Natural Hazards and Earth System Sciences
Discussions

Nat. Hazards Earth Syst. Sci. Discuss., author comment AC2
https://doi.org/10.5194/nhess-2021-243-AC2, 2021

Reply on RC2

Katrin M. Nissen et al.

Author comment on "Quantification of meteorological conditions for rockfall triggers in Germany" by Katrin M. Nissen et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-243-AC2, 2021

Dear Reviewer,

thank you very much for your constructive comments.
In the following we would like to describe how we intend to address your suggestions and to answer the most important questions.

General comments:

- **Structure:** Both reviews suggest a more classical outline (data, methods, results). We will therefore restructure the paper.
- **Terminology:** Both reviewers pointed out that we should clarify the use of certain terms. In detail these are:
  -sub-surface water
  -pore water
  -soil moisture
  -promote
  We will address this by defining the terms and homogenizing their usage in the revised version of the manuscript.
- **Discussion:** We agree that an additional paragraph comparing the results with previous literature on the topic is needed. This was pointed out by both reviewers.
- **Region of applicability:** Both reviewers suggest to be more restrictive when naming the region in which the statistical model can be applied. The intention was to express that the applicability of the model does not stop at the state borders. We will change the title of the manuscript and discuss in more detail the possibility to apply the model in other Central European low mountain regions with similar climatological, hydrological, geological and topographical characteristics.

Reply to specific comments:

Title: Please see our comment “Region of applicability”.

Abstract
L 10: We will state that precipitation minus evapotranspiration is a pore water proxy.

Introduction
L 33: Please see our comment “Terminology”.

L 45-55: We will extend the literature review on the linkage between climate forcing and rockfall/landslide occurrence in the introduction.

Meteorological and hydrological variables

L 112- 119: We will extend the description of the mHM model in the revised version of the manuscript. In this model setup, the soil component in mHM consists of six soil horizons (vertical levels) up to a depth of 2m. The horizontal simulation resolution is 5x5 km (grid cell size). All processes, states and fluxes are calculated for each cell. This includes among others land cover, slope, aspect, soil texture, clay percentage, sand percentage and mineral bulk density.

L 114: Please see our comment "Terminology.

Figure 1: We will add information on the clusters to the figure caption.

L 120: The model will be used to analyse climate scenario simulations. This will be clarified in a revised version of the manuscript.

L 120: D and the soil moisture simulations are not validated against observations. Instead their ability to improve the statistical model in terms of the logarithmic skill score is compared. We will clarify that in the revised manuscript.

L 128-129: Will be rephrased.

L 134: For D accumulation periods between 14 and 6 days were tested in terms of their ability to improve the logarithmic skill score of the logistic regression model. The skill increased with decreasing duration and reached its peak at 7 days.

Selection of potential predictors

L 145: In order to allow comparison of the WOE for different variables the same number of bins needs to be selected for each variable. Here it was set to 6. Each bin has to contain the same number of observations. This restriction determines the range included in a bin.

L 149: Please see our comment "Structure".

L 155-164: Please see our comment "Structure".

L 156: For the two variables moisture precondition and freeze-thawing cycles the days before the rockfall events were considered. We will clarify this in a revised version of the manuscript.

L 157: Time spans between 2 and 14 days were tested.

L 161: We think that the analysis of the relationship between rockfall and the individual potential predictors is most robust if all available data is used. We therefore show this result in Fig. 3 of the manuscript. In order to make sure that using periods of different length for the different predictors does not distort the information of the IV value on the importance of the predictors we conducted a sensitivity analysis using only the period available for all variables. We can add this figure as supplementary material. It is too similar to Fig 3 to warrant an extra figure in the main paper.

L 165: We will restructure the paper.

L 169: This sentence refers to the relationships described in the introduction. We will add an explanation here.

Construction of a statistical model

L 178: Input for a WOE analysis are two equally long vectors. The first contains the concatenated time series of a meteorological observation extracted from the grid boxes closest to the positions of the rockfall events. The second one contains the information if a rockfall event occurred at this time step and location (yes/no). If more than one landslide occurs in a grid box the time series associated with this grid box is included only once in the WOE analysis.

This procedure of removing duplicated time series is not practical for the logistic regression were the time series of the different meteorological variables are analysed together. Two rockfall events may be located in the same grid box of the coarser observational data set but in different grid boxes of the higher resolution data set. The number of sites used for model fitting would vary for each predictor combination. This

would make a comparison of the statistical models impossible. It is important to ensure that the model selection process is done by comparing statistical models fitted using an equal number of time series and time series of equal length. Comparing models 14 and 11 instead of 14 and 15 demonstrates how important this is.
L 179: We will add “spatial” to the text.
L 213: The best result in terms of the logarithmic skill score is achieved by using all possible combinations. The relationship between D and precipitation is linear if only the sum is used. A linear relationship does not reflect the fact that precipitation becomes more efficient if D is high. The product reflects this fact but seems to overestimate the probabilities for high precipitation or D percentiles. Including the sum in addition to the product has a dampening effect on the high probabilities. We will extend the discussion and include this information

Results
L 218: AIC will be introduced in the new methodology section.
L 238: “across-site percentile” is the percentile over all grid boxes which include the location of an event. This will be added to the text.
L 246: We will add this to the discussion
L 254: The low AIC must be seen in perspective, as model 15 was fitted using fewer and shorter observational time series. The AIC of model 15 shouldn’t be directly compared to model 16. Please see also our comment to L178. We will clarify that in a revised version.

Discussion
L 270: Please see our comment “Region of applicability”
L 284: From the literature review we conclude that we have included the most important climate and hydrological variables. Including too many variables can result in overfitting. As we see by looking at model 10 this can already happen with 16 parameters.
L 291: As we did not use data from stations directly but a gridded product (based on station observations) the length of the time series is the same for all locations. Local and across-site percentile calculations are based on the same length of time series.
L 303: Please see our comment “Region of applicability”