Karlsruher Institut für Technologie

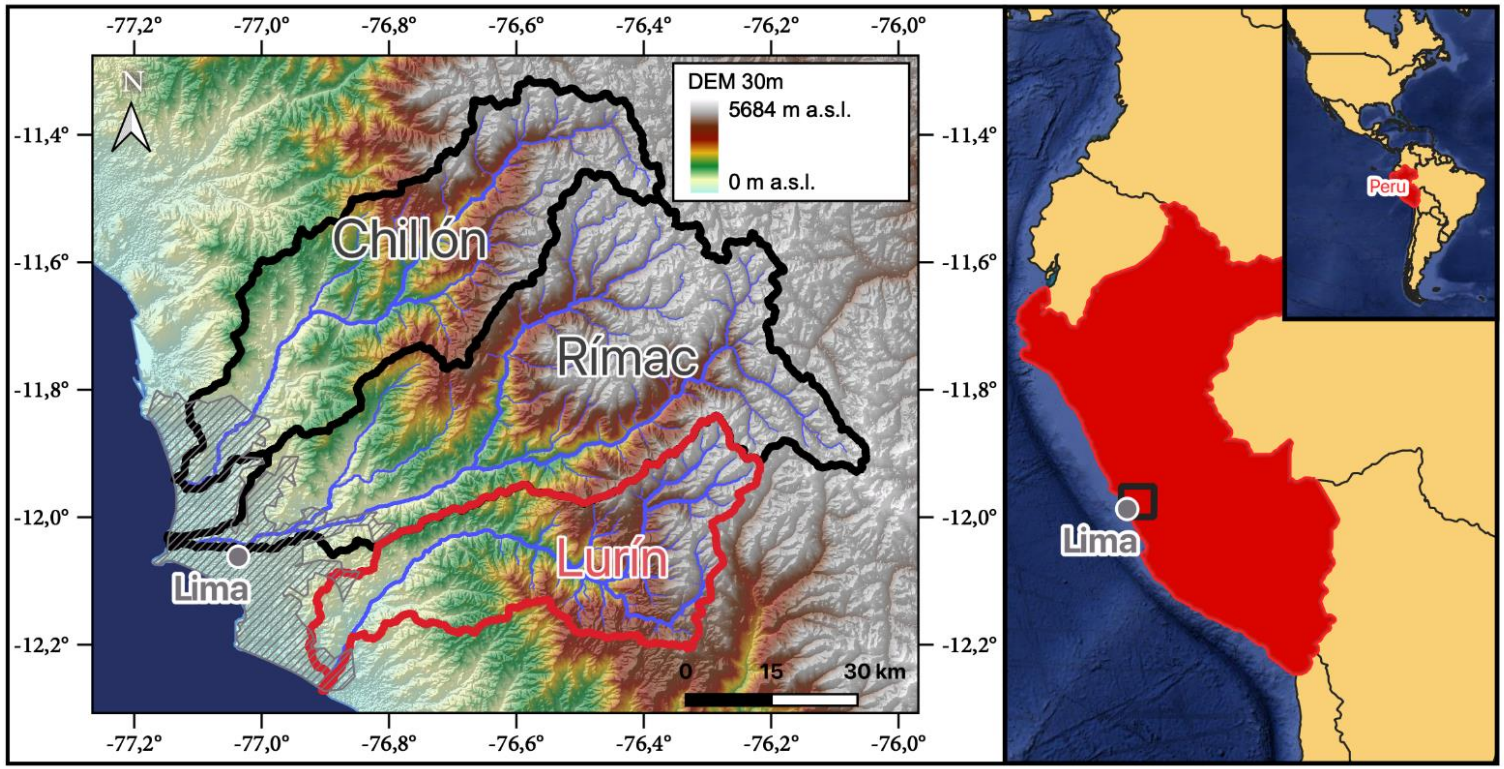
trust

# Hydrology of the Lurín catchment: Monitoring and Modelling

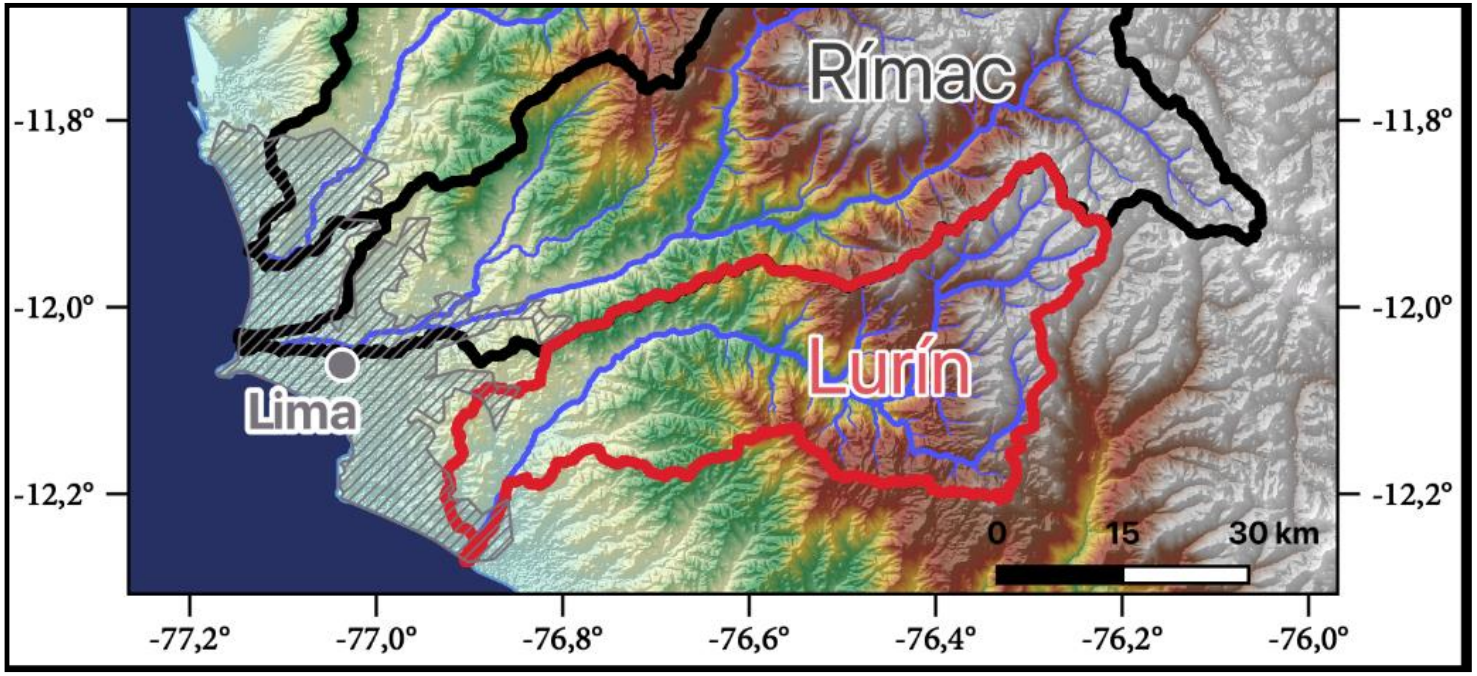
INSTITUTE OF WATER AND RIVER BASIN MANAGEMENT - HYDROLOGY

# Study Area: ChiRiLu

- We studied the Lurín catchment near Lima, Perú
