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Eutrophic status of the Lekki and Epe Lagoons in Lagos, Nigeria

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Abstract:*The Lekki and Epe lagoons are important lagoons in the southwest of Nigeria as they contribute immensely to fishery and serve as a source income to people living around them. The study investigates the sediment nutrient load at both lagoons by estimating the amount of available phosphate, nitrate, sulphate, silicate and the effect of pH and TOC on their availability. Results showed phosphate ranged from 0.2-16.7mg/kg, nitrate 10.6-25.4 mg/kg, sulphate 11.3-76.4 mg/kg and silicate 15.7-130.5 mg/kg at Lekki lagoon while concentrations for Epe lagoon ranged from 0.5-85.9 mg/kg phosphate, 15.2-39.9 mg/kg nitrate, 26.7-900.9 mg/kg sulphate and 1.1-232.2 mg/kg silicate. Epe lagoon was found to be more eutrophic than Lekki lagoon and this was attributed to the anthropogenic activities around it. A strong relationship was observed in the more eutrophic Epe lagoon between phosphate/silicate concentrations and phosphate/sulphate concentrations.*

Keywords *-Epe lagoon, Lekki lagoon, Nutrients, Sediment, TOC.*

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I. Introduction

Coastal waters are susceptible to the increasing rate of industrialization with the introduction of different types of organic, inorganic and nutrient pollutants. Nutrients are important in the aquatic system for primary production and they can be divided majorly into the primary nutrients; nitrogen and phosphorus (limiting nutrients) [1] and secondary nutrients which includes silicate and sulphate. The presence of these nutrients in high amount leads to higher productivity in the aquatic system, distorting its balance and leading to Eutrophication. Eutrophication has led to deterioration of coastal line in many coastal cities with the loss of aquatic life and fauna and is mainly caused by the presence of excess nitrate and phosphate in water. This pollution has also caused diseases in human [2] and reduced the socio-economic values of the lagoons. Basically, when eutrophication occurs, there is a bloom in the growth of algae which leads to reduction of the oxygen level in the water body and this is known as hypoxia [3, 4]. This has led to major pollution problems both locally and internationally.

Zafaralla et al. [5] reported that eutrophication was the most common type of pollution in lakes of the Philippines. Also in Nigeria, deterioration of coastal areas in the country has been largely attributed to eutrophication [6].Many indicators have been used to measure the extent of pollution in the aquatic environment; such as water, fish, flora and fauna [7, 8], however, sediment serves as a good measure of pollution level because it is static and shows deposition over time [9]. Sediments are a combination of several materials, which consist of inorganic materials, mineral particulates and organic matter at different phases of decomposition[10]. They are natural sources of nutrients, micro- and macro fauna that are essential for growth of primary producers in the aquatic system[11]. Additional introduction of nutrients results in accumulation over time. Many factors affect the holding capacity of nutrients in sediment and one important factor is the total organic carbon (TOC) [12].TOC is very significant in the aquatic environment because it influences sediment properties such as colour, nutrient availability and stability[13]. As a result of this, the determination of total organic carbon is an essential part in determining the eutrophication status as it is a strong factor in sediment characterization in coastal waters.

Lagos which is a coastal city and the commercial nerve center of Nigeriaispresently experiencing intense urban development pressure leading to loss of conservation of the aquatic life. Lekki and Epe lagoons are important lagoons on the southwest coast, they contribution immensely to the fishery of the country and they serve as a source of income to people living around them. Within the last decade, the lagoon and estuarine fisheries production in the country has declined [14], this can be attributed to various commercial activities such as sand mining, refined crude oil product bunkering and direct disposal of waste into the lagoons leading to abuse of the environment.This study intends to measure levels of nutrients; phosphate, nitrate, sulphate and silicate in sediments in Lekki and Epe lagoonsand also determine the relationship between TOC and nutrient availability in order to verify their eutrophic status.

