Transdisciplinary Assessment of High-Andean Water Resources

Giova Mosquera

Departamento de Ingeniería
Pontificia Universidad Católica del Perú
gmosquerar@pucp.edu.pe

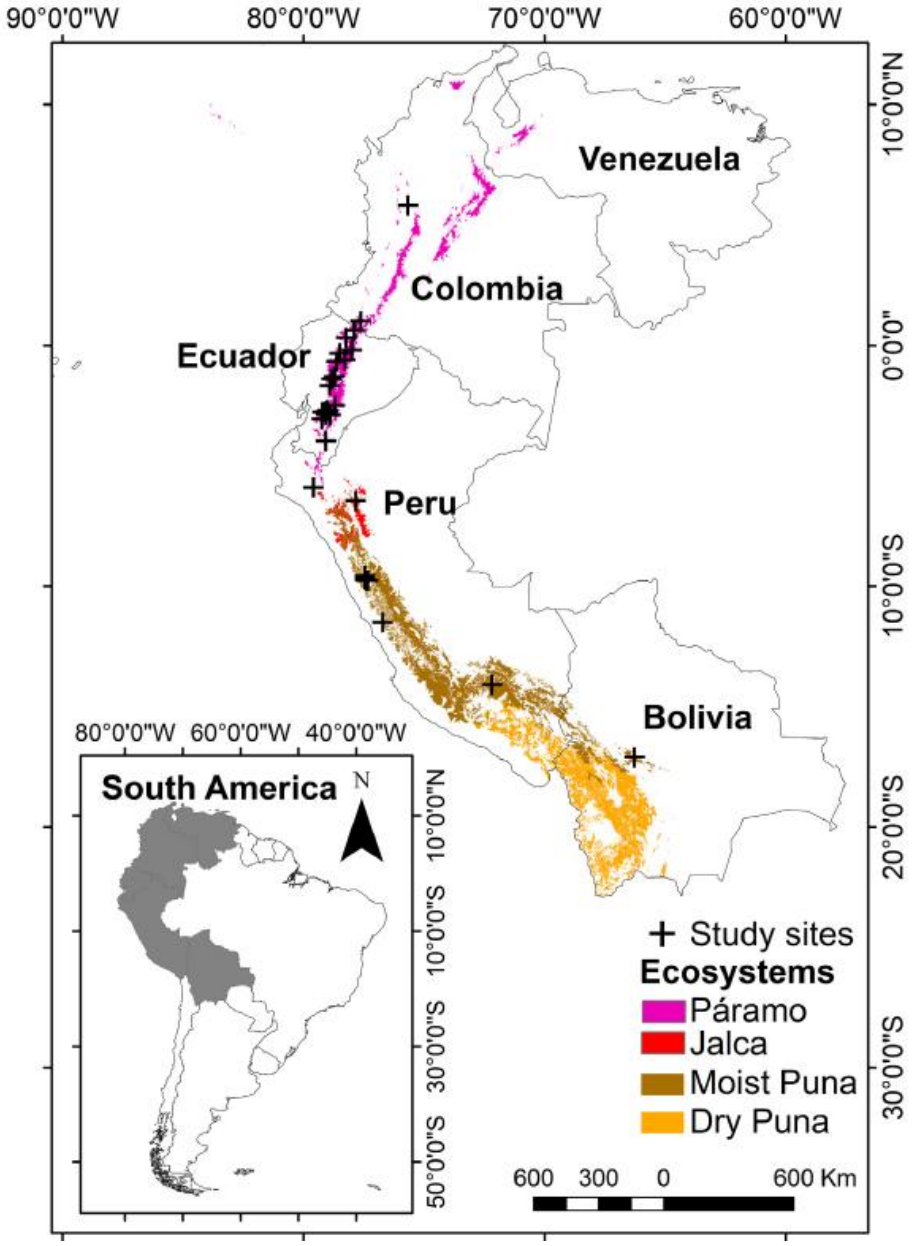
PUCP
Sección
Ingeniería Civil

Grupo de Glaciología y
Ecohidrología de Montañas Andinas

DIGIWATER: Resilience through Digitization Workshop

October 20, 2025

High-Elevation Ecosystems in the Tropical Andes



Ecosystem	Areal Extent (km^2)	Percentage (%)
Páramo	66.366	12
Jalca	19.754	3
Puna	498.025	85
TOTAL	**584.145**	**100**

