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Hungarian contribution to the Global Soil Organic Carbon Map (GSOC17) using advanced machine learning algorithms and geostatistics

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The knowledge about soil organic carbon (SOC) baselines and changes, and the detection of vulnerable hot spots for SOC losses and gains under climate change and changed land management is still fairly limited. Thus Global Soil Partnership (GSP) has been requested to develop a global SOC mapping campaign by 2017. GSPs concept builds on official national data sets, therefore, a bottom-up (country-driven) approach is pursued.

The elaborated Hungarian methodology suits the general specifications of GSOC17 provided by GSP. The input data for GSOC17@HU mapping approach has involved legacy soil data bases, as well as proper environmental covariates related to the main soil forming factors, such as climate, organisms, relief and parent material. Nowadays, digital soil mapping (DSM) highly relies on the assumption that soil properties of interest can be modelled as a sum of a deterministic and stochastic component, which can be treated and modelled separately. We also adopted this assumption in our methodology. In practice, multiple regression techniques are commonly used to model the deterministic part. However, this global (and usually linear) models commonly oversimplify the often complex and non-linear relationship, which has a crucial effect on the resulted soil maps. Thus, we integrated machine learning algorithms (namely random forest and quantile regression forest) in the elaborated methodology, supposing then to be more suitable for the problem in hand. This approach has enable us to model the GSOC17 soil properties in that complex and non-linear forms as the soil itself. Furthermore, it has enable us to model and assess the uncertainty of the results, which is highly relevant in decision making. The applied methodology has used geostatistical approach to model the stochastic part of the spatial variability of the soil properties of interest.

We created GSOC17@HU map with 1 km grid resolution according to the GSPs specifications. The map contributes to the GSPs GSOC17 proposals, as well as to the development of global soil information system under GSP Pillar 4 on soil data and information. However, we elaborated our adherent code (created in R software environment) in such a way that it can be improved, specified and applied for further uses. Hence, it opens the door to create countrywide map(s) with higher grid resolution for SOC (or other soil related properties) using the advanced methodology, as well as to contribute and support the SOC (or other soil) related country level decision making.

Our paper will present the soil mapping methodology itself, the resulted GSOC17@HU map, some of our conclusions drawn from the experiences and their effects on the further uses.

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