Model framework based on weighted WEFE indicators for climate- and socio-economic resilient water governance for the Upper Main catchment

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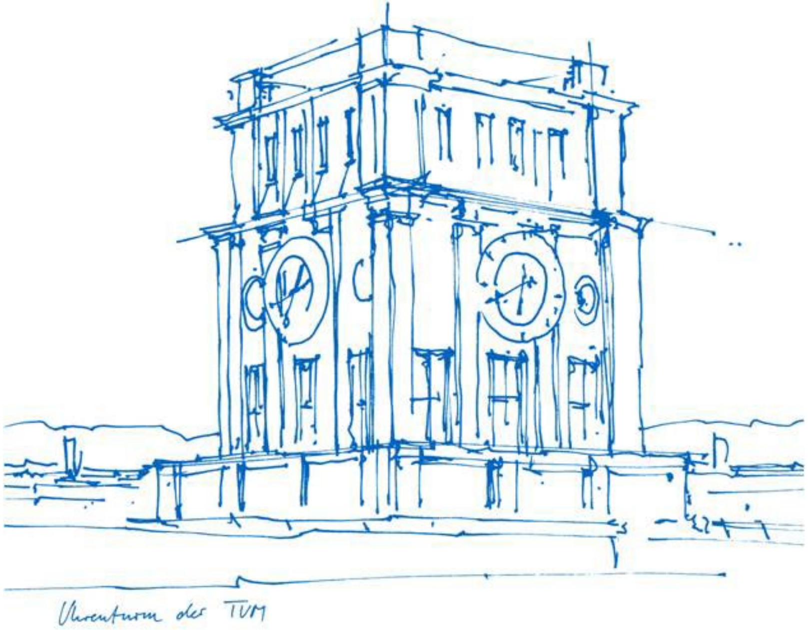
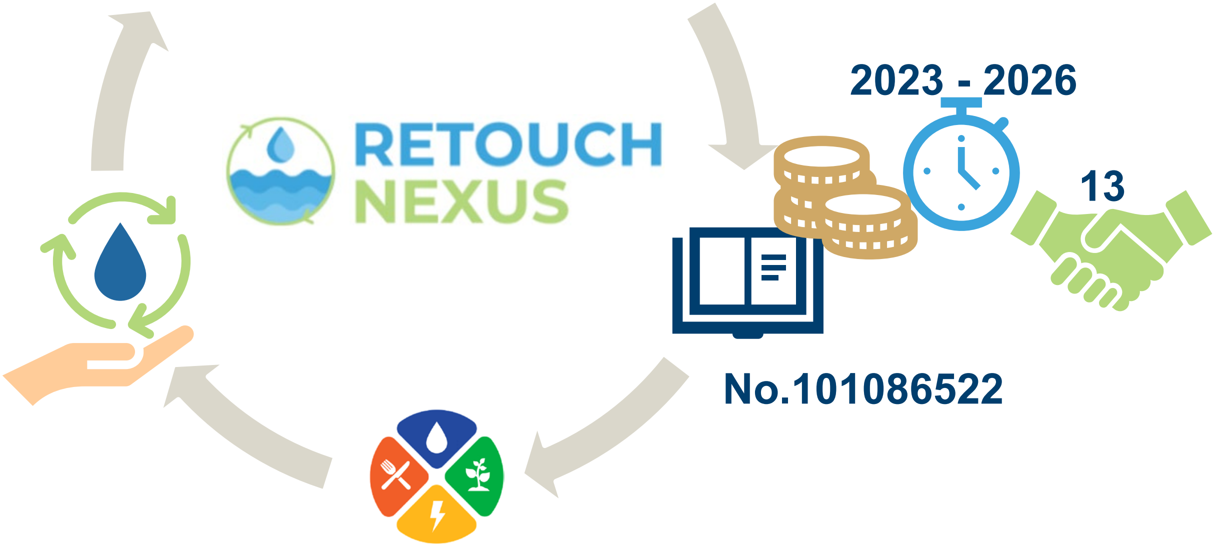


Content

1 Introduction

REsilien**T** water g**O**vernance **U**nder climate **CH**ange within the WEFE **Nexus**



1 Introduction

RETOUCH NEXUS aims to promote robust, integrated, sustainable, inclusive and upscalable water governance practices

- → evidence-based approach
- → 6 case studies in EU

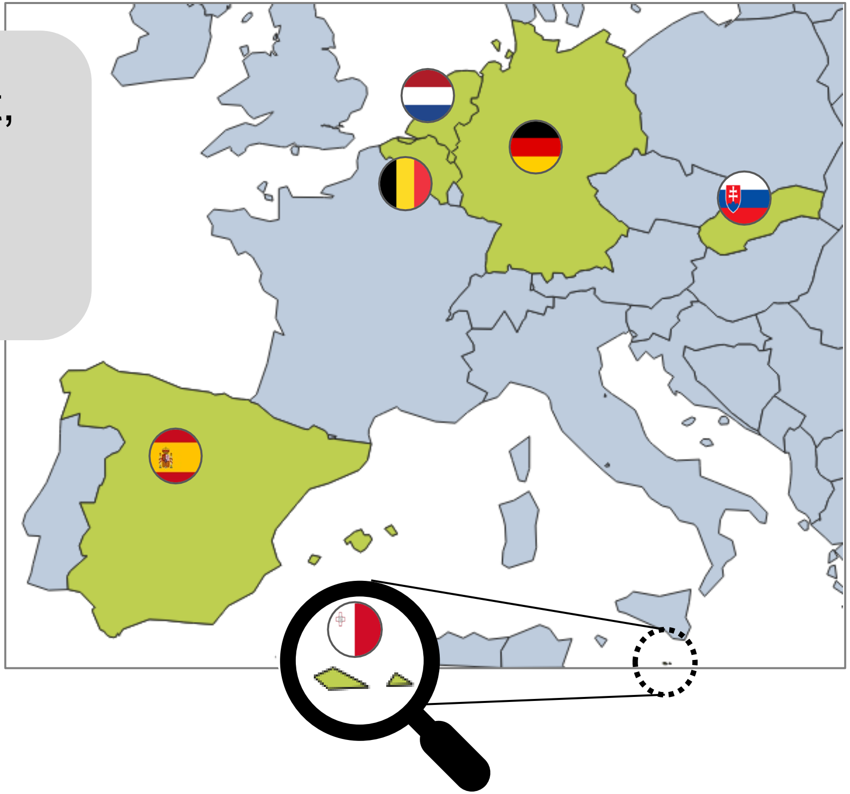


Figure 1: Location of the case studies with the RETOUCH Nexus project.

2 Research questions

1. How to implement a weighted indicator based model framework for a sustainable climate- and socio-economic resilient water governance for the Upper Main Catchment using the SWAT+ and WEAP model?
    1.1. Which indicators based on WEFE und ESS can be derived using the SWAT+ and WEAP models?
    1.2. How do the stakeholders weight the indicators provided?
    1.3. What conditions prevail in the Upper Main catchment when the model framework is applied?