High-Andean ecosystems

~3,000-5,000 m asl

Above the continuous tree line
Below the perennial snow line

Headwaters of main rivers draining to the Amazon Basin and the Pacific Ocean

Mosquera et al. 2022 (STOTEN)

Socio-ecohydrological relevance of high-Andean ecosystems

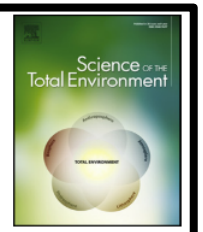
- High-Andean ecosystems are considered social-ecological systems of vital importance in the tropical Andes.
- These ecosystems provide key hydrological ecosystem services and are the water towers of high-Andean communities and downstream urban centers.
- There is an urgent need to understand the hydrological function of high-Andean headwater ecosystems and their relationship with ecological and social processes.

What do we know?

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv



Review Article

Progress in understanding the hydrology of high-elevation Andean grasslands under changing land use

Giovanny M. Mosquera [a,*], Franklin Marín [b,c], Margaret Stern [d,e], Vivien Bonnesoeur [f,e], Boris F. Ochoa-Tocachi [g,h,e], Francisco Román-Dañobeytia [f], Patricio Crespo [b,e]

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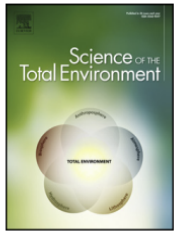
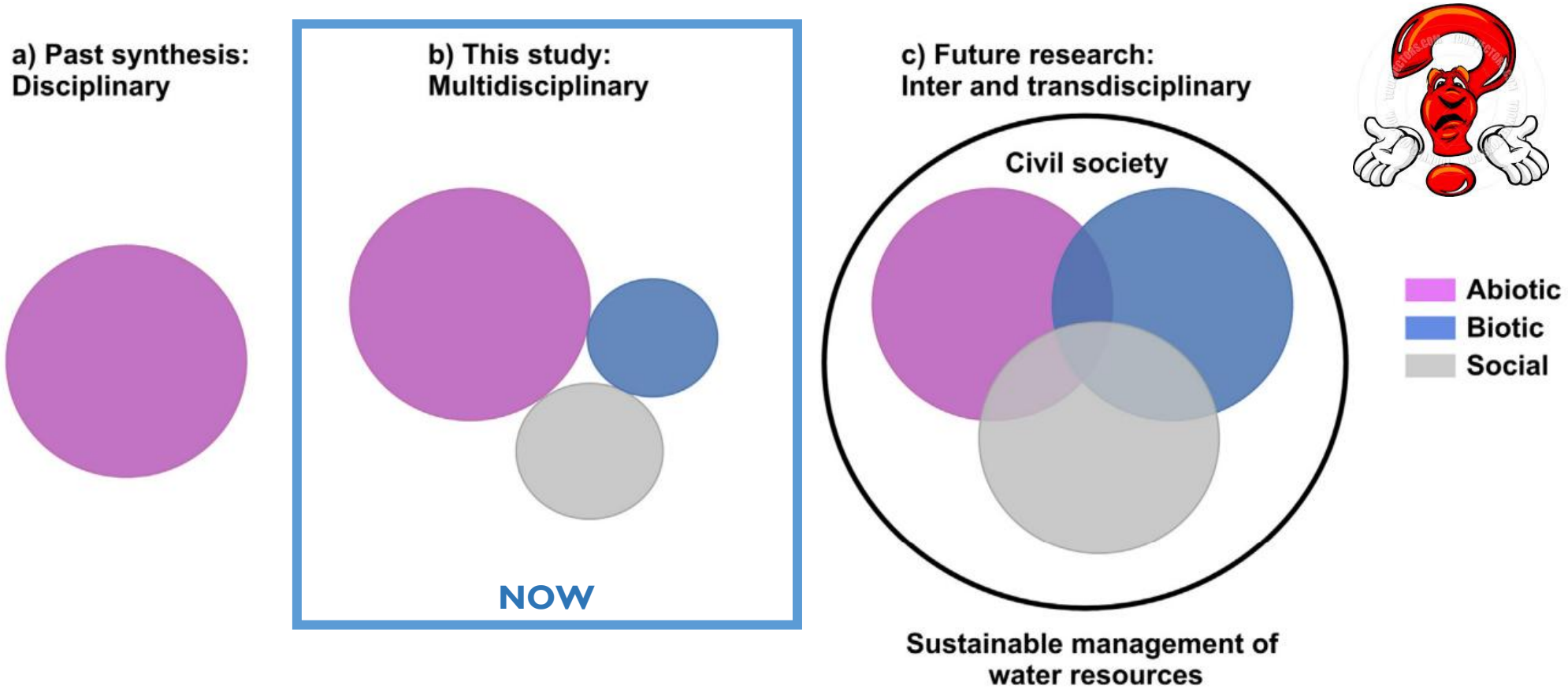


