Geophysical Research Abstracts
Vol. 14, EGU2012-8057-2, 2012
EGU General Assembly 2012

A three-dimensional slope stability model based on GRASS GIS and its application to the Collazzone area, Central Italy

M. Mergili (1), I. Marchesini (2), W. Fellin (3), M. Rossi (2), S. Raia (2), and F. Guzzetti (2)

(1) Institute of Applied Geology, BOKU University of Natural Resources and Life Sciences Vienna, Austria (martin.mergili@boku.ac.at), (2) IRPI CNR, Perugia, Italy, (3) Unit of Geotechnical and Tunnel Engineering, University of Innsbruck, Austria

Landslide risk depends on landslide hazard, i.e. the probability of occurrence of a slope failure of a given magnitude within a specified period and in a given area. The occurrence probability of slope failures in an area characterized by a set of geo-environmental parameters gives the landslide susceptibility. Statistical and deterministic methods are used to assess landslide susceptibility. Deterministic models based on limit equilibrium techniques are applied for the analysis of particular types of landslides (e.g., shallow soil slips, debris flows, rock falls), or to investigate the effects of specific triggers, i.e. an intense rainfall event or an earthquake. In particular, infinite slope stability models are used to calculate the spatial probability of shallow slope failures. In these models, the factor of safety is computed on a pixel basis, assuming a slope-parallel, infinite slip surface. Since shallow slope failures coexist locally with deep-seated landslides, infinite slope stability models fail to describe the complexity of the landslide phenomena. Limit equilibrium models with curved sliding surfaces are geometrically more complex, and their implementation with raster-based GIS is a challenging task. Only few attempts were made to develop GIS-based three-dimensional applications of such methods. We present a preliminary implementation of a GIS-based, three-dimensional slope stability model capable of dealing with deep-seated and shallow rotational slope failures. The model is implemented as a raster module (r.rotstab) in the Open Source GIS package GRASS GIS, and makes use of the three-dimensional sliding surface model proposed by Hovland (1977). Given a DEM and a set of thematic layers of geotechnical and hydraulic parameters, the model tests a large number of randomly determined potential ellipsoidal slip surfaces. In addition to ellipsoidal slip surfaces, truncated ellipsoids are tested, which can occur in the presence of weak layers or hard bedrock. Any raster cell may be intersected by various sliding surfaces, each associated with a computed factor of safety. The lowest value of the factor of safety is stored for each raster cell together with the depth of the associated slip surface. This results in an overview of potentially unstable regions without showing the individual sliding areas. We test the model in the Collazzone area, Umbria, Central Italy, which is susceptible to landslides of different types. The presence of both shallow translational and deep-seated rotational landslides, and the availability of reference data, allow for the critical evaluation of the model in comparison with standard infinite slope stability models.