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University of Victoria

Finding integrated SDG pathways for the Indus River Basin

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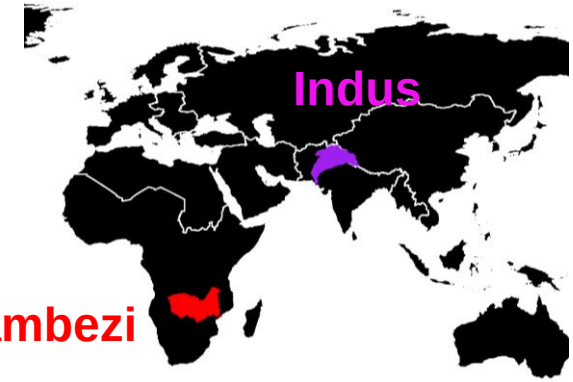
Scenarios Forum: Sub-national scenarios for integrated modeling and analyses
March 12, 2019, University of Denver, United States

Context:
Integrated Solutions for the Water-Energy Land Nexus Project

- 3-year initiative funded by GEF and UNIDO (1-year remaining)
- Focus on model development, stakeholder engagement and capacity building
- Case studies in the Indus and Zambezi basins



Nexus challenges for the Indus basin

Water, land and ecosystems

- Transboundary disputes
- Complex canal and irrigation system
- Very little flow reaches the sea
- Groundwater depletion
- Lack of wastewater treatment and storage

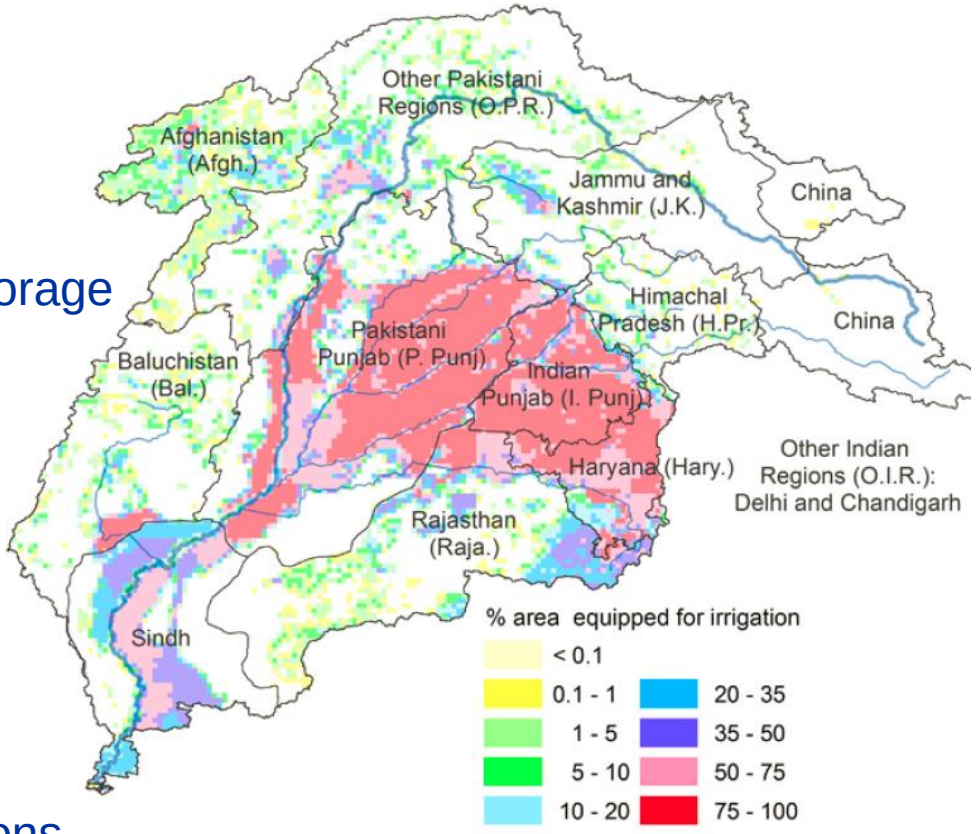
Energy systems

- Electricity can be unreliable
- Planned expansion of coal
- Hydropower generation

Livelihoods

- Employment impacts of transformations

Laghari and others (2012)



Research Question

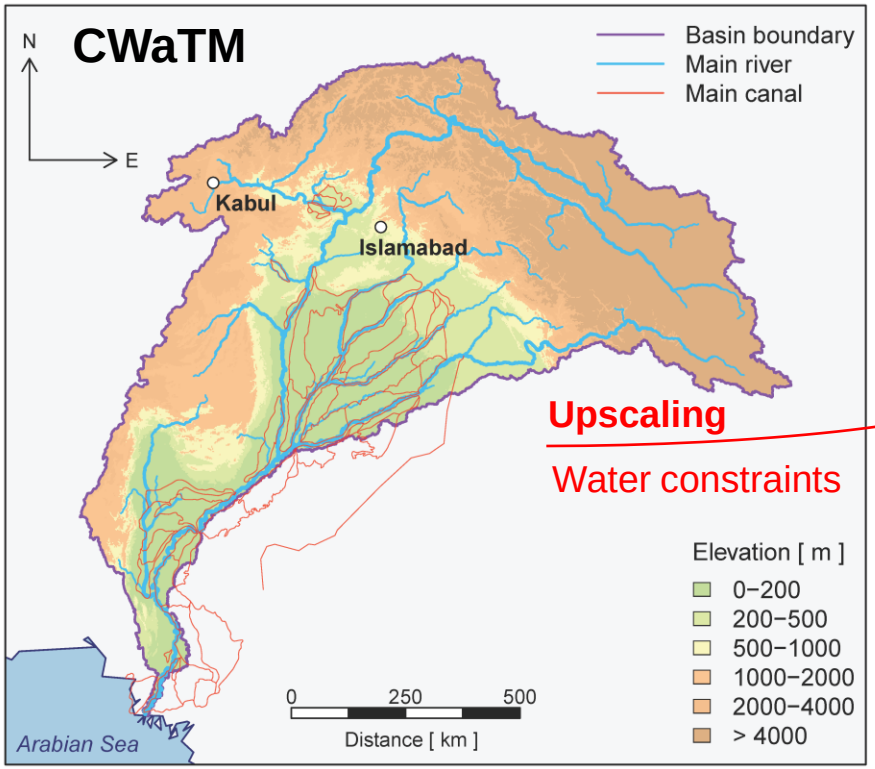
How to strike a balance between objectives?

