottle, the bottle sealed and refrigerated until sample was required for analysis. This procedure stabilizes the sample, maintain the oxidation state of the element, and prevent adhering of the metals to the walls of the container (29). pH, dissolved oxygen and temperature of the water sample were determined at sampling site using a pH meter (Model PHS 25), dissolved oxygen analyzer (Model Jonway 970) and a mercury bulb thermometer, with calibration of 0-360$^o$C. Other physico-chemical parameters that were later determined in the laboratory include; alkalinity and total hardness by titrimetry. Total dissolved solid, Biological oxygen demand (BOD), chemical oxygen demand (COD), were all determined by method as described by Franson (30). Turbidity was measured using a turbidity meter (WGZ-IB Shanghai), while conductivity was also determined using a conductivity meter (DDS-IIA, Shjinmai). All the chemicals used in the analyses were of analytical reagent grade purchased from BDH Laboratory, Poole, England. Deionised water was obtained from a deionzer (Pure-Aqua Inc, Santa-Ana, CA, USA). For HMs metals (Fe, Cu, Pb, Ni, Hg, Cr, Cd, As), analyses was performed as describe by Egereonu et al. (13) using Atomic Absorption Spectrophotometer (AAS) (Model Hitachi FS 240 Varian). Three repetitions were made for each of the physicochemical parameters determined and HMs analyzed. Mean average of three determinants were obtained separately for physicochemical parameter and HMs analysis as described by Ukiwe and Oguzie (31). The above procedure was repeated in August for the rainy season, and then in October and November, respectively, for the dry season.

## 2.3 Data analysis

Data was presented as arithmetic mean and standard deviation. The BMDP Statistical Software was used for data analysis. The one-way Analysis of Variance (ANOVA) was used to determine statistical difference in HMs concentration in water between months. The *F*-test was used to estimate significance in HMs concentration using the above mentioned protocol.

# 3.0 Results and Discussion

## 3.1 Results

**Table 1: Mean concentrations of physico-chemical parameters of water sample in the rainy and dry seasons.**

| Sampling months | July | August | October | November | WHO Standard |
|---|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | |
| **Parameters** | | | | | |
| Fe (mg/l) | 0.906 ± 0.1 | 0.805 ± 1.3 | 1.102 ± 0.1 | 1.401 ± 0.2 | <0.50 |
| Cu (mg/l) | 0.071 ± 0.1 | 0.101 ± 1.2 | 0.975 ± 0.1 | 0.865 ± 0.1 | <2.00 |
| Pb (mg/l) | 0.001 ± 0.0 | 0.001 ± 0.0 | 0.005 ± 0.0 | 0.004 ± 0.0 | <0.01 |
| Ni (mg/l) | ND | 0.087 ± 0.1 | 0.003 ± 0.0 | 0.002 ± 0.0 | <0.02 |
| Hg (mg/l) | ND | ND | ND | ND | <0.002 |
| Cr (mg/l) | 0.006 ± 0.0 | ND | 0.008 ± 0.1 | ND | <0.05 |
| Cd (mg/l) | 0.002 ± 0.0 | 0.001 ± 0.0 | 0.004 ± 0.0 | ND | <0.003 |
| As (mg/l) | 0.001 ± 0.0 | ND | 0.001 ± 0.0 | ND | <0.01 |
| pH | 6.7 ± 0.0 | 6.2 ± 0.1 | 6.5 ± 0.0 | 6.8 ± 0.0 | 6.5-8.5 |
| Temperature ($^o$C) | 24.6 ± 0.0 | 24.2 ± 0.0 | 25.7 ± 0.2 | 26.2 ± 0.1 | 25-28 |
| Dissolved oxygen (mg/l) | 9.020 ± 0.1 | 9.00 ± 0.1 | 10.01 ± 0.1 | 9.51 ± 0.1 | <6.0 |
| Alkalinity (mg/l) | 8.721 ± 1.2 | 8.011 ± 1.0 | 10.46 ± 0.2 | 7.716 ± 0.1 | <50 |
| BOD (mg/l) | 0.172 ± 1.2 | 0.252 ± 0.0 | 0.216 ± 0.1 | 0.328 ± 0.1 | <150 |
| COD (mg/l) | 0.814 ± 0.2 | 0.621 ± 0.0 | 0.448 ± 0.1 | 0.610 ± 0.1 | <150 |
| Turbidity (NTU) | 2.161 ± 0.1 | 3.140 ± 0.1 | 3.612 ± 0.1 | 3.470 ± 0.1 | <5.0 |
| Conductivity (μScm$^{-1}$) | 1.031 ± 0.1 | 1.682 ± 0.1 | 2.018 ± 0.1 | 1.881 ± 0.1 | <250 |
| Total dissolved solid (mg/l) | 0.482 ± 1.0 | 0.614 ± 0.2 | 1.116 ± 0.0 | 0.574 ± 0.1 | <500 |

| | | | | | |
|---|---|---|---|---|---|
| Total hardness (mg/l) | 1.921± 0.1 | 2.116 ± 0.1 | 2.210 ± 0.2 | 2.431 ± 0.1 | <500 |

## 3.2 Discussion

**Table 1** shows the mean values of physicochemical parameters of water sample of Oguta Lake in the months of July and August (rainy season) and October and November (dry season). It was observed that Fe (0.805mg/l) was the highest HM in the water sample observed in August, while Fe (0.906mg/l) was also the highest HMs observed in the water in July. Nickel and Hg were not detected in July, while Hg and Cr were also not detected in August. For mean physico-chemical values of water sample in October and November, it was observed that 1.102 and 1.401 mg/l Fe were present in the water sample in October and November respctively. However, in November, it was also observed that Hg, Cr, Cd and As were not detected in the water, while only Hg was also not detected in the water sample in October. Copper was the second highest metal detected in the water sample in both months; ( 0.975 and 0.865 mg/l, October and November, respectively). Nickel and Cd were the least detected metals in both months (0.001mg/l Cd, October and 0.002 mg/l Ni, November).

The elevated level of Fe observed in the present study was not surprising. Studies have suggested that Fe occur at high levels in soil/sediments in aquatic systems in Nigeria (32). Olaifa et al. (33) and Olowu et al. (34) had earlier documented evidence revealing that huge concentrations of HMs are present in water courses in Nigeria. However, in their assessment of water quality and HMs in Oguta Lake, (8) had observed high concentrations of Fe and Ni while investigating physico-chemical parameters of the lake in June and September, 2013 and attributed the pollution to dredging activities by oil exploration companies at the bank of the lake. The results of the authors agree with that of the present study with respect to Fe and Ni contamination, though the present study reports a slightly low value of Fe and Ni contamination of the lake in July and October, 2014.

However, the difference in HMs concentrations between seasons (rainy and dry) wasn't significant. The *F*-test between HMs in July and October was 2.25. Testing this value at 7 and 7 degrees of freedom, $P < 0.05$.

## 4.0 Conclusion

The present research has investigated the physico-chemical parameters of water sample from the Oguta Lake, Nigeria, during the rainy and dry seasons of 2014. Mercury was not detected in all the water samples, while As was present in insignificant amount (0.001 mg/l) in the month of July and October. Iron was the highest HM observed in the water samples in both seasons. The high level of Fe may be attributed to industrial, agrarian and oil exploration activities taking place near the lake. Other HMs and physico-chemical parameters investigated were within WHO maximum permissible limits. Heavy metals were higher (not significantly) during the dry than the rainy season.

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