Learning from our ancestors:

Using modern hydrological techniques to understand ancient water harvesting practices

Boris F. Ochoa-Tocachi, Wouter Buytaert, Mountain-EVO and iMHEA teams

mountain EVO
environmental virtual observatories
iMHEA

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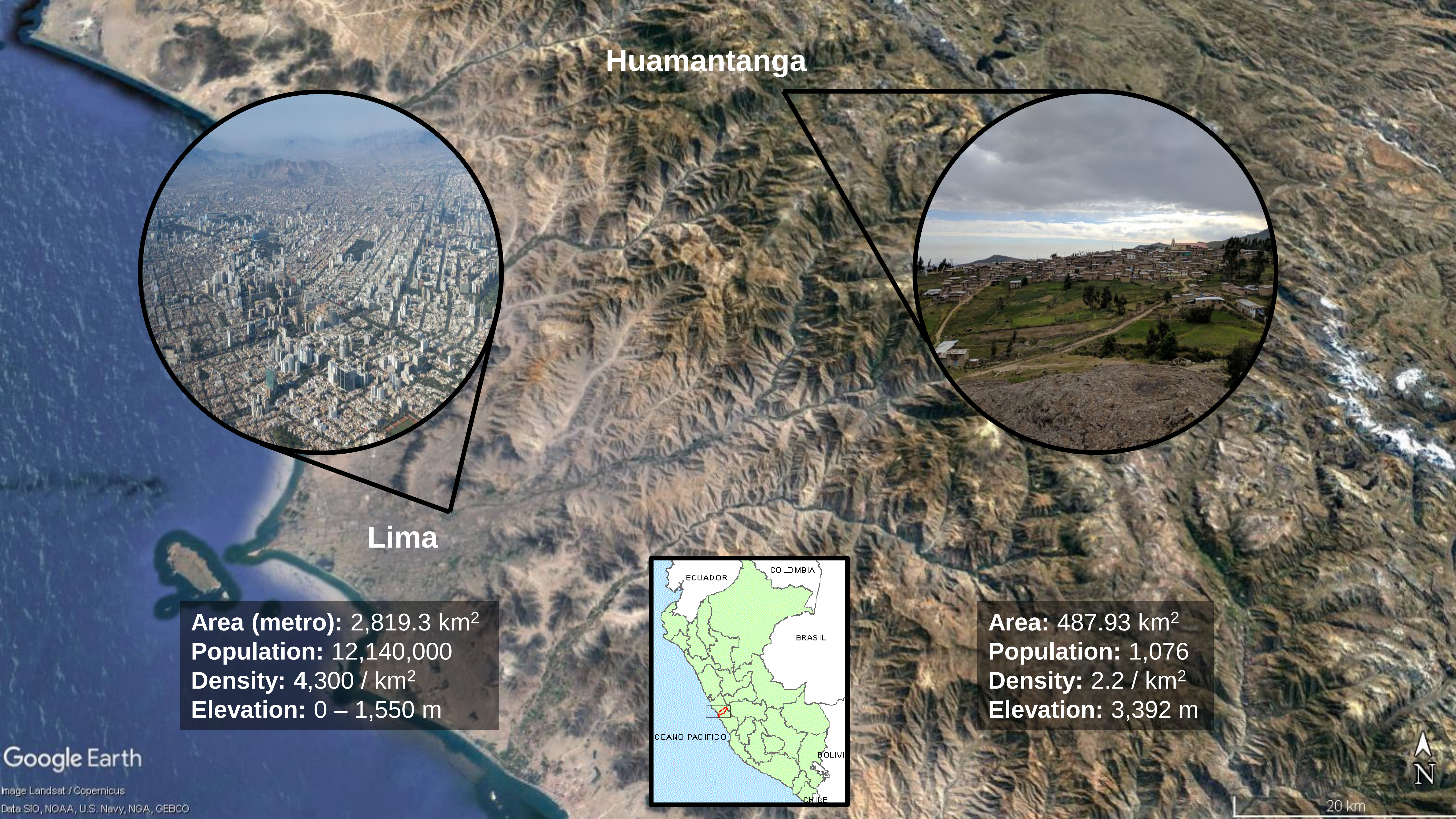
