Estimation of clay and organic matter content using laboratory, field and airborne hyperspectral measurements on agricultural fields of the test site DEMMIN

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Abstract

To counteract possible implications caused by soil erosion on agricultural fields, erosion risk needs to be assessed quantitatively. However, the provision of appropriate model input parameters currently poses a problem, in particular on a regional to local scale. In our research we focus on the determination of soil variables linked to soil erosion processes, which are organic matter and clay content. Topsoil organic matter and clay content was studied using a three-tiered approach based on laboratory spectra, field spectra and airborne hyperspectral imagery. Reflectance measurements on bare soil were acquired in the lab from 135 soil samples, and in the field on the agricultural test-site DEMMIN (Durable Environmental Multidisciplinary Monitoring Information Network). Hyperspectral image data evaluated in the study originates from the Australian sensor HyMAP, acquired in May 2005.

For the quantification of clay content and organic matter two approaches were assessed: a continuum removal technique parameterising specific absorption features (1) and a multivariate calibration method using multiple linear regression based on absorption characteristics related to clay and organic matter (2). At first, models were set up using laboratory measurements. To examine the feasibility of applying these lab based models to field measurements and to HyMAP image, field and image based estimates were compared with lab-based estimates in terms of R^2 and one way Anova analysis. Model performance was evaluated calculating standard error of calibration (SEC), standard error of prediction (SEP) and the relative prediction error (RPD). Results point out a number of factors interfere the applicability of parameters derived from spectral absorption features in mapping soil properties on agricultural fields. By contrast, findings from multiple linear regression models indicate a good transferability of models from laboratory measurements to field and HyMAP image. R^2 values from multiple linear regression models for the estimation of clay content are of high accuracy ($R^2_{laboratory}$ =0.96, R^2_{field} =0.80 and R^2_{HyMAP}=0.85). Models for organic matter content perform less accurate with $R^2_{laboratory}$ values of 0.83. But the model can still explain 69 % of the variability for the HyMAP imagery.

Results of the presented study suggest the potential applicability of our MLR models to provide soil maps of clay and organic matter content of the test site DEMMIN which can serve as input parameters for soil erosion modelling. Due to very tight management plans, time slots for bare soil on agricultural fields are short. Therefore, a multi-temporal approach is suggested to consecutively complement soil parameter maps for different agricultural fields in the test site.