iMHEA: Initiative for Hydrological Monitoring of Andean Ecosystems

Bert De Bievre

Boris F. Ochoa-Tocachi

And all iMHEA partners

FONAG
FONDO PARA LA PROTECCIÓN DEL AGUA

Imperial College London

Iniciativa Regional de
**Monitoreo Hidrológico**
de Ecosistemas Andinos

Common hydrometeorological monitoring

- Run by specialized staff (national institutions)

- Scale of hydrological stations always implies catchment has a mixture of ecosystems, and states of conservation

- Extreme data scarcity in remote headwater areas (usually most important area for natural infrastructure

- Data processing mostly long time series analysis

Hydrology of ecosystems, of land use changes, of natural infrastructure
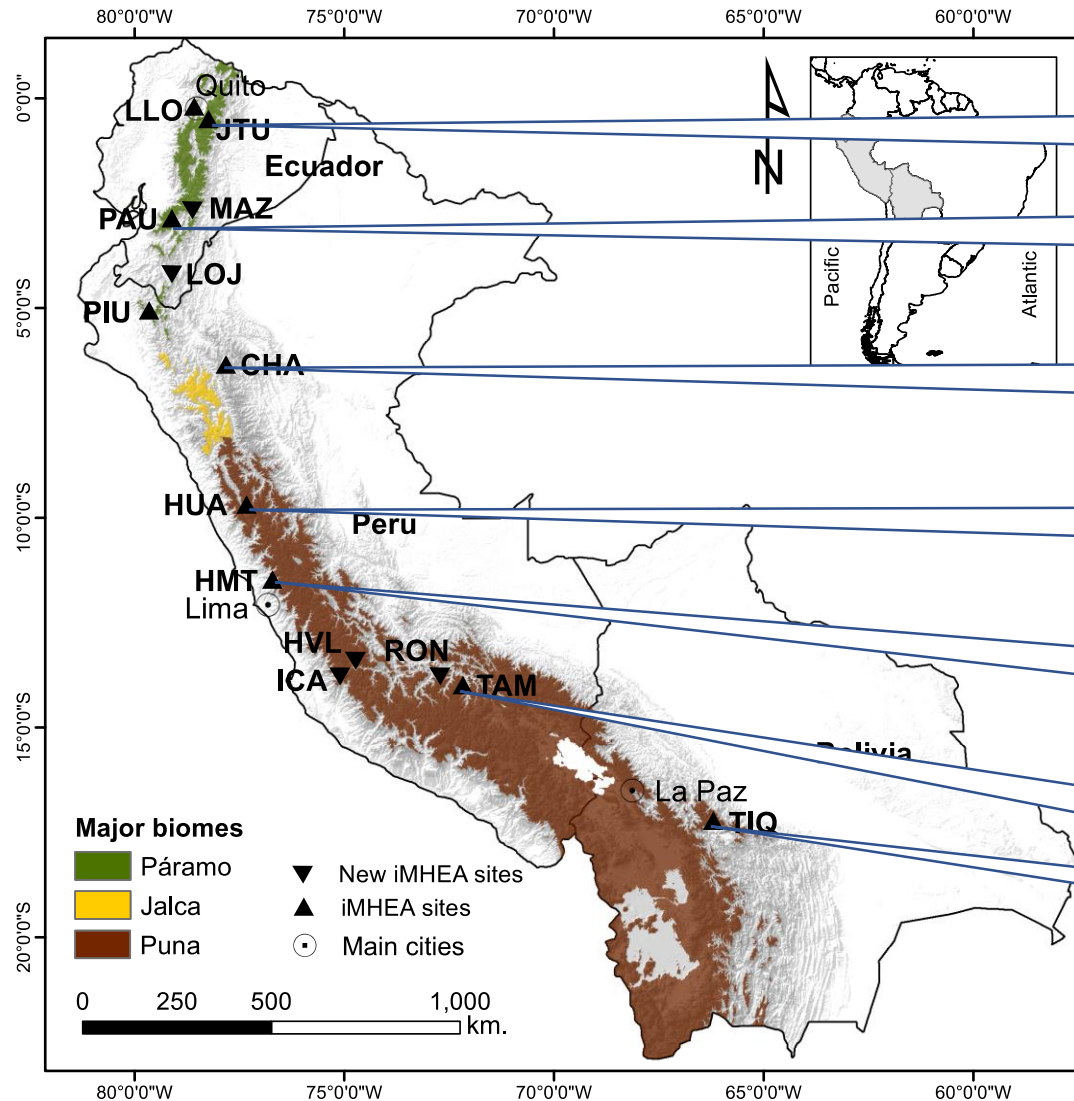
How does the hydrological response of degraded páramo change under **restoration interventions**?

