Responses to the reviewers November 2024

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Dear Reviewers, dear Editor,

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Thank you for your positive feedback. In accordance with your decision, we have made the requested revisions to our manuscript based on the feedback from reviewer 2. Please refer to the detailed text below for a detailed explanation on the integrated changes. We hope that the revised version is to everyone's satisfaction

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With best regards,
Christoph Schaller

1 Anonymous Referee 2

15 Dear Authors In the revised manuscript "Predicting the thickness of shallow landslides in Switzerland using machine learning", you present/developed a model that enhances existing landslide thickness prediction methods. You test three machine learning (ML) techniques. The ML approach is based on two landslide inventories and leverages various environmental covariates to achieve improved predictions. Landslide thickness is a critical parameter for landslide susceptibility modelling and hazard indication mapping, making it highly relevant for researchers and practitioners in natural hazard management. This study will

20 certainly interest the readership of NHESS.

The revised manuscript is significantly clearer than the original first version of the manuscript. I recommend minor revisions, which are listed below. My review is based on your version with tracked changes, so please refer to that document for line numbers.

1.1 General comments

25 – You often use nested sentences and include examples in parentheses. I recommend simplifying these passages and adopting more paratactic (shorter, simpler) sentences to enhance clarity. If an example is essential, incorporate it directly into the text to improve fluency.

>> We tried our best to simplify following your suggestion.

– Regarding the graphs, I found many of them difficult to read due to e.g. small font size, tiny dots (e.g., Fig. 6), or white
30 text on light grey backgrounds. I suggest reviewing these graphs and making adjustments to improve their clarity and readability.

>> Concerning the visualisations we are aware that the display in the PDF version may not be entirely optimal. We further improved the readability of the graphics and will provide additional high-resolution variants will be provided for most of the graphics together with the article source code upon final submission.

35 – You frequently refer to R-package names throughout the manuscript. Please ensure consistency in how you format them. I suggest using italics for package names.

>> As suggested, we set the names of R-packages in italics throughout the manuscript.

– There is inconsistency in how you refer to figures and table – for example, sometimes you use "Figure/Table," and other times "Fig." and "Tab." Please standardise this across the manuscript. Additionally, I recommend omitting the word see
40 before referring to figures or tables. Instead of writing sentences like "In Figure 5, you see a XY-plot," I suggest directly presenting your results and referring to the figure in parentheses, e.g., (Fig. 5). This approach would improve readability.

>> We checked the entire manuscript if the use of labels for tables and figures conforms with the NHESS submission guidelines and revised where needed. In addition, we revised the text based on your second suggestion. The references to figures are now all indirect in parentheses. For tables, the references connected to results were also rewritten to be indirect. One direct reference to a table remains in the case connected to table 1 with the overview of models in literature.

1.2 Specific comments

1.2.1 Abstract

L1: Throughout the manuscript, you often refer to variables as parameters, which is understandable. However, I recommend avoiding the term parameter, especially when discussing statistical methods due to its specific statistical connotation.

>> Thank you for this suggestion. We replaced the term "parameter" in several places with the term "variable". However, we kept the term where it refers to the parametrization of models (especially "hyper-parameters").

L3: I suggest introducing the abbreviation "RF" for random forest when it first appears in the text and consistently using it afterwards.

>> We added abbreviations for the three models.

L4: For "existing models," could you briefly specify which ones you refer to (simple-Z...)?

>> We added the Abbreviations of the models to the abstract.

1.2.2 Introduction

L14: Rainfall-induced spontaneous landslides.

>> This change was incorporated.

L15: Remove the word *such* for simplicity.

>> We removed the *such* from the sentence.

L16ff: Consider shortening the detailed descriptions and numbers related to damages; they may not be essential here.

>> We shortened the text in this passage. However, we consider the numbers essential for demonstrating the societal relevance.

L34: Rewrite as a new sentence: However, in some cases, the shear horizon is located within the top three meters.

>> We integrated an adapted version of your suggestion to prevent all ambiguity to the term horizon.

L38: . . . is measured perpendicular to the original slope surface down to the failure plane.

>> We integrated this formulation, slightly changing it to fit with the first part of the sentence.

L67: The pure engineering perspective on soils somewhat contradicts the soil horizons described below.

>> We removed the mention of "different soil horizons" and replaced it by "layers with different soil characteristics" to avoid ambiguities.

L94: Figure caption: Variations in shading reflect differences in soil properties.

>> We integrated this change.

L95: parameter (see my comment above).

>> This was changed to *variable*.

L101: . . . modelling approaches have been adopted: (i) conceptual models, (ii) empirical models, and (iii) physically based models. -> Maintain this order in the subsequent descriptions (you changed it somehow right now).

>> Thank you for pointing this out. We opted to change the order in the leading sentence to match the subsequent descriptions.

L118: Start the sentence with The accuracy of the. . .

>> We modified and shortened the sentence based on your suggestion.

L123ff: I recommend numbering the objectives for better clarity and structure.

>> We added numbering to the to the objectives.

1.2.3 Study area

First paragraph: Please refer to Fig. 2.

>> We added a reference to Fig. 2 in the beginning of the paragraph.

1.2.4 Materials

L147: . . . different Swiss landslide inventories. . .

