Geophysical Research Abstracts
Vol. 13, EGU2011-7305, 2011
EGU General Assembly 2011

Environmental Monitoring Networks: Analysis and Quantification of Clustering

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Most of environmental monitoring networks (EMN) are clustered, i.e. measurement points are distributed in space in a nonhomogenous manner. The clustering of EMN has many important consequences from data collection (ability to detect the phenomena under study) to the analysis, geostatistical modeling, and interpretation of the results [Kanevski, 2008]. Several important characteristics of clustering are related to spatial/topological and dimensional (fractal) resolutions. If the measurements are taken into account the concepts of functional measures of clustering and preferential sampling appear. In order to deal with such problems and to extract representative information from data in geostatistics several declustering algorithms exist.

In the present study a comprehensive review of topological (Voronoi polygons), statistical (density distribution, Morisita index) and fractal measures (box and sandbox counting) were applied to quantify the degree of clustering of real EMN: meteorological networks, indoor radon data, monitoring of heavy metals pollution, radioactivity. In order to reduce problems with the finiteness and irregularities of the regions under study and to estimate real level of clustering, a concept of validity domain was used. Validity domain takes into account the natural constraints of the space under study, like administrative borders, shapes of lakes or forests, etc. By Monte Carlo simulations many homogeneous/random patterns within the validity domains were produced. In this way, one obtains a reference level of clustering along with a confidence level. Some of the considered measures were efficient in detecting multiscale level of clustering as well. Such analysis can help in selecting declustering method and in the interpretation of the results.

Finally, the consequences of clustering on the analysis and modeling of environmental data is demonstrated on simulated data produced by geostatistical conditional simulations.

Acknowledgements: the research was partly supported by Swiss NSF grant #200020-121835.

Reference: Kanevski M. (Editor). Advanced Mapping of Environmental Data. Geostatistics, Machine Learning and Bayesian Maximum Entropy. iSTE and Wiley, 2008.