Mapping of soil characteristics in (semi)-natural ecosystems using imaging spectroscopy derived plant indicator values

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Species composition of vegetation in (semi)-natural ecosystems is typically driven by variation in soil and hydrological conditions. The concept of plant indicator values uses the inverse of this relationship to estimate soil characteristics from species composition present in a certain plot. Continuous maps of plant indicator values can provide spatial explicit information about soil gradients and processes and are an important input source for ecological models. However, as field-based mapping requires extensive sampling, most assessments are at the plot level instead of covering large areas. The potential of remote sensing to map plant indicator values has been shown in earlier studies, however these were based on a relatively small sampling set in a grassland ecosystem.

In the present study we investigate the spatio-temporal robustness of the relations between imaging spectroscopy derived vegetation reflectance and plant indicator values. Ellenberg indicator values for water supply, soil pH and soil fertility were derived using species data from vegetation plots of a river floodplain (n=80) and dune ecosystem (n=150) in the Netherlands, and a brook ecosystem in Belgium (n=35). For the three study areas, airborne imaging spectrometer data were acquired using the AHS sensor (pixel size 4.5 m and 63 bands in VNIR) during two weeks in June 2005. Partial least-squares (PLS) regression was adopted to relate indicator values and plot reflectance extracted from the imaging spectrometer data. Applying the regression models to the

imagery resulted in spatial continuous maps for water supply, soil pH and soil fertility in the three study areas ($R^2 = 0.42 - 0.71$ for independent test-set).

The results show that comparable reflectance wavelength regions are important to estimate indicator values for the three investigated ecosystems. However, intercalibration of the regression models shows that they are partly depending on vegetation and sensor type. We conclude that imaging spectroscopy offers opportunities to map soil characteristics in (semi)-natural ecosystems which can be adopted as base for digital soil mapping approaches. Further research will focus on the development of a mechanistic approach to model the relation between vegetation canopy reflectance and patterns of indicator values.