Frontiers in páramo water resources research: A multidisciplinary assessment

Giovanny M. Mosquera [a,*], Robert Hofstede [a,b], Leah L. Bremer [c,d], Heidi Asbjornsen [e], Aldemar Carabajo-Hidalgo [f,g], Rolando Célleri [g,h], Patricio Crespo [g,h], Germain Esquivel-Hernández [i], Jan Feyen [g,j], Rossana Manosalvas [k,l], Franklin Marín [m,n], Patricio Mena-Vásconez [k,l], Paola Montenegro-Díaz [g,o,p], Ana Ochoa-Sánchez [p], Juan Pesántez [g], Diego A. Riveros-Iregui [q], Esteban Suárez [a]

Status of research in high-Andean water resources

Interdisciplinary and **transdisciplinary** methods and approaches are required to improve the understanding of tropical alpine ecosystems as a **socio-ecological systems** that provides important hydrological services.



Mosquera et al. 2023 (STOTEN)

How did this start?

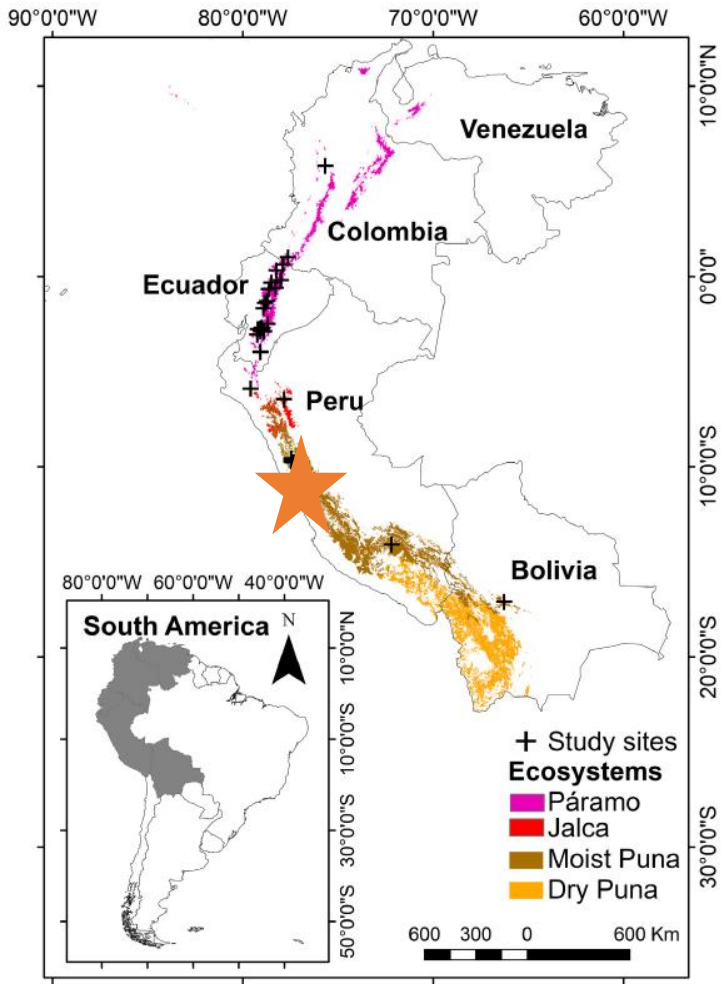
Giova Mosquera
(Engineering Department)
Civil Engineer; Catchment hydrology, ecohydrology

