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Mapping Soil Organic Matter with Hyperspectral Imaging

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Soil organic matter (SOM) plays a central role for both food security and the global environment. Soil organic matter is the 'glue' that binds soil particles together, leading to positive effects on soil water and nutrient availability for plant growth and helping to counteract the effects of erosion, runoff, compaction and crusting.
Hyperspectral measurements of samples of soil profiles have been conducted with the aim of mapping soil organic matter on a macroscopic scale (millimeters and centimeters). Two soil profiles have been selected from the same experimental site, one from a plot amended with biochar and another one from a control plot, with the specific objective to quantify and map the distribution of biochar in the amended profile.

The soil profiles were of size (30 x 10 x 10) cm3 and were scanned with two pushbroomtype hyperspectral cameras, one which is sensitive in the visible wavelength region (400 – 1000 nm) and one in the near infrared region (1000 – 2500 nm). The images from the two detectors were merged together into one full dataset covering the whole wavelength region. Layers of 15 mm were removed from the 10 cm high sample such that a total of 7 hyperspectral images were obtained from the samples. Each layer was analyzed with multivariate statistical techniques in order to map the different components in the soil profile. Moreover, a 3-dimensional visalization of the components through the depth of the sample was also obtained by combining the hyperspectral images from all the layers.

Mid-infrared spectroscopy of selected samples of the measured soil profiles was conducted in order to correlate the chemical constituents with the hyperspectral results.

The results show that hyperspectral imaging is a fast, non-destructive technique, well suited to characterize soil profiles on a macroscopic scale and hence to map elements and different organic matter quality present in a complete pedon. As such, we were able to map and quantify biochar in our profile. Smaller interesting regions can also easily be selected from the hyperspectral images for more detailed study at microscopic scale.