

Interactive comment on “Meteorology triggering factors analysis for rainfall induced hydrogeological events in alpine region” by Andrea Abbate et al.

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REPLY TO REFEREE 2 We would like to thank the reviewer for the time and effort he/she put into thoroughly reviewing this manuscript. We believe that the comments are constructive and would lead the considerable improvement of our work.

Interactive comment on “Meteorology triggering factors analysis for rainfall induced hydrogeological events in alpine region” by Andrea Abbate et al. Anonymous Referee #2 Received and published: 24 December 2020

The manuscript deals with an interesting attempt to strengthen the estimation of ex-

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treme hydrological conditions, which led to landslide and flash flood phenomena in the Sondrio Province (northern Italy) in the period 1951-2019, by linking them to estimations of magnitude and return period (temporal probability) as well as meteorological conditions occurred at the continental scale. In the opinion of this reviewer, such a methodological effort is certainly to be appreciated because tending to reduce uncertainties of a single approach, such as empirical rainfall thresholds for shallow landslide triggering and hydrological probabilistic models. Specifically, starting from an inventory of principal landslide and flash flood phenomena collected for the study area, authors analyzed triggering hydrological factors by three methods. The first is based on the comparison of intensity/duration of rainfall events, which led to landslide and flash flood phenomena, to empirical rainfall thresholds for shallow landslides known by the literature for the region studied and worldwide. The second is the estimation of return periods for triggering rainfall conditions by a known regional probabilistic model (De Michele et al., 2005). The third is the analysis of meteorological conditions which lead to extreme rainfall events, based on data taken from the National Centres of Environmental Prediction (NCEP) (Kalnay et al., 1996; MeteoCiel, 2020; NOAA, 2020). Notwithstanding the challenging and innovative premises, the manuscript presents several conceptual points of weakness which are described below in form of both general and specific comments.

GENERAL COMMENTS: 1) Rainfall thresholds considered, known by the literature, are related to shallow landslides, instead Authors compare to them also deep-seated phenomena (1987 deep-seated Val Pola landslide) and flash floods. Therefore, the comparison appears too heterogeneous and would need a motivation.

R:Probably is not sufficiently specified but the intent is to try to focus mainly on shallow landslides that are generally more influenced by meteorological condition. We consider your advice and provide a better explanation for this topic.

2) The procedure used for assessing the magnitude ranking (Fig. 6), by taking into account of both return period and areal extent of meteorological phenomena, appears

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questionable for being based on the mean of normalized value. By a conceptual point of view, considering the mean value is allowed for the same variable, not for different variables. Very likely, the normalized product of return period and areal extent of meteorological phenomena would incorporate more consistently the magnitude at local scale (return period) and the areal extension.

R:We have worked out about that topic and we found the same inconsistency. In fact, affected area and rainfall return period contain 2 important information that are complementary to explain an intensity of a rainfall triggered event. Therefore, the product of the 2 normalized index seems to be more appropriate. We will re-elaborate it.

3) Parts of the paragraph 3.2.1 regards general methodological aspects and preceding knowledge, therefore they appear more suitable for the methods section rather than the results one.

R:We will consider to move it in the Method section.

4) Nothing is given about the regional probabilistic model (De Michele et al., 2005), which has been considered to the estimation of return periods. In the opinion of this reviewer, it's an important point to explain aspects related to the regional probabilistic model adopted.

R:We will add further details about this part because is necessary also in the description of Return Period evaluation.

5) Authors should motivate with a greater emphasis the possible applications of their findings in the field of landslide and flood hazard assessment as well as early warning systems.

R:This part is rather fundamental. Our intent is to try to built a bridge among two different discipline that sometimes find the same difficulties around the interpretation hydrogeological event intensities. We will built a paragraph in order to better motivate our study.

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6) English language should be revised. The adjective "hydrogeological", used extensively throughout the text, appears not suitable to indicate landslide and flood phenomena. It is recommended to substitute this term. R:We will provide an extensive English editing after during the article revision.

Block 20. The sentence is not clear and it should be rewritten. R:OK Block 30. The use of the term "back analysis" is questionable because it is commonly used in the geotechnics field for inverting a slope stability analysis and estimating shear strength of geological materials involved in landsliding. In this case the analyses carried out are just re-examinations of past landslide and flash flood events. R:OK Block 40. Substitute "deep landslide" with "deep-seated landslide". R:That is more correct. Block 80. Substitute "will be" with "is". R:OK Block 90. "Old debris" is not a geological term. Maybe, just debris could be better, otherwise the age should be indicated more clearly (e.g. Pleistocene). R:That is more precise. Table 1: A column indicating the mean intensity should be considered. The definition of Extremely Localized (EXTL) and Diffuse (DIF) could be substituted with Localized (L) and Areal (A). R:That is more synthetic. Blocks 250-255 and Fig. 4. To consider the vertical distance between the curve and the critical event point appears conceptually incorrect due the possibility that the curve itself (I/D rainfall thresholds) indicates points with different return period. Authors should verify and discuss this point. R:We will consider all these useful advices during the revision of the paper.

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