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Using Logistic Regression and Random Forests multivariate statistical methods for landslide spatial probability assessment in North-Est Sicily, Italy

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North-East Sicily is strongly exposed to shallow landslide events. On October, 1st 2009 a severe rainstorm (225.5 mm of cumulative rainfall in 9 hours) caused flash floods and more than 1000 landslides, which struck several small villages as Giampilieri, Altolia, Molino, Pezzolo, Scaletta Zanclea, Itala, with 31 fatalities, 6 missing persons and damage to buildings and transportation infrastructures. Landslides, mainly consisting in earth and debris translational slides evolving into debris flows, triggered on steep slopes involving colluvium and regolith materials which cover the underlying metamorphic bedrock of Peloritani Mountains. In this area catchments are small (about 10 square kilometres), elongated, with steep slopes, low order streams, short time of concentration, and discharge directly into the sea. In the past, landslides occurred at Altolia in 1613 and 2000, at Molino in 1750, 1805 and 2000, at Giampilieri in 1791, 1918, 1929, 1932, 2000 and on October 25, 2007. The aim of this work is to define susceptibility models for shallow landslides using multivariate statistical analyses in the Giampilieri area (25 square kilometres). A detailed landslide inventory map has been produced, as the first step, through field surveys coupled with the observation of high resolution aerial colour orthophoto taken immediately after the event. 1,490 initiation zones have been identified; most of them have planimetric dimensions ranging between tens to few hundreds of square metres. The spatial hazard assessment has been focused on the detachment areas. Susceptibility models, performed in a GIS environment, took into account several parameters. The morphometric and hydrologic parameters has been derived from a detailed LiDAR 1×1 m. Square grid cells of 4×4 m were adopted as mapping units, on the basis of the area-frequency distribution of the detachment zones, and the optimal representation of the local morphometric conditions (e.g. slope angle, plan curvature). A first phase of the work addressed to identify the spatial relationships between the landslides location and the 13 related factors by using the Frequency Ratio bivariate statistical method. The analysis was then carried out by adopting a multivariate statistical approach, according to the Logistic Regression technique and Random Forests technique that gave best results in terms of AUC. The models were performed and evaluated with different sample sizes and also taking into account the temporal variation of input variables such as burned areas by wildfire. The most significant outcome of this work are: the relevant influence of the sample size on the model results and the strong importance of some environmental factors (e.g. land use and wildfires) for the identification of the depletion zones of extremely rapid shallow landslides.