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Modeling alpine permafrost distribution using rock glacier inventory data and logistic regression analysis

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In high mountain geosystems, permafrost plays an important role for the activity of many geomorphic processes. Consequently, the existence of permafrost and its reaction to climatic changes influence the development and spatial distribution of sediment storages. Thus, knowledge of permafrost distribution and its sensitivity to climatic changes is an important component of sediment budget studies in high mountain geosystems. To determine regional permafrost distribution, rock glaciers have been mapped in the Turtmanntal, a meso-scale geosystem (area: 110 km^2) in the central Swiss Alps. The rock glaciers have been compiled in an inventory and represent the data basis for an empirical-statistical permafrost distribution model. The inventory contains geomorphological and geomorphometrical data of 83 rock glaciers at all states of activity. Geomorphological mapping in the field and geomorphometrical analyses are supported by high resolution image and digital elevation data (resolution: 1 m) obtained by an airborne version of the High Resolution Stereo Camera (HRSC-A), which has been developed by the German Aerospace Centre (DLR). The empirical-statistical permafrost distribution model PSIM presented here is based on a logistic regression analysis. In this analysis, active and relict rock glaciers represent the dependent variables whereas potential direct solar radiation and mean annual air temperature (represented by altitude) are the explanatory variables. Since (active) rock glaciers, representing local occurrences of permafrost, have been related statistically to calculated solar radiation and air temperature (altitude), the approach of the model PSIM is novel. According to PSIM, the probability of permafrost is high at approximately 33 % of the study area. In the Turtmanntal, many active rock glaciers occur at the lower boundary of the modelled permafrost distribution. As the activity of rock glaciers depends on the existence of permafrost, these rock glaciers will become inactive soon in the course of an expected shift of the lower permafrost boundary to

higher altitudes. This will lead to a major change in the configuration of the geosystem regarding sediment budget.