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Variation of Water Quality in an Impacted Coastal Lagoon over the Last Decade (Küçükçekmece Lagoon, Turkey) †

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Abstract: Küçükçekmece Lagoon, located inside the Istanbul metropolitan area, is connected to the Marmara Sea by a small canal. Due to the construction of a dam on the Sazlıdere stream, which is the most important feeding source for the lagoon, there has been a decrease in freshwater inflow, so the amount of salinity in the lagoon has started to increase. While salinity was around 11 ppt at the surface water of the lagoon in the 2010s, the level of salinity concentration exceeds 17 ppt today which also has an impact on the ecosystem. The aim of this study is to evaluate the water quality changes in the Kucukcekmece lagoon in a decade. The water quality revealed a high spatial and temporal variation in the lagoon and the bottom (ca 18 m) waters were rich in H_2S of which the highest concentration was measured as 215 mg/L. Overall, from the large dataset of water quality for more than ten years, there is an obvious effect of anthropogenic activities and the closure of freshwater inlets on the trophic conditions of the lagoon.

Keywords: pollution; water quality; Küçükçekmece Lagoon; H_2S

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1. Introduction

Coastal lagoons are complex and dynamic ecosystems that show sharp distributional gradients and short-term and seasonal variability in their physical, chemical and biological properties [1]. As a result of long hydrologic retention times, lagoons are very vurnerable ecosystems to chemical contamination [2]; pollutants are consequently retained longer [3].

Küçükçekmece Lagoon, located in Istanbul, Turkey, is suffered from many problems, which might lead to environment degradation, differences in salinity levels and substantial changes in its ecosystem. It has been affected by population pressure around the lagoon, wastewater discharges, algal blooms, and salinity increases due to cutoff of freshwater inputs [4].

In this study the spatial and seasonal variability of physicochemical parameters and the chlorophyll-*a* were assessed in a coastal lagoon connected to the sea. Our main goal was to understand the nutrient dynamics including the importance of water exchanges between the lagoon and the adjoining area, determination of the effect of anthropogenic activities and the closure of freshwater inlets on the trophic conditions of the lagoon for more than ten years.

2. Materials and Methods

Küçükçekmece Lagoon is located between in the south-west of Istanbul (Figure 1). It has a direct connection to the Marmara Sea with a canal. It has a 15.22 km^2 surface area and a maximum depth of 18.5 m. Because of the rapid urbanization and industrialization,

significant deterioration in water quality was observed due to intense wastewater discharge. A gradual increase in eutrophication has resulted in cyanobacterial blooms from the 1990s to the 2010s [5,6].

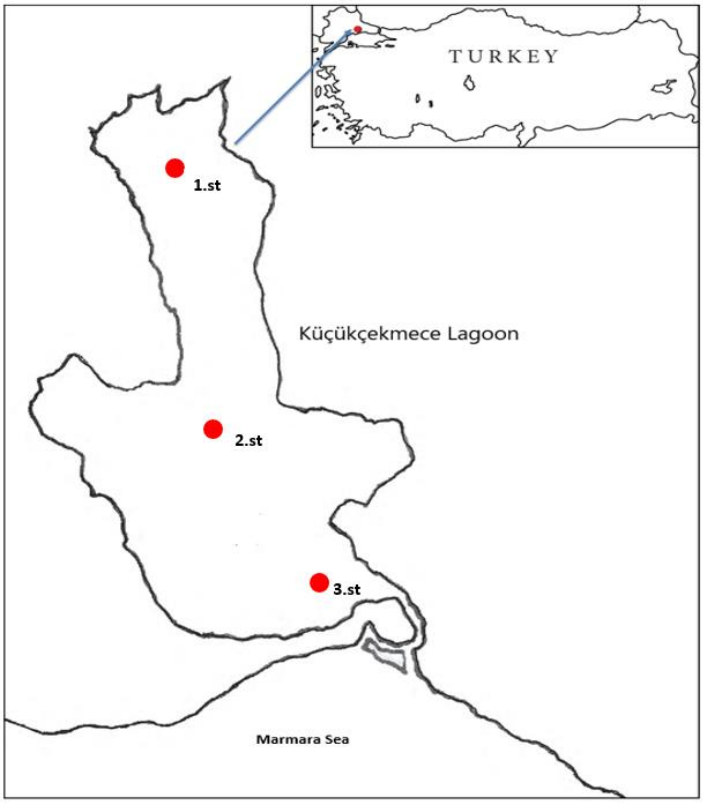

Figure 1. Location of sampling sites in Küçükçekmece Lagoon.

To compare water quality variations, samples were collected from June-December 2012 and 2022 at regular monthly intervals. Water samples were collected from the surface in two stations (1st and 3rd station) andto observe the depth profile the samples were collected throughout the water column (surface, 9 m, and 18 m) from the 2nd station. Dissolved oxygen (DO), salinity, and temperature were measured in situ using the YSI multiparameter (YSI 650 MDS). Chlorophyll-*a* (chl-*a*) was determined using the method of ISO 10260 (1992) [7]. Nutrient analyses for nitrite ($N0_2$), nitrate ($N0_3$), total phosphorus (TP) and silicate were performed according to APHA-AWWA WPCF (1989) [8].