What are the hydrological impacts of **cultivation and afforestation** in the humid páramos of southern Ecuador?

What is the hydrological response after **pine forestation** of the jalca in northern Peru?

What are the hydrological benefits of **pasture restoration** in the humid puna of central Peru?

How does water regulation change after **cattle grazing exclusion** in the dry puna of central Peru?

What is the impact of pine forestation and **infiltration trenches** in the puna highlands of southern Peru?

What is the hydrological impact of **cultivation and overgrazing** in the puna ecosystems of Bolivia?

Major biomes

Páramo
Jalca
Puna

▽ New iMHEA sites
▲ iMHEA sites
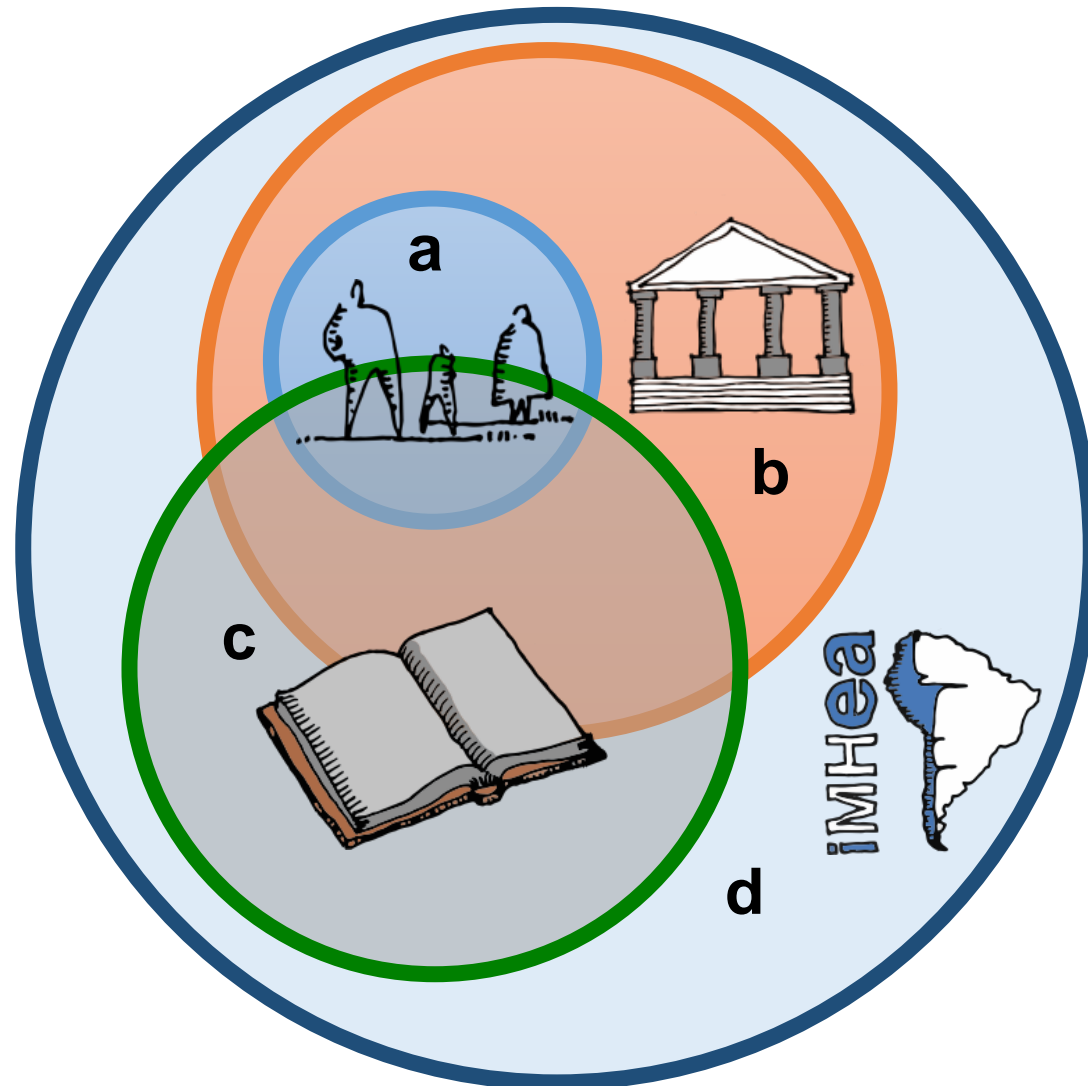⊙ Main cities

Participatory monitoring

- Precipitation and river discharge

- Off-the-shelf, low-cost sensors

- Grassroots driven approach with local buy-in

- Addressing local questions, local hypotheses

Institutional setup

a. Direct users of land and water
- **Commitment:** Security of the equipment.
- **Benefit:** Use information for decision making and improvement of local practices.

b. Local development institutions
- **Commitment:** Logistics for data and information collection.
- **Benefit:** Relevant information for development projects.

c. Research institutions
- **Commitment:** Data processing and interpretation.
- **Benefit:** Information research for their students and projects.

d. Monitoring network
- **Commitment:** Technical assistance, partnership, generate exchange mechanism.
- **Benefit:** Several monitoring sites help provide a better idea of Andean hydrology. Decision making incidence.