- One of the ChiRiLu catchments that supply Lima with water
  - Lima: ~ 10 mill. people, ~ 10 mm rainfall per year



# Study Area: Lurín River




Length
- 111 km

Catchment area
- 1670 km²

Elevation range
- 0 to 5250 m amsl

WHERE DOES THE WATER COME FROM?

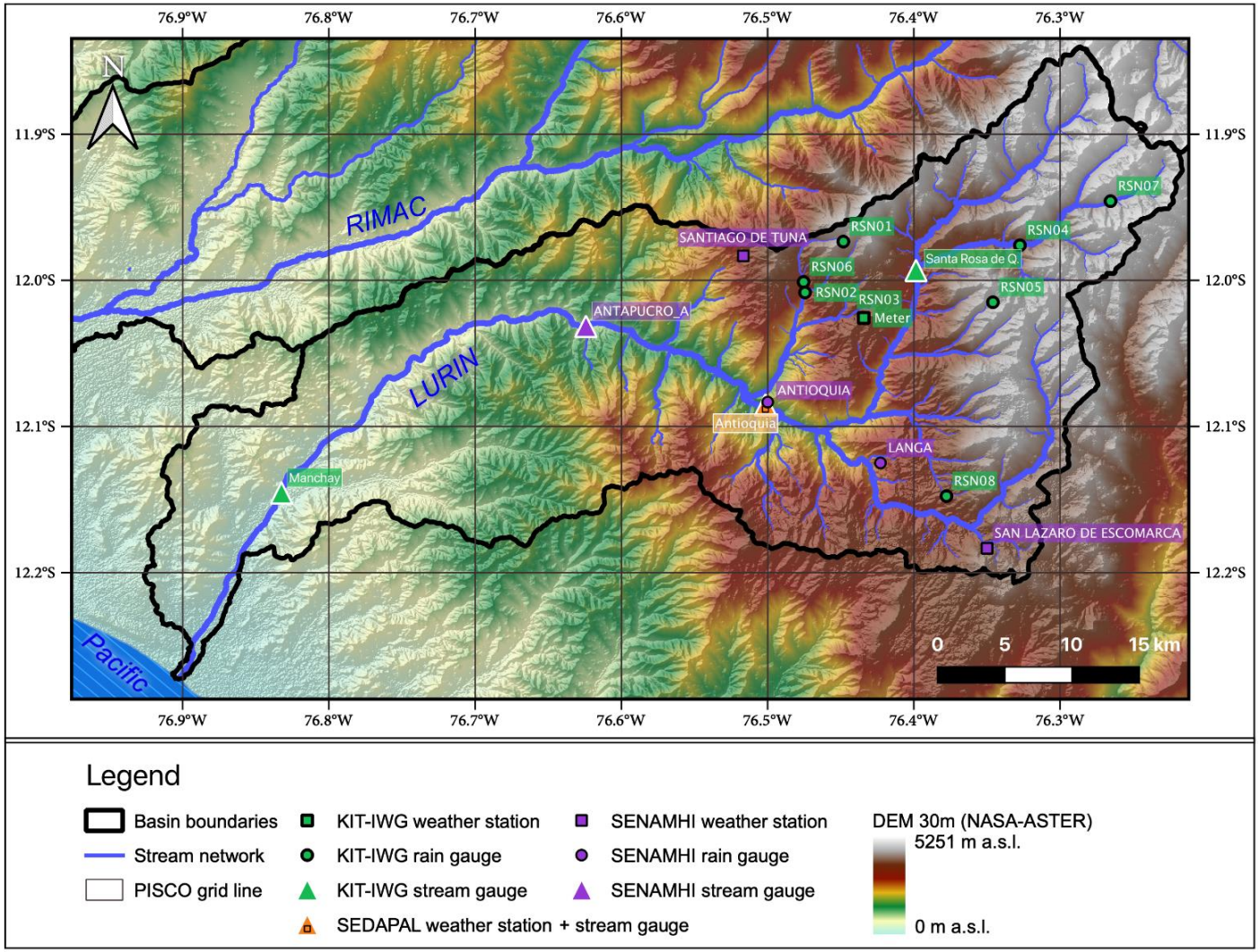
WHERE DOES THE WATER GO?