2. What are the results of using the weighted indicator based model framework in combination with climate change and socio-economic scenarios within the Upper Main catchment?

3. How can the weighted indicator based model framework contribute as a decision/planning framework to develop adaptation strategies to CC and SE scenarios within the Upper Main catchment?

3.1 Study area – Location

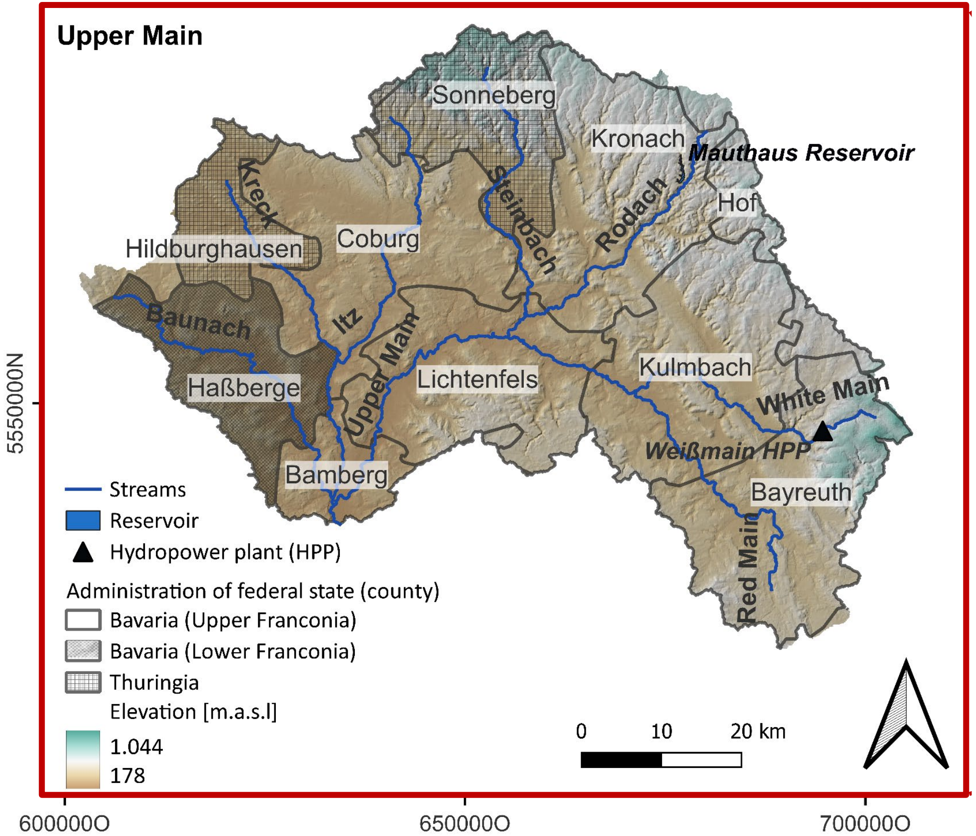


Figure 2: Location of the Upper Main catchment.

- **Catchment area:** 4.646 km^2
- **Elevation:**
  - east-west slope
  - [178, 1044] m.a.s.l.
  - ~ 75% located [178,500] m.a.s.l.
- **River network:**
  - Upper main has two springs:
    - White Main
    - Red Main
  - several tributaries
- **Mauthaus reservoir**
- **Weißmain Hydro Powerplant**

3.2 Study area – Land use

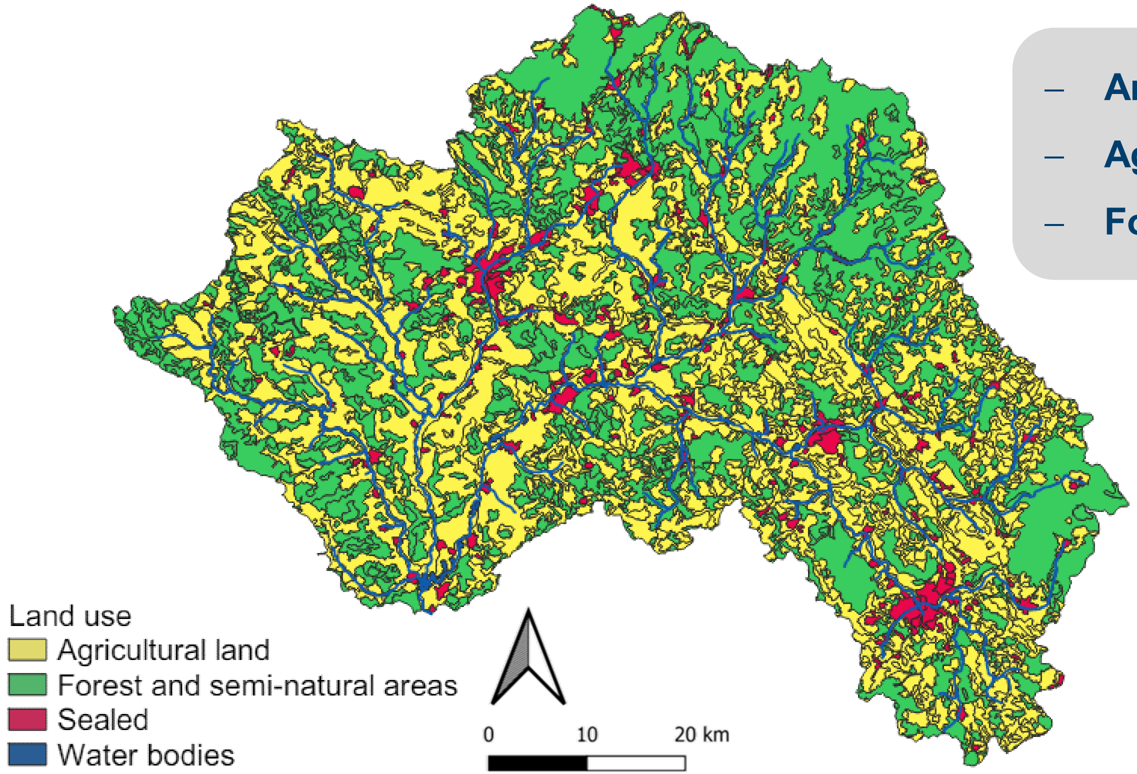
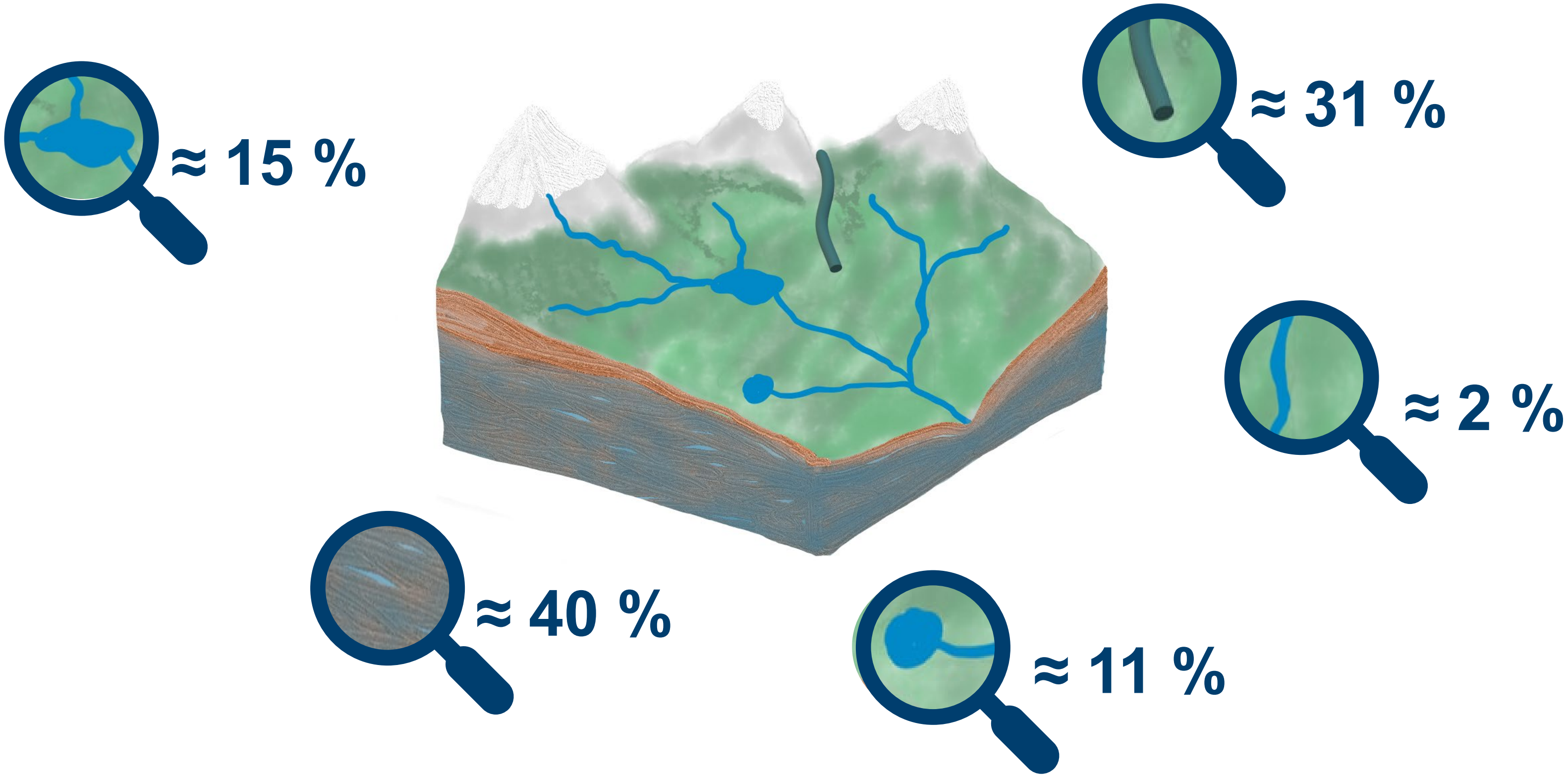


