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EDITORIAL

Introduction to the special issue "Landslides: forecasting, hazard evaluation, and risk mitigation"

M. Parise · G. R. Iovine · P. Reichenbach · F. Guzzetti

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The papers collected in this special issue of Natural Hazards were originally presented as oral or poster contributions in the sessions "Innovative approaches for evaluation of the landslide hazard and mitigation of the landslide risk" and "Landslide forecasting", which were part of the scientific program of the Geoitalia 2009 meeting, the 7th Italian Forum of the Earth Sciences, held in Rimini, Italy, from 9 to 11 September 2009.

The eighteen papers comprising the special issue of Natural Hazards discuss topics related to techniques, tools, and methods for landslide identification, forecasting, hazard evaluation, and the mitigation of landslide risk. The issue opens with the two keynote lectures invited in the sessions: in the first keynote, Jaboyedoff and co-workers review the application of light detection and ranging (LIDAR) technology for landslide investigation, including the study of slides, rockfalls, and debris flows. The authors discuss critically the application of LIDAR very-high-resolution terrain elevation data for the detection and characterization of landslides, for hazard assessment and susceptibility modeling, and for landslide monitoring and modeling. In the second keynote, Günther and co-workers, discuss a GIS-based deterministic approach for the spatial evaluation of the geometrical and kinematical properties of rock slopes. Based on spatially distributed directional information on planar geological fabrics, and DEM-derived topographic attributes, the internal geometry of the rock slopes is characterized. The obtained information, in combination with hydraulic and strength data on the geological discontinuities, can be used to prepare scenario-based rock-slope stability evaluations, at different geographical scales.

M. Parise (✉)
Consiglio Nazionale delle Ricerche, Istituto di Ricerca per la Protezione Idrogeologica, via Amendola 122-I, 70126 Bari, Italy
e-mail: m.parise@ba.irpi.cnr.it

G. R. Iovine
Consiglio Nazionale delle Ricerche, Istituto di Ricerca per la Protezione Idrogeologica, via Cavour 4-6, 87036 Rende, Italy

P. Reichenbach · F. Guzzetti
Consiglio Nazionale delle Ricerche, Istituto di Ricerca per la Protezione Idrogeologica, via della Madonna Alta 126, 06128 Perugia, Italy

The majority of papers in the special issue (eight papers) discuss research aimed primarily at determining landslide susceptibility at different geographical scales, and for different landslide types, including shallow and deep-seated slope failures. De Falco and co-workers exploit geometrical measurements of shallow landslides to determine an empirical relationship between area and height of the landslides. Working in Campania, southern Italy, the authors measure the total area and the height of the source and transport areas of 213 historical channeled and unchanneled landslides in pyroclastic deposits, and use their empirical dataset to determine a dependence of the landslide area on the landslide height. Adopting this empirical dependency, and assuming a constant thickness for the pyroclastic cover, the volume of the landslides is determined. Results of this study have implications for shallow landslide susceptibility modeling, and for landslide hazard and risk assessments in volcanic areas. Tarolli and co-workers describe new methodologies to extract geomorphological features indicative of shallow landslides and bank erosion from very high resolution (VHR) DTM obtained from LIDAR sensors. The methodologies are based on the detection of thresholds determined through the analysis of the variability of landform curvature. Working in a 0.2 km^2 area in the eastern Italian Alps, the authors find that curvature is scale dependent, and suggest that an appropriate geographical scale has to be selected for the successful extraction of the geomorphological features. The results of this study may facilitate the semi-automatic detection of shallow landslides and bank erosions. Segoni and co-workers compare five different methods for determining the geographical distribution of soil thickness in two different study areas in Tuscany and in Liguria, Italy. The resulting soil thickness maps are used in slope stability distributed model to evaluate the influence of differences in soil thickness in slope stability modeling. The comparative analysis indicates that more sophisticated, geomorphologically based soil thickness models perform better than simplified models based on morphometric parameters. Costanzo and co-workers, working in Sicily, southern Italy, exploit VHR satellite information available through the freely available Google Earth™ software to detect and map landslides in a 20 km^2 portion of the Tumarrano catchment, and adopt a multivariate statistical approach to determine landslide susceptibility using lithology, terrain slope, plan curvature, and wetness index as controlling factors. Rapolla and co-workers propose an alternative method for the regional zonation of earthquake-induced landslide susceptibility. The method, based on the combination of a reduced number of lithological, morphometric, and geophysical factors, was tested in Campania, southern Italy, where a correlation was found between the abundance of the historical earthquake-induced landslides and the modeled susceptibility zonation. Conforti and co-workers adopted a bivariate classification technique to ascertain landslide susceptibility in the Vitravo catchment, Calabria, southern Italy. For their experiment, the authors exploited landslide information obtained through the visual interpretation of aerial photographs and field surveys. To prepare the susceptibility zonation, the landslide information was split in two subsets: one subset was used to construct the susceptibility model, and the other subset was used to test the performance of the susceptibility map. In a similar way, Rotigliano and co-workers, working in Sicily, southern Italy, partitioned a 90 km^2 study area in 774 slope units, and determined the susceptibility posed by 490 landslides in the area. These authors adopted a multiparameter univariate model, which allowed to determine a restricted set of geomorphological factors affecting slope instability. Perriello and his co-workers, working in Campania, southern Italy, use GIS technology to determine the initiation points of destructive shallow soil slips and debris avalanches in terrains mantled by pyroclastic deposits. To prepare soil-sliding susceptibility maps for two areas, the authors use the SLIDE (SLiding Initiation areas

