Development of a landlside EWS based on rainfall thresholds for Tuscany Region, Italy

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We present the set-up of a landslide EWS based on rainfall thresholds for the Tuscany region (central Italy), that shows a heterogeneous distribution of reliefs and precipitation. The work started with the definition of a single set of thresholds for the whole region, but it resulted unsuitable for EWS purposes, because of the heterogeneity of the Tuscan territory and non-repeatability of the analyses, that were affected by a high degree of subjectivity. To overcome this problem, the work started from the implementation of a software capable of objectively defining the rainfall thresholds, since some of the main issues of these thresholds are the subjectivity of the analysis and therefore their non-repeatability. This software, named MaCumBA, is largely automated and can analyze, in a short time, a high number of rainfall events to define several parameters of the threshold, such as the intensity (I) and the duration (D) of the rainfall event, the no-rain time gap (NRG: how many hours without rain are needed to consider two events as separated) and the equation describing the threshold. The possibility of quickly perform several analyses lead to the decision to divide the territory in 25 homogeneous areas (named alert zones, AZ), so as a single threshold for each AZ could be defined. 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, a WebGIS-based EWS has been implemented. In this system it is possible to focus both on monitoring of real-time data and on forecasting at different lead times up to 48 h; forecasting data are collected from LAMI (Limited Area Model Italy) rainfall forecasts. The EWS works on the basis of the threshold parameters defined by MaCumBA (I, D, NRG). 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. One more issue that came to surface, after the EWS implementation, was the time-limited validity of the thresholds. On one hand rainfall thresholds can give good results, on the other hand 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 the aforementioned reasons some of the thresholds defined for Tuscany region were updated, by using new landslide data (from 2010 to march 2013). A comparison between updated and former thresholds clearly shows that the performance of an EWS can be enhanced if the thresholds are constantly updated.