Mapping soil pollution by constrained kriging

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Soil contamination by heavy metals and organic pollutants around industrial premises is a problem in many countries worldwide. As a first step in mitigating the related health risks, one has to delineate zones where the concentrations of the pollutants exceed tolerable levels. Predictions of metal concentrations are usually required for blocks because remediation or regulatory decisions are imposed for entire parcels. Parcel areas typically exceed the observation support, but are smaller than the survey domain. Mapping soil pollution involves therefore a local change of support. Gaussian conditional simulations (CS) are usually preferred when one has to predict threshold exceedance by block means in soil pollution studies. However, CS is highly parametric, for real life problems still computationally demanding and predictions may be badly biased if the probabilistic model is misspecified. Unlike CS, universal block kriging (UK) is less demanding to compute and more robust against model misspecification, but nonlinear functionals of UK block predictions are biased because the variance of the UK predictor is smaller than the variance of the target quantity. The constrained (CK, Cressie, 1993) and covariance-matching constrained kriging predictors (CMCK, Aldworth and Cressie, 2003) share with UK the simplicity of a linear predictor, but should be less biased than UK for nonlinear predictions. In addition to the usual unbiasedness constraint of UK, these predictors satisfy the constraints that the variances (CK) or the covariances (CMCK) of the predictions match for a set of target blocks the (co-)variances of the target quantities. The goal of our work was to find a simple, robust and precise method for predicting

block means (linear predictions) and threshold exceedance by block means (nonlinear predictions) from data observed at points that show a spatial trend. We compared the performance of UK, CS, CK and CMCK for linear and nonlinear local change of support prediction situation by simulations. Furthermore, using data from an extensive survey of heavy metals in the soils around a metal smelter, we validated block predictions by CS, UK and CK with measured heavy metal concentrations that were representative for the mean metal content on 53 parcels with areas of 500-5500 m2. Block predictions were computed from observations with quasi-point support (2-100 m2). Target quantities were the block means of metal content in 0-20 cm depth and exceedance of regulatory thresholds of the Swiss Soil Protection Ordinance by these means. In the presentation a selection of result of this validation exercise will be presented.