Monitoring setup

★ Rain gauges

▼ River flow gauge

Monitoring setup
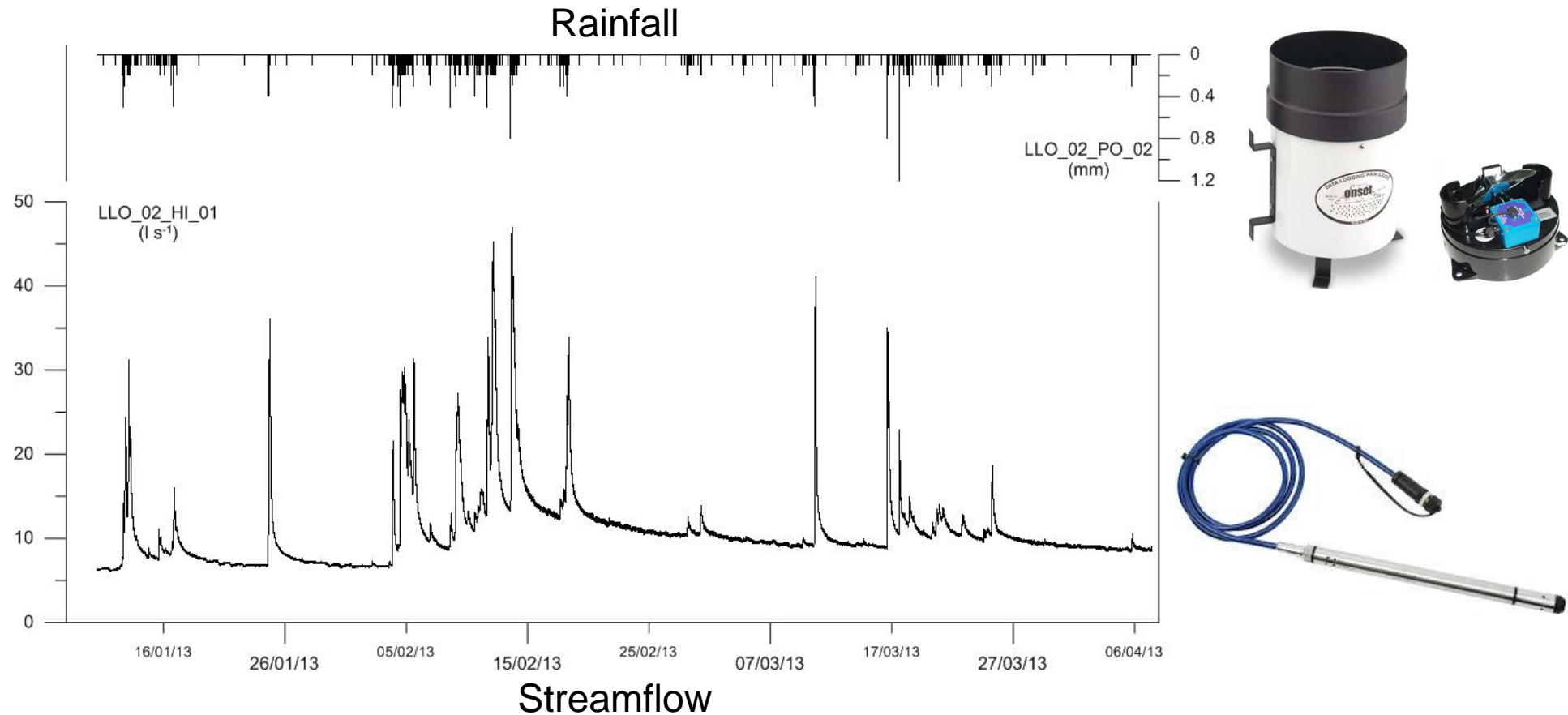
Example of rainfall-streamflow time series in a single catchment from northern Ecuador. The data have a resolution of 1 min, with an accuracy of 0.2 mm for rainfall and 1 mm for streamflow.