HOW MUCH IS AVAILABLE FOR USAGE?

# Study Area: Lurín River

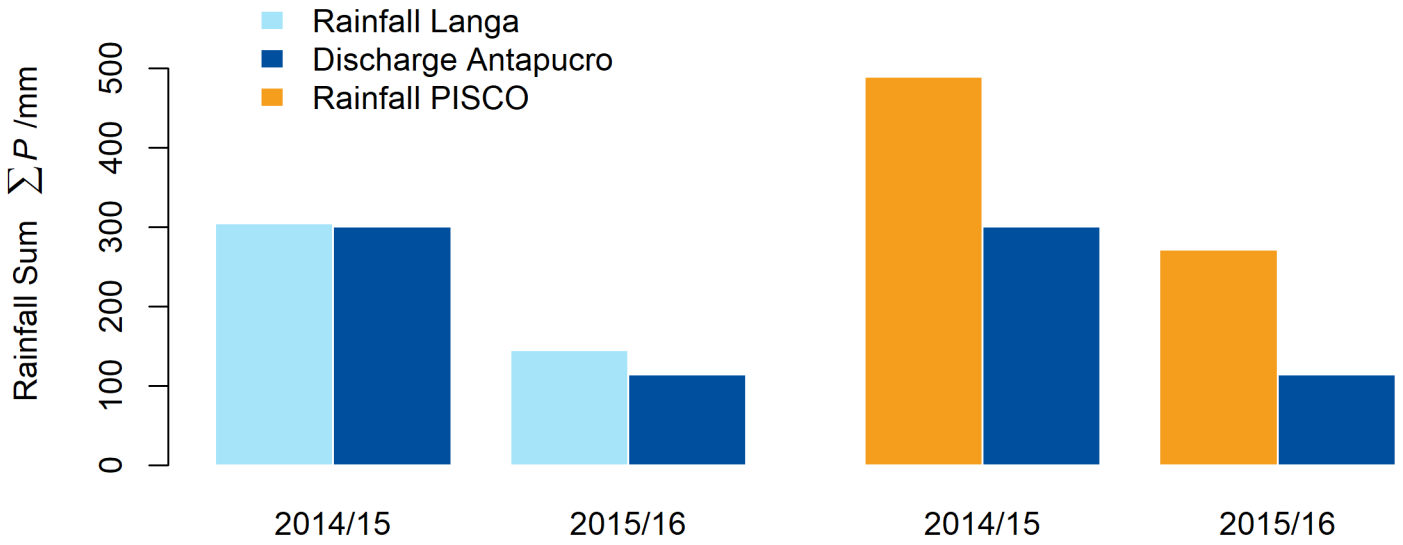
## Monitoring stations

- as of 2017:
  - 1 stream gauge
  - 3 rain / meteo stations
  - operated by SENAMHI[1]
- in 2018/19
  - + 1/+2 stream gauges
  - + 1/+8 rain/meteo
  - operated by SEDAPAL[2]/ TRUST




[1] Servicio Nacional de Meteorologia e Hidrologia
[2] Servicio de Agua Potable y Alcantarillado de Lima

