

Multidimensional analysis of PM₁₀ air concentration levels in Italy

Analisi Multidimensionale dei Livelli di Concentrazione in Aria del Particolato PM₁₀ in Italia

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Riassunto: In questo lavoro vengono analizzati i dati di concentrazione di particolato atmosferico PM₁₀ in Italia, relativi all'anno 2005, dichiarati dalle regioni nei questionari di qualità dell'aria compilati ai sensi del D.M. 60/02. Dopo uno studio preliminare volto a esaminare la variabilità spaziale e temporale dei superamenti del limite giornaliero per il PM₁₀, si propone una sintesi multivariata attraverso l'analisi delle componenti principali, per individuare micro e macro aree a rischio omogeneo.

Keywords: particulate matter, spatial and temporal variability, multidimensional analysis.

1. Introduction

Particulate matter consists in a class of liquid and solid particles with various chemical nature and physical properties. These particles exist in the atmosphere in a large range of sizes (aerodynamic diameter stretches from 0.01 µm to more than 100 µm) and are originated by a big number of anthropogenic and natural sources.

In recent years, several scientific studies have demonstrated the harmful effects of these particles on human health, vegetation and manufactured materials.

Specifically, only a restricted fraction of particulate matter can penetrate to the human thoracic region. So, to protect people from inhaling these dangerous substances, the PM₁₀ size-specific standard has been internationally adopted (PM₁₀ indicator includes particles of aerodynamic diameter less than 10 µm).

Regarding airborne particulate matter pollution, the Italian environmental legislation is based on the European Directive 99/30/EC, implemented in Italy in 2002 by Ministerial

Decree N° 60/02 which has defined PM₁₀ daily and annual limit values: respectively, 50 µg/m³ (not to be exceeded more than 35 times a year) and 40 µg/m³.

2. Data description and methodology

Daily and annual PM₁₀ concentrations, recorded during 2005 in 144 monitoring stations and collected through the air quality questionnaires compiled by Italian regions, were structured into a matrix.

Each station was classified by area type (urban, suburban, rural), depending on the edification of the area, and site type (traffic, industrial, background), referred to dominant emission sources.

The analysis of temporal variation in PM₁₀ exceedances showed an evident seasonal characterization due, principally, to different meteo-climatic conditions during the year; at the same time, the spatial variability was correlated to macro-areas territorial features. Factorial methods were applied in several studies to explore variability in multivariate data; in this work a principal components analysis (PCA) was used to analyse multidimensional connections among concentration levels and monitoring stations, synthesizing information, highlighting associations and contrasts, so to pick up, for each site, specific patterns and analogies. The first and the second axis described 78% of the variance; the first axis represented the pollution levels, the second one, the data-coverage.

Cluster analysis (an agglomerative technique was used) identified homogeneous sets of stations and areas with the higher risk to exceed limit values.

3. Conclusions

The PCA allowed to define the main relations among stations synthesizing available information about PM₁₀ exceedances. Cluster analysis suggested to collocate statistical units (stations, provinces, regions) on the basis of information collected in air quality questionnaires, identifying micro and macro areas characterized by homogeneous risk.

References

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