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Estimation of soil organic carbon by spectral data in a Mediterranean agricultural mountain landscape

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Soil organic carbon (SOC) is a useful indicator of soil fertility that plays an important role in improving soil quality, increasing agronomic productivity and maintaining sustainability of agricultural systems. The use of hyperspectral data for SOC estimation offers a fast, cost-effective, and non-destructive alternative to conventional soil analyses. Spectral data analysis with multivariate statistical methods has been already successfully used to transfer soil reflectance data on quantitative estimation of SOC content.
The spectral sensor type and calibration, and the data acquisition conditions are determinants of the quality and accuracy of the hyperspectral data. Therefore, our study aims to test the capability of the Vis-NIR-SWIR spectral information for the quantitative prediction of organic carbon content in Mediterranean soils by comparing laboratory-based spectroscopy and spectral data acquired in field conditions. We also test the effect of changes in solar illumination on the soil spectral reflectance by comparing soil spectral data under field conditions in different sky conditions.
In 2017, soil samples were collected in a Mediterranean agricultural mountain landscape (NE Spain) where the main land uses are cropland, Mediterranean natural forest and scrubland and pine afforestation. We selected a dataset (n=73) that includes a wide range of SOC content from 2 to 71 g kg-1. Laboratory-based spectral data of the soil samples were acquired using an ASD FieldSpec 3 portable spectroradiometer (350 – 2500 nm wavelength range) in a dark room to avoid interference from stray light. An average value of 4 spectral measurements for each sample was used as the final spectral reflectance. In addition, multispectral data were acquired in field conditions with a RedEdge-M narrow-band multispectral camera. After spectral measurements, the SOC content (g kg-1) of all soil samples was measured at 550°C by dry combustion using a LECO RC-612 multiphase carbon analyser. These laboratory reference SOC measurements were coupled with the laboratory and field derived spectral measurements to explore the correlations between soil spectra and SOC.
Results of partial least squares regression (PLSR) modelling of spectral data show that the tested multispectral narrow-bands were useful for SOC prediction with a satisfactory level of accuracy (root mean square error, RMSE = 1.15, ratio of performance to deviation, RPD = 1.44, R2 = 0.61)
The spectral data provided by the tested multispectral camera can be successfully employed for SOC prediction in field conditions, providing an efficient method for fast acquisition of data also in the spatial domain, especially in the perspective of UAV applications.