TRANSPORT OF PHOSPHORUS AND SUSPENDED MATTER ALONG THE COASTAL WATERS OF ALEXANDRIA (SE MEDITERRANEAN SEA)

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Abstract

A hydrodynamic and water quality model were applied to a coastal bay east of Alexandria City in the southeastern sector of the Mediterranean Sea subjected to industrial, agricultural and sewage water discharge, to determine the transport and dispersion of phosphorus and total suspended matter within the bay. The numerical simulation for the dispersion of phosphorus discharged into the bay, mainly in the particulate form, exerted a major effect on the marine environment as indicated by phytoplankton blooms in the area.

Keywords: Water quality model, phosphorus, suspended matter, Alexandria coast

Abu-Qir Bay, lying east of Alexandria City, is considered one of the hot spots in the southeastern Mediterranean Sea. The Bay is mostly affected by different sources of land drainage; industrial polluted water of El-Tabia outfall which receives daily about 1.5-2.0 x 10^9 m^3 of untreated sewage and industrial wastes, agricultural polluted water from Lake Edku discharged through El-Maadiya outlet at a rate of 3.3 x 10^6 m^3/day and fresh water from Rosetta branch of the River Nile (about 3.76 x 10^9 m^3/y). About 22 different factories mainly food processing and canning, paper industry, fertilizer industry, textile manufacturing and gas exhausting are located in the surrounding area of the Bay. These factories dump their wastes to the bay mainly through El-Tabia Pumping Station.

In view of the rapid increase in the population and development of Mediterranean cities like Alexandria, and consequent increase in industrialization, and accumulation of contaminants derived from terrestrial, industrial and domestic disposals to the coastal waters, the objective of the present work is to study the water circulation in Abu-Qir Bay and its effect on phosphorus (a limiting nutrient along the southern Mediterranean) and suspended matter transport using numerical modeling. By developing a hydro-dynamical model (POM) together with a water quality model (EIA), the study will discuss and explain both the water circulation and phosphorus transport to find out a predictable distribution which can be used in understanding the fate and impact of phosphorus on the marine biota and human life.

The water circulation in the Abu-Qir Bay is dynamic and is controlled by two factors: the velocity and frequency of the prevailing wind and the amount of drainage water discharged into the Bay. Five scenarios are proposed in Abu-Qir Bay. The **first** occur during summer when the drainage water discharged into the Lake increases and a weak Northerly or Northwesterly wind prevails. In this case, the spreading of large amount of lake water discharged into the Bay was limited by the weak prevailing wind. The **second** scenario occurs when a strong Northerly or Northwesterly wind prevails and small quantity of drainage water is discharged into the Lake. In this case the accumulated water in the southern part of the Bay penetrates into the Lake. The **third** scenario occurs when a strong Northerly or Northwesterly wind is acting on the Bay and large amount of drainage water reaches the Lake. In this case, the water accumulates from the Lake and the Bay at El-Maadia outlet, raising the sea level. The salinity gradient between the Lake and the Bay in this case is very high. The **fourth** scenario occurs under the influence of the Westerly wind where the surface water is directed to the east and turned with the coastline to the northeast direction to escape from the northeastern edge of the Bay causing an accumulation in the eastern part of the Bay. The **fifth** scenario appears when the Easterly wind pushed the fresh water coming from Rosetta mouth to spread in the Bay especially if there is a Northerly component.

According to their importance and availability of credited data, Total Suspended Matter (TSM) and Phosphorus (PTOT) data were used since a main part of this limiting nutrient is discharged to the bay through the particulate form rendering it non-bioavailable. Data and measurements had been taken in front of the main sources of land runoff. From numerical simulation, PTOT and TSM had two privileged flowing directions during **Winter**. The first is parallel to the coast along the northeastern region of the Bay while the most important direction was flowing south to the western edge of the central part of the Bay, which seems to be more often affected. Total Phosphorus (PTOT) was significantly distributed in the eastern coast of the Bay near Rosetta Mouth due to the maximum discharge of phosphorus from the River Nile during winter (11,371 kg/d) as well as the accumulation of PTOT at the western part near TPS (915 kg/d) and Lake Edku (300 kg/d) approaching the offshore area (Figure 1). The PTOT load derived from Rosetta Mouth is directed westwards covering most of the eastern part of the Bay. The flow extends seaward exceeding the open sea boundary. In the coastal zone, particularly in the area adjacent to the main outlets, PTOT levels reached maximum values causing high phytoplankton bloom as indicated from the elevated Chlorophyll a content of the surface water.

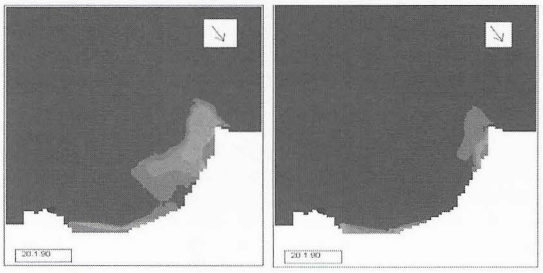

Fig. 1. PTOT and TSM in Abu-Qir bay during winter.

Generally, TPS and Lake Edku are considered the main sources affecting the distribution of PTOT and TSM among the Bay during **Spring** and **Autumn**, where the discharge of Rosetta Mouth is decreasing to its minimum levels. During spring, and under the effect of northeast winds, the targeted variables are piled at the area located between TPS and Lake Edku. High concentrations of TSM were recorded at the immediate vicinity of Lake Edku and TPS causing high turbidity in the water column, which is considered to contain high oxygen consuming material since most of the discharge from TPS is formed of cellulose derived from the paper industrial complex. Such oxygen demanding wastes will severely affect the marine biota in the Bay, creating unsuitable conditions for biological life, especially in front of these sources.

Under the influence of the north and northeasterly winds prevailing during **Summer**, PTOT and TSM derived with brackish water, were directed eastward. The area lying southwest of Abu-Qir Bay sustained high concentrations due to the maximum discharge from TPS during this season (Fig. 2).

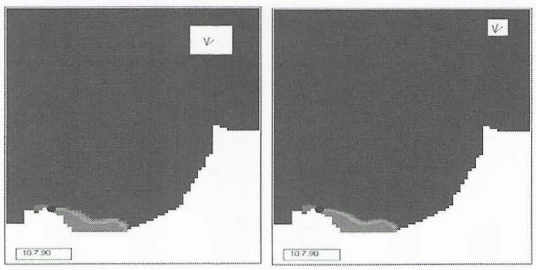

Fig. 2. PTOT and TSM in Abu Qir bay during summer.

Generally, PTOT normally peaked following the peak of sewage discharge. Although the increase of phosphorus is important for increasing plankton biomass and productivity, negative consequences ex: eutrophication sometimes take place in the bay.