… and at what cost?

SDGs

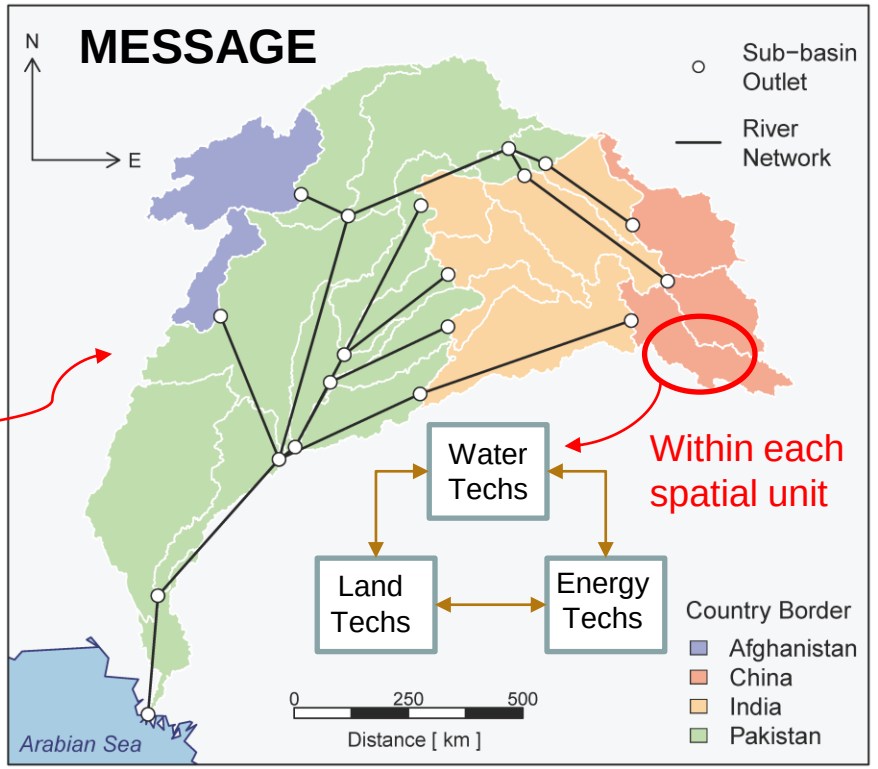
Transboundary Agreements

Multi-scale modeling for transforming systems

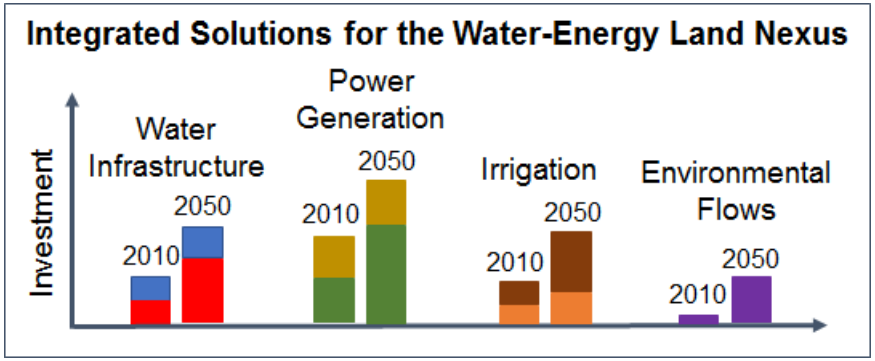


Upscaling

Water constraints



Downscaling
Water and land-use



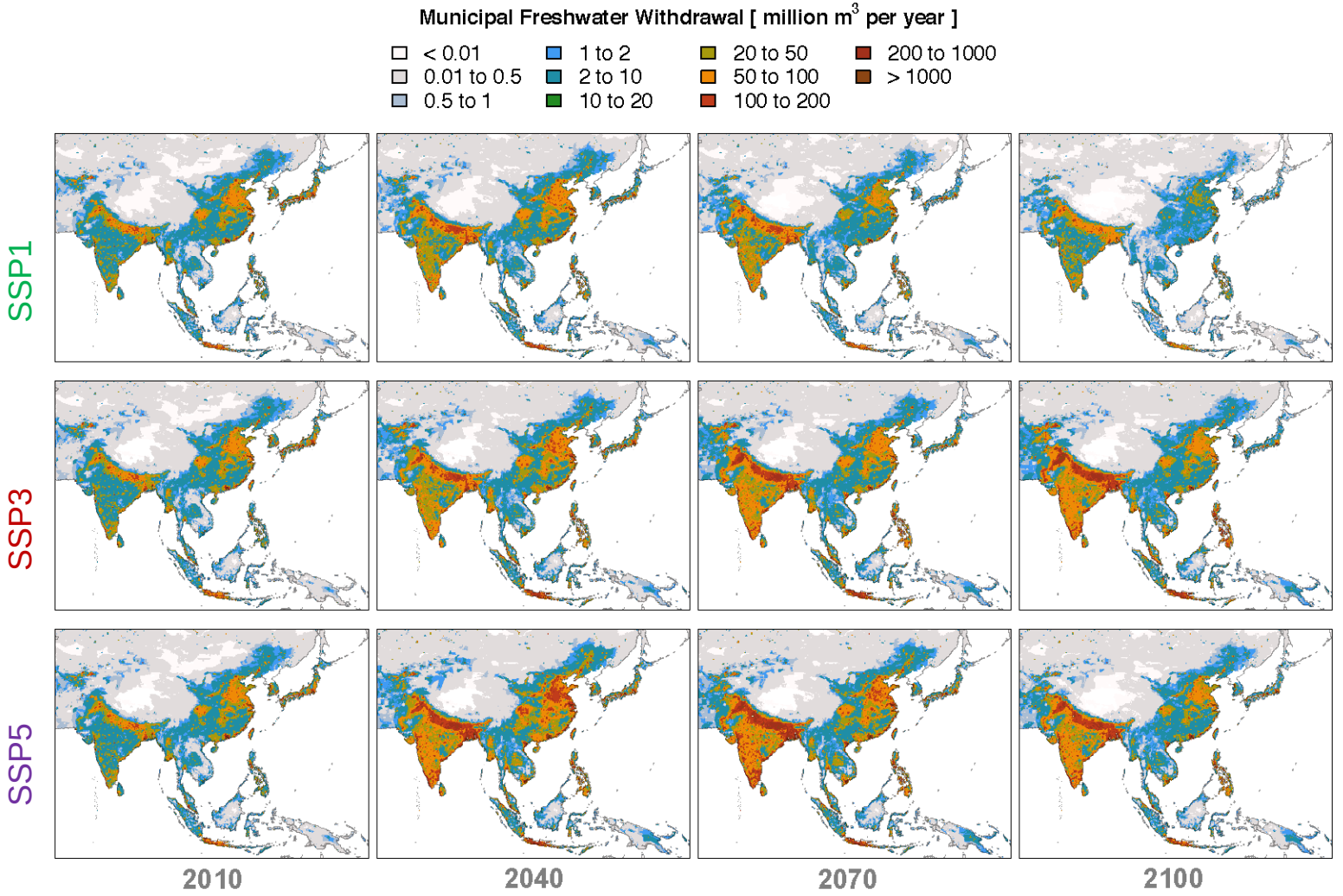
Multi-criteria optimization: Capacity and operation of technologies

Vinca et al., (forthcoming)

Constructing integrated SDG scenarios using the SSP-RCP framework

- **RCP narrative**
  - *Locks in*