II. Materials And Methods

2.1Study Area

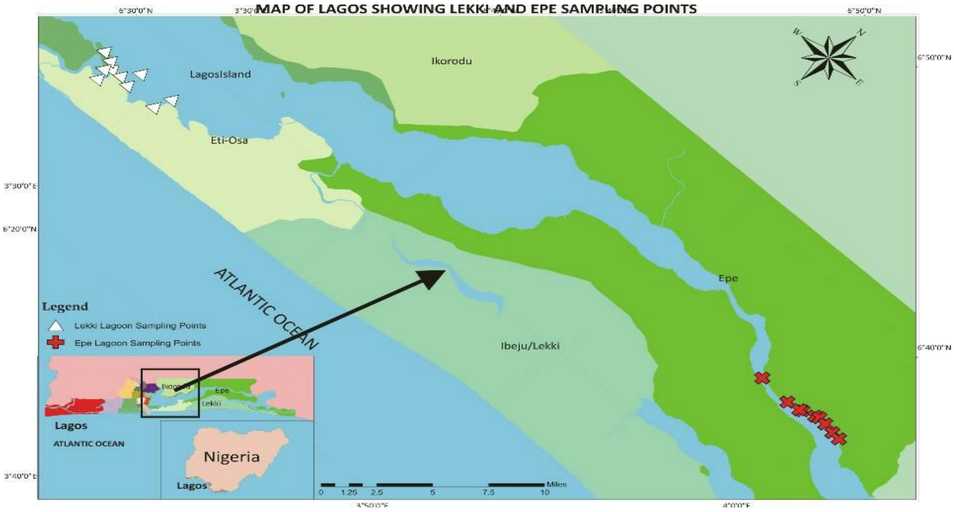

Figure 1: Map of the study area.

A total of 19 sampling stations were chosen for this study (Fig. 1); 10 sampling points from the Lekki lagoon and 9 sampling points from the Epe lagoon. The sampling locations were chosen based on closeness to the metropolis, population and activities around it. Activities apart from fishing include sand mining, refined crude oil product bunkering and location of the Egbin thermoelectric power plant at Epe lagoon while activities in Lekki lagoon include sewage disposal, agricultural waste and industrial effluent. Grab samples of sediments were collected using a Van Veen grab in the month April, 2014 for analysis at the two lagoons and taken to the laboratory at temperature below 4^oC prior to analysis.

2.2Reagents

All reagents and salts used were of high purity and analytical grade supplied by BDH laboratory supplies England.Stock standard solutions for calibration were prepared from salts and serial dilutions were made with de-ionized double-distilled water in order to prepare working solution.

2.3 Sample preparation

Collected samples were air dried and sieved through a 0.5-mm mesh to remove debris and coarse particles. TOC was determined using the Walkely-Black method where ferrous ammonium sulphate (FAS) was titrated against potassium dichromate in the presence of concentrated H_2SO_4 and ferroin indicator [15]. pH of the samples were determined using a calibrated pH meter in air dried sediments to distilled water at a ratio 1:1. Extraction of nutrients was then carried out based on the analyte of interest.Available phosphorus in sediment was extracted using sodium bicarbonate and its determination was done with ammonium molybdate to form molybdenum blue, using ascorbic acid [16].Nitrate concentrations in sediments were extracted using 2M potassium chloride [17] and estimated using the brucine colour development reagent. Sulphate in sediments were extracted using a mixture of glycerol, concentrated hydrochloric acid, ethanol and sodium chloride in distilled water [18] and barium chloridewas used as the colour development reagent. Silicate was extracted using 0.5M sodium carbonateand determined with the use of hydrochloric acid, oxalic acid and ammonium molybdate colour developing reagent. Blank determination was also carried out using the above procedure to correct for contamination and impurities.
Absorbances of colour developed were measured using an Agilent UV spectrophotometer at wavelengths 880nm for phosphate, 420nm for sulphate, 410nm for nitrate and silicate.

III. Results And Discussion

For both stations and at both periods of sampling, pH values were neutral ranging from 7.3-7.5 (Fig. 2). This shows similar characteristic at the different stations of both the Lekki and Epe lagoons. The pH influences the species composition of an aquatic environment and the availability of nutrients [19]. The neutral values obtained were within susceptible range when compared to WHO standards [20]. Similar pH values were found in the study of Dang An et al. [21] who found average pH values of 7.9 in coastal waters in Vietnam.

