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Characterizing Soil Organic Carbon Content in Forests at National Scale using Reflectance Spectroscopy

Asa Gholizadeh[1], Raphael Viscarra Rossel[2], Mohammadmehdi Saberioon[3], Lubos Boruvka[1], and Lenka Pavlu[1]

[1]Soil Science and Soil Protection, Czech University of Life Sciences Prague, Prague, Czechia
[2]Soil and Landscape Science, Curtin University, Perth, Australia
[3]Section 1.4 Remote Sensing and Geoinformatics, Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany

Any strategy to change Carbon (C) pool would have a substantial effect on functionality of numerous ecosystem functions, detachment of Soil Organic Carbon (SOC), atmospheric carbon dioxide (CO_2) concentration, and climate change mitigation. As the largest amount of the world's C is stored in forests soils, the importance of forest SOC management is highlighted. Total SOC in forest varies not only laterally but also vertically with depth; however, the SOC storage of lower soil horizons have not been investigated enough despite their potential to frame our understanding of soil functioning. Visible–Near Infrared (vis–NIR) reflectance spectroscopy enables rapid examinations of the horizontal distribution of forest SOC, overcoming limitations of traditional soil assessment. This study aims to evaluate the potential of vis–NIR spectroscopy for characterizing the SOC contents of organic and mineral horizons in forests. We investigated 1080 forested sites across the Czech Republic at five individual soil layers, representing the Litter (L), Fragmented (F), and Humus (H) organic horizons, and the A_1 (depth of 2–10 cm) and A_2 (depth of 10–40 cm) mineral horizons (total 5400 samples). We then used Support Vector Machine (SVM) to model the SOC contents of (i) the profile (all organic and mineral horizons together), (ii) the combined organic horizons, (iii) the combined mineral horizons, and (iv) each individual horizon separately. The models were validated using 10-repeated 10-fold cross validation. Results showed that there was at least more than seven times as much SOC in the combined organic horizons compared to the combined mineral horizons with more variation in deeper layers. All individual horizons' SOC was successfully predicted with low error and R^2 values higher than 0.63; however, the prediction accuracy of F and A_1 was greater compared to others (R^2 > 0.70 and very low-biased spatial estimates). We have shown that modelling of SOC with vis–NIR spectra in different soil horizons of highly heterogeneous forests of the Czech Republic is practical.