Estimation of Pollutant and Nutrient Loads from Domestic Wastewater Discharges of Turkish Coastal Cities to Aegean and Mediterranean Seas and Future Scenarios

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ABSTRACT

The study presents an estimation of pollutant (biological oxygen demand (BOD) and suspended solids (SS)) and nutrient (nitrogen and phosphorus) loads from the domestic wastewaters discharged directly to the Aegean Sea and the Mediterranean Sea from the coastal provinces in Turkey. Current national statistical database (TUIK) including population, degree of the treatment, wastewater flowrate per capita was used for the estimation and pollutant loads per capita were assumed based on the degree of the treatment. The results showed that about 2.2 million cubic meter of municipal wastewater is discharged directly to the seas, causing annual loads of 8.5 kton BOD, 13.4 kton SS, 9.8 ktons N and 1.8 ktons P. Finally, modification of the plants to advanced levels with nutrient removal were assessed in terms of their positive effect.

Keywords: Aegean Sea; Mediterranean Sea; Municipal Wastewater; Nutrient; Wastewater Treatment.

INTRODUCTION

Approximately 21 million people live in the Aegean and Mediterranean regions of Turkey. These regions are extremely important for Türkiye not only in terms of industry and agriculture, but also due to their high tourism potential. According to 2023 data, approximately 30 million local and foreign tourists visited the Mediterranean Region, while the number of tourists visited the Aegean Region was approximately 15 million (YİGM, 2023). Due to both the people living in densely populated coastal provinces such as Izmir and Antalya and the high tourist population during the tourism season, large amounts of domestic wastewater are discharged into the Aegean and Mediterranean Seas. Although most of the discharged wastewaters are treated, the pollutant and nutrient loads resulting from high wastewater flowrates cause some pollution problems in the seas. Especially in the Aegean Sea, where there are many closed bays and gulfs, turbidity, eutrophication, algal blooms etc.caused by the wastewater discharges are observed frequently. In this study, pollutant and nutrient loads from domestic wastewater discharged directly from coastal provinces of Aegean and Mediterranean regions were estimated. For this purpose, current TÜİK data on population, wastewater, treatment level and discharge in these provinces were used. Afterwards, personal pollution loads specific to Turkey (biological oxygen demand, suspended solids, nitrogen and phosphorus) were determined on the basis of treatment levels and the pollutant loads discharged into the seas from each coastal province were calculated. Finally, scenarios for future revision of treatment facilities and increasing treatment levels were evaluated and the possible effects of these improvements on the seas were examined.

METHODOLOGY

In the study, first of all, the current populations of the provinces and districts on the Aegean and Mediterranean coasts were taken from the TÜİK database (TÜİK-CİP, 2021). Per capita wastewater production rates and sewage service population rates for the provinces were also obtained from TÜİK Geographic Statistics Portal and municipal wastewater statistics. Pollutant loads per capita were taken as 35, 55, 11 and 1.5 g/person/day for BOD, AKM, total nitrogen (N) and total phosphorus (P), respectively, taking into account the values given for Turkey in the Wastewater Treatment Facilities Design Guide (AAT, 2013). The removal efficiencies of these parameters in treatment plants are accepted as shown in Table 1, according to the treatment levels in domestic wastewater treatment plants (Metcalf and Eddy, 2002). The treatment levels and discharge points of domestic wastewater treatment facilities in the provinces and districts on the Aegean and Mediterranean coasts were taken from the 2021 Provincial Environmental Status Reports prepared by the Provincial Environmental Directorates for these provinces and the treatment facility statistics of the relevant municipalities (ÇŞB, 2021).

Table 1. Pollutant/Nutrient Loads per Capita and Removal Rates Based on Treatment Levels

Loads per Capita (g/cap/day)		Removal Rates Based on Treatment Level (%)		
		Physical	Biological	Nutrient Removal
BOD	35	20	90	95
SS	55	50	90	95
N	11	0	15	80
P	1.5	0	10	80

RESULTS AND DISCUSSION

According to population data, the population living on the Aegean and Mediterranean coasts, whose domestic wastewater is treated by classical biological treatment or by advanced treatment systems with nutrient removal and then discharged directly into the sea, is around 9.3 million, 58% of which is in the Aegean region and 42% in the Mediterranean region. The amount of domestic wastewater discharged into the seas in this way is approximately 2.2 million m^3/day, 54% of which is directly discharged to the Mediterranean Sea (1.17 million m^3/day) and 46% to the Aegean Sea (1 million m^3/day). The amounts of pollutant and nutrient loads discharged into the seas by domestic wastewater discharge are given in Figure 1.

