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Hydrological characterization of traditional water harvesting practices in the tropical Andes using tracers

Wouter Buytaert (1), Boris F. Ochoa-Tocachi (1), Juan D. Bardales (2), Javier Antiporta (3), Katya Perez (3), Luis Acosta (2), Junior Gil-Ríos (2), Aocar Angulo (2), and Bert De Bièvre (4)

(1) Imperial College London, Civil and Environmental Engineering, London, United Kingdom (w.buytaert@imperial.ac.uk), (2) Superintendencia Nacional de Servicios de Saneamiento (SUNASS), Lima, Peru, (3) Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN), Lima, Peru, (4) Fondo para la Protección del Agua (FONAG), Quito, Ecuador

Increasing water security is often an important aspect of climate change adaptation strategies. The technical challenges, high cost, and limited flexibility of classic water supply infrastructure such as reservoirs, drives a quest for alternative approaches. The use of nature-based solutions is gaining momentum as a potential strategy in this regard. The term encompasses a wide range of catchment interventions that leverage natural processes, such as reducing overland flow, promoting water infiltration in the soil, and increasing natural storage capacity in wetlands. However, many of the underlying hydrological processes are often poorly characterised and quantifying the impact of interventions is essential to incorporate them in broader catchment management strategies. Because hydrological residence time and hydrological partitioning are often the determinant catchment characteristics that are affected, tracer hydrology techniques can be effective tools to quantify their impacts on water resources.

In the Peruvian Andes, policy makers are showing increasing interest in the restauration of a traditional water "sowing and harvesting" practice as a pathway to increasing water security. Many different types exist, ranging from artificial recharge enhancement systems to restoration of wet- and grasslands. We present the results of a specifically designed tracer experiment for the hydrological characterisation of a traditional water harvesting practice in the headwaters of the city of Lima. The system consists of canals that divert water from mountain streams to allow it to infiltrate on mountain slopes, which enhances downslope natural springs. We injected fluorescent dye tracers (eosin and fluorescein) in two different infiltration canals to study the hydrological connectivity between the infiltration areas and the downslope springs. We equiped the springs with activated carbon samplers. We find an average residence time of 45 days with maxima that extend several months. We then built a regional hydrological model to simulate the impact of upscaling the practice to the main watershed that provides water to the city of Lima, and find that it can increase baseflows of the Rimac river with up to 10% during at least a part of the dry season.

Although our experiment confirmed the hydrological connectivity and quantified the residence time distribution, it does not allow assessing the water recovery rate of practice. Doing so will require a more comprehensive analysis of the hill slope water balance, including flows that bypass the springs, and may resurface further downstream in the catchment. However, the methodology can be applied for evaluation of a variety of ancient or more modern "sowing and harvesting" practices, in order to evaluate their potential specific application niche.