

# MESSAGE-basin Model applied to Indus

*Indus Basin Knowledge Forum, June 2018*



# Overview

- Contestualization
- MESSAGE*ix*
- MESSAGE-basin
- Progress
- Next steps

# Research Objectives

## Develop new nexus tool to identify sustainable development pathways at the river basin-scale

- Balances human development and environmental objectives
- Integrates water and energy infrastructure planning
- Incorporates key global change processes in the assessment of resource availability
- Interacts with global tools used to provide international market and policy guidance
- Incorporates key regional and local indicators from stakeholders
- Addresses issues and provides results for the whole basin

# Prioritized nexus challenges for the Indus basin assessment

## Water and land

- Complex canal and irrigation system
- Groundwater depletion and water storage
- Lack of wastewater treatment
- Burning of crops leads to air pollution
- Very little flow reaches the sea

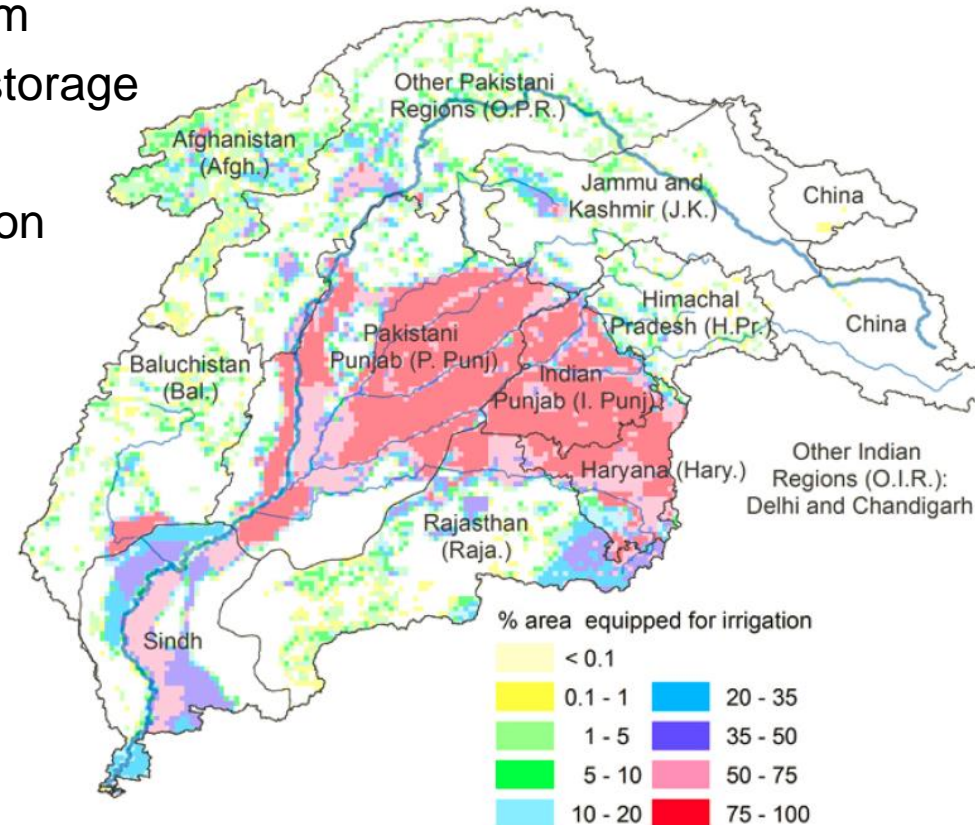
## Energy systems

- Electricity can be unreliable
- Electricity can be too cheap
- Air pollution and GHGs increasing
- Hydropower generation

