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Applying non-uniform grids to evaluating susceptibility from flow-type phenomena: an example of application to Mount Etna

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The hazard induced by dangerous flow-type phenomena – e.g. lava flows, earth flows, debris flows, and debris avalanches – can be assessed by analysing a proper set of simulations of hypothetical events. Non-uniform grids are commonly used to study particular areas of interest in computational domains. Examples of application concern, for instance, the turbulence in a boundary layer. While non-uniform grids frequently appear in adaptive methods, they may also be used in a "static" environment.

A purposive sampling method, based on a non-uniform grid of sources coupled with numerical simulations of independent events, has recently been employed to evaluate the hazard induced by flow-type phenomena. An example of application to lava-flows at Mount Etna (Italy) is described in this study. The method aims at refining the spatial distribution of hypothetical eruptive vents with respect to an original uniform grid.

The density of eruptive vents has been determined by considering the historical distribution of lateral and eccentric vents, and the distribution of the main faults/structures on the volcano. A higher number of sources marks higher-probability zones of vent opening, based on classes of activation: the number of vents in each class has been set proportionally to the probability of activation of the class.

By considering the different types of eruption expected from the considered volcano, based on the historical activity of the past 400 years, a set of simulations per each vent has been performed. The employed model is SCIARA-fv2, a Cellular Automata numerical code recently applied to the same study area for preliminary hazard analyses. In this work, calibration could therefore be skipped, by taking advantage from such experience of tuning of the parameters.

Performed simulations have been analysed by a GIS, to verify the number of events affecting each cell of the domain. A probability of occurrence could be assigned to each simulation, based on statistics of historical events: the spatial hazard has then been obtained by considering the summation of the probabilities associated to the simulated flows affecting each point of the study area.

With respect to a uniform distribution of vents, the non-uniform grid permits mapping lava-flow susceptibility from the higher-probability zones with a finer resolution. By comparing the results obtained with a non-uniform grid of vents with those of a uniform one, the following differences can be appreciated: in the first case, the extent of the highest probability zones is greater, while that of the lowest probability zones is smaller than in the second case. Moreover, a refined description of the boundaries of the most threatened areas can be obtained. Further analyses are in progress, concerning the temporal validation of the results.