Quantifying the contribution of glacier melt on human water use

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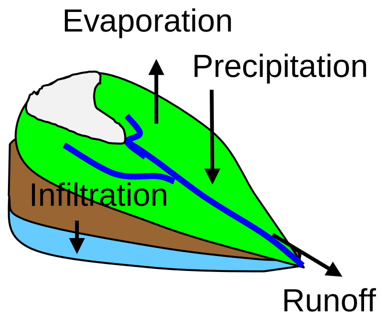
Assessing vulnerability to glacier melt



Vulnerability depends on:

- Glacier melt contribution
- Future change in space and time
- Current and future water demand
- Current and future change in water scarcity
- Socio-economic context: resilience and adaptive capacity

Methodology

Supply model

- Input data: high resolution maps of P, T, ET_0
- Water balance model: Budyko
- Routing model: Linear reservoir
- Calibration data: Monthly river flow

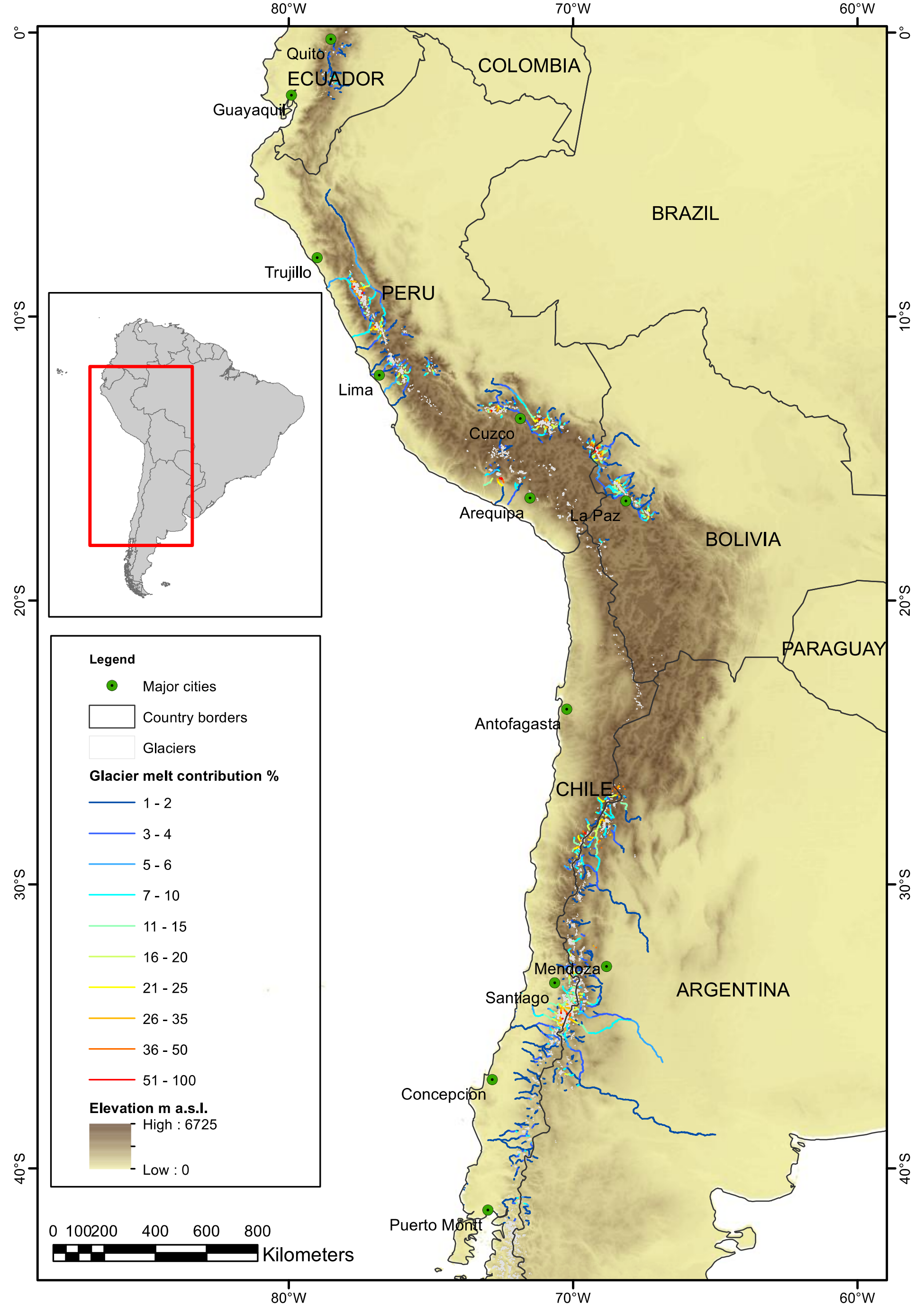
Demand model

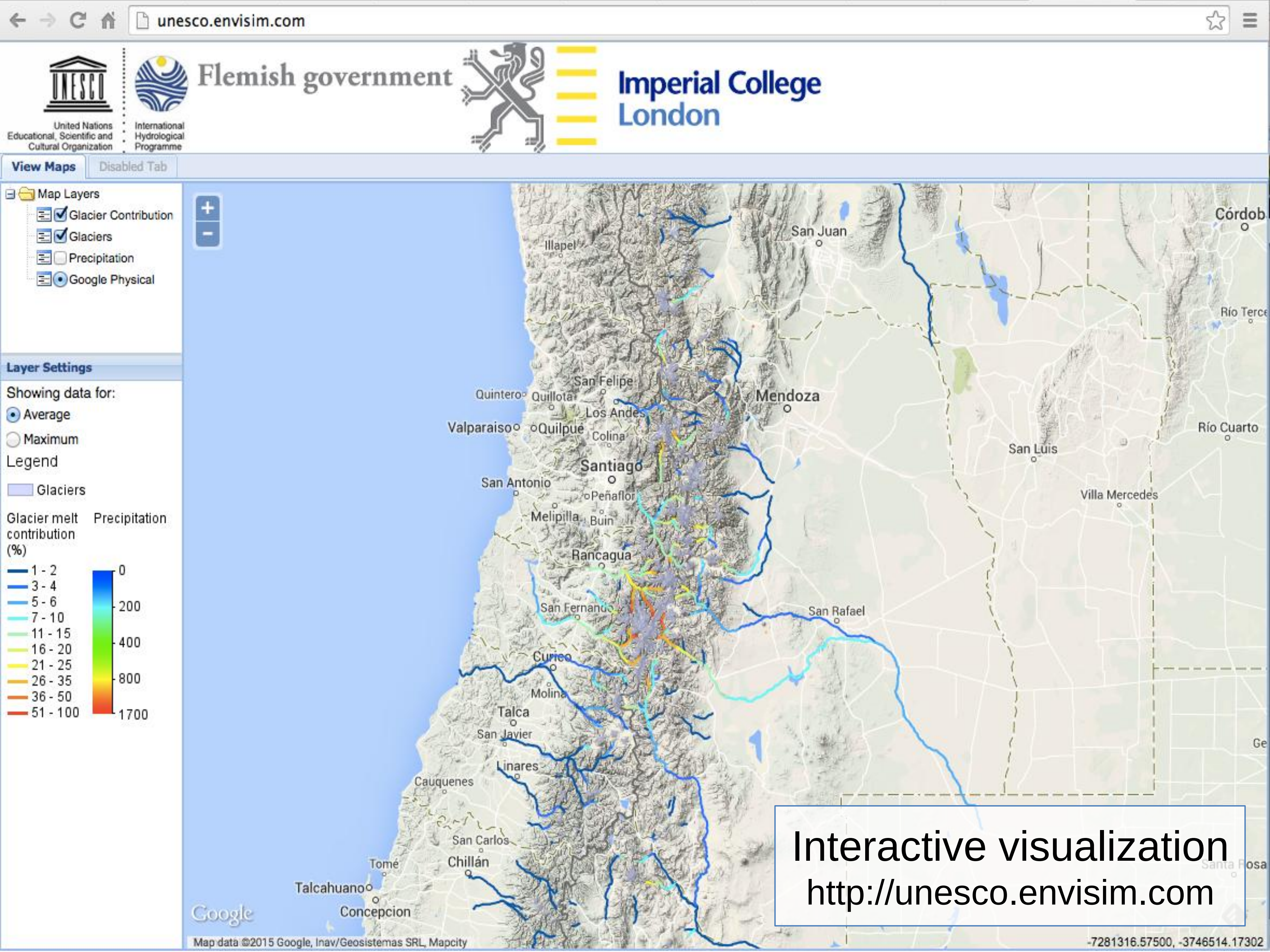
- Compilation of demand data from various sources (national statistics bureaus, meteorological offices, FAO, …)
- Generation of high-resolution maps using various interpolation techniques and proxies (e.g., population maps, land-use)

