



Mountain Permafrost in Change – History, Status Quo, Scenarios

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In the higher zones of the Alps, glacial and permafrost ice react very sensitively to climate change. In addition, erosion processes are very intensive here. Thus, the rise of temperature since the end of the Little Ice Age ca. 150 years ago, has distinctively affected the glacial and periglacial zones in particular. Glacier retreat, increase of permafrost temperatures, slope instabilities and mass movements are indicators for the reaction of the alpine environment to climate changes that have occurred. They have considerable influence upon the present and future natural hazard potential.

Commissioned by the Province of South Tyrol Nature Park Agency in Bozen, investigations on the spatial distribution of permafrost and its degradation in the Rieserferner-Ahrn Nature Park in South Tyrol have been carried out since May 2005. In the past years in this area, there have been repeated mass movements and debris flows in areas that were still glaciated or solid due to permafrost 50 - 60 years ago. In addition, damages to high altitude buildings and infrastructure caused by settlement due to ground ice melting have been recorded. The research in the Nature Park is integrated into the national monitoring programme of the Autonomous Province of South Tyrol (PROALP: Mapping and Monitoring of Permafrost in the Alps using Differential Radar- Interferometry). In this context, the investigation area is one of four permanent monitoring areas.

The study in the Rieserferner-Ahrn Nature Park is based on the evaluation and analysis of geomorphological, hydrological and physical permafrost indicators, such as rock glaciers, frozen talus and moraines, perennial snow patches, basis temperature of the winter snow cover (BTS) as well as temperature and electrical conductivity of melt water. Model calculations, derived from the distribution and characteristics of the permafrost indicators, were carried out to quantify the current permafrost area in the Nature Park. Furthermore, as a basis for the hazard analysis, the potential extent of the permafrost areas for colder and warmer time periods was calculated. This allows the environmental situation in the Nature Park to be simulated under “stable“ geomorphologic conditions on the one hand (larger permafrost area from the time period before the significant current warming) and under “unstable” geomorphologic conditions on the other hand (smaller permafrost area with further increasing temperatures).

The investigation results indicate that the degradation of the permafrost in the Rieserferner-Ahrn Nature Park has largely reached the limits of the range of the postglacial variations. The current area that has a high probability of permafrost is approximately 109 km². This area has decreased in the past 150 years by approximately 50 %. A temperature increase of 1 - 2° C by the middle of the 21st century would let the lower permafrost boundary rise ca. 200 - 300 m. Under such a scenario, the permafrost area would decrease by another ca. 72 % of today's extent to ca. 30 km². Permafrost would only be found in the higher crest areas. Permafrost slopes below 3000 m asl would thaw, which would have corresponding consequences for the geo-technical stability. At the same time, the water bound in the permafrost would be reduced from 950 to 270 million cubic metres.