    - climate impacts to demands and resources
    - mitigation level
- **SSP narrative**
  - *Locks in*
    - demand drivers (pop, urbanization, GDP)
    - Baseline infrastructure access levels
    - Budgetary constraints
- **SDG narrative**
  - *Locks in:* additional policies

Projecting infrastructure demand under clean water goals



Sustainability
Low population
Low demand
High-tech

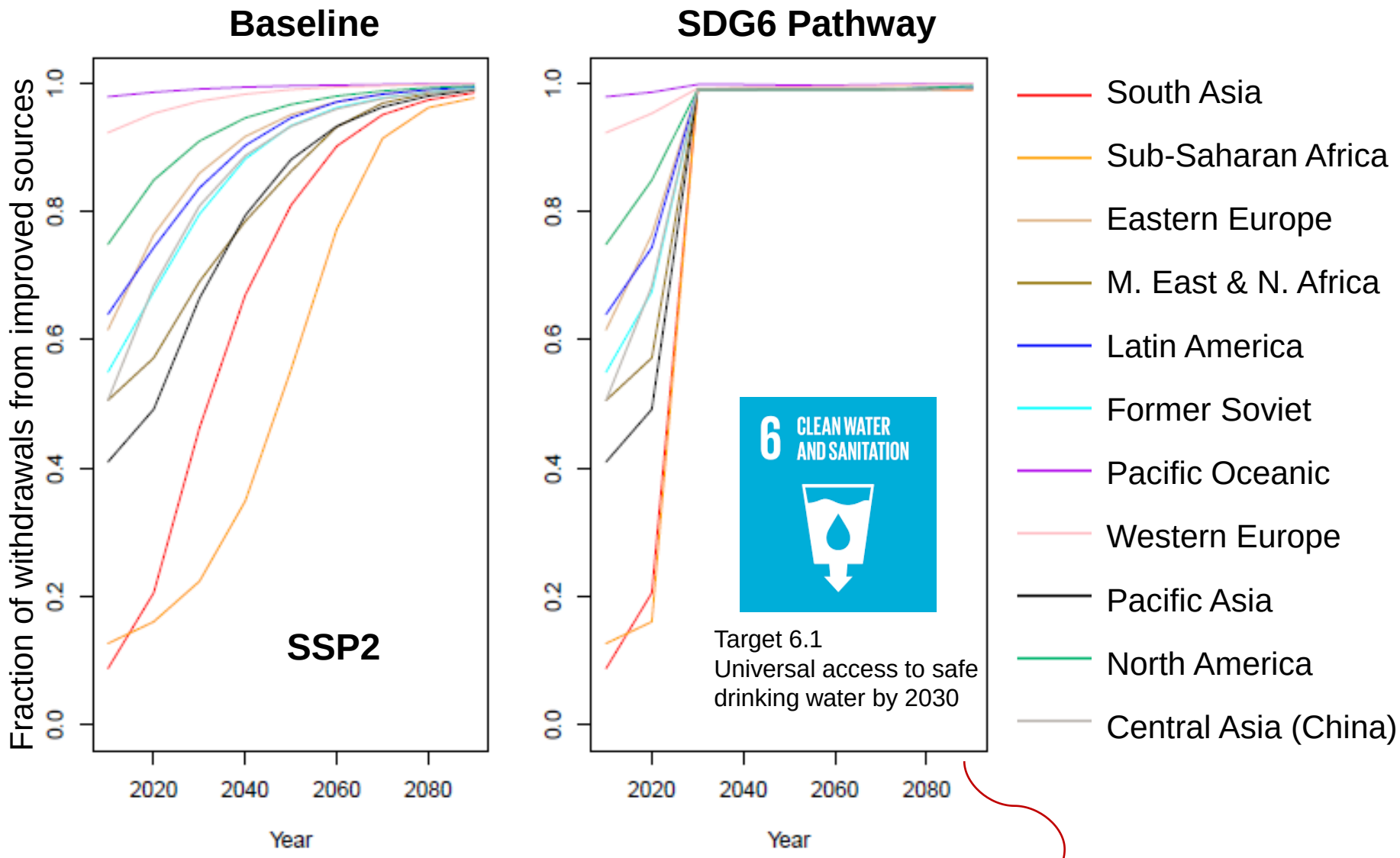
Regional Rivalry
High population
Medium demand
Low-tech

