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Full Length Article

Evaluation and mapping spatial distribution of bottom sediment heavy metal contamination in Burullus Lake, Egypt

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ABSTRACT

Burullus Lake is one of most important lakes in north Delta of Egypt. It is exposed to huge amounts of serious pollutants especially heavy metals. The sediments within the lake aid in the dispersion of these metals. The main objectives of this research were to evaluate and map the spatial distribution of heavy metals in Burullus Lake sediments. Accordingly, 37 locations were randomly distributed within the lake. Sediment samples were taken from these locations. These samples were analyzed for seven metals including Fe, Cu, Zn, Cr, Co, Cd and Pb. Also, five indices were used to identify the status of metal pollutants in the Lake. These indices are: enrichment factor (EF), contamination factor (CF), degree of contamination (DC), pollution load index (PLI) and geo-accumulation index (*Igeo*). Ordinary Kriging was used to interpolate the spatial distribution of the studied elements within the lake. The obtained results indicated that cadmium was the most enriched element in the lake sediments due to industrial and agricultural wastes drained into the lake. The *Igeo* index revealed that Cd and Pb were the common pollutants in lake sediments. The DC values ranged between low (near El-Boughaz) and moderate (near drainage areas). The spatial distribution of pollutants within the lake indicated that the highly polluted areas are located close to the drains, whereas as the less polluted areas were close to El-Boughaz.

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1. Introduction

Burullus Lake of the central Nile Delta is a UNESCO-protected area and one of the most conspicuous wetland habitats in Egypt, which were taken into consideration according to RAMSAR convention in 1971 [1]. In the last decades, it has suffered from different types of pollutants which adversely affect its water and sediment quality.

The sediments of the aquatic environment act as major reservoir of metals and source of contaminants. Enrichment of heavy metals due to industrialization and urbanization was recorded in the sediment of coastal areas all over the world. Sediments are not only functioning as heavy metal scavengers, but also as one of the potential sources of heavy metals to the ecosystem [2,3].

Heavy metals in high concentrations are considered as serious pollutants to aquatic ecosystems due to their high potential to enter and accumulate in the food chain [4]. Some heavy metals such as Fe, Co, Cu, and Zn are essential micronutrients for fauna and flora, but they are dangerous at high levels, whereas the most toxic heavy metals are Cr, Pb and Cd, which are considered carcinogenic elements [5]. Geographic information system (GIS) provides a very powerful tool for the analysis and creation of models that integrate the relations between the different features on the earth's surface and their effect on the environment. GIS can also be used to perform a number of fundamental spatial analyses and operations. Spatial distribution of some important heavy metals is essential to assess their effects on sediments and to delineate contaminated areas [6,7].

The objectives of this work were to evaluate and study spatial distribution of heavy metals in Burullus lake sediments using GIS techniques. This is to provide decision makers with more accurate information about the status of pollution within the lake.

2. Study area

Burullus Lake is located in Kafr El-Sheikh Governorate (30° 22' - 31° 35'N; 30° 33' - 31° 08'E) with an area of about 460 km^2. It is situated on the eastern side of Rosetta branch of the River Nile. The lake receives an annual water volume of about 4.1 milliard cubic meters through a system of eight drains and a freshwater canal called Brinbal. The drainage system collects agricultural drainage water from about 998 thousand acres in the catchment area. Drainage water is discharged into the lake through a group of pumping stations at the end tail of the drains except Gharbia drain which discharges its water freely without pumping EMI [8]. The lake is connected to the Mediterranean Sea via Boughaz El-Burullus at the northeastern part of the Lake as illustrated in Fig. 1.

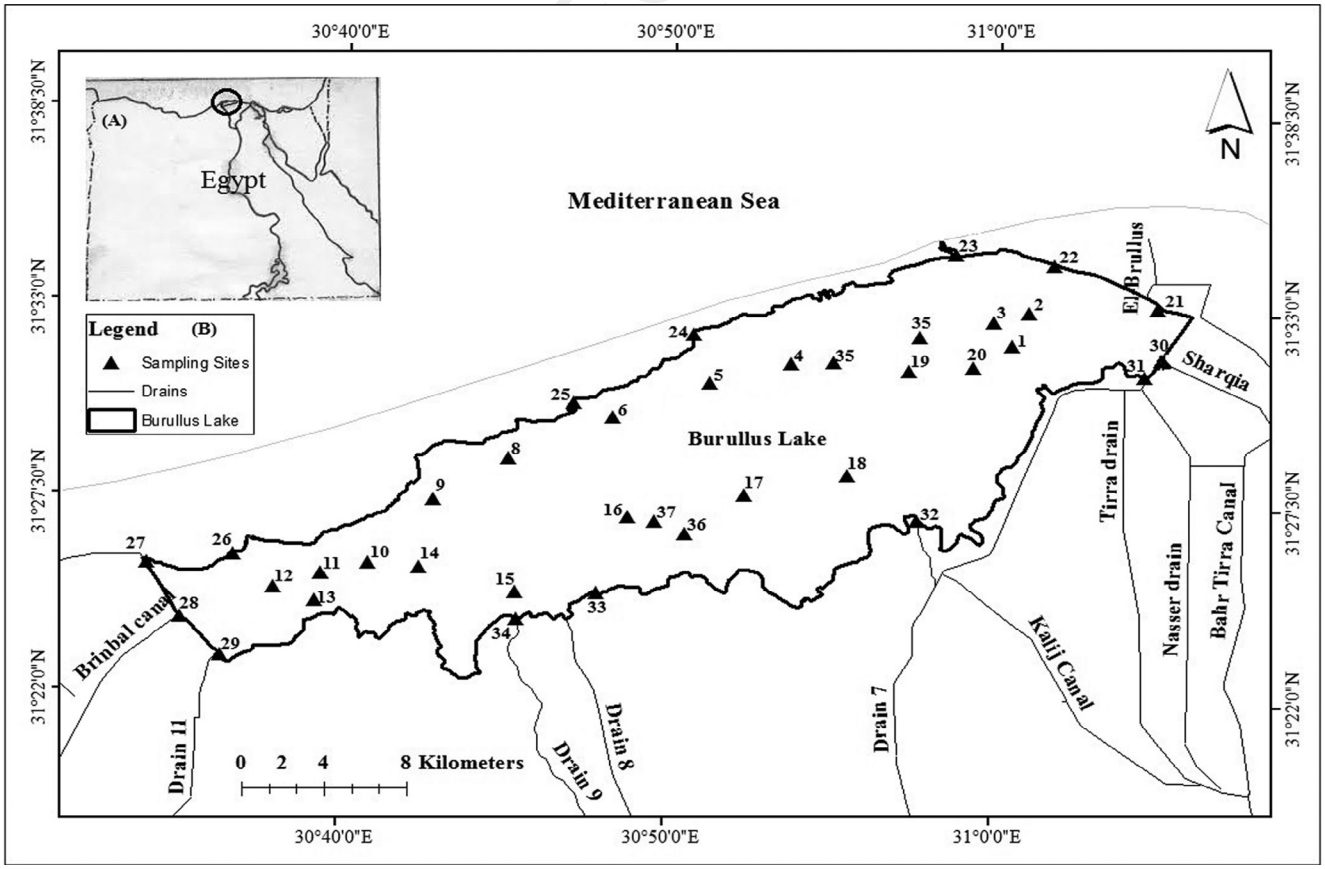

Fig. 1 – Locations of (A) study area in Egypt and (B) sampling locations within the lake.

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