Uncertain water resources under global change

Assessing water use-climate feedbacks in the UWaRes project

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Background

Adequate access to freshwater is essential for human well-being, economies, and ecosystem functioning. However, high water demands from industries, households, and agriculture frequently result in water scarcity, disproportionately impacting the environment due to an unequal distribution of available resources.

Global change will further exacerbate water scarcity worldwide. Continuous global population and socio-economic growth will further result in a higher food demand that can often only be met through massive increases in irrigation activities.

How does irrigation affect regional climate?

Large-scale irrigation affects regional precipitation patterns, monsoon dynamics, and local temperatures. However, previous studies modelling irrigation impacts did not consider limited water availability and conflicting water use across different sectors - thereby ignoring water scarcity and decreased supply during droughts.

We adopt a fully-coupled approach to overcome that issue by combining a regional climate model and a socio-hydrological model.

A Coupled Water Modeling Tool

We aim to create an accessible **socio-hydrological modeling tool** that

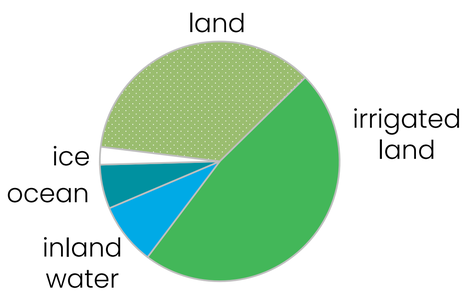
1. is coupled to the regional model REMO
2. can be easily linked with other regional or even global climate models

Coupled Modeling

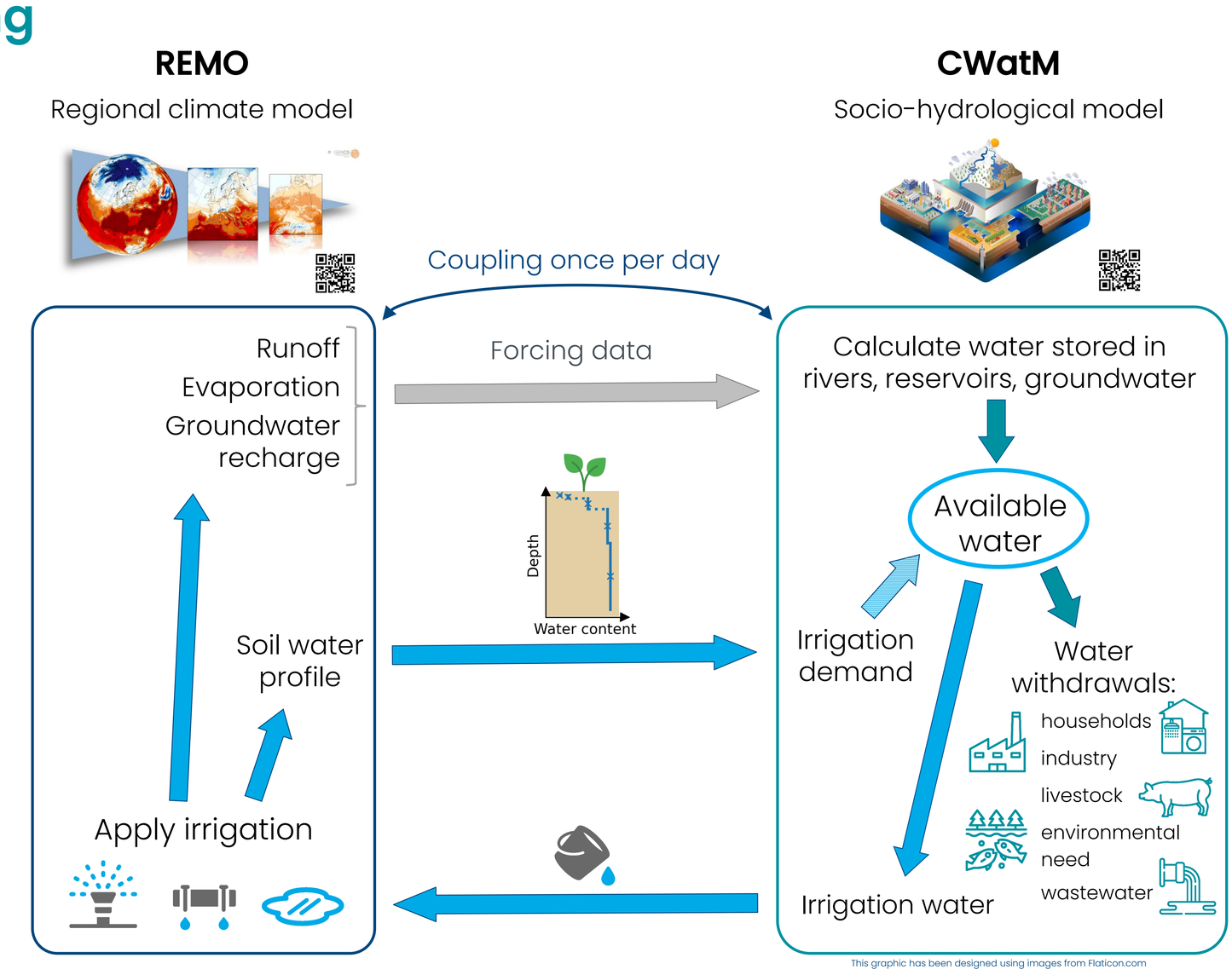
Regional Climate Modeling

REMO is a regional climate model currently maintained GERICS.

Grid cells are tiled and **irrigated land** is included as an additional tile (as in Asmus et al. 2023).



Horizontal resolution:
- down to 0.11° (hydrostatic)
- kilometer scale (non-hydrostatic)



Socio-Hydrological Modeling

The Community Water Model (CWatM) is a large-scale water resources model.
It is used to quantify:
- water supply
- human water withdrawals from different sectors (industry, domestic, agriculture)
- effects of water infrastructure (reservoirs, groundwater pumping, irrigation canals)

Horizontal resolution:
30' to 0.5'
Time step: 24 hours

Current Activities

We develop an open-source, flexible, and accessible water resources modelling tool to be coupled to state-of-the-art (regional) climate modelling systems. The tool is based on a simplified version of CWatM.

We apply the tool to REMO and evaluate the coupled framework by assessing the entire range of hydroclimatological impacts arising from extensive human water use.

The project will provide
- a new perspective on process-based analyses of future water availability
- novel avenues towards high-resolution, fully-coupled climate-human-water impact research.

Specific Research Questions

- What is the added value of employing a fully-coupled modeling system?
- How can we represent specific end-user needs and visions through tailored scenarios and storylines?
- What is the impact of climate change – especially **droughts** - on coupled water use-climate interactions and water availability?

  → focus on heavily-irrigated regions such as the Po Valley, South Asia, or California.
- How do results change for different irrigation practices or a changed distribution of water between sectors?

References

Asmus, C., Hoffmann, P., Pietikäinen, J.-P., Böhner, J., and Rechid, D. (2023): *Modeling and evaluating the effects of irrigation on land-atmosphere interaction in South-West Europe with the regional climate model REMO2020-iMOVE using a newly developed parameterization*, EGUsphere [preprint].

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