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Rainfall thresholds from theory to operative Early Warning System: the case of Tuscany Region (Italy)

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We present the set-up of an EWS for operative forecasting of landslide triggering, based on rainfall thresholds.
This work has been carried out in Tuscany Region (Italy), which is 23'000 km2 wide and has a heterogeneous distribution of relieves and precipitation.
The whole work carried out to get to create the EWS, from early studies to the design of the EWS is here described. Early studies highlighted the unsuitability of a single threshold for the whole territory, because of its heterogeneity, moreover the first analyses were characterized by a high degree of subjectivity, which made the non-replicable. To overcome these problems the territory was split into several more homogeneous areas and a software capable of objectively defining the rainfall thresholds was developed. This software (named MaCumBA) is based on the definition of several fixed parameters, which can be easily repeated in future analyses, to be used to identify the best threshold of each homogeneous area.
For the definition of the thresholds two independent datasets (of joint rainfall-landslide occurrences) have been used: a calibration dataset (data from 2000 to 2007) and a validation dataset (2008-2009).
Once the thresholds were defined, they have been used to develop a Web-GIS based EWS. This system allows both the monitoring of real time data and the forecasting at different time intervals, up to 48h.
The EWS individuates rainfall events capable of triggering (or not triggering) landslides, on the basis of the parameters defined by the MaCumBA software and classifies them as alert or no alert. An important feature of the warning system is that the visualization of the thresholds in the WebGIS interface may vary in time depending on when the starting time of the rainfall event is set. Therefore, the starting time of the rainfall event is considered as a variable by the system: whenever new rainfall data are available, a recursive algorithm identifies the starting time for which the rainfall path is closest to or overcomes the threshold. This is considered the most hazardous condition, and it is displayed by the WebGIS interface.
Once the work was finished, a new issued came to surface: the threshold can give good results, but their validity is limited in time, because of several factors, such as changes of pluviometric regime, land use and urban development. Furthermore, the availability of new landslide data can lead to more robust results. For these reasons the thresholds of those areas with new landslide data were updated in 2014 and the comparison between updated and former thresholds clearly showed that the performance of an EWS can be enhanced if the thresholds are constantly updated.