3. Results and Discussion

The physicochemical characteristics of surface waters' of Küçükçekmece Lagoon are given in Figure 2. The water temperature ranged between 8.1–28.2 °C. The salinity diagrams (Figures 2,3) showed that seawater inflow influences the lagoon's characteristics. It has been determined that the salinity level has doubled from 2012 (mean; 7.44 ppt) to 2022 (mean; 14.1 ppt). Due to the increase in salinity, the detected cyanobacteria members shifted to marine species 015. This revealed with chl-*a* decreased in 2022. While the mean value of total phosphorus concentration was 712.1 µg/L in 2012, it was measured as 370 µg/L in 2022. The mean value of nitrate and nitrite concentrations were increased from 0.72 mg/L to 2.9 mg/L in 2022. All these measurements showed that the trophic status of Küçükçekmece Lagoon had hypertrophic conditions since the 1990s and did not show any sign of enhancement.

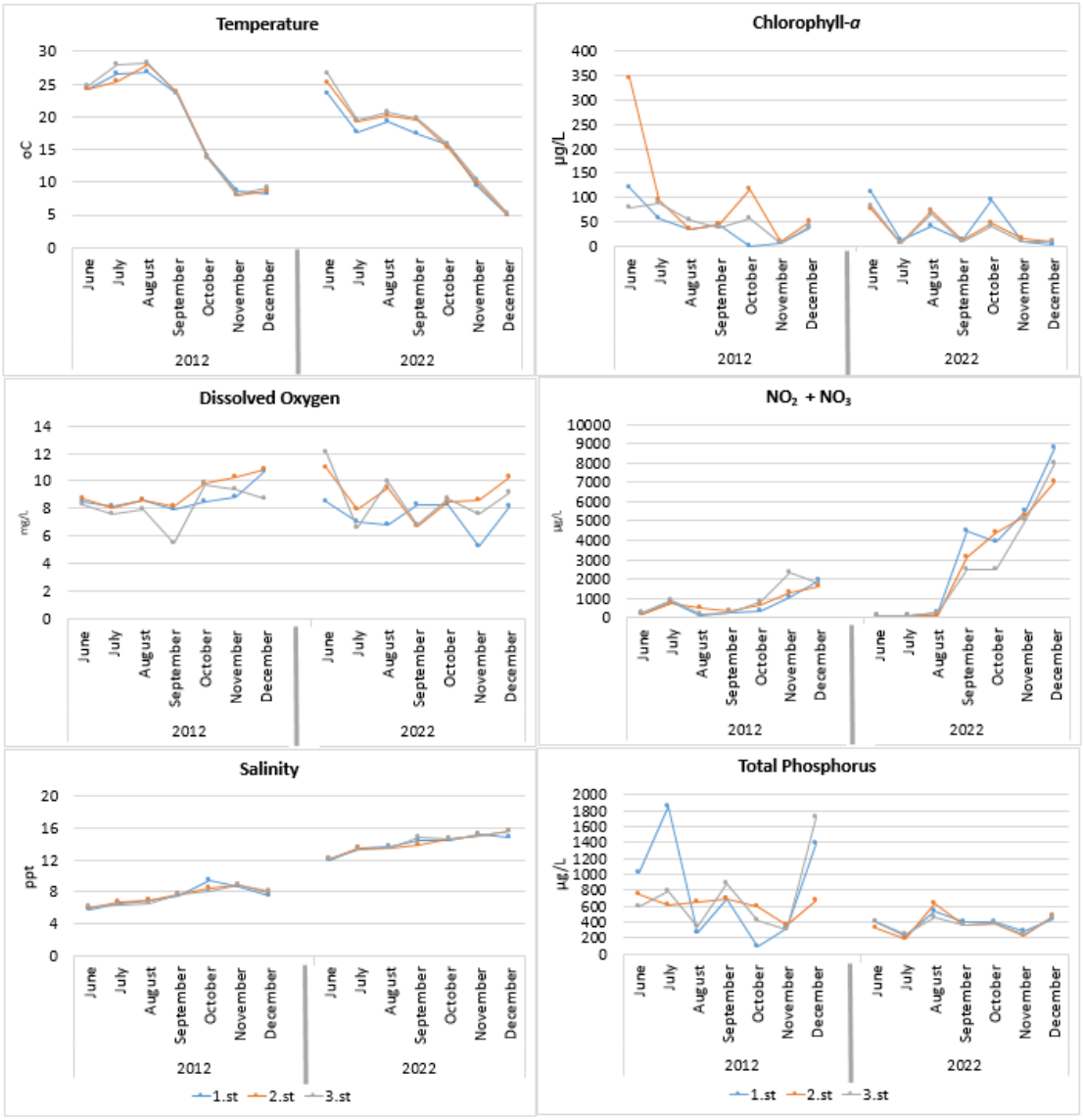

Figure 2. Physicochemical characteristics of surface waters of stations.