Glacier contribution

4 scenarios:

- Long term average
- Month with highest contribution
- Extreme drought (annual average)
- Extreme drought (month with highest contribution)





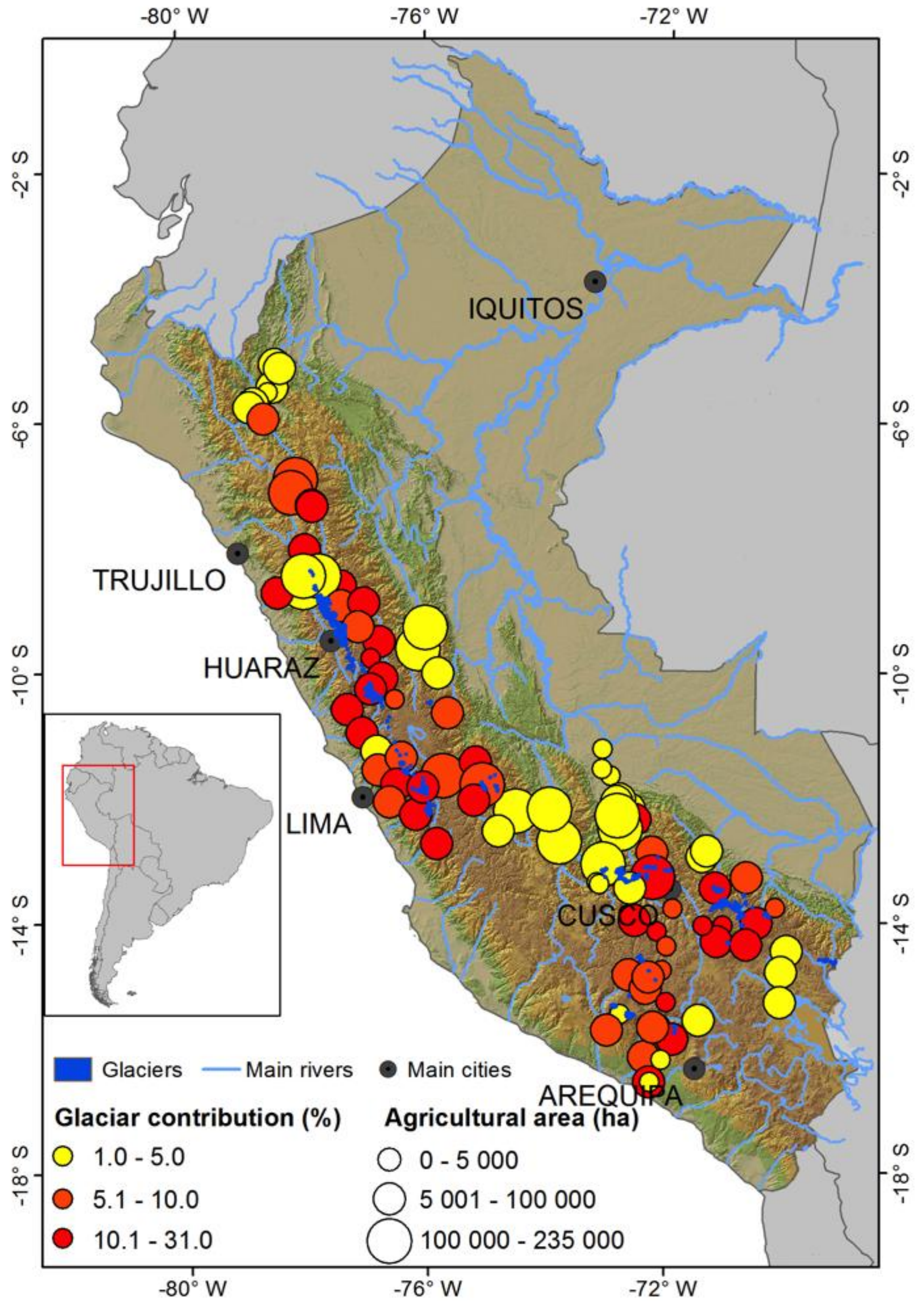
Interactive visualization

http://unesco.envisim.com

Water use

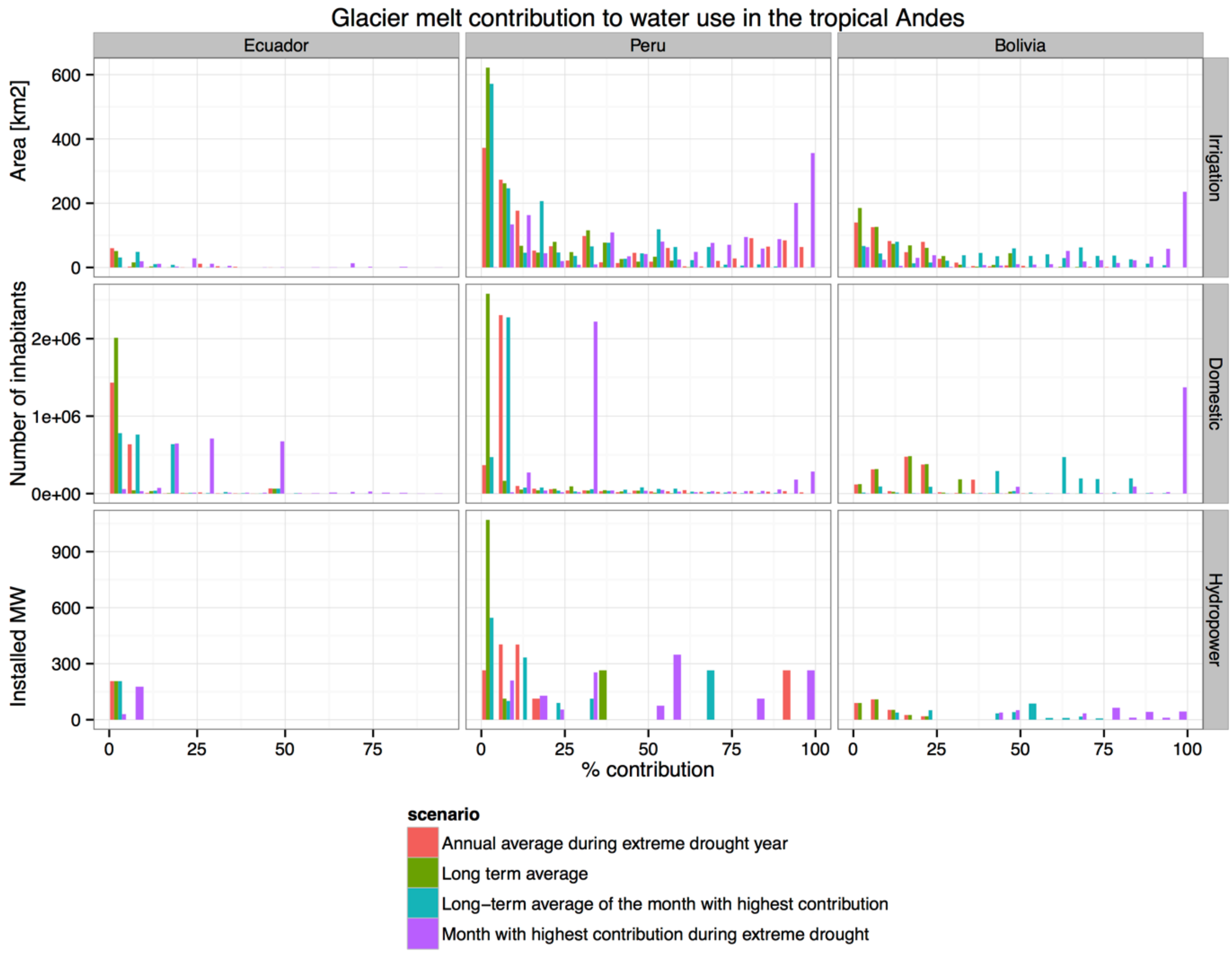
Focus on 3 types of water use:

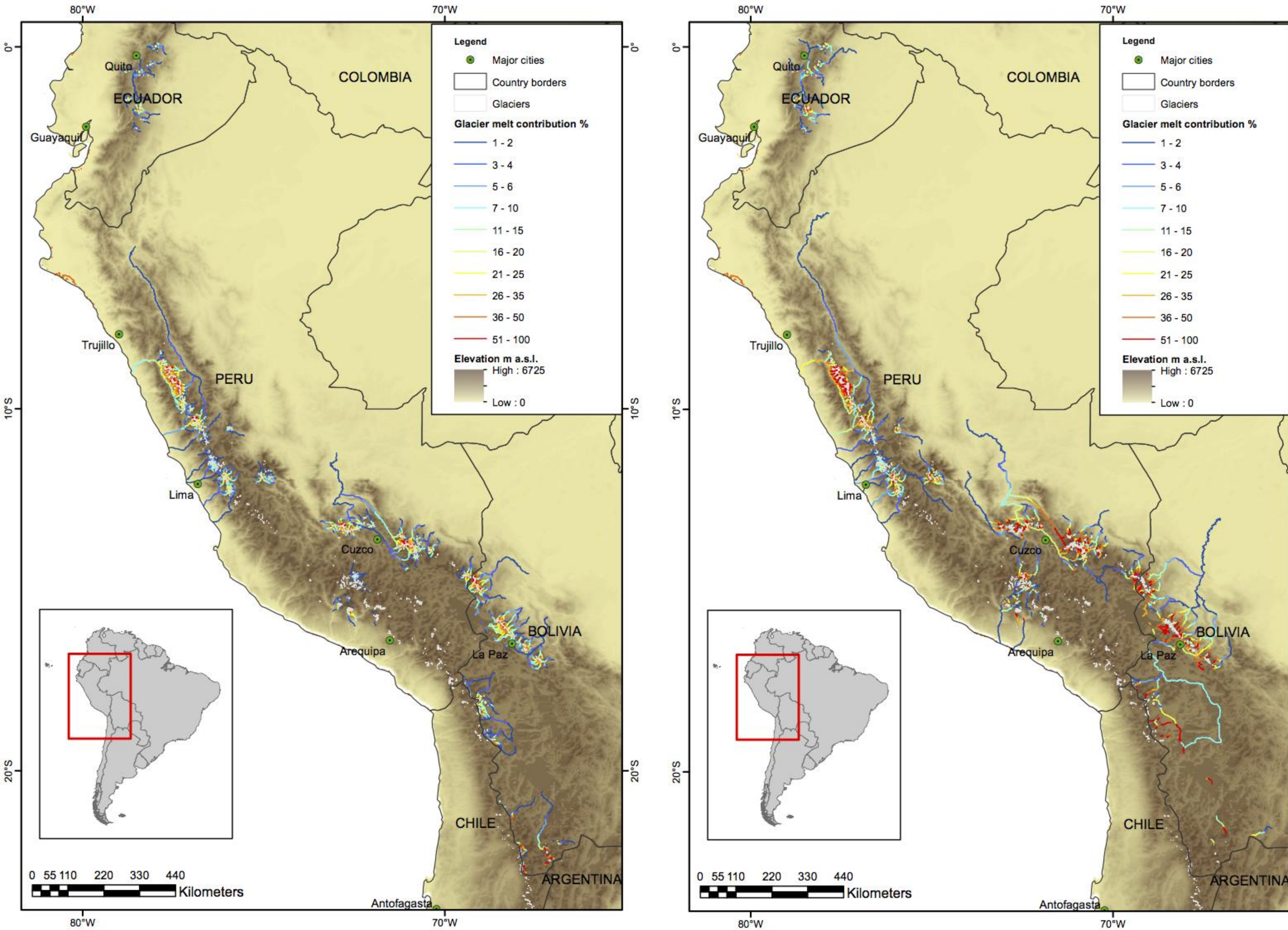
- Domestic
- Irrigation
- Hydropower



Example: Peru

Combining supply and demand models: glacier melt contributions to water use





80°W
70°W
0°
10°S
20°S
Legend
Major cities
Country borders
Glaciers
Glacier melt contribution %
1 - 2
3 - 4
5 - 6
7 - 10
11 - 15
16 - 20
21 - 25
26 - 35
36 - 50
51 - 100
Elevation m a.s.l.
High : 6725
Low : 0
COLOMBIA
ECUADOR
PERU
BOLIVIA
CHILE
ARGENTINA
Quito
Guayaquil
Trujillo
Lima
Cuzco
Arequipa
La Paz
Antofagasta
0 55 110 220 330 440
Kilometers

