

# Water and water-human interactions - overview of the IIASA Water group research

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Water Security Research Group

International Institute for Applied Systems Analysis (IIASA)

A presentation for the IIASA-Israel Symposium on  
Sustainability Pathways empowered by Systems Analysis

November 28 -29<sup>th</sup>, 2022, Tel Aviv-Yafo, Israel

# Agenda

- Who are we? The Water Security Research Group
- Tools and Models
- A few examples for ongoing and upcoming research projects
- Opportunities for collaborations
- Thank you!

# Water Security Research Group (WAT)

## Researchers



## Guest researchers



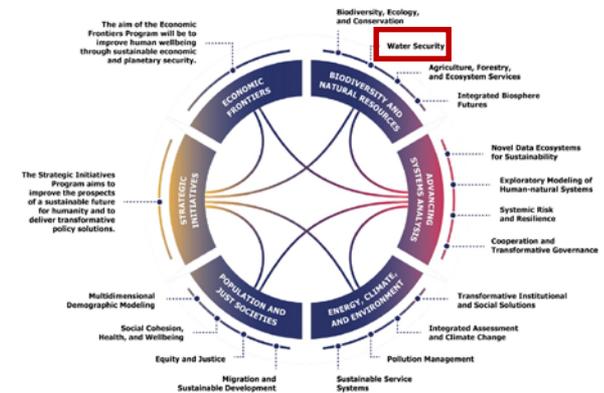
## IIASA Postdoc fellows



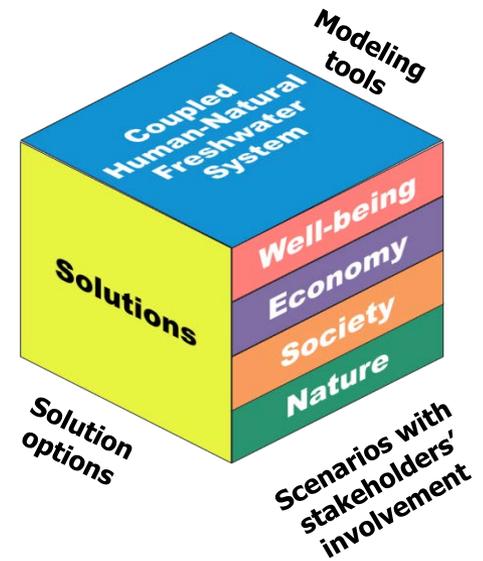
## Administration



- 17 full time equivalent staff members
- 17 nationalities

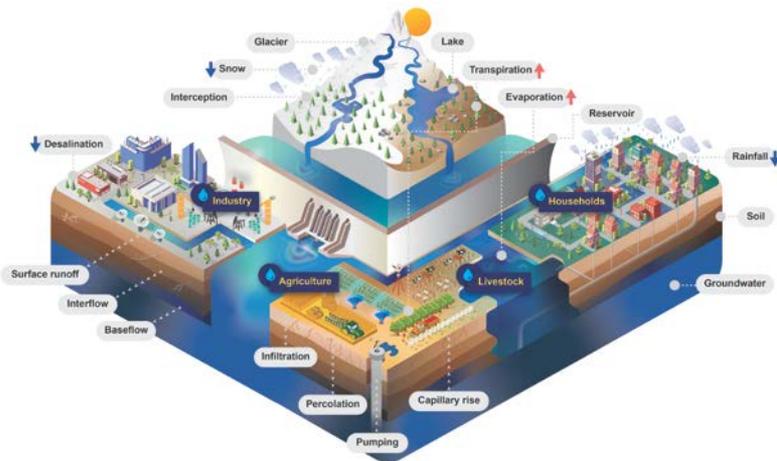


- Develops interdisciplinary approach for water connecting different sectors and scales.
- Develops and uses global to regional hydrological (quantity and quality) and hydro-economic modeling.
- Develops water future scenarios (e.g., Water-extended SSP scenarios, East African regional water scenarios) and assesses their implications on water resources.
- Engages with stakeholders for basin-level planning.
- Performs capacity development activities (models, simulation games).



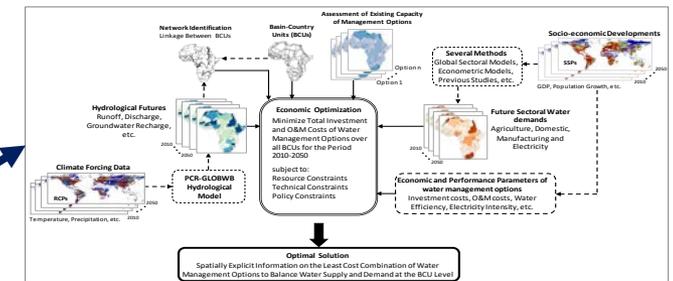
# Hydrological and hydro-economic models at the Water Security group of IIASA

**CWATM** (Community Water Model) for large-scale high-resolution hydrology



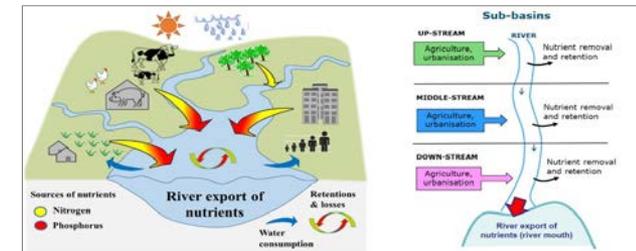
Hydrology  
Water Demand

**ECHO** (Extended Continental-scale Hydroeconomic Optimization model) to identify least-cost combination of solution options



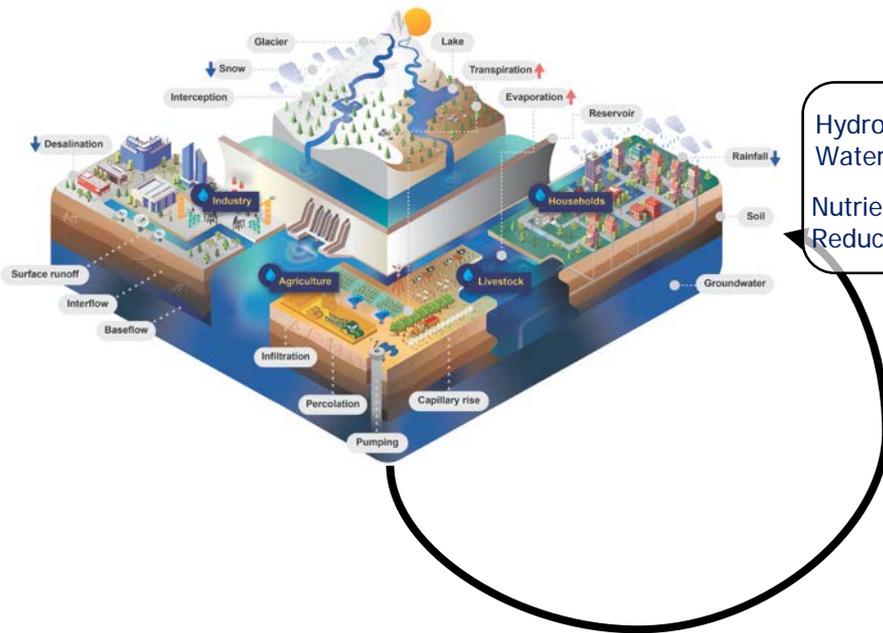
Nutrient load/concentrations  
Reduction targets