Generally, sediments sampled had fairly low TOC at both lagoons which were within the range of 0.1-1.0 (Fig. 3). This perhaps could be because of their grain size which is characterised with high porosity and permeability [22, 23] enabling erosion and mineralization of organic matter due to mixing of the water column [24]. Generally, Lekki lagoon had higher TOC levels than Epe lagoon indication presence of more organic matter.

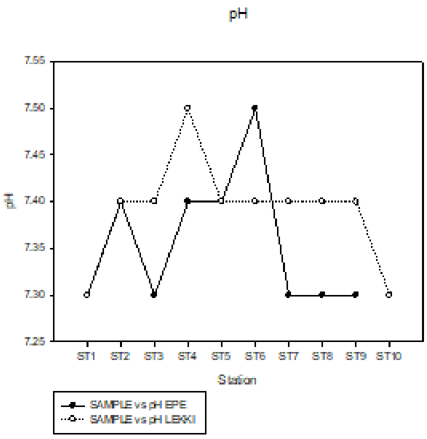

Figure 2: pH levels in sediment

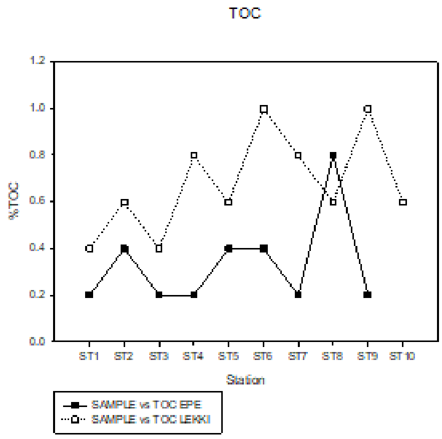

Figure 3: TOC levels in sediment

Nutrient levels in the Epe lagoon were mostly shown to be at higher levels than concentrations found at the Lekki lagoon. This difference could be largely attributed to their TOC levels, as Lekki lagoon has higher content when compared to Epe lagoon. TOC is regarded an important factor which determines the release of nutrients and its increase in sediment is largely aided by decrease in grain size [25]. The presence of fine medium grain size at the Lekki lagoon [23] increases its TOC content thereby reducing rate of nutrient release [26]. Spatial concentrations of phosphate and nitrate at the two lagoons were not in any particular pattern as shown in Fig. 4 and 5. Epe lagoon showed highest levels of phosphate (85.9mg/kg) at station8 and nitrate (39.9 mg/kg) at station5 while highest level of phosphate at Lekki lagoon was found to be 16.7mg/kgat station8 and nitrate 25.4mg/kg at station1. High levels of nitrate found at the lagoons could be attributed to human contribution which includes runoffs containing fertilizers from agricultural lands, disposal of sewage and other anthropogenic waste. High phosphate level found in station8 of the Epe lagoon could be due to precipitation of iron phosphate under anaerobic condition [27].

