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Debris flow reconstruction - geomorphologic and numerical approach. A case study from the Selvetta event in Valtellina, Italy, July 2008

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On Sunday morning of 13th July 2008, after more than two days of intense rainfall, several debris and mud flows were released in the central part of Valtellina valley between Morbegno and Berbenno. One of the largest debris flows occurred in Selvetta, a fraction of Colorina municipality. The debris flow event was reconstructed after extensive field work and interviews with local inhabitants and civil protection teams. At
first several rock blocks about 2 m3 in size fell down from the direction of the torrent. The blocks were followed by a wave of debris and mud that immediately destroyed one building and caused damage to other nine houses. A stream flow following the debris flow consisting of fine mud with high water content that partially washed away the accumulation of deposits from the debris phase could also be distinguished.

Geomorphologic investigations allowed identification of five main sections of the flow: 1) the proper scarp; 2) path in the forested area; 3) path on the alpine meadows; 4) accelerating section; 5) accumulation area. The initiation area of the flow is situated at 1760 m. a.s.l. (1480 m above the deposition zone) in a coniferous forest. The proper scarp consisted of an area of approximately 20 m2 in size, and a height of about 0.8 m. The final volume of the debris was estimated by field mapping to be between 12 000 and 15 000 m3. It was observed that erosion and entrainment played an important role in the development of the debris flow.

The Selvetta event was modelled with the FLO2D program. FLO2D is an Eulerian formulation with a finite differences numerical scheme that requires the specification of an input hydrograph. The internal stresses are isotropic and the basal shear stresses are calculated using a quadratic model.

Entrainment was modeled at each section of the flow, and different hydrographs were produced in agreement with the behavior of the debris flow during its course. The significance of calculated values of pressure and velocity were investigated in terms of the resulting damage to the affected buildings. The physical damage was quantified for each affected structure within the context of physical vulnerability, which is defined as the ratio between the monetary loss and the reconstruction value. Two different empirical vulnerability curves were obtained, which are functions of debris flow velocity and pressure, respectively.