Fossil fuel
Low population
High demand
High-tech

Spatially-explicit municipal water withdrawal modeling for different socioeconomic scenarios

S Parkinson, et al. *Environmental Modelling & Software* (2016)

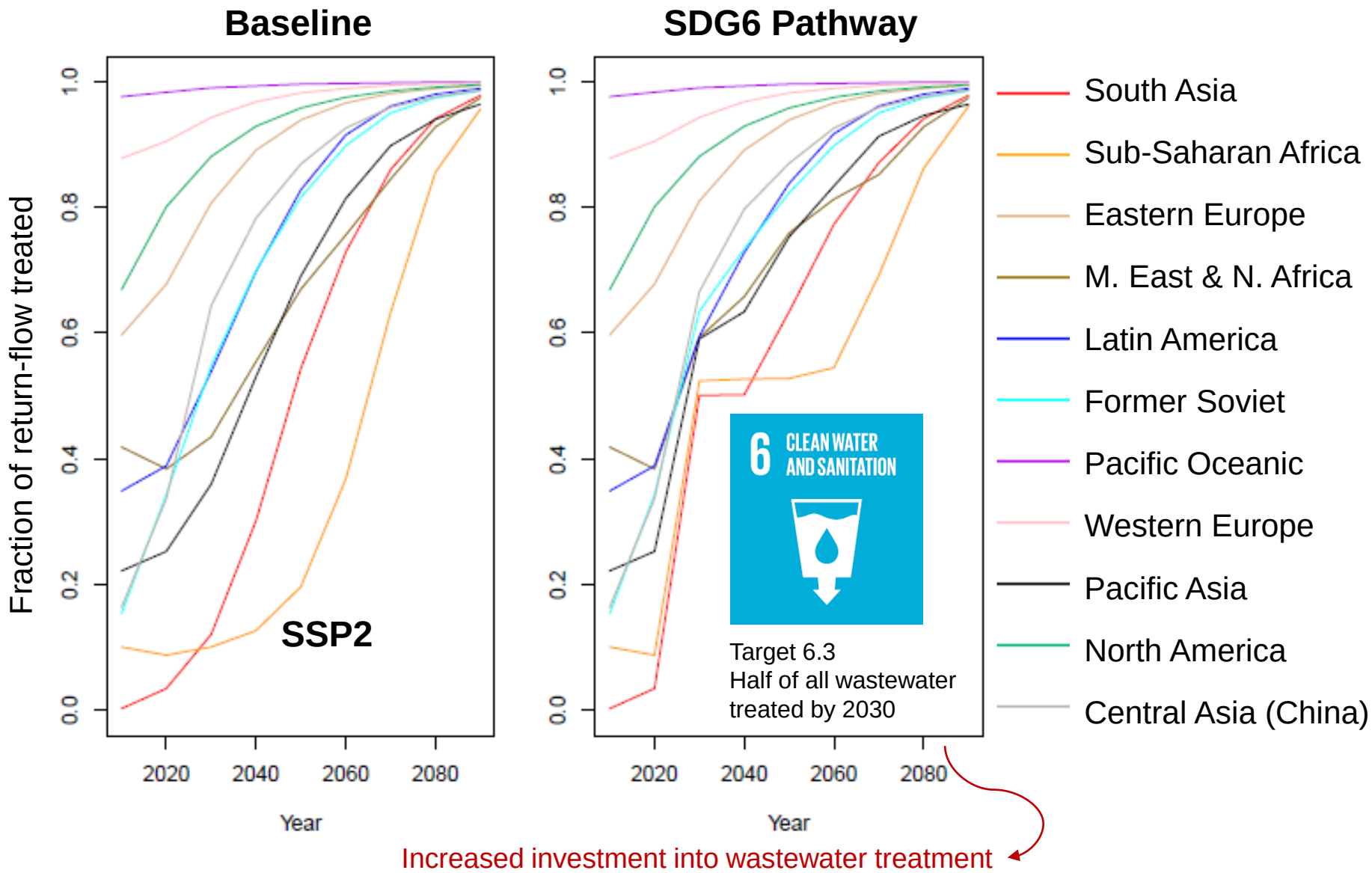
Access to piped water infrastructure under different scenarios



Increased investment into water distribution and wastewater collection

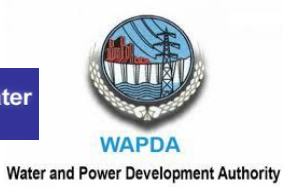
S Parkinson, et al. *Environmental Research Letters* (2019)

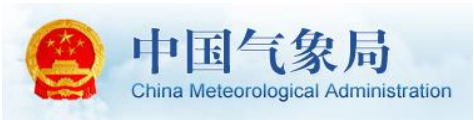
Access to wastewater treatment under different scenarios



S Parkinson, et al. *Environmental Research Letters* (2019)