Figure 3: Land use change from 2000 to 2018 (CORINE Land Cover).

- **Artificial** areas: **+ 3.4 %**
- **Agricultural** areas: **- 6.5 %**
- **Forest** and **semi-natural** areas: **+ 2.9 %**

3.3 Study area – Water management



3.3 Study area – Flow regime

- **water bodies** are mainly fed by **rainwater**
- **summer season:**
  high ET → lower discharges
- **winter and early spring:**
  higher discharges

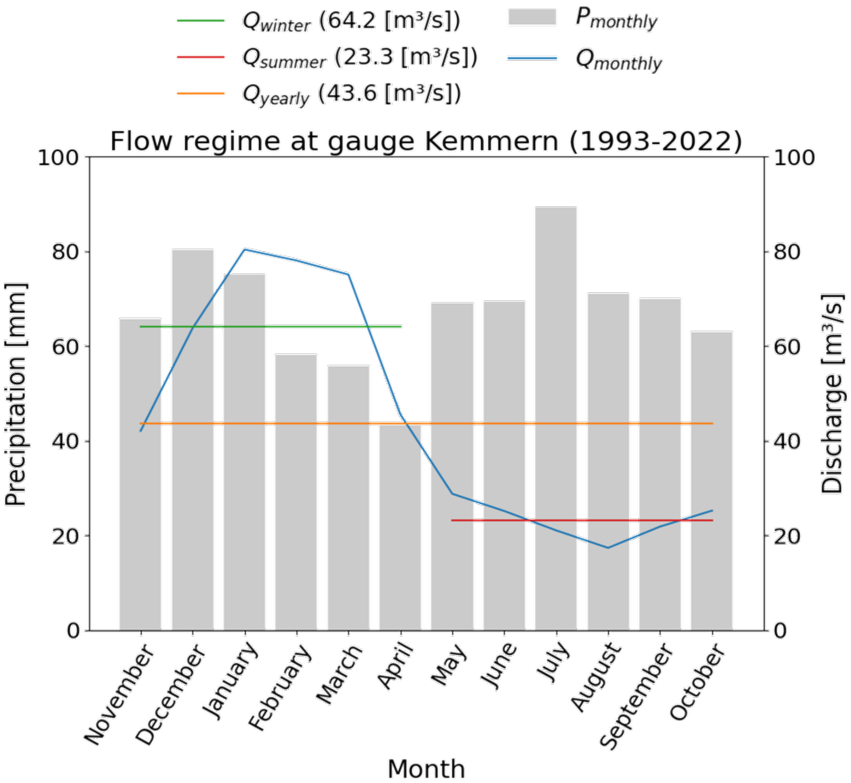
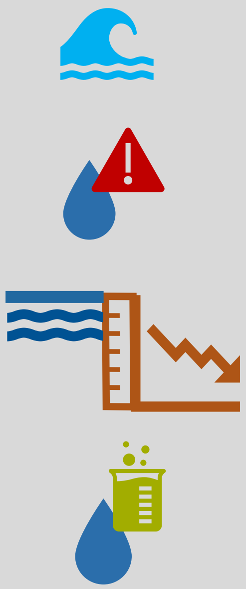
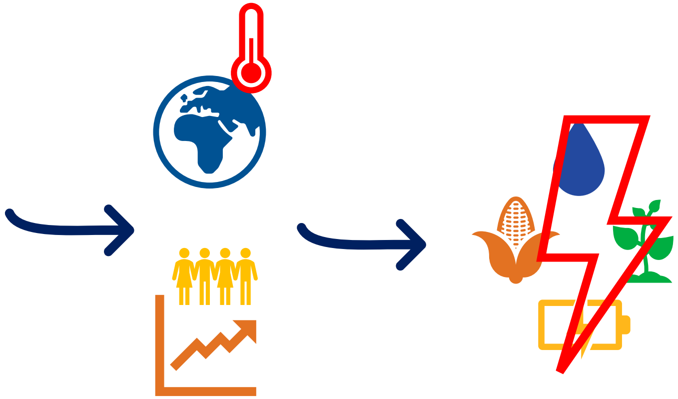


Figure 4: Flow regime of the Upper Main catchment (gauge Kemmern) within the period from 1993 to 2022.

