Comments by Wilfried Haeberli *on*

Brief communication: A landslide-induced winter outburst from a frozen glacial lake in the Central Himalaya

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by
Q.Liu, Y. Yin,Y. Yin, J.Yang, Y.Luo, X. Lu, H. Wang, Y. Fu, B. Zhang, Q. Zheng, D. Lei, X. Wang, S. Liu, Y. Nie and S. Kang

General:

The submitted manuscript describes an interesting case of a large winter rock-ice avalanche from a steep, lateral, glacially de-buttressed permafrost rock slope, partially onto a glacier and partially into a lake with a thick lake ice cover. Even though the event did not cause grave damage, the documentation of the involved lake-ice damping effects and "lake ice tsunami" is an important contribution to the ongoing learning process about increasing hazards and risks from rock-ice avalanches into lakes events at other sites worldwide. The authors may wish to more clearly emphasize the cold-dry climatic conditions of this Tibetan region, with largely continuous permafrost in moraines and rock walls probably reaching to depths of up to hundred meters and more.

The presented case study provides interesting and useful information about hardly ever considered aspects related to impulse waves in lakes and induced down valley floods. It is perfectly suited as a "brief communication" in The Cryosphere.

The observations and reconstructions of the event with its cascading processes are well described. The formulations may in places need some smoothing. Related minor technical comments and recommendations are listed below.

Minor remarks:

Line 18 : broke (not broken)

Lines 22/23: Better perhaps " … occurrence window of GLOFs in high mountain areas relates to all seasons, and winter events onto frozen lakes may even become more frequent as climate-induced paraglacial slope failures tend to increase in number".

Lines 23/24: This is not a general "blind spot" in science, therefore better write something like: "This single event concerns an often ignored or underestimated winter aspect related to hazards from expanding or newly forming glacial lakes."

Lines 34-36: Better eliminate "the strategy of mitigation preparation". This is not straightforward and would need further explanation.

Line 38: Better "globally reported".

Line 43: Better “represented in red” than “texted with red”?

Line 49: Better “exact timing”

Line 57: Better “meeting”, “which meet”, “accompanied by” or the like (sentence otherwise incomplete)

Line 61: The presented case study indeed documents strong damping effects. This could be more strongly emphasized.

Line 63: Better “ … here we report …”

Line 66/67: There is no need for an “alert” (the scientific community does not “ignore” the described phenomena) but rather a need to raise awareness about the described phenomena.

Line 72: Eliminate “were” (“occurred” alone is fine).

Line 74: The authors could even write “ … a perennially frozen lateral moraine collapse”. The phenomenon of permafrost at South Lhonak was of fundamental importance for our understanding of the observed coherent flow fields, related stability conditions and involved volumes before the final event. The moraines in the here described region are most likely all frozen to large depths. This must have strong effects not only on slope stability but especially also on river erosion. As the outlet of Pida lake was artificially excavated (to what depth?), frozen ground may have been encountered.

Line 77: Better “glacier-contact lakes”. In fact, these lakes are probably also in contact with periglacial permafrost.

Line 83: Better “in the southern Tibetan plateau”

Line 95/96: Perhaps better: “ … sudden increase in water level and turbidity together with drifting river …”

Line 116: Better “rock-ice avalanche” (as the event detaches from permafrost, it amost certainly contains ice)

Line 121: Better “This toe landslide induced calving of about 2700 …”

Lines 123-125: The sequence of the statements could be improved, for instance: “The second landslide occurred in the late afternoon of 16 December. A volume of ~4.29Mm3 collapsed from the upper part of the same glacially de-buttressed permafrost slope, leaving a distinct scarped edge line on the cliff wall. An estimated part of ~2.86 Mm3 of this rock-ice avalanche directly struck the frozen lake. This impact generated a sub-ice impulse wave that fractured the ~35 cm thick lake ice, producing an “ice tsunami” with ~10 m run-up, and triggered a down valley flash flood (see discussion below).”

Lines 138 and 139 : Better “rock mass”

Line 173: Perhaps better: “ … causes flood. As evident from the described case, a thick lake ice cover can exert a strong damping effect on the induced impulse wave.”

Lines 181- 184: Better avoid over-emphasizing the importance of the observed aspects. Perhaps better write something like: “ … should adequately include lake-ice monitoring as part of early-warning systems in connection with possible winter GLOFs.

This could directly be followed by the very last sentence: “Since water-pressure-based sensors often become non-operational when a lake freezes, new sensing technologies or strategies are needed to monitor real-time lake and ice disturbances and integrate these into GLOF early warning systems.”

The quite general text in between could be eliminated without loss of essential information.

Figures: The complex multi-graphs and multi-images, particularly in Fig. 1, contain rich information. This information, however, is hard to read due to the small individual sizes/fonts of the partial graphs and images. A re-arrangement, for instance through making two figures out of one, could help.