Glacial lake outburst floods in High Mountain Asia: From large scale assessment to local disaster risk management

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Widespread retreat of glaciers has accelerated over recent decades in most mountain regions as a consequence of global warming, leading to rapid expansion of glacial lakes, bringing related risks. When water is suddenly released, Glacial Lake Outburst Floods (GLOFs) can devastate lives and livelihoods up to hundreds of kilometres downstream of their source. This threat is most apparent in High Mountain Asia (HMA), home to >200 million inhabitants, and where >150 GLOFs have been recorded from moraine dammed lakes alone. Here we reflect on our recent experience working across HMA to outline key learnings, challenges and perspectives in applying GLOF hazard and risk assessment at various scales, with an emphasis on how results have or can inform local response planning.

The number of large-scale assessment studies has increased exponentially over recent years, often giving inconsistent results in terms of what are considered potentially dangerous lakes. This makes it difficult for authorities and funding agencies to identify where more detailed hazard mapping and risk management strategies should be targeted, especially in cases where the science may not be aligned with local understanding and experience. We therefore recommend a consensus approach, drawing across multiple studies, and including the knowledge of local authorities to arrive at a final listing of high priority lakes which may be subject to further monitoring, Early Warning Systems and other response strategies. In our stakeholder interactions, we have particularly emphasised that GLOFs from even relatively small lakes can lead to significant
damages when combined with other hazardous processes, e.g., the case of 2013 Chorabari GLOF combining with monsoon flooding and landslides in Northern India, or the 2016 outburst from Gongbatongshaco, Chinese Himalaya, Tibet, where erosion and bulking was significantly enhanced as a consequence of the Gorkha earthquake occurring a year earlier.

Looking to the future, several assessment studies have now combined modelling of glacier bed topography to identify where new lakes could emerge in the future, and even combined this information with changing exposure levels (e.g., planned hydropower development). However, there are challenges around communicating these uncertain future hazards and risks, and to what extent they should be considered in planning. In the transboundary Poiqu basin originating in Tibet, we have focussed on worst-case scenario modelling for such a future lake, demonstrating that flow depths and velocities would exceed the threat from current lakes, and the peak wave would reach the border with Nepal up to 20 minutes faster. Open questions remain around how triggering processes will evolve in the future. Most assessments currently focus on cascading process chains triggered by ice or rockfall, whereas under a wetter and warmer future climate, heavy rainfall and snowmelt as a direct or indirect trigger could become increasingly important. Further, major uncertainties arise from socio-economic developments and related changes in exposure and vulnerability, that could, in some regions, be the most significant drivers of future GLOF risk. Ultimately, forward-looking, GLOF hazard and risk assessment must ensure that response strategies remain robust in the face of ongoing environmental and societal change.