Pairwise catchment comparison
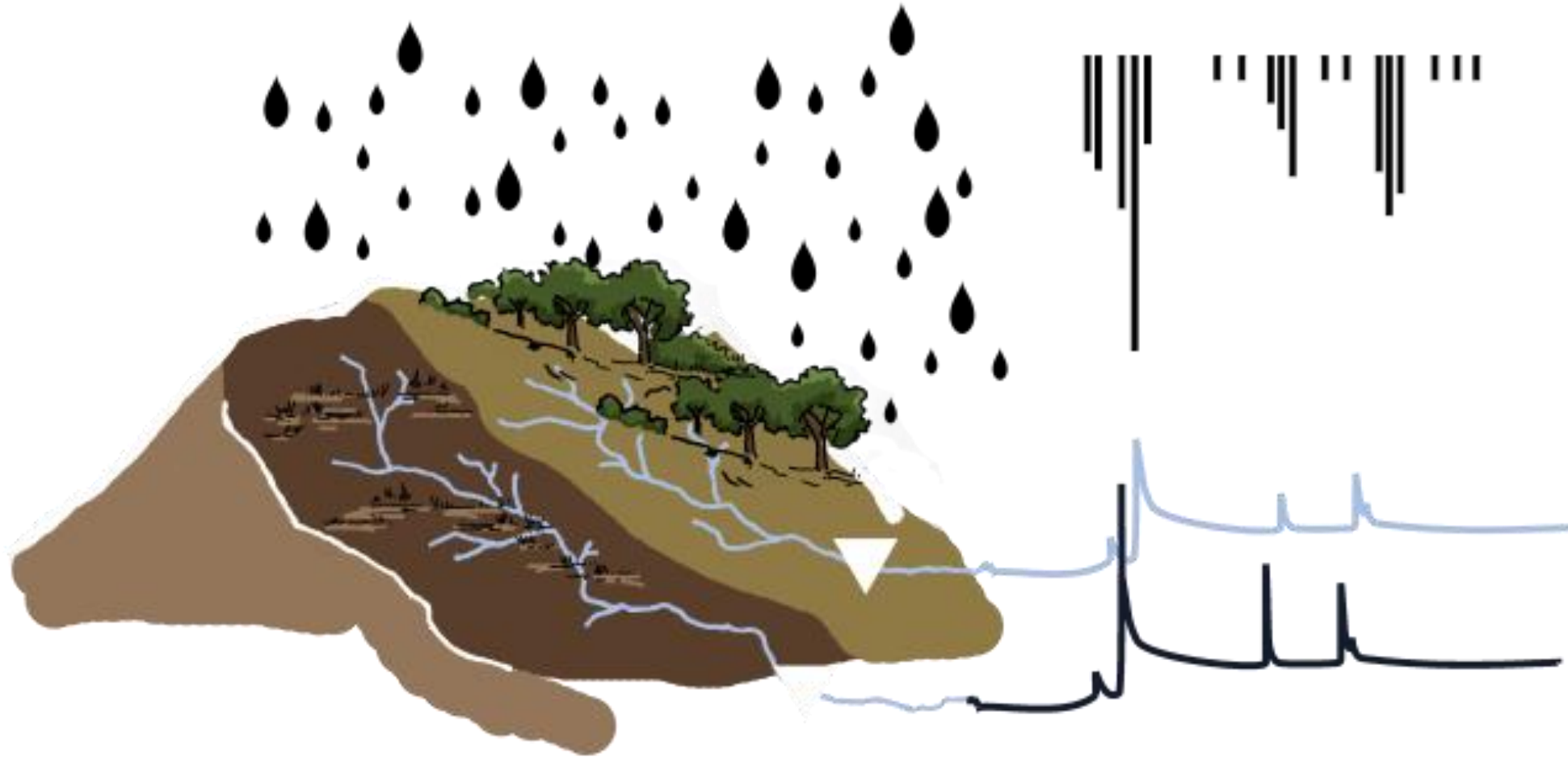
