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Impact of uncertainty in rainfall estimation on the identification of rainfall thresholds for debris flow occurrence

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Estimation of rainfall intensity-duration thresholds, used for the identification of debris flows/landslides triggering rainfall events, has been traditionally based on raingauge observations. The main drawback of using information from gauges is that rainfall estimates are available only over gauge locations, which are usually located far away from the debris flow/landslide initiation areas. Thus, successful implementation of gauge-based rainfall thresholds involves the intrinsic assumption that rainfall over gauge and actual initiation point is highly correlated. However, in complex terrain where this natural hazard takes place, spatial variability of rainfall can be very high even at very small scales due to orographic enhancement of precipitation and the development of highly localized convective systems.

This work is focused on the assessment of the impact of rainfall estimation uncertainty on identification and use of rainfall thresholds for debris flow occurrence. The Upper Adige river basin, northern Italy, is the area of study. A detailed database of more than 400 identified debris flows during period 2000-2010 and a raingauge network of 95 stations, is used for this work. The methodology examines the intensity-duration thresholds derived from a set of raingauge locations that is assumed to be collocated with debris flow/landslide points (DFR) and an equivalent set of raingauges assumed to have the role of closest available measurement (MR). Comparison between the rainfall thresholds derived from DFR and MR, revealed that uncertainty in rainfall estimation has a major impact on estimated intensity-duration thresholds. Specifically, results showed that thresholds estimated from MR observations are consistently underestimated. Evaluation of the estimated thresholds for warning procedures showed that while detection is high, the main issue is the high false alarm ratio, which limits the overall accuracy of the procedure. Overall performance on debris flow prediction was shown to be good for low rainfall thresholds and poor for high rainfall thresholds examined. These findings have consequences in the operational use of the thresholds and provide evidence of the regional dependence of uncertainty in estimation of ID thresholds.