

Interactive comment on “Controls of outbursts of moraine-dammed lakes in the greater Himalayan region” by Melanie Fischer et al.

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General comments: The authors employ Bayesian multi-level regression to quantitatively investigate possible GLOF indicators (controls) in the HKKHN region, building on the inventory of 3,390 moraine-dammed lakes and 31 historical GLOFs. The study is well-structured and well-written, employed methods are statistically sound. I found this study of potential interest for readers of The Cryosphere.

The authors present interesting results, some of which are novel in a sense that contradict assumptions of previous GLOF hazard assessment studies (e.g. the assumption that fast-growing lakes are more susceptible to GLOF), but this is only one part of the story (so far pretty much model-oriented) in my opinion. If the overall aim is enhanced

C1

identification of potential future GLOF sites or so, stronger linkages of investigated GLOF indicators to physical processes behind as well as (at least brief) characterization of documented GLOFs (in terms of triggers, mechanisms) are missing. For instance, how (process-wise) is the EDW, glacier-mass balance or lake (catchment) area linked to documented GLOF? What are triggers of historic GLOFs considered in this study? In fact, I'd expect this to be taken into consideration in the very first step – selection and justification of GLOF indicators.

It would be interesting at least discuss how many of documented GLOFs were actually triggered by processes associated with investigated GLOF indicators? This is briefly touched in the introduction (L36-39) or study area section (L108), but I'm convinced that bit deeper and more comprehensive elaboration (e.g. a separate discussion section) would be beneficial for readers. Another example - on L244-245 it is mentioned that 'greater lakes are more likely to having had a GLOF . . .'. I wonder what do primary data say about this – what proportion of these 31 GLOF-producing lakes would be classified as large at the time of GLOF and what this proportion is in the population of 3,390 moraine-dammed lakes? And in the other way around - can a specific combination of values of GLOF indicators infer about possible (likely) GLOF trigger and mechanism (if not known)?

Let me also critically comment on some of the selected GLOF susceptibility indicators (in general, I'm convinced it would be useful presenting these indicators in a separate table with more detailed and comprehensive description than stated in the overview Tab. 1, and in places of the text):

- Lake area change – I'm aware this indicator is always tricky to define and employ; according to what is written on L134-135, two intervals are used for lake area change (1990-2005 and 2005-2018); considering GLOFs occurring throughout the period 1981-2017, it means than these intervals may be pre-GLOF, post-GLOF or the GLOF occurred somewhen during one of these intervals – please comment on how this inconsistency was treated and whether it can explain that no link was observed

C2

between lake area change and the occurrence of GLOF

- Glacier mass balance – similarly to my comment on lake area change - how can 2000-2016 glacier mass balance be used to explain GLOFs occurring throughout the period 1981-2017? These characteristics (mass balance as well as lake area change) are dynamic in nature and I'm wondering how can a static information from available datasets possibly blur a GLOF signal, especially for pre-2000 GLOFs?

- Monsoonal – using climate indicators in GLOF research is promising, but proportion of summer precipitation doesn't tell you about the extremity; for instance, the proportion will be lower in areas where extreme rainfalls occur in summer, but also some precipitation in winter, but will be super-high in generally dry areas with some precipitation during the summer and no precipitation in winter. But process-wise, the first area will have much higher potential to trigger GLOF in my opinion

I'm aware that these comments are somewhat tricky to deal with, but I'd appreciate some reflection in methods / discussion section.

Minor comments: L11: yes, the approach is quantitative, but selection of GLOF indicators in this study is also expert judgement-based as the authors are GLOF experts

L34: see also Cook et al., 2018, Science

L36-37: this needs deeper elaboration in relation to selected GLOF susceptibility indicators (see also my general comment)

L103: I suggest to use 'GLOF susceptibility indicators' instead of 'diagnostics of GLOF potential' or 'diagnostics of GLOF hazard' (L125); similarly, 'controls' and 'predictors' are used throughout the manuscript, please define a difference or unify

L111-112: lake deepening increases hydrostatic pressure, not areal or volumetric growth

L115-116: the authors usually argue that larger lakes are more susceptible because

C3

large lake areas are more exposed to slope movements potentially triggering GLOFs; large area is also correlated with larger depth (and so hydrostatic pressure acting on a dam)

L130: how is different date of GLOF and input data for model treated? (how possibly different environmental conditions at the time of GLOF and at the time of datasets acquisition can influence your results?) see also my general comments

L136-139: I suggest to move this to L133

Fig. 2: three lake inventories are mentioned (ICIMOD, Veh et al., 2019 and Wang et al., 2020); please make clear how these were integrated; these 3,390 lakes (L131) are from which inventory?

L166: delete 's'

Fig. 3: how about green color in Many Models part?

L176: delete ','

Tab 2: what is PDF?

L207: what is meant by 'common susceptibility'?

L262-263: this step is not clear to me? Please explain

L263: please provide details about this correlation

L272: what is meant by 'average lake'?

Tab. 4: please also consider presenting false positives and false negatives

L352-354: this can be true for a specific period in long-term evolution of a mountain range (considering gradual glacier retreat and overall shift of all rapid processes including GLOFs to higher elevation zones; i.e. the general shift of morphoclimatic zones)

L365: so why not to consider this indicator in your model?

C4

L373: are 'minute'? Please check

Fig. 10: please consider highlighting GLOF-producing lakes; switch a-d in the panel (e)

- - - To sum up, I'm convinced this is an interesting study worthy publishing, but I recommend some moderate to major revisions to be done first. I invite the authors to confront and synthesize their predominantly model-oriented study with processes behind past GLOFs and provide some insights into issues I raised. Thank you.

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