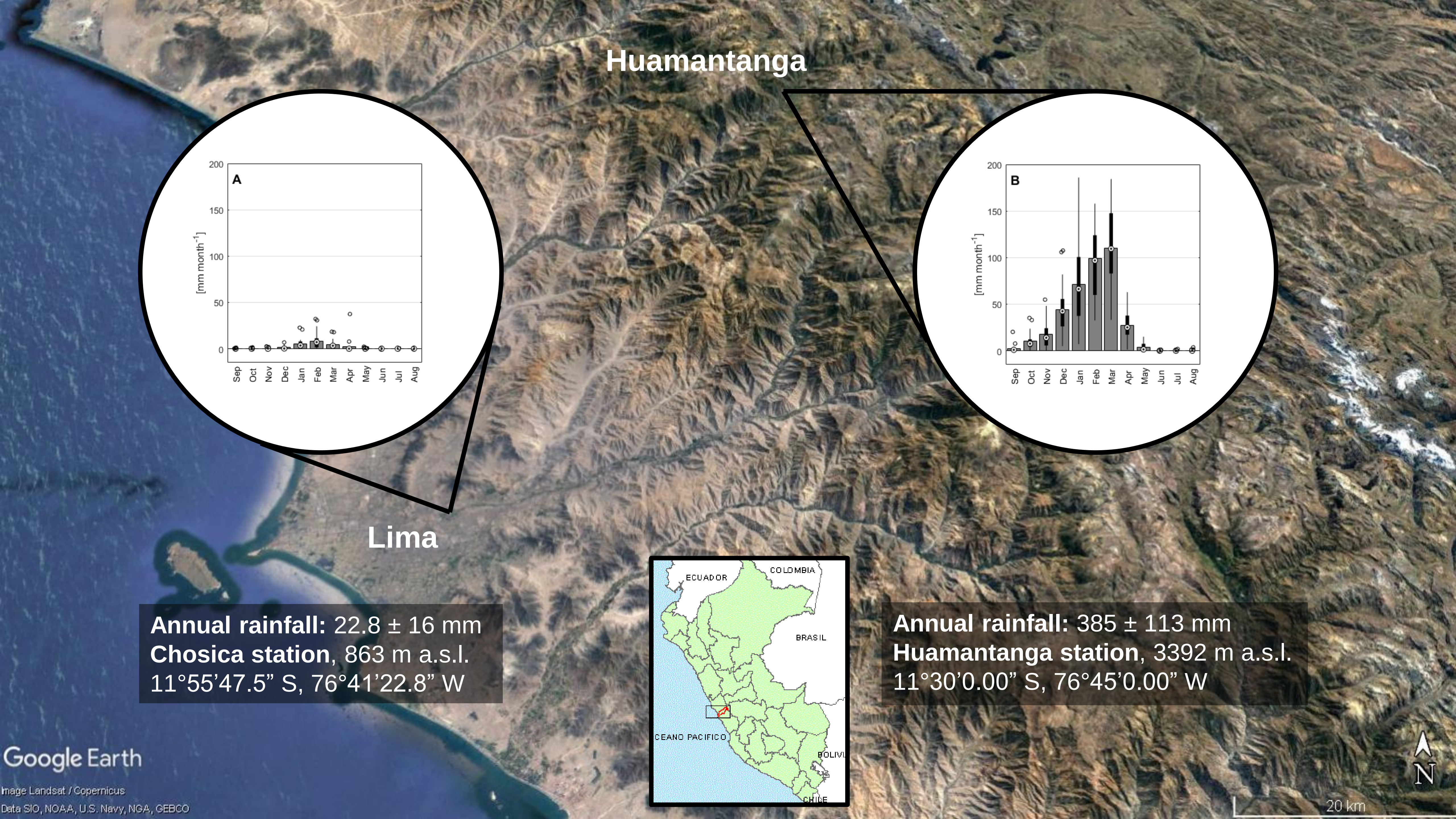
“At first glance, there is little in common between the village farmer herding his cattle in the pastures of the Peruvian Andes and the office worker toiling at his desk in the capital city of Peru, Lima. **But they both depend on exactly the same water source.**