Calibrating sub-national scenarios: Stakeholder Engagement

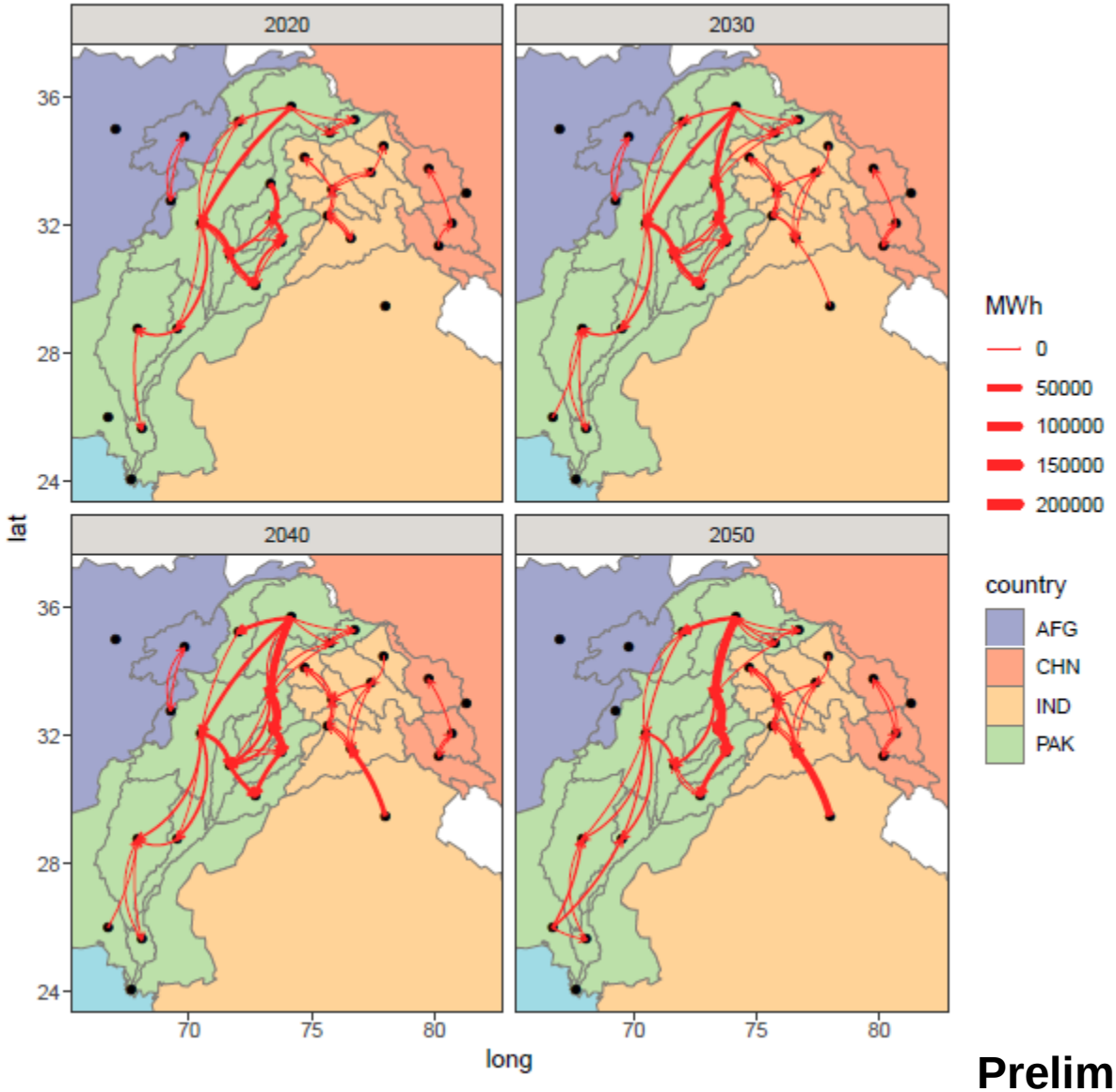




Tracking basin-wide investments

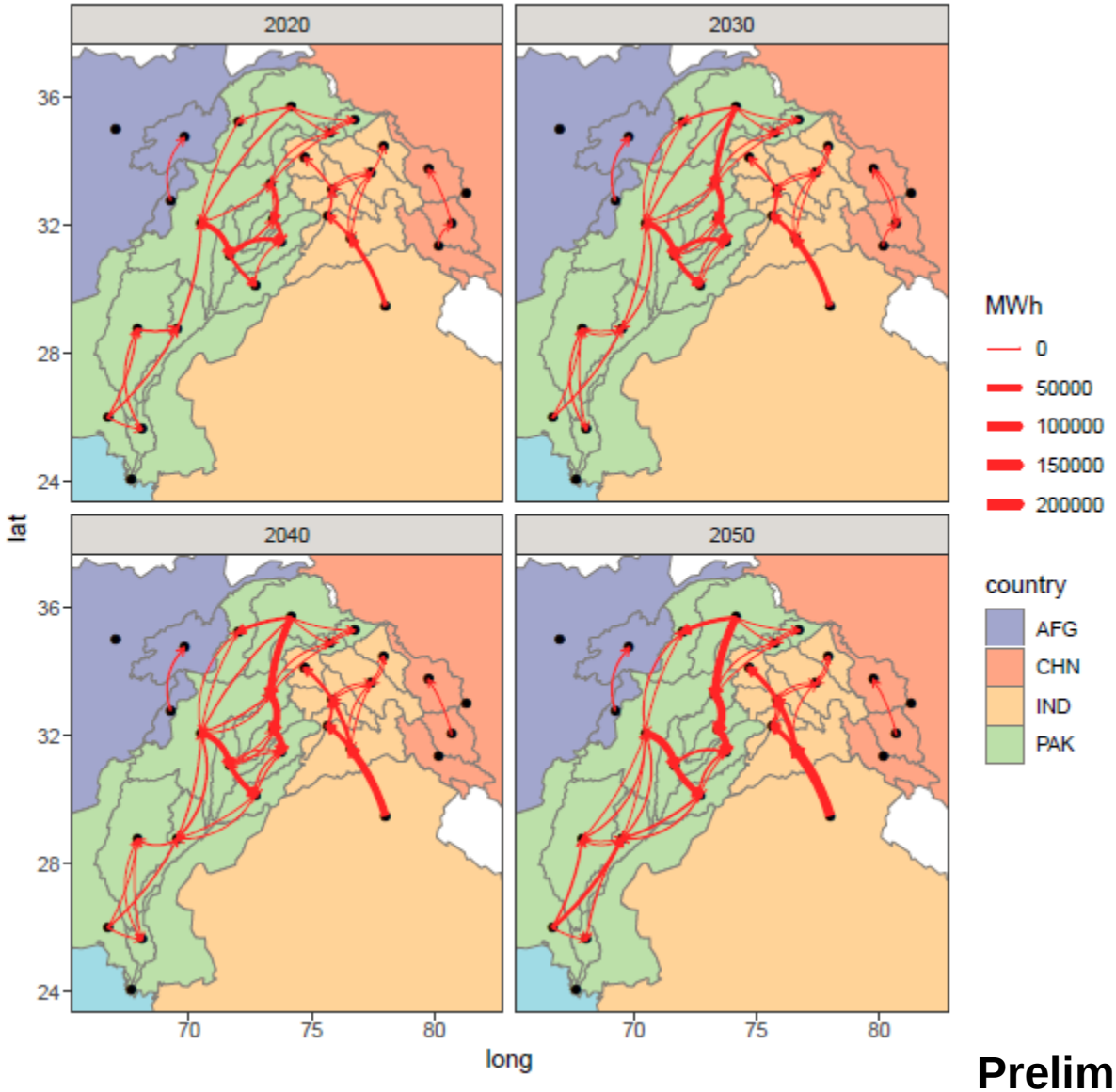
Preliminary Results
Do not cite or quote

