THE EFFECTS OF A WASTEWATER TREATMENT PLANT ON NUTRIENT AND CHLOROPHYLL A VARIATIONS IN IZMIR BAY (EASTERN AEGEAN SEA)

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Abstract
The aim of this study was to determine the effects of the Izmir Big Channel Waste Water treatment plant oninorganic nutrients, physico-chemical parameters, (such as pH, dissolved oxygen, water temperature, salinity) and chlorophyll a levels of Izmir Bay. The variation of inorganic nutrients and chlorophyll a were investigated weekly during one year (2003-2004) in Izmir Bay.
Keywords: Aegean Sea, Nutrients, Chlorophyll-a, Coastal Waters, Pollution

Introduction
The Bay of Izmir is located in the Western part of Turkey and surrounded by a densely populated community (Fig. 1). The Bay is divided into inner, middle and outer bays from the standpoint of topographical and hydrographical characteristics. The inner bay is considerably small in area (57 km2) and shallow in depth (max. 15 m). It received the majority of domestic and industrial wastewaters before the construction of wastewater treatment plants. This part of the bay still receives some inflow of freshwater from several creeks which are mostly polluted by industrial wastewaters. Because of limited water exchange with the outer bay and the Aegean Sea, pollution of the inner bay reached unacceptable levels. For this reason, the Izmir Municipality decided to construct the Izmir Big Channel Wastewater Project in 1969. Unfortunately, the construction of the plant could not be completed until the end of 2002. At the end of the plant construction in 2002, the pollutant levels of the inner bay water decreased gradually and the recovery period began. The aim of this study is to determine the effects of Izmir Big Channel Waste Water treatment Plant to the inorganic nutrients and chlorophyll a levels of Izmir Bay.

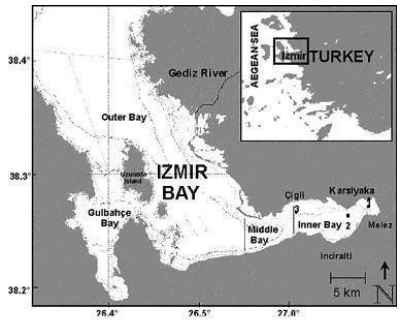

Fig. 1. Locations of the stations

Materials AND Methods
In this study, three stations were chosen for sampling, two in the inner and one in the middle part of the Izmir Bay (Figure 1). Physico-chemical parameters, nutrients, and some biological parameters were measured weekly during a one-year period. The samples, collected from three different stations and water depths, and nutrients were analyzed by standard methods ([1], [2], [3]). Chlorophyll a analyses, were carried using a UVD spectrophotometer (Bosch-Lomb Spectronic 21) following the method by [1]. Seawater temperature was recorded by an electronic thermometer with a sensitivity of ±0.1 °C. The pH of the samples was also measured on-site using a pH-meter (Hanna Ins.). The dissolved oxygen (DO) was measured with a DO-meter (YSI, Model 55). The salinity of seawater was determined by the Harvey method.

Results and Discussion
The minimum, maximum and average values of the physico-chemical parameters belonging to the water samples from Izmir Bay are given in Table 1.The fact that the processes affecting Reactive Phosphate (RP) and TIN occur at different times indicates important differentiations in the temporal distribution of these two nutrients in the Inner Bay. From the distribution of the nutrients and their percentages, important evidence regarding the process have been gathered: a) Inflow with the creeks is especially evident during rainfall and there is a big increase in Si, Nitrogen forms; and b) the winds, although increasing fresh water inflow and water columns, frequently carry the ground water to the surface. This shows that the Inner Bay is often subject to a ground-water-based nutrient enrichment. c) The phytoplankton blooms caused by the inflow of nutrients to the Inner Bay in turn result in the uptake of nutrients by the phytoplankton (especially diatoms) which are then exported to the bottom waters and constitute the source for future phytoplankton blooms.

Tab. 1. Ranges and mean (± s.e.) values of physico-chemical parameters

	Station 1		Station 2		Station 3	
	Range	Mean±SE	Range	Mean±SE	Range	Mean±SE
Temperature	9.0-28.2	18.68±0.5	8.9-27.4	18.56±0.42	9.6-28.0	18.90±0.37
Salinity	31.93-43.85	39.84±0.13	33.97-43.85	39.98±0.11	33.97-44.85	39.9±0.1
pH	7.4-8.6	8.03±0.01	7.5-8.7	8.08±0.01	7.5-8.6	8.09±0.01
DO	3.86-14.40	7.44±0.14	4.57-13.60	7.72±0.12	4.16-12.9	7.72±0.09
NH_4-N	0.21-36.97	7.83±0.56	0.00-32.19	4.89±0.30	0.09-40.94	3.84±0.29
NO_3-N	0.00-19.31	4.55±0.38	0.00-21.35	3.50±0.26	0.00-17.63	2.10±0.16
NO_2-N	0.00-28.99	3.54±0.38	0.00-16.99	2.54±0.24	0.00-9.69	1.06±0.10
PO_4-P	0.60-16.05	3.67±0.16	0.54-19.56	3.51±0.18	0.00-31.43	2.77±0.21
Si	0.31-43.89	12.62±0.77	0.47-54.12	11.47±0.64	0.16-41.80	8.81±0.54
N/P	0.57-15.69	5.43±0.29	0.23-20.52	4.46±0.26	0.00-53.65	4.36±0.40
Si/P	0.22-28.03	4.31±0.35	0.27-56.38	4.56±0.40	0.00-83.38	5.60±0.61
Chl a	0.00-66.13	5.72±0.59	0.00-23.55	4.65±0.28	0.00-12.82	2.78±0.17

Thus, the horizontal export of the nutrients out of the Inner Bay remains limited. It is only due to the winds that the wastewaters flow outwards from time to time. Silicate, coming with the rainfall from the shore in non-point sources (i.e. creek, river) and point sources, is of great importance for the Inner Bay. Silicate is essential for the diatoms to compete effectively with dinoflagellates and it plays an important role in the increase in species diversity in the bay. We believe that unless the nutrient levels in the rivers are decreased, the Bay will continue its current state for a long time. Although a decrease in nitrogen has been observed after the start of the wastewater treatment plant, former studies showed that phosphate concentrations have not changed and that the plant has been ineffective regarding this subject.([4], [5],[6],[7]). The effective removal of phosphate will be an important precaution against the new strategy that the phytoplankton might take up against the decreasing TIN. A study of the N/P relations shows that for the biggest part of the year the ratio is below 16 and that nitrogen is the limiting nutrient. As a result, with the start of the wastewater treatment plant a decrease in the nitrogen and chlorophyll-a levels has been found, however there is no such evidence regarding the phosphate levels.

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