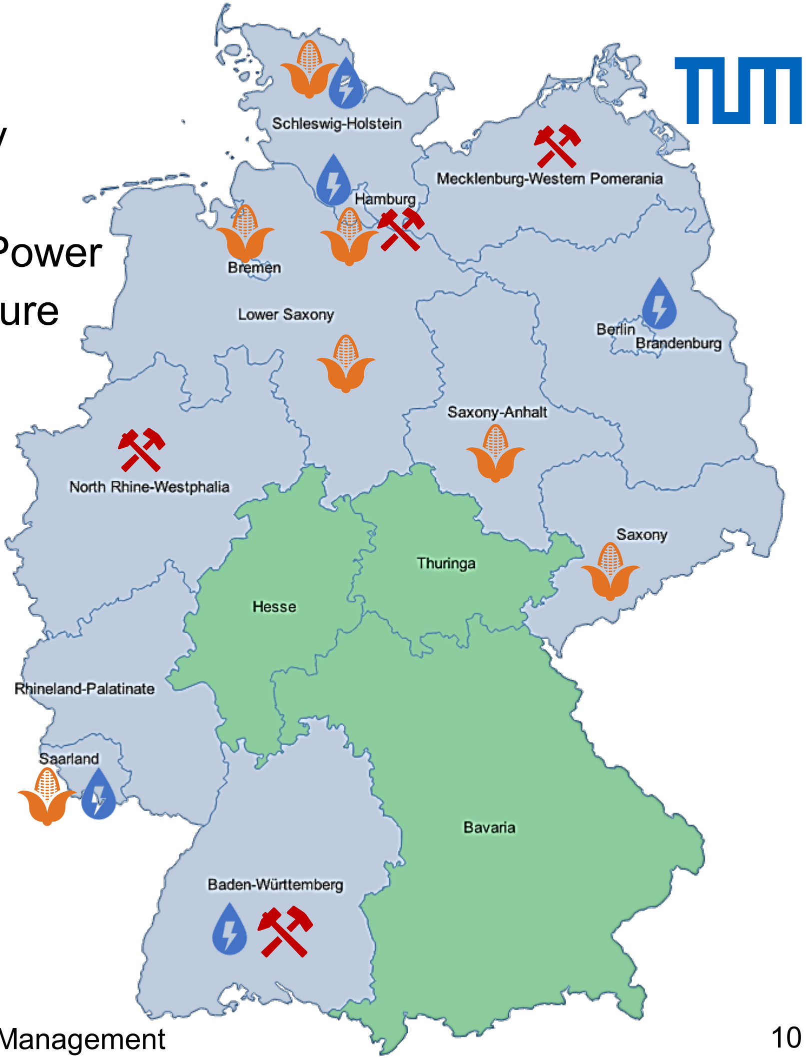
4.1 Methods – Motivation

Current challenges



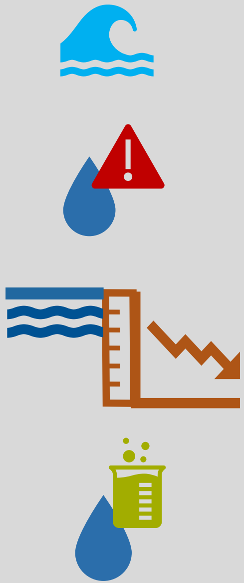


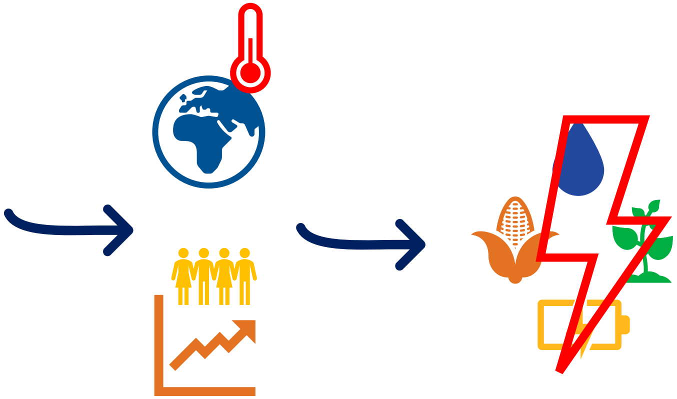
- Industry
- Mining
- Hydro Power
- Agriculture



4.1 Methods – Motivation

Current challenges





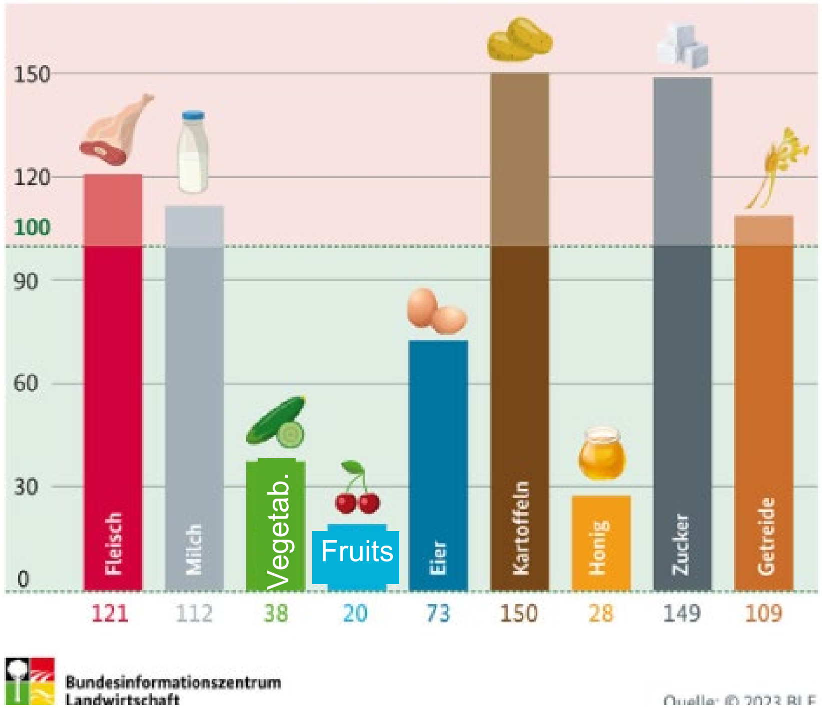
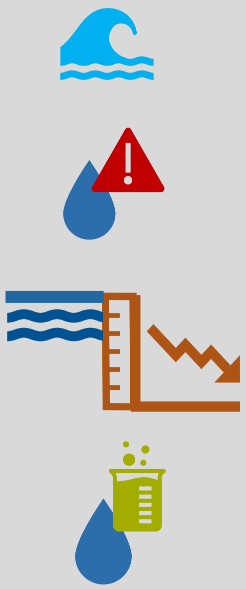
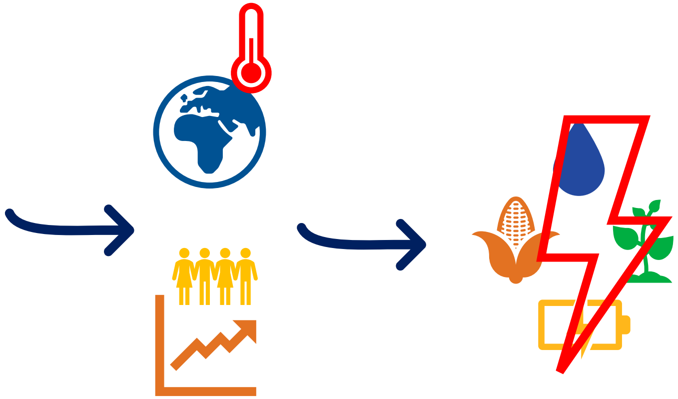


Figure 5: Degree of self-sufficiency in Germany (BLE, 2023).