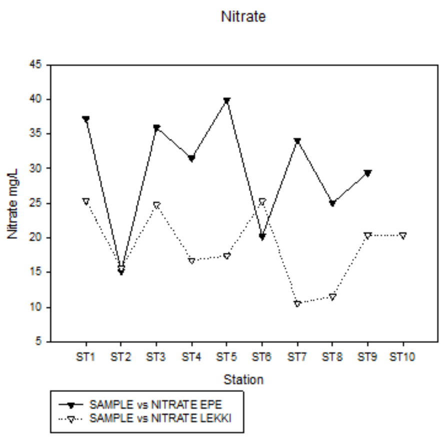

Figure 4: Nitrate levels in sediment

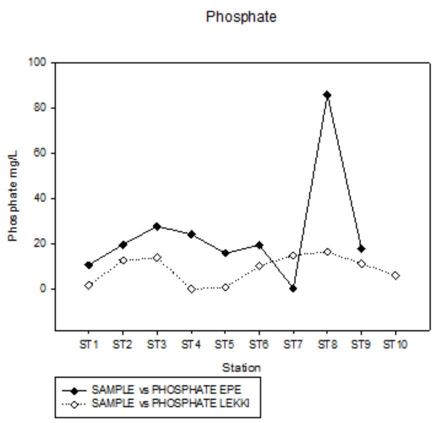

Figure 5: Phosphate levels in sediment

Sulphate and silicate are macronutrients in sediment and they occur at high concentrations (Fig. 6 and 7). The levels of sulphate ranged from 11.3-76.4 mg/kg at the Lekki lagoon and 26.7-900.9 mg/kg at Epe lagoon while silicate was in the range of 15.7-130.5mg/kg at Lekki lagoon and 1.1-232.2mg/kg at Epe lagoon. Unlike phosphate and nitrate, less attention is paid to the concentration of sulphate and silicate in coastal waters. However, they have been shown to be of great importance in the balance of the aquatic system. Silicate has been reported to be an essential nutrient for some biota such as diatoms and these contribute more than 40% of the primary production in water bodies [28]. In this study at the Epe lagoon, highest levels of silicate was reported at station7 (232.2mg/kg) which had the lowest concentration of phosphate 0.5mg/kg and highest levels of phosphate 85.9mg/kg was also observed where silicate had the lowest concentration (1.1mg/kg) at station8. This is in support of Hartikainen et al. [29]'s study, which stated that silicate and phosphate can be specifically absorbed unto sediment surface of iron and aluminium oxide through a specific ligand exchange mechanism and their preferential absorption is important in determining the release of phosphate into the water column [30].

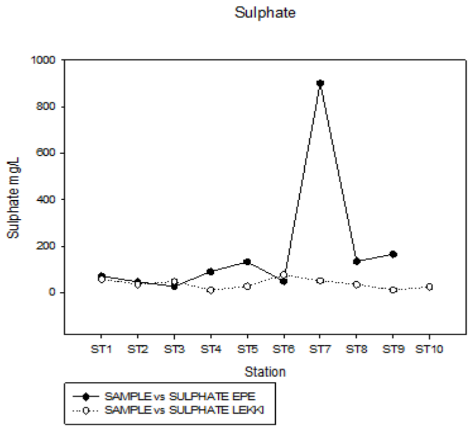

Figure 6: Sulphate levels in sediment

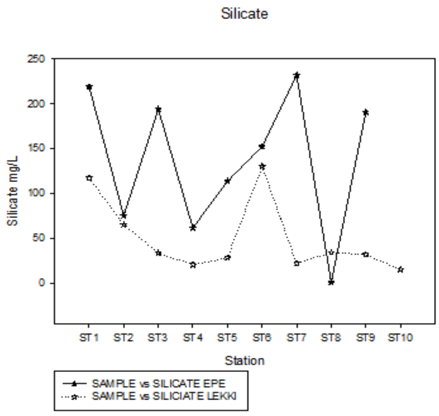

Figure 7: Silicate levels in sediment

Also, relationship between level of sulphate and phosphorus release in eutrophic sediments have been established [31] where the formation and precipitation of insoluble iron sulphide compounds reduces the binding of phosphate iron oxide releasing phosphate from sediment into the water column [32]. This scenario is also evident in Epe lagoon at station7 where highest sulphate concentration of 900.9mg/kg and lowest phosphate concentration of 0.5mg/kg were observed. There is no specific sediment quality guideline (SQG) for nutrients in sediments [33], but it is important to note that the characteristic of the sediment will determine the rate at which the nutrients are released into the water column.

IV. Conclusion

The ability of different sediments to assimilate nutrients differs due to varying physical, chemical and biological activities. Presently, there are no sediment quality guidelines for nutrients in sediment but it is important to note that the individual unique characteristic of each water body determines the release of nutrients into the water column. From the study, amount of TOC did not make any significant impact on the spatial distribution of nutrients at both lagoons; this could be as a result of anthropogenic input of excess nutrients. A strong relationship was observed in the more eutrophic Epe lagoon between phosphate/silicate concentrations and phosphate/sulphate concentrations. Activities around the lagoon proved to be a factor to reckon with as Epe lagoon showed generally higher amount of nutrient load as a result of oil bunkering, Egbin power plants and other activities going on around the lagoon.

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