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Morphological evolution of protective works by Genetic Algorithms: An application to Mt Etna

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The hazard induced by dangerous flow-type phenomena – e.g. lava flows, earth flows, debris flows, and debris avalanches – has increased in recent years due to continuous urbanization. In many cases, the numerical simulation of hypothetical events can help to forecast the flow path in advance and therefore give indications about the areas that can be considered for the construction of protective works – e.g. earth barriers or channels. In this way, urbanized areas, as well as cultural heritage sites or even important infrastructures, can be protected by diverting the flow towards lower interest regions.
Here, we have considered the numerical Cellular Automata model Sciara-fv2 for simulating lava flows at Mt Etna and Genetic Algorithms for optimizing the position, orientation and extension of an earth barrier built to protect the Rifugio Sapienza, a well-known touristic facility located near the summit of the volcano. The Rifugio Sapienza area was in fact interested by a lava flow in 2003, which destroyed a Service Center, a parking area and a Cafeteria. In this study, a perimeter was devised around the Rifugio (i.e. security perimeter), which delimitates the area that has to be protected by the flow. Furthermore, another perimeter was devised (i.e. work perimeter), specifying the area in which the earth barrier can be located. The barrier is specified by three parameters, namely the two geographic coordinates of the vertex and the height. In fact, in this preliminary analysis the barrier was modeled as a segment (in plant) having a constant height.
Though preliminary, the study has produced extremely positive results. Among different alternatives generated by the genetic algorithm, an interesting scenario consists of a 35 meters barrier high solution, which completely deviates the flow avoiding that the lava reaches the inhabited area. The relative elevated height of the barrier is high due to the fact that the crater is located close to the area to be protected and, consequently, the lava rate is very high.