DEtection) model that combines morphometric data and information on the presence or absence of volcanic soils, and of discontinuities in the soils.

Five papers in the special issue deal with miscellaneous topics, from modeling and forecasting of shallow landslides and debris flows, to aspects related to monitoring, modeling, forecasting, and hazard assessment of single landslides. Li and co-workers proposed a fractal method to determine landslide susceptibility. The method is based on the empirical observation that in the Zhejiang Province, China, rainfall-induced landslides cluster geographically. The authors exploit information obtained from historical landslide inventory maps to determine landslide susceptibility. The landslide information is split temporally into two subsets, with one subset used to construct the model and a second subset used for model validation. Palma and co-workers, investigate rockfall hazard and risk along a state road in the Sorrento Peninsula, Campania, southern Italy. Information on the geo-mechanical properties of the rock mass obtained through field surveys, and numerical modeling of rock falls using three different numerical codes, are used to evaluate rockfall hazard. Del Gaudio and co-workers present a new procedure for the assessment of seismic hazard impact on slope stability using the Arias intensity as a measure of the seismic shaking, and the critical acceleration as a measure of the slope strength to seismically induced failure. The methodology was tested in Daunia, southern Italy, where landslides are frequent and abundant. Parise and Cannon discuss the impact of wildfires on the multiple and complex processes that can generate debris flows in burned areas, including accelerated runoff, erosion, and debris flows. Exploiting a unique combination of data on debris flows in burned areas in the Mediterranean and in the Western United States of America, the authors discuss the main processes causing fire-related debris flows, including runoff-dominate erosion by surface overland flow, and infiltration-triggered failure and mobilization of a discrete landslide mass. Salciarini and her co-workers exploit GIS technology to determine physically based rainfall thresholds—of the intensity-duration type—for the possible initiation of shallow landslides. The proposed method, implemented in specific software, evaluates the spatial distribution of the minimum rainfall intensity that can result in shallow landslides and associated debris flows. The method was tested in Umbria, central Italy.

The special issue closes with three papers debating aspects related to monitoring, modeling, forecasting, and hazard assessment of single landslides. Capparelli and her co-workers analyze two recent phases of mobilization of a large, rainfall-induced debris slide at San Benedetto Ullano, Calabria, southern Italy. The authors forecast the dates of activation and the main phases of acceleration of the active mass movement exploiting the FLaIR (Forecasting of Landslides Induced by Rainfalls) hydrological model, which is calibrated using the local rainfall history since 1970. The results are significant for the implementation of a warning system for the large landslide. Calcaterra and co-workers discuss the result of a monitoring effort to detect surface and subsurface movements of two complex, deep-seated landslides in a clay slope in the southern Italian Apennines. A network of six permanent and ten nonpermanent GPS stations was deployed to measure surface measurements, including two GPS stations mounted at the top of inclinometer pipes used to measure the subsurface deformations. Combined analysis of the independent GPS and inclinometer measurements revealed a good correlation between the surface and the subsurface deformations in the landslide areas. Poisel and co-workers describe a recent complex landslide in the Gschliefgraben area, Austria. In the winter period 2007–2008, the 4-million cubic meter slope failure moved at a maximum rate of 5 m per day, threatening an area interested by intense touristic activity. The population living in the area menaced by the moving landslide had to be evacuated temporarily. The inhabitants could return to their homes only when the rate of movement of the slope failure had decreased significantly, also as a result of landslide mitigating measures.

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