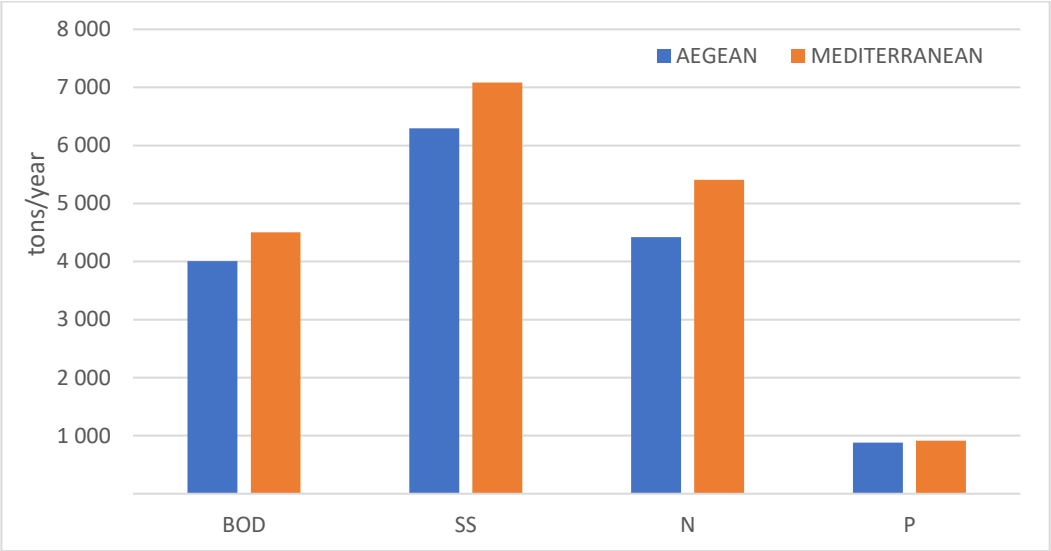


Figure 1. The Amounts of Pollutant and Nutrient Loads Discharged into the Seas by Domestic Wastewater Discharge

The percentages of treatment levels fort he municipal wastewater discharges are shown in Figure 2.

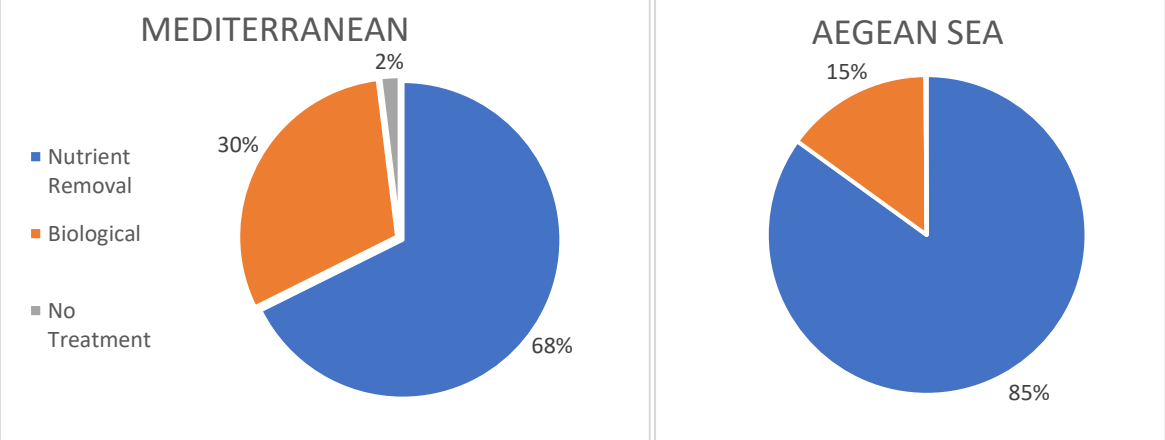


Figure 2. Treatment Level Percentages

Figure 2 shows that the majority of domestic wastewater discharged into the sea is treated in advanced biological treatment facilities with nutrient removal systems. The percentage of advanced treatment is lower in the Mediterranean Region. Additionally 2% is discharged into the Mediterranean without any treatment. This part originates from Hatay-Arsuz district and the construction of a treatment facility is at the planning stage. The major earthquake in the region in 2021 delayed this project.

Within the scope of the study, the scenario including the case that all treatment facilities are modified to advanced treatment systems was also examined to estimate especially the reduction in nitrogen and phosphorus inputs. In such a scenario, nitrogen and phosphorus loads are expected to decrease by 62% and 43% respectively. In this regard, it has been stated that modifying existing classical biological treatment systems to advanced treatments by economically cost-effective methods will cause a significant reduction in the nutrient loads.

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