## Livelihoods

- Transformations and employment impacts

## Laghari and others (2012)



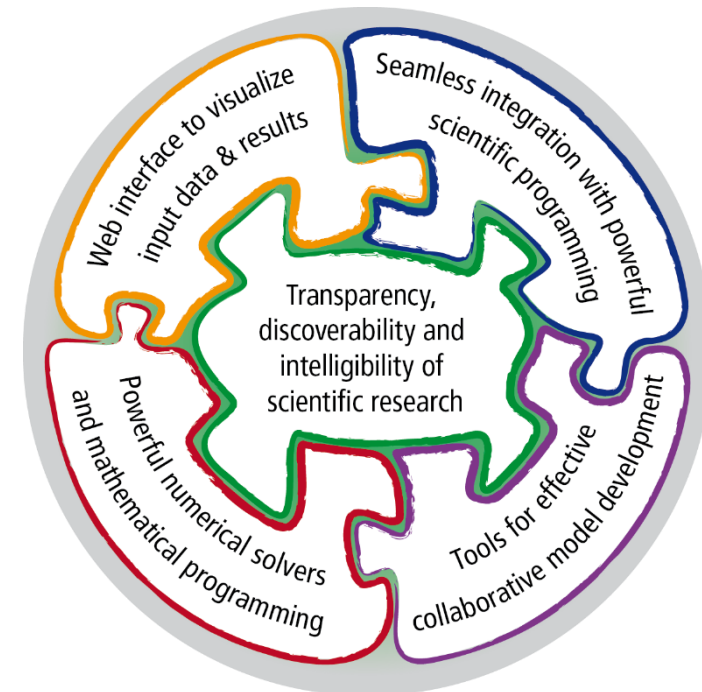
# MESSAGEix framework

## Why using the MESSAGEix framework?

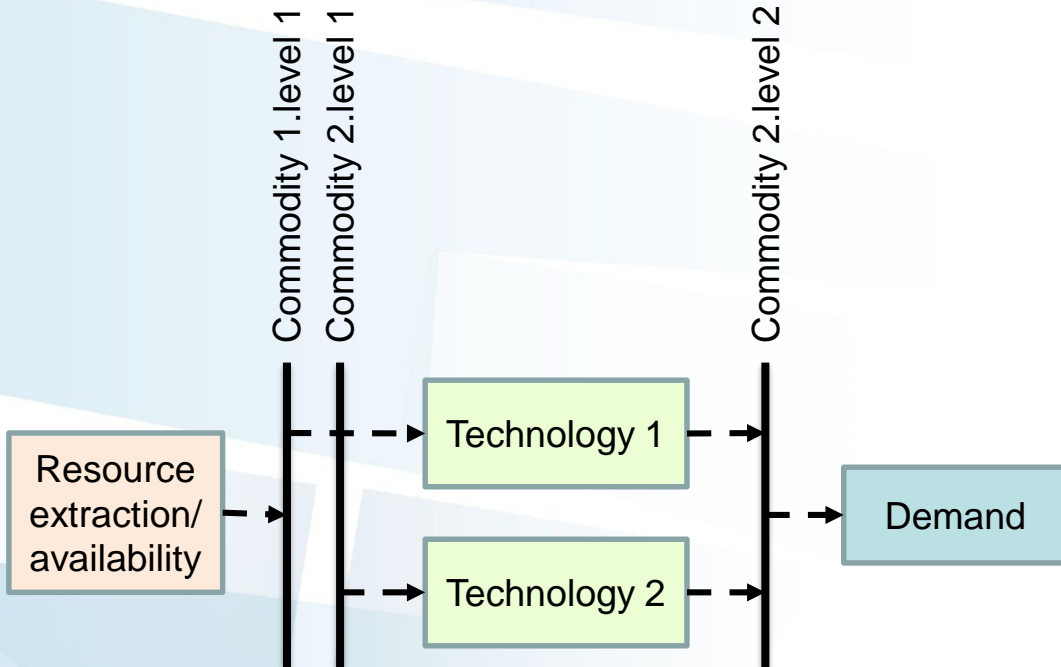
- Well consolidated
- Open source: sharing, capacity building
- Online IIASA scenario database
- Prerequisites for transferability

## Possible future opportunities

1. Application of the model to other basins
2. Multi-basin analysis
3. Nesting basin model with the MESSAGEix global model



# MESSAGEix: basic concepts



Optimization variables associated to each technology:

**CAPACITY** → Investment cost  
**ACTIVITY** → Fixed and variable costs

Linear optimization model

- minimization the **total system costs**
- **Commodity balance** with demand



# MESSAGE-basin: Indus

## An *integrated tool* for nexus analysis

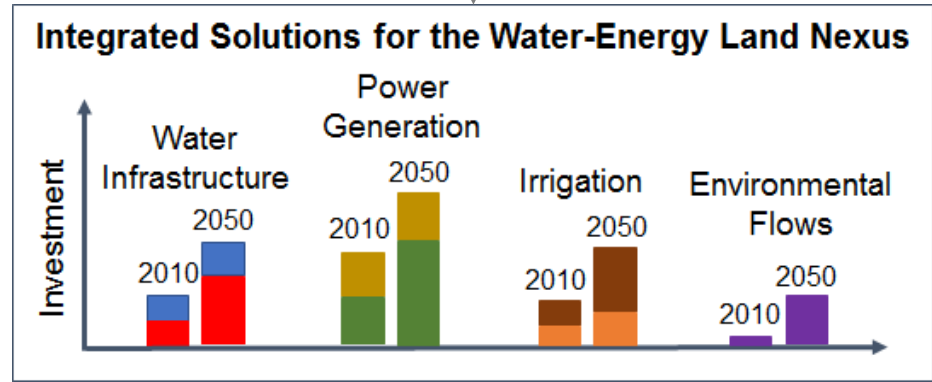
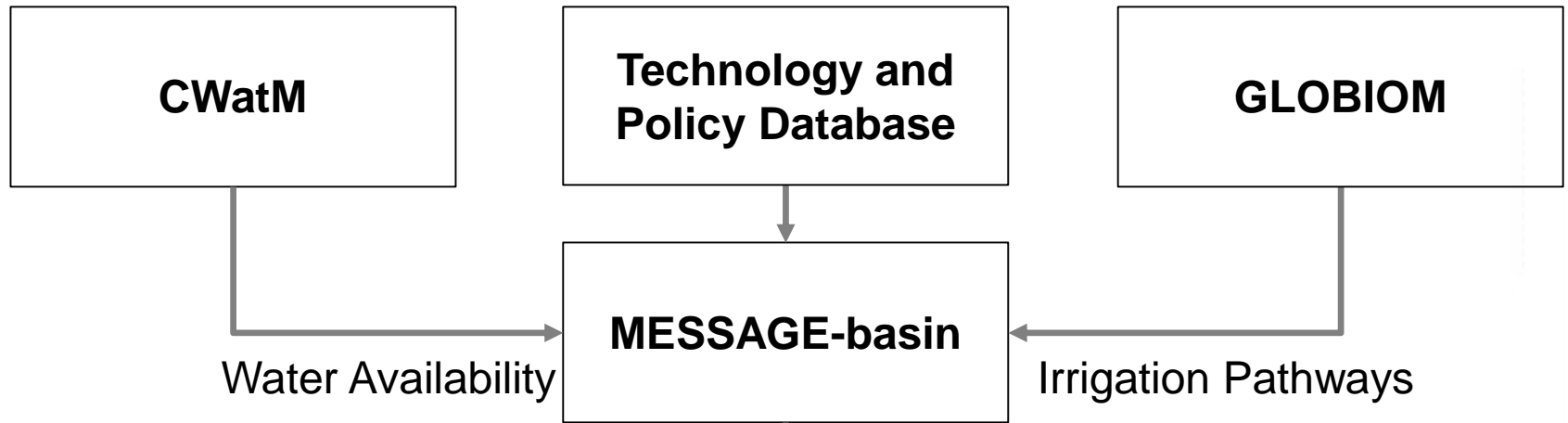
### Key features

- Focus on medium- to long-term technological pathways
- Optimization of technology size (capacity), location and inter-linkages between technologies
- Technology output optimized to meet varying demands and resource constraints through time
- Computes economic and environmental impacts of technologies and policies

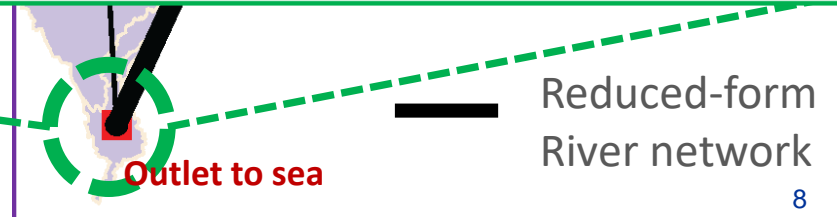
### Novelties of MESSAGE-basin

1. Co-optimization of water and energy technologies
2. Linkage to land-use and hydrological modeling
3. Flexible approach for application in other regions

