

Emmer_hessd-11-2391-2014

Review

General Comments

The paper presents a method for assessing the potential hazardousness of glacial lakes within the Peruvian region of Cordillera Blanca. Lake hazard is assessed based on a combination of decision trees for clarity and numerical calculation for objectivity. Seventeen assessed characteristics of lakes are used, of which seven are claimed to be new. Five typical glacial lake outburst flood scenarios are considered. Seven lakes which have produced GLOFs in the past and ten which have not are considered. The method does not deal with the magnitude of a potential GLOF, just the probability of its occurrence.

In general, the authors present a method that can be very useful to the risk managers in the Cordillera Blanca region and other regions experiencing an increased potential for GLOF events. The readers of the journal will likely be very interested in this material. However, as pointed out below, the paper suffers from a lack of clear presentation of basic principles of the method and needs major revision prior to publication. Comments and suggestions for improvement are presented below.

There are numerous places that exhibit repetition throughout the paper and these should be edited and repetition minimized or removed.

Some corrections to language usage needed throughout the paper. A complete and thorough proofreading is needed. Just a very few examples:

- The impacts of glacial lake outburst floods cannot ever “been” completely eliminated
- risk management and mitigation, “therefore” it is of great importance.
- four principles which “were” consider
- also “allowed” any gaps
- “sinus function”

Specific Comments:

1. GLOFs within the Cordillera Blanca *significantly differ* from GLOFs in other glacierised mountain ranges worldwide (Emmer and Cochachin, 2013) – This is pretty vague and needs elaboration.
2. The characteristics which need to be taken into account in a *regionally based method* for assessing the potential hazardousness of glacial lakes within the Cordillera Blanca (– These are NOT regional characteristics and would apply equally well to glacial lakes in the Himalaya, e.g., Tsho Rolpa)
 - (a) the possibility of dynamic slope movement into the lake;
 - (b) the distinction between a natural dam and a dam with remedial works (more generally dam stability);
 - (c) the dam freeboard (ratio of dam freeboard);
 - (d) the possibility of a flood wave from a lake situated upstream; and
 - (e) the possibility of a dam rupture following a large earthquake.

4. "(c) landslides on steep lateral moraines surrounding the lake" – Landslides could occur from the end of the lake or form a slump of the terminal moraine.
5. Term "maximal lake width" needs to be defined, perhaps in a diagram.
6. The physical meaning of "potential for icefall into the lake" based on the ratio is unclear and needs to be explained in physically meaningful terms.
7. Subjectivity – "assess the potential for a landslide of a moraine into the lake" "on the basis of manual expert analysis" this seems to remove the objectivity here.
8. Lake volume equation –why not use the bathymetry?
9. "An assessment of the potential for a flood wave from a lake situated upstream is only meaningful when the ratio of the upstream lake volume to downstream lake retention potential (rV/V_{ret} [unitless]) is higher than 1" – This does not seem to include the possibility that the release from the upper lake could create a wave in the lower lake that overtops the dam, or perhaps I am missing the point here. Depends on definition of "retention potential" of lower lake (eq. 6). No good reason for eq. 6 is given and this must be explained, especially how the equation accounts for the possibility of a wave overtopping the dam.
10. Equation 8 for the Critical Area of a lake seems to be somewhat subjective in that it is based on the experience of one lake and expert opinion. What is the effect of implementing this suggestion? What sensitivity analysis has been done to assess the impact of choosing this parameter (0.05) rather than some other value?
11. "With reduced demands on input data, the dam material is only characterized by dam type (moraine dam x bedrock dam)." How is the dam type determined "on the basis of remotely-sensed high resolution images and digitam (spelling?) terrain model, without any field survey"??
12. How did the authors arrive at Equation 10? This is not clear and either additional elaboration is needed or the equation should be justified with some reference to the literature.
13. Equation 11 seems to assume that the entire volume of the upstream lake is released into the downstream lake. This seems unreasonable and needs to be justified or modified. Also, check the units of this equation $((m^3)/(m^2))^2 = m^2$ which are not the units of discharge (m^3/s). The authors assume "The power of two was used to emphasize the non-linear trend in the flow rate increase.", but very little justification is given for choosing this exponent.
14. "A comparison between the pre-GLOF conditions of the lakes which have produced GLOFs with those which have not should highlight the most susceptible lakes for each scenario. "The assumption is that the presented method should clearly distinguish between lakes which have already produced GLOFs and those which have not." Some of the lakes of concern in the Cordillera Blanca have yet to evolve to the state at which they may be dangerous, but they may reach this state in the next 1-2 decades. Clearly, the authors have not dealt with this in their method. Does the proposed method have the ability to analyze

situations where the conditions of the lake(s) may change considerably over time and progress from a relatively safe state to one which is dangerous.