**MARINA** for nutrient export to rivers & sea



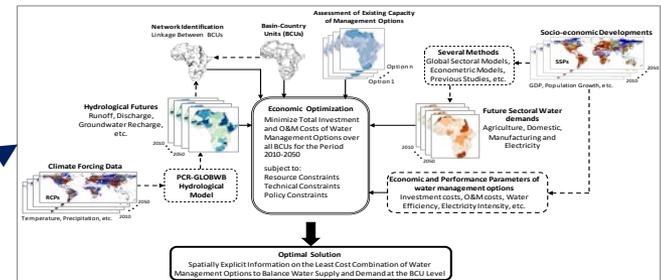
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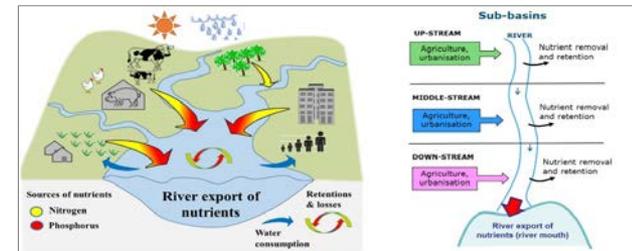
**CWATM-WQ** Incorporating water quality in the Community Water Model (Under development)

**ECHO** (Extended Continental-scale Hydroeconomic Optimization model) to identify least-cost combination of solution options



Nutrient load/concentrations  
Reduction targets

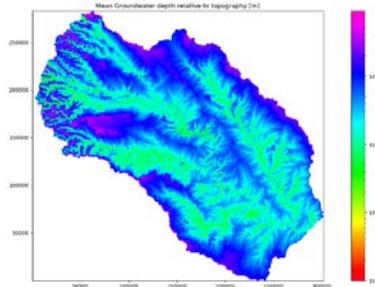
**MARINA** for nutrient export to rivers & sea



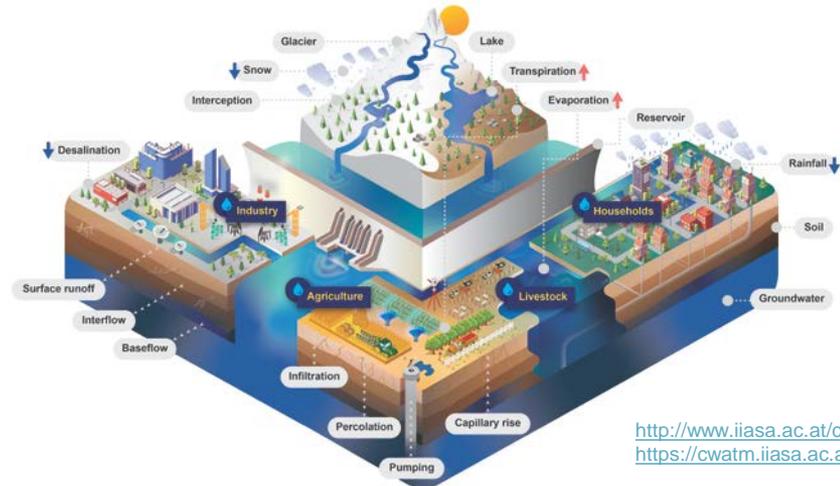
# CWatM Users and Applications

A growing community of users are utilizing the global (0.5°, 5') and regional (5', 30'') open-source and modular CWatM for extensive hydrological simulation at a daily time step.