# Water balance with available data

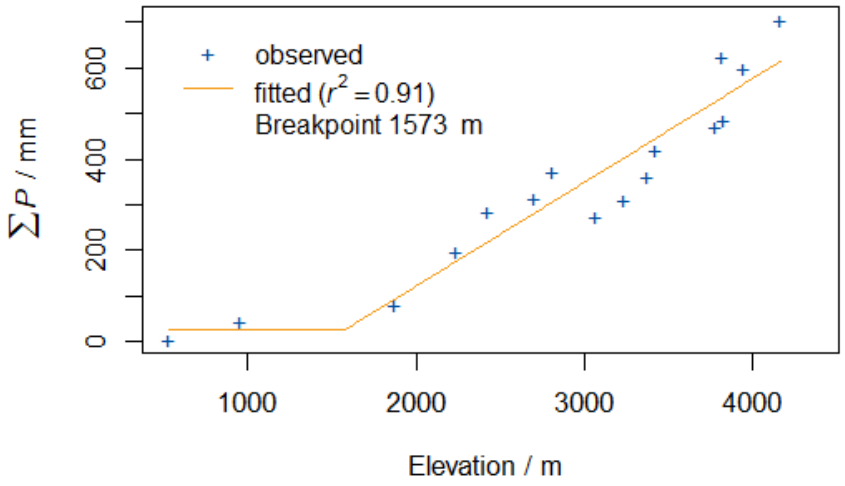


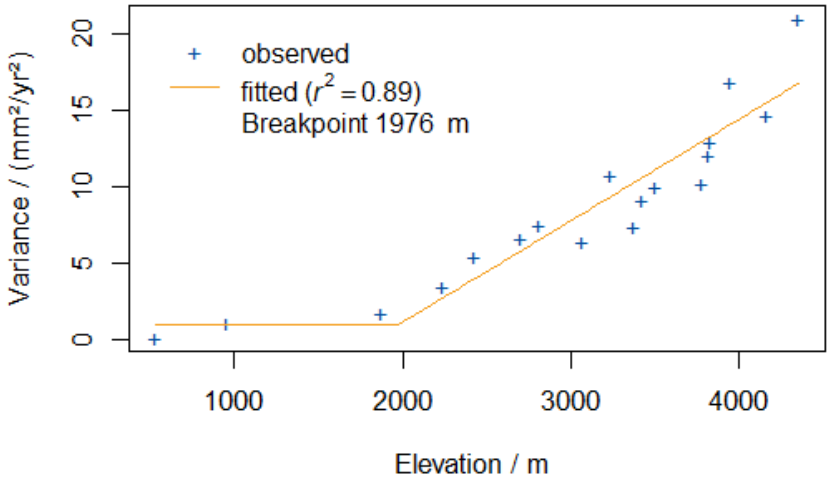

- Rainfall from station data leaves no water for evapotranspiration (left)
- Gridded rainfall product PISCO[1] much better (right), but
  - not available after 2018, rather coarse resolution (0.1°)

[1]Peruvian Interpolation of the SENAMHI'S Climatological and hydrological data Observations - precipitation; Aybar et al., 2019, *Hydrological Sciences Journal*

# Rainfall patterns in ChiRiLu

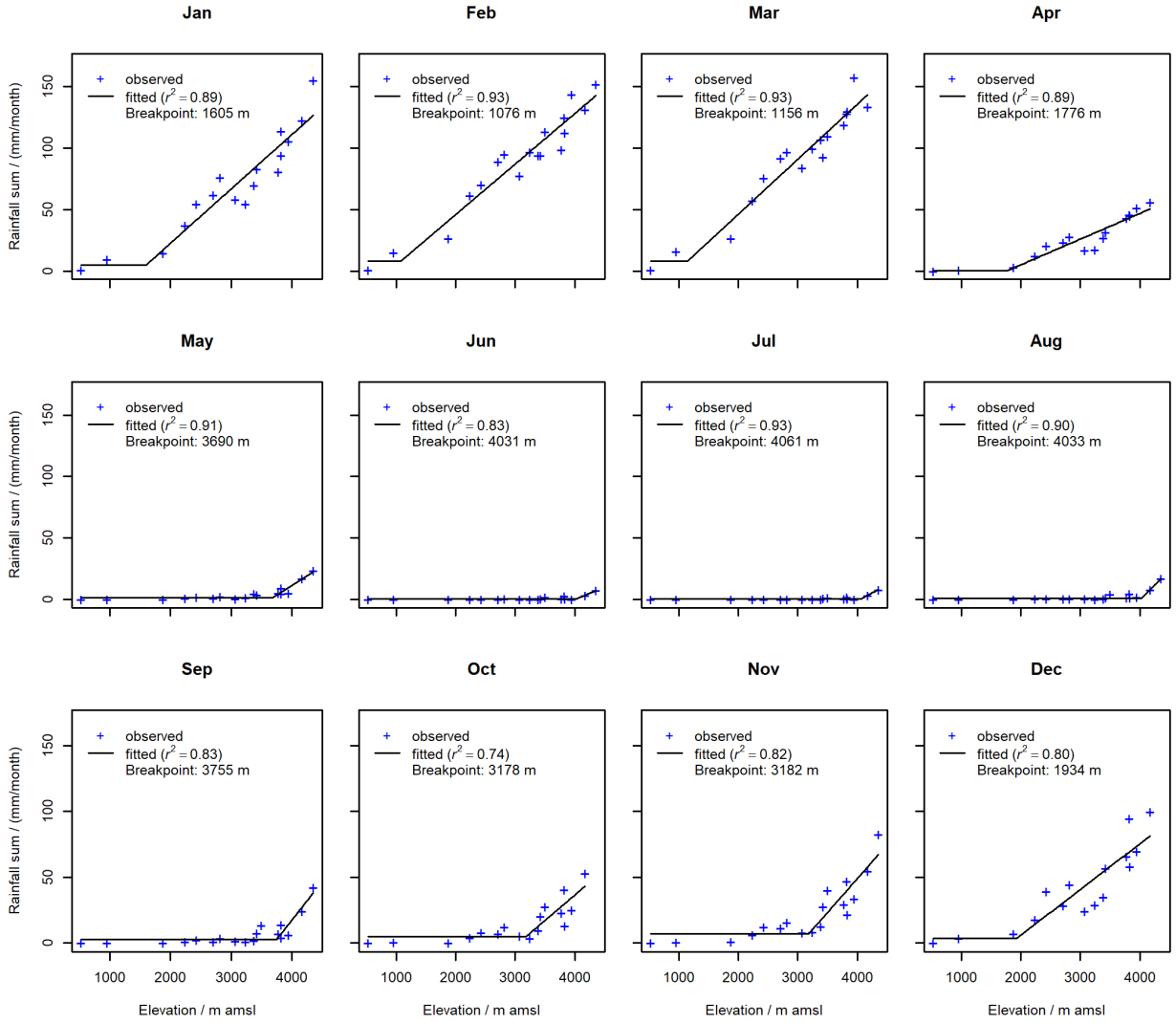
- Analysis of 18 rainfall gauges with 30 or more years of data in the three catchments
- Rainfall interpolation at monthly and daily timesteps using covariance structures



