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Forecasting the timing of activation of rainfall-induced landslides. An application of GA-SAKe to the Acri case study (Calabria, Southern Italy)

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In Calabria (Southern Italy), rainfall-induced landslides often cause significant economic loss and victims. The timing of activation of rainfall-induced landslides can be predicted by means of either empirical ("hydrological") or physically-based ("complete") approaches. In this study, by adopting the Genetic-Algorithm based release of the hydrological model SAKe (Self Adaptive Kernel), the relationships between the rainfall series and the dates of historical activations of the Acri slope movement, a large rock slide located in the Sila Massif (Northern Calabria), have been investigated.
SAKe is a self-adaptive hydrological model, based on a black-box approach and on the assumption of a linear and steady slope-stability response to rainfall. The model can be employed to predict the timing of occurrence of rainfall-induced landslides. With the model, either the mobilizations of a single phenomenon, or those of a homogeneous set of landslides in a given study area can be analysed.
By properly tuning the model parameters against past occurrences, the mobility function and the threshold value can be identified. The ranges of the parameters depend on the characteristics of the slope and of the considered landslide, besides hydrological characteristics of the triggering events.
SAKe requires as input: i) the series of rains, and ii) the set of known dates of landslide activation. The output of the model is represented by the mobilization function, Z(t): it is defined by means of the convolution between the rains and a filter function (i.e. the Kernel). The triggering conditions occur when the value of Z(t) gets greater than a given threshold, Zcr.
In particular, the specific release of the model here employed (GA-SAKe) employs an automated tool, based on elitist Genetic Algorithms. As a result, a family of optimal, discretized kernels has been obtained from initial standard analytical functions. Such kernels maximize the fitness function of the model: they have been selected by means of a calibration technique based on the operators selection, crossover, and mutation. In this way, the values of model parameters could be iteratively changed, aiming at improving the fitness of the tested solutions.
An example of model optimization is discussed, with reference to the Acri case study, to exemplify the potential application of SAKe for early-warning and civil-protection purposes.