**Bhima basin (India) [1km]**

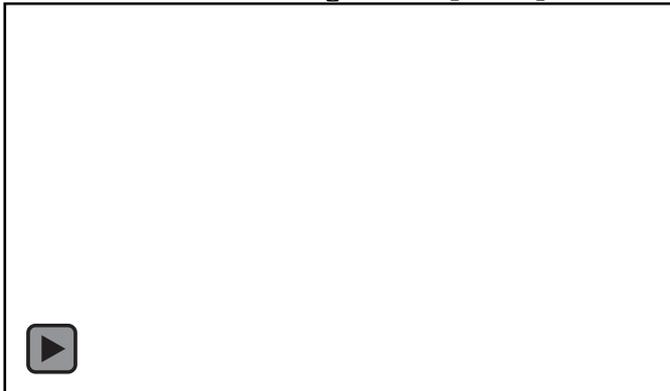


**Conceptual framework of CWatM**

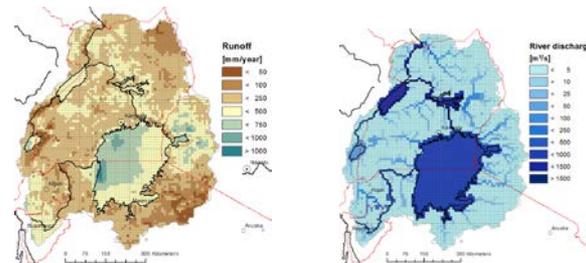


<http://www.iiasa.ac.at/cwatm>  
<https://cwatm.iiasa.ac.at/>

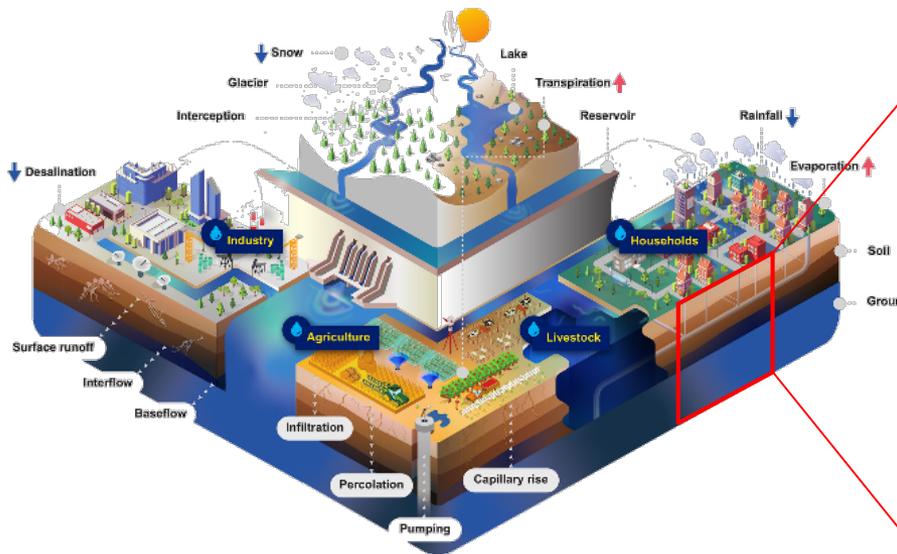
**Global discharge demo [50km]**



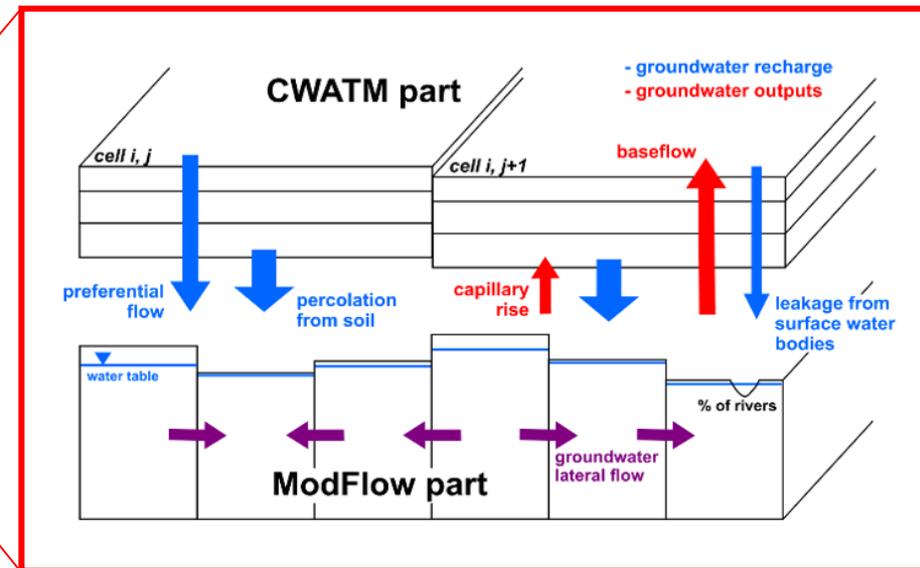
**Lake Victoria basin (East Africa) [10km]**



# CWatM-groundwater coupling at fine resolution for regional scale investigations



CWatM [1km-10km]

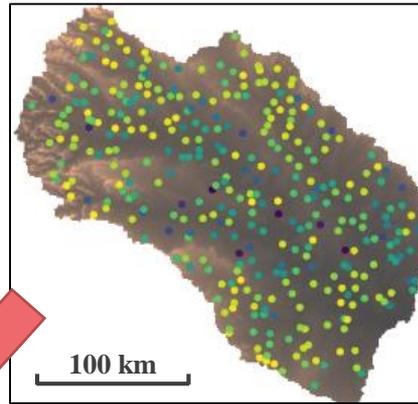


ModFlow 6 [ $< 1\text{km}$ ]

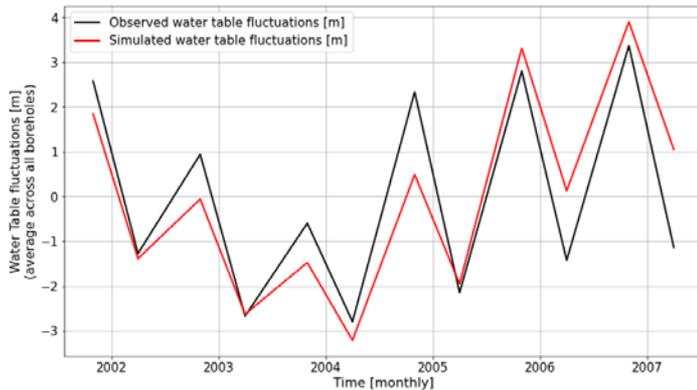
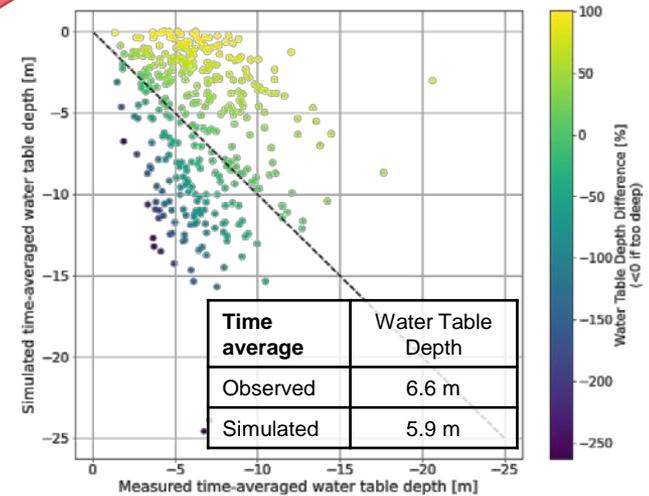
# Example of comparison between simulated and observed water table in boreholes (Bhima basin, India)



