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Multi-temporal analysis of aerial images for the investigation of spatial-temporal dynamics of shallow erosion – a case study from the Tyrolean Alps

C. Wiegand (1,2), C. Geitner (2), K. Heinrich (1), M. Rutzinger (1,2)

(1) Institute of Mountain Research: Man and Environment, Austrian Academy of Sciences, Innsbruck, Austria (christoph.wiegand@uibk.ac.at), (2) Institute of Geography, University of Innsbruck

Small and shallow eroded areas characterize the landscape of many pastures and meadows in the Alps. The extent of such erosion phenomena varies between 2 m2 and 200 m2. These patches tend to be only a few decimetres thick, with a maximum depth of 2 m. The processes involved are shallow landslides, superficial erosion by snow and livestock trampling. Key parameters that influence the emergence of shallow erosion are the geological, topographical and climatic circumstances in an area as well as its soils, vegetation and land use. The negative impact of this phenomenon includes not only the loss of soil but also the reduced attractiveness of the landscape, especially in tourist regions.
One approach identifying and mapping geomorphological elements is remote sensing. The analysis of aerial images is a suitable method for identifying the multi-temporal dynamics of shallow eroded areas because of the good spatial and temporal resolution. For this purpose, we used a pixel-based approach to detect these areas semi-automatically in an orthophoto. In a first step, each aerial image was classified using dynamic thresholds derived from the histogram of the orthophoto. In a second step, the identified areas of erosion were filtered and visually in-terpreted.
Based on this procedure, eroded areas with a minimum size of 5 m2 were detected in a test site located in the Inner Schmirn Valley (Tyrol, Austria). The altitude of the test site ranges between 1,980 m and 2,370 m, with a mean inclination of 36°, facing E to SE. Geologically, the slope is part of the “Hohe Tauern Window”, characterized by “Bündner schists” deficient in lime and regolith. Until the 1960s, the slope was used as a hay meadow. Orthophotos from 2000, 2003, 2007 and 2010 were used for this investigation. Older aerial images were not suitable because of their lower resolution and poor ortho-rectification. However, they are useful for relating the results of the ten-year time-span to a larger temporal context.

No significant increase of erosion could be observed for the investigated ten-year period. The majority of the eroded areas show no distinct trend but rather an irregular pattern of increase and decrease. The results fit well in a larger temporal context: in aerial images of the 1950s, the slope already shows several eroded patches, which did not change until the year 2000. The owners also confirm that erosion was even a problem before abandonment. In this case, the inclination of the terrain seems to exceed the influence of land-use activities.
With the semi-automated detection of such eroded areas, a more objective and time-saving method was found. The results contribute to an improved understanding of the process and can initiate a long-term observation. In subsequent studies we will apply the approach to further test sites and adapt it for the detection of smaller eroded areas.