Flux of Phophorus and Nitrogen in a sewage-impacted coastal sediments of a South-Eastern Mediterranean Basin

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Introduction

In shallow coastal marine environments, there are good evidences that the bottom sediments play an important role in nutrients supply to the photic zone. Some workers estimated that the flux of nutrients from sediments may make up between 30% and 100% of nutrient requirements of the phytoplankton in the photic zone (ROWE *et al.*, 1975; HARGRAVE and CONNOLLY, 1978).

In this paper, our goal is to conduct laboratory experiments to study the flux of phosphorus and nitrogen (nitrate and ammonia) from the sewage-impacted sediments of the Eastern Harbor (E.H) of Alexandria and to calculate their contribution to the nutrients cycles in the study area.

Material and Method

The study area is a semi-circular shallow bay (Eastern Harbor), surrounded by Alexandria city, connected to the Mediterranean through two openings. The basin is subjected annually to about $35x10^6$ m^3 of unprocessed sewage, rendering its flushing time to be 5 months. Representative bottom sediment samples were collected from 3 stations in the Harbor basin. The flux of nutrients in the harbor basin was measured using two methods:

1- Calculating the flux using concentration gradients between constituents of interstitial water and overlying water column.

2- Measurement of the nutrient flux by laboratory experiments under static conditions. Following the method of HARGRAVE and CONNOLY (1978), a small portion of sea floor was cut out with some overlying water (2 liters) from the same stations and incubated in glass basins without disturbance under controlled conditions in the laboratory. For each station, the sediment sample was placed in three identical basins, two with sea water and the other with distilled water. Samples were taken from these basins above the sediments without disturbance at time intervals of 5 days for one month and analyzed. The flux (F) of dissolved material into or out of undisturbed sediments can be calculated as ug at/m^2/day, using the following equation:

$$F = \frac{V\,(Co - C_t)}{A} \times \frac{10^4}{T}$$

Where V: is the volume of water over the sediments (liters); Co & C_t: are the dissolved nutrient concentration (per liters) before and after time (T); A: is the sediments area (cm^2) enclosed. The experiment requires that the water be homogeneously mixed, that changes in concentration are known or assumed to be linear over time and that dissolved material is only exchanged at sediment surface.

Results and discussion

Results indicated that maximum phosphorus released from sediments was attainted during the first five days (Figure 1). An overall average of about 206 kg PO_4-P/Km^2 was estimated. In other words, 520 kg PO_4-P were added annually to the overlying water body in the E.H via flux from sediments. This amount is about 52% of the total input of DIP in the harbor marine environment.

In the case of nitrogen, experiments indicated that the highest flux of ammonia occurred during the first five days, after that the rate of reflux decreased gradually (Figure 1). Several workers found that nitrogen flux from sediments is mainly in the form of ammonia, and the highest rate was measured during the first 17 hours of incubation (DUGDALE *et al.*, 1977). On the other hand, the rate of nitrate flux was much smaller and irregular (figure 1). The average amount of the flux of nitrate-nitrogen and ammonia from bottom sediments amounted to 1.78 and 3.77 kg/Km2, respectively. The annual averages estimated for the E.H. area were 4.50 and 9.49 Tons, respectively. In other words, both nitrate and ammonia fluxes represented about 60% and 186% of their annual input to the harbor water. respectively (ABOUL-KASSIM, 1987).

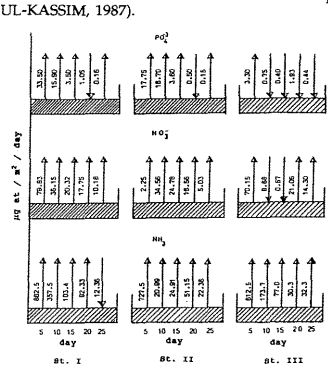

Figure 1: Flux of phosphate, nitrate and ammonia into or out the harbor sediments at stations I, II, and III (μg at/m^2/day)

The high contribution of both phosphorus and nitrogen concentrations to the overlying water column of the harbor environment via flux from sediments is a characteristic feature for the sewage-impacted coastal marine environment of Alexandria with a short flushing time (i.e. 5 months), even when compared with other heavily polluted areas in the Mediterranean region (ABOUL-KASSIM, 1987).

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