% glacier contribution for some Andean cities

	Quito	Lima	La Paz	Huaraz
Annual average (normal year)	2.2 [0.9 – 5.0]	<1.0 [0 – 1.0]	14.8 [5.9 – 26.8]	19.0 [7.5 – 35.4]
Monthly maximum (normal year)	5.3 [2.3 – 11.1]	1.17 [0.0 – 2.7]	61.1 [37.8 – 77.1]	67.3 [41.9 – 82.8]
Average annual (drought year)	3.7 [1.5 – 8.0]	<1.0 [0.0 – 1.0]	15.9 [6.4 – 29.4]	27.2 [11.6 – 46.7]
Monthly maximum (drought year)	15.4 [7.3 – 27.6]	4.15 [0.0 – 9.1]	85.7 [74.1 – 91.5]	91.1 [78.1 – 96.0]

Next steps: impacts of climate change

Assessing the impacts of climate change on water supply is problematic because:

- Uncertainties in climate projections

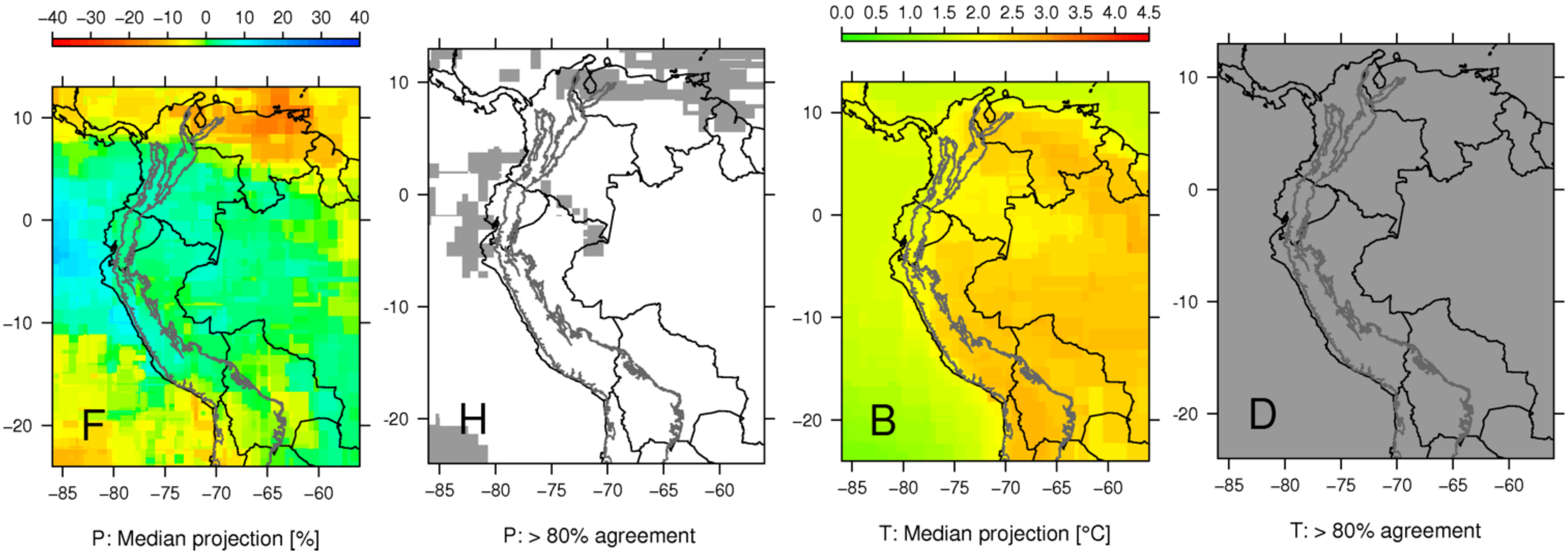
- Uncertainties in hydrological models

- Uncertainties in glacier evolution

Example: climate projections

Precipitation

Temperature



Median [%]

Agreement

Median [ºC]

Agreement

IPCC CMIP3 model ensemble, A1B, 2040 - 2069

Next steps: impacts of climate change

Assessing future water demand is problematic because:

- Uncertainties in evolution of human consumption
- Uncertainties in evolution of irrigation

Nevertheless, there is a much clearer trend of increasing demand!

