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Assessment of Nutrients in Water and Sediment Core of the Abule Eledu Creek in Lagos, Nigeria

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Abstract Lagos is a coastal city with a number of surrounding water bodies which includes the Abule Eledu creek. The Abule Eledu creek serves as a harbor for many aquatic fish species and flora. Levels of phosphate and nitrate was analysed in water and sediment at the creek to determine the eutrophic status. Concentrations of nutrients in water were considerably lower when compared to concentrations in sediment. Pattern of vertical distribution of phosphate in sediment indicated characteristic of an eutrophic environment while nitrate distribution was in no particular pattern.

Keywords Water, Sediment, Phosphate, Nitrate, Abule Eledu Creek

Introduction

Coastal waters in Nigeria include a system of lagoons which receive a number of rivers and creeks [1]. Lagos metropolis, the current economic capital of Nigeria is a coastal city with a number of lagoons, rivers and creeks. These creeks include the tidal and the non-tidal creeks [2]. Abule-Eledu creek is one of the tidal creeks that drain into the Lagos lagoon and serve as a harbor for many fish species and aquatic flora. The creeks experience exchange of water during tidal and seasonal periods introducing nutrients and in some instance causing water dilution [3]. The increase in industrialization and population has led to other major sources of nutrients in creeks and their sediments and this includes discharge from industries, agricultural run-offs and disposal of domestic sewage. These anthropogenic depositions are reflected in the vertical concentrations of nutrients in the sediment over a long period of time [4]. Sediments play an important role in the nutrient cycle and distribution in aquatic environments [5]. Vertical sediment profiling is used to monitor and investigate contamination in sediment. It provides details on spatial and temporal distribution of contaminants [6-8]. Understanding the exchange of nutrients mechanism between water-sediment interfaces is very important but complex [9] and it depends on several physical, chemical and biological factors [10]. The amount of nutrients released into the water column determines the trophic status of the water body. Eutrophication in the aquatic environment is associated with algae bloom usually as a result of abundant of limiting nutrient; phosphate and nitrate. The aim of this study is to quantify the amount of nutrients phosphate and nitrate in water and sediment at the Abule Eledu creek at different depths in order to ascertain their eutrophic status.

Materials and Methods

The study was carried out in the inner Abule Eledu creek (N06^o 31’ 22.1” E003 ^{o} 23’ 41.4”), the point of entry into the creek (N06^o 31’ 22.5” E003^o 23’ 58.5”) and at the outer creek (N06^o 31’ 24.5” E003 ^{o} 24’ 03.7”). Water and sediment samples were collected in the month of June 2017. Water samples were collected using a water sampler at the inner and outer Abule Eledu creek, Temperature and pH in water were measured in situ using a Horiba U10 meter and samples for nutrient analysis were collected into previously washed plastic containers and store at 4^oC prior to laboratory analysis. Sediment samples were collected at the surface using a grab sampler and at different depths using a gravity corer, the sediment core was sub-sampled into 10, 20, 30 and 40cm below the surface. The samples were store at 4^oC in well labelled plastic bags prior to analysis in the laboratory. In the laboratory, sediment samples were dried at room temperature, sorted by removing large debris and sieved using a 2mm sieve. Dissolved oxygen measurement in water was determined by Winkler titration and pH of the samples was determined using a calibrated pH meter in air dried sediments to distilled water at a ratio 1:1. Extraction of nutrients from sediment samples was 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 [12]. Nitrate in sediment was extracted using 2M potassium chloride [13] and concentrations estimated using the brucine colour development reagent. In the determination of phosphate and nitrate in water sample, ALPHA [11] was adopted. Phosphate was determined using the ascorbic acid method and nitrate was measured following cadmium reduction method.