Tracking electricity flows - Baseline



Preliminary Results
Do not cite or quote

Tracking electricity flows - SDG



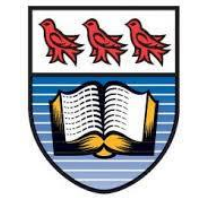
Preliminary Results
Do not cite or quote

Conclusions

- **Nexus approach key to quantifying adaptation challenges associated w*/* SSPs**
  - *Linking of earth system and economic models at high spatial resolution to quantify dynamic constraints on water, energy and land resources*
  - *Joint optimization of synergies and tradeoffs across the nexus*
  - *Challenge: models projecting future hydro-climatic conditions are highly uncertain*
- **Application to the Indus Basin**
  - *Investment costs to achieve multiple SDGs*
  - *New insights into adaptive measures across sectors*

Thank you!

Collaborators from around the world



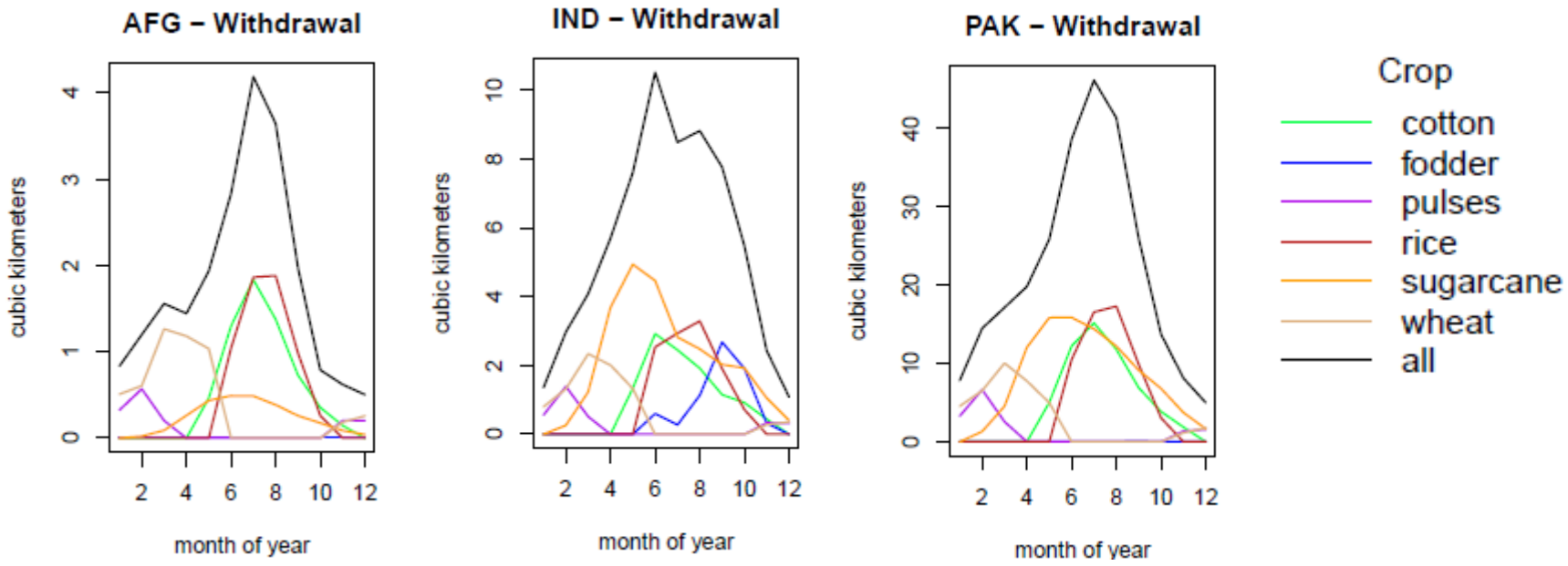
EXTRA

Input data

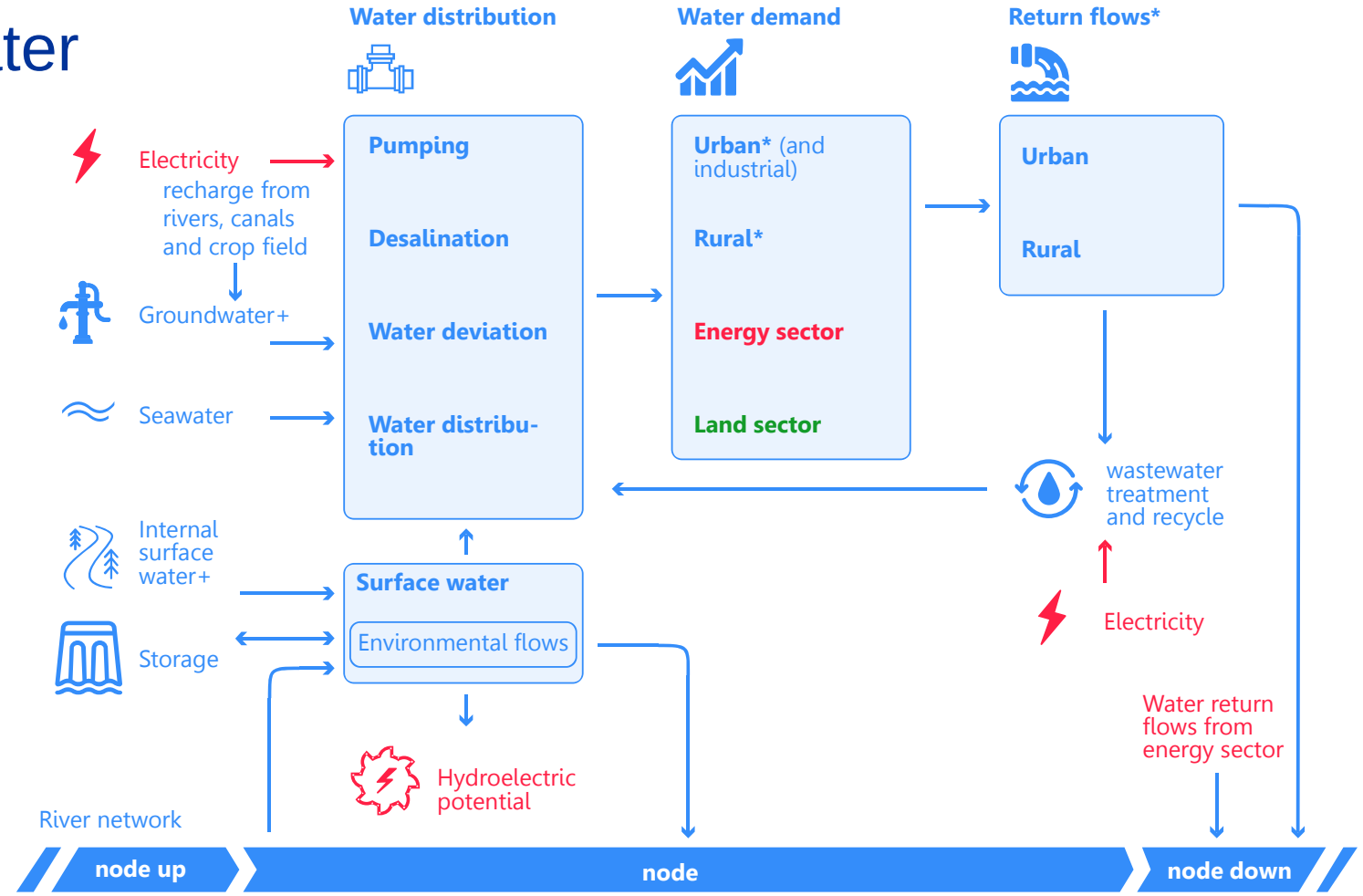
Mapping infrastructure, potentials and policies

- ✓ Power generation (existing and planned)
- ✓ Transmission and road networks
- ✓ Groundwater pumping capacity
- ✓ Wind, PV and hydropower potentials
- ✓ Urbanization pathways
- ✓ Irrigation intensity
- ✓ Indus water treaty allocations
- ✓ Reservoirs (existing and planned)
- ✓ Urban water transfers (e.g., Karachi)
- ✓ Algorithms for model integration

