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Comment on hess-2021-133

Anonymous Referee #1

Referee comment on "Simulated or measured soil moisture: which one is adding more value to regional landslide early warning?" by Adrian Wicki et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-133-RC1, 2021

In the manuscript the authors compare modeled and measured soil moisture in the context of landslide prediction in Switzerland. Measurements are available at 35 sites across Switzerland, while the 1D soil moisture transfer model CoupModel providing estimates of soil moisture is set up at 133 sites. The landslide prediction model used is based on different soil moisture metrics and optimized by using ROC-statistics.

The authors carry out different comparisons/experiments: comparing measured and modeled soil moisture over 14 reference sites, comparing performances of the landslide prediction model based on measured or modeled soil moisture, studying the impact of boundary conditions of the hydrological model, and the impact of soil parametrization (using soil samples, uniform texture sets, or soil properties obtained with pedotransfer functions and the SoilGrid database).

The authors find that modeled soil moisture is outperforming measured moisture, that the model is sensitive to boundary conditions, and performances worsen as the distance between soil moisture and landslide locations increases.

The manuscript is clear, well written and structured, and the topic addressed is relevant. Overall, the manuscript is worth publication in hess.

Nevertheless, there is one important aspect which is worth addressing and discussing more in details, concerning the choice and results of the hydrological model. It has been shown in previous studies that vertical flow is the dominant process leading to landsliding, compared to lateral flow (e.g., Iverson 2000), but lateral flow becomes essential for adequate description of initial soil moisture conditions (e.g., Mirus et al., 2017, Leonarduzzi et al., 2020). This idea and the fact that the model seem to reproduce mostly just event dynamics is confirmed by several of the results:

- Figure 4: the better R2 for shallowest depth (typically better matching the patterns of meteorological forcing)
- Underestimation of seasonal variations of soil moisture
- Line 382-383: "*resulting even in a slight forecast goodness increase for extreme and normal coarse-grained uniform-texture profiles*". Using a highly conductive soil which drains quickly, basically reduce the model to "get rid" of initial conditions and just represent the current infiltration event (i.e., your estimate of soil moisture is basically matching P-ET). But these soils are the one giving the worst match to measured soil moisture
- 9: modeled moisture outperforming measured moisture for event dynamics but not for antecedent condition metrics.

All these aspects, lead me to think that what is happening is that the hydrological model is actually just using the information in the recent meteorology (transformed into saturation estimate using soil parameters), while the "memory" component of saturation is not well represented/useful for landslide prediction. This is sort of the opposite of what one would expect in terms of information context in a "antecedent condition" metric, as typically saturation is considered a "cause", while recent rainfall the "trigger". The authors checked this by comparing the results to a simple rainfall-based prediction and indeed find similar performances. It would be worth exploring, or at least addressing, if using a combination of measured soil moisture (providing antecedent conditions) and rainfall event dynamics (possibly accounting also for soil properties), would actually lead to better landslide predictions (e.g., logistic regression using antecedent conditions saturation metrics measured/observed and rainfall event metrics). This would not invalidate the work presented or any of the findings but would definitely be a more complete/objective answer to the question the authors pose in the title: "*Simulated or measured soil moisture: Which one is adding more value to regional landslide early warning?*".

Finally, some minor comments:

- In Figure 5, are the lines showing the average across 14 sites for each depth?
- It could be interesting (although probably worth including only in the appendix), to see the trends of soil moisture observed and measured at different depths.

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