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Assessment and mapping of debris flow hazard through integrated physically based models and GIS assisted methods.

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Catastrophic events periodically occur in the area of Messina (Sicily, Italy). Both in October 2007 and in October 2009 debris/mud flows triggered by heavy rainfall affected various towns and villages located along the jonian coast of the town, highlighting the destructive potential of these events. The two events gave rise to severe property damage and in the latter more than 40 people were killed.
Objective of this study is to present an integrated modelling approach based on three different models, namely an hydrological model, a slope stability model and an hydraulic model, to identify potential debris flow hazard areas. A continuous semi-distributed form of the well known hydrological model IHACRES has been used to derive soil moisture conditions by simulating the infiltration process in Hortonian form. As matter of fact, the soil is conceptually schematized with a catchment storage parameter which represents catchment wetness/soil moisture.
The slope stability model allows identifying potential debris-flow sources and is based on the model SHALSTAB that permits to detect those parts of the catchment whose stability conditions are strongly affected by pore water pressure build-up due to local rainfall and soil conductivity and those parts of the basin that, conversely, are unconditionally stable under static loading conditions.
Assuming that the solids and the interstitial fluid move downstream with the same velocity, debris flow propagation is described using a two dimensional depth averaged model. Based on extensive sediment sampling and morphological observations, the rheological characterization of the flowing mixture, along with erosion/deposition mechanisms, will be carefully considered in the model. Differential equations are integrated with an implicit Galerkin finite element scheme or, alternatively, finite volume methods.
To illustrate this approach, the proposed methodology is applied to a debris flow occurred in the Mastroguglielmo catchment in September 2007. This event was used to calibrate model parameters needed for simulations. Based on the simulation results, potential hazard zones were mapped and presented by using a GIS interface.