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Comparing the performance of various digital soil mapping approaches to map physical soil properties

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Spatial information on physical soil properties is intensely expected, in order to support environmental related and land use management decisions. One of the most widely used properties to characterize soils physically is particle size distribution (PSD), which determines soil water management and cultivability. According to their size, different particles can be categorized as clay, silt, or sand. The size intervals are defined by national or international textural classification systems. The relative percentage of sand, silt, and clay in the soil constitutes textural classes, which are also specified miscellaneously in various national and/or specialty systems. The most commonly used is the classification system of the United States Department of Agriculture (USDA). Soil texture information is essential input data in meteorological, hydrological and agricultural prediction modelling.

Although Hungary has a great deal of legacy soil maps and other relevant soil information, it often occurs, that maps do not exist on a certain characteristic with the required thematic and/or spatial representation. The recent developments in digital soil mapping (DSM), however, provide wide opportunities for the elaboration of object specific soil maps (OSSM) with predefined parameters (resolution, accuracy, reliability etc.).

Due to the simultaneous richness of available Hungarian legacy soil data, spatial inference methods and auxiliary environmental information, there is a high versatility of possible approaches for the compilation of a given soil map. This suggests the opportunity of optimization. For the creation of an OSSM one might intend to identify the optimum set of soil data, method and auxiliary co-variables optimized for the resources (data costs, computation requirements etc.). We started comprehensive analysis of the effects of the various DSM components on the accuracy of the output maps on pilot areas.

The aim of this study is to compare and evaluate different digital soil mapping methods and sets of ancillary variables for producing the most accurate spatial prediction of texture classes in a given area of interest. Both legacy and recently collected data on PSD were used as reference information. The predictor variable data set consisted of digital elevation model and its derivatives, lithology, land use maps as well as various bands and indices of satellite images.

Two conceptionally different approaches can be applied in the mapping process. Textural classification can be realized after particle size data were spatially extended by proper geostatistical method. Alternatively, the textural classification is carried out first, followed by the spatial extension through suitable data mining method.

According to the first approach, maps of sand, silt and clay percentage have been computed through regression kriging (RK). Since the three maps are compositional (their sum must be 100%), we applied Additive Log-Ratio (alr) transformation, instead of kriging them independently. Finally, the texture class map has been compiled according to the USDA categories from the three maps. Different combinations of reference and training soil data and auxiliary covariables resulted several different maps.

On the basis of the other way, the PSD were classified firstly into the USDA categories, then the texture class maps were compiled directly by data mining methods (classification trees and random forests). The various results were compared to each other as well as to the RK maps.

The performance of the different methods and data sets has been examined by testing the accuracy of the geostatistically computed and the directly classified results to assess the most predictive and accurate method.

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