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Sentinel 2 and machine learning-based estimation of soil organic carbon stock

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One of the most important properties of soil is soil organic carbon due to its contribution to the plants growing and environment management. Research in this field requires inexpensive, good quality and time efficient acquisition of soil data. The use of high resolution sensors, particularly Sentinel-2, has been identified as a potential mean of reducing the limitations of classical procedures and accurately enhancing the soil databases at large scales. Each space-borne sensor has its strengths and weaknesses regarding the spatio-temporal and spectral features in digital soil mapping, reason why Sentinel-2 is considered to be a reliable remotely sensed data source for quantifying the soil organic carbon stock (SOC). Thus, optical remote sensing data offer soil extractable information, remote-located areas mapping, multi-temporal analysis, synoptic approach and cost-effective results.
The study's main aim is to estimate the SOC stock applying machine learning algorithms by integrating terrain data, classical data (laboratory analysed soil samples) and satellite data sets. The research is focused on total area of 418 sq.km which is representative for its landscape complexity including the Carpathians east sector, Subcarpathians and Moldavian tableland. Several key characteristics of the collected soil samples are: parental material, land use / land cover (LU/LC), physical and chemical properties. SOC content of the samples was determined based on total organic carbon which was analyzed with Analytik Jena multi N/C 2100 with HT 1300 solid module. The spectral bands and the derived indices were determined as environmental variables along with the morphometric - topographic indices, climatic index, LU/LC and soil texture being used as predictors. As statistical prediction models have been used and analysed stochastic gradient boosting (SGB), support vector machine (SVM), multiple linear regression (MLR) and random forest regression (RFR). Regarding the obtained results corroboration, cross validation was perform while for the predicted data was utilized independent validation samples.
The findings highlight the potential of field and remote sensing data for quantifying the SOC stock at detailed scale. The advantage of satellite data usage can lead to optimized soil processing workflow, the data fusion providing more accurate results than non-integrated approaches.

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