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Assessment and visualization of uncertainty for countrywide soil organic matter map of Hungary using local entropy

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Uncertainty is a general term expressing our imperfect knowledge in describing an environmental process and we are aware of it (Bárdossy and Fodor, 2004). Sampling, laboratory measurements, models and so on are subject to uncertainty. Effective quantification and visualization of uncertainty would be indispensable to stakeholders (e.g. policy makers, society). Soil related features and their spatial models should be stressfully targeted to uncertainty assessment because their inferences are further used in modelling and decision making process.

The aim of our present study was to assess and effectively visualize the local uncertainty of the countrywide soil organic matter (SOM) spatial distribution model of Hungary using geostatistical tools and concepts.

The Hungarian Soil Information and Monitoring System's SOM data (approximately 1,200 observations) and environmental related, spatially exhaustive secondary information (i.e. digital elevation model, climatic maps, MODIS satellite images and geological map) were used to model the countrywide SOM spatial distribution by regression kriging. It would be common to use the calculated estimation (or kriging) variance as a measure of uncertainty, however the normality and homoscedasticity hypotheses have to be refused according to our preliminary analysis on the data. Therefore, a normal score transformation and a sequential stochastic simulation approach was introduced to be able to model and assess the local uncertainty. Five hundred equally probable realizations (i.e. stochastic images) were generated. The number of the stochastic images is fairly enough to provide a model of uncertainty at each location, which is a complete description of uncertainty in geostatistics (Deutsch and Journel, 1998). Furthermore, these models can be applied e.g. to contour the probability of any events, which can be regarded as goal oriented digital soil maps and are of interest for agricultural management and decision making as well.

A standardized measure of the local entropy was used to visualize uncertainty, where entropy values close to 1 correspond to high uncertainty, whilst values close to 0 correspond low uncertainty. The advantage of the usage of local entropy in this context is that it combines probabilities from multiple members into a single number for each location of the model.

In conclusion, it is straightforward to use a sequential stochastic simulation approach to the assessment of uncertainty, when normality and homoscedasticity are violated. The visualization of uncertainty using the local entropy is effective and communicative to stakeholders because it represents the uncertainty through a single number within a [0, 1] scale.

References:
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