Dear Dr. Pascal Haegeli:

Thank you very much for handling our manuscript and giving us careful suggestions to improve its quality. Below, we would like to explain our reply to each comment with blue-colored text.

Best regards,
Ryota Tsubaki, as a representative of the authors.

Comments from Pascal Haegeli

Dear Drs. Wangchuk and Tsubaki:

Thank you very much for revising your manuscript “A glacial lake outburst flood risk assessment for the Phochhu River Basin, Bhutan” and resubmitting it to NHESS. As pointed out by the reviewers, your study addresses an important knowledge gap. I have now examined your revisions and studied the updated manuscript in detail. I believe that your edits improved the quality of the manuscript tremendously. However, I have a series of additional suggestions that aim to further improve the clarity and accessibility of your manuscript. Please see below for details. I would appreciate it if you could address these comments before I accept your manuscript for publication.

I hope you find my comments useful and they help you bring your manuscript to the next levels. Please let me know if you have any questions or require additional information.

Pascal Haegeli, PhD

NHESS Editor

Simon Fraser University, Vancouver BC, Canada

Introduction

L41 – Fig. 1: Please move Fig. 1 to the end of Section 1.3 after you introduced the figure in the text for the first time (L60). Figures should always follow their introduction.

Thank you very much for the suggestion. We moved the location of the figure.

L41 – Fig. 1: Adding major cities and transportation routes to the map might make it easier for readers to understand the map and put other map features in context.

Thank you for the suggestion. We edited the figure as suggested.

L41 – Fig. 1: Please introduce the PDGL abbreviation in the caption of the figure. Maybe the term could be written out in the legend.

We edited the figure caption.

L41 – Fig. 1: It might be useful to highlight Luggye Lake, Tshojo Lake, and Thorthomi Lake in Figure 1 to allow readers to see where these lakes are.

We edited the figure as suggested.

L61: Does "the largest in the country" relate to the size of the river basin? If that is the case, reword the sentence to "The Punatsangchhu River Basin (the largest in the country) contains eleven PDGLs".

The Punatsangchhu River Basin contains the largest number of PDGLs per basin in the country. This point is explained in the revised manuscript.

L80+ – Section 1.5: This section seems at the wrong spot as it does not seem to justify the study objective and disrupts the flow of Sections 1.4. and 1.6. Instead, it highlights a limitation of the existing data/understanding, which has implications on your modelling approach. Hence, it seems more meaningful to include this information in the methods section.

We described the lack of direct data for GLOF bathymetry here because one of the main objectives of our study was to estimate the bathymetry of the focused GLOF. However, we understand that the flow is not smooth, so we moved the information to Section 3.1.

L94: Start this section with "To contribute to these risk management efforts, …" (or similar) to better tie this paragraph to the research need outlined in Section 1.4.

Thank you for the suggestion to improve the connection between sub-sections. Based on the suggestion, we edited the section.

L94+ - Section 1.6: You should use present tense to describe what your study does in the introductory section. This is different from the methods section.

We corrected the tense in the sub-section.

L100: The sentence “Since the overtopping …” seems out of place. You could either move it up to L94 where you introduce the objective of the study or to the methods section.

The sentence has been moved.

L110+ – Section 1.7: Please write this section a little bit more interesting and not just have a sequence of similar sentences: “Section 2 describes… Section 3 describes … Section 4 reports … Section 5 discusses …”

We attempted to put some flavor in the description of paper structure.

L115 – Figure 2: This figure seems too detailed and out of place for the introduction section. It would be better to move it to the beginning of the methods section (see later comment).

We moved this figure to the methods section.

Study area and GLOF event

L121: The description of the Punatsangchhu River Basin and its link to Fig. 3 is a bit confusing as the figure seems to primarily focus on the Phochhu sub-basin. Please clarify.

We edited the caption and the text to clarify the location of the Punatsangchhu River Basin.

L121: It would make the section easier to read if the physical characteristics (location, area, discharge volumes, …) were discussed together and the population and administrative characteristics explained together in a separate paragraph. They are mixed right now.

We edited the section based on the suggestion.

L130 – Figure 3: Note that the outline of the study area/Phochhu sub-basin (I believe) shown in Fig. 3 is different from what is shown in Fig. 1. In my opinion, Fig. 3 could be substantially simplified by a) eliminating panel (b) and already outlining the study area in Fig. 1, and b) combining panels (a) and (c) into a single annotated map. Please also note that the labels of the different panels (a, b, c) do not line up with the labels in the caption and the text!

Fig. 3 (Fig. 2 in the revised manuscript) shows the study area, which is not identical to the Phocchu Basin (the study area is the catchment area of the PHPA-I & II excluding the Mocchu River Basin). For clarity, we kept panel (b) (panel (a) in the revised manuscript) and edited the figure caption.

L144+: The paragraph starting at this line does not seem to fit under the heading "2.2 Thorthomi glacial lake" as it describes the social and economic characteristics of the downstream areas. Please consider combining Sections 2.1, 2.2., and 2.3 into a single section that describes the study area. There should be separate paragraphs describing the physical and economic characteristics of the region.

We edited the text based on the suggestion.

L155: It is not considered good style to write "As shown in Figure 4, …". Instead write "The lake is one of four glacial lakes in an area that spans a few kilometres (Figure 4) and had an outburst in 1994." This is much more concise. Also, it is not necessary to write "(see Figure 4)" (e.g., L161). Just write "(Figure 4)".

