A regional early warning system for shallow landslides based on rainfall thresholds and soil moisture indexes

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A prototype regional early warning system for the prediction of rainfall-induced shallow landslides in Sicily, Italy, is presented. The system is prepared in collaboration with the Regional Civil Protection Department of Sicily. Rainfall thresholds and soil moisture indexes are used for the definition of the predictive tool. In particular, soil moisture indexes derived in a continuous form are used to define a first alert phase. Then, rainfall thresholds, derived as a function of the soil moisture conditions at the beginning of the day, are employed for the subsequent activation of alarm phases.

Daily soil moisture indexes, representative of the moisture condition of the catchment, were derived by using a parsimonious and simply to use approach based on the IHACRES model application in a modified form developed by the authors. It is a simple, spatially-lumped rainfall-streamflow model, based on the SCS-CN method and on the unit hydrograph approach that requires, as input data, only rainfall, streamflow and air temperature data (Brigandì and Aronica, 2015). It consists of two modules. In the first a non linear loss model, based on the SCS-CN method, was used to transform total rainfall into effective rainfall. In the second, a linear convolution of effective rainfall was performed using a total unit hydrograph with a configuration of one parallel channel and reservoir, thereby corresponding to 'quick' and 'slow' components of runoff. In the non linear model a wetness/soil moisture index, varying from 0 to 1, has derived to define daily soil moisture catchment conditions.

A catalogue of 229 rainfall conditions that have resulted in 265 shallow landslides in Sicily in the period 2002-2012 (Gariano et al., 2015) is used to define rainfall thresholds at different exceeding probabilities and at different soil moisture conditions, for the prediction of slope failures and the activation of the first alert level is based on soil moisture condition analysis.

The system can be applied at regional and sub-regional scale (e.g., considering one or more alert zones defined by Civil Protection Department), and can be validated and updated with recent data.

References:
Gariano, S.L., Brunetti, M.T., Iovine, G., Melillo, M., Peruccacci, S., Terranova, O., Vennari, C., and Guzzetti, F.: Calibration and validation of rainfall thresholds for shallow landslide forecasting in Sicily, southern Italy, Geomorphology, 228, 653–665, 2015.
Brigandì, G. , and Aronica, G.T.: A flash flood early warning system based on rainfall thresholds and daily soil moisture indexes., Geophysical Research Abstracts, Vol. 17, EGU2015-11878, 2015