Location of the boreholes in the Bhima basin



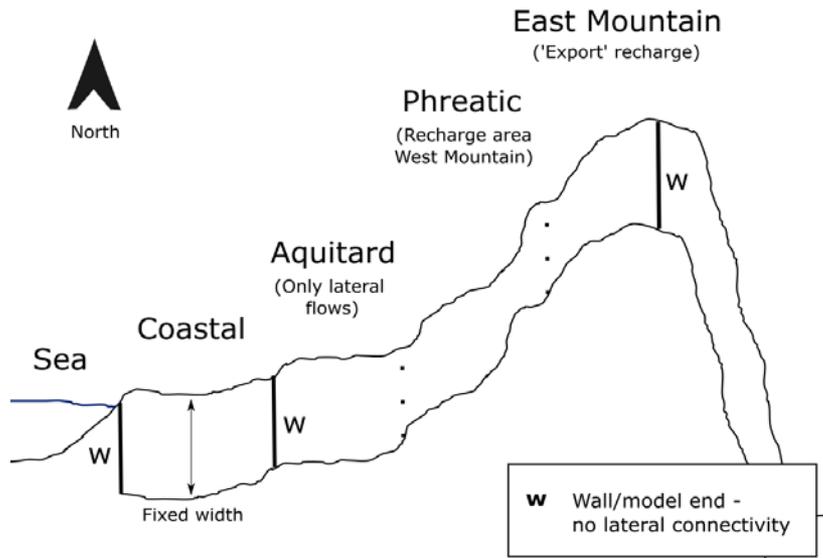
Time-averaged water table depth



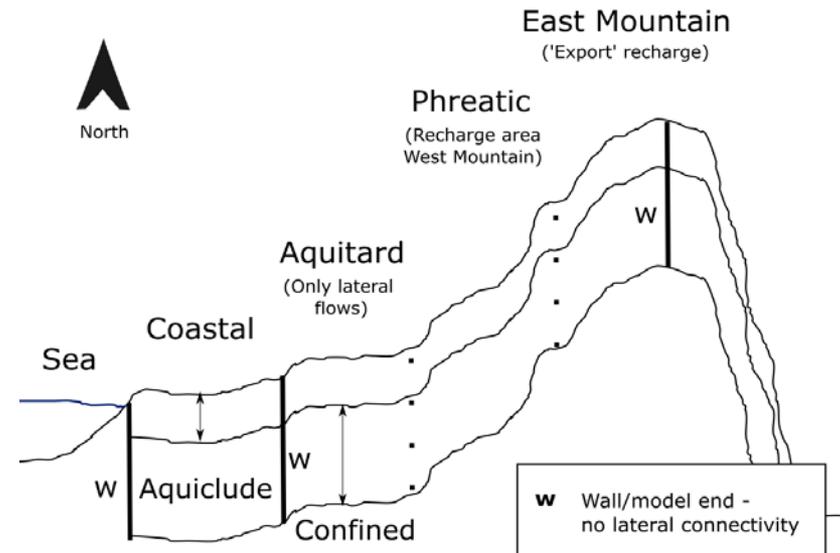
Water table time fluctuations

# A layered-aquifer CWatM-ModFlow Model

**CWatM-ModFlow  
(Israel)**

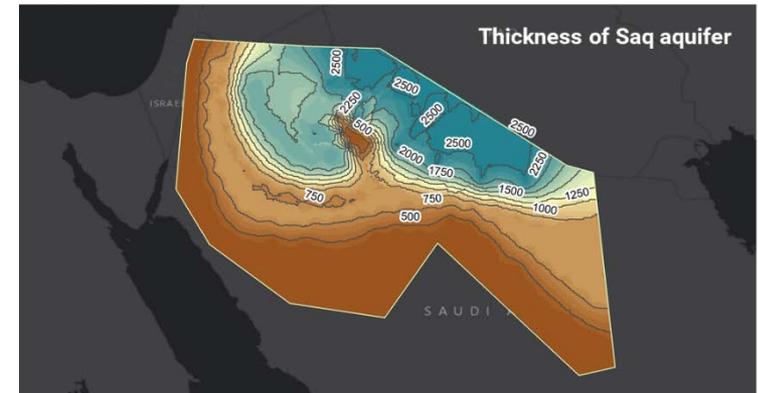
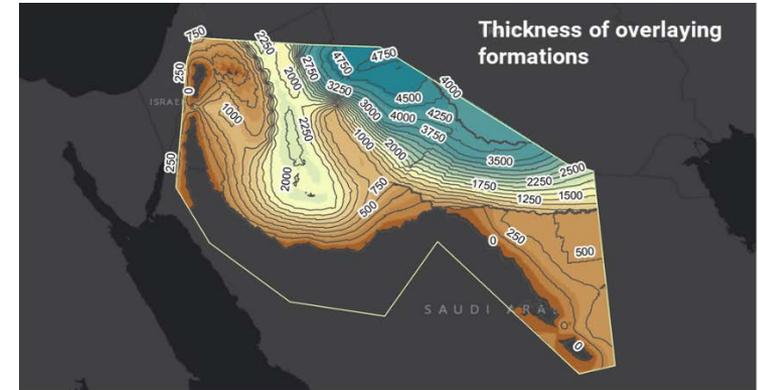
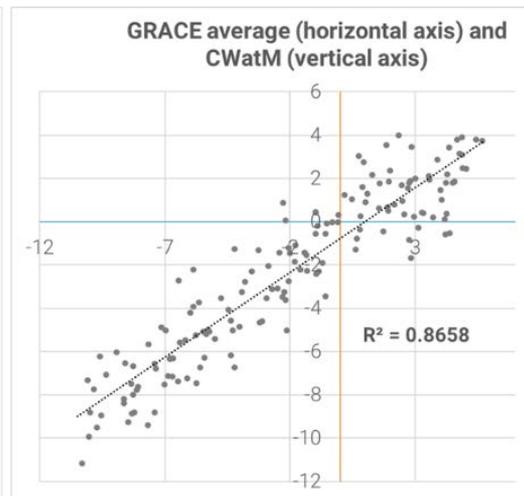
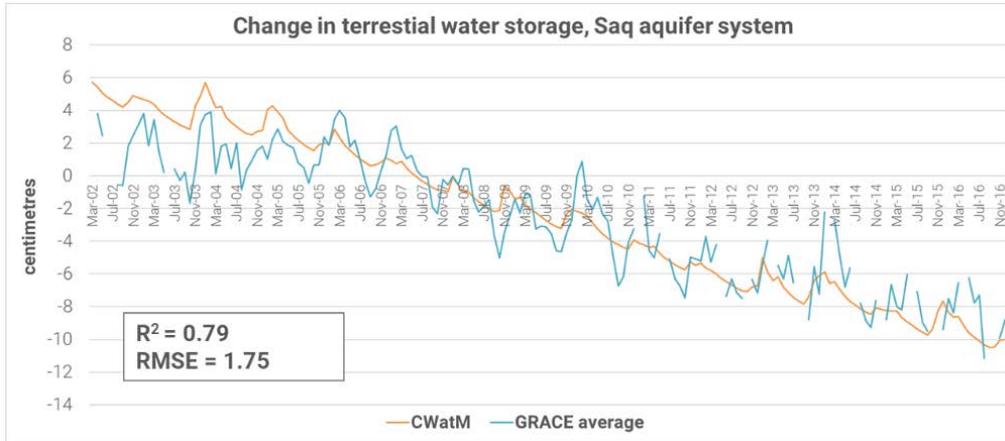


**In-development: Multi-layer aquifer  
(Israel)**



- A more realistic representation of the aquifer, including confined units.
- Allow vertical variations in hydraulic properties.

# A layered-aquifer CWatM-ModFlow Model



A layered model for the Saq Aquifer in Saudi Arabia and Jordan

# Coupled Agent based and Hydrological modelling (GEB v0.1)

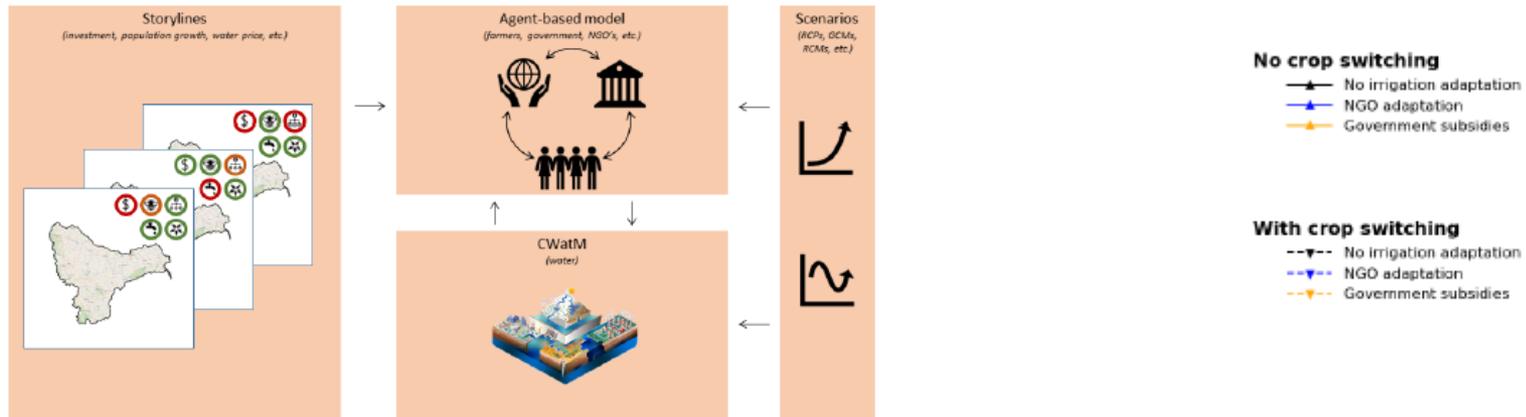
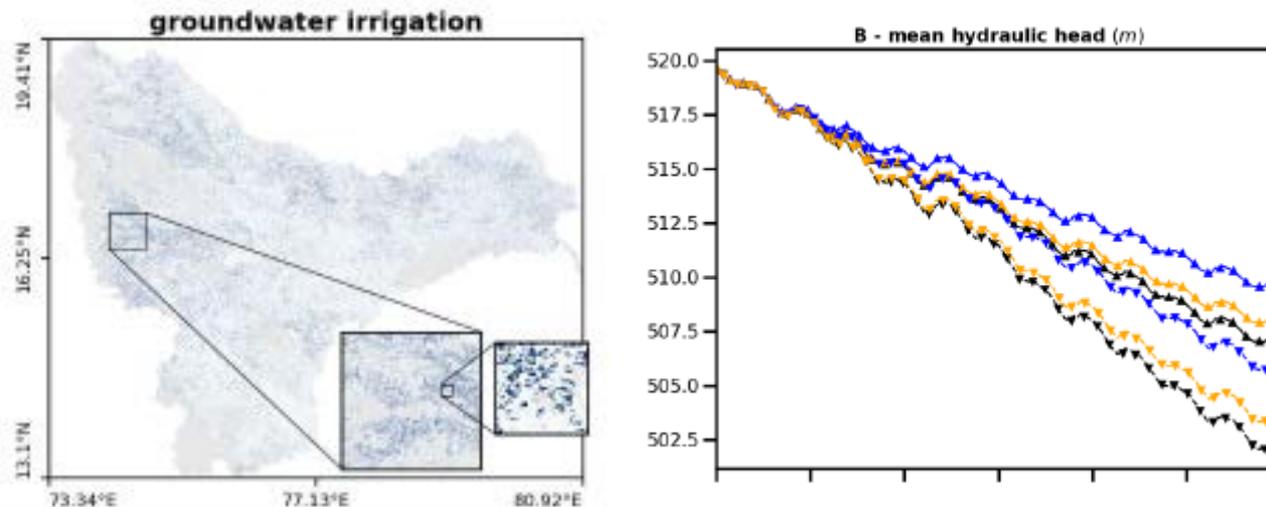


