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Assessing climate change impacts on water resources in remote mountain regions

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From a water resources perspective, remote mountain regions are often considered as a basket case. They are often regions where poverty is often interlocked with multiple threats to water supply, data scarcity, and high uncertainties. In these environments, it is paramount to generate locally relevant knowledge about water resources and how they impact local livelihoods. This is often problematic. Existing environmental data collection tends to be geographically biased towards more densely populated regions, and prioritized towards strategic economic activities. Data may also be locked behind institutional and technological barriers. These issues create a "knowledge trap" for data-poor regions, which is especially acute in remote and hard-to-reach mountain regions. We present lessons learned from a decade of water resources research in remote mountain regions of the Andes, Africa and South Asia. We review the entire tool chain of assessing climate change impacts on water resources, including the interrogation and downscaling of global circulation models, translating climate variables in water availability and access, and assessing local vulnerability.

In global circulation models, mountain regions often stand out as regions of high uncertainties and lack of agreement of future trends. This is partly a technical artifact because of the different resolution and representation of mountain topography, but it also highlights fundamental uncertainties in climate impacts on mountain climate. This problem also affects downscaling efforts, because regional climate models should be run in very high spatial resolution to resolve local gradients, which is computationally very expensive. At the same time statistical downscaling methods may fail to find significant relations between local climate properties and synoptic processes. Further uncertainties are introduced when downscaled climate variables such as precipitation and temperature are to be translated in hydrologically relevant variables such as streamflow and groundwater recharge. Fundamental limitations in both the understanding of hydrological processes in mountain regions (e.g., glacier melt, wetland attenuation, groundwater flows) and in data availability introduce large uncertainties. Lastly, assessing access to water resources is a major challenge. Topographical gradients and barriers, as well as strong spatiotemporal variations in hydrological processes, makes it particularly difficult to assess which parts of the mountain population is most vulnerable to future perturbations of the water cycle.