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Comparison between different approaches of modeling shallow landslide susceptibility: a case history in the area of Oltrepo Pavese, Northern Italy

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Shallow landslides are triggered by intense rainfalls of short duration. Even though they involve only small portions of hilly and mountainous terrains, they are the cause of heavy damages to people and infrastructures. The identification of shallow landslide prone-areas is, therefore, a necessity to plan mitigation measures. On the 27th and 28th of April 2009, the area of Oltrepo Pavese, northern Italy, was affected by a very intense rainfall event, which caused a great number of shallow landslides. These instability phenomena meanly occurred on slopes taken up by vineyards and caused damages to many roads and one human loss. On the basis of aerial photographs taken immediately after the event and field surveys, it was possible to detect more than 1,600 landslides. After acquiring all the information dealing with topography, geotechnical properties of the involved soils and land use, a susceptibility analysis on territorial scale has been carried out. The paper deals with the application and the comparison, on the study area, of different methods for the susceptibility assessment: a) the physically-based stability models TRIGRS (Transient Rainfall Infiltration and Grid-Based Regional Slope-Stability Model, Baum et al., 2008), which is designed for modelling the potential occurrences of shallow landslides by incorporating the transient pressure response to rainfall and downward infiltration processes and SLIP (Shallow Landslides Instability Prediction; Montrasio, 2000; Montrasio and Valentino, 2008), which allows to dynamically take into account the connection between the stability condition of a slope, the characteristics of the soil, and the rainfall amounts, including also previous rainfalls; b) the logistic regression and the Neural Artificial Network (ANN) that take into account some important predisposing factors in the study area (slope angle, landform classification, the potential solar radiation, soil thickness, permeability, topographic ruggedness index, slope position index).
In order to apply the different methods, a test area, with an extension of 17.5 km2, was selected in the sector of Oltrepo Pavese with the highest density of the April 2009 landslides.
The main peculiarities distinguishing the different models are outlined and their predictive capabilities for the forecasting of the potential source areas are evaluated using a quantitative method (the ROC plot). TRIGRS is characterized by different levels of complexity and its results strongly depend on the quality and detail of input data. The SLIP model allows a “dynamic” (i.e. time-varying) stability analysis on territory scale. ANN and logistic regression are very promising and have the advantage to take into account some important predisposing factors in the study area, that are not considered by the other models.
Finally, both the main limits and the most important advantages of the different methods are discussed, and comparisons between the results obtained are highlighted.

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