MUNICIPAL SOLID WASTE DISPOSAL IN KOCAELI, TURKEY
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Abstract
Uncontrolled solid wastes may cause serious environmental problems. The amount of solid wastes especially for industrialized cities due to high population density and economical development are continuously increasing. Kocaeli, one of the most industrialized cities of Turkey, located in the northwest quarter of Turkey, right next to Istanbul. In this paper, municipal solid waste disposal activities in Kocaeli are presented.

Key Words: Kocaeli, Municipal solid waste, sanitary landfilling, waste management.

INTRODUCTION
The metropolitan city of Kocaeli with a population of 1.4 million and population density of 400 km2 has undergone a dense industrialization followed by a rapid increase in population and an irregular urbanization since the 1960s. It is one of the most important commercial and industrial centers of Turkey. The city provides 70 % contribution to the gross domestic product in Turkey and has more than 7,000 private enterprises including more than 1000 industrial plants with a huge refinery, a petrochemical complex, a hazardous waste incinerator, and many industrial sectors: textile, machine, mine, metal, food, automotive, paper, chemistry, paint, wood, petroleum, tanning, coal, etc. It is located at the Gulf of Izmit (on the east of Marmara Sea) and lies between the 29°22'-30°21' eastern longitude and 40o31'-41o13' northern latitude. The city carries a geopolitical importance as it is located in junction point of roads connecting Asia and Europe.

The climate around the Kocaeli and the surrounding area is a transition between Mediterranean and Black Sea climates. The dominant type of precipitation is rain; however, snow can be observed in winter. The average annual precipitation in Kocaeli is over 835 mm. The average temperature is 15 oC. The whole city is divided into 12 urban sub-municipalities; Basiskele, Cayirova, Derince, Darica, Gebze, Dilovasi, Golcuk, Izmit Kandira, Karamursel, Kartepe and Korfez. All of the districts have different socioeconomic conditions and population densities. This study presents municipal solid waste disposal activities for the period 2006-2010 in Kocaeli.

MUNICIPAL SOLID WASTE ACTIVITIES IN KOCAELI
Kocaeli has two landfill sites namely Solaklar and Dilovasi landfills (Figure 1). Landfills are owned by the Metropolitan Municipality of Kocaeli and are operated by IZAYDAS (the Izmit Waste and Residue Treatment, Incineration and Recycling, Inc.), a municipal-owned enterprise.
Figure 1. The Metropolitan City of Kocaeli (A: Solaklar Landfill; B: Dilovasi Landfill; 1: Gebze Waste Transfer Station; 2: Korfez Waste Transfer Station; 3: Karamursel Waste Transfer Station; 4: Kandira Waste Transfer Station).

The Solaklar landfill is located 15 km northeast of the center of Izmit at average 120 m above mean sea level (Figure 2). It has been in use since 1997 and covers an area of 363,007 m² with a total capacity of 3,163,000 m³. It is divided into seven cells: six cells for domestic solid waste (264,842 m²) and one cell for industrial solid waste (98,165 m²). Domestic solid waste sections accept primarily residential (household) garbages from the sub-municipalities of Basiskele, Derince, Golcuk, Izmit, Kandira, Karamursel, Kartepe and Korfez. The industrial solid waste section is primarily designed to deposit ashes from waste incineration and the sludge from wastewater treatment plants. Currently, four of the six cells for domestic solid waste was filled (corresponds to almost 75% of the landfill) and covered with natural soil without any precautions for percolation of rainwater. The landfill is equipped with a gas collection system, and landfill gas is released directly to the atmosphere from passive vent pipes. A bottom liner and leachate collection system are installed in each cells to provide a means of intercepting and collecting leachate. Leachate is pre-treated in site and transported to the Kocaeli municipal wastewater treatment plant for a treatment and final disposal. More information about the leachate pre-treatment plant in the Solaklar landfill is provided elsewhere (Durmusoglu ad Yilmaz, 2006).

The Dilovasi landfill is located 5 km north of the center of Dilovasi. The landfill accepts garbages from the sub-municipalities of Dilovasi, Gebze, Cayirova, and Darica. It has been in use since 2007. In present situation, a one cell is constructed and currently under operation. Four more cells are planned to be constructed in the near future. The cell covers an area of 32,000 m² with a total capacity of 500,000 m³. Currently, almost 90% of the cell was filled. The cell is equipped with a gas collection system, and landfill gas is released directly to the atmosphere from passive vent pipes. A bottom liner and leachate collection system are installed. Since the Dilovasi landfill does not have a leachate treatment plant, the leachate is collected in a pond and transferred to the leachate pre-treatment plant in the Solaklar landfill.
Since, two landfills are designed to serve an entire Metropolitan Municipality of Kocaeli, they are sited at a considerable distance from the collection service areas. In the last two years, four waste transfer stations (WTS) located in different sub-municipalities are constructed. Transfer stations are centralized facilities where waste is unloaded from smaller collection vehicles and re-loaded into larger vehicles for transport to a disposal or processing site. Since transporting waste from the route to the landfills takes longer and uses more fuel, transfer stations are attractive choices. The four transfer stations are Gebze WTS, Korfez WTS, Karamursel WTS, and Kandira WTS with the capacities of 500, 70, 7, and 60 tons/day, respectively. The wastes collected in the Korfez WTS and Kandira WTS are transferred daily to the Solaklar Landfill, the wastes in the Karamursel WTS are transferred every other day to the same landfill. The distances between the Solaklar Landfill and the Korfez WTS and Kandira WTS are transferred daily to the Solaklar Landfill, the wastes in the Karamursel WTS are transferred every other day to the same landfill. The distances between the Solaklar Landfill and the Korfez WTS, Karamursel WTS, and Kandira WTS are 35, 70, and 50 km, respectively. Wastes collected in the Gebze WTS are transferred to the Dilovasi Landfill multiple times in a day. The distance between the Gebze TWS and the Dilovasi Landfill is 17 km. Prior to 1997, solid wastes in Kocaeli were collected by sub-municipalities and open dumped in several places without any precautions.

RESULTS AND DISCUSSION
In both landfills, solid wastes are directly deposited without any sorting or processing. During deposition, they are compressed and a daily soil cover is applied in order to prevent odor, spillage, and proliferation of harmful livings. Figure 3 shows the MSW deposited in both landfills between 2004 and 2009.
Data used in this study was obtained from Statistical Department of Turkey and Environmental Protection Department of Kocaeli Metropolitan Municipality (SIS, 2008). From these data it is seen that annual waste generation was increased from 451873 ton to 498286 ton in period 2006-2009. For this period population growth rate and waste generation rate were determined as 5.9% to 10.3%, respectively. Difference in these ratios can be described with growing consumption habits as a result of financial development. Increase in MSW generation in terms of annual amounts for capita is shown in Figure 4.

Figure 3. Lanfilled Municipal Solid Waste Amounts in Sanitary Landfills in Kocaeli

Figure 4. Annual MSW generation (kg/year per capita) in Kocaeli for period 2006-2009.
CONCLUSIONS

In Kocaeli, the amount of municipal solid waste has been continuously increasing due to rapid population growth and economical development. Hence, the proper disposal of wastes becomes an important issue. In this manuscript, municipal solid waste disposal activities in Kocaeli were presented. The data presented should be used as a reference material for comparative studies conducted especially for heavily industrialized cities.

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References
