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Water quality management for Lake Mariout

N. Donia [a,*], M. Bahgat [b]

[a] Institute of Environmental Studies and Researches, Ain-Shams University, Cairo, Egypt
[b] HRI, National Water Research Center, Delta Barrage, Egypt

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Abstract A hydrodynamic and water quality model was used to study the current status of the Lake Mariout subject to the pollution loadings from the agricultural drains and the point sources discharging directly to the Lake. The basic water quality modelling component simulates the main water quality parameters including the oxygen compounds (BOD, COD, DO), nutrients compounds (NH4, TN, TP), and finally the temperature, salinity and inorganic matter. Many scenarios have been conducted to improve the circulation and the water quality in the lake and to assess the spreading and mixing of the discharge effluents and its impact on the water quality of the main basin. Several pilot interventions were applied through the model in the Lake Mariout together with the upgrades of the East and West Waste Water Treatment Plants in order to achieve at least 5% reduction in the pollution loads entering the Mediterranean Sea through Lake Mariout in order to improve the institutional mechanisms for sustainable coastal zone management in Alexandria in particular to reduce land-based pollution to the Mediterranean Sea.

1. Introduction

Since the shallow coastal lake at the downstream of the catchment is considered as a sink that receives all the wastewater discharged from the watershed, it was important to develop a more detailed modelling component for the lake system. Nowadays, relative to the present advances in computational sciences, hardware and software, improvement in rivers, catchments and lakes modelling has been only modest since the last decades. Therefore, most catchment models are difficult to understand, use and adapt, leading to frustration amongst the users of such models and their developers [1]. Applying a hydrodynamic and water quality numerical modelling technique at the coastal lakes will help to give some answers to both planning and technical questions of water quality managers, decision makers, and those of technical engineers working on the sampling, monitoring, and analysis of water quality parameters. This technique was applied in Egypt at Lake Mariout, as a part of Alexandria Coastal Zone Management Project (ACZMP), and the Alexandria Lake Mariout Integrated Management project (ALAMIM) to improve institutional mechanisms for the sustainable management of the coastal zones in Alexandria under the umbrella of adopting the ICZM. The tensions between resource management and science are explored by [2] and his

* Corresponding author. Tel.: +20 1228301999.
E-mail addresses: ndonia@gmail.com (N. Donia), mohbahgat@gmail.com (M. Bahgat).
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findings are especially applicable to environmental modelling which can be expensive and highly technical.

The main objective of the study is to examine and evaluate the impact of alternative water quality management practices in the selected drainage catchment, and their effect on the environmental condition of the lake as an important component of the watershed. This is achieved by at least 5% reduction in the pollution loads entering the Mediterranean Sea through Lake Mariout by the several pilot interventions applied in the Lake Mariout together with the upgrades of the East and West Waste Water Treatment Plants. A hydrodynamic and water quality model was used to study the current status of the Lake Mariout "the main basin" subject to the discharges and pollution loadings coming from the agricultural drains and the point sources discharging directly to the Lake, through simulating the flow circulation inside the main basin of Lake Mariout, the transport and advection of the pollutants due to the effluent discharges from drains and other sources of pollutants, and identifying and developing the most critical surface drainage water quality indicators to simulate and predict the temporal and spatial variation of pollution.

2. Description of the pilot area

Lake Mariout is a salt lake and it is considered a major coastal lagoon, which actually forms the southern border of Alexandria city. It is separated from the Mediterranean Sea by the narrow isthmus on which the city of Alexandria was built. The lake shore is home to fisheries and saltworks. In 1801, the original area was probably in excess of 700 km^2, because of railway and road construction isolating parts of the lake, the cessation of annual Nile flood after building the Aswan High Dam, and land reclamation and the area of the lake is now less than 65 km^2 and ranges in depth from 1 to 3 m (AICZMP 2009). Currently, the lake is divided artificially into four main basins as shown in Fig. 1, namely 6000 feddans basin (Main Basin), 5000 feddans basin (South Basin), 3000 feddans basin (West Basin) and 1000 feddans basin (Aquaculture Basin). These ponds are dissected by roads and embankments. The point sources of pollution originate mainly from rural and agricultural areas while the other interventions target point source pollution as shown in Fig. 1.

Comparison of the chemical composition of Lake Mariout water with that of proper sea water and drainage water shows that the lake water presents an intermediate composition between both sea and drainage water. This phenomenon can be explained by seepage from the sea. Such explantation is supported by the low level of water and by the water balance which is supported by older data of the salt content of wells in Mariout region [3]. There are three main canals (El-Qalaa, El-Omoum and El-Nubariya) that are considered the main inflows to the Lake. El-Qalaa drain is located at North-East while El-Omoum and El-Nubariya canals are located at the East and South of the Lake, respectively. Other inflows are the water treatment plant (WTP) and the discharges from the Petrochemical area nearby the north western basin. El-Omoum and El-Nubariya canals are less polluted drains, considering their nutrients (N, P) and DO concentrations [4]. El-Omoum receives mainly agricultural drainage water; moreover, the drain receives both raw and treated wastewater from several defined and undefined sources [5]. Therefore, these drains also contribute with the nutrient loadings in the Lake, but to a lesser extent. Additionally, non-point sources such as agricultural run-off containing pesticides and fertilizers are also contributing to the deterioration of the environmental quality of the lake [6].

As a result of the high nutrient loading, the lake has become anthropogenic polluted and eutrophic. Eutrophication of lakes is a natural process that can be accelerated by man's activities that introduce an excess of nutrients together with other pollutants. The main sources of nutrients and pollutants can include the following: Human sewage, industrial waste, farm and urban run-off [7]. Currently, the lake is 60% covered by

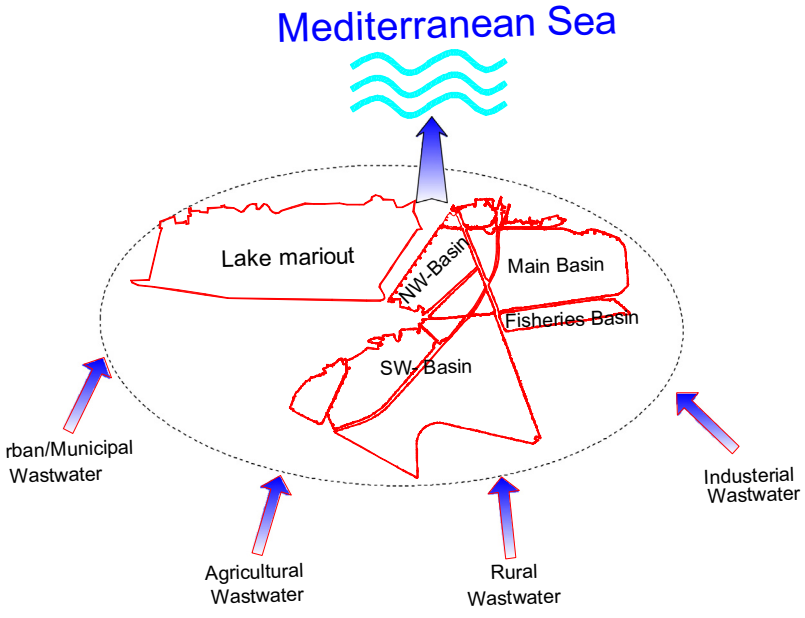

Figure 1 General layout of Mariout Lake basins.