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Can the normalized soil moisture index improve the prediction of soil organic carbon based on hyperspectral remote sensing data?

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One of the problems for mapping of soil organic carbon (SOC) at large-scale based on visible – near and short wave infrared (VIS-NIR-SWIR) remote sensing techniques is the spatial variation of topsoil moisture when the images are collected. Soil moisture is certainly an aspect causing biased SOC estimations, due to the problems in discriminating reflectance differences due to either variations in organic matter or soil moisture, or their combination. In addition, the difficult validation procedures make the accurate estimation of soil moisture from optical airborne a major challenge. After all, the first millimeters of the soil surface reflect the signal to the airborne sensor and show a large spatial, vertical and temporal variation in soil moisture. Hence, the difficulty of assessing the soil moisture of this thin layer at the same moment of the flight. The creation of a soil moisture proxy, directly retrievable from the hyperspectral data is a priority to improve the large-scale prediction of SOC. This paper aims to verify if the application of the normalized soil moisture index (NSMI) to Airborne Prima Experiment (APEX) hyperspectral images could improve the prediction of SOC. The study area was located in the loam region of Wallonia, Belgium. About 40 samples were collected from bare fields covered by the flight lines, and analyzed in the laboratory. Soil spectra, corresponding to the sample locations, were extracted from the images. Once the NSMI was calculated for the bare fields' pixels, spatial patterns, presumably related to within field soil moisture variations, were revealed. SOC prediction models, built using raw and pre-treated spectra, were generated from either the full dataset (general model), or pixels belonging to one of the two classes of NSMI values (NSMI models). The best result, with a RMSE after validation of 1.24 g C kg-1, was achieved with a NSMI model, compared to the best general model, characterized by a RMSE of 2.11 g C kg-1. These results confirmed the advantage to controlling the effect of soil moisture on the detection of SOC. The NSMI proved to be a flexible concept, due to the possible use of different SWIR wavelengths, and ease of use, because measurements of soil moisture by other techniques are not needed. However, in the future, it will be important to assess the effectiveness of the NSMI for different soil types, and other hyperspectral sensors.