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Geostatistical modelling of uncertainty for the risk analysis of a contaminated site in the northern Italy

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The assessment of the risks associated with contamination by elevated levels of pollutants is a major issue in most parts of the world. Risk is generally taken to mean the probability of the occurrence of an adverse event, in this case contamination above legally and/or socially acceptable levels. Risk arises from the presence of a pollutant and from the uncertainty associated with estimating its concentration, extent and trajectory. The uncertainty arises from the difficulty of measuring the pollutant concentration accurately at any given location and the impossibility of measuring it all locations within a study zone. Estimations tend to give smoothed versions of reality with the smoothing effect being inversely proportional to the amount of data (Dowd, 2004). If risk is a measure of the probability of pollutant concentrations exceeding specified thresholds then variability, or variance, is the key characteristic in risk assessment and risk analysis. For this reason, Geostatistical simulation provides an appropriate way of quantifying risk by simulating possible “realities” and determining how many of these realities exceed the contamination thresholds. In this context Geostatistical simulation also provides a means of visualising risk and the geological causes of risk (Dowd, 1997).

This project is a study of the multivariate simulation of pollutants, in order to assess uncertainty for the risk analysis of a contaminated site. The main geostatistical tools

are used to model the local uncertainty of environmental attributes (e.g. pollutant concentrations) which prevail at any unsampled site, in particular by means of stochastic simulation (Goovaerts, 1998). These models of uncertainty can be used in decision-making processes such as delineation of areas targeted for remediation or design of sampling schemes.

The study started from data collected for a remediation project of a steelworks in northern Italy. The terrain samples were taken from boreholes excavated two years ago and analysed by a chemical laboratory. The data set comprises concentrations of several pollutants from which a subset of ten organic and inorganic compounds was selected.

The first part of study is a univariate and bivariate statistical analysis of the data. All data were spatially analysed and transformed to the Gaussian space so as to reduce the effects of extreme high values due to contaminant hot spots and because of the requirements of sequential Gaussian simulation (Goovaerts, 1997).The variography analysis highlighted spatial correlation and cross-correlations which led to an hypothesized linear model of coregionalization for all variables (Wackernagel, 2003).

Geostatistical simulation methods were applied in order to assess the uncertainty. Three types of simulation were performed: univariate Sequential Gaussian Simulation (SGS), correlation correction simulation and Sequential Gaussian Co-Simulation (SGCOS) (Chiles & Delfiner, 1999). The outputs from the correlation correction simulations and SGCOS were analysed and grade-tonnage curves were produced to assess basic environmental risk based on geostatistical simulation (Clark & Harper, 2000).

Finally, this work provides a basis for planning reclamation and remediation, besides it identifies future applications of this method for this particular site and for other similarly contaminated sites.

References

Chiles, J.P. & Delfiner, P. (1999) - *Geostatistics: modeling spatial uncertainty*, Wiley, New York; Chichester. xi, 695 pp.

Clark, I. & Harper, W.V. (2000) - *Practical Geostatistics 2000*. Vol. 1, Ecosse North America Llc., Columbus, Ohio, U.S.A. 342pp

Dowd, P.A. (1997) - *Risk in mineral projects: analysis, perception and management*. Trans. Insts Min. Metall. (Sect. A: Min. industry). 106: p. A9-A18.

Dowd, P.A. (2004) - *MINE5290: Geostatistical Simulation*. MSc in Mineral Resource and Environmental Geostatistics, University of Leeds, Leeds. 156pp.

Goovaerts, P. (1997) - *Geostatistics for natural resources evaluation*. Applied geostatistics series., Oxford University Press, New York; Oxford. xiv, 483 p.

Goovaerts, P. (1998) - *Geostatistical tools for characterizing the spatial variability of microbiological and physico-chemical soil properties*. Biol Fertil Soils. 27: p. 315-334.

Wackernagel, H. (2003), *Multivariate Geostatistics: An Introduction with Applications*. 3rd ed, Springer-Verlag, Berlin, Germany. 387 pp.