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Back-analysis of the Abbadia San Salvatore (Mt. Amiata, Italy) debris flow of July 27-28, 2019 using the WEEZARD system

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Mountain environments are naturally exposed to debris flows, a mass movement which represents one of the major geomorphological hazard sources for urbanized alluvial fan. In the last decades, climate change has contributed to extreme precipitations increase, making debris flows both larger and more frequent than in the past. The assessment and management of the risk associated with these events, according to UE Flood Directive, is feasible and desirable by using appropriate practices and the best available technology that do not imply excessive costs.
In line with the above-mentioned European Directive, we present a multidisciplinary approach for the numerical modelling of the debris flow event that occurred on July 27-28, 2019 in Abbadia San Salvatore, a village located in a catchment of the Mt. Amiata area (Southern Tuscany, Italy). Debris flow was triggered by an extreme rainfall of 110 mm/1 h causing a channelled erosive process, and the subsequent obstruction of a culvert at the entrance to the village, flooding and damaging it.
Mt. Amiata is an extinct Pleistocene volcano mainly consisting of trachidacitic lavas characterized by a pervasive saprolite weathering, resulting in a large amount of residual loose debris resting on the hillslopes and along the hydrographic network. Specific geological and engineering-geological field investigations were carried out to assess the availability of debris material and its hydrological behaviour, providing more constraints for numerical modelling.
The Green-Ampt model, implemented in the FLO-2D software, was used for the evaluation of discharge values in the hydrographic network. Subsequently, the debris flow modelling was conducted applying the WEEZARD system, composed of a previously developed advanced two-phase debris-flow model (TRENT2D), re-coded as a web service. The mass movement was simulated to quantify erosive and depositional processes that occurred during the event. In addition, a specific approach was implemented to model the effect of the culvert that was clogged during the event.
Despite the challenging modelling aspects, the results in terms of debris volume, erosion rates, flooded area and timing of the culvert obstruction, are in agreement with observed data.
The WEEZARD system has therefore proved to be an effective tool, in line with the indications of the European Directive. Moreover, the reconstruction was obtained using most of the a priori parameters setting. This shows that the used modelling approach has a good predictive capacity and can therefore be reasonably used to support further predictive hazard mapping analyses. Finally, another important element to be highlighted is that an accurate input model based on the integration of detailed geological-geomorphological investigations is necessary to obtain reliable modelling results.