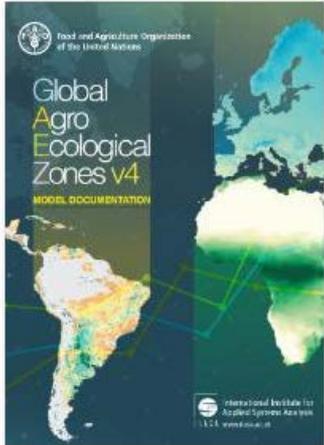
Figure 1: GEB: High-level interaction between CWatM and the agent-based model. © OpenStreetMap contributors 2022. Distributed under the Open Data Commons Open Database License (ODbL) v1.0.



[GitHub - jensdebruijn/GEB](https://github.com/jensdebruijn/GEB)

De Bruijn, et al. 2022

# The Global Agro-Ecological Zones (GAEZ) v.4



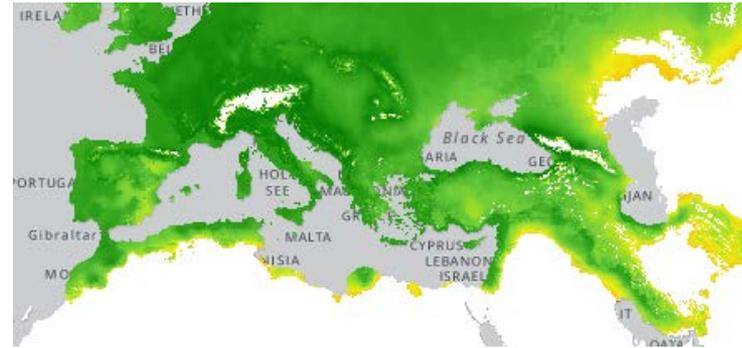
<https://gaez.fao.org/>

1981 -2010  
Historic, Rainfed



Potential yield  
loss due to  
climate change

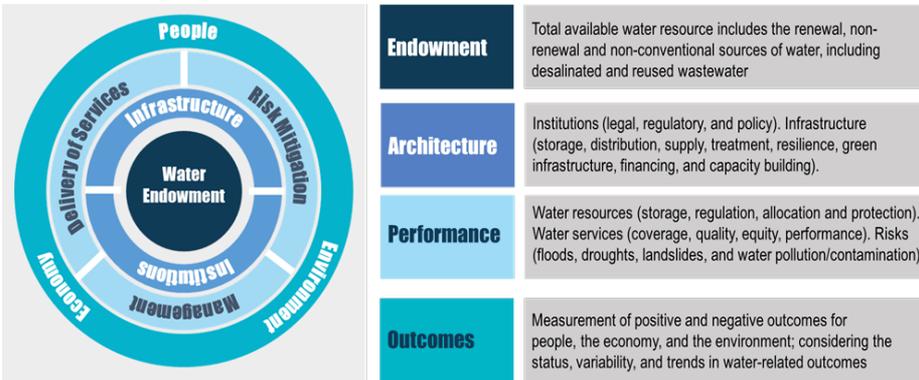
2041 – 2070  
HadGEM2-ES, RCP4.5,  
Rainfed



- Global analysis on the **biophysical suitability of over 50 crops**, modeled by more than **300 generic production systems**.
- Cultivation potentials for **historic, current (2000/2010), and future trajectories** is modeled using four different representative greenhouse gas concentrations pathways (RCPs), for three periods up to 2080.

# One-Water Methodology

A methodological framework for the rapid assessment of water security, smart planning and development of practical recommendations



WB Water Security Diagnostic Framework



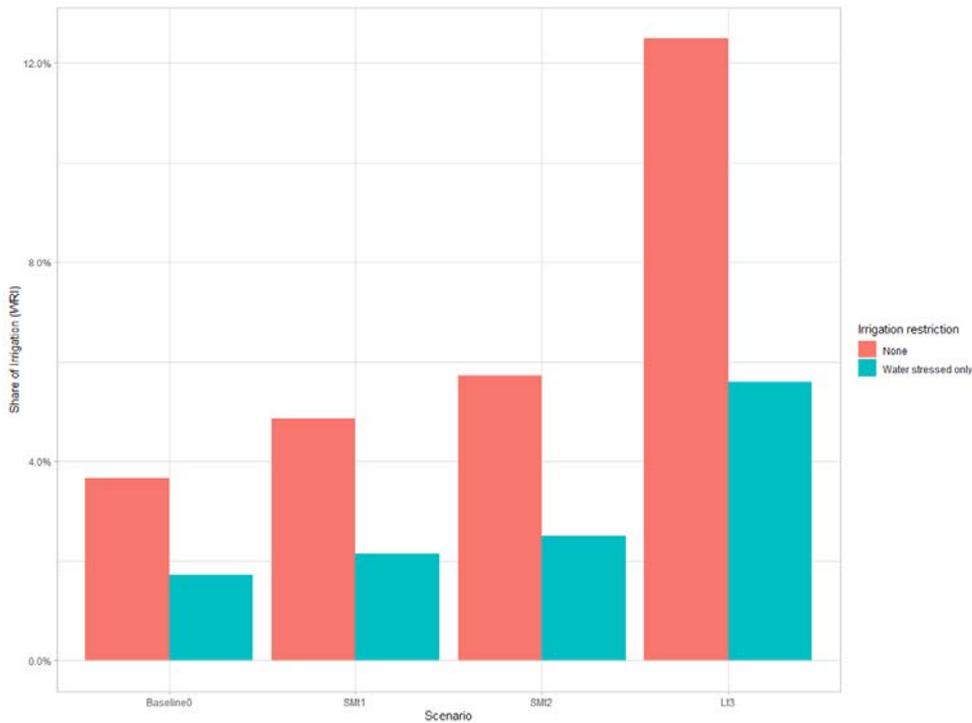
## The 10-Steps-Process of the country One-Water Methodology



