Geophysical Research Abstracts
Vol. 19, EGU2017-3615, 2017
EGU General Assembly 2017

Kriging – a challenge in geochemical mapping

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Geochemists can easily provide datasets for contamination mapping thanks to recent advances in geographical information systems (GIS) and portable chemical-analytical instrumentation. Kriging is commonly used to visualise the results of such mapping. It is understandable, as kriging is a well-established method of spatial interpolation. It was created in 1950's for geochemical data processing to estimate the most likely distribution of gold based on samples from a few boreholes. However, kriging is based on the assumption of continuous spatial distribution of numeric data that is not realistic in environmental geochemistry.
The use of kriging is correct when the data density is sufficient with respect to heterogeneity of the spatial distribution of the geochemical parameters. However, if anomalous geochemical values are focused in hotspots of which boundaries are insufficiently densely sampled, kriging could provide misleading maps with the real contours of hotspots blurred by data smoothing and levelling out individual (isolated) but relevant anomalous values. The data smoothing can thus it results in underestimation of geochemical extremes, which may in fact be of the greatest importance in mapping projects.
In our study we characterised hotspots of contamination by uranium and zinc in the floodplain of the Ploučnice River. The first objective of our study was to compare three methods of sampling: random (based on stochastic generation of sampling points), systematic (square grid) and judgemental sampling (based on judgement stemming from principles of fluvial deposition) as the basis for pollution maps. The first detected problem in production of the maps was the reduction of the smoothing effect of kriging using appropriate function of empirical semivariogram and setting the variation of at microscales smaller than the sampling distances to minimum (the "nugget" parameter of semivariogram). Exact interpolators such as Inverse Distance Weighting (IDW) or Radial Basis Functions (RBF) provides better solutions in this respect. The second detected problem was heterogeneous structure of the floodplain: it consists of distinct sedimentary bodies (e.g., natural levees, meander scars, point bars), which have been formed by different process (erosion or deposition on flooding, channel shifts by meandering, channel abandonment). Interpolation through these sedimentary bodies has thus not much sense. Solution is to identify boundaries between sedimentary bodies and interpolation of data with this additional information using exact interpolators with barriers (IDW, RBF or stratified kriging) or regression kriging. Those boundaries can be identified using, e.g., digital elevation model (DEM), dipole electromagnetic profiling (DEMP), gamma spectrometry, or an expertise by a geomorphologist.