



A Systematic Review of Loss and Damage in the Mountain Cryosphere

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Glaciers around the world are shrinking mostly as a result of climate change. Glacier changes impact sea level rise, water runoff and result in socio-economic changes for downstream communities depending on their services. The 2-year work plan of the Executive Committee of the Warsaw International Mechanism on Loss and Damage under the United Nations Framework Convention on Climate Change (UNFCCC) has recognized glacier changes and their impacts as important processes that need to be further investigated in view of loss and damage. It calls for enhancing data and knowledge on their impacts and risks and to identify ways to deal with the associated changes. Whereas the loss of landscape and services resulting from glacier and more generally from cryosphere changes have become evident, there is currently a lack of research perspective on realized and potential loss and damage originating from the mountain cryosphere. By using a systematic literature review approach, we selected 41 peer-review papers published between 2013 and 2017 whose focus is on the physical and social impacts of climate related changes in the mountain cryosphere, and analysed them under a loss and damage perspective. Our analysis revealed that none of the selected papers makes a direct reference to loss and damage although several papers discuss impacts in terms of loss of assets and lives as well as damage to property and landscape resulting from glacier shrinkage and melting. In terms of events and process, the majority of the papers focus on slow impact processes, i.e. hydrology and landscape changes with only a handful of papers examining the consequences of sudden onset events such as Glacier Lake Outburst Floods (GLOFs), or ice avalanches and other types of landslides. Based on the coding of the literature, we aggregated a broad range of categories of loss and damage including economic and non-economic losses. We noticed how non-economic losses characterize the majority of our categories, namely cultural identity and lifestyle losses, loss of livelihoods, loss of lives, loss of social security and order. Economic losses refer mainly to loss of assets and property as well as loss of revenue and/or productivity. More than half of the papers discuss impacts which are yet to be realized and hints at a number of strategies to address such impacts. This suggests that whereas glacier melting and shrinkage is to be considered to a certain extent as an unavoidable loss, the associated impacts could be avoided through appropriate adaptation and mitigation strategies. Indeed, more than half of the papers see adaptation and mitigation as promising strategies to avert the damage and losses caused by glacier changes. We conclude that the loss and damage perspective is relevant for the analysis of impacts originating from the mountain cryosphere but it is rarely made explicit in the literature. A systematic and analytical approach to loss and damage by the research and policy community would create a more comprehensive understanding of impacts and risks of cryosphere related impacts and contribute to enhance actions for adaptation, mitigation and risk management.