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Quantitative risk assessment using empirical vulnerability functions from debris flow event reconstruction

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For a quantitative risk assessment framework it is essential to assess not only the hazardous process itself but to perform an analysis of their consequences. This quantitative assessment should include the expected monetary losses as the product of the probability of occurrence of a hazard with a given magnitude and its vulnerability. A quantifiable integrated approach of both hazard and risk is becoming a required practice in risk reduction management. Dynamic run-out models for debris flows are able to calculate physical outputs (extension, depths, velocities, impact pressures) and to determine the zones where the elements at risk could suffer an impact. These results are then applied for vulnerability and risk calculations. The risk assessment has been conducted in the Valtellina Valley, a typical Italian alpine valley lying in northern Italy (Lombardy Region). On 13th July 2008, after more than two days of intense rainfall, several debris and mud flows were released in the central part of valley between Morbegno and Berbenno. One of the largest debris flows occurred in Selvetta. The debris flow event was reconstructed after extensive field work and interviews with local inhabitants and civil protection teams. Also inside the Valtellina valley, between the 22nd and the 23rd of May 1983, two debris flows happened in Tresenda (Teglio municipality), causing casualties and considerable economic damages. On the same location, during the 26th of November 2002, another debris flow occurred that caused significant damage. For the quantification of a new scenario, the outcome results obtained from the event of Selvetta were applied in Tresenda. The Selvetta and Tresenda event were 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. 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. Prospective economic direct losses were estimated.