Response to the Editor:

We sincerely thank the Editor for considering our manuscript for potential publication in the 'Natural Hazards and Earth System Science (NHESS)' journal and for sending it out for peer review. We appreciate the time and effort the editor and reviewers invested in providing constructive and insightful comments that helped improve the scientific clarity and robustness of our work.

We have carefully addressed all reviewer comments and prepared a detailed, point-by-point response to each. Necessary modifications will be made to the manuscript, and a revised version will be prepared incorporating all suggested changes to improve clarity, methodological transparency, and the interpretation of results, and to address the limitations of the current study. We believe that these revisions will significantly improve the overall quality of the manuscript, and we sincerely thank the reviewers for their constructive and thoughtful evaluation.

The responses to reviewer comments are provided in blue font, and the corresponding excerpts from the revised manuscript are shown in green italic font within the response document.

Reviewer 2

General Comment

This paper details mass movements in the remote Warwan sub-basin which has experienced development and population increases. Multiple mass movements, including GLOF events, have largely gone unreported due to the inaccessibility of the region. This paper focusses on three major events; one triggering a GLOF. They carry out geomorphological mapping, avalanche reconstruction (using scenario-based modelling), GLOF process-chain modelling and Mapping GLOF-exposed infrastructures

The paper aims to model past events and quantify future downstream GLOF exposure in order to provide a foundation for the future of GLOF research. They also hope to provide information for future planning and infrastructure to help build resilient communities. They highlight the need to integrate cascading hazards in future assessments, as the interactions of different triggering hazards can exacerbate the rick to communities. The results presented highlight the need for integrated monitoring of cryospheric processes, improved early warning systems, community-based preparedness, and robust mitigation strategies to safeguard life, livelihoods, and infrastructure in the region.

We sincerely thank the reviewers for their careful evaluation of our manuscript and for their encouraging comments on the relevance of our work. We addressed all the

comments from the reviewer and have prepared point-wise responses, which will be incorporated into the revised version of the manuscript. All the reviewer comments are in black color, while the responses are in blue in this response document.

Suggestions for improvement:

I would consider revising the title to include GLOFs, as this is a focus of the paper.

We will revise the title as “Unreported mass movements and future GLOF hazard in the Warwan basin, Jammu and Kashmir, Western Himalaya.”

I would consider shortening the introduction - there is a lot of information contained, not all of which is particularly relevant to the study or narrative of the paper. Specifically paragraph 2 could introduce the ideas presented around hazard potential and integrate this with paragraphs 3 and 4. I don’t feel like you need so many specific examples, but if you feel that these add weight, then please do consider condensing the information. Paragraph 5 highlights how these are underreported, but could be shortened.

Thanks for the suggestion. We will shorten the introduction and incorporate all the reviewers' suggestions to strengthen the revised manuscript.

Specific comments:

P1 L3 You mention that the population of the area has expanded, it would be interesting to put this into context if you have any regional statistics.

Thanks for the comment. We will give the available statistics in the revised version.

P5 L7-9 - could the area of the glaciers be in a figure/table and removed from the text? It’s hard to read.

Thanks for the comment. However, we politely disagree with the reviewer's recommendation to remove the glacier area from the running text. It fits with our paper's narrative and provides an idea of the glaciers' area, ranging from 2.16 to 20.5 km^2.

Figure 1. You include the modelled GLOF path, but this is coloured differently in 1A and 1B. It is also not clear if this is for the 2020 GLOF or for a modelled (e.g. Fig 9) scenario; you just need to clarify.

Thanks for pointing this out. We will make the suggested changes in the revised version of the figure.

P8 L16-18 It's not clear what you're talking about, the future volume of what? The glacier? How? What is the "ice thickness product"?

Many thanks to the reviewer for pointing this out. We discuss the volume of Lake-B in the sentences. The spatially distributed glacier ice thickness product is based on Farinotti et al. (2019).

Section 3.3 could do with revision - it's obscure and not clear what you were trying to achieve or how. It feels like you have cut out elements which are fundamental to being able to reproduce the methodology. For example, P9 L10-11 are unclear: "The density of the modeled avalanche was assumed to be 2300 kg m-3 assuming it to be potential rock-ice avalanches." Doesn't make sense.