# Integrated water-energy systems modeling

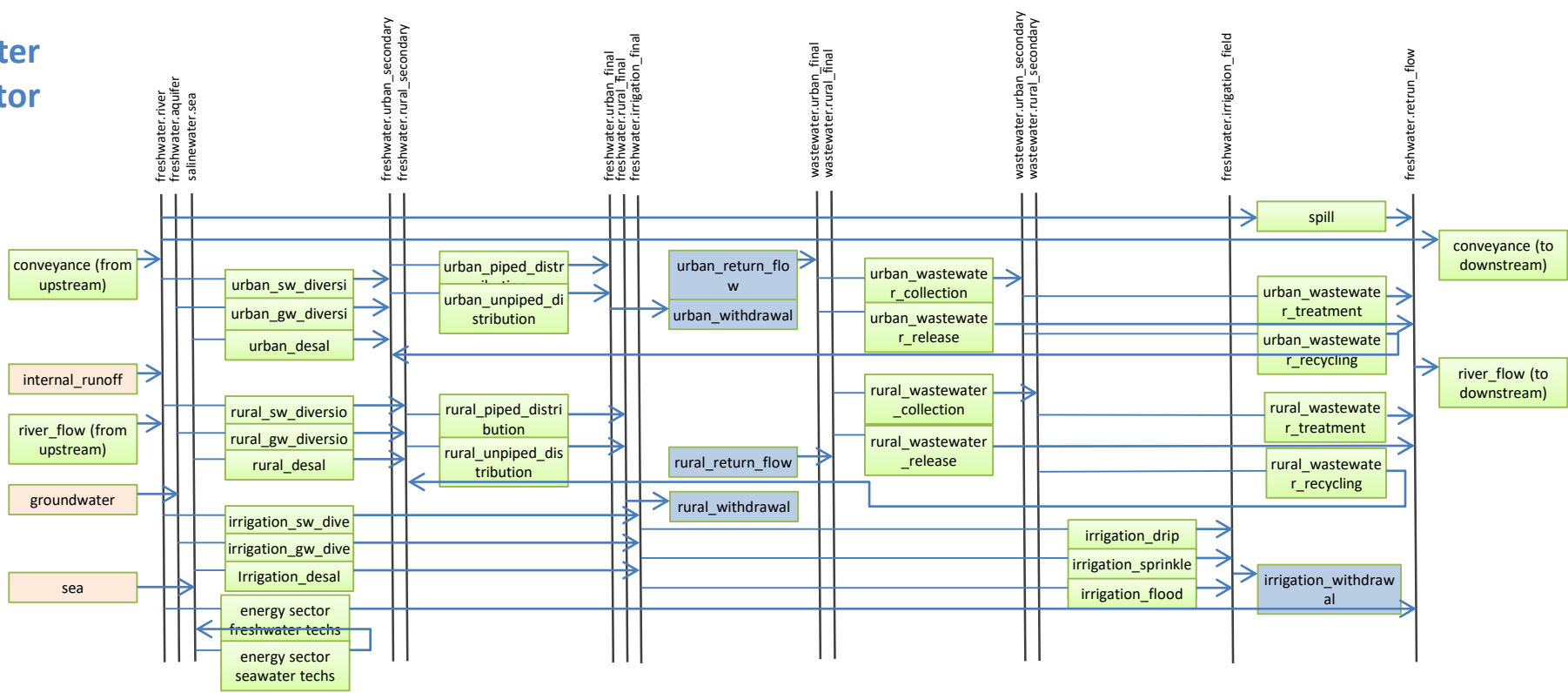


*Optimal system transformations under combined policy objectives*