Results and Discussion

Table 1: Nutrients and Physico-chemical parameters in water at Abule Eledu creek

Parameters	Inner Abule Eledu creek	Outer Abule Eledu creek
pH	7.26	7.09
Temperature (^oC)	29.0	29.0
Dissolved Oxygen (mg/l)	2.40	2.40
Nitrate (mg/l)	1.33	1.25
Phosphate(mg/l)	2.16	1.77

Table 2: pH of sediment samples at Abule Eledu creek

Depth (cm)	Inner Abule Eledu creek	Entry Abule Eledu creek	Outer Abule Eledu creek
Surface	7.20	7.30	7.40
10	7.80	7.20	7.50
20	7.30	7.50	7.30
30	7.10	7.00	7.30
40	7.50	7.10	7.50

It was observed that the average pH in both sediment and water varied between 7.09 and 7.80 (table 1 & 2) indicating a neutral environment. Temperature of 29^oC was consistent across the sampled sites, dissolved oxygen concentration in water was the same at 2.40mg/l both at the inner and outer Abule Eledu creek. The average concentration of phosphate in water compartment ranged from 1.77mg/l in the outer creek to 2.16mg/l in the inner creek while nitrate concentration in the water column was between 1.25mg/l in the outer creek and 1.33mg/l in the inner creek.

Table 3: Organic matter (%) content in sediment at Abule Eledu creek

Depth (cm)	Inner Abule Eledu creek	Entry Abule Eledu creek	Outer Abule Eledu creek
Surface	2.40	1.72	1.37
10	0.69	0.69	0.69
20	0.34	0.69	0.34
30	0.69	0.34	0.34
40	0.69	0.69	1.03

In general, sediment in Abule Eledu creek had relatively low organic matter content (table 3) in the range of 0.34-2.40%, this could probably be due to high precipitation of calcium carbonate and mineralization of organic matter as a result of intensive mixing of the water column [14]. Highest percentage organic matter was observed at the surface of the sampled sites indicating external loading by surrounding settlements. The particle size distribution of the sediment samples were predominantly in the fraction of silt and sand at the topmost layers and clay at the lower parts. Nutrient content in sediment are controlled by numerous factors such as the rate of sedimentation, sediment type, intensity of mineralization of organic matter and degree of mixture with the water column [15]. Vertical distribution of nutrients in sediment profile shows the history of sedimentation in the aquatic body.

