Geophysical Research Abstracts
Vol. 14, EGU2012-10739, 2012
EGU General Assembly 2012

Root profile modeling as a link between ecohydrology and slope stability

S. Tron (1), A. Dani (2), F. Laio (1), F. Preti (2), and L. Ridolfi (1)

(1) Dipartimento dell'Ambiente, del Territorio e delle Infrastrutture, Politecnico di Torino, Turin, Italy, (2) Dipartimento di Ingegneria Agraria Forestale, Università degli Studi di Firenze, Florence, Italy

The vertical plant-root distribution within the soil is strongly affected by the hydrological and pedological characteristics of a site. In turn, the root profile influences the stability of a slope through the root anchorage to deeper layers and consequent soil reinforcement. The purpose of this study is to determine an approximated root profile by means of simple ecohydrological model and, hence, to provide a preliminary estimate of the conditions triggering instability in vegetated slopes.

We assume that the root density decreases exponentially with parameters depending on climatic and pedologic descriptors. The required variables are the mean rate and the depth of precipitations events, the potential transpiration rate and the hydraulic characteristics of the soil. We use the Curve Number SCS method to account for precipitation losses – or reinfiltration effects – due to surface runoff, which can be relevant over hillslopes.

Once obtained the mean root profile over a vegetated area, we use it to estimate the additional cohesion factor given by roots at different soil depths. Then, using an infinite slope model that considers root cohesion, we calculate the safety factor of vegetated slopes as a function of soil depth. This framework allows one to preliminarily assess the landslide risk on vegetated areas according to climatic and pedologic informations which are quite readily available.

This framework has been applied to a case study in Tuscany (Italy), where measured root profiles over 18 vegetated slopes are available. The aim of the work is twofold: to compare the root profile obtained with the ecohydrological model with the measured one, and to verify if the slope stability model (with the theoretical root profile as a forcing factor) provides consistent estimates of the soil depth where instability occurs.

As mentioned, the model requires climatic and pedologic parameters. The soil parameters have been measured in each landslide site; the climatic parameters have been estimated by data collected from the meteorological gauges available in the zone of interest. In particular, the daily time series of temperature have been spatially interpolated with the inverse square distance method in order to obtain a temperature series at each landslide site, accounting for the temperature lapse rate. The potential transpiration during the growing season has been estimated from these series. The mean frequency and intensity of rainfall events during the growing season have been calculated at each station from the daily time series of precipitation, subtracting the runoff rate determined with the Curve Number method. The values obtained have been interpolated with the inverse square distance method in order to achieve the required hydrological parameters at each landslide area. The obtained results demonstrate that the method is able to provide relatively accurate estimates of the safety factor in vegetated slopes, which can be used as zero-order approximations in large-scale analyses of the landslide risk.