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Spatio-temporal analysis of soil degradation in Swiss alpine grasslands based on Object-Based Image Analysis

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Alpine grasslands are seriously affected by soil degradation due to various forms of soil erosion, amplified by the extreme prevailing topographic and climatic conditions. Climate change is expected to have a strong impact on the alpine region causing not only an increase in temperature but also a change in frequency and increase in intensity of precipitation events. Combined with changing land-use practices, an increase in soil degradation is anticipated. Historically and due to the different tools and methods used, scientific studies focus mostly on one or two types of soil degradation processes (e.g., landslides, live-stock trails, rill or inter-rill erosion). With this study, we present a holistic approach to identify and monitor the different types of processes causing soil degradation in alpine grasslands.

High-resolution aerial images taken between 1993 and 2015 are analysed to identify soil degradation at catchment scale at selected sites in the Swiss Alps (Urseren-, Bedretto- and Piora valley). The mapping of the degraded soil (bare and low vegetation cover) areas is carried out with an object-based image analysis (OBIA) rule-set developed with the software eCognition Developer. In addition to using the spectral properties of the aerial images, it allows for integrating information gained from a digital elevation model as well as various thematic vector layers. This supplementary information allows for a more precise classification of the objects. The mapped degraded soil for the respective years is further used to identify increasing, decreasing, fluctuating as well as permanently degraded sites during the investigated time period. Additionally, the mapped soil degradation sites are classified into the different occurring processes. The temporal investigation over several decades allows for the analysis of fast developing processes as well as gradually developing processes.

First results of the three valleys show a general increase in landslide incidence with a distinct shift of the landslide susceptibility zones. While in the Urseren valley the increase occurs mainly at low elevation and more intensely managed grasslands (1500-1750 m asl), the increase in the other valleys occurs above the managed grassland at south-east to south-west facing slopes. As such, the latter shift is likely triggered by changes in climatic conditions. The results provide a comprehensive understanding of the occurring degradation processes over time as well as their spatial distribution and as such may improve our understanding of the status and trends of alpine grassland soil degradation.