

THE SEA OF MARMARA AS A POLLUTING ROUTE

Colpan POLAT, Suleyman TUGRUL

Institute of Marine Sciences, Middle East Technical University, P.O.Box 28, 33731, Erdemli, Icel, Turkey

The Sea of Marmara, an enclosed basin which permits exchanges of distinct different waters from the Black and Aegean seas through the two narrow and shallow straits of Bosphorus and Dardanelles, acts as a receiving water environment not only for industrial and domestic waste discharges but also for chemical pollutants from the adjacent seas. Accordingly, excess amount of organic matter and nutrients entering the Marmara surface waters both from the Black Sea through Bosphorus surface flow and from land-based sources, which have drastically modified the marine ecosystem, reach as far as the Mediterranean Sea through the Dardanelles Strait.

The annual rates of chemical exchanges between the Marmara Sea and the two adjacent seas including the entrainment fluxes are illustrated in Fig. 1, together with recent estimates of water fluxes and annual means of chemical properties of the exchanging waters. Systematic data of inorganic and particulate nutrients and organic carbon were obtained during the national oceanographic studies in the Marmara Sea whereas the dissolved organic nitrogen and dissolved ammonia data were derived from the literature as discussed recently in POLAT and TUGRUL (1994). It appears that the entrainment free loads of total phosphorus (TP), total nitrogen (TN) and total organic carbon (TOC) entering the Aegean Sea from the Marmara Sea through the Dardanelles are about 1.0×10^4 , 1.3×10^5 and 1.8×10^6 tonnes per year respectively. Such loads are very similar to the inputs from the Black Sea into the Marmara surface layer, but at least 3-4 times larger than the exports from the Aegean Sea through the Dardanelles. As also clearly seen from the mean concentration data displayed in the figure, the saline waters of Mediterranean origin in the lower layer of the Marmara basin, which are poor in nutrients before entering the basin, are enriched with such chemicals by nearly ten-fold relative to its initial value at the Dardanelles Strait due to the input from the productive surface layer of the Marmara Sea. The decay of organic matter sinking from the surface waters have resulted in an oxygen deficiency in the lower layer of the Marmara Sea though the Aegean inflow into the basin is saturated with dissolved oxygen.

When the Marmara inputs to the Aegean Sea through the Dardanelles (see Fig.1) are compared with the riverine, atmospheric and Atlantic loads (COSTE *et al.*, 1988, BETHOUX *et al.*, 1992, MONTÉGUT, 1993), it can be suggested that they contribute to the nutrient pools of the Mediterranean Sea at the comparative levels with the anthropogenic inputs, but being about an order of magnitude less than the Atlantic input as expected.

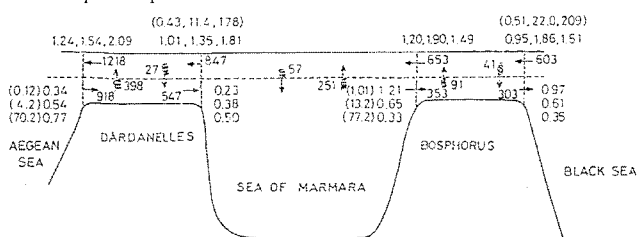


Fig. 1. The annual fluxes of water (values given with the arrows, km^3y^{-1} , BESIKTEPE, 1991), TP, TN and TOC through the Marmara Sea and the straits. The numbers are in the order of phosphorus ($\times 10^4$ tons P), nitrogen ($\times 10^5$ tons N) and organic carbon ($\times 10^6$ tons C). The values in parantheses are the annual average concentrations (μM) of TP, TN and TOC.

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