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Satellite-rainfall estimation for identification of rainfall thresholds used for landslide/debris flow prediction

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Rainfall-induced landslides and debris flows pose a significant and widespread hazard, resulting in a large number of casualties and enormous economic damages worldwide. Rainfall thresholds are often used to identify the local or regional rainfall conditions that, when reached or exceeded, are likely to result in landslides or debris flows. Rain gauge data are the typical source of information for the definition of these rainfall thresholds. However, in-situ observations over mountainous areas, where these hazards mainly occur, are very sparse or inexistent. Therefore identification and use of gauge-based rainfall thresholds is impossible in many landslide prone areas over the globe. The vast advancements in satellite-based precipitation estimation over the last couple of decades have lead to the creation of a number of global precipitation datasets at various spatiotemporal resolutions. Although several investigations have shown that these datasets can be associated with considerable uncertainty, they provide the only source of precipitation information over many areas around the globe. Therefore it is important to assess their performance in the context of landslide/debris flow prediction and investigate how we can potentially benefit from the information they provide. In this work, we evaluate the performance of three widely used quasi-global satellite precipitation products (3B42v7, PERSIANN and CMORPH) for the identification of rainfall threshold for landslide/debris flow triggering. Products are available at 0.25deg/3h resolution. The study region is focused over the Upper Adige river basin, northern Italy where a detailed database of more than 400 identified debris flows (during period 2000-2015) and a raingauge network of 95 stations, is available. Rain-gauge based rainfall thresholds are compared against satellite-based thresholds to evaluate strengths and limitations in using satellite precipitation estimates for defining rainfall thresholds. Analysis of satellite precipitation uncertainty is carried out using a stochastic satellite rainfall error model. Satellite precipitation ensembles derived from the error model are used to produce ensembles of rainfall thresholds. The use of rainfall threshold ensembles for probabilistic prediction of landsdlide/debris flow occurrence is evaluated.