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STEM Development Impact Memos

Adapting to melting glaciers

A voluntary network is giving communities and policymakers the evidence they need to ensure water security

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“One of the main bottlenecks in supporting water management in the Andean mountains is a lack of basic data, such as rainfall and river discharge.”

Wouter Buytaert, Imperial College London.

The Challenge

— In the Andes, shrinking glaciers and other climate change impacts are endangering the supply of water to downstream ecosystems and millions[1] of people.

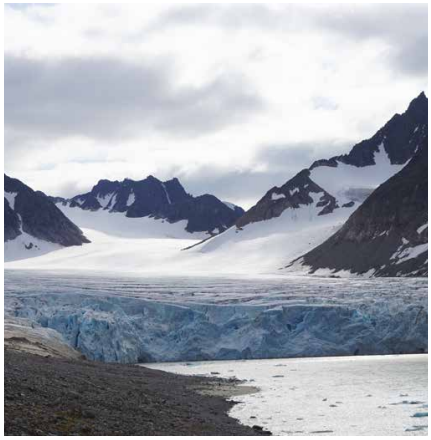
— There is little data about the flow of water in Andean catchment areas, and whether adaptation measures are working.

— Many sites in the Andes are difficult to access, which makes monitoring and maintaining equipment challenging.

— A network of low-cost, community-maintained sensors is filling this information chasm and driving collaboration, evidence-based decision-making, and adaptation in the region.

“When it comes to adaptation, we cannot change a shrinking glacier – aside from stopping climate change. But we can adapt in the ecosystems below it and that’s where we come across these knowledge limitations in the hydrology of these ecosystems.”

Bert de Bievre, FONAG (Fondo para la Protección del Agua), the Quito Water Protection Fund.



The Context

More than 50-million people[1] depend on the water that cycles through the Andes mountains. The mountain range extends thousands of miles along the west coast of South America, running through several countries including Ecuador, Peru and Colombia. The tropical glaciers that cap their heights act as giant water reservoirs that slowly release water into the hydrological system that supports communities and industries below.

However, warmer temperatures, driven by climate change, are impacting the water cycle of the Andes, including shrinkage of the glaciers, which are up to 50% smaller than they were half a century ago[2]. They are currently the smallest they have been in the last 11,700 years[1], reducing the quantity of water available to people and ecosystems downstream. Communities and industries have to adapt to this new reality – which is likely to become even drier in the years ahead – but there is a dearth of data showing how the hydrological system has changed and whether interventions to adapt are working.

The Regional Initiative for Hydrological Monitoring of Andean Ecosystems (iMHEA) is a voluntary network of more than 40 organisations that aims to increase and strengthen knowledge about the hydrology of Andean ecosystems. Founded in 2010, this network has sensors in more than 50 catchments in six Andean countries and its partners work to improve the management of water resources and ecosystem services on a regional level.

The decentralised network not only collects data on the Andean hydrological system, but also ensures that the information is relevant to the local context and responds to the needs of communities and decision-makers. By co-creating data with local communities and stakeholders, iMHEA fosters grassroots involvement and knowledge generation. In one project, for example, researchers have shown the efficacy of ancient indigenous technologies to store and safeguard water resources[4].

The monitoring network also allows stakeholders – including researchers, funders, community groups and government officials – to gauge the efficacy of interventions. For example, one study produced by iMHEA members showed that reforestation in the Andes was reducing water availability downstream, increasing water stress[1].

Imperial College London was one of the founding members of the iMHEA network, and works to develop and share sensor technology that is robust enough for the extreme mountain environment. It also analyses iMHEA data to understand broader trends in the Andean hydrological system and region.

The Method

— iMHEA partners deploy sensors, which collect data on precipitation, water level and streamflow, among other variables. They adhere to agreed upon standards when generating and managing the information.

— While individual projects pursue their own research questions, the data can be shared among iMHEA partners to understand the movement of water through the Andean system at multiple levels – within that specific catchment, at sites with similar characteristics, and at a regional level.

— The project aims to make the knowledge generated through the network accessible to all stakeholders, from community members to policymakers.

