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Empirical approaches for quick management of cascading hazards in the Italian Alps: a warning procedure for landslide reactivation, river damming and outburst waves

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Landslide hazard management usually requires time-consuming campaigns of data acquisition, elaboration, and modeling. However, in the post-emergency phase management, time is a factor, and simple but fast methods of analysis are needed to support decisions in the short-term. This paper analyzes the Theilly landslide (Western Italian Alps), which was recently affected by a series of reactivations. While some instrumental campaigns (aimed at supporting physics-based modeling and the design of effective protection measures) were still in progress, simple tools were set up to manage the hazard of future reactivations and to evaluate the possibility of damming the stream flowing at the footslope. After a detailed geomorphological survey, state-of-the-art empirical methods were customized for the specific case of study. First, a set of intensity-duration rainfall thresholds depicting increasing hazard levels is used to monitor and forecast possible reactivations. Second, in case the landslide body reaches the narrow valley at the footslope, the possible evolution scenarios (i- landslide that does not block the river; ii- river blockage with formation of a stable dam and a lake; iii- river blockage with formation of an unstable dam and release of an outburst wave) are evaluated by means of a methodology based on the hydro-morphometric characterization of the site. The proposed empirical methodologies have the advantage of requiring only ready-available input data and quick elaborations, thus allowing the rapid set up of tools that could be used for hazard management. In this case of study, these tools are being used until mitigation measures (to date, still in the project phase), are completed.