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Feedbacks between vegetation and solifluction processes on hillslopes: a case study of an alpine turf-banked solifluction lobe

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Solifluction is one of the most widespread processes transporting soil on hillslopes in periglacial environments. While periglacial geomorphologists identified climatic and soil parameters as most important factors influencing solifluction, ecologist have long recognized the importance of vegetation and the co-occurrence of certain species and vegetation communities with solifluction processes and landforms. However, the mechanism of vegetation influences on solifluction, as well as feedbacks between solifluction processes and vegetation, which result in specific vegetation organization and specific landforms, e.g., turf-banked solifluction lobes, is only partly understood.

The aim of our study is to improve the understanding of feedbacks between vegetation and solifluction processes and landforms by using established and up-to-date methods in a detailed small-scale study on a turf-banked solifluction lobe in the Turtmann glacier forefield (Switzerland). Our objectives are (i) to examine the effects of species composition and vegetation organization on landform properties; (ii) to investigate the effects of landform properties on species composition and vegetation organization and (iii) to evaluate if feedbacks create turf-banked solifluction lobes as biogeomorphic structures. To assess solifluction lobe and vegetation properties, we employed a detailed geomorphic and vegetation mapping (1:50), complemented by an UAV derived high-resolution orthophoto and DEM, and 2D and 3D electrical resistivity tomography (ERT) measurements in combination with soil moisture measurements.

Vegetation mapping shows that (i) dwarf shrubs, which through their plant functional traits can act as engineer species, are the main species covering the solifluction lobe. Geomorphic mapping, DEM terrain analyses and 3D ERT indicate that (ii) lobe geomorphometry and material properties (grain size, moisture) strongly influence species distribution and diversity. 2D ERT shows permafrost-free conditions and a pronounced lobe (depth of up to 3 m), despite low terrain age (< 90 years). This indicates the importance of positive feedbacks between vegetation, soil texture and moisture and solifluction processes for lobe development and supports the identification of turf-banked solifluction lobes as a biogeomorphic structures.