

Chemical composition of landfill leachate in a karst area with a Mediterranean climate (Marbella, southern Spain)

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Abstract Between March 1994 and April 1997, the physical and chemical parameters and chemical composition of the urban solid waste leachate of the Marbella landfill (southern Spain) were determined. The data obtained show an ammonium and sodium chloride and bicarbonate type, a $\text{pH} > 7$ and high mineralization, effectively described by the following parameters: Na^+ , K^+ , NH_4^+ , Cl^- and alkalinity. The chemical composition depends on the rainfall: in dry years, the mineralization and component concentrations have values as much as double those found in normal rainfall years. After storm events, a major and rapid dilution (within several hours) is seen in the leachate.

Key words Mediterranean climate · Landfill leachate · Chemical composition

Introduction

As in other places in the world, landfilling is one of the most common waste disposal methods in the southern Spanish towns. The rainwater which percolates through the landfill and dissolves the inorganic and organic substances of the solid waste produces leachates, which can move towards the groundwater and environment (Freeze and Cherry 1979; Baedeker and Back 1979). The amount, quality and movement of such leachates has been studied by many researchers to observe the potential pollution from landfills (Nicholson and others 1983; Radi and others 1987; Arneith and others 1989; Christensen and others 1994, among others).

The Marbella landfill is located 2 km north of Marbella (Fig. 1). It started operating at the beginning of the 1970s and it is still in use today. The population of Marbella is around 80 000 but in summer rises to 200 000. Considering these data and a waste production of 1 kg/person per day, the total amount of urban solid waste generated is at least 80 tons/day. The Marbella landfill contains typical urban solid waste, composed of organic matter, paper, glass, wood and building waste. Waste disposal involves spreading, compacting and covering the waste with sand and clay.

Geologically, the landfill is situated in the southern part of the Sierra Blanca, on the marbles which form part of the aquifer system of Marbella (Andreo 1997). Depth to the water table is approx. 130 m. There is no liner between the landfill and the marbles, so a part of the leachate migrates downwards and groundwater degradation occurs. This occurrence has been described previously (Carrasco and Andreo 1994; Ortíz 1994).

The study area has a Mediterranean climate, and is of particular interest because the investigation was carried out during a transition between a period of extreme drought (1994 and 1995) and a very wet period (1996 and 1997). For this reason a discussion of the rainfall data is presented, followed by the characterization of the chemical composition of the leachate, and the study of different parameters and their temporal evolution.

Analysis of the rainfall data

Marbella has had a meteorological station since 1945. The annual precipitation varies between 253 mm and 1426 mm, and averages 672 mm. Thus, although the monthly average precipitation is 56 mm/month, Fig. 2a shows that rainfall distribution over time is very irregular, as is typical for the region (Andreo 1997). There are wet years (precipitation 15% above the average rainfall) in which total amount of rainfall is double that of an average year (1955/1956, 1988/1989, 1989/1990, and 1995/1996). In several dry years (precipitation is below 85% of the average rainfall) precipitation is half the average (1949/1950, 1982/1983 and 1994/1995).

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