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Air quality monitoring network optimization: a regional case study

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Statistical analysis of data collected in air quality monitoring networks may give interesting information for an optimal management of the resources. Particularly the integrated use of different methodologies may increase our capability for characterizing and interpreting the correlation structure among the measured variables in the different sampling sites. At the first all, it is useful to evaluate the informative content of each site and of each measured variable, pointing out the redundant elements. In a following step, the analysis of the underlying correlation structure of the network allows to identify the relationships among the different descriptors evaluating the role of redundant and no-redundant elements respectively. In this way the subset of sites with the lowest informative content (redundant elements of the network) may be individuated and eliminated, reducing the costs. The same procedure may be used also to point out the subset of redundant variables in order to reduce the amount of data collected, simplifying the data analysis.]. The statistical procedure is based on the application of informational indices, derived by Shannon entropy and multivariate techniques [11, 12]. These last techniques allow to analyze a large amount of variables pointing out the underlying relationships among them and to individuate an interpretative scheme. The combined application of different methods allows us to reduce the original data set without losing important information (ordination or dimension reduction methods), to point out samples or descriptor homogeneous subsets (variance analysis, discriminant analysis, clustering) and to characterise the data structure (canonical correlation analysis, non parametric multiscaling). Particularly we focus the integrated use of classification techniques (cluster analysis CA) and

ordination techniques based on the evaluation of the principal component (PCA). The results coming from these multivariate methods may be easily combined with informational indices based on Shannon entropy. These indices (information loss index, effectiveness index and total effectiveness index) calculated starting from the covariance matrix, are able to evaluate the informative content of a subset of elements in comparison to the information quantity of the entire data set, in order to exclude the monitoring stations or the measured pollutants with the lowest informative contents. Here we present the study conducted on hourly data collected in the air quality monitoring network of Basilicata region (southern Italy) from June to December 2006. The network includes 10 measurement stations located in specific areas in which the impact of anthropogenic activities is more relevant: four station in Potenza urban area, one station in Matera urban area, three stations in Melfi industrial area, one station in the industrial areas of Agri valley e Basento valley respectively. The measured pollutants are SO_2, CO, NO_2, O_3, PM_{10}, CH_4 and C_6H_6. The quality of data is biased by the heterogeneous distribution of measured pollutant and by the presence of a large amount of data missing. Particularly, maximizing the number of the station (n) and/or the number of measured variables (m), an automatic procedure allowed us to determine four matrices [n x m x k] including k hourly data: M_1 [8x3x76]; M_2 [7x4x163]; M_3 [5x2x106]; M_4 [4x6x92]. The results point out that there are any redundant sites or pollutants. On the contrary, for each monitoring area, it is possible to reduce the measured pollutants and to re-localize some devices. In this way it is possible to revise and to update a local network improving its performance.

1 References

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