

Interactive comment on “Radar-Based Quantitative Precipitation Estimation for the Identification of Debris-Flow Occurrence over Earthquake affected Region in Sichuan, China” by Zhao Shi et al.

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General comments The paper deals with debris-flow occurrence thresholds in terms of rainfall intensity-duration by using radar data in an earthquake-affected area (Sichuan, China). The paper addresses technical questions within the scope of NHESS and is conform to international standards; scientific methods are clearly outlined. Authors try to address the definition of the rainfall-field by the use of radar to better evaluate the relation between rainfall and debris-flow. But, as described in the technical comments, to overcome some objective limitations of the methodology used, further investigations

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would be needed to properly take into account the susceptibility of the territory. The title is clear; the abstract is pertinent, easy to understand and resumes well the contents of the paper. Mathematical formulas, symbols and abbreviations are correctly defined. Technical language is precise and understandable.

An I-D threshold curve is proposed on the basis of six rain events that caused 512 debris-flows between 2012 and 2014. Based on rain data estimates obtained from 2 radars, the authors use various techniques for estimating rainfall from reflectivity, by also considering the rainfall detected by rain gauges for comparative analysis and correction of the bias. As shown, the use of radar data provides a better estimate of the precipitations responsible of landslides triggering. In one case (cf. Table 2), the amount of rain measured by radar is 10 times greater than that detected by the rain gauge network (Event # 3). Before evaluating the I-D threshold, the authors describe some techniques to detect the best estimate of radar precipitation, identifying the Kalman's filtering application as the best tool to reduce radar-rain gauge bias. Using the frequentist approach, the authors compute the relation $I = \alpha D - \beta$ which binds intensity and duration of precipitation for three estimates of rainfall fields. Scatter plots are shown in fig. 8 Technical Comments

The article is of interest as it performs a radar application on I-D threshold models, historically developed using only rain gauges. Although, I-D thresholds generally suffer from limitations that can affect practical applications. In fact, in case of convective rainfall events (responsible of most debris-flow and shallow-landslide events), the area affected by ground effects is usually small (normally few km²) and tends to reproduce a low I-D curve when only rain gauges are used. On the other hand, landslides occur in correspondence of highest rainfall intensities. Aiming at evaluating the precipitation field, authors try to solve the problem by also using radar data, and considering possible estimation errors. Another intrinsic lack of the method lies in the determination of the duration of the event, and the simplification of the average intensity or accumulated precipitation for the whole interval. Analyses of uniform rainfall distribution inside the in-

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tervals excludes soil characteristics that heavily affect the development of gravitational movements. In the case of stratiform rain events, with uniform intensity, landslides are more frequent in permeable areas; in case of convective rainfalls, landslides are more easily triggered in areas with low permeability. An additional limit of the model is the absence of discriminant analysis of susceptibility to shallow landslides in the study area. The adopted method for determining the threshold I-D, in fact, ignores lithology, geomorphology (e.g. slope), land use, and soil coverage. Consequently, it tends to lower the threshold as is results mostly controlled by the most fragile portions of the territory. Looking at the threshold I-D of Figure 8 for the same duration of precipitation, the corresponding rain intensity that triggers debris-flow varies with one order of magnitude. The paper, assessing thresholds I-D using radar rainfall field, contributes to improve the model by reducing limitations due to the use of only rain gauges, especially in the case of convective phenomena. Among possible improvements to the method, multiple thresholds (e.g. for class of slope, lithology, etc.) could be considered in addition to accurate rainfall radar estimation.

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