Characterizing the pollution produced by an industrial area
Chemometric methods applied to the Lagoon of Venice

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Abstract

The industrial area of Porto Marghera discharges every year about $1.85 \ 10^9 \ m^3$ of waste waters in the Lagoon of Venice through its 142 discharge points, 17 of them being constantly active. The Anti-Pollution Department of Magistrato alle Acque, the Venice Water Authority, has been controlling these discharges for many years. The huge database built up during the last years could help the authorities in making choices regarding the water quality of the Venetian environment. The application of chemometric methods to the dataset obtained from chemical analyses of industrial waste water samples (almost 250, for each of them up to 57 chemical variables having been measured) is useful to answer fundamental questions related to the pollution generated by the industrial area: *i) which are the main differences among the individual discharge points? ii) is there a temporal trend in global and punctual pollution? iii) which is the discharge point having the strongest relative impact on the waters?* The results of the present work allow to 1) identify two different groups of discharge points, discriminated by the level of contamination and by the presence of different contaminants; 2) detect a relevant temporal trend in one of the main outfalls (the industrial and civil waste treatment plant); 3) set up a multivariate strategy to "measure" the relative modification induced on receiving lagoon waters by a single discharge. The application of such a "3-STEP multivariate analysis" to the present and future data of water quality could represent a relevant tool for monitoring industrial activities, providing at the same time a support in management decision processes.
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1. Introduction

1.1. The industrial area of Porto Marghera

The Lagoon of Venice is one of the most important wetlands of Europe and of the Mediterranean region. Porto Marghera, located at the border of the Lagoon, is one of the main industrial areas in Italy. During the 1970s, when about 35 000 people used to work there, it was actually one of the biggest industrial areas in Europe. Nowadays many areas are experiencing a shift from typically industrial activities (chemical and side-rurgical industry) to mainly commercial ones. Nonetheless, still about 300 firms and 12 000 people are operating in the district. The most important industrial activities are petrochemical (production of PVC, textile fibres), refinery, iron metallurgy (production of steel and

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aluminium), shipbuilding and oil-seeds working. Besides these activities, an industrial and civil waste waters treatment plant, an area for collection and treatment of urban solids wastes, an area for collection and treatment of sediments dredged from the lagoon and four power plants are present. The impact of these activities on a delicate environment such as the Lagoon of Venice may be found in air, soil and waters. The Magistrato alle Acque di Venezia (MAV), the Venice Water Authority, has been controlling the quality of water discharges in the lagoon since the second half of the 1980s. The census of all 142 discharges was carried out also with the aid of a laser pointer and a satellite controlled system so that it was possible to produce the map shown in Fig. 1. Most of the discharges are meteoric (95 out of 142); the remaining ones are characterized by waters used in cooling circuits or by waste waters generated in the production processes; most often (41 cases) the discharges

are constituted by a mix of the last two types. The total amount of water discharged from all activities in a year is about 1.85 10^9 m^3. Table 1 summarizes the pollutant loads released from industries during the year 2002, as estimated by MAV (2004) by means of the data collected during the ordinary control campaigns started in the early 1990s and still operational.

Seventeen outfalls are constantly active. Most of them are constituted of cooling waters that are taken from the lagoon itself or from the rivers entering the lagoon in the vicinity of the industrial area. The water quality at the inlet point is regularly controlled by MAV in order to be able to estimate the difference between waters before and after their utilization in industrial plants. In the present study we focused on 11 industrial outfalls (mix of cooling and process waters), together with their corresponding points of water inlet, and on 3 discharges from civil and industrial treatment plants.
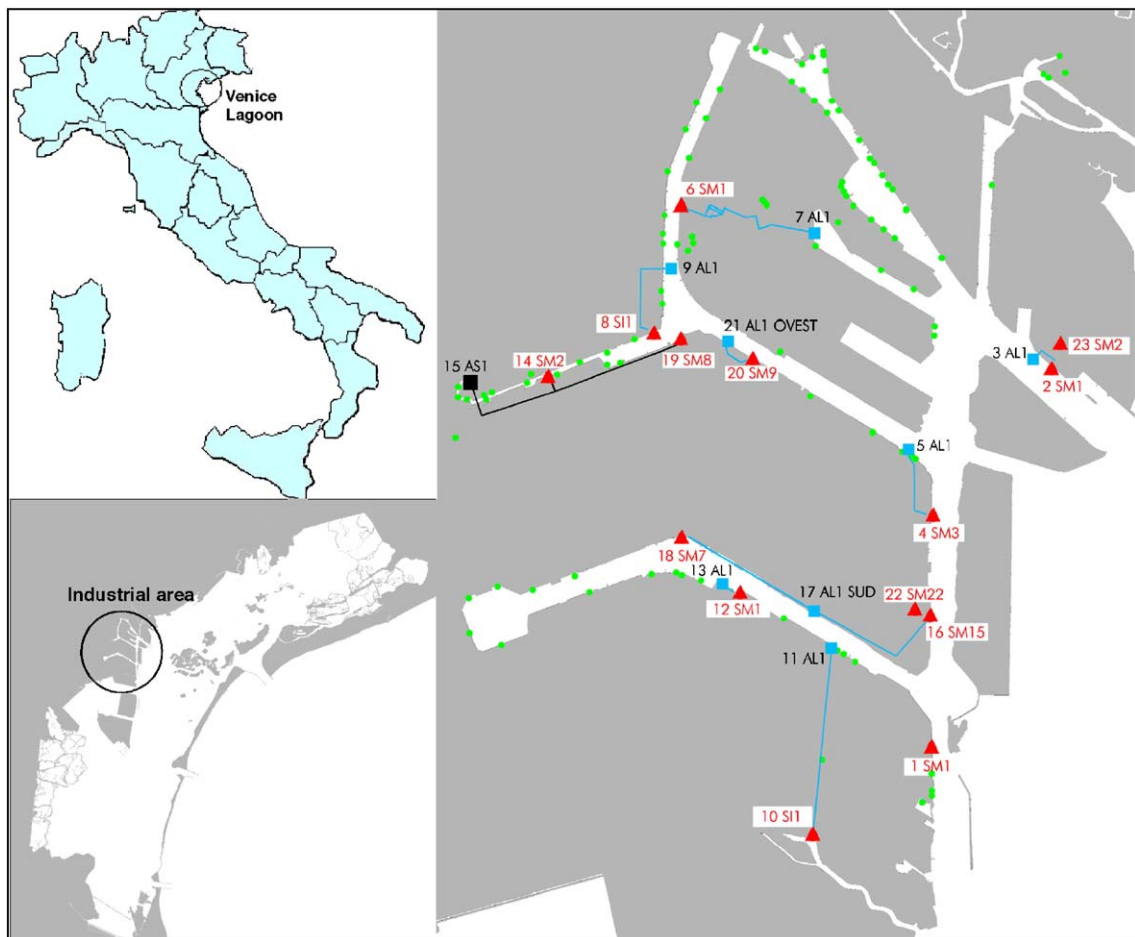

Fig. 1. The Lagoon of Venice with the location of the industrial area. The image on the right shows the discharge points considered in this study (triangles) and the corresponding industrial inlet water sampling points (squares) with their respective codes. The circles represent the periodically active discharges.