Monthly irrigation withdrawals calibrated for 2015

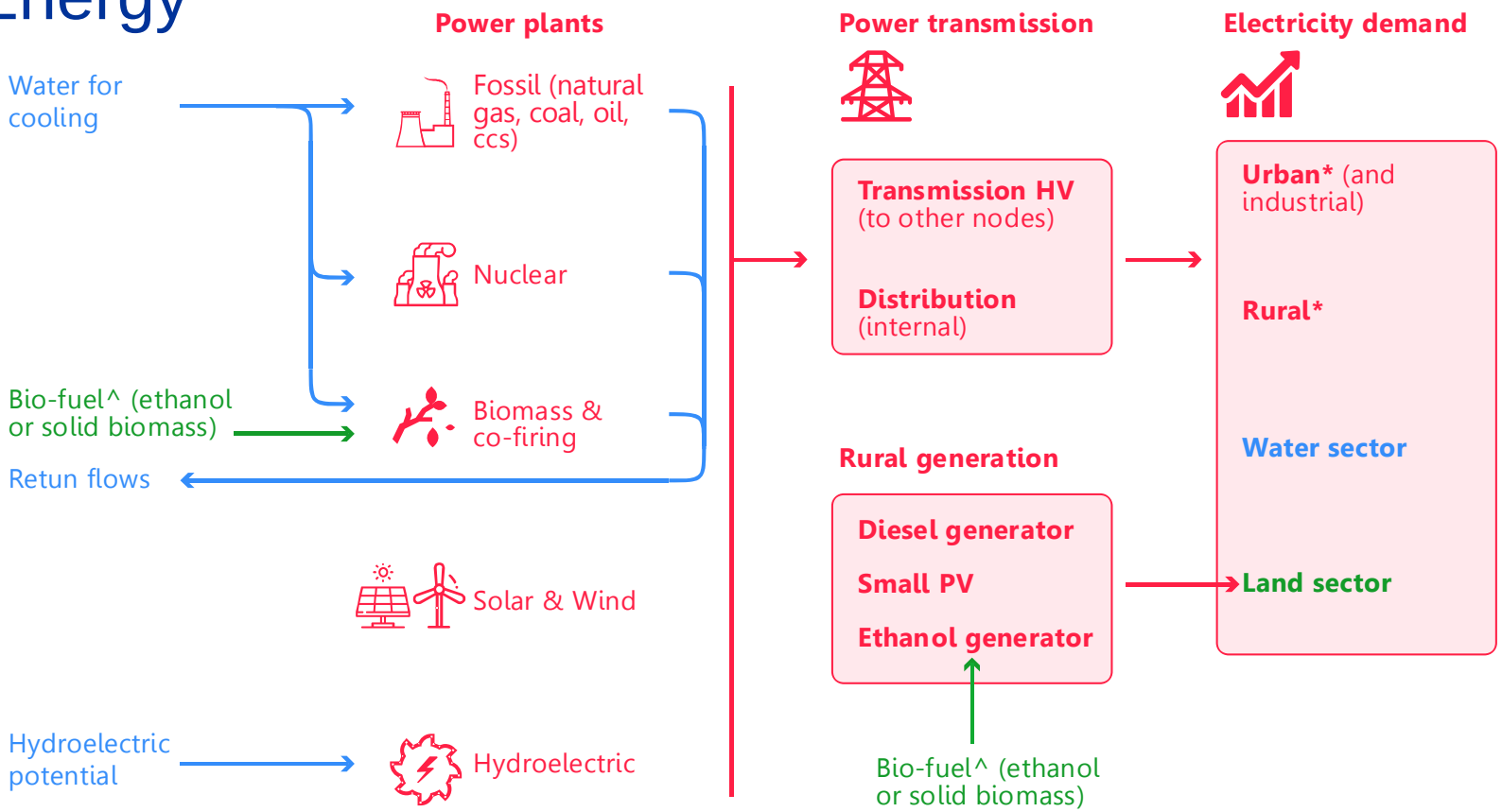


Water



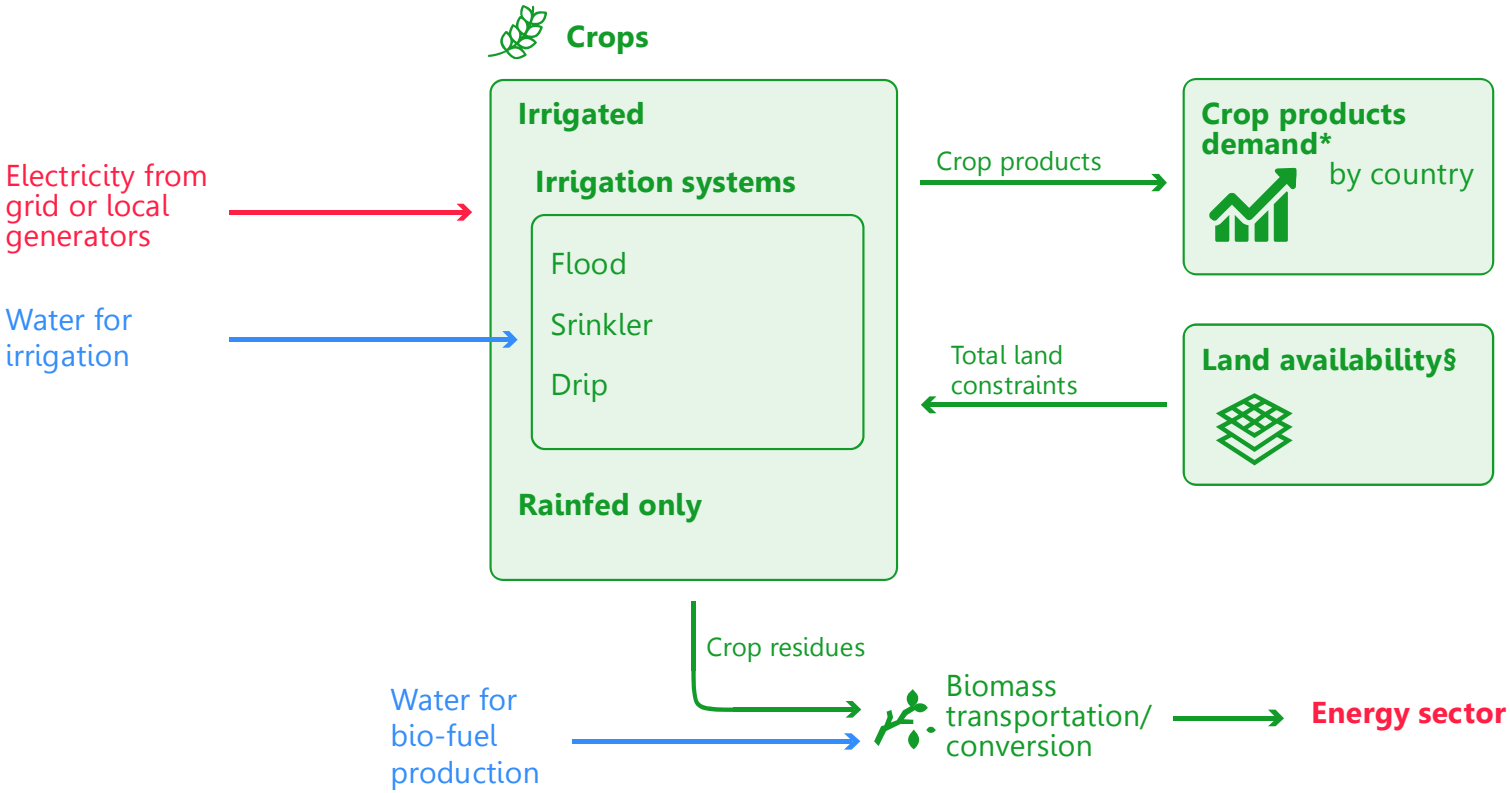
* exogenous
\+ limints are imposed based on information from hydrolocial model

Energy



* exogenous
^ crop residues can be transported as solid biomass or converted in ethanol, technolgies not represented here

Land



* exogenous.
§ total available area for agriculture based on historical data