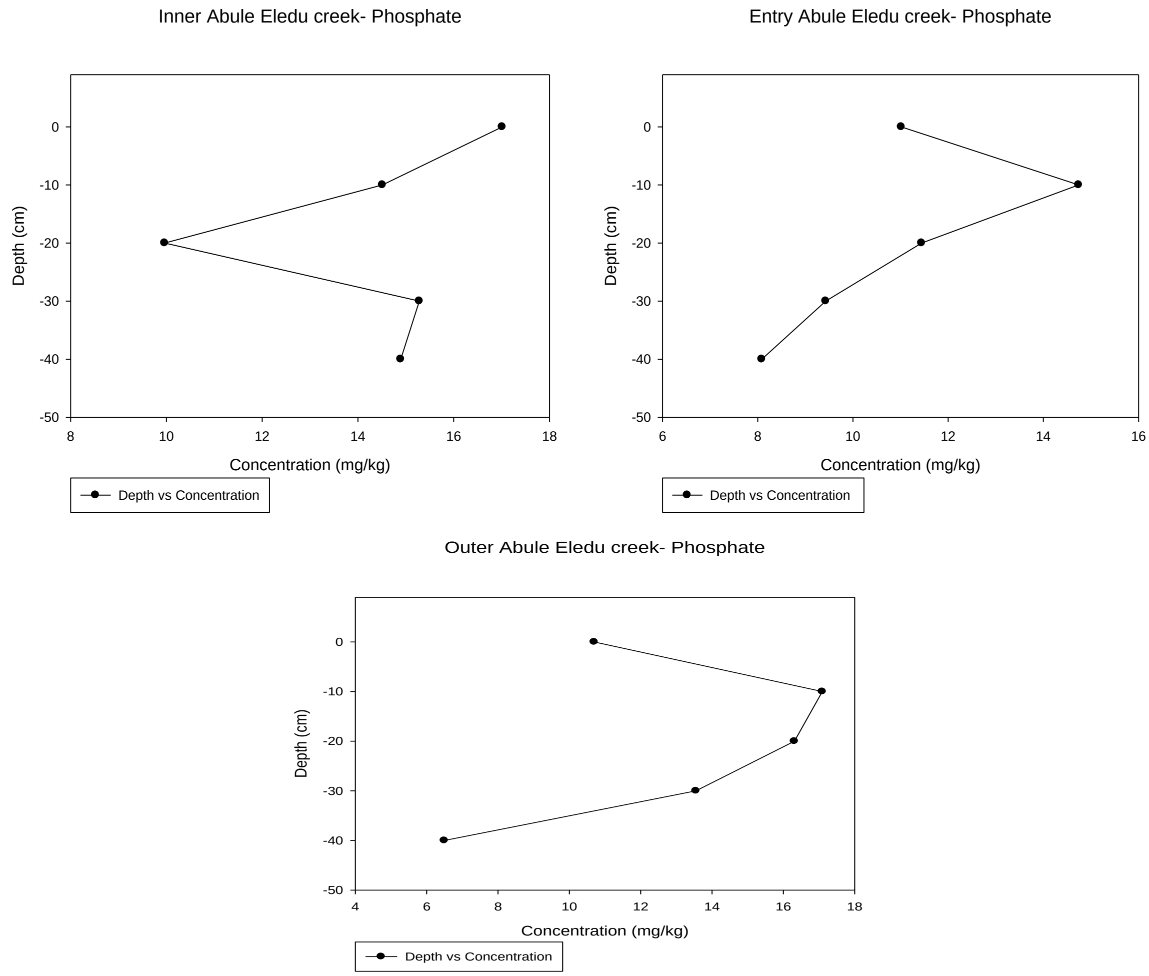

Figure 1: Vertical distribution of Phosphate at Abule Eledu creek

Phosphate concentrations (fig.1) ranged from 6.50-17.09mg/kg at the outer creek, 8.09-14.74mg/kg at the creek entry and 9.97-17.01mg/kg at the inner creek. The phosphate profile showed that concentration gradient in sediment decreased with depth from 10cm to 40cm at the entry and outer creek. The probable cause of gradual decline in concentration could be due to upward movement of phosphate and low microbial activities [16]. This scenario reflects recycling of phosphate through degradation with depth and subsequent release of phosphate which is in accordance to the study of Rydin [17], who stated that eutrophic lakes generally exhibit decrease in phosphate with depth. The relatively lower phosphate levels in surface sediment could be attributed to mixture of the top sediment and water column [18]. An exception of this pattern was shown in the inner creek where concentration reached maximum of 17.01mg/kg at the surface and decreased to 14.51mg/kg and 9.97mg/kg at depth 10cm and 20cm respectively which then increased to 15.28mg/kg at depth 30cm and had a subsequent decrease to 14.89 at 40cm depth. This variation in trend indicates external loading of nutrients due to closeness of the inner creek to settlement areas.