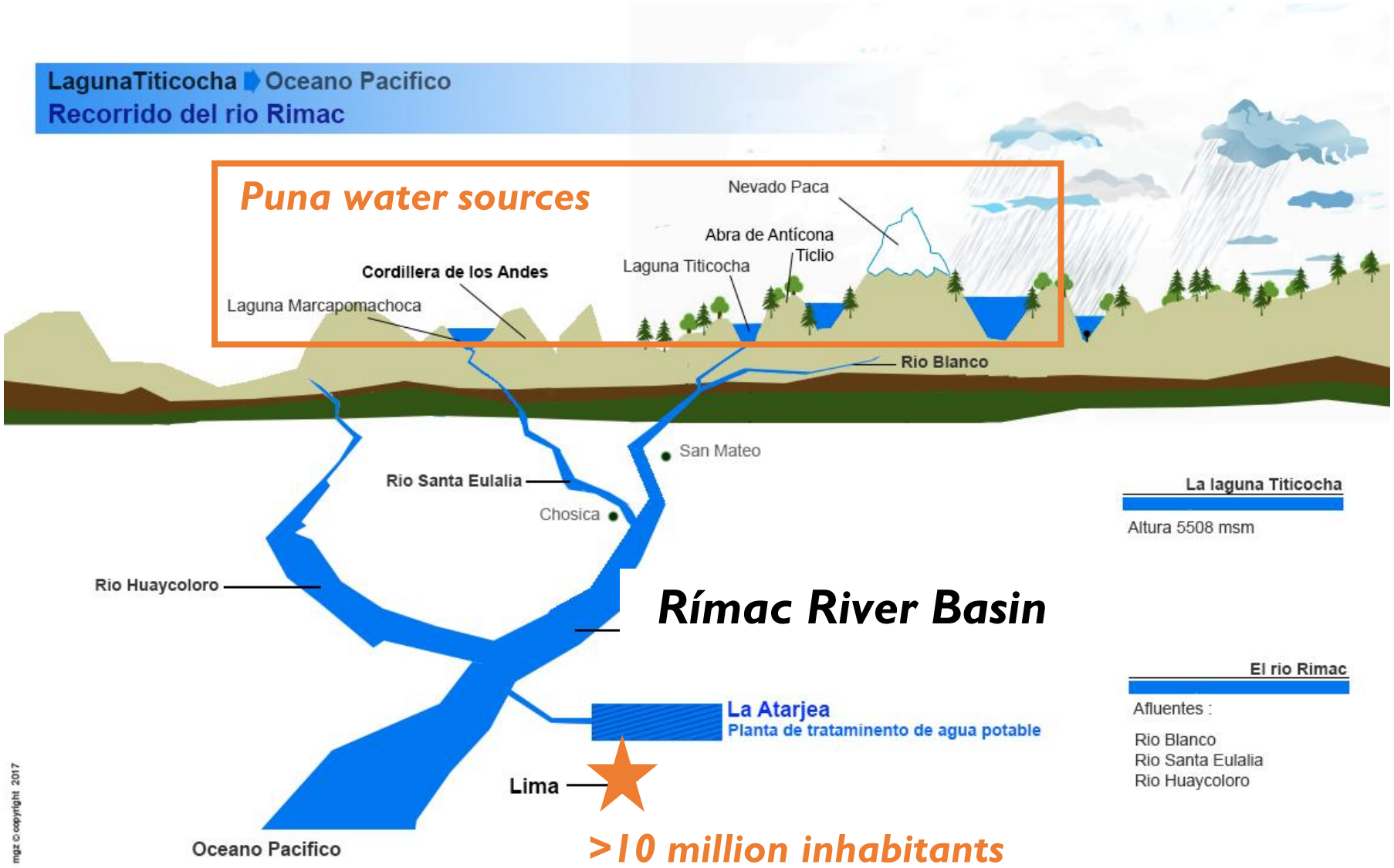
Isabel Gurrero-Ochoa
(Economics Department)
Economist; Environmental economics and development