# Water sector



**Legend**

- Fixed Demand
- Resource Extraction
- Technology

commodity.level

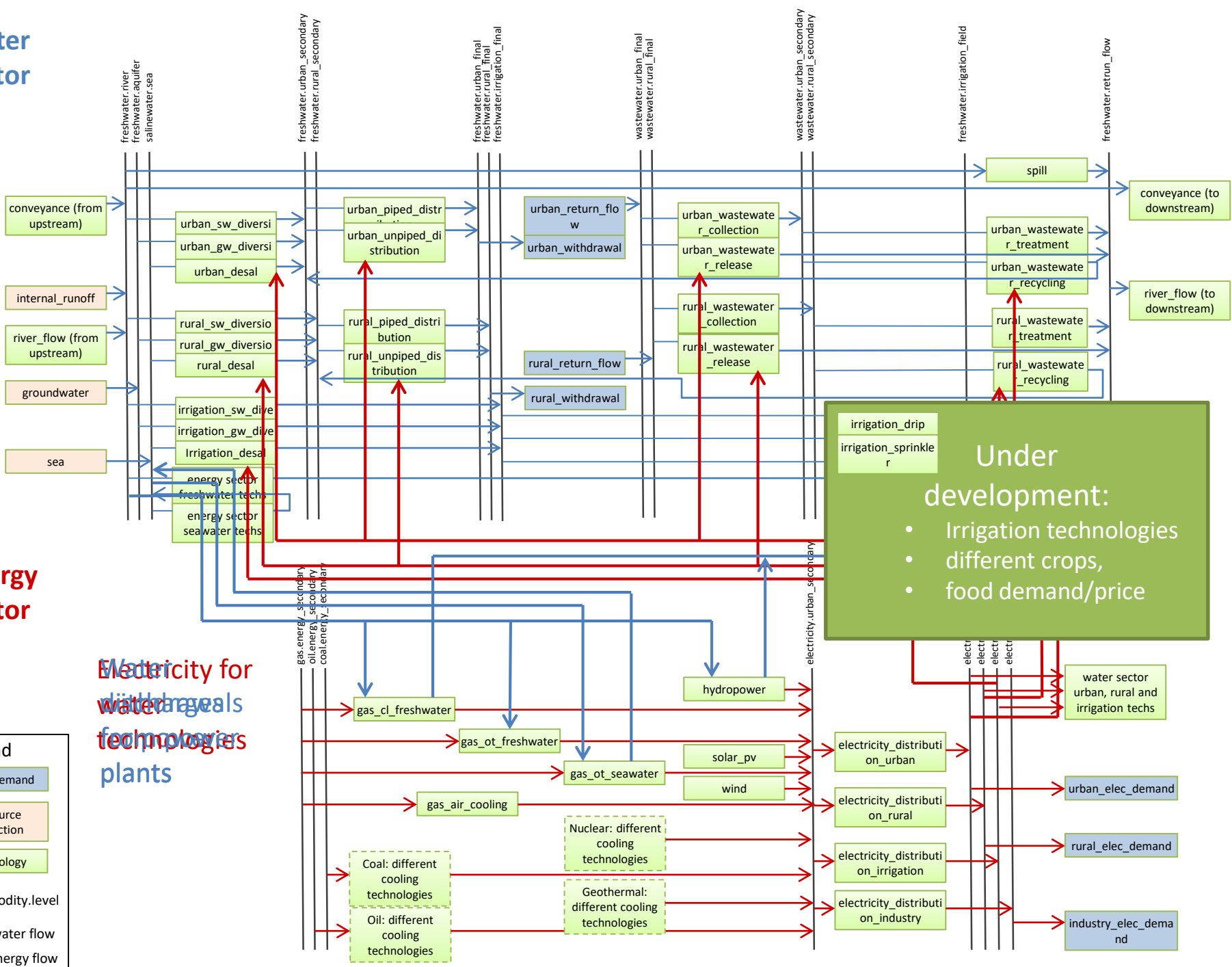
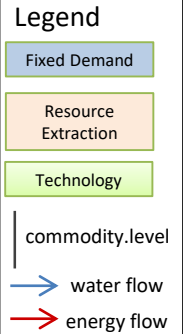
→ water flow