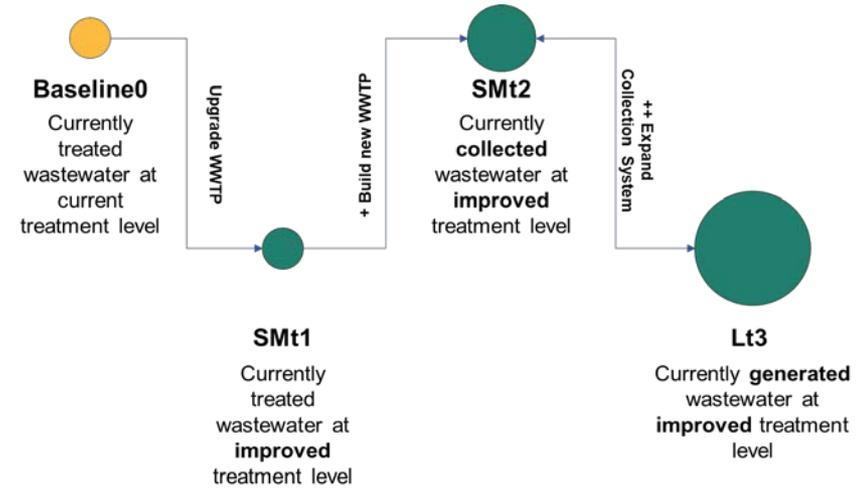
WAT is developing and testing (sponsored by the World Bank) a systems-based approach to assess quantitatively and qualitatively national water security status now and in the future and provide recommendations for improvement.

## Global Assessment of the Treated Wastewater Irrigation Potential

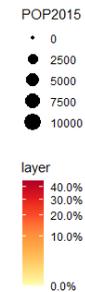
Potential for wastewater irrigation for the different scenarios



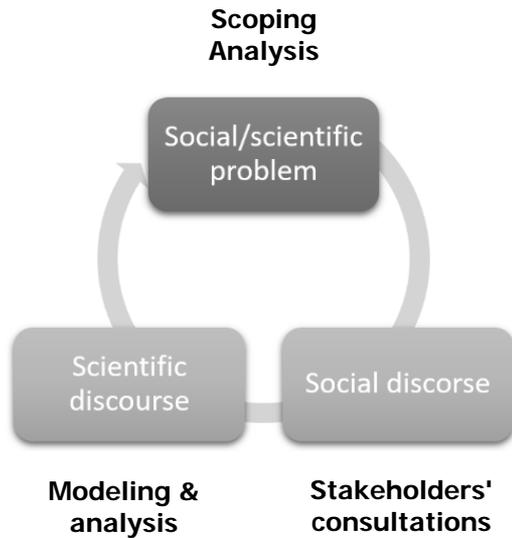
Technological-temporal scenarios



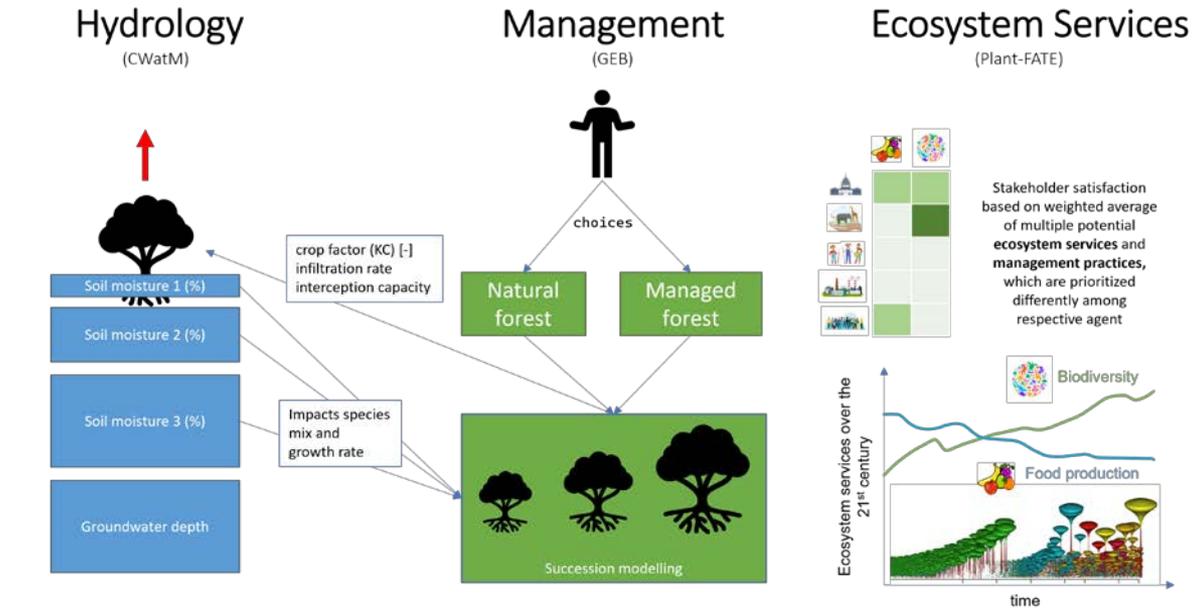
Effects of water conveyance (40 km vs. 0 km)



Considering procedural and distributional justice for risk management in Nexus issues.



Research co-production cycle

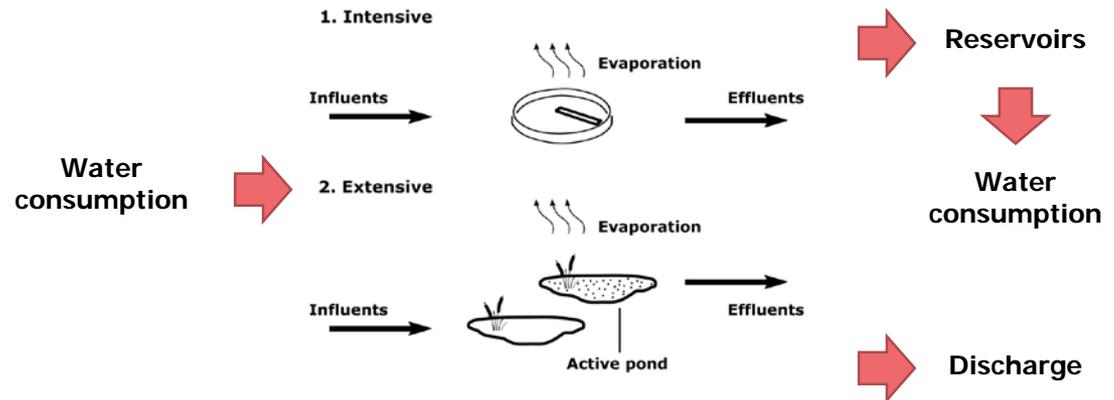


Slide is adapted from the FairSTREAM\* & RESIST\*\* projects information.  
 \*FairSTREAM is a WAT, EQU, and BEC project.  
 \*\*RESIST is a BEC, WAT, EQU, EM, IACC, and ECU project.