Fabian Drenkhan
(Humanities Department)
Geographer; Glaciology, water (in)security

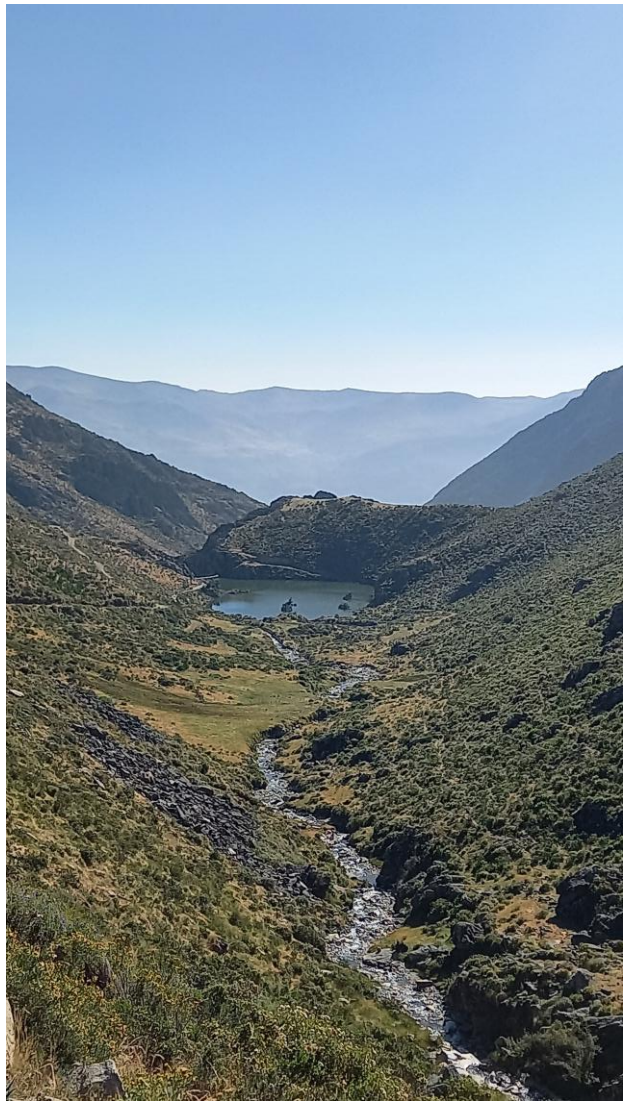
Sofía Castro
(Institute of Nature and Energy)
Economist; territories, water governance

Where can we carry out transdisciplinary research?



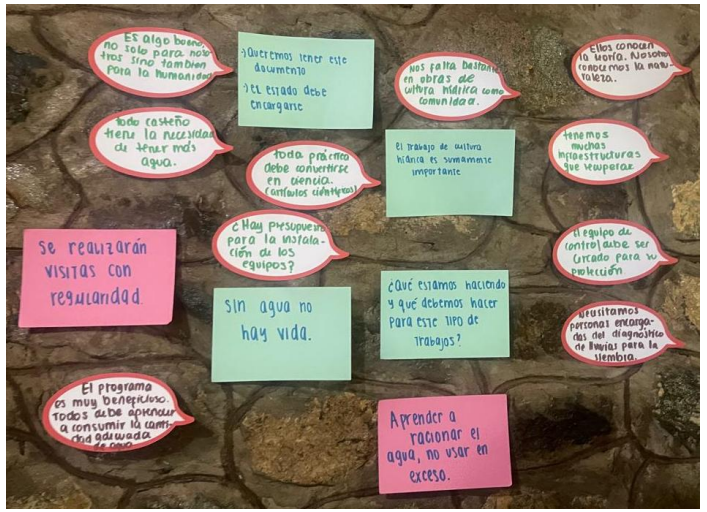


Carhuayumac Socioecohydrological Observatory



Source: Sofía Castro (INTE, PUCP)