→ energy flow

# Water sector

# Energy sector

Water for  
little  
plants



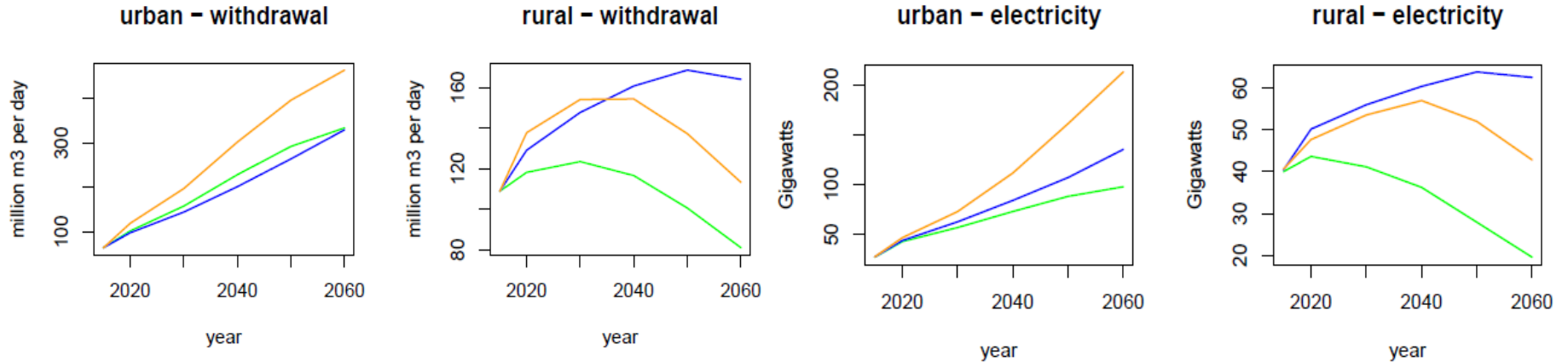
# Progress to date

## Mapping infrastructure, potentials and policies

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

## Urban and rural water withdrawal and electricity demand

— SSP1 — SSP2 — SSP3



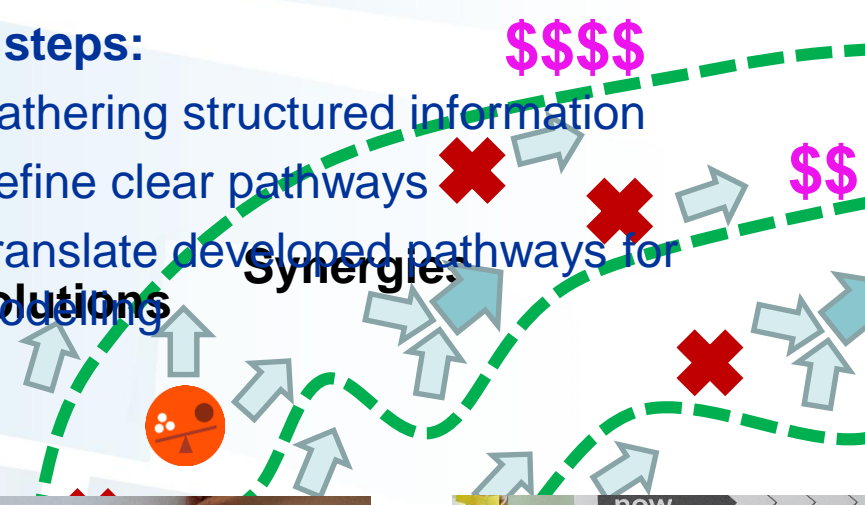
# Sustainable Development Pathways

## Next steps:

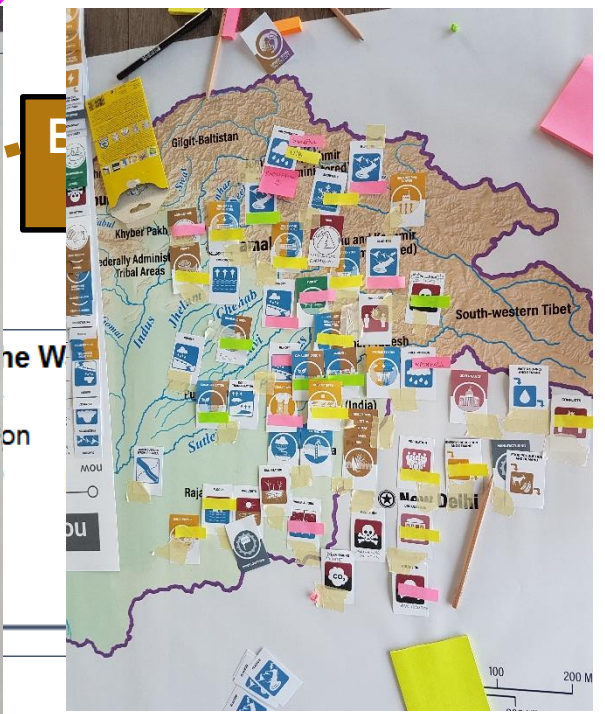
- Gathering structured information
- Define clear pathways
- Translate developed pathways for

**Solutions**

**Synergies**



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# Next Steps

## *Finalizing model inputs*

- Mapping the irrigation canal system
- Calibrate to most recent data
- Establishing a formal linkage with the global models

## *Capacity building*

- Visiting PhD students from the Indus (YSSP Program)
- Provincial planning agencies
- Online platform for sharing model and results

**Questions?**