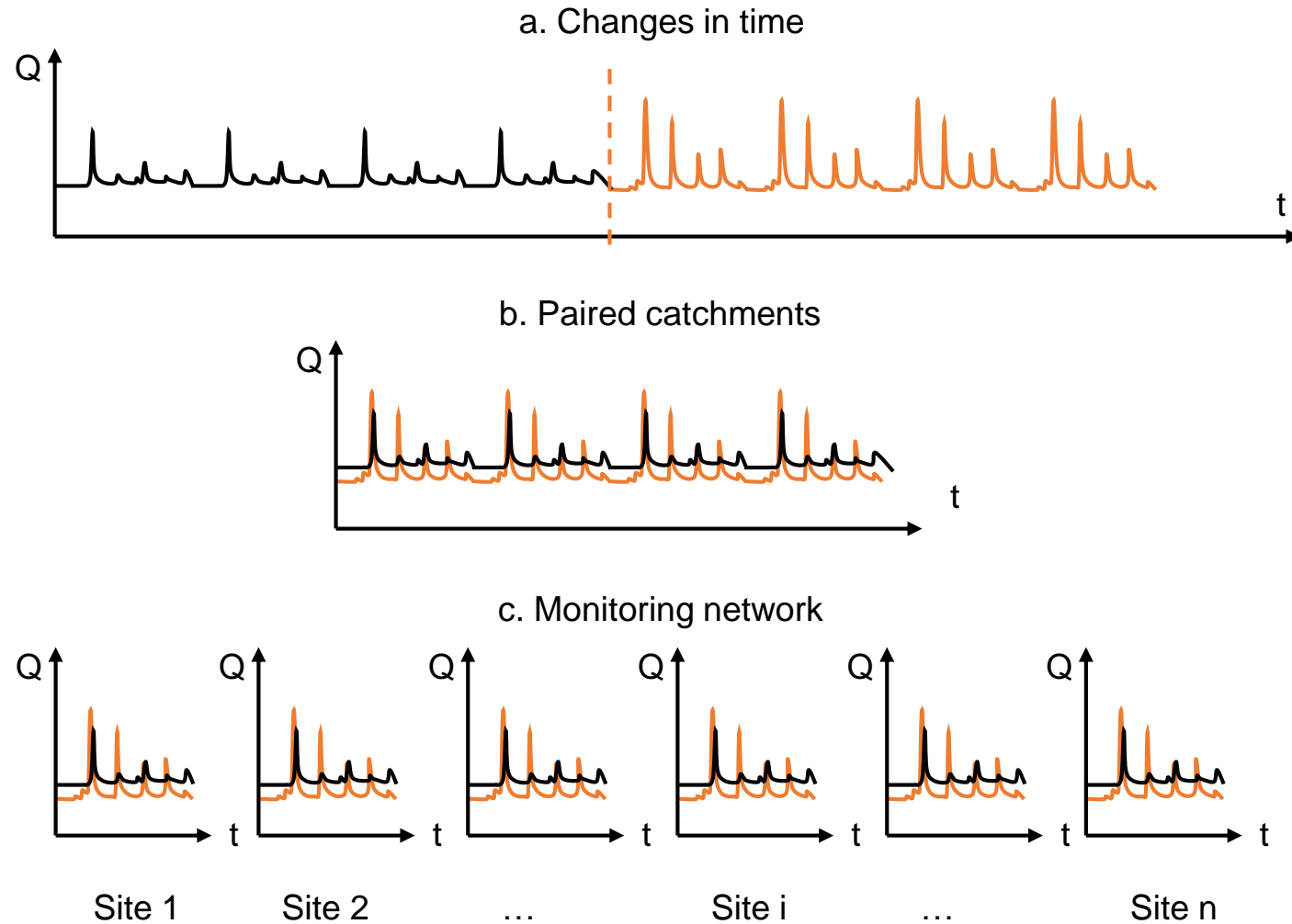Micro-catchments