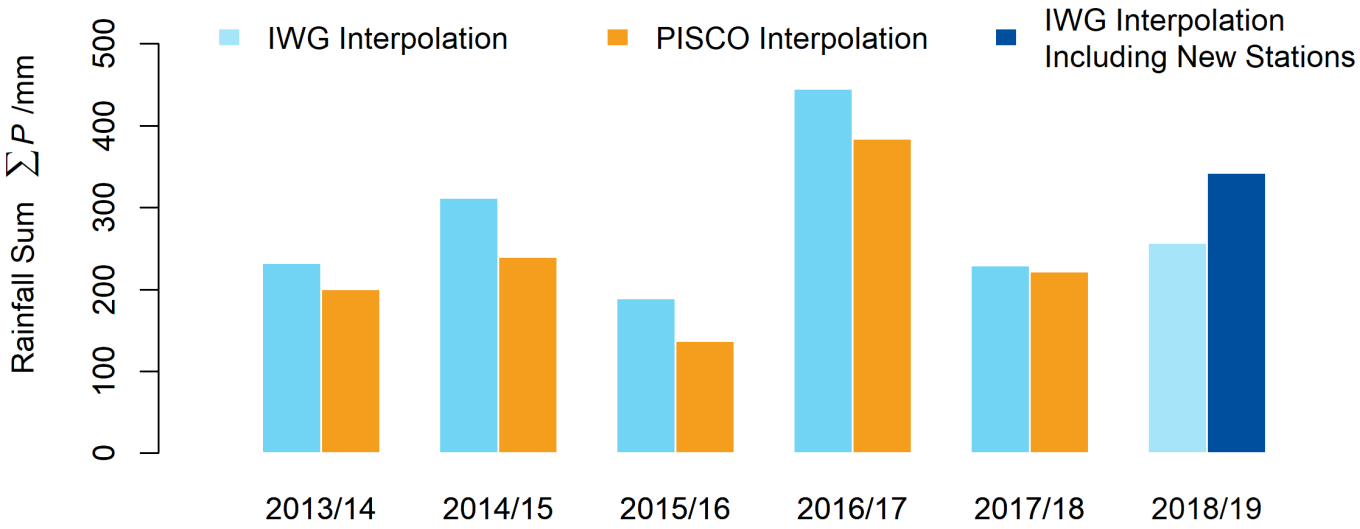

**Correlation of rainfall sums and variance with elevation above threshold at yearly (here) and monthly scales (next page)**