>> We added *Swiss* to the sentence.

L162: So you estimated the thickness value of 435 records (which is your target to predict afterwards. . . .). It is probably a bit misleading.

>> We adapted the text in the methodology to make this clear.

L165: You wrote in L150 that you already removed these landslides with a value larger than 2m.

>> We revised the text to avoid this redundancy.

L185: This is one of these sentences where you write what is seen in Figure 2 and Table 2 (please see my comment above).

>> The sentence has been rewritten to mention the content directly, only referring to the figure and table in parentheses.

Table 2: . . . . HMDB and KTBE shallow landslides datasets.

>> We integrated this change into the caption.

Figure 2: It would be helpful to include the boundary lines between the Jura, Central Plateau, and the Alps. Minor comment: In the first sentence describing the study area, you mention that it encompasses large parts of Switzerland. However, based on the map, this doesn't appear to be the case.

>> We modified the map to show the regions in different shades of grey.

>> After excluding the StorMe inventory, the data admittedly covers less area than before. However, the spread between the sites is still considerable. We modified the text to say "the study area is distributed across large parts of Switzerland" to reflect that.

L198ff: Please maintain consistency in your bullet points, using either complete sentences or concise phrases throughout.

>> We revised the bullet points to be more concise.

1.2.5   Methods

L312: The last sentence seems more suited to the discussion section.

>> We revised the text to better integrate the last sentence of the section.

L386: Please remove the sentence, as the following description is repetitive.

>> We removed the sentence.

1.2.6   Results

In the first section, the descriptions of the figures and tables tend to shift back and forth. I recommend restructuring this section to improve the flow and clarity.

>> We restructured this section.

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L412: I suggest avoiding the term trend since no statistical trend was tested. Instead, consider using tendency. You also use the word trend later in the text, though I did not mark those parts.

>> We replaced the term trend with tendency throughout the manuscript.

L418: With visual, you refer to a verification based on orthoimages/maps?

>> Yes. We added a mention of the orthoimages and maps for clarity.

L407: Is there a peak at 1m in the HMBD, or could the bin size influence it? How did you determine the bin size choice?

>> The bin size was chosen through an iterative process with manual changes to the plot parameters. The current size of 0.1 was chosen as a compromise since it shows sufficient detail without having gaps in the plot. There is a slight peak at 1 m that is also visible in a density plot, though less pronounced than in the histogram.

Table 5: (i) The MAD is missing, despite being described in the text. It would be helpful to place the related key figures next to each other (e.g., mean and standard deviation; median and MAD) for better clarity. (ii) Landslide thickness (HMDB: n=709) and slope (HMBD: n=648). Could you explain where these discrepancies in the HMBD and sample size come from? (iii) For the covariates, please refer to SwissAlti3D, as the values are derived from there, correct? (iv) Also, for clarity: elevation [m a.s.l.].

>> (i) Unfortunately the PDF rendering of the version with changes cut off that part of the table containing the MAD. We reorganized the table to group mean/SD and median/MAD.

>> (ii) We added a short note to the caption that lower sample sizes result from missing values in the inventory.

>> (iii) We added a reference to swissALTI3D in the caption.

>> (iv) We added the [m a.s.l.].

Figure 5: I don't see a clear trend with the KtBe slope from the dataset, as the medians are approximately the same between 30° and 40°.

>> Thank you for pointing this out. Part of the mentioned tendency was present in an earlier version of the figure where the slope classes with only few entries also showed boxes. We updated the description to better reflect the current plots.

L439: You mention the existing models (also in other parts of the manuscript). It might be clearer to refer to them as 'models in comparison' to distinguish them more explicitly.

>> Thank you for this suggestion. We opted to adapt the term "simple models" throughout the manuscript since "models in comparison" would lead to some weird phrasing like "compared to models in comparison" in several places.

Table 6: You could add a line between your ML models and the models in comparison and hence, split the table.

>> We added a horizontal line between our models and the simple models.

L439ff: As I mentioned in my first review, the data is, from my point of view, not distributed along the 1:1 line.

>> The data is indeed not strictly distributed along the 1:1 line nor was it our intention to claim so. However, the ML data is certainly located closer to the 1:1 line compared to the other models. We reformulated the sentence.

150   Figure 5: Please increase the dot size. Instead of landslide thickness actual, I suggest writing measured landslide thickness and predicted landslide thickness.

>> We have changed the axis labels in the figure to "Measured landslide thickness [m]" and "Predicted landslide thickness [m]".

>> We increased the point size by another 30%. We are aware that the discerning the points in figure as rendered in the
155   PDF can still be somewhat difficult depending on the zoom level. To alleviate that, we will provide an additional high-resolution version of the figure with the final manuscript. When we created test plots with further increased point size, it became more difficult to distinguish finer structures in the plot because the dots obscured each other. Therefore, we feel that the currently used point size is a good compromise.

1.2.7   Discussion

160   The newly introduced Chapter 6.4 seems weak from my perspective. The entire paragraph does not reference other publications. Additionally, statistical methods have strengths and weaknesses, which could/should be addressed as well.

>> We revised section 6.4 and focused more on the most important points while referencing relevant literature. In addition, we added some information on the properties of the ML models in section 6.2.