Modeling framework

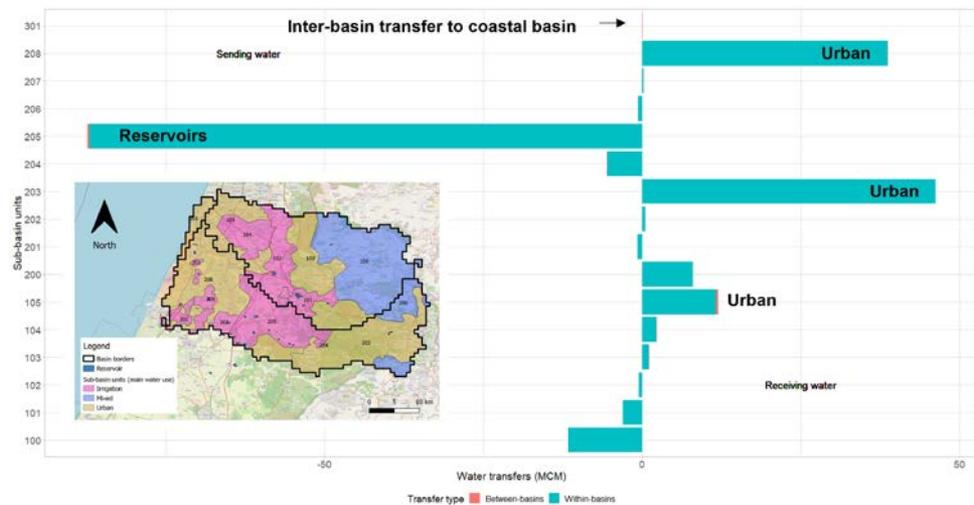
# WINTER: Applying CWatM for Israel

Model development and case study application to a complex, intensively managed water system.



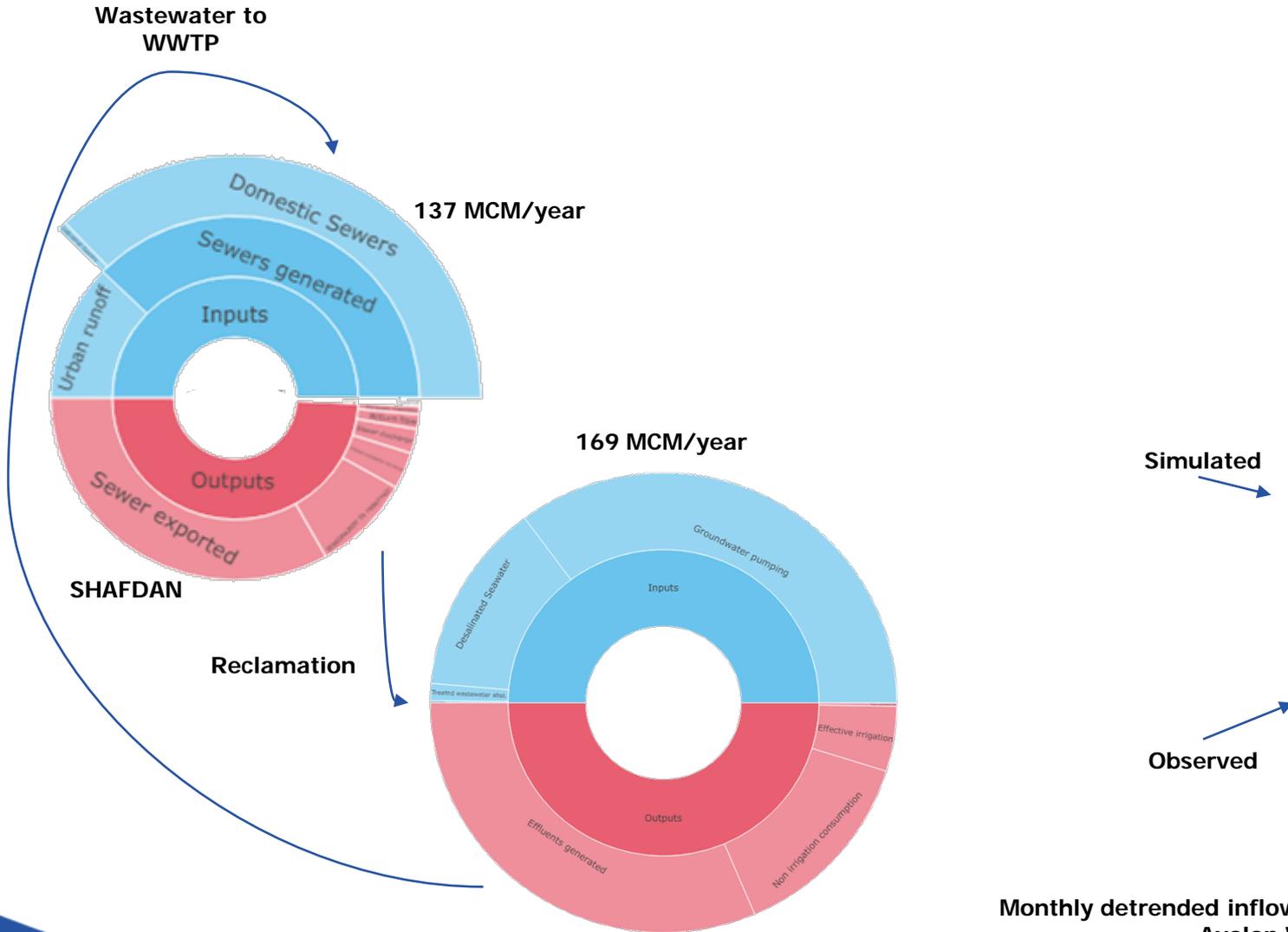
Developing a wastewater module

Selected river basins



Developing a water distribution and interbasin-transfer module

# WINTER: Example of the Ayalon basin



Monthly detrended inflows of wastewater to the Ayalon WWTP

# SOS-Water: Water Resources System Safe Operating Space in a Changing Climate and Society

Research project coordinated by the Water Security Research Group funded in 2022 within Horizon Europe – Cluster 6: Food, Bioeconomy, Natural Resources, Agriculture and Environment

Call: Land, oceans, and water for climate action

Topic: Improved understanding, observation and monitoring of water resources availability

Expected outcomes: Support decision makers defining the safe operating space in terms of water quantity and availability

Objective: Assess and understand the Safe Operating Space of the entire water resources system based on:

- integrated water modelling
- water quantity and quality monitoring
- advanced indicator development
- inclusive stakeholders' engagement including co-development of scenarios and management pathways.

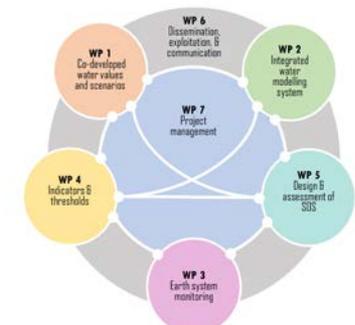
Case studies: 5 (Jucar Basin, Rhine and Rhine Meuse Delta, Upper Danube, Danube Delta, Mekong Delta)

Budget: 4M Euro

Partners: 11

Work Packages: 5 (+DEC and Project Management)

Starting date: October 2022



# SWAQ-Uganda: Sustainable water quality management supporting Uganda's development ambitions

Objective: To **improve knowledge** and to **enhance institutional capacities** in water quality management in support of policymaking and effective water resources management in Uganda.

