Egyptian Journal of Basic and Applied Sciences xxx (2017) xxx–xxx

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Contents lists available at ScienceDirect

Egyptian Journal of Basic and Applied Sciences

journal homepage: www.elsevier.com/locate/ejbas

Full Length Article

Spatio-temporal evaluation of the surface water quality in the middle Nile Delta using Palmer's algal pollution index

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ARTICLE INFO

Article history:
Received 23 November 2016
Received in revised form 18 May 2017
Accepted 19 May 2017
Available online xxxx

Keywords:
Middle Nile Delta
Water pollution
Palmer index
Irrigation canals
Drians

ABSTRACT

This work aims to evaluate the spatio-temporal change in the surface water pollution in the middle Nile Delta using algal pollution index (Palmer Index). Water was sampled during winter and summer seasons from 18 stations distributed along the water pathways from south to north for two main irrigation canals (Qudaba and Mit-yazed canals) and two drains (El-Gharbia main drain and Janag drain). An algal analysis was carried out based on the species and genera that mentioned in Palmer Index (PI). High Palmer Index scores were noticed in most of the stations especially during summer, which might be related to various pollution supplies. Limited number of stations showed low palmer index scores indicating relatively clean water. In winter, the two irrigation canals showed similar spatial distribution patterns where PI values increased reaching its maximum at the middle of water pathways and then decreased. In summer, PI had no definite trend in Qudaba canal and decreasing trend in Mit-yazed canals along the water pathway to the northern direction. PI of El-Gharbia main drain showed increasing and decreasing trends in winter and summer, respectively. Janag drain had opposite patterns compared to that of El-Gharbia main.

One of the major differences between irrigation canals and drainage water was the algal community structure where the drainage water was characterized by the abundance of Euglenophyta and *Chlamydomonas* spp. and rare occurrences of Bacillariophyta except the last station of El-Gharbia main drain, which was of estuary nature.

1. Introduction

River Nile is the main water resource for Egypt. It supports the country with water needs for food, urban, industrial and environmental uses [1]. The main body of the River bifurcates near Cairo into Damietta and Rosetta branches. A network of Irrigation canals and drains covers all Delta regions (Fig. 1A). The irrigation canals network helps to deliver the water to most of the cultivated lands and urban areas, while the drains help to discharge the waste water.

River Nile provides Egypt with about 55.5 Billion cubic meters of fresh water every year [2]; however there is an increased shortage of water. So, suitable management of water resources should be considered, including the control of water loss and the amount of pollutants that deteriorate the water quality in the river and the irrigation canal network due to the irresponsible discharging of variety of wastes in the water pathways.

Organic pollution in the river Nile considers an essential active field of research [3,4]. It became a significant environmental problem. Almost all freshwater bodies are widely affected by the human population explosion and urbanization. Water pathways are polluted by organic material such as sewage, food waste and farm effluent [5,6]. So, detecting the organic pollution and trying to manage this environmental crisis are considered important tasks to do.

Algae are considered an important component of any aquatic ecosystem and are responsible for the primary productivity of those systems [7]. Due to their relatively short life spans, their community composition alters quickly in a response to the changes of the water physico-chemical parameters [8]. That is why algal communities are used as indicators of aquatic pollution [9].

The first attempt to identify and prepare a list of the most tolerant algal species and genera to pollution had been done by palmer [10]. Palmer index is considered a rapid, reliable and relatively inexpensive way to record water pollution probability across number of sites [11]. It is used beside other indices for inorganic pollution and eutrophication level [9]. Palmer index has been used before in Egypt by El-Kassas and Gharib [12]. In the present

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http://dx.doi.org/10.1016/j.ejbas.2017.05.003
2314-808X/