We will revise the section giving more details of the inputs to the model and justify the assumptions in the GLOF process-chain modeling in the revised version.

P10 L23 What do Sections 1-3 refer to?

Sections 1 to 3 refer to different sites that are used to measure the hydraulic behavior of GLOF, especially the discharge.

P11 L11-14. You mention that lakes have expanded by different percentages, but it would be better to be consistent about the dates that you choose - it might be that there was rapid expansion between 2020 and 2024 which is not captured in your reporting of lake-A. Can you please address this for context or make sure you state why this is not nesecary.

Thank you for pointing this out. We will evaluate the expansion patterns of the lakes across different time intervals from 1999 to 2024 to assess whether there were differential rates of lake expansion. Here, we would also like to mention that in 2020, Lake-A was completely drained by an ice avalanche and later it formed again in the same lake basin. This has already been shown in Fig. 3, where, if we compare, Lake-A has attained its original area before the GLOF (see the 2019 timestamp in Fig. 3) in the year 2024.

P13 L10/11 Consider revising, this is unclear. You also refer to “empirical equations” in section 3.3, but there are no equations in this section. Can you please explain.

The empirical area-depth-volume relationships from published studies were used; these studies are listed in the first paragraph of section 3.3. The equations will be listed in the supplementary material, as they would take too much space in the manuscript itself. The wording of the statement will be revised to ensure clarity.

P15 L15 You talk about lake expansion. Previously, you used percentages. Can you please keep this consistent?

Sure, we will keep the statistics here also as a percentage for consistency.

P17 When talking about the R1-4 scenarios, you quote different release volumes for R1 (L4 it is 8.53 x 105 m3, L12 you quote 8.69 x 105 m3) - can you please provide more detail on this? It might be useful to have this in a table so that you don’t need to quote scenario specifics in the text.

In L4, we provided the R1 as 8.53 x 10 ^5 m^3 for GL-A, which experienced an avalanche in September 2020 and has a proglacial lake (Lake-A) that experienced GLOF. Meanwhile, in L12, we are providing the release volume for GL-F, which experienced an avalanche in March 2020 from the headwall and has no proglacial lake. See Fig. 1 for the details.

This release volume also depends on the topographic conditions and the release area.

P20 L10 What V–A scaling approach was used?

We used several V-A scaling approaches given by Evans (1986), Fujita (2013), Wang 2012 (D), Huggel (2002), Loruax and Casassa (2013), Emmer and Velmik (2014), Cook and Quencey (2015), Kapisita (2017), Munoz et al (2020) for the estimation of lake volume. We average all V-A scaling outputs to determine the volume. A Supplementary Table giving details of the V-A scaling approaches will be provided in the revised version.

Other:

Please make sure you consistently use either Lake A and Lake B or Lake-A and Lake-B.

We will use Lake-A and Lake-B throughout the manuscript, and wherever Lake A or Lake B is present, that will be revised accordingly, including figures.

Consider revising your use of “respectively”. It would be easier to say P10 L 3/4: Similarly, in scenarios 2 (SC-2) and 3 (SC-3)… You have used “respectively” a total of 9 times in the paper.

Thanks for pointing this. We will remove and avoid the extensive use of the word “respectively”.

You don’t refer to your figures in order. You should reorder these.

We will reorder them, and similar will be mentioned in the revised version of the draft.

“Basin” is used throughout and sometimes seems as if it is a substitute for the word “lake”. Can you please check the use of this? This first happens on P12 L9 - I think this needs reconsideration/clarity.

Thank you for pointing this out. We will carefully revise the entire manuscript and correct such instances.

There are a number of times you reference twice in the same sentence. Please remove the second references in the following locations:

P5 L 18/19; P25 L26; P29 L7/8; P29 L9; P31 L10

We have corrected them in the revised version.

Please check grammar, punctuation and for typos (e.g. P5 L19; P15 L16/17; P20 L14).

Thanks for pointing this out. We have carefully checked for grammar and typos and corrected them in the revised version.

References:

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