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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Data limitations and potential of hourly and daily rainfall thresholds for shallow landslides" *by* Elena Leonarduzzi and Peter Molnar

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This NHESS Discussions paper provides a detailed and objective investigation of numerous factors related to development of rainfall thresholds for landslide forecasting. It relies on a database of landslide occurrence across Switzerland and four alternative configurations of rainfall data in daily and hourly resolutions. Beyond the issue of data temporal resolution, the authors investigate the effect of uncertainty in landslide timing, sparseness of rain gage data, duration of records, normalization of rainfall thresholds for different regions, and the role of antecedent rainfall in threshold performance.

Overall it is a very relevant topic and a very nice contribution. In fact, it provides quite a

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Discussion paper

few surprising and constructive insights that can inform future considerations for landslide threshold development, so I wonder if the title could be rephrased to reflect the various novel contributions of the work, not just the limitations? Ultimately, the paper should definitely be published in NHESS with some quite minor revisions. In particular, the investigation of antecedent conditions was not entirely clear to me, so the description of the methods and results could be improved. Otherwise, numerous edits would enhance the clarity of other aspects of the study, which I have outlined by line number below.

1: When it comes to landslides, I have started to prefer “forecast” over “predict” since it implies less specificity on location and/or timing. Also, for a concise abstract one could delete phrases such as “In this paper” as it’s not needed.

2: You are not quite providing a comprehensive evaluation of “landslide prediction performance,” since that can take many forms, but rather specifically of “rainfall threshold performance.”

15: Avoid ending on a negative note. Perhaps rephrase to state that is it worth the additional effort to build antecedent rainfall into threshold curves?

21: In a new paper we provide further updates and review of reports on economic losses in the U.S. as well as analysis of over 300,000 landslides (Mirus et al., Landslides, 2020, DOI: 10.1007/s10346-020-01424-4).

50: Specify that you focus on “different temporal resolution of data.” Even though this does also relate to the negative consequence of lower density and duration of rainfall measurements.

60-61: Might be worth clarifying that these studies have in fact demonstrated the utility of including antecedent conditions, but at a relatively narrow scale comparted to the effort you explore here. However, as you know, Wicki et al. (Landslides, 2020, DOI 10.1007/s10346-020-01400-y) have already evaluated soil moisture at the regional

scale for landslide warning. Also, probably our other paper from 2018 is more appropriate for citating here related to comparing antecedent rainfall and soil state (Mirus et al., Landslides, 2018, DOI: 10.1007/s10346-018-0995-z).

62: It's not clear what a realistic comparison means, so it might be more accurate to state "... an extensive, objective comparison between real rainfall data at hourly and daily resolutions for..."

67: What is "TSS"? Should introduce all acronyms before using and also repeat definitions in figure captions and tables for clarity.

80-83: This is a bit unclear and maybe includes several typos or confusing phrasing, so I had to re-read a few times:

- Rainfall not raninfall

- Clarify that you used two different hourly gridded data, not two-hourly gridded rainfall. Just avoid that source of confusion.

- Initially it was unclear how hourly data could be derived from RDI, so I thought it was a typo until later reading the disaggregation methods.

Suggested revision: "We used two different hourly datasets that were derived by disaggregating the RDI such that the daily sums match that of the corresponding RDI cell at the same 1 x 1 km resolution."

87: Is it possible to give a range of distances to explain what you mean by "quite sparse"?

89: It may be unclear to some readers what the fourth record is. You have only described the daily RDI and two hourly records RHIR and RHIG (derived using the RDI and RHG). Consider listing out all four record names here to avoid confusion.

175: Consider adding Thomas et al. (WRR, 2019, DOI: 10.1029/2019WR025577P) here as well regarding investigations into satellite measurements for landslide warning.

179-180: Since this is the opposite of what is normally done, I think a slightly more detailed explanation is needed. I was not able to fully grasp the methods or interpretation of the results in Figure 7.

239: Consider listing “his/her/their”, using only the pronoun “their,” or more simply revising to “overconfidence in the threshold predictions.”

300: As you note, the 3-15 day approach of Chleborad and others is indeed specific to the Seattle area. It would be possible to evaluate what time-scales are most appropriate for distinguishing between rainfall linked to the “trigger” versus the “cause” as outlined by Bogaard and Greco (2018). We re-evaluated the appropriate timescales for ID and cumulative rainfall thresholds (Scheevel, Baum, Mirus, and Smith, 2017; doi: 10.3133/ofr20171039) as well as rainfall-saturation thresholds (Mirus, Morphew, and Smith, 2018, already cited herein). Thus, it is possible that other timescales are better for Switzerland. Can you clarify which timescales you tested, how, and why those times were selected? Again, the methodology for considering antecedent conditions was not totally clear to me.

308: Confusing. Revise to clarify that they were wrongly predicted as triggering, but no known landslides occurred due to low antecedent rainfall.

340-348: This paragraph has a number of typos and grammatical errors relative to the rest of the paper, so perhaps these were overlooked in the authors final editing?

343: Careful to clarify that the threshold / triggering intensity is over-estimated, not the measured max. rainfall itself being overestimated.

356: This may be a good point to mention that whereas hourly records capture some indication of rainfall intensity, daily rainfall totals tend to represent a metric somewhere in between the intensity of the storm and its cumulative depth. It might provide another explanation for why the daily still performs reasonably well, since not all landslides are triggered by brief, high-intensity events.

357: Consider specifying which two methods.

364: The only method? I'm sure that some alternative approaches could be proposed by others. Consider avoiding such an absolute statement.

365: For brevity: "Lastly, we demonstrate the benefits of normalizing the rainfall thresholds using high quantiles of rainfall intensities, quantiles of event properties, MAP, or RDN. These are all particularly useful when using daily data, but we suggest MAP as it is general and a widely available climatological variable."

371: Still not clear what you mean by "realistic comparison." Suggest: ". . . of providing a rigorous and objective comparison between. . ."

372: ". . .unknown landslide timing, and more sparse rain gage networks . . ."

376: Suggest: ". . . more appropriate for forecasting landslides since it better captures triggering intensities, several other aspects. . ."

380: Suggest: ". . . daily data are not far behind, potentially since it does tend to capture cumulative storm totals that may also be relevant for landslide triggering." [?]

383-385: This is true and useful, but unlike your other conclusions, it is nothing new. Consider clarifying that your results further underscore/reinforce previous findings about the importance of non-triggering events.

392: ". . .these would increase. . .."

Figure 1. Define NASS and mdi. Increase legend size for RDI in Swiss map.

Table 1. I think you know the dates of all the landslides during the various time periods, no? If so, please revise "known timing" should really be "known date and time" to avoid any confusion. Same for the subsequent figures.

Figure 2. Define all acronyms used in figure and caption.

Figure 4. It's a bit surprising that the duration in the upper plots (hours) have the same

axis numbers (10ˆ0 and 10ˆ1) as the duration does in the lower plots (days).

Figure 6: Define acronyms like MAP and MDP. I'm not sure I understand the x-axis label and there are no numbers. Please clarify.

Figure 7. Consider labelling (a) and (b) or clarifying that lower plot is Mean Antecedent rainfall (MAR) for 30d. Again, define all acronyms used in caption or legend. These results are a bit confusing and I'm not sure the methods or results are explained clearly enough. What does the "duration" refer to? Duration of the triggering storm event?

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