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A methodological approach for mapping mudflow potential through integrated Cellular Automata modelling, Genetic Algorithms, and GIS techniques, combined with historical and hydrological analyses of major past events. An example of application to the Bagnara-Scilla coastal sector (Calabria, Southern Italy).

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An integrated method for mapping mudflow potential on the coastal sector between the villages of Bagnara and Scilla (Calabria, Southern Italy) by applying the Cellular Automata model SCIDDICA is described, together with employed techniques of calibration and validation through Genetic Algorithms. The study area is located along the Tyrrhenian coast: it is crossed by notable road (highway SA-RC, motorway SS.18) and railway (Rete Ferroviaria Italiana) networks, and is diffusely urbanised. It has repeatedly been affected by mudflow damaging events in historical time (even very recently), and shows evidence of a dominant NE-SW-trending normal fault system.

In this study, some of the recentmost mudflow damaging events have been selected for model calibration and validation purposes, by applying Genetic Algorithms. Quantitative evaluation of the simulations, with respect to the real events, has been performed by means of a simplified fitness function which mainly considers the affected areas. A Sensitivity Analysis is still in progress, in order to thoroughly evaluate the role of parameters, topographic input data, and mesh geometry on model performance; though, preliminary results have already given encouraging responses on model robustness.

In order to evaluate the mudflow potential in the study area, a regular grid of possible sources, uniformly covering the considered area, has been hypothesised. For each source, a statistically-significant number of simulations has been planned, by adopting combinations of sources' extent (volume) and material characteristics, selected by considering available geological and historical data. Performed simulations have been stored in a GIS environment for successive analyses and map elaboration. Probabilities of activation, empirically based on past events, have been assigned to each source of the grid, by considering its location, slope, and presence of erodable regolith. Similarly, different probabilities can be assigned to each "type of event" (i.e. the considered combinations of volumes and material properties), by also taking into account the observed historical frequencies of cases and the results of hydrological analyses of the triggering meteoric events. In such a way, an implicit assumption has been made that the morpho-evolutive style will not dramatically change in the near future.

Depending on adopted criteria for probability evaluation, different maps of mudflow potential can be compiled, by taking into account both the overlapping of the simulated mudflows, and their assumed probabilities, by also ranking computed values into few classes of relative potential. The adopted methodology also allows to rapidly exploring changes in mudflow potential as a function of varying probabilities of occurrence, by simply re-processing the database of the simulations stored in the GIS. For Civil Protection purposes, in case of expected imminent triggering of a source in a given sector of the study area, re-processing may help in real-time forecasting the presumable affected areas, and thus in better managing the hydrogeological crisis. Further simulations can even be added to the GIS data base at any time new different types of event were recognised to be of interest.

In this study, two examples of maps of mudflow potential for the coastal sector between Bagnara and Scilla are presented. The first has been realised without assigning any probability to the performed simulations, by simply counting the frequencies of mudflows affecting each site. In the second map, information on past events is taken into account, and probabilities are "empirically" attributed to each simulation based on location of sources and types of event. Despite only preliminary (as based on a subset of the overall planned simulations), the maps clearly depict the most hazardous sectors, according to the assumed criteria.