4.1 Methods – Motivation

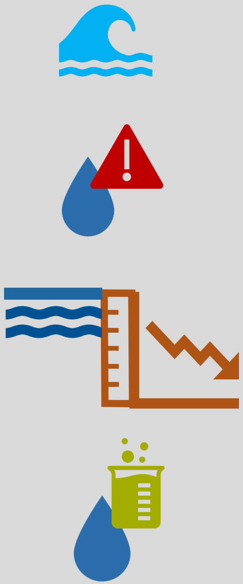
Current challenges

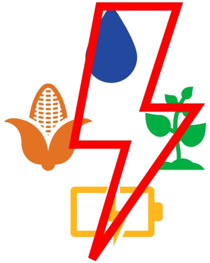




4.1 Methods – Motivation

Current challenges





Arising challenge

climate and socio-economic

adaptation

4.2 Methods – Model framework

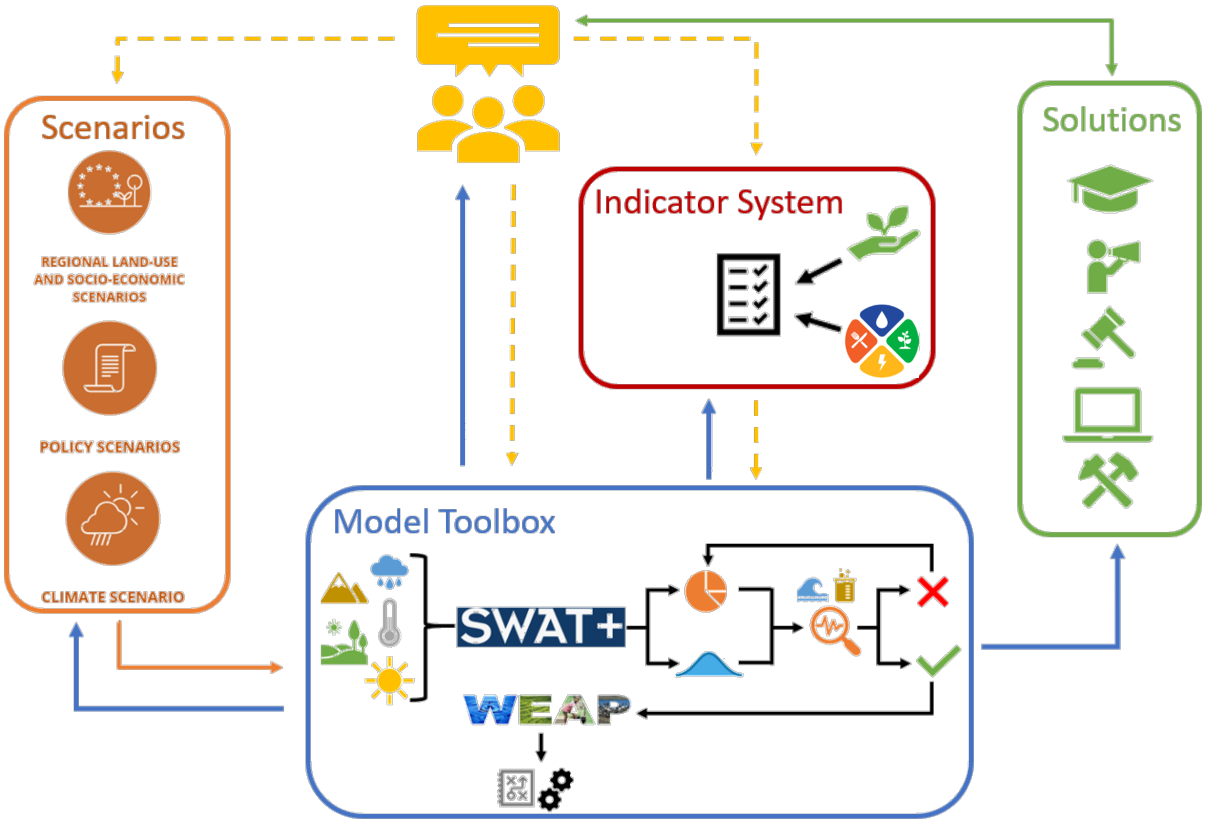
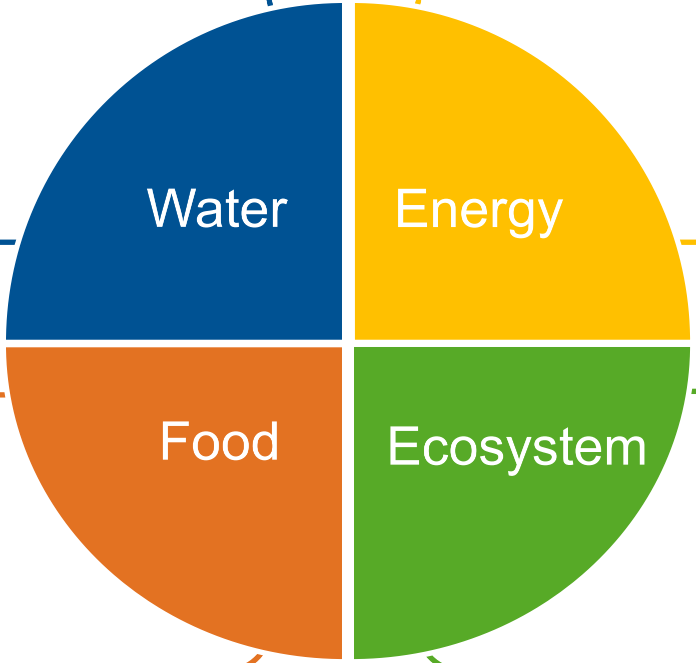


Figure 6: Overview of model framework used for the Upper Main catchment.