In the water column, data showed that as a result of thermal stratification, water quality deteriorated at the bottom of the lake because of slow water exchange between layers [8]. As an important indicator of trophic status, oxygen concentration or depletion rates in hypolimnetic water have long been studied (Nürnberg, 1996). In all sampling periods, the bottom layer was characterized by anoxic conditions (Figure 3). Gürevin et al. reported that the significant release of nutrients from sediment caused long-term eutrophication in lagoon [10].

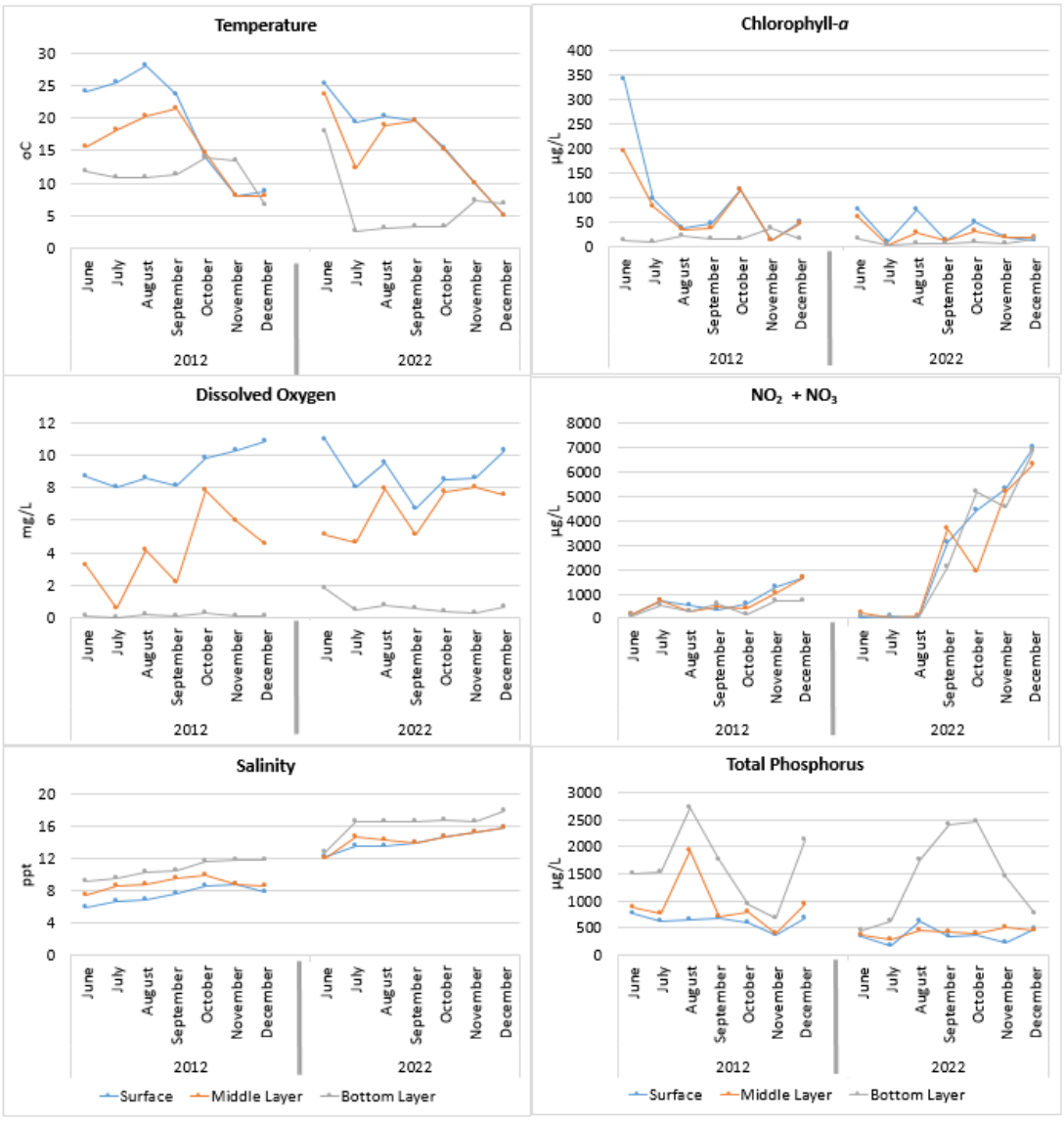

Figure 3. Depth profile of physicochemical characteristics of station 2.

4. Conclusions

In this study, due to rapid industrialization and population growth, a significant deterioration in water quality has been observed since the 1990s. From the large dataset of water quality for more than ten years, exposure to wastewater discharges and the closure of freshwater inlets has been shown to be related to adverse effects on the water quality in the lagoon. These changes are having a serious effect on ecosystem dynamics revealing a shift in local species.

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