Geophysical Research Abstracts
Vol. 12, EGU2010-13413, 2010
EGU General Assembly 2010

Evolutionary polynomial regression applied to rainfall triggered landslide reactivation alert

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Evolutionary Polynomial Regression (EPR) is a hybrid evolutionary modelling paradigm, which allows for the construction of explicit model equations, starting from measured data. It was successfully applied to multiple cases study as well as to different model aims, i.e. dynamic natural systems, pipe burst analysis, geotechnical soil characterization, etc.
A landslide located on a slope on the Adriatic coast of south Italy, close to the small town of Petacciato, is here investigated. In particular, starting from the rainfall data, which are available for the last 110 years as daily records, and from 11 activation episodes which range between 1932 and 2009, a data-driven model aimed at describing the reactivation as function of cumulative rainfall values was identified.
Petacciato landslide is a deep large landslide; it lays on a slope characterized by outcropping Pleistocenic blue clays, which are somewhere spaced out of thin loamy-sandy layers. Moving towards the upper part of the slope, which is closer to the town, blue clays are progressively replaced by sand and conglomerates. The slope is also characterized by frequent terraces which show slope inversions.
The landslide is quite wide and the slope is characterized by a low steepness. In addition, the bottom of the sea, close to the shore, is very gently deepening, thus excluding an effect of water on the slope stability. For these reasons, the dynamic of Petacciato landslide is quite difficult to be interpreted.
The particular mechanism of the landslide as well as the exceptional data availability, in particular in terms of reactivations, make it possible to cope with this system according to a data mining approach. It was observed that the landslide reactivated after long rainy periods, and then rainfall was assumed as a triggering factor. Therefore, cumulative rainfall values were constructed in order to account with long periods, up to 500 days. These were used as candidate inputs for the construction of a model, accounting for cumulative rainfall heights and their lags with the reactivation event. In words, the model returns 0 if no reactivation is forecasted and 1 when there is a reactivation, based on an input set made of cumulative values evaluated at different number of days before the reactivation date. The time lag and the cumulative values as well as the structure of the model are selected by the methodology, on a training set comprising 8 out of 11 events. The remaining 3 events are not involved in model construction in order to use them as a test set. The obtained results are very interesting since 2 of 5 rainfall are forecasted on the test set, while 7 of 8 are forecasted on the training set. Finally, it is noteworthy that the model never forecasts a reactivation when it does not really takes place, both for training and test data.