Accurate basin scale soil depth modelling and its impact on shallow landslides prediction

(Article begins on next page)

Geophysical Research Abstracts, Vol. 9, 10828, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10828

Accurate basin scale soil depth modelling and its impact on shallow landslides prediction

F. Catani (1), S. Segoni (1), G. Falorni (1)
University of Firenze, Department of Earth Sciences - filippo.catani@unifi.it

Although the objects of numerous studies, both the location and timing of triggering conditions for shallow landslides are still not predictable with a suitable degree of accuracy at the basin scale. Many of the problems are due to the difficulties encountered in predicting the basin-scale distribution of the main parameters used in the most common slope stability models. In hilly or mountainous soil covered terrains, the depth of the rupture surface in shallow, rainfall-triggered landslides is controlled by rainfall parameters (intensity, duration), slope topographic attributes (elevation, slope, curvature) and soil characteristics (permeability, thickness, cohesion, internal friction angle). In basins with sufficiently long rainfall records it is relatively simple to establish intensity-duration relationships and with the widespread use of GIS and the acquisition of high resolution topographic data, it has become straightforward to characterize the topographic attributes of an area. Perhaps the field that currently requires the most work is the study of the soil parameters and their extension to basin scale. Within a river basin soil thickness, intended here as depth to bedrock (DTB) can vary as a function of many different and often interrelated parameters including vegetation cover, lithology, climate, gradient, hillslope curvature, upslope contributing area and land use. For the application of numerical codes regarding shallow landslide stability, such as the commonly used infinite slope stability model, soil depth is often assigned a constant value for the entire basin. In other cases very simple predictive schemes are used, such as the direct correlation of soil thickness with elevation or with slope gradient. If some punctual field measurements of soil thickness are available, the extension to basin scale usually involves a simple linear relationship with gradient, where DTB is considered inversely proportional to slope gradient at a point. We propose a method that links soil thickness to gradient, slope curvature, landsurface unit definition and relative position within the hillslope profile. This last parameter is the main novelty compared to other approaches and we think that it is fundamental: points having equal gradient and curvature can have very different soil thicknesses due to their different position on the hillslope. The model is implemented in a GIS environment and tested in two river basins in Central and Northern Italy through the application of a numerical code for the assessment of the factor of safety. Different simulations have been carried out for each tested DTB model using several runs at various degrees of soil saturation. Result validation indicates good agreement with field data and mean errors are significantly lower than those obtained from other topography-based methods. The use of predicted soil depth to determine the factor of safety for landsliding potential within the basin also provides promising results, confirming that this method can significantly enhance the prediction of shallow landslide hazard, sediment production, etc. when utilized in conjunction with distributed hydrological and geomorphological models.