There are few more powerful examples of the interconnectedness of ecosystem health and human wellbeing.”



Huamantanga
Lima
Area (metro): 2,819.3 km2
Population: 12,140,000
Density: 4,300 / km2
Elevation: 0 – 1,550 m
Area: 487.93 km2
Population: 1,076
Density: 2.2 / km2
Elevation: 3,392 m
ECUADOR
COLOMBIA
BRASIL
CEANO PACIFICO
BOLIVI
CHILE
Google Earth
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
N
20 km

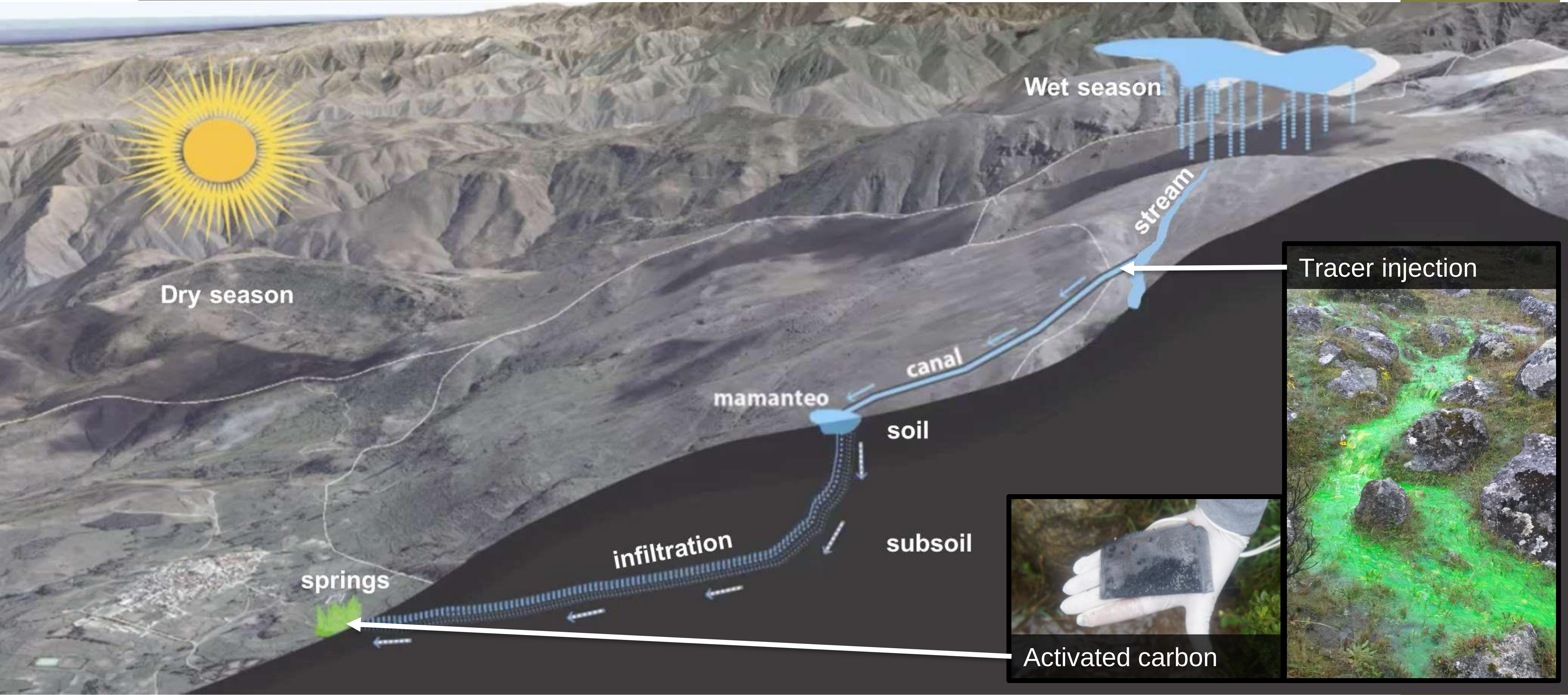

Huamantanga
Lima
A
B
200
150
100
50
0
[mm month-1]
Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug
Annual rainfall: 22.8 ± 16 mm
Chosica station, 863 m a.s.l.
11°55'47.5" S, 76°41'22.8" W
Annual rainfall: 385 ± 113 mm
Huamantanga station, 3392 m a.s.l.
11°30'0.00" S, 76°45'0.00" W
ECUADOR
COLOMBIA
BRASIL
CEANO PACIFICO
BOLIVI
CHILE
Google Earth
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
20 km
N

Extreme seasonality and changes in land-use in the Andean highlands…

… have similarly extreme consequences for downstream communities.

To cope with water scarcity and the strong climate variability of the Peruvian Andes, the community of Huamantanga in the central Sierra has developed artificial infiltration systems that increase water availability for the dry season