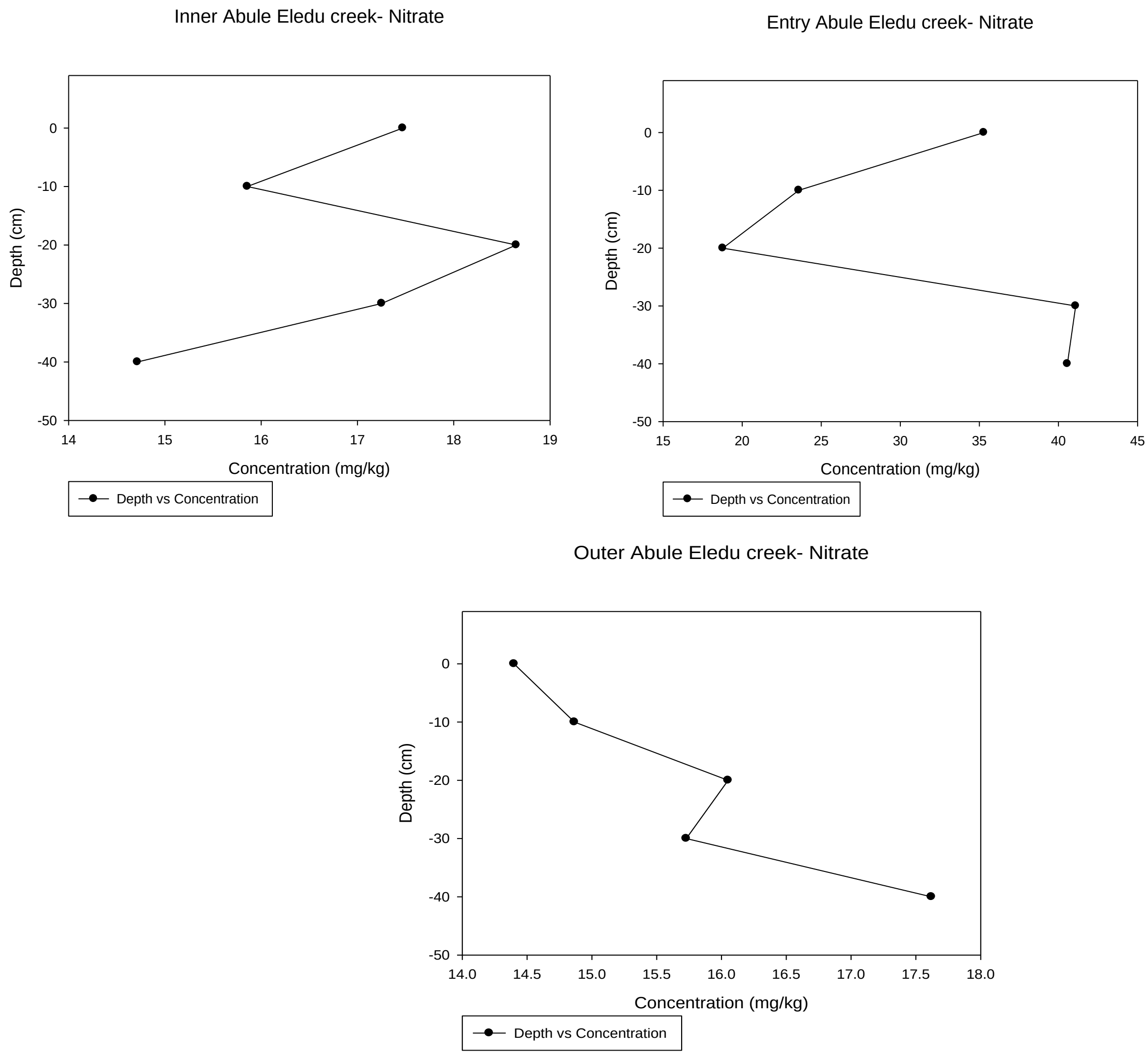

Figure 2: Vertical distribution of Nitrate at Abule Eledu creek

Unlike phosphate, the content of nitrate in sediment depth (fig. 2) obviously varied with sampling site and did not follow any particular pattern [16]. This could be attributed to differences in sedimentation, microbial activities, nitrogen fixation and assimilation of nitrate by organisms [19]. Nitrate level at the outer creek was shown to generally increase with increasing depth from 14.40mg/kg at top sediment to17.62mg/kg at 40cm depth. At the creek entry, there was no particular pattern observed, a downward trend was shown from surface sediment (35.28mg/kg) to 10cm depth (23.58mg/kg) and 20cm depth (18.78mg/kg). This rapidly increased to 41.09mg/kg at 30cm and reduced slightly to 40.56 at depth of 40cm. Similar to the entry of the creek, the inner creek nitrate profile decreased from surface concentration of 17.47mg/kg to 15.86mg/kg (10cm depth), increased slightly to 18.65mg/kg (20cm depth) and subsequently decreased to 17.25mg/kg (30cm depth) and 14.72mg/kg (40cm depth). The creek entry was shown to have higher nitrate levels compared to the inner and outer creek, this could be due to fresh load of nitrate being introduced through industrial discharge, domestic sewage and agricultural runoffs. Increased levels of nitrate at 30-40cm depth could be as a result of more oxygenation and less microbial activities at the deeper core. Sediment profiling is important because it gives details on nutrient availability; increase in depth reduces nutrient availability and rate of decomposition [20]. Though phosphate and nitrate concentrations in water were not as high as levels in sediment, continuous introduction of nutrient into the creek could lead to a more eutrophic environment resulting in release of nutrients to the water column.

Conclusion

Surface nutrients generally represents external load of deposited nutrients through anthropogenic sources and are not substantial enough to determine the actual sediment concentrations and availability of nutrients. It is important to examine the concentration over the sediment core to get a clear and better picture of the Abule Eledu creek. The study showed that Abule Eledu had characteristics of an eutrophic environment as nutrient profile dynamics particularly phosphate was linked to studies of eutrophic lakes. Though nutrient concentrations in water was lower compared to sediment concentrations, if pollution is not controlled, sediment in Abule Eledu creek might not be able to bind to all nutrients leading to release in the water layer.

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