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Revealing spatial distribution of soil organic carbon contents and stocks of a disturbed bog relict by in-situ NIR and apparent EC mapping

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Previous studies showed that in-situ visible near-infrared (vis-NIR) spectroscopy can overcome the limitations of conventional soil sampling. Costs can be reduced and spatial resolution enhanced when mapping field-scale variability of soil organic carbon (SOC). Detailed maps can help to improve SOC management and lead to better estimates of field-scale total carbon stocks. Knowledge of SOC field patterns may also help to reveal processes and factors controlling SOC variability.

In this study, we apply in situ vis-NIR and apparent electrical conductivity (ECa) mapping to a disturbed bog relict. The major question of this application study was how field-scale in-situ vis-NIR mapping performs for a very heterogeneous area and under difficult grassland conditions and under highly-variable water content conditions. Past intensive peat cutting and deep ploughing in some areas, in combination with a high background heterogeneity of the underlying mineral sediments, have led to a high variability of SOC content (5.6 to 41.3 %), peat layer thickness (25 to 60 cm) and peat degradation states (from nearly fresh to amorphous). Using a field system developed by Veris Technologies (Salina KS, USA), we continuously collected vis-NIR spectra at 10 cm depth (measurement range: 350 nm to 2200 nm) over an area of around 12 ha with a line spacing of about 12 m. The system includes a set of discs for measuring ECa of the first 30 and 90 cm of the soil. The same area was also mapped with a non-invasive electro-magnetic induction (EMI) setup that provided ECa data of the first 25, 50 and 100 cm. For calibration and validation of the spatial data, we took 30 representative soil samples and 15 soil cores of about 90 cm depth, for which peat thickness, water content, pore water EC, bulk density (BD), as well as C and N content were determined for various depths.

Preliminary results of the calibration of the NIR spectra to the near-surface SOC contents indicate good data quality despite the challenging site conditions. Bore hole data indicates that the peat layer is characterized by lower BD, higher pore water EC, higher SOC content, and higher water contents compared to the underlying mineral sediments. This ECa contrast at the peat-sand interface is promising for using the various ECa investigation depths as predictors for peat thickness. Preliminary EMI results also show a correlation between ECa and SOC content, most strongly for the 25 cm EMI signal. We evaluate how vis-NIR and ECa data can be used in a joined approach to estimate SOC content as well as SOC stock distribution.