A pre-Inca artificial system for water infiltration enhancement



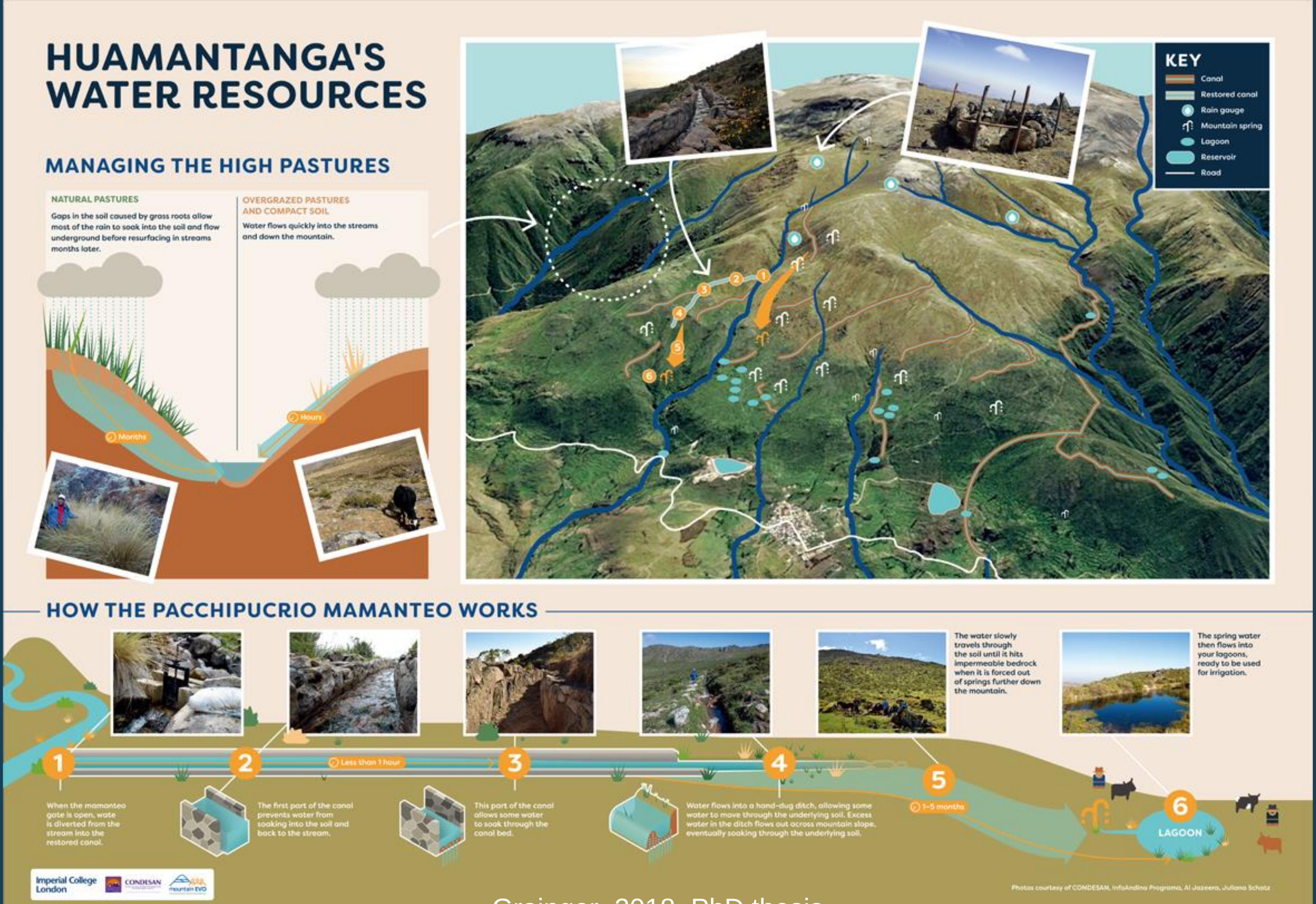
Participatory monitoring

Ochoa-Tocachi et al., 2017, Andean Hydrology, ISBN: 9781498788403
Ochoa-Tocachi et al., 2018, Sci. Data, DOI: 10.1038/sdata.2018.80

- Off-the-shelf, low-cost monitoring equipment,
- Grassroots driven approach with local buy-in.
- Addressing local questions, local hypotheses.

