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Experimental analysis of seasonal processes in shallow landslide in a snowy region through downscaled and in situ observation

Laura Longoni[1], **Lorenzo Panzeri**[1], Michele Mondani[2], and Monica Papini[1]
[1]Politecnico di Milano, Department of Environmental and Infrastructure Engineering , Italy (laura.longoni@polimi.it)
[2]Politecnico di Torino University, Department of Environment, Land and Infrastructure Engineering, Italy

The frequency and intensity of heavy precipitation events increased since the mid-20th century and, considering the climate crisis, it is important also to analyze the effects of processes and events that lead to faster snow mantle melting cycles in mountain areas.

Shallow landslides are induced by extreme hydrological events such as the occurrence of short and intense rainfall or by events of medium intensity but prolonged over time. Such slips involve generally reduced portions of land both in area and in thickness, however, they are dangerous due to the absence of warning signals and the lack of knowledge regarding their possible evolution.

This work deals with the experimental study of these landslides through the laboratory simulations on a small-scale slope, reproduced at the LIMAG Lab - Laboratory of mountain hydraulics and applied geology of the Lecco Campus and in situ seasonal processes observation at a mountain closed basin nearby Champoluc village in Aosta Valley region.

The central objective is to study the evolution of shallow landslides in reduced scale caused by external factor as snowmelt and rainfall and to compare the observations done in laboratory with the ones in situ. In order to investigate the behaviour of shallow landslides in these critical conditions, a series of sensors have been installed on the simulator. This technology includes three modified pressure transmitters for the pore water pressure evaluation which have been accompanied by other support instrumentation consisting of GoPro's cameras, TDR (Time Domain Reflectometry) and georesistivimeter; all of them provide a cross check of phenomena processes.

Throughout the downscaled simulations with snow cover it was possible to observe several processes. The direct interaction between snow and ground does not favor the infiltration of a large amount of water. The protective role of snow lies in keeping the first film of soil at 0 degrees and loading the soil by decreasing its infiltrative capacity; this no longer occurs when the water melted by the snow flows downstream and begins to infiltrate into uncovered and warmer soils. Without thermal or overload barriers, the water pours into the ground. Therefore, a potential susceptible area can be the subject of different filtering and infiltrative contributions from upstream, saturating quickly and collapsing.

These laboratory experiments are the starting point for the in-situ analyses and provide a

comparison with the observations made by means of ad hoc instrumentation set up at the Champoluc station. Highly detailed information is obtained concerning the density and thickness of the snowpack during seasonal processes. These contribute to defining the hydrogeological processes within the terrain, already studied in the laboratory, and to establishing the water balance.