Exploratory Analysis of Spatial-Temporal Patterns of Air Pollution in the City

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Air pollution in the city is an important problem influencing environment, well-being of society, economy, management of urban zones, etc. The problem is extremely difficult due to a very complex distribution of the pollution sources, morphology of the city and dispersion processes leading to multivariate nature of the phenomena and high local spatial-temporal variability. The task of understanding, modelling and prediction of spatial-temporal patterns of air pollution in urban zones is an interesting and challenging topic having many research axes from science-based modelling to geostatistics and data mining.

The present research mainly deals with a comprehensive exploratory analysis of spatial-temporal air pollution data using statistical, geostatistical and machine learning tools.
This analysis helps to 1) understand and model spatial-temporal correlations using variography, 2) explore the temporal evolution of spatial correlation matrix; 3) analyse and visualize an interconnection between measurement stations using network science tools; 4) quantify the availability and predictability of structured patterns.

The real data case study deals with spatial-temporal air pollution data of canton Geneva (2002-2011). Carbon dioxide (NO_2) have caught our attention. It has effects on health: nitrogen dioxide can irritate the lungs, effects on plants; NO_2 contributes to the phenomenon of acid rain. The negative effects of nitrogen dioxides on plants are reducing the growth, production and pesticide resistance. And finally the effects on materials: nitrogen dioxides increase the corrosion.

Well-defined patterns of spatial-temporal correlations were detected. The analysis and visualization of spatial correlation matrix for 91 stations were carried out using the network science tools and high levels of clustering were revealed.

Moving Window Correlation Matrix and Spatio-temporal variography methods were applied to define and explore the dynamic of our data. More than just exploratory of data analysis, this study brings to front the high complexity of air pollution in the city.
This approach allowed the definition, parameterisation and analysis of the air pollution data in the city with the future goal of integrating this knowledge in the development of different models of air pollution diffusion.

Keywords: space-time environmental data, variography, moving window correlation matrix, network science