Natural Hazards and Earth System Sciences Discussions

Nat. Hazards Earth Syst. Sci. Discuss., referee comment RC2
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Comment on nhess-2022-175

Anonymous Referee #2

Referee comment on "Using principal component analysis to incorporate multi-layer soil moisture information in hydrometeorological thresholds for landslide prediction: an investigation based on ERA5-Land reanalysis data" by Nunziarita Palazzolo et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2022-175-RC2, 2022

The authors compare classical intensity-duration power law thresholds with hydrometeorological thresholds that combine mean intensity with ERA5-Land reanalysis soil moisture. They consider both the soil moisture at 4 different depths and a combination of them obtained with principal component analysis. They find that adding soil moisture information improves the prediction of a rainfall-based threshold.

The manuscript is generally clear and well organized. I only have one major concern with the publication. In fact, the novelty in the work is the use of PCA for combining the soil moisture information at the different depths and keeping the problem 2D (rainfall intensity and soil moisture derived component). While I see the potential of such a methodology and agree with the advantage of keeping the dimensionality of the problem small, I believe some further analyses are required to demonstrate that it is indeed advantageous.

The TSS obtained using intensity and soil moisture at the first or second shallowest depth is pretty much identical to the one using the first component of the PCA. This means that the overall performances are not sufficient to demonstrate the advantage of PCA. The authors should find some alternative way of either demonstrating the advantages directly (with data/results) or demonstrating that the most influential soil layers changes depending on some properties. Can they observe any pattern in which one is more influential than the others? Those could be spatial patterns (e.g., in certain regions the shallower/deeper soil moisture is more important) or relative to landslide properties (e.g., for certain types of landslides the deeper/shallower soil moisture is more important) or relative to the time of the year (e.g., over certain times of the year deeper/shallower soil moisture is more important). Because the PCA piece is the novel piece in this manuscript, I believe it is important to show and demonstrate the advantage compared to just using the shallowest soil moisture.

Besides this, I also have some minor comments:

- I think the method for the definition of rainfall events should be better explained. The definitions of parameters P1-P2-P3-P4 are unclear and so is the sentence in line 148. What does it mean that rainfall conditions were not identified? What are the uncertainties? In rainfall? In landslide properties. Does this mean they were incorrectly identified as "rainfall triggered" in the database ()? Also, what are the values of the parameters chosen (e.g., the maximum radius Rb)? Only information about the interarrival times was provided.
- On soil moisture: could you provide more information about soil moisture? The only information I could find is "association of SM data to the beginning of each rainfall event", but what does this mean? The first hour of the rainfall event? The hour before its beginning?
- Do rainfall events end when the hour of landslide occurrence or whenever they ended (which could be N hours before or even after the landslide)?
- Would be good to report in Figure 5 also the timing of each landslide (maybe as a vertical black line)
- In Figure 6 you could consider using different plotting techniques to make the figure more readable. In fact, it is impossible from a scatter plot to understand where/how many points there are in the different parts of the plot. You should consider plotting the 2D histogram instead (e.g., see Leonarduzzi et al., 2017). This would allow the reader to better see where most of the events are and which groups of events are "driving" the thresholds. Based on more visible (because it's less events) distribution of the triggering events, it looks like the not triggering ones are "driving" the threshold. In other words, just by looking at the triggering events, a steeper threshold would improve the performances, which seems to suggest there are a lot of not triggering events in the 20-300h 0.1-1 mm/h region. Would be nice if that could be looked at! What I am suggesting is something similar to what Leonarduzzi et al., (2017) did in Figure 3.
- Would be nice to have information also about TPR and FPR also for the ID threshold (maybe as an additional entry in Table 2)
- I have a similar suggestion for Figure 8 as for Figure 6, allowing the reader to see the distribution of the no-triggering events (the triggering sample is small enough that they are visible without much overlapping)

Finally, in the supplementary pdf, some grammar/rewording suggestions are provided.

Leonarduzzi, E., Molnar, P., and McArdell, B. W. (2017), Predictive performance of rainfall thresholds for shallow landslides in Switzerland from gridded daily data, *Water Resour. Res.*, 53, 6612– 6625, doi:10.1002/2017WR021044.

Please also note the supplement to this comment:
https://nhess.copernicus.org/preprints/nhess-2022-175/nhess-2022-175-RC2-supplement.pdf