World Academy of Science, Engineering and Technology
International Journal of Geological and Environmental Engineering
Vol:15, No:10, 2021

Using Soil Texture Field Observations as Ordinal Qualitative Variables for Digital Soil Mapping

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Abstract : Most of the digital soil mapping (DSM) products rely on machine learning (ML) prediction models and/or the use or pedotransfer functions (PTF) in which calibration data come from soil analyses performed in labs. However, many other observations (often qualitative, nominal, or ordinal) could be used as proxies of lab measurements or as input data for ML of PTF predictions. DSM and ML are briefly described with some examples taken from the literature. Then, we explore the potential of an ordinal qualitative variable, i.e., the hand-feel soil texture (HFST) estimating the mineral particle distribution (PSD): % of clay (0-2µm), silt (2-50µm) and sand (50-2000µm) in 15 classes. The PSD can also be measured by lab measurements (LAST) to determine the exact proportion of these particle-sizes. However, due to cost constraints, HFST are much more numerous and spatially dense than LAST. Soil texture (ST) is a very important soil parameter to map as it is controlling many of the soil properties and functions. Therefore, comes an essential question: is it possible to use HFST as a proxy of LAST for calibration and/or validation of DSM predictions of ST? To answer this question, the first step is to compare HFST with LAST on a representative set where both information are available. This comparison was made on ca 17,400 samples representative of a French region (34,000 km2). The accuracy of HFST was assessed, and each HFST class was characterized by a probability distribution function (PDF) of its LAST values. This enables to randomly replace HFST observations by LAST values while respecting the PDF previously calculated and results in a very large increase of observations available for the calibration or validation of PTF and ML predictions. Some preliminary results are shown. First, the comparison between HFST classes and LAST analyses showed that accuracies could be considered very good when compared to other studies. The causes of some inconsistencies were explored and most of them were well explained by other soil characteristics. Then we show some examples applying these relationships and the increase of data to several issues related to DSM. The first issue is: do the PDF functions that were established enable to use HSFT class observations to improve the LAST soil texture prediction? For this objective, we replaced all HFST for topsoil by values from the PDF 100 time replicates). Results were promising for the PTF we tested (a PTF predicting soil water holding capacity). For the question related to the ML prediction of LAST soil texture on the region, we did the same kind of replacement, but we implemented a 10-fold cross-validation using points where we had LAST values. We obtained only preliminary results but they were rather promising. Then we show another example illustrating the potential of using HFST as validation data. As in numerous countries, the HFST observations are very numerous; these promising results pave the way to an important improvement of DSM products in all the countries of the world.

Keywords : digital soil mapping, improvement of digital soil mapping predictions, potential of using hand-feel soil texture, soil texture prediction
Conference Title : ICDMSD 2021 : International Conference on Digital Mapping and Spatial Data
Conference Location : London, United Kingdom
Conference Dates : October 21-22, 2021