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Geophysical Research Abstracts
Vol. 13, EGU2011-3395-1, 2011
EGU General Assembly 2011

A statistical model based on rainfall thresholds for landslides forecasting: implementation in the alert systems of the Emilia Romagna region (Italy) for civil protection purposes.

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In Italy landsliding is a recurrent phenomenon responsible of human life loss, destruction of assets and infrastructures and major economical loss. Since rainfall represents the most common triggering factor, in Italy many Civil Protection agencies are setting up alert systems based on the interaction between rainfall and landslides. These agencies are responsible of large territories (e.g. regions or large subdivisions such as provinces), therefore they cannot rely on physically based approaches because of the difficulty of defining the exact spatial and temporal variation of the many involved factors (rainfall variation in space and in time, effect of vegetation, mechanic and hydraulic properties of both bedrock and soil layer). As a consequence, the most diffuse methodology is the use of "black box" models based on empirical or statistical rainfall thresholds. The term black box refers to a methodology in which the complex physical processes involved in landslide initiation are ignored (because too difficult to correctly calibrate over large areas) and a more simple and functional empirical correlation is found between the primarily cause (rainfall) and the effect (landslide) which is to be predicted. Amongst all the factors influencing the triggering of a landslides, in fact, rainfall is one of the most important and the most easy to correctly quantify, e.g. using rain gauges or radar measurements.

In the proposed model the thresholds are based on the total amount of rain cumulated considering different time intervals: a 3-days cumulate takes into account the critical rainfall which should influence shallow movements, while a 60-days cumulate is used to consider the slow seepage that in low-permeability terrains is responsible of the triggering of the deep seated landslides of the area. To increase the efficiency of the model, the test area was partitioned into 19 subdivisions, for which distinct threshold were derived.

On a first step, a prototypal version of the model was set up defining statistically defined thresholds: this can be considered as a "base" version of the model, which has the advantage of being easily and rapidly exportable to other contexts, since it requires only rainfall data from a sufficiently organized network to be implemented. Then, thresholds were further refined on the basis of a calibration performed using an accurate database of past geo-referenced and dated landslides. A validation procedure showed that the calibration highly improves the results and therefore the model was integrated in a regional warning systems for civil protection purposes.