Mountain Cryosphere Change and Community Adaptation in Pakistan

The mountain cryosphere is an important part of the environmental and hydrological systems of Pakistan. The Hindu Kush–Karakoram–Himalaya (HKH) region hosts significant glaciers and seasonal snow cover that contribute to runoff regulation, support mountain ecosystems and provide water to populations downstream. The changes in the cryosphere are not limited to physical changes of glaciers and snow; changes in the cryosphere have cascading impacts on water resources, agriculture, ecosystems, infrastructure, livelihoods and human settlements.

Climate change is altering the amount and timing of snow and glacier melt, increasing variability and uncertainty in mountain hydrological systems. Meanwhile, hazards from the cryosphere are posing new and emerging risks to communities in high mountain valleys, especially Glacial Lake Outburst Floods (GLOFs). These processes are happening concurrently with ongoing development pressures, environmental degradation, and a lack of infrastructure and socioeconomic vulnerabilities that make adaptation more complex in mountain areas.

The consequences of the cryosphere change are especially strong in mountainous communities where livelihoods and daily life are directly related to the natural resources and environmental conditions of the seasons. Water availability changes can impact irrigation and agricultural production, changes in pasture and ecosystem conditions can impact on livestock systems, and increasing hazard exposure can impact on settlements, roads, critical irrigation infrastructure, etc. Thus, the essence of adaptation to cryosphere change is not just physical but livelihood security, institutional capacity, local knowledge and social resilience.

There are multiple pathways of adaptation that we see in high mountain communities, and evidence shows that these adaptations are already being implemented. Traditional ecological knowledge and local institutions are identified as important in shaping community responses to environmental change. Ingty (2017) identifies six types of adaptation (institutional capital, rationing, forecasting, mobility, economic diversification, and communal pooling), which show that there are locally embedded mechanisms in place for managing climatic and environmental uncertainty in mountain communities.

Likewise, Rasul et al. (2020) in their systematic review of adaptation to change in the mountain cryosphere, looked at adaptation responses on multiple dimensions: changes in practices and behavior, awareness and education, infrastructure and technology, migration and relocation, and policy and institutional arrangements. They found that adaptation in mountains is often self-directed, small-scale, and reactive, and that knowledge, finance, technology, institutions, and adaptive capacity are important constraints on longer-term adaptive resilience.

A significant policy and research gap exists in Pakistan, and there is a need to better understand the impacts of cryosphere change on mountain communities, the adaptations they are already undertaking, and what is needed to support institutional, financial, and knowledge systems to increase their capacity to adapt.

A community-centred approach is especially relevant as local communities are not just beneficiaries of adaptation interventions. They are actors of adaptation, having knowledge and experience of environmental variability, social networks and customary institutions related to their environments. But local response may be inadequate when the magnitude or rate of environmental change is greater than the adaptive capacity. The challenge, thus, is to identify

areas for strengthening community-based adaptation; areas for integration of scientific and local knowledge; and areas where external institutional and financial support is needed.

The session will aim to discuss these topics with an interdisciplinary approach, with experts from the field of cryosphere science, climate adaptation, Disaster Risk Reduction (DRR), water management, livelihoods, development policy and mountain communities.

The discussion will offer a consolidated understanding of how changes in Pakistan's mountain cryosphere are affecting water security, livelihoods, ecosystem services and disaster risks, while documenting existing community-based adaptation practices and local responses. The session will also highlight the contribution of traditional ecological knowledge, local institutions and community mechanisms to resilience, alongside key gaps and constraints in climate information, early warning systems, infrastructure, finance, technology and institutional capacity. It will further identify practical policy and research priorities to strengthen community resilience in Pakistan, integrate scientific and local knowledge, and improve coordination among communities, government, research institutions and development partners.

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