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Incorporating scale into digital terrain analysis

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Digital Elevation Models (DEMs) and their derived terrain attributes are commonly used in soil-landscape modeling. Process-based terrain attributes meaningful to the soil properties of interest are sought to be produced through digital terrain analysis. Typically, the standard 3 X 3 window-based algorithms are used for this purpose, thus tying the scale of resulting layers to the spatial resolution of the available DEM. But this is likely to induce mismatches between scale domains of terrain information and soil properties of interest, which further propagate biases in soil-landscape modeling.

We have started developing a procedure to incorporate scale into digital terrain analysis for terrain-based environmental modeling (Drăguţ et al., in press). The workflow was exemplified on crop yield data. Terrain information was generalized into successive scale levels with focal statistics on increasing neighborhood size. The degree of association between each terrain derivative and crop yield values was established iteratively for all scale levels through correlation analysis. The first peak of correlation indicated the scale level to be further retained.

While in a standard 3 X 3 window-based analysis mean curvature was one of the poorest correlated terrain attribute, after generalization it turned into the best correlated variable. To illustrate the importance of scale, we compared the regression results of unfiltered and filtered mean curvature vs. crop yield. The comparison shows an improvement of R squared from a value of 0.01 when the curvature was not filtered, to 0.16 when the curvature was filtered within 55 X 55 m neighborhood size. This indicates the optimum size of curvature information (scale) that influences soil fertility.

We further used these results in an object-based image analysis environment to create terrain objects containing aggregated values of both terrain derivatives and crop yield. Hence, we introduce terrain segmentation as an alternative method for generating scale levels in terrain-based environmental modeling. Based on segments, R squared improved up to a value of 0.47.

Before integrating the procedure described above into a software application, thorough comparison between the results of different generalization techniques, on different datasets and terrain conditions is necessary. This is the subject of our ongoing research as part of the SCALA project (Scales and Hierarchies in Landform Classification).

References:

Drăguţ, L., Schauppenlehner, T., Muhar, A., Strobl, J. and Blaschke, T., in press. Optimization of scale and parametrization for terrain segmentation: an application to soil-landscape modeling, Computers & Geosciences.