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Landform segmentation for digital soil mapping

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Knowledge of the spatial distribution of soil is the basis for many agri- and silvicultural applications and provides information about ecological soil functions. Especially in mountain regions slow and often disturbed soil formation leads to shallow soil depths and a high soil vulnerability considering for instance soil erosion and human modification. The project 'ReBo - Terrain Classification of Airborne Laser Scanning (ALS) Data to Support Digital Soil Mapping', funded by the Autonomous Province of Bolzano - South Tyrol, aims to increase the availability of such information by combining geomorphometric analysis and field survey. The proposed digital soil mapping strategy is making use of a geographic object-based analysis (GEOBIA) approach considering the strong relation between soil formation and surrounding geomorphological settings. The first analysis step is the terrain segmentation using a high resolution ALS digital terrain model (DTM) with regard to geomorphological features.

This study investigates the applicability of the GRASS GIS extension r.geomorphons for landform segmentation in the GEOBIA digital soil mapping approach. The module r.geomorphons (Jasiewicz and Stepinski, 2013) applies a pattern recognition method based on the visibility neighborhood of the focus pixel. The input parameter search radius (L) represents the maximum distance for line-of-sight calculation, splitting landforms into components if a landform is larger than L. The module yields, along with the unclassified results, a map containing the landform elements flat, peak, ridge, shoulder, slope, spur, hollow, foot slope, valley and pit. As soil formation and hence soil units (i.e. classes or soil communities) are often related to one or more specific landform elements (or parts of them) it is investigated to what extent there is a correlation between the landforms identified by r.geomorphons and mapped soil units. Due to the hitherto lack of detailed soil information in South Tyrol, an example from North Tyrol (Austria) is used for testing. The recurrence of specific combinations of soil units and landform elements is statistically analyzed. Additionally to this spatial analysis, elevation profiles are extracted from the DTM and combined with information from the soil map to create typical toposequences. By comparing to the progression of landform elements along the same profile, further relationships between neighboring landform elements and changes in the sequence of soils are investigated. r.geomorphons has previously been applied mainly to elevation models with a grid size of 30 m, whereas the DTMs provided for South and North Tyrol have a resolution of 2.5 m and 1 m, respectively. The effects of DTM resolutions and changing values of L for investigating landform and soil distributions are analyzed as well.

References: Jasiewicz, J. & Stepinski, T. F. (2013): Geomorphons — a pattern recognition approach to classification and mapping of landforms. Geomorphology, 182, 147 - 156