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Measurement of velocity profiles in real scale debris flows

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To mitigate natural hazards like debris flows, the velocity of the moving mass is an important factor for modeling the runout as well as for designing impact forces on structural measures. Especially the connection between pore fluid pressure and the internal deformation behavior is of fundamental interest for understanding the mechanics of the process. Up to now, most investigations were made in small scale experiments, which may be affected by scaling issues.

For this contribution, we measured vertical velocity profiles in natural debris flows using an array of paired conductivity sensors installed on a novel monitoring barrier in the Gadria creek, Italy. We present results from two debris flow events, with different sediment concentrations and volumes of around 5,000 m^3 each. Additional to basal total normal stress, we measured basal pore fluid pressure and local flow depth at two locations close to the velocity profiler.

The flows exhibited significant longitudinal changes of flow properties like flow depth, mean velocity and density. The liquefaction ratios reached values up to unity in some sections of the flow event, which had higher sediment concentrations. Corresponding velocity profiles were mostly concave up, while the profiles for the more liquid event were linear to convex.

Though limited by boundary roughness at the wall and occasional sediment deposition on the force plates and pressure sensors, these measurements provide new insights in the dynamics of real-scale debris flows.