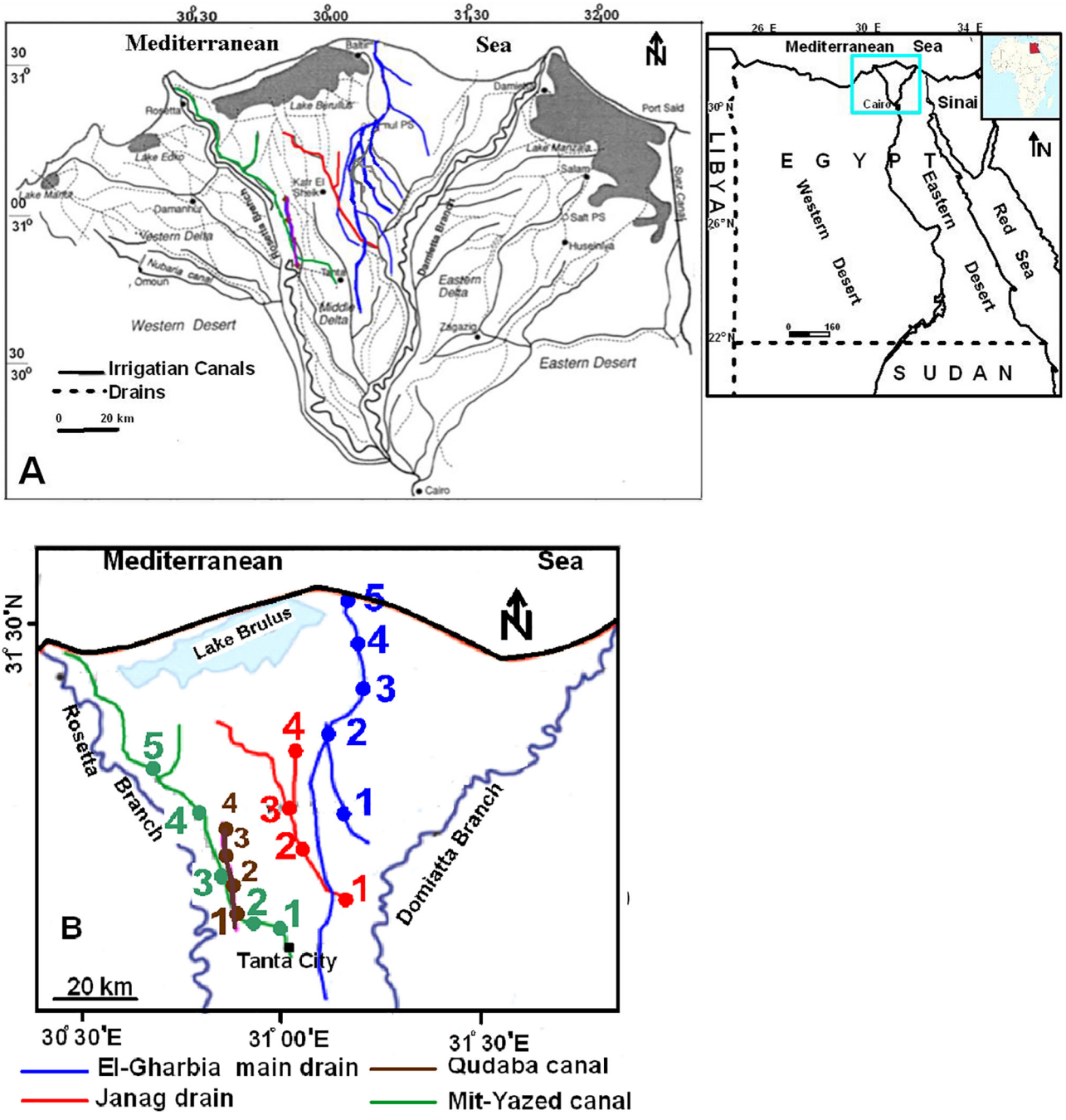

Fig. 1. Maps of the Nile Delta show the distribution of irrigation canals and drains (A) and sampling stations (B).

study Palmer index (PI) was used to obtain information about the water pollution probability along the path of two main irrigation canals and two main drains in the Middle part of the Nile delta.

2. Material and methods

Water was sampled from 18 sites (Fig. 1B) twice from every location in 2015, once in winter and the other in summer. Sampling sites were distributed along the path ways from south to north of two main irrigation canals (Mit-Yazed, 4 sites and Qudaba canal, 5 sites) and two main drains (El-Gharbia main drain, 5 sites and Janag drain, 4 sites). Mit-yazed canal is recharged from Shubin rivulet at 30°52′ N and 31°08′ E. Qudaba canal receives water from Rosetta branch near El-Qanater El-khiria at 30°11′ N and 31°07′ E and goes parallel to the Rosetta branch until discharging in it at Rosetta city. El-Gharbia main drain starts in the middle part of the Nile Delta and collecting the agricultural, domestic and industrial waste water by number of smaller drains along its path and discharges in the Mediterranean Sea near Burullus Lake. Janag drain is a relatively short drain located in the middle Nile Delta region to the west and starts at Kafr El-Ziat City (Industrial city) and runs to the northern direction (Fig. 1B). Fig. 2 includes some photos showing the water bodies in some of the sampling stations.

2.1. Sampling and microalgae analysis

Samples were collected in clean opaque one liter-sized plastic bottles. About 7–10 ml of Lugol's solution (iodine in potassium

Please cite this article in press as: Salem Z et al. Spatio-temporal evaluation of the surface water quality in the middle Nile Delta using Palmer's algal pollution index. Egyp. Jour. Bas. App. Sci. (2017), http://dx.doi.org/10.1016/j.ejbas.2017.05.003