We edited the text based on the suggestion (we changed "(see Figure X)"s to "(Figure X)"s in other places too).

L177: The sentence "We constructed …" seems out of place because it describes the analysis approach and not just the event as implied by the section heading on L154.

This sentence has been move to the beginning of Section 3 and edited to fit the description there.

Materials and methods

L179 – Materials and methods: I recommend you start this section with a brief overview of your analysis approach that includes Fig. 2. This would provide valuable overview and context for the content presented in the following subsections.

The figure was edited and an explanation has been added to the beginning of Section 3.

L180+ – Section 3.1: The heading for this section is misleading as you are only presenting an approach for estimating lake volumes and not a regression analysis. Please consider

using a more appropriate title like “Estimating lake volumes”. The section also goes back and forth multiple times between the mean depth (e.g., Huggel et al, 2002; Cook and Quincey, 2015) and the maximum depth approaches (Sakai, 2012). For example, on L195, you mention that the approach of Cook and Quincey (2015) included the dataset of Huggel et al (2002), which was already mentioned on L195. Please improve the structure of this section to make it less convoluted for the reader.

The sub-section title has been changed to “Estimating geometries of glacial lakes”. The paragraphs have been edited to improve readability.

L218: Please explain why you chose to use the approach of Sakai (2012).

For predicting moraine dam breach processes, the maximum depth is crucial, so we employed the equations proposed by Sakai (2012).

L222 – Section 3.2: Here is the place to let the reader know that you are focusing on overtopping of lake water as the failure mode. See earlier comment.

We edited the text based on the suggestion.

L241: The sentence “Unlike parametric models, physically based breach models consider the geotechnical aspects of dam materials, as well as …” should go earlier when you introduce the BREACH model for the first time. This section should focus on what you did with the model and why.

We edited the text based on the suggestion. We added the reason why we used BREACH: “because of its better predictive accuracy for future extraordinal GLOF events”.

L271: Can you elaborate on how the data was adopted from available reports and research documents.

The dam breach model requires detailed data regarding moraine dam materials. No single source or paper contains the parameter data required. As a result, we used some data from Koike and Takenaka (2012) and some data from the publication of NCHM (2019a).

L271: The sentence “Table 2 provides …” is unnecessary. Just cite the table in the previous sentence. Similar to earlier comment.

We edited the text based on the suggestion.

L274 Table 1 & 2: These two tables could potentially be combined with the parameter names in the first column and the parameter estimates for the Luggye and Thorthomi Lakes in columns 2 and 3 respectively. This would allow readers to compare the parameters estimate between the two lakes more easily.

We agree that it is good idea and edited the text based on the suggestion.

L 281 & 289: It is only necessary to introduce the HEC-RAS abbreviation once.

We introduce the abbreviation of HEC-RAS in Section 1.

L 305: Please avoid subheadings at a fourth level (e.g., 3.3.2.1). The information in this section can easily be presented in just two paragraphs without subheadings.

Fourth level subheadings have been removed in the revised manuscript.

L316: It might be useful to state here that three different DEMs are available for the study area. This would set the stage for the descriptions of the different DEMs that follow.

The manuscript has been revised based on the suggestion.

L329: The sentence “Figure 6 illustrates …” is not necessary. Just cite the figure in the previous sentence. Similar to earlier comments.

We edited the text based on the suggestion.

L357 – Section 3.3.3 and 3.3.4: These two sections can probably be combined into a single section that explains the hydrodynamic modelling at the two study sites. This would result in the following streamlined subheadings for the flood routing section: 3.3.1 Hydrodynamic model; 3.3.2 Ground elevation data; and 3.3.3 Implementation for GLOF reconstruction and prediction.

The structure was edited based on the suggestion.

L367: Delete “almost that was” so that the sentence reads “We used a hydrodynamic model similar to …”.

We edited the text based on the suggestion.

Results

L375 (and other sections): Try not to start sentences with “As shown in Figure X. Instead, just cite the figure at an appropriate location in the first sentence. Similar to earlier comments.

We edited the text based on the suggestion.

L407 – Table 3: Is it necessary to include the measured and estimated values of all these PDGL in this manuscript? It is unclear to me who this relates to the information presented in this study.

Since it added little or no major contribution to the manuscript, we removed the Table.

L443+: The information presented in this paragraph seems to belong to the methods section.

We edited the text based on the suggestion.

Discussion

L455: Simplify the heading to just “Discussion”

We edited the text based on the suggestion.

L474 – Figure 13: Please reverse panels d) and e) to produce the regular top-to-bottom and left-to-right flow.

We modified the layout of the figure.

L474 – Figure 13-15: If possible, if would increase the font size of the labels in these figures. The time step labels in Fig. 15 are particularly difficult to read.

We enlarged the labels in the figures and added labels (a) to (g) in Figure 15.

Conclusion

No suggestions or comments.

General

Language: The writing of your manuscript is still not at the level it should be for publication. The paragraph and sentence structures are often convoluted, there are way too many commas in the writing. While you are correct that Copernicus staff will copy-edit the manuscript before sending it into production, their role is to fix error and not the make the writing easier to understand. I therefore recommend that you work through the text of the manuscript in detail again.

We reviewed the whole text in the manuscript and tried to improve its readability.

Finally, we would like to express our sincere thanks to the review and editorial teams for giving us careful comments and suggestions to improve the quality of the manuscript.