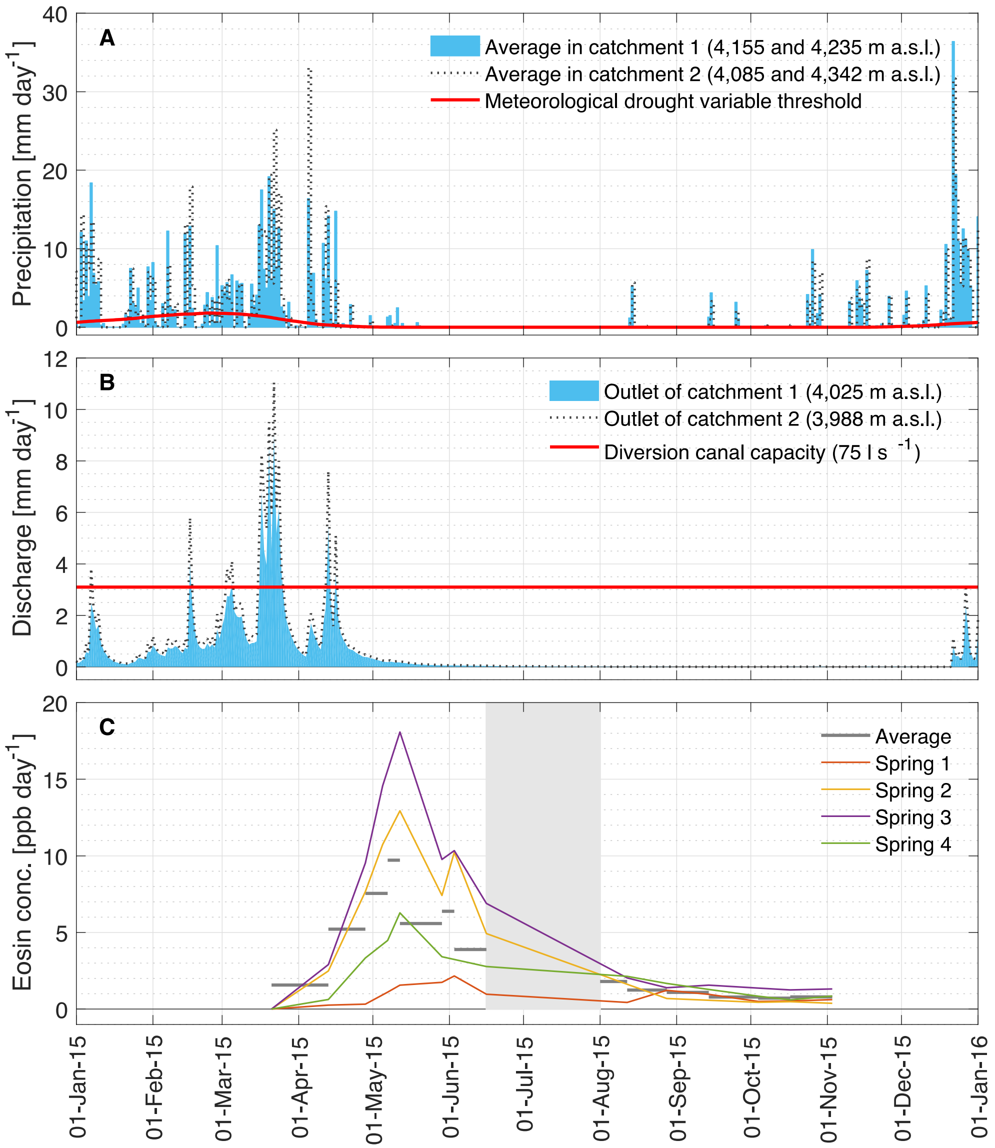
- Investigate the impact of cattle grazing on streamflow.
- Evaluate a restored ancient hydrological technique.



Grainger, 2018, PhD thesis

Quantification of infiltration volumes



(**A**) Precipitation in the highlands is highly seasonal, mostly occurring as rainfall from December to April (~500 mm yr^{-1}).

(**B**) The generated discharge is also highly seasonal, averaging ~5 l s^{-1} km^{-2} from January 2015 to December 2016. The resulting runoff coefficients are around 1/4.

(**C**) Tracer concentrations in 4 springs located downslope of the diversion canal show travel times of water between 2 weeks and 8 months, peaking at 2 months.

Annual water balance		Wet season flow	
Rainfall	**Runoff**	**Potential**	**Effective**
343–663	82–184	75–170	29–96