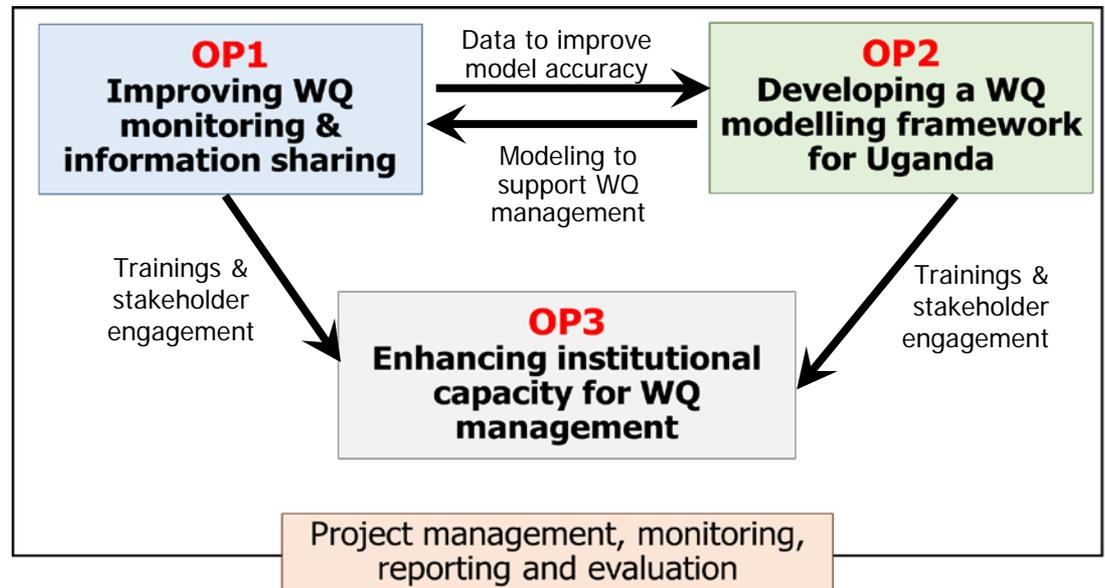
Funding: 1.7 million EUR

Funder: Austrian Development Cooperation

Coordinator: International Institute for Applied Systems Analysis

Partners: Ministry of Water and Environment  
REPUBLIC OF UGANDA

**BOKU**  
Universität für Bodenkultur Wien

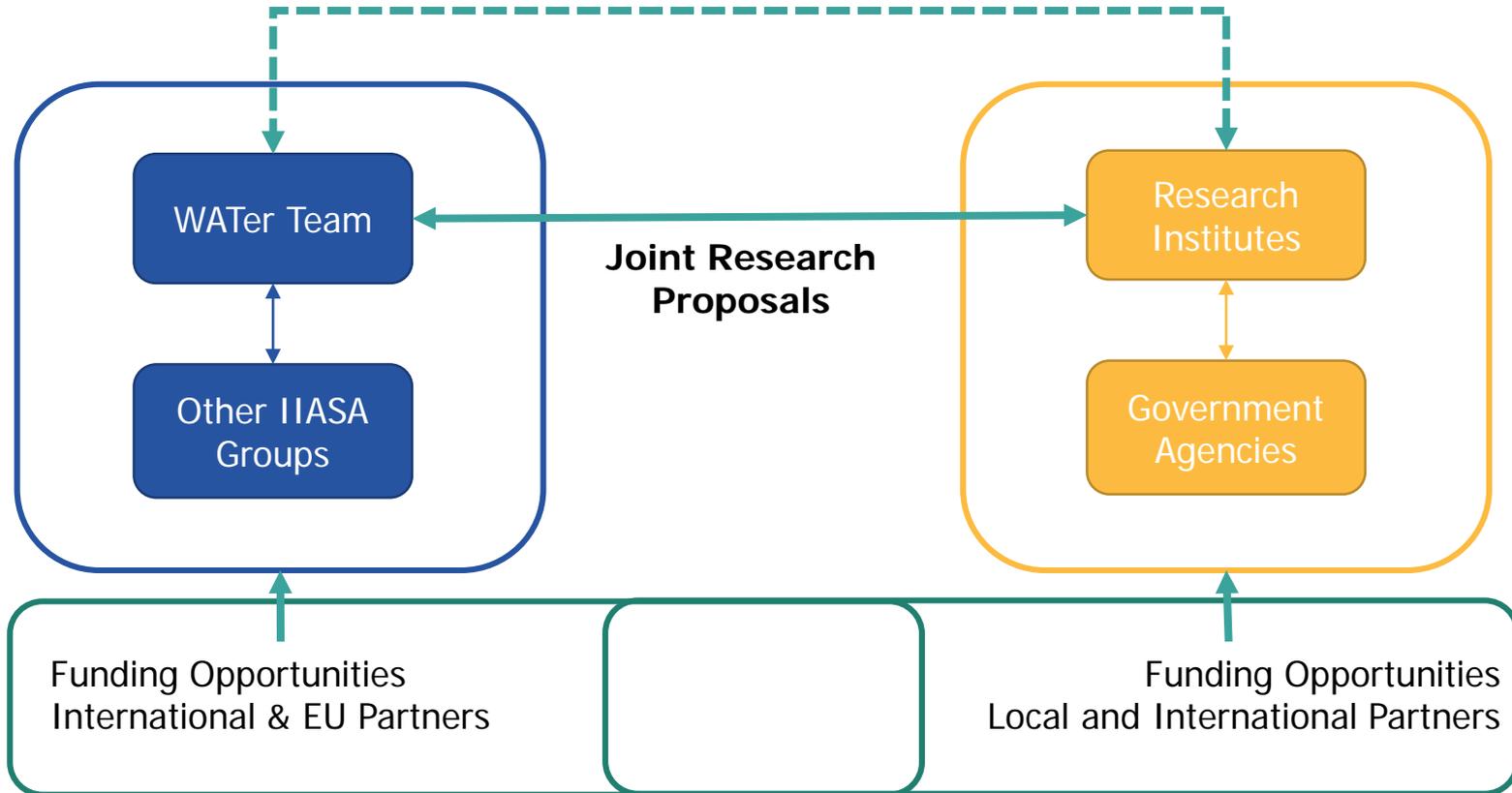


OP: output area; WQ: water quality

# Opportunities and Collaboration

## Knowledge Exchange & Capacity Building

Research Stays, YSSP, Postdoc, Tools' support



# Young Scientists Summer Program (YSSP)

- An NMO funded three-months research stay for PhD candidates/students within one of IIASA's research groups.
- Applicants should connect the desired group prior to developing a project proposal.
- The Water Security Research Group encourage Israeli candidates to apply.
- Deadline: 12/1/2023
- Link: [YSSP - Young Scientists Summer Program | IIASA](#)



# Thank you for listening

Any questions?

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[Water Security \(WAT\) | IIASA](#)