Source: José Hilario (SensorVital)

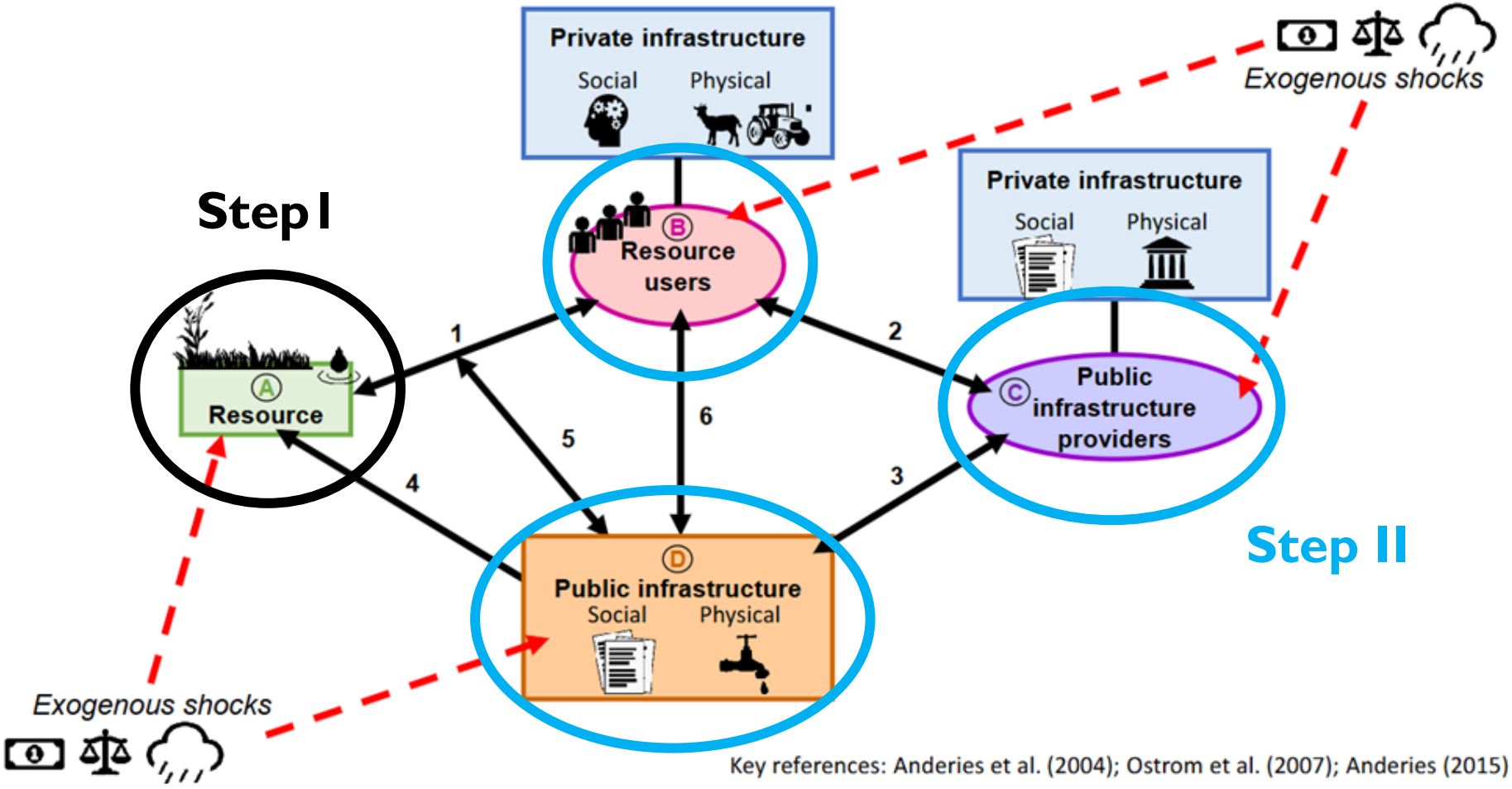


San Pedro de Casta Peasant Community (3,200 – 4,700 m a.s.l.)