Precipitation – Streamflow

Pairwise catchment comparison

Trading space for time

a. Changes in time

b. Paired catchments

c. Monitoring network

Site 1   Site 2   …   Site i   …   Site n

Monitoring data
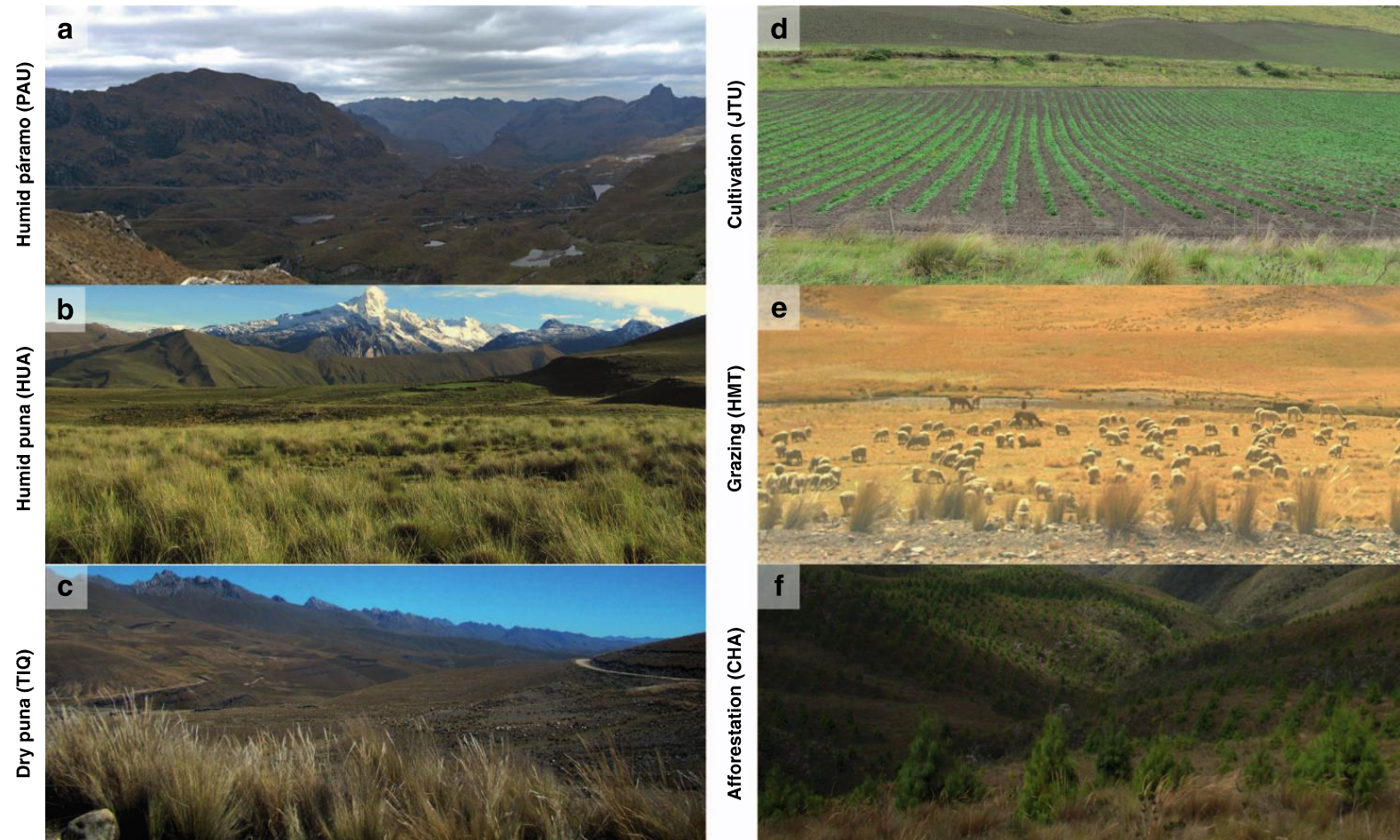
Figure 3. Representative landscapes of the monitored catchments. The iMHEA network covers major high Andean biomes, including (**a**) Humid páramo in southern Ecuador (e.g., PAU), (**b**) Humid puna in central Peru (e.g., HUA), and (**c**) Dry puna in central Bolivia (e.g., TIQ). Land use types include common human activities such as (**d**) cultivation of potato and tubers (e.g., JTU), (**e**) livestock grazing (e.g., HMT), and (**f**) afforestation with exotic tree species (e.g., CHA). For a reference of site codes and locations, see Fig. 1 and Table 1.
