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A decision support tool to help prevent risks induced by permafrost degradation in high alpine environments

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In the framework of the Federal Office for the Environment (FOEN) pilot program “climate change adaptation” and with support from the canton of Valais, a computerized monitoring tool has been developed for the management of natural hazards inherent to the degradation of permafrost in Alpine environment. This tool is primarily intended to municipal and regional actors involved in local management of natural hazards. Ultimately, it is intended to integrate the future cantonal platform for the monitoring of slope instabilities, GUARDAVAL 2.0.

Following several years of high temperatures, 2015 was the warmest year ever recorded since the beginning of meteorological measurements (OMM, 2016). As demonstrated by recent observations of the Swiss Permafrost Monitoring Network (PERMOS), this has direct impact on the evolution of permafrost that never warmed as much as during the hydrological year 2014/2015 since the beginning of measurement. Besides the destabilization of high altitude rocky slopes, an additional effect of the permafrost melt is a significant increase in rock glacier creep rate that rose by 20% on average compared to the previous year (SCNAT, 2016). The purpose of the climate change adaptation FOEN pilot program, initiated in 2013 in Valais, is to provide an integrated concept for handling debris flows issued from permafrost degradation through the study of two sites (Figure 1): the debris covered glacier Bonnard located above the village of Zinal in the Val d'Anniviers and the rock glacier Bielzug located above the village of Herbriggen in the Mattertal.

This decision support system is based on the computation of a series of direct (rainfall, air/ground temperature, snowmelt) and indirect (rock glacier movements, photographic survey) weather/climate indicators. The aim of this system is to help municipal natural hazards specialists detect and anticipate a potentially hazardous situation based on operational data available (observations, forecasts) and, if necessary, to enter vigilance state.

Basic data are heterogeneous both in source and type:

- Land-based observation (federal, cantonal and local networks), rainfall radar measurements (MeteoSwiss data) or satellite imagery (MODIS),
- Rainfall and temperature forecasts (MeteoSwiss COSMO products)

They are fetched in real time from the different cantonal databases dedicated to natural hazards management. The collected data are consolidated, structured, enhanced and aggregated so they can be displayed to the user as tailored views (charts, maps, indicators) via a synthetic and interactive dashboard (Figure 1) providing an overview of the periglacial system's current hazard status.

The web portal development was conducted from the early design phase by a multidisciplinary team, including, in addition to computer scientists, experts in natural hazards and permafrost. They brought their knowledge of periglacial environments and dynamics for selecting the relevant parameters and to develop the calculation method for the indicators.