So, how we will start?

New project: November 2025-October 2027

Interdisciplinary system understanding: The Coupled Infrastructure Systems Framework (CISF; Anderies, 2025) enables an integrated analysis of the socio-ecological water system by bridging local knowledge with expert insights from physical, ecological, and the social sciences.



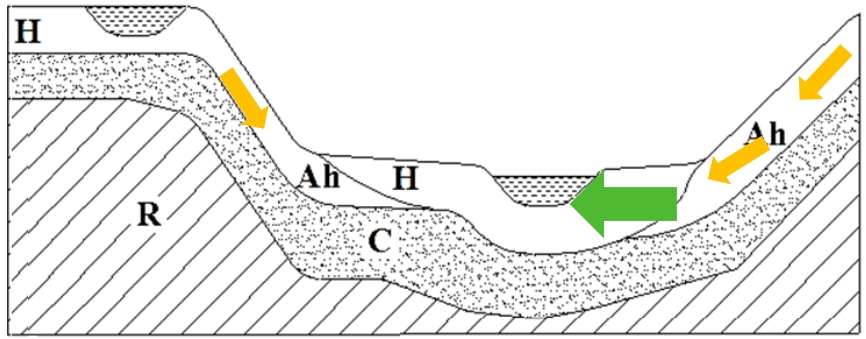
Key references: Anderies et al. (2004); Ostrom et al. (2007); Anderies (2015)

Step 1. The biophysical dimension

Biophysical and ecohydrological interactions: It highlights the complex interactions among natural resources—such as water, soils, and vegetation—within ecohydrological cycles that shape the puna landscape's resilience and function.

Resources: Water, vegetation, soil

Methods: Physicochemical measurements



Mosquera et al. 2016 (HyP)
Correa et al. 2017 (WRR)

Step 2. The political dimension

Actors, institutions, and infrastructure: The framework helps identify and analyze the roles of water users, infrastructure providers (e.g., community committees, municipalities), and the formal and informal rules that govern access and management.

Methods:
Semi-structured interviews

Peasant community members

Management committees, boards of directors

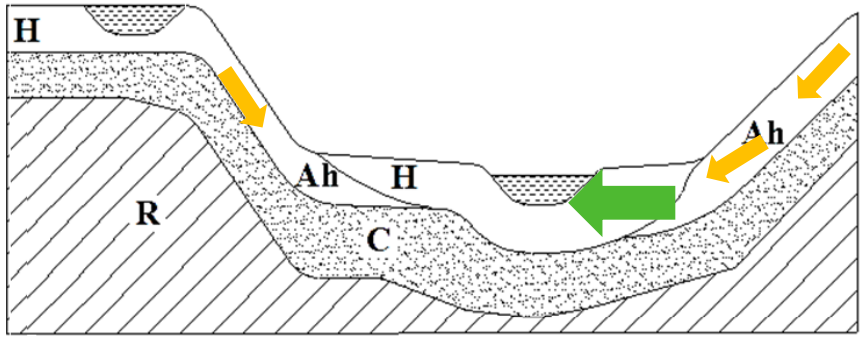
Ancient infrastructure, reservoirs, pipelines

Step 3. The human dimension

Problem identification through knowledge contrast: Through participatory methods, the CISF facilitates contrasting local and expert perspectives to reveal key challenges such as overuse, governance gaps, or degraded infrastructure.

