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Digital soil classification and elemental mapping using imaging Vis-NIR spectroscopy: How to explicitly quantify stagnic properties of a Luvisol under Norway spruce

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Digital soil classification and elemental mapping using imaging Vis-NIR spectroscopy: How to explicitly quantify stagnic properties of a Luvisol under Norway spruce

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Laboratory imaging Vis-NIR spectroscopy of soil profiles is a novel technique in soil science that can determine quantity and quality of various chemical soil properties with a hitherto unreached spatial resolution in undisturbed soil profiles. We have applied this technique to soil cores in order to get quantitative proof of redoximorphic processes under two different tree species and to proof tree-soil interactions at microscale. Due to the imaging capabilities of Vis-NIR spectroscopy a spatially explicit understanding of soil processes and properties can be achieved. Spatial heterogeneity of the soil profile can be taken into account.
We took six 30 cm long rectangular soil columns of adjacent Luvisols derived from quaternary aeolian sediments (Loess) in a forest soil near Freising/Bavaria using stainless steel boxes (100×100×300 mm). Three profiles were sampled under Norway spruce and three under European beech. A hyperspectral camera (VNIR, 400–1000 nm in 160 spectral bands) with spatial resolution of 63×63 μm^2 per pixel was used for data acquisition. Reference samples were taken at representative spots and analysed for organic carbon (OC) quantity and quality with a CN elemental analyser and for iron oxides (Fe) content using dithionite extraction followed by ICP-OES measurement. We compared two supervised classification algorithms, Spectral Angle Mapper and Maximum Likelihood, using different sets of training areas and spectral libraries. As established in chemometrics we used multivariate analysis such as partial least-squares regression (PLSR) in addition to multivariate adaptive regression splines (MARS) to correlate chemical data with Vis-NIR spectra. As a result elemental mapping of Fe and OC within the soil core at high spatial resolution has been achieved. The regression model was validated by a new set of reference samples for chemical analysis.
Digital soil classification easily visualizes soil properties within the soil profiles. By combining both techniques, detailed soil maps, elemental balances and a deeper understanding of soil forming processes at the microscale become feasible for complete soil profiles.