

## ***Interactive comment on “Local land-use change based risk estimation for future glacier lake outburst flood” by S. Nussbaumer et al.***

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In addressing the comments of the reviewers please also take note of the additional comments below:

- I don't find the risk calculation approach used very convincing. You say you adapted the risk equation by Bründl et al. (2009), and calculate risk as  $R = I \cdot S \cdot V$ . As far as I can tell Bründl calculated risk as function of hazard probability, exposure (probability of an object being affected, value of the given object/element at risk, and its vulnerability – in my view quite different from your approach. Your conceptualisation reduces the first 2 terms to intensity, thus saying that you adapted their approach is somewhat questionable. Strictly speaking, risk indicates the expected losses due to a certain haz-

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ard type and magnitude for a defined time period (usually per year). Your risk concept includes nothing on the probability (and you state why) – explain this better. Also see my comment below on the exposure aspect (in the context of social vulnerability)

– I think for people the exposure element could be included in the risk conceptualization (as you briefly discuss in the final section)

- Reduce number of citations – including nearly 100 citations is excessive for this type of paper; also ensure that all citations in the text are included in the bibliography

- P6: “. . . were identified based on a literature review (CIPRA, 2010; OcCC, 2007; Müller, 2005; BUWAL, 2003; ARE and UVEK, 2005; IPCC, 2012; Voigt et al., 2010; de la Vega-Leinert and Schröter, 2004), and interviews with the local planning authorities and the government representative (oral statement Michlig, 2011; oral statement Holzer, 2011).”

- L19: “on socio-economic scenario” should be scenarios

- L25: “quantification in driving forces” should be “of driving forces”

- Remove the many double periods at the end of sentences

- P9: isexpected

- Explain better what the 2 intensity scenarios mean. It's not just a matter of water height, but given the amount of water surely also one of flow/impact velocity. In that sense, can a GLOF with a water height  $< 2$  m be considered medium? Please make this clearer

- P10, Vulnerability: Please rework the sentence: “The definition and use of vulnerability varies depending on the conceptual approach and its relation to risk (cf. ATEAM, 2004; UNISDR, 2009; Dow, 1992; Cutter et al., 2009).” Vulnerability is understood to be the capacity for loss. Citing publications that use now outdated definitions is not very useful. Also define social vulnerability (e.g., “people's differential incapacity to

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deal with hazards, based on the position of the groups and individuals within both the physical and social worlds”, Clark, GE, Moser S, Ratick S, Dow K, Meyer WB, Emani S, Jin W, Kasperson JX, Kasperson RE, Schwarz HE (1998) Assessing the vulnerability of coastal communities to extreme storms: the case of Revere, MA, USA. *Mitigation Adapt Strat Glob Change* 3(1):59–82.

- In the discussion on social vulnerability it would be worth commenting on the time it takes between a GLOF occurring and expected impact in the various settlements, which allows an assessment of the possibility of early warning and possibly some evacuation/relocation measures. Even if there are only a few minutes before impact there might be enough time to flee to higher ground/higher floors in strong buildings. This will reduce the overall risk, and is interesting to be discussed in the context of social vulnerability (those poorer/foreign/disadvantaged people may have higher a SV). I also assume that by 2045 (if not long before then) some form of monitoring of the lakes will take place, allowing effective early warning (you only briefly touch on this point on P18). Elaborate on this point

- P15: the sentence “Very high physical vulnerability, however, is predominantly present at the marginal areas of the case study area, as it mostly belongs to forests, agriculture and unproductive areas.” makes little sense to me: vulnerability must always be assessed with respect to a given hazard type and hazard magnitude. In Fig 1 you show that the GLOF scenarios predominantly affect the southern part of the study area, close to the blue runout line. What is really the expected hazard event magnitude along the northern edge that is marked as high physical vulnerability? It also is not clear why forest and unproductive lands (fallow/unused land?) have very high vulnerability, while built-up areas/residential areas exposed to higher GLOF intensities have lower vulnerability (again, recall that vulnerability is capacity for loss due to a certain hazard type and magnitude – hard to see what losses you expect for categories such as unproductive land). Explain better

- P15: “Contrary to the value for physical vulnerability, marginal areas featured low  
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social vulnerability.” I think the discussion of variable social vulnerability only makes sense if you discuss it in the context of exposure and early warning/evacuation. If you have a situation where the GLOF catches the entire community by surprise the vulnerability will only be a function of hazard intensity (and perhaps physical vulnerability of the building the people happen to be in), but social vulnerability will be identical. It only becomes relevant in a situation such as early warning messages that may not be received or understood by everyone, or evaluation that is hampered by large family sizes, lack of transport or similar indicators for people with high SV. Discuss better

Regarding the comments of the reviewers:

- Use of “Cf.” in principle seems ok to me, but check if it’s also ways appropriate (in that it stands for “see also”/ “compare with”)

- Reviewer 1 already correctly remarked that multiplying your ordinal category values is not meaningful – this is a critical issue that must be carefully addressed

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