# Rainfall patterns in ChiRiLu



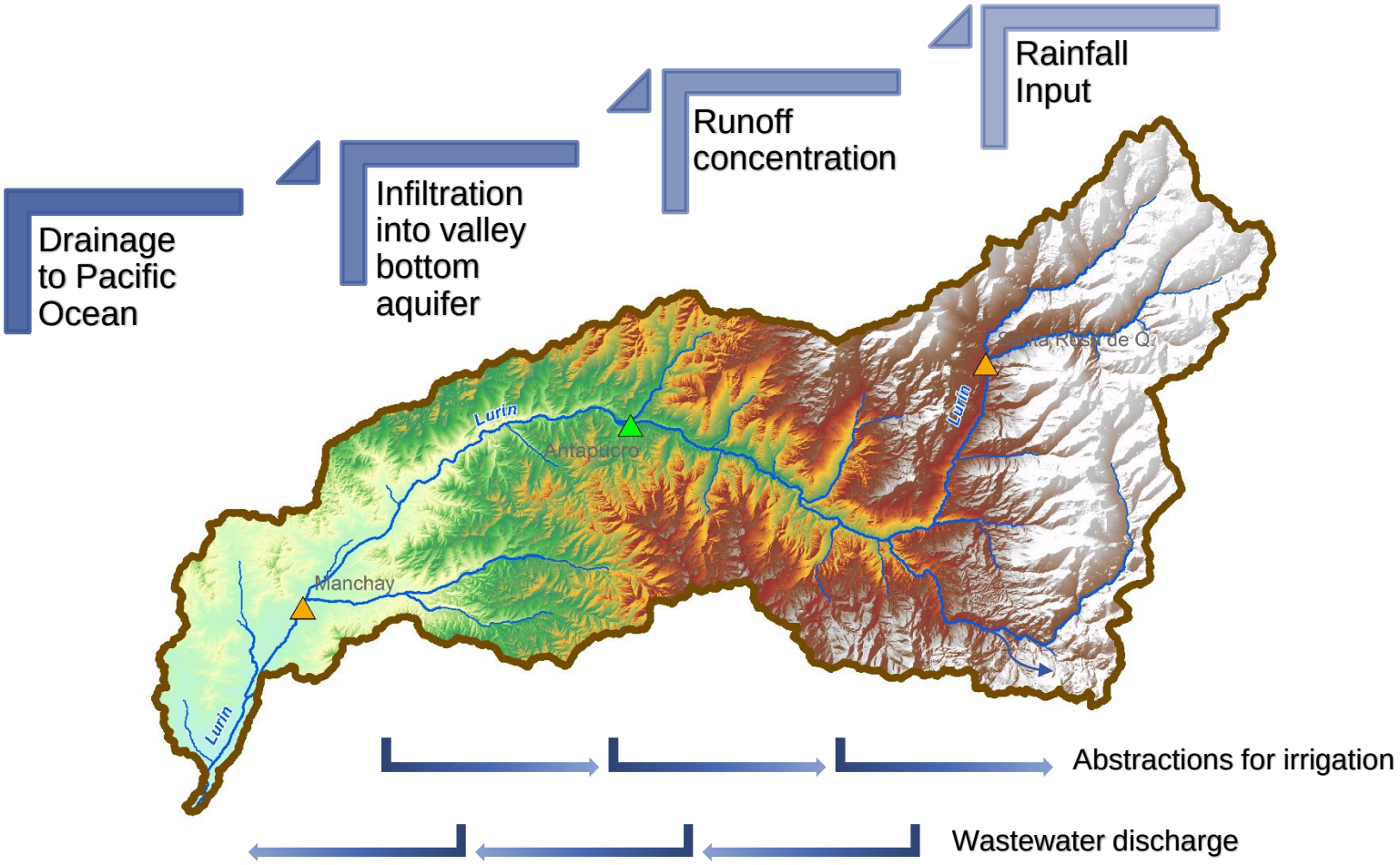
# Rainfall Interpolation

- Covariance-variance model interpolates higher rainfall sums for the Lurín, and allows to include new station data



