Exploring nature-based adaptation options for improved water security in the deglaciating Andes of Peru

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In the tropical Andes, mountain communities and coastal livelihoods downstream strongly depend on glaciers and Andean ecosystems for their water security. Year-round streamflow from glaciers, high-altitude peat bogs and hydraulic infrastructure buffer water scarcity and discharge variability in many areas. Nonetheless, climatic and non-climatic stressors are altering the hydrological regime and exacerbating human vulnerabilities. In the Vilcanota-Urubamba basin (VUB) in Southern Peru, the overall glacier area has substantially decreased by 37% between 1988 and 2016. At the same time, water demand from growing population, irrigated agriculture and hydropower is considerably increasing. This development bears threats to local water security and several challenges to long-term water management and governance in a context of data scarcity and social conflicts arising from socioenvironmental grievances, and highlights the need for interdisciplinary and interlinked water resource research and management.

In this context, the two projects Water security and climate change adaptation in Peruvian glacier-fed river basins (RAHU) and Natural Infrastructure for Water Security (NIWS) are collaborating at developing adaptation strategies to increase long-term water security in deglaciating basins in Peru. In the face of global environmental change, natural infrastructure – including forests, wetlands, and nature-based solutions – has been promoted as a buffer to attenuate the loss of hydrological ecosystem services caused by accelerated glacier shrinkage. Furthermore, natural infrastructure can provide a complement to man-made ‘grey’ infrastructure enhancing its performance, lifespan, and adaptability and provide multiple defense lines against natural disasters and other climate risks.

Here, we implemented hydrological data collection using participatory monitoring approaches and integrated ancestral and contemporary nature-based solutions. Conservation of natural
grasslands can avoid streamflow variability and flashiness caused by common land-use activities such as cultivation and grazing. Flow duration curves show that median flows in cultivated catchments are approximately half those of natural catchments, whereas low flows are up to five times lower but high flows remain virtually the same. Despite being highly promoted, afforestation interventions reduce water yield significantly. High and mean daily flows in afforested catchments are approximately four times lower than in natural grasslands, whilst low flows are between seven to ten times lower. Most catchment management practices, however, are more complex, and involve a combination of interventions. An example of this are pre-Inca infiltration enhancement systems, which divert water from headwater streams onto mountain slopes to increase the yield and longevity of downslope natural springs. Tracer experiments in another study site reveal that water residence times range between 2 weeks and 8 months, with a mean of 45 days, which might be able to increase dry season flow downstream by up to 33%.

Currently, a first Water Management Plan is being implemented in the VUB and part of its headwaters have just been declared a Regional Conservation Area. This progress in local policy and headwater conservation offers new opportunities for the project consortium to provide scientific evidence to stakeholders. Our first findings have particular implications for the implementation of robust adaptation measures for future water management planning embedded into local-national policies in close collaboration with science and society.