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Natural Hazards and Earth System Sciences
Discussions



# *Interactive comment on* "The role of antecedent soil moisture conditions on rainfall-triggered shallow landslides" *by* Maurizio Lazzari et al.

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Reply to Reviewer 1

We would like to express our gratitude to the reviewer for his hard work and constructive criticism. Many observations are worthy of consideration and will allow us to improve and rebalance different parts of the work. At the same time, we must point out that being this a short communication, we had to summarize many of our activities giving more emphasis to the outcomes of the research and neglecting some information.

Going into the details of the reviewer comments, we provide a point by point comments in the following.

1) Regarding to the literature, we have considered a large part of literature on rainfall



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thresholds. Many of their results are reported in review work quoted in bibliography (Brunetti et al., 2010; Guzzetti et al., 2008; Segoni et al., 2018). Given the editorial rules on a short communication and having to give more space to data and discussions, we thought to summarize the introduction. However, we will certainly integrate the introduction with a more detailed bibliographic analysis, taking into account works on threshold validation.

2) We had to make a strong synthesis of the text to follow the editorial rules in terms of short communication. To overcome this problem we will redraw Figure 1 (as also suggested by the referee), inserting the geolocalizations of landslides and a graph with their monthly distribution. The information requested by the referee will be inserted in the text, in order to better explain the available data and their treatment methodology. Regarding to the climatic data, as explained in the text ( Page 3 line 18-20) the territory is covered by a near real-time hydrometeorological network, that are uniformly distributed on the territory (1 station every 80 km2) and characterized by uninterrupted and high-quality data (recording time interval from 1 to 60 min). We have used hourly data.

3) A database of rainfall events that have resulted in shallow landslides was compiled from 2001 to 2018. The landslide information was obtained through a detailed bibliographical research [Lazzari, 2011; Lazzari and Gioia, 2015; Lazzari et al., 2018] including national and local newspapers and journals, Internet blogs, and the scientific and technical literature. The collected information was organized in a catalogue listing 326 shallow landslide events from January 2001 to March 2018. For each rainfall event, the information collected and stored in the catalogue includes (see new Figure 1): the precise or approximate location of the area affected by the rainfall and the landslides; the precise or approximate time, date, or period of the failures; the rainfall conditions that resulted in slope failures, including the total event rainfall, the rainfall duration, the mean rainfall intensity, and the antecedent rainfall for different periods; the landslide type; a generic description of the main rock types. Hourly rainfall and temperature





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is obtained from the raingauges of the Civil Protection. The rainfall duration D was determined measuring the time between the moment, or period, of initiation of the failure(s) (rainfall ending time) and the time when the rainfall event started (rainfall starting time). The rainfall ending time was taken to coincide with the time of the last rainfall measurement of the day when the landslide occurred. As suggested by Brunetti et al. (2010), for the identification of the starting time has been considered a minimum period without rain (a 2-day period without rainfall was selected for late spring and summer, May–September, and a 4-day period without rainfall was selected for the other seasons, October–April) to separate two rainfall events. Once the duration of the event was established, the corresponding rainfall mean intensity I (in mm h-1) was calculated dividing the cumulated (total) rainfall in the considered period (in mm) by the length of the rainfall period(in hours). Using this method, the rainfall mean intensity for the event was determined.

4) We agree with the reviewer and more details about the hydrological modelling and calibration will be given in the revised version of the manuscript.

5) In the work were actually calculated of rainfall thresholds as shown in figures 3 and 4. We neglected reporting the equations obtained. We have reported on Table 1 the obtained critical rainfall thresholds estimated for several durations to better highlight the different impact in using different threshold as a function of soil saturation estimates. However, we realize that these data do not provide an essential contribution to this discussion. Therefore, the table will be removed giving more emphasis to the rainfall thresholds conditional on the antecedent soil moisture conditions. Moreover, a second extended manuscript on the use of the proposed procedure is already in progress, where the methodology will also be validated.

6) Finally, we understand that some of the conclusion must be revised after a more robust validation of the proposed methodology. The aim of the present short communication is only to underline the strong control played by antecedent soil moisture condition on rainfall induced landslides. Therefore, the conclusion will be reorganized

removing any reference to warning systems. This will certainly be a second step of the research. All specific corrections will be made in the final review.

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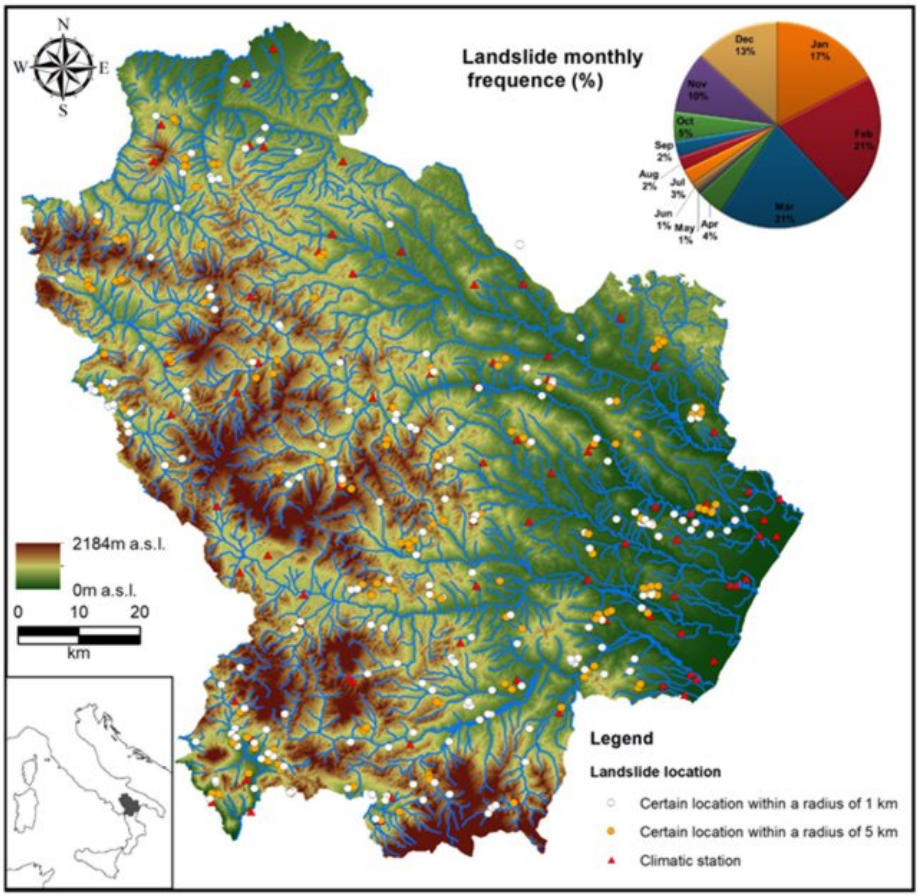
N
W
E
S
Landslide monthly frequence (%)
Dec 13%
Jan 17%
Nov 10%
Oct 5%
Sep 2%
Aug 2%
Jul 3%
Jun 1%
May 1%
Apr 4%
Mar 21%
Feb 21%
2184m a.s.l.
0m a.s.l.
0 10 20
km
Legend
Landslide location
Certain location within a radius of 1 km
Certain location within a radius of 5 km
Climatic station

**Fig. 1.**