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DEM-due uncertainties in gravity-driven mass movements on Earth surface

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The gravitational force, on Earth, drives a large variety of mass movements bounded by the ground surface. As a first approximation, these movements are always driven along the steepest descent path of the surface. As a consequence, the morphology of the bedrock is crucial in determining the path of surficial flows, and the characterization of its mathematical representation (Digital Elevation Models - DEMs) is of primary importance in environmental studies. We present two novel maps characterizing in an effective way the interplay between a gravitational mass flow and the surface over which the mass moves. In the first map (type 1 map), each point express the susceptibility of mass movements starting from this point to stay channellized or to spread over the surface. In the second map (type 2 map), each point express how the resulting mass movements remain stable as the starting point is shifted by a given distance. We take lava flows as mass movement test case and the flanks of the Mount Etna volcano (Sicily, South Italy) as surface test case. We perform our analysis by elaborating a large database of lava flow simulations carried out by using the DOWNFLOW code, which has been extensively used for lava flow forecasting at several basaltic volcanoes (Mount Etna, Mount Nyiragongo and Mount Cameroon). These simulations are triggered from about 70,000 possible future vents located at the nodes of a 80 m-spaced grid covering a wide area of the volcano, from the summit craters down to the lower flanks. These maps are of use in hazard and risk assessment because at the onset of a new eruption, as far as the new forming vent is set on the maps, they allow the characterization of two important properties of the expected lava flow. Type 1 maps tell, at each point, if the flow venting at that point or reaching that point is expected to spread or not over topography, helping in designing barriers for lava flow diversion. Type 2 maps provide the DEM-due uncertainty on lava flow path as a function of the precision in vent position, and is very useful to design a new hazard map. Maps like the one presented here can be derived for different kinds of gravity-driven mass movements over the Earth surface in other areas.