min–max volumes in mm.
1 mm equals 1,000 m^3 / km^2

Infraestructura Natural para la Seguridad Hídrica

Natural infrastructure for water security

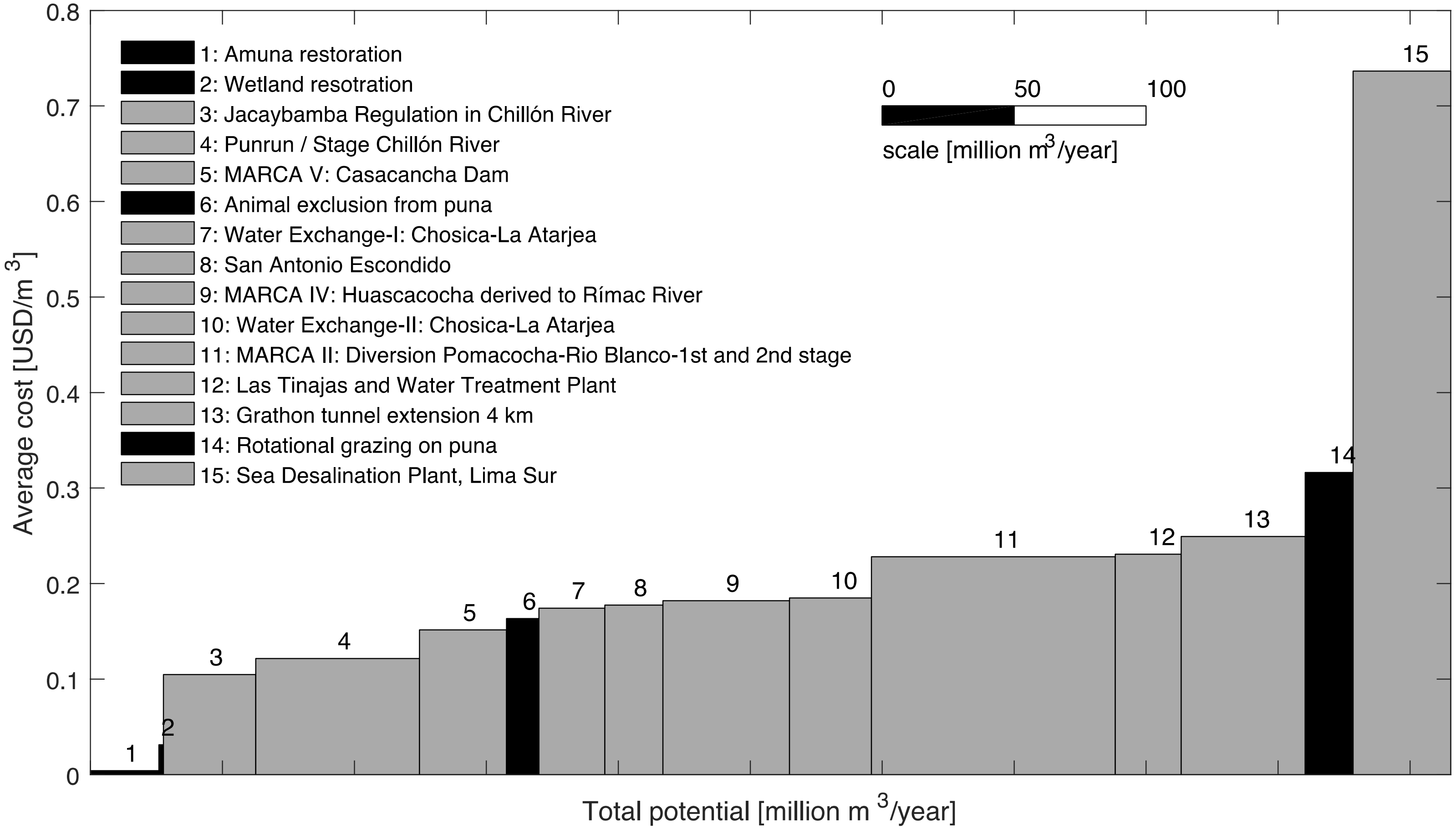
The estimated infiltration amounts are comparable to those of relatively small reservoirs able to satisfy the local irrigation demand of communities such as Huamantanga.

In Huamantanga itself, two reservoirs with design capacities of 350 and 400 thousand m^3 were built at a cost of USD 1.5–2 million each.

Hydro-economics of natural infrastructure

Gammie and De Bièvre, 2015, Forest Trends, technical report

Similar water storage volumes could have been achieved by restoring ancient mamanteo canals at a cost 10 times cheaper




The capacity of ancient systems such as mamanteo to help bridge the dry season
is a great example of the capacity and knowledge of indigenous populations to cope with water-related problems

Katya Pérez, CONDESAN

“

Comuneros in Huamantanga had sometimes said that ‘problems occur because their own lack of knowledge’.

The participatory monitoring looked exactly at bridging that gap: not only generating new knowledge on the local water cycle but **revaluing local, ancestral knowledge** as well.

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Muchas gracias

Boris F. Ochoa-Tocachi
boris.ochoa13@imperial.ac.uk

**Natural Infraestructure
for Water Security**