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GLOF risk management experiences and options in a global context

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Glacier lake outburst floods (GLOF) are cryospheric hazards of severe destructive potential. GLOFs are prevalent in all glacierized mountain ranges globally and can cause high economic losses and pose a threat to people and livelihoods, potentially impacting agricultural land, lives and infrastructure. This underlines the importance of effective GLOF disaster risk management (DRM). GLOF DRM experiences are reported on in mountain ranges globally. However, there are relevant gaps in their documentation, analysis, and evaluation.

This study compiled GLOF DRM experiences in South and North America, Europe, and Asia. We categorized the different structural and non-structural measures that have been taken and systematically analysed the temporal scope in which they function (i.e., short-term, long-term), as well as the risk component they influence (i.e., hazard, exposure, vulnerability). We analysed for the different DRM measures, in what context they were practiced, what their benefits were, what challenges were faced, as well looking at aspects of sustainability.

We found that the biggest share of DRM measures is based on and applied in a limited spatial context often aiming at the reduction of a physical hazard emerging from a specific glacial lake. Examples of such activities are syphoning and pumping of lakes, drainage channels (with/out sluice gates) and tunnels for lake level regulation, flow channel adaptation, dam reinforcement, etc. Such measures, while generally taken once and aimed at short-term fixes (e.g., lake level lowering by pumping) as well as at long-term fixes (definitive lake level lowering by outflow tunnel), can face issues of sustainability. This can be the case for structural measures, for instance, when structures become unfit due to environmental changes (e.g., climate-related, earthquakes). While there are short-term as well as long-term measures in all three risk management components (hazard, exposure, vulnerability), there is a tendency for hazard reduction measures to be more short-term focused, and for exposure reduction (e.g., early warning systems, spatial planning, relocation, etc.) and vulnerability reduction (e.g., information, governance, preparedness, economic diversification, disaster relief, etc.) to be more mid- and long-term focused. Different

challenges were found for all examined DRM measures mostly arising from issues in the technical feasibility (due to harsh climatic and environmental settings), the financial cost (of deploying people and material, and maintaining structures), and social acceptance and appropriation.

While the findings from this study should not be generalized and strictly imposed on all other GLOF DRM cases, the knowledge gained by it is urgently needed to develop recommendations for GLOF DRM based on best practice experiences. GLOF DRM will become increasingly important in warming and increasingly exposed mountain environments globally. It will, thus, be important to further investigate the cost and benefit as well as the effectiveness of different DRM strategies. For sustainable DRM it is important to not look at GLOF hazard in isolation, but to take into account also other physical hazards in the same catchment. It should be considered within the wider context of integrated multi-hazard assessment in order to appropriately tackle/approach the interrelated effects of events that may occur simultaneously, cascadingly or cumulatively.