



## **PROALP - Mapping and monitoring of permafrost phenomena in the Autonomous Province of Bolzano, Italy**

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Permafrost is highly sensitive to changes of the climatic conditions. During the last summers, increasing intensities and higher frequencies of both rock fall and debris flow processes have been observed throughout the Alps. In 2005, the authorities responsible for natural hazards and risk management in the Autonomous Province of Bolzano started a project which a) aims at monitoring the impact of environmental changes on mountain permafrost areas and b) gains to develop an information basis for the assessment of natural hazards related to these shrinking permafrost zones. In this project, different methods of permafrost detection and mapping were combined. For the whole territory an inventory of rockglaciers was compiled on the basis of information derived from orthophotos, stereo pairs of aerial photos and the laserscan DEM. Multi-temporal analyses were used a) to derive an inventory of perennial snow patches from orthophotos and b) to establish an inventory of slope movements in mountain permafrost areas by means of SAR interferometry (DiffSAR) applied to spaceborne C- and L-band data starting from 1993 until 2007. Additionally to the regional investigations, detailed geophysical, hydrological (water temperature, electrical conductivity, discharge), geochemical and morphological measurements were carried out in five specific test-sites. At one test-site BTS-measurements, which originally started in

1994 were repeated annually. On specific rockglaciers, georadar measurements (GSS SIR System 2000 with a multiple low frequency antenna; center frequency 35 MHz, constant antenna spacing in point mode) provided information on the internal structure and thickness of active rock glaciers. Surface flow velocities of rock glaciers were measured by using the differential GPS technique. The high precision terrestrial survey results were compared with the results of the DiffSAR slope movement measurements. The combination of detailed investigations in a local scale with regional-scale mapping methods allowed for a cross-validation of the various approaches and, in a further step, an extrapolation of geomorphologic characteristics of different test-sites to the entire region. Due to the multi-temporal approaches a basis for the characteristics of developments in permafrost areas due to changing environmental conditions was built up, e.g. for slope movements since the mid 1990ies. The datasets provide a valuable basis for decision-making in risk management regarding permafrost related processes.