Country	Population [million]	Growth rate [%]	City	Growth rate [%]
Colombia	46.30	1.35	Bogotá	1.82
Ecuador	13.77	2.10	Quito	2.42
Peru	29.50	1.55	Lima	2.00
Bolivia	10.03	2.82	La Paz	2.36

Information gaps on climate change or **adaptation** to CC

- Research OF climate change

Versus

- Research needed for adaptation TO climate change

- Ex. Monitoring of climate change ≠ Monitoring of adaptation measures

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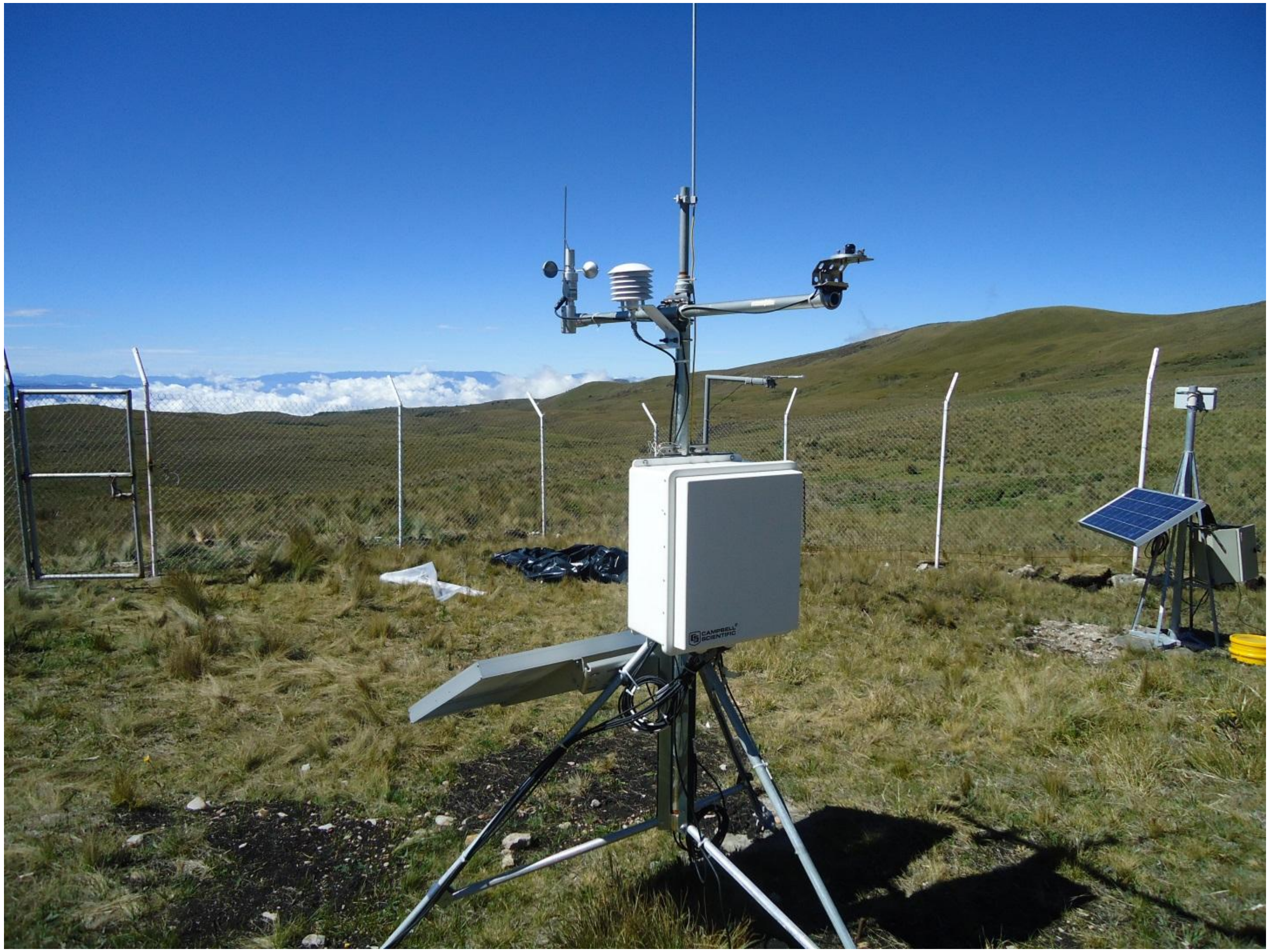
Monitoring of climate (change)



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Monitoring of adaptation to CC

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Research priorities

- In watershed management , there is a "portfolio" of adaptation measures like (re)forestation, infiltration trenches, water harvesting…
- These measures are not being monitored and have not been evaluated , which limits their effectivity towards goals they aim at
- Cost-effectivity of adaptation measures

Questions?