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Multi-scale analysis of slope-mass wasting under climate change: from laboratory tests to regional assessment in the Pyrenees.

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Slope mass-wasting induced by rainfall and associated sediment transfer have multiple impacts on mountainous regions. With ongoing climate change mean and maximum temperature as well as extreme precipitation events are expected to continue rising considerably over the next decades.
In a multidisciplinary research project, we investigate the impacts of climate change at different scales. Special attention is paid to the soil-plants-atmosphere interactions (SPAI) under climate and vegetation changes. Therefore, laboratory tests and a full-scale experiment are conducted under controlled conditions, while in-situ monitoring at slope and catchment scale is performed in natural environments. In addition, our inventory of shallow slides and debris flows occurred in the Pyrenees is used to analyse the effect of vegetation and other factors at regional scale. All the different results are compared and our coupled thermo-hydro-mechanical program Code_bright simulates the physical processes in order to make forward predictions.
The full-scale experiment is of great importance for this study, since monitoring data is a key aspect for a better understanding of the SPAI and for the calibration of the numerical model. A 2.5 m high and 18 m long embankment was built near Barcelona and multiples sensors were installed enabling more than 100 time-series on temperature, heat flux, soil moisture, suction etc. Four slope partitions are analysed distinguishing between different orientations (south and north) and vegetation (bare and vegetated slope).
First results confirm the positive effect of vegetation on the soil strength and thus the influence on the probability of slope mass-wasting. This effect was detected in both the laboratory tests and the susceptibility analysis of the slope failures observed during the 2013 episode, which affected the Central Pyrenees. On the other side, preliminary results of the monitoring data from the full-scale experiment show a clear effect of the slope orientation on the temperature profile in the shallow soil layer.