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Multi-scale quantitative vulnerability assessment of buildings towards debris-flows: an application to Fella River Basin, Italy

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In physical vulnerability assessments, selection of working tools and methods is dependent not only on practical applications or decision question and data availability, but also on the scale of investigation. The aim of this study is to implement and compare two methodologies for assessing vulnerability of buildings in Fella River Basin (Friuli-Venezia Giulia, Italy). In this region, a major rainfall event in August 2003 triggered more than a thousand debris flows and floods resulting in two casualties. Damages to buildings, communication and transport infrastructure exceeded 400 million euros of monetary losses.
The approaches considered are developed based on two methods of estimating debris-flow intensities: (1) for the regional and local scale, the behavior and run-out of the flow event was reconstructed using numerical debris flow modeling (Flow-R and Flow2D, respectively) to generate physical outputs (extension, depth, impact pressure, velocities) and determine the areas where elements at risk can be impacted; (2) for the local scale, a second method uses orthophoto documentation acquired shortly after the 2003 event for determining the location of the debris deposition and its depth at each impacted building. An extensive building inventory comprising information about the material of construction, occupancy type and use was compiled by desktop mapping and field work. The significance of the calculated intensity values were investigated in terms of resulting physical damages which were quantified for each affected structure as the ratio between the monetary loss and the reconstruction value.
Different empirical vulnerability curves were obtained as functions of debris flow depth and impact pressure, respectively. The obtained curves were lastly compared with existing ones from the literature and sources of uncertainty from data input and the models employed were studied and discussed. The results of this study can be applied to further local consequence analysis and risk calculations, but can also been applied in other regions worldwide where respective data are available.