4.3 Methods – Indicators (WEFE)



- Water yield
- Blue water
- Green water

- Water yield
- Vegetation biomass (estimate biofuels)
- Soil erosion / deposition (reduce lifespan of HPP)

- Net rate
- Crop yield
- Sown area
- Crop land area
- NPP
- C-, N and H_20- flux

- carbon sequestration
- N
- P
- Dissolved Oxygen
- Temperature
- Q

4.3 Methods – Indicators (ESS)

- Productivity availability (e.g. water, bio fuels, timber)
- Food sovereignty
- Water availability
- Water quantity
- Water quality

Provisioning

Regulating

- Erosion / sediment
- Deposition control
- Food control
- Drought control
- Soil nutrient cycling
- Pollination (water, soil)

indicator literature review is still ongoing

Supporting

Difficult
→ more literature review necessary

Cultural

- Scared sites
- Knowledge of territory
- Traditional knowledge
- Ecotourism areas
- Maintenance of oral tradition

4.4 Methods – Model toolbox

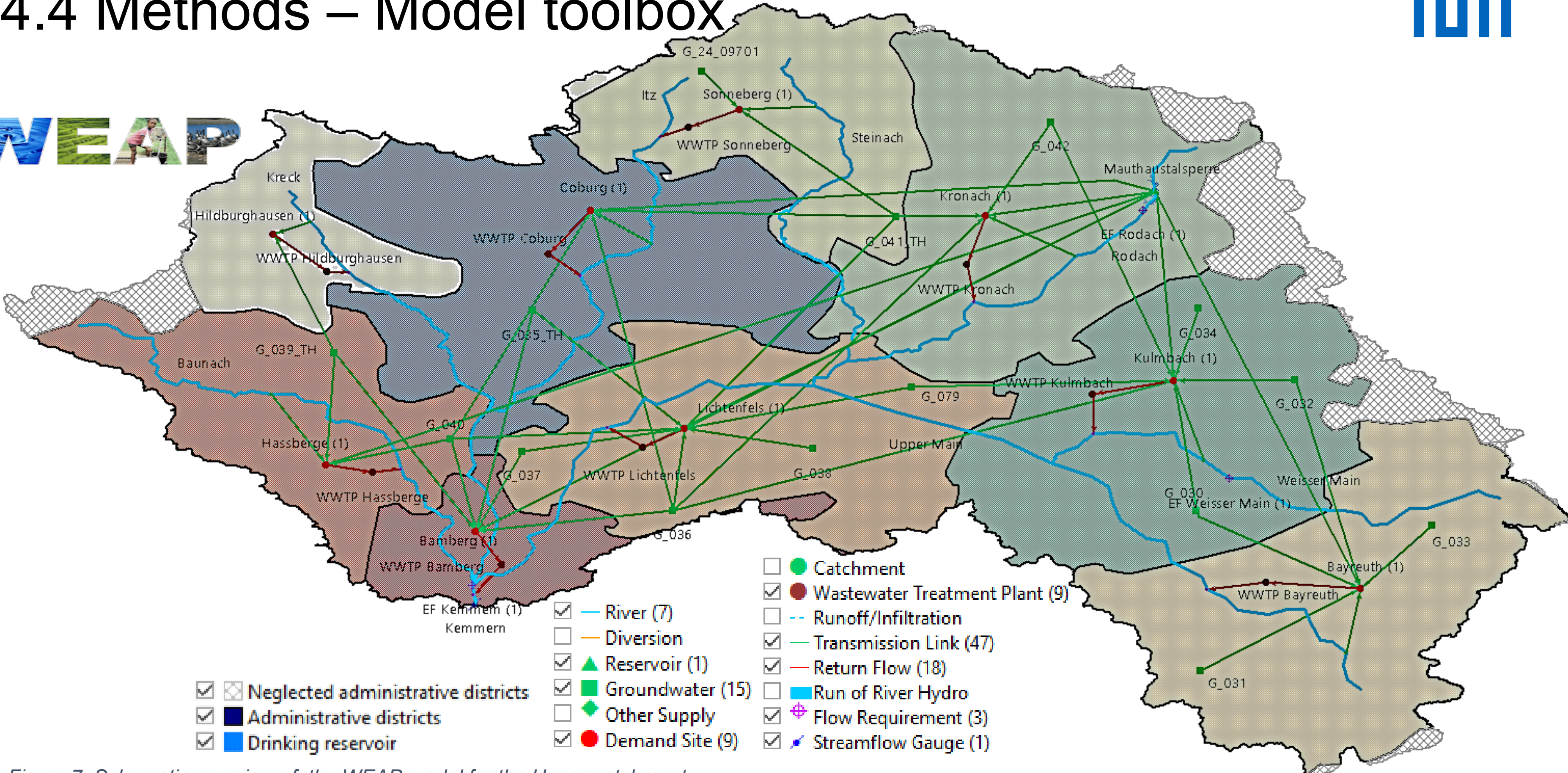


Figure 7: Schematic overview of the WEAP model for the Upper catchment.

4.4 Methods – Model toolbox

Why on district level?