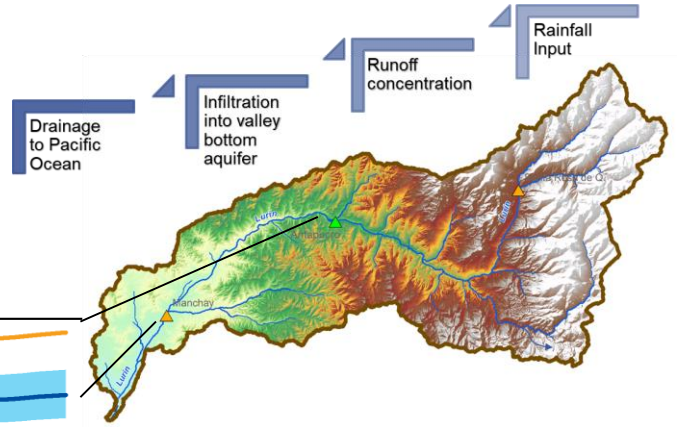

- Rainfall is main input requirement for hydrological modeling

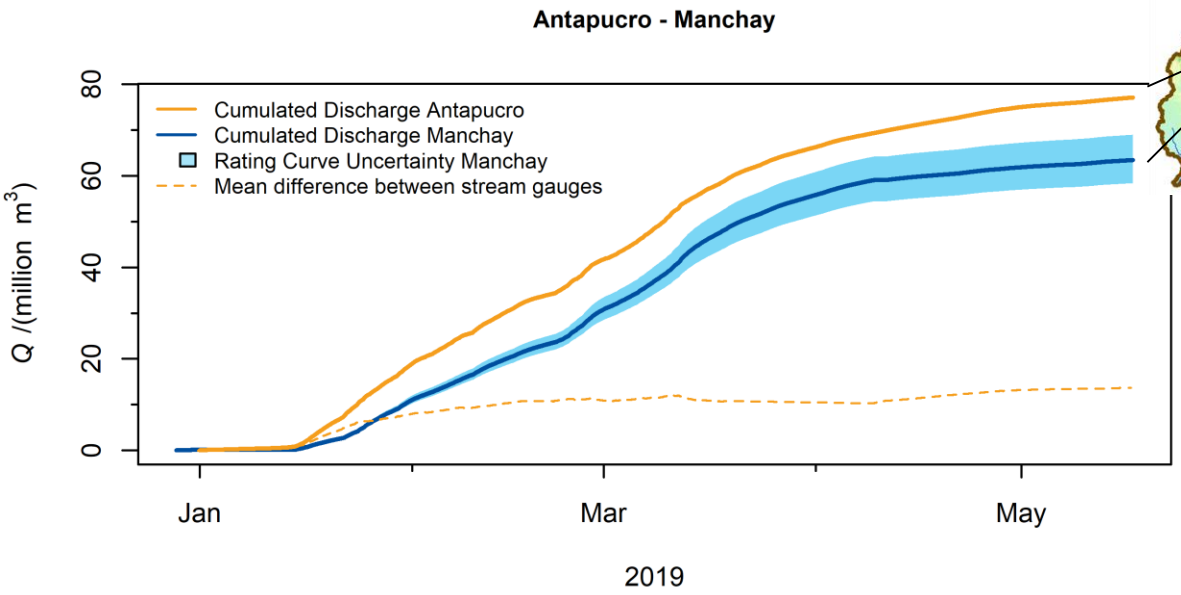
# Perceptual Model of the Lurín River



# Quantification of Groundwater Renewal Rate

- Difference between stream gauges Antapucro and Manchay allows to estimate amount of infiltrated river water

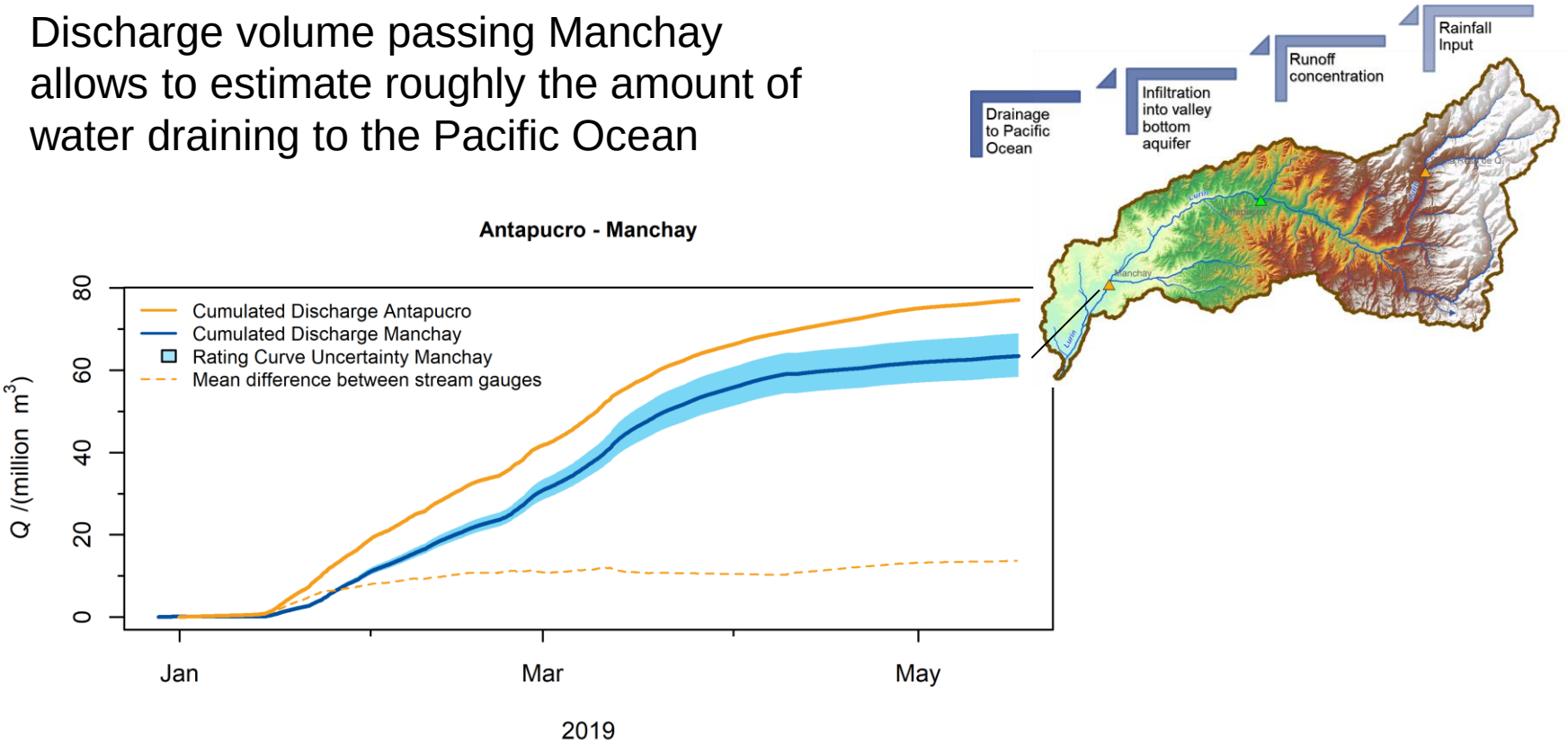



- In the first (almost completely monitored) rainy season, around 14 (8 to 19) million m³ were ‘lost’ between the two gauges
- Mostly infiltrated (the river even falls dry there regularly)
- Allows to infer sustainable groundwater usage

