



MONSTER: a landslide prediction model for the Arno river basin, Italy

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Monster (acronym of MONitoraggio della Stabilità dei versanti in TEMpo Reale, Real Time Monitoring of Slope Stability) is a joint project between the Arno River Basin Authority and the Earth Sciences Department of the University of Florence, Italy. The project objective is to create a landslide prediction model for the whole Arno basin, to be used as an alert system.

A coupled approach – hydrological modelling and statistical analysis – is followed to find hydrological thresholds for landslides. Research strategy can be explained as follows:

- selection of some sub-watersheds as test sites and data collection on landslide, rainfall and flow time series;
- establishment of a certain number of Unique Condition Units (UCU) based on different soil characteristics (land use and lithology);
- hydrological characterisation of test catchments and related UCUs;
- hydrological modelling of two series of rainfall events: with or without consequent landslide;
- statistical analysis of the two series of hydrological data, to calculate triggering thresholds for each UCU.

Bisenzio, Era and Greve basins are the model test areas and a large archive work was carried out to build temporal data-bases on landslides, as suitable time series are necessary to perform statistical analyses.

The hydrological characterisation is performed by means of the Curve Number method. For each test basin, a unique CN value is assigned by comparing runoff data against the results provided by the hydrograph separation with a digital recursive filter. UCUs' CN values are obtained rearranging literature data, in order to be coherent with the hydrological behaviour of each entire test subwatershed, represented by the comprehensive basin CN.

For each UCU, two groups of major hydrological events are then analysed: rainfall events originating landslides and events not originating landslides. The CN method is used to calculate water retention values from rainfall inputs. Retention is assumed, in fact, as the most important factor related to the pore pressure increase causing slope instability.

As another fundamental aspect triggering landslides, soil moisture conditions are characterized by taking into account precipitations before each event. For some UCU, rainfall values are cumulated over 30 days; for another group of UCU, an antecedent precipitation index calculated over 10 days is employed. These two variables and their characteristic time periods derive from the analysis of a large range of combinations of antecedent rainfall data, plotted against retention values of each event, and are the ones that provide the best results for separating landslide events.

Therefore they are alternatively adopted in the statistical analysis of retention data and landslide events for each UCU, supplying different threshold functions useful for predicting dangerous conditions.