Interactive comment on "Antecedent wetness and rainfall information in landslide threshold definition" *by* Binru Zhao et al.

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GENERAL COMMENTS

In the paper under consideration, the authors present rainfall characteristics, soil moisture data, and landslide inventories collected in North Italy from 2006 to 2016. The commonly used thresholds based on antecedent precipitation index (API-threshold) and 3-day cumulated rainfall (3-day-threshold) are compared with two new thresholds. The hybrid threshold combines information from the established API- and 3-day-thresholds, whereas the updated API threshold considers positive or negative trends in the API preceding the landslide event.

In general, I see some merit in the paper as it addresses important aspects of rainfall-

triggered landslides and how to improve risk predictions in regions prone to strong rainfall events. However, I consider the present manuscript needs substantial improvements in order to be publishable. During my revision I focused on the following issues: (1) Is the study sufficiently motivated by literature? (2) Are the methods sufficiently described to allow others replicating their work? (3) Are the results presented in a comprehensive way? And (4) are the conclusions supported by the results of the paper?

SPECIFIC COMMENTS

(1) Is the study motivated by the literature?

[p.1 – p.3 | Introduction] The authors introduce the rainfall triggering of landslides and give examples. They introduce existing rainfall thresholds in detail and support their motivation for the paper with literature. In my opinion, there is some potential for shortening, though.

Conclusion 1: the paper is well motivated by literature and furthermore fits well within the framework of the journal.

(2) Are the methods sufficiently described to allow others replicating their work?

[p.5 | L13-L19] The reference cited for equation 1 is a M.Sc. thesis and not an adequate reference, as it doesn't have any proper ISI citations. I wonder, if there is a better paper to cite here as the API is a well-known equation. The authors did not define how API itself is derived from rainfall data. This would be helpful for readers not working with API on a daily basis.

[p.6 | L14-L26] I had a hard time understanding this paragraph and am not sure I fully understood it in the end. The authors write 'The hybrid threshold is established to explicitly include the antecedent wetness condition and the recent rainfall. [...] antecedent wetness condition is indexed by the API value of the day prior to the recent 3 days. [...] Various combinations of these two variables are explored, where the API

value and the recent 3-day cumulated rainfall is defined by their different percentiles.' What do the authors mean exactly with 'explicit'? Why do the authors use the API of the day prior to the recent 3 days? What do the authors mean with various combinations of both variables in respect to the percentiles? The authors proceed with 'The percentile rank considered in this study includes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20 and 50.' However, Figs. 3 and 4 display percentile ranks up to 100%. From the text it is unclear to me how the authors calculated the API curves (e.g. green and blue curve in Fig. 3a). The authors proceed with 'We firstly used the API threshold as a cutoff, under which no landslide is expected. When it is exceeded, the 3-day cumulated rainfall threshold is then compared. The landslide occurrence is predicted only when these two threshold values are exceeded.' What do the authors mean with 'cutoff' and 'landslide occurrence is predicted'? I advise the authors to improve this paragraph by adding more details and a schematic figure explaining how the threshold(s) work. I think a basic figure of rainfall characteristics and occurrence of landslides would also be beneficial to better understand the threshold.

[p.6-p.7 | L28-L4] Maybe move these thresholds to the beginning as they are already established in the literature.

[p.7 | L6-L12] Similar to the paragraph explaining the hybrid threshold, this paragraph lacks in detail and clarity. It is not clear how this 'added rule' works in practice. What do the authors mean with 'more explicitly consider the effect of the recent rainfall'? I wonder whether the hybrid or the updated API threshold is more explicit?

[p.7 | L14-L19] This paragraph describes how the thresholds are compared between each other. I wonder why the authors did not compare each combination but only three? At least, it would be helpful, if the authors would point out the reason for their choice.

Conclusion 2: The methods could be much better explained by the authors. One may not be able to fully understand all steps required for data evaluation as well as the

threshold definitions.

(3) Are the results presented in a comprehensive way?

[p.9 | L8-L20] The authors write 'The distribution of landslides' variables (as listed in Table 1) is shown in Figure 3 and Figure 4.' What do the authors mean with 'landslide variables'? The table only lists the types of rainfall thresholds used in the study. 'Variables' is ambiguous. The Figs. 3 and 4 show API and 3-day rainfall vs percentile rank and no landslide variables. The authors proceed with 'Figure 3a is for the API value of the day prior to the recent 3 days, Figure 3b is for the recent 3-day cumulated rainfall prior to landslide occurrences, and Figure 4 is for the API value prior to landslide occurrences.' As mentioned before, the plots confuse me because it was not well explained how the authors calculated API or 3-day rainfall for percentiles between 1 and 100% (lines in Figs. 3 and 4). For me it was hard to connect Figs. 3 and 4 to the four thresholds listed in Tab. 1. I therefore suggest to have four plots showing each of the four thresholds independently. The authors write 'For rainfall - induced landslides, they mostly occur in the wet season, during which the temperature is low.' One can hardly judge about this statement because the authors did not provide time scales of rainfall and landslide occurrences. Later the authors write 'Taking the 3-day cumulated rainfall as an example, the amount of 0.4 mm is likely to trigger landslides, while the amount of 231.2 mm is also responsible for the landslide initiation.' I cannot find these numbers in the plot. Why is 0.4 mm rainfall more 'likely to trigger landslides' than 232.2 mm, which is mentioned as only 'responsible for the initiation of landslides'? Please revise the argumentation.

[p.9 | L21-L25] This is redundant to methods and I advise to delete it.

[p.9 – p.11 | Threshold comparison] I had a hard time understanding the Figs. 5 and 6 and the text corresponding to these figures. In my opinion, the text is too technical and requires more details when explaining the principle of the plots. For example, I did not understand why plotting the FAR in Fig. 5b, whereas in Fig. 5a the curves lie more

closely to the Hit Rate axis. In addition, what do the authors mean with 'threshold level of 3-day cumulated rainfall' in Fig. 5b? The bars reflect the percentiles not only for 3-day rainfall threshold but also for the hybrid threshold.

Conclusion 3: The presentation of results could be improved.

(4) Are the conclusions supported by the results of the paper?

[p.12-.14 | Discussion] In my opinion, the discussion needs to be improved. The authors did not critically reflect their results and compared them with other results from the literature. Generally, the discussion section requires more references.

[p.14 | L10-L24] In my opinion conclusions 1 and 2 are more or less identical. The only real conclusion the authors make here is '[...] could improve the threshold's prediction performance in terms of reducing false alarms.' Just stating that the antecedent wetness is important is not enough because this has been shown by numerous researchers in the past. The third conclusion is fine.

Conclusion 4: The conclusions are supported by the results, but need to be more specific and unique.

TECHNICAL CORRECTIONS

[p.7 | L26] Should read as 'true positive'