Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2020-243-SC1, 2020

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Uncertainty analysis of the estimation of stony debris flow rainfall threshold: the application to the Backward Dynamical Approach" *by* Marta Martinengo et al.

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Received and published: 17 November 2020

The paper by Martinengo et al. investigates the uncertainty in the determination of the debris-flow rainfall threshold based on the Back Dynamical Approach (BDA) proposed by Rosatti et al. (2019). The uncertainty analysis is performed through two Monte Carlo cascade simulations. The objectives of these simulations are (i) providing a sensitivity analysis of the BDA parameters and (ii) quantifying the impact of the variability of the rainfall estimate on the threshold parameters. Results highlight that the variability in the rainfall condition estimate is strongly related to the debris-flow characteristics and the to the hyetograph shape, while the threshold parameters are characterized by a

low statistical scattering. The paper diligently presents the uncertainties of the BDA method. However, it neglects some theoretical limitations of this method that are, in my opinion, important uncertainties to discuss. Here following the main points I would recommend addressing to provide a complete, physically-based (i.e., based on both analytical framework and experimental observations) uncertainty analysis.

1) More details are needed about the dataset (e.g., location of debris flows and rain gauges, data source for the volumes, etc.), possibly as a supplementary material. One minor observation related to this point: "stony debris flow" is rarely used in the debris-flow community. If the authors are referring to debris flows characterized by coarse material, especially at the front, and to non-cohesive mixtures, I would suggest clarifying this point in the dataset description stating that they are analyzing "collisional-frictional debris flows".

2) Direct observations collected in many Alpine basins (Bel et al., 2017; Coviello et al., 2020; Nikolopoulos et al., 2014) contradict the assumptions of uniform rainfall over the basin and of certain rainfall intensities associated with debris flows. Rainfall data gathered in the Gadria basin, that is located in the study area of the paper, can be used to discuss the uncertainties descending from these assumptions (Coviello et al., 2020). At Gadria, two different rain gauges located in the headwaters (Malga Gadria and Spartiacque) can be used for defining a critical rainfall threshold and data show a significant variability of both measured intensity and duration (see Fig. 1 from Marchi et al., 2019). For instance, the debris flow of 10 July 2017 shows very different I-D values at the two rain gauges while a pure rainfall analysis does not explain the initiation of the debris flow of 26 July 2016 that is characterized by a very low rainfall intensity recorded by only one rain gauge.

3) "Since being greater than zero is the only constraint of the other parameters, for homogeneity this CV value is considered suitable for all parameters". Field evidences and data show that a variation coefficient equal to 5% strongly underestimates the real variability of both basin area and deposited volume (Hürlimann et al., 2019). In

many monitored basin worldwide, it has been observed that the actual area contributing to debris flow initiation is considerably smaller than the whole basin area (Berti et al., 2020). Debris-flow volume estimations significantly differ - up to 30% - when performed through a digital elevation model of difference analysis, compared to the time-integration of the debris-flow discharge estimates (Coviello et al., 2020).

4) A constant sediment concentration of 0.65 in the bed of all debris-flow channels is questionable. Field studies show that sediment concentration and rheo-physical properties of debris flows feature a significant variability also during a single event (see Hürlimann et al., 2019 and reference therein).

Best regards, Velio Coviello

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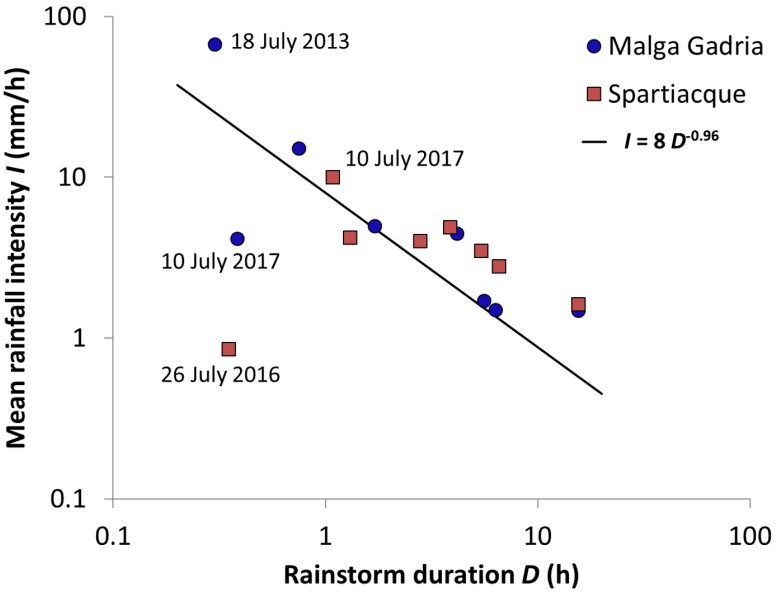

Fig. 1. Expert-based critical rainfall threshold at Gadria, Italy (Marchi et al., 2019).