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Geomorphons and structure metrics for the characterization of geomorphological landscape regions in Austria

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Morphometry is a suitable method to describe geomorphological landform elements in different scales. Here, we present a workflow investigating the suitability of an area-wide elementary landform map computed for the entire country of Austria to delineate major natural geomorphological regions by analyzing spatial variability and distribution of elementary landforms.
The workflow makes use of r.geomorphon, an extension module for the free and open source geographic information system GRASS GIS. It is a raster based tool that intends to delineate landform elements by applying a pattern recognition algorithm which is based on the visible neighborhood computed from a focal pixel. The input parameter lookup distance (L) represents the maximum distance for line-of-sight calculations for each pixel. Applying a local ternary pattern concept and a lookup table used for classification, a map containing the landform elements flat, peak, ridge, shoulder, slope, spur, hollow, footslope, valley and pit is generated. Jasciewicz and Stepinski (2013), who authored the extension, applied it to create a general geomophometric map of Poland.
We present a geomorphon-based landform map of Austria calculated with r.geomorphon with L=1500 m, which corresponds to 60 pixels based on the 25 m digital elevation model (DEM) provided by the European Environmental Agency. The visual inspection of the resulting map allows the viewer to distinguish major natural geomorphologic regions of Austria. For instance, the variability and distribution of landform elements i.e. classified geomorphons within the crystalline rocks of the Bohemian massive in the northern part of Austria seem to be similar to those of the area encompassed by the Austrian Alps, however at a much finer scale. In contrast, the Vienna Basin can be clearly identified by a sudden shift in the distribution of the landform elements towards the element "flat". For an objective, transferable and reproducible approach we developed a workflow deriving further landscape metrics i.e. indices from the computed geomorphons map of Austria. Using the GRASS GIS module r.li for landscape structure analysis we calculate several patch and diversity indices to characterize the shape and distribution of the geomorphons within the landscape. Indices such as shape and edge density can help to quantify scale-related differences despite seemingly similar geomorphon distributions, e.g. when the distribution of landform patches in one region is similar to that of another, but the size of the individual patches is consistently smaller. Diversity indices highlight differences in the distribution of the ten different landform elements. By combining such landscape indices we investigate the suitability of a geomorphon-based landform map of a whole country, in this case Austria, to delineate major natural units by analyzing its spatial variability and distribution of elementary landforms. As a result, we are able to delineate and characterize the major geomorphological landscape regions in Austria with our approach.
references: Jasiewicz, J. & Stepinski, T. F. (2013): Geomorphons — a pattern recognition approach to classification and mapping of landforms. Geomorphology, 182, 147 - 156