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Mapping rainfall-induce landslide susceptibility by integrating GIS, slope stability analysis, and Monte Carlo simulations

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Taiwan's slope disasters resulted from its mountainous topographic condition and occasionally heavy rainfalls and typhoons. It is of importance to map the landslide susceptibility induced by rainfall as references for land-use planning and for public construction. This paper presents the evaluation of landslide susceptibility along Nantou-71 route, a road connecting Puli and Renai in mountainous region of central Taiwan. The heavy rainfall came with typhoon Toraji in 2001, which caused more than 10 shallow failures along the road slope of Nantou-71 route, was used as the study event. These failures were identified as sliding along the interface of looser deposits composed of colluviums and weathered geological material and underlying less weathered rock. The soil profiles of the study region were investigated by conducting site exploration including 21 boreholes and 5 refraction seismic tests. The engineering properties of soils including strength parameters and hydraulic conductivity were estimated from laboratory test results. The study region is divided into 8064 grids each with a 10m$\times$10m dimension. The geospatial data of topography, slope, and aspect of each grid was constructed using geographical information systems (GIS). These data along with soil profiles and engineering properties were input into a wide-range slope stability analysis code, TRIGRS, to calculate the transient water pressure induced by this rainfall event and corresponding factor of safety of each grid. The deterministic measure of landslide susceptibility is not appropriate enough because significant uncertainty exists in the engineering properties in situ. Therefore the Monte Carlo simulations which incorporate the uncertainty in parameters into the deterministic analysis of landslide susceptibility were conducted to generate the potential map of landslide. The analysis results showed fair agreement between the susceptibility map and the ac-

tual landslide data. Finally, the statistic properties of rainfall for different return years were estimated based on statistical extreme theory. The similar procedures were repeated using these rainfall extreme data to generate landslide susceptibility maps. The result shows that, for the conditions described in this study, the long-term landslide susceptibility will converge into an extreme value in a design life of 150 years.