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Multiple-scale modelling of landslide susceptibility for hazards assessment

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We describe the preliminary results of an experiment aimed at assessing landslide hazards in Italy at different geographical scales, from the local (i.e., catchment) scale, to the synoptic (i.e., national) scale. For this experiment we selected three study areas of different size, extending from 139.000 to 317 square kilometres, and nested one into the other. The larger area - used for small scale, nationwide modelling - comprises 10 Italian Regions along the Adriatic coast in northern and central Italy. The intermediate area, used for regional modelling, extends for 8681 square kilometres and comprises the Reggio Emilia, Modena and Bologna provinces, in the Emilia-Romagna Region. The area selected for the large scale modelling consists of the Setta catchment, a tributary of the Reno River, in the Bologna province. At the synoptic scale, we performed multivariate analysis of thematic data and historical information on landslide occurrence to determine the spatial probability (i.e., the susceptibility) of landslides. For the statistical modelling, the municipality (i.e., a political subdivision) was selected as the mapping unit of reference. As the dependent variable, we used the presence or absence of historical landslide events in each municipality. We obtained this information from the SICI information system (http://sici.irpi.cnr.it), a catalogue of historical landslide events in Italy. The independent variables for the statistical analysis were obtained form a set of thematic layers, including lithological, soil type, and morphometric information, which were available at small scale for the entire study area. Through discriminant analysis modelling, the municipalities were classified based on the expected probability of containing past landslide events in the period from 1900 to

2002. This probability was assumed a proxy for landslide susceptibility, i.e., the spatial probability of future landslide occurrence. Next, for the Reggio Emilia, Modena and Bologna provinces we estimated the temporal probability of landslide occurrence. For the purpose, we exploited a detailed catalogue of historical landslide events compiled by the Regione Emilia-Romagna. For each of the 152 municipalities in the three provinces, we computed the number of landslide events in the period from 1900 to 1996. Knowing the time span of the catalogue and the number of landslide events, we estimated the average recurrence interval between successive landslide events. Assuming landside recurrence was constant, and adopting a temporal probability model (e.g., a Poisson model, a binomial model) we estimated the expected probability of landslide occurrence in each municipality, for different periods. Finally, for the Setta catchment, in the Bologna province, we performed discriminant analysis of thematic and geomorphological data to predict the spatial occurrence of landslides (i.e., landslide susceptibility). The study area was first subdivided into 1635 hydrological units, which became the mapping unit of reference. For each mapping unit, we computed the percentage of different lithological types obtained from a detailed geological map, the land use, and statistics of morphometric parameters obtained from a 10 m x 10 m DEM. As a dependent variable we used the presence or absence of landslides identified through filed mapping and interpretation of aerial photographs by the Geological Survey of the Emilia-Romagna Region. The mapping units were classified based on the expected probability of containing past landslides. Assuming the spatial probability of past landslides is the same as the spatial probability of future landslides, we determined landslide susceptibility. We conclude comparing the results obtained, and discussing the advantages and limitations of the selected modelling approach, considering the extent and complexity of the studied areas and the available data. The work was completed in the framework of the RISKAWARE project, a research initiative partly financed by the European Commission through the Interreg IIIB - CADSES programme.