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A multi-dimensional Sentinel-based Soil Monitoring Scheme (S2MoS) for soil clay content estimation

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Earth Observation (EO) has an immense potential as an enabling tool for mapping the spatial variation of the topsoil layer. Additionally, machine learning based algorithms deployed on cloud computing infrastructures have a great potential to revolutionize the processing of EO data. This paper aims to present a multi-dimensional Sentinel-based Soil Monitoring Scheme (S2MoS) based on open-access Copernicus Sentinel data and the Google Earth Engine platform to map soil properties. Building on key results from existing data mining approaches to extract bare soil reflectance values the current study presents i) preliminary insights on the synergistic use of open access SAR and optical images obtained from Sentinel-1 and Sentinel-2 sensors; and ii) evaluate the efficiency of machine learning algorithms to predict soil attributes based on multi-temporal analysis. In that regard, this study evaluated, based on Sentinel images extending over a 3 years period (2017-2019), the performance of two state of the art machine learning approaches, namely random forest and neural networks. Spatial thresholds values of 0.25 and 0.075 for Normalized Difference Vegetation Index and Normalized Burn Ratio 2 indices respectively were applied to mask bare soil pixels. In this study, we used 5000 soil data belonging to cropland land use from the European LUCAS topsoil database. We calibrated the models based on 4000 soil samples and then validated this approach with the rest 1000 samples predict soil clay content. A higher prediction performance ($R^2=0.53$) was achieved by the inclusion of both types (SAR and optical) of observations using the neural network model, demonstrating an improvement of about 5% in overall accuracy compared to the R^2 using the multi-year median optical composite.