— Researchers at Imperial developed low-cost sensors to monitor various parameters within catchment areas. The design has been made available for free. Imperial partnered with UNESCO to offer a course entitled, “Cookbook for Open Hardware Sensors for Water Resources Management”[5].

— Imperial also spun out a company called RiverLabs to produce these sensors for researchers and non-governmental organisations that would rather procure the devices.

“Nature-based solutions will be key to climate-change adaptation, and can complement infrastructural civil engineering solutions.”

Boris Ochoa-Tocachi,
ATUK Strategic Consultancy.

Benefits

— **Improved water management:** Robust and standardised data empowers policymakers to take water management decisions based on evidence.

— **Efficient adaptation:** iMHEA data allows stakeholders to measure the efficacy and consequences of adaptation efforts.

— **Co-creation:** Through partnerships with local stakeholders, grassroots projects can take ownership of sensor maintenance and respond to the needs of communities on the ground.

— **Capacity building:** Collaboration with local institutions ensures knowledge transfer and bolsters capacity on the ground to improve monitoring and decision-making.

— **Scalable:** The decentralised nature of the iMHEA network means that partnerships are agile and scalable.

— **Technology transfer:** The open source sensor technology toolbox empowers local institutions to develop and innovate their own sensors and monitoring systems.

— **Protecting indigenous knowledge:** By including communities in adaptation and monitoring efforts, researchers have been able to record and demonstrate the benefits of indigenous water stewardship methods.

“Working with local communities is the best way to get as many good ideas on the table as possible and to come up with the best adaptation strategies.”

Wouter Buytaert, Imperial College London.

"It is necessary to develop an efficient portfolio of adaptation measures. If we don't generate concrete information on the hydrological benefits of different measures in our portfolio, we will lose credibility and this is going to affect adaptation funding flows."

Bert de Bievre, FONAG (Fondo para la Protección del Agua), the Quito Water Protection Fund.

For more information:

iMHEA network: https://imhea.org/

Hydrology and water resources laboratory at Imperial College London: https://ichydro.github.io/index.html

The Impact

For communities: Communities are partners in the iMHEA network, and so its research and projects respond to the needs of people on the ground. This partnership ensures that solutions are sustainable and that knowledge is shared and accessible.

For researchers: The iMHEA network fosters collaboration between researchers, as well as capacity development within local institutions. Sharing data allows researchers to map and understand the regional hydrology, and predict future trends. The sensor technology tool box also allows researchers to set up their own water monitoring programmes, and adapt the existing technology to their needs.

For decision makers: Governments, water utilities, and water managers can use iMHEA's findings to guide their water – and land use decisions. iMHEA's data and monitoring can help them to focus their investments where they are needed to ensure water supply, and ensure that adaptation projects are effective and do not have unintended consequences.

Notes:

1. Bonnesoeur, V. et al. 'Impacts of forests and forestation on hydrological services in the Andes: A systematic review', Forest Ecology and Management, Vol. 433 (2019). https://www.sciencedirect.com/science/article/abs/pii/S0378112718311836?via%3Dihub

2. Rabatel, A. et al. ' Current state of glaciers in the tropical Andes: a multi-century perspective on glacier evolution and climate change', The Cryosphere, Vol. 7 (2013). https://tc.copernicus.org/articles/7/81/2013/tc-7-81-2013.html

3. Gorin, A. 'Recent tropical Andean glacier retreat is unprecedented in the Holocene', Science, Vol. 385 (2024). https://www.science.org/doi/10.1126/science.adg7546

4. Ochoa-Tocachi, B. et al. 'Potential contributions of pre-Inca infiltration infrastructure to Andean water security', Nature Sustainability, Vol. 2 (2019). https://www.nature.com/articles/s41893-019-0307-1

5. Unesco, 'Cookbook for Open Hardware Sensors for Water Resources Management', 2025. https://openlearning.unesco.org/courses/course-v1:UNESCO+OpenWater+2023_01/about

STEM Impact Memos offer policymakers and stakeholders insight into projects in Imperial College London's Global Development Hub and their real-world impact.

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https://www.imperial.ac.uk/global-development-hub