# Quantification of Drainage to Ocean

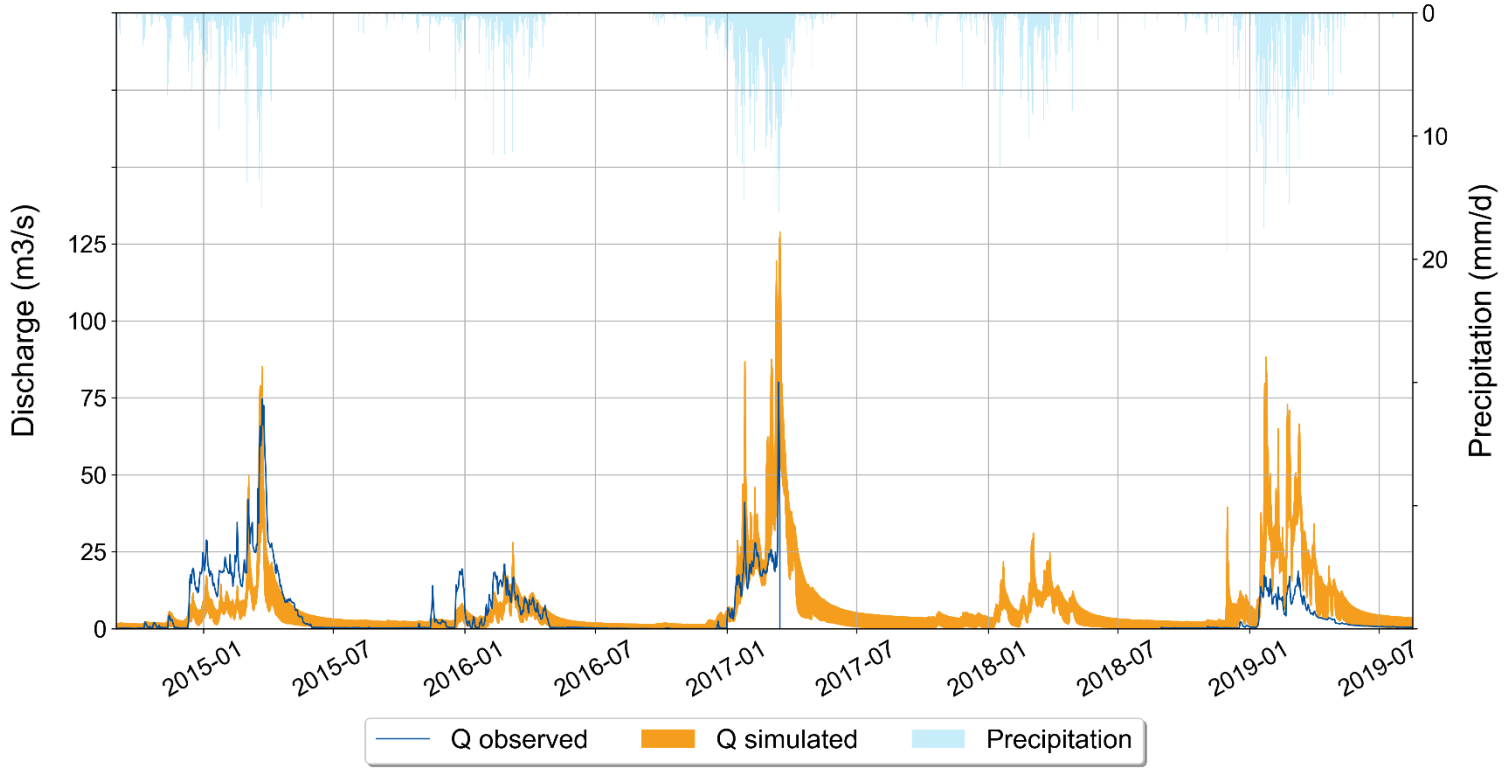
- Discharge volume passing Manchay allows to estimate roughly the amount of water draining to the Pacific Ocean




- 55 (48 to 64) million m³ of river water that have drained from the Lurín catchment to the Pacific Ocean during this period (assuming that infiltration losses continue as upstream)

# Hydrological Modeling

- Setting up and calibrating a distributed hydrological model (mHM [2]) against the only long-term stream gauge (Antapucro) revealed considerable differences in rainfall-runoff reaction between years → quality of discharge data?




[2] Mesoscale hydrological model;
Samaniego et al., 2010, *Water Resources Research*

# Summary and Conclusions

- Rainfall in the upper parts is the only water input for the catchment, and monitoring improved with new rain gauges at high altitudes
- Low-cost stream gauges at the right locations allowed first estimates for major parts of the water balance
- Groundwater renewal rate is much below estimated groundwater extraction
- Considerable volume of water discharges to the ocean

- Measures to hold and delay discharge are needed, for example more small-scale reservoirs and infiltration enhancement in the upper catchment
- Further investigations are needed to plan such measures locally, and to support the management of water resources with whole catchment view
- Establishing and maintaining a representative monitoring is essential

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