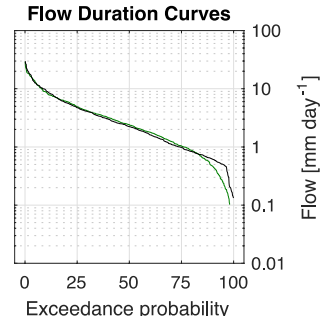
Data analyses: impacts of land use
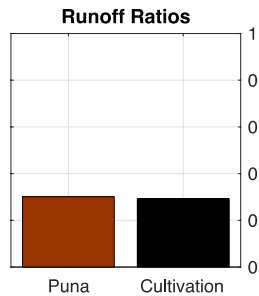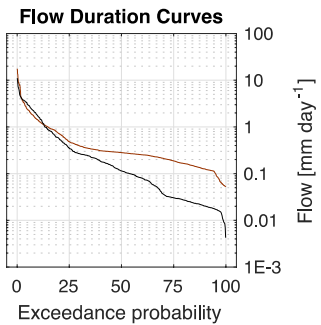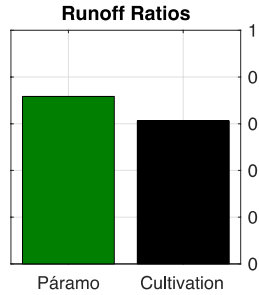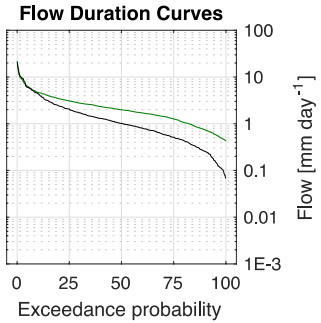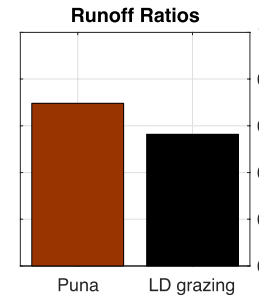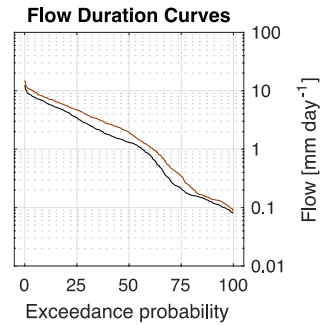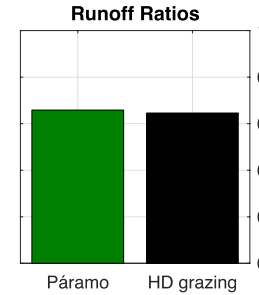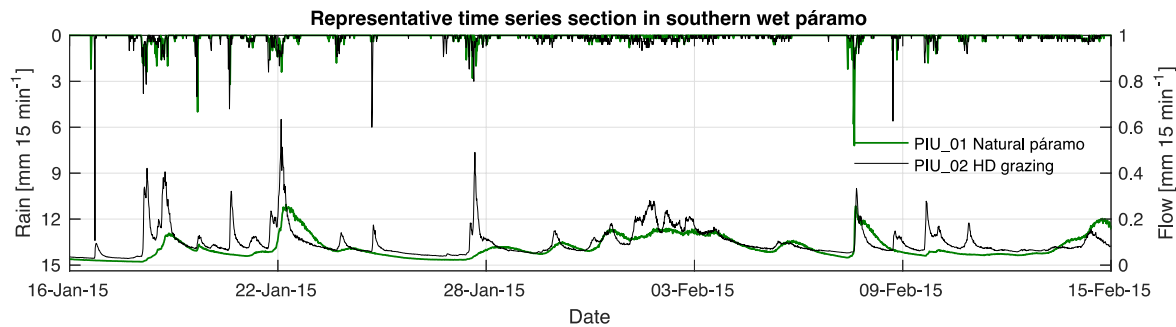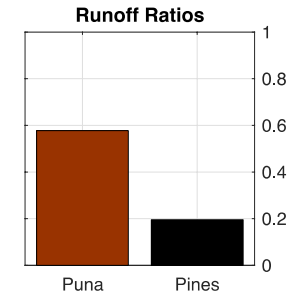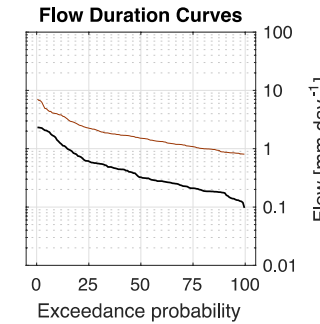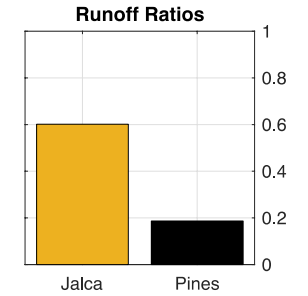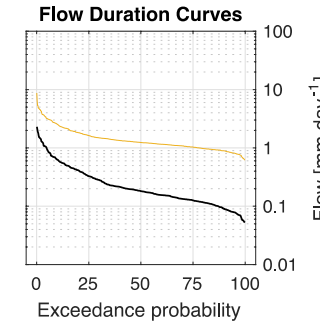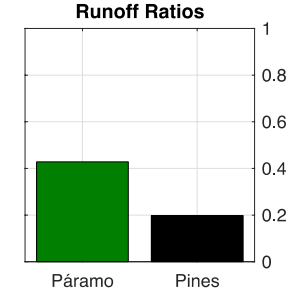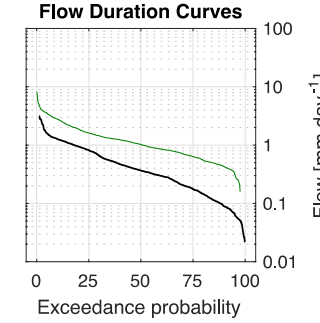
Hydro-economic analyses