Community members

Methods: Semi-structured interviews & workshops



Mosquera et al. 2016 (HyP)
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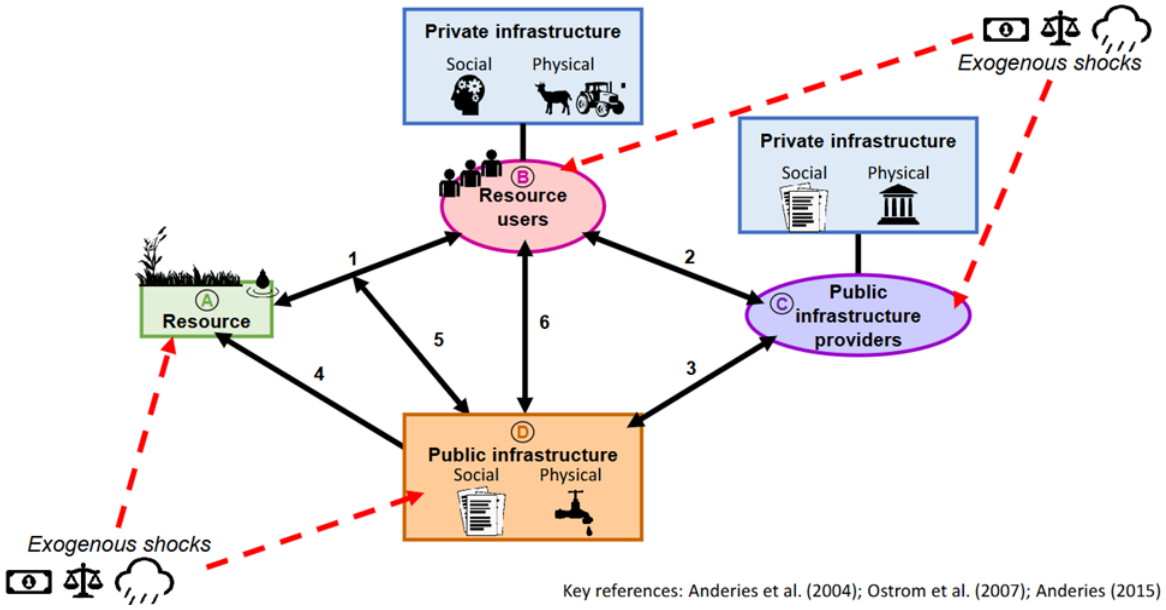
Academics

Integration of local and academic knowledge

Transdisciplinary solutions and co-production: It supports the co-creation of context-specific, sustainable solutions that strengthen collective action, enhance institutional robustness, and adapt water governance to social and environmental change.



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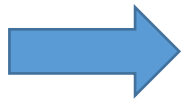

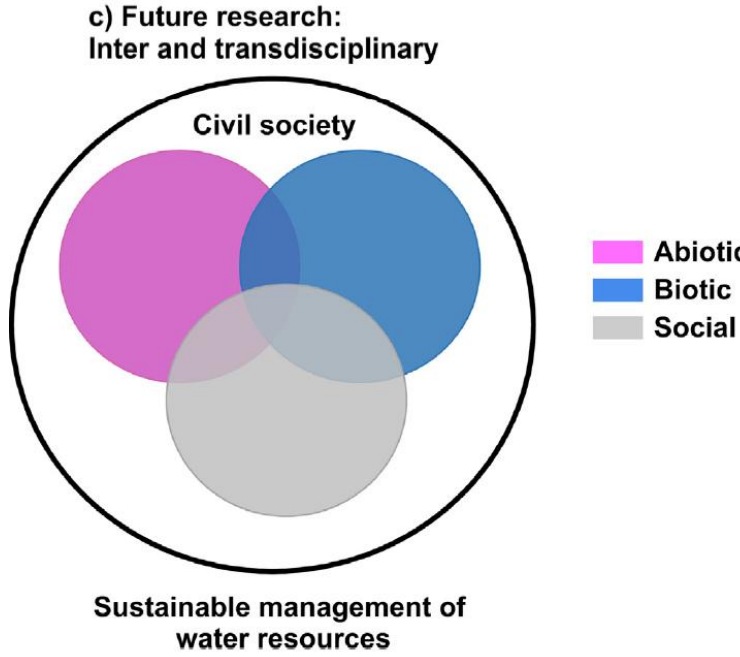

Thanks for your attention!

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Questions?

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Research Gate

Giova Mosquera
Pontificia Universidad Católica del Perú
gmosquerar@pucp.edu.pe