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The 1st October 2009 Messina debris flows: first analysis for a susceptibility model

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In the evening of the 1st of October 2009, a sector of the Messina district (Sicily, Italy) was struck by a number of debris flows, triggered by extraordinary intense rainfall that, from 2 pm to 10 pm, discharged an amount of more than 160 mm and that followed the ones of September 23-24 (more than 200 mm in 10 hours). A number of villages (Altolia, Briga, Giampilieri, Guidomandri, Itala, Molino, Pezzolo, Scaletta), suffered for severe damages, including the destruction of houses and small buildings and more of 30 deaths.

The area is located South from the city of Messina and mainly includes five short fluvial basins, that from the Peloritanian chain drain south-eastward for some kilometres to the Ionian sea. The area is characterized by the outcropping of metamorphic rocks and, due to the closeness of the chain (ranging up to 1200 meters a.s.l.) to the sea, the steepness of the slopes is typically very high.

The debris flows involved the shallow layer made up of colluvial/eluvial and landslide deposits, having a thickness of some decimetres; both pure debris flow and debris slide movements have been inferred at the initiation zones, in light of the morphologic features of the source area (scarps). Also, according to the specific patterns recognized for the flow track zone, four typologies have been distinguished: ribbon-shaped, triangular, arch-shaped and multi-lobed debris flow. The landslides moved fast, as single or multiple/successive confluent style, so that already at the medium sector of the slopes, where the villages are, huge volumes of the debris flowed.

Due to the shallowness of the failure zone, the high water content and velocity, the tracks of the debris flows have been highly controlled by hydrography, reaching, where no obstacles were present, the valley floor, with kilometric run-out distances.

To each of the 379 recognized debris flows, which produced a total landslide area of about 7 km2, a landslide identification point (LIP) has been assigned, corresponding to the highest point along the scarp.

In order to define a landslide susceptibility model for the area, a first analysis of the physical conditions characterizing the slopes is proposed, aimed at defining the controlling factors to be included in a multivariate previsional model.

The investigated area, which extends for about 20 km2, was first semi-automatically partitioned into 692 slope units (SLUs), exploiting a DEM and a GIS system, so that morphodynamically independent polygons are delimited. Bedrock lithology, slope angle, length and aspect derived by processing the DEM and a vectorized geologic map, have been assigned to each SLU. By intersecting the LIP and the SLU layers, physical – environmental conditions for unstable slopes have been evidenced. The analysis points out that phyllites and mica schists bedrock lithologies, 25-40° slope angles and 250-350m slope length, more typically characterize the unstable slope units. By analyzing the DEM in the neighbouring areas of the LIPs, 30-35° steep and convex profile curvature are identified as local favourable conditions inside the SLUs, for the initiation of the movement.