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The crysophere as a resource and hazard - Integrated framework for the assessment of future water resource vulnerability and glacial hazard risk assessment in the Kullu district, Himachal Pradesh, India.

Simon Allen (1,2), Kirtiman Awasthi (3), Juan Antonio Ballesteros (4), Holger Frey (1), Christian Huggel (1), Mustafa Kahn (3), Andreas Linsbauer (1,5), Mario Rohrer (6), Virginia Ruiz-Villanueva (4), Nadine Salzmann (5), Simone Schauwecker (6), Markus Stoffel (2,4)

(1) Department of Geography, University of Zurich, Zurich, Switzerland, (2) Climatic Change and Climate Impacts, Institute for Environmental Sciences, University of Geneva, 1227 Carouge, Switzerland, (3) Indian Himalayas Climate Adaptation Programme, SDC, Delhi, India, (4) Dendrolab.ch, Institute of Geological Sciences, University of Berne, 3012 Berne, Switzerland, (5) Department of Geosciences, University of Fribourg, Fribourg, Switzerland, (6) Meteodat GmbH, Zurich, Technoparkstrasse 1, Switzerland

High mountain environments are particularly susceptible to changes in atmospheric temperature and precipitation patterns, owing to the sensitivity of cryospheric components to melting conditions, and the importance of rainfall and river runoff for sustaining crops and livelihoods. The Himalayan state of Himachal Pradesh (population ca. 6 mil.) is the initial focus of a joint program between the governments of India and Switzerland aiming to build scientific capacity to understand the threat, and plan for adaptation to climate change in the Himalaya. Here we focus on the cryosphere, and provide an overview of the integrated framework we will follow to assess future water resource vulnerability from changes in runoff, and assess future disaster risk from mass movement and flood hazards. At this early stage of our project, we aim to identify key methodological steps, data requirements, and related challenges. The initial implementation of our framework will be centered on the Kullu district.

Core and integrative components of both the traditional climate vulnerability framework (eg., IPCC AR4), and the vulnerability and risk concepts of the disaster risk management community (eg., IPCC SREX 2012) include the assessment of sensitivity, exposure, and adaptive capacity.

Sensitivity to water vulnerability in the Kullu district requires the quantification of current and future water resource usage at the block or community level, using metrics such as total irrigated land area, total electricity usage, population density and birth rates. Within the disaster risk framework, sensitivity to mass movement and flood hazards will be determined based on factors such as population density and demographics (notably age and gender), strength of building materials etc.

Projected temperature and precipitation data from regional climate model output will be used to model changes in melt water runoff and streamflow, determining the exposure of communities and natural systems to future changes in water quantity and quality. For disaster risk assessment, the goal is to identify the intersection of potential mass movement and flood hazards, with exposed people, resources, and assets. Base level information is required on glacier area and volume, mass balance, glacial lake distribution, surface topography, information on snow cover, duration, and snow water equivalent, and gauge measurements on river and stream flows. Where instrumental data is lacking, information of past hydrological regimes and evidence of mass movement can be derived from documentary records (archival reports), from geological indicators (i.e. palaeofloods: sedimentary and biological records over centennial to millennial scales), and from botanical sources (i.e. dendrogeomorphology).

The adaptive capacity to face the challenges associated with a changing cryosphere in the Kullu district will require economic, political, and knowledge capacity to plan, prepare, and respond to issues of water quantity and quality, and disaster risk associated with mass movement and flood hazard. Socio-economic information to be assessed includes economic metrics, literacy rates, and population demographic factors such as gender, age, and religion. These same factors largely determine a communities capacity to anticipate, respond to, and recover from disasters.