

## **Sampling Design and Spatial Modeling of Heavy Metals in Contaminated Soils**

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Issues of sampling design and accuracy of soil survey data have become matters of priority in recent years (e.g. Domburg et al., 1994; 1997; De Gruiter et al., 1994). There is much need to develop sampling strategies to quantitatively assess spatial variability of heavy metals in contaminated soils. Such issues have to be taken into account by those buying, selling or developing such soils. This paper reports a case study which was undertaken at an old industrial site in Central Scotland. Use was made of a hierarchical sampling design based on an unbalanced sampling scheme of Webster & Oliver (1990). As a result, an unbalanced hierarchical nested design with random orientation of sampling points was used to represent spatial variation in heavy metals. Information from each sampling stage with stated quantified accuracy was obtained by applying geostatistical methods. Semivariance was calculated for log-transformed data to stabilize the variance. The sampling scheme was designed to allow the calculation of semivariance at small values of lag distance relative to the size of the sampling grids. Variables were described by isotropic linear semivariance model to reflect the spatial dynamics on the heavy metal parameters. This model proves that the degree of contaminant variability increases linearly with sample spacing and the range of spatial dependence is determined by the size of the dumped tip. Through applying semivariance analysis with error estimation for each sampling stage it was established that the nugget values increase with each sampling stage. The linear variogram maintains its shape but reduces the slope of the best fit line. It proves that on such artificial sites variability needs to be based on observations at rather close distances. At each stage goodness-of-fit for the semivariogram models was assessed by jackknifing analysis. Resultant kriged maps illustrate continuous spatial behavior of heavy metals. In order to develop an approach to risk assessment, disjunctive kriging was applied.