Geophysical Research Abstracts
Vol. 16, EGU2014-15932, 2014
EGU General Assembly 2014

Radar rainfall estimation for the identification of debris-flow precipitation thresholds

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Identification of rainfall thresholds for the prediction of debris-flow occurrence is a common approach for warning procedures. Traditionally the debris-flow triggering rainfall is derived from the closest available raingauge. However, the spatial and temporal variability of intense rainfall on mountainous areas, where debris flows take place, may lead to large uncertainty in point-based estimates.

Nikolopoulos et al. (2014) have shown that this uncertainty translates into a systematic underestimation of the rainfall thresholds, leading to a step degradation of the performances of the rainfall threshold for identification of debris flows occurrence under operational conditions. A potential solution to this limitation lies on use of rainfall estimates from weather radar. Thanks to their high spatial and temporal resolutions, these estimates offer the advantage of providing rainfall information over the actual debris flow location. The aim of this study is to analyze the value of radar precipitation estimations for the identification of debris flow precipitation thresholds.

Seven rainfall events that triggered debris flows in the Adige river basin (Eastern Italian Alps) are analyzed using data from a dense raingauge network and a C-Band weather radar. Radar data are elaborated by using a set of correction algorithms specifically developed for weather radar rainfall application in mountainous areas. Rainfall thresholds for the triggering of debris flows are identified in the form of average intensity-duration power law curves using a frequentist approach by using both radar rainfall estimates and raingauge data. Sampling uncertainty associated to the derivation of the thresholds is assessed by using a bootstrap technique (Peruccacci et al. 2012).

Results show that radar-based rainfall thresholds are largely exceeding those obtained by using raingauge data. Moreover, the differences between the two thresholds may be related to the spatial characteristics (i.e. spatial variogram) of the triggering rainfall. These results show that weather radar has the potential to effectively increase the accuracy of rainfall thresholds for debris flow occurrence. However, these benefits may only be achieved if the same monitoring instrumentation is used both to derive the rainfall thresholds and for use of thresholds for real-time identification of debris flows occurrence.

References

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