Legend:
1: Amuna restoration
2: Wetland resotration
3: Jacaybamba Regulation in Chillón River
4: Punrun / Stage Chillón River
5: MARCA V: Casacancha Dam
6: Animal exclusion from puna
7: Water Exchange-I: Chosica-La Atarjea
8: San Antonio Escondido
9: MARCA IV: Huascacocha derived to Rímac River
10: Water Exchange-II: Chosica-La Atarjea
11: MARCA II: Diversion Pomacocha-Rio Blanco-1st and 2nd stage
12: Las Tinajas and Water Treatment Plant
13: Grathon tunnel extension 4 km
14: Rotational grazing on puna
15: Sea Desalination Plant, Lima Sur

scale [million m^3/year]

Average cost [USD/m^3]

Total potential [million m^3/year]

New sensor technologies
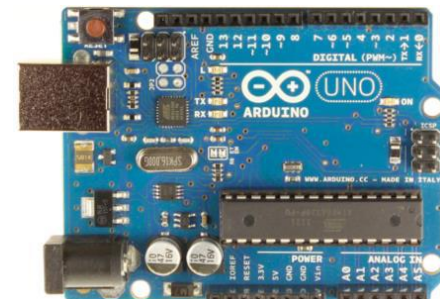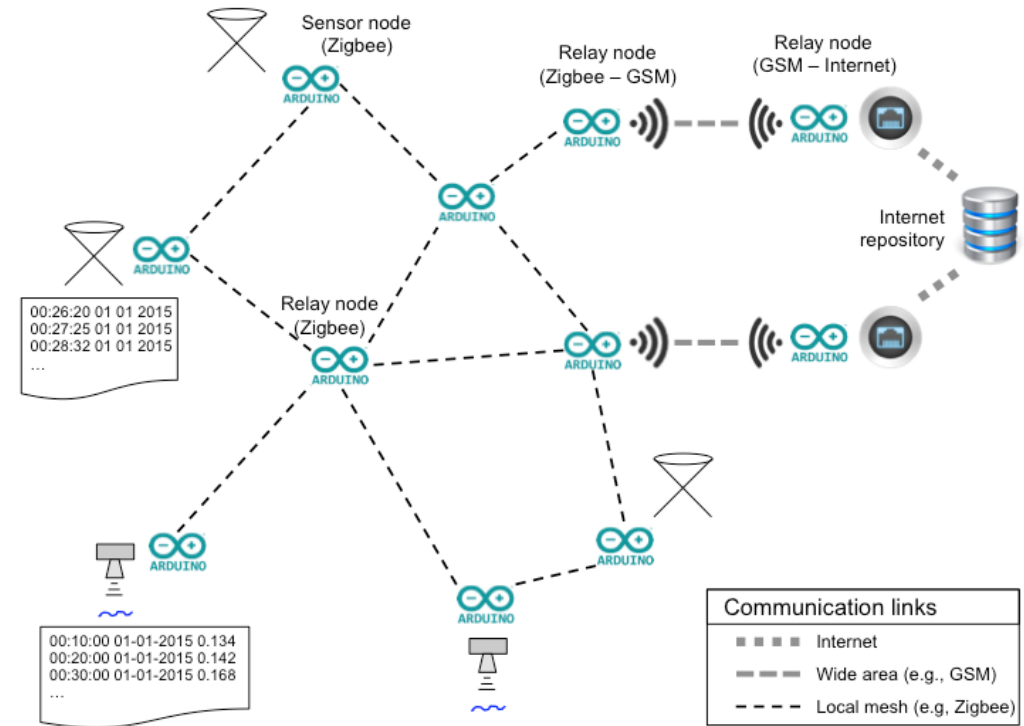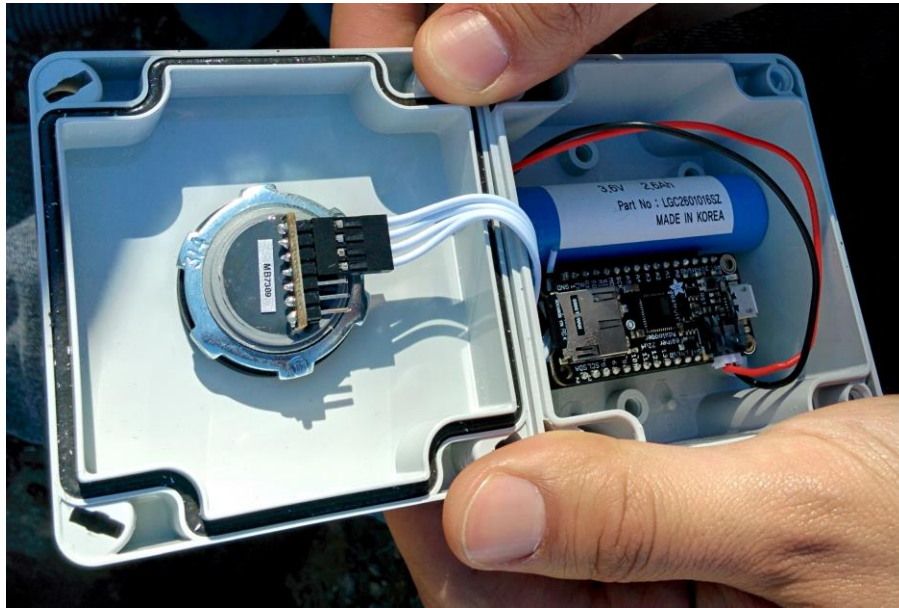
Discussion

bert.debievre@fonag.org.ec
boris.ochoa13@imperial.ac.uk