Water demand is available on district level

Measures are issued at district level

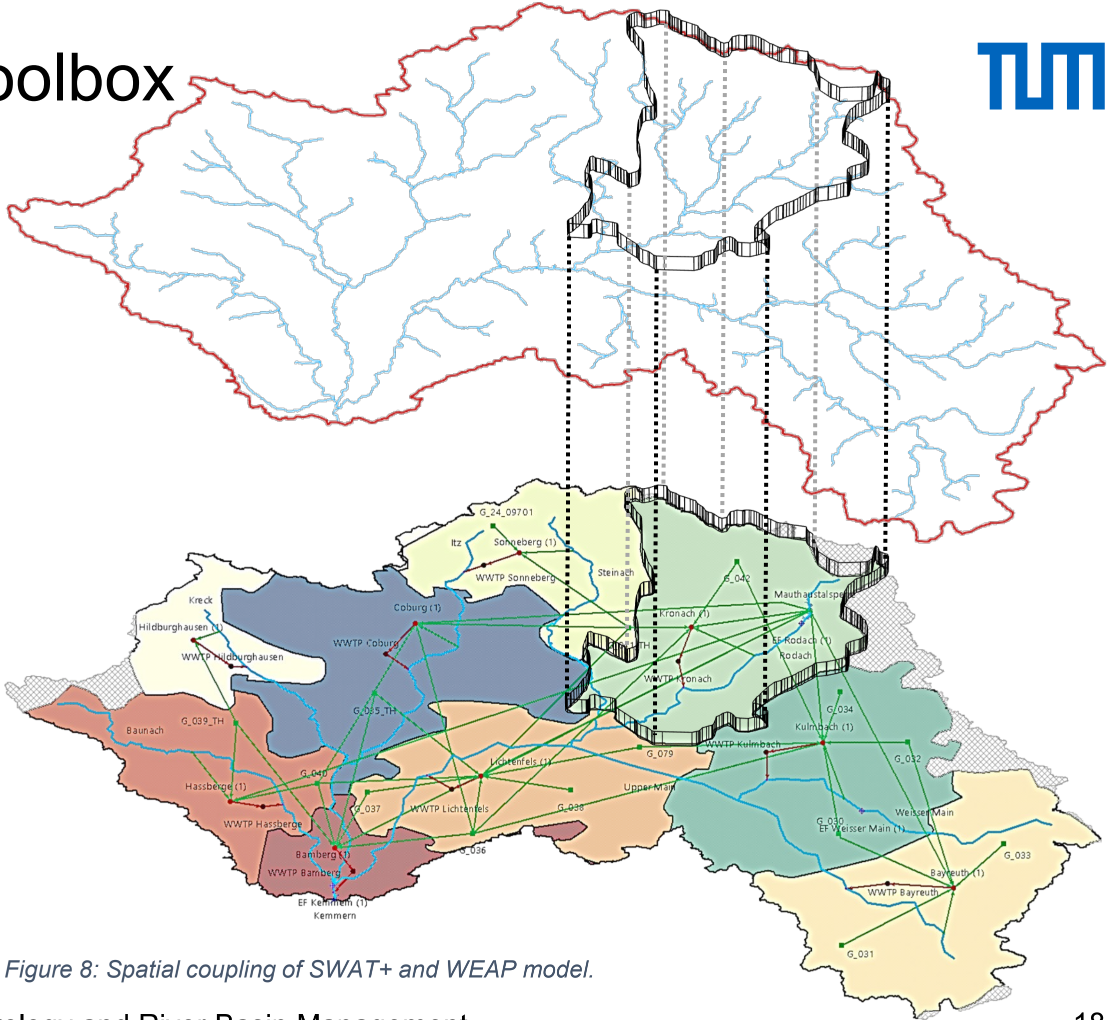
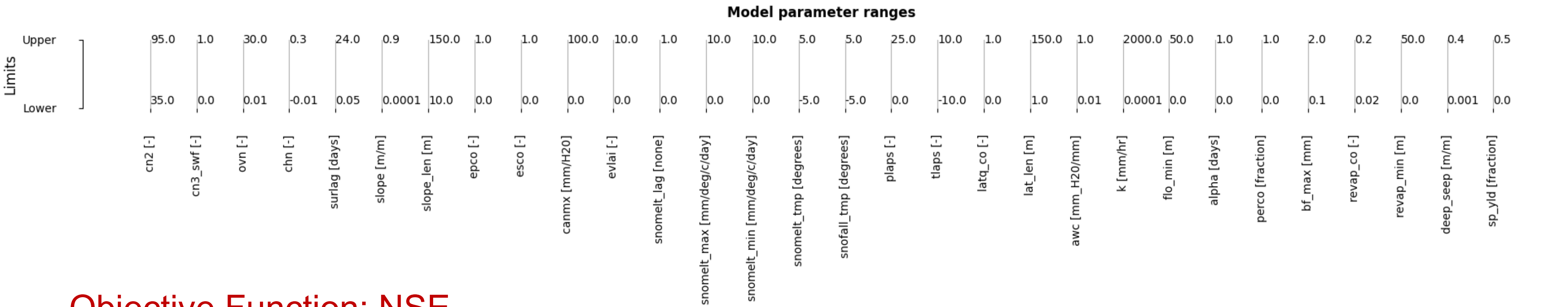
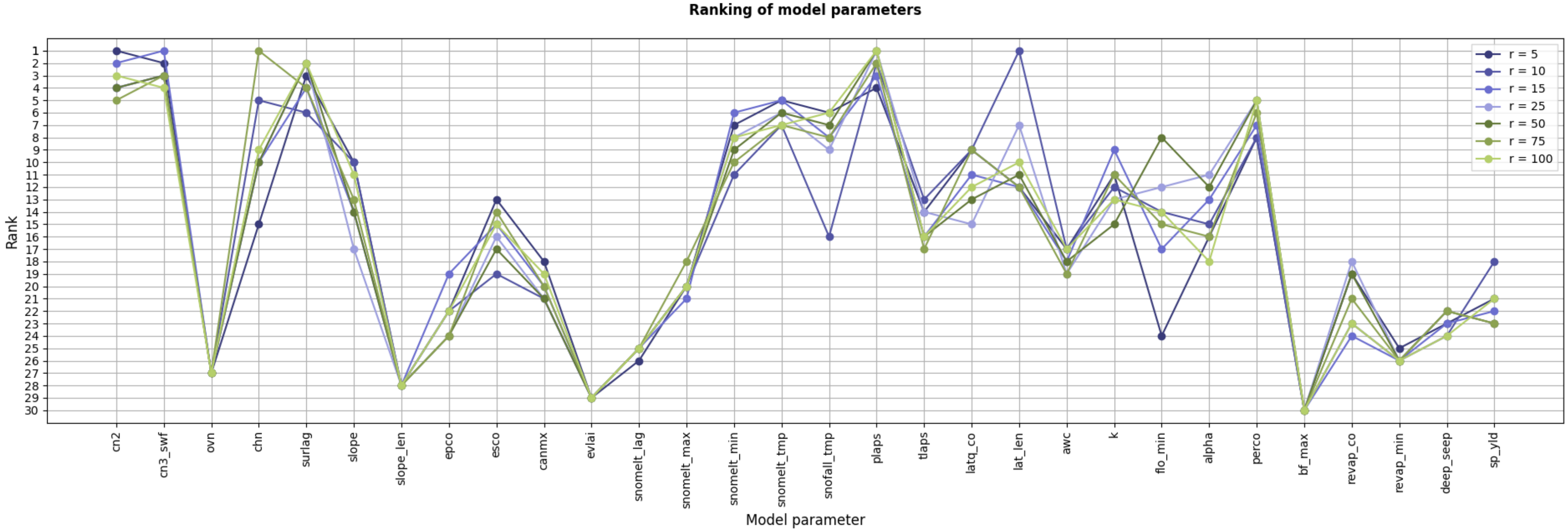


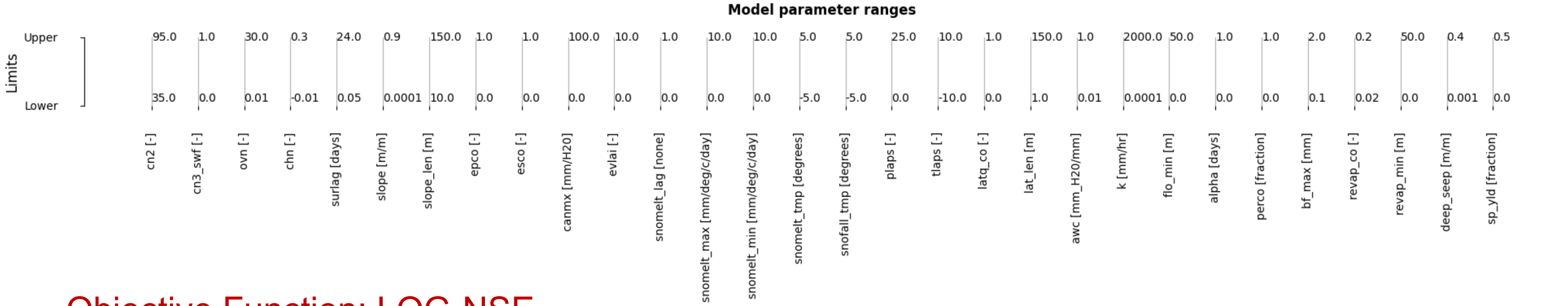
Figure 8: Spatial coupling of SWAT+ and WEAP model.

5 Preliminary results

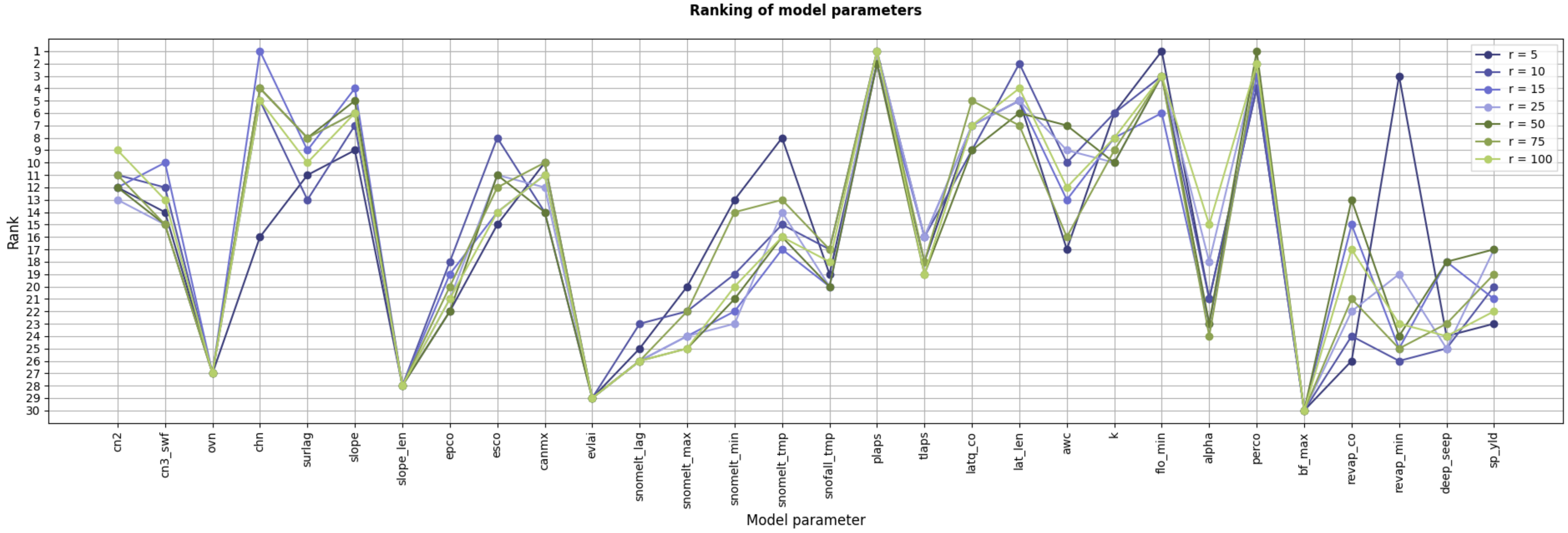


Objective Function: NSE

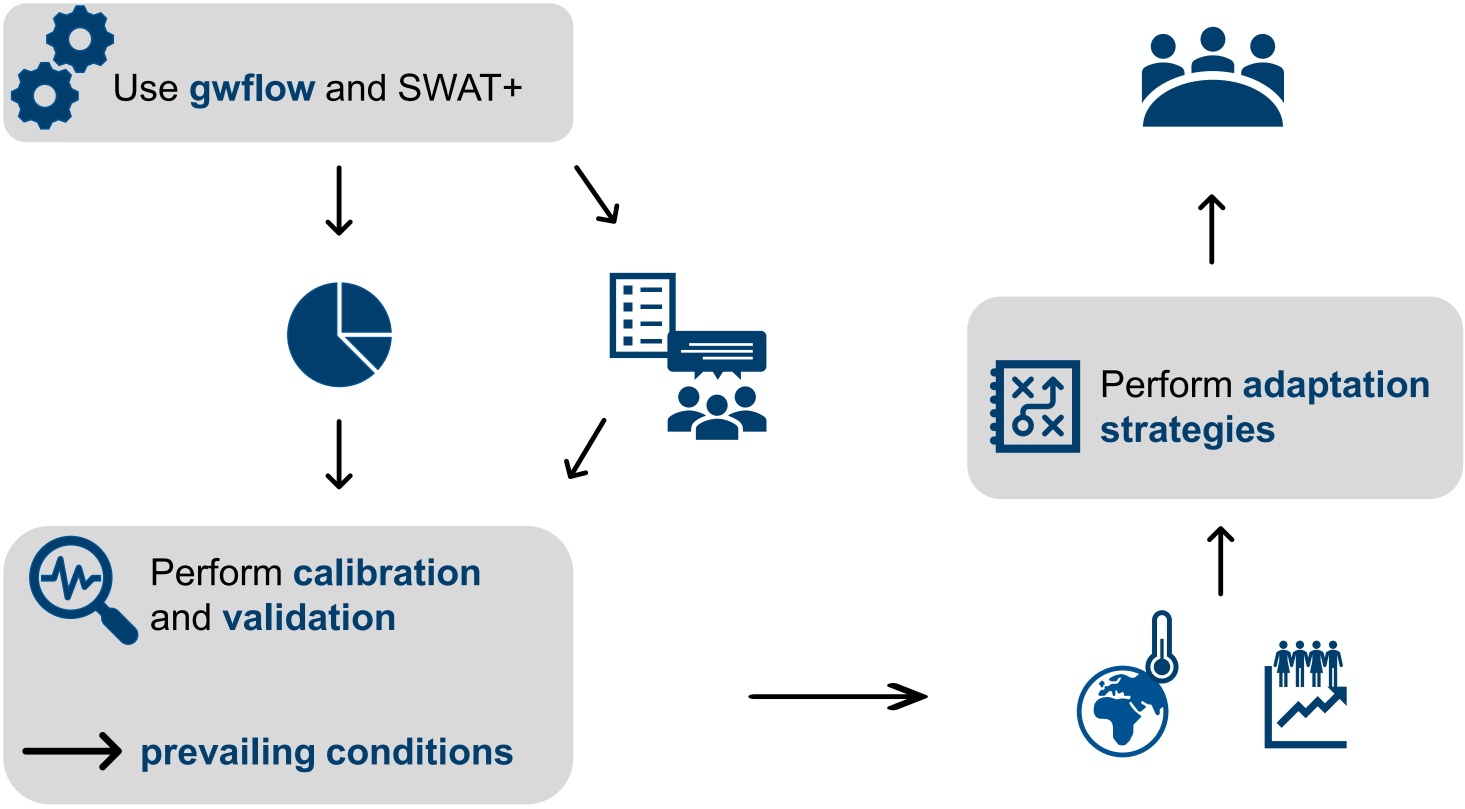




Objective Function: LOG-NSE



6 Outlook


Use **gwflow** and SWAT+
Perform **calibration** and **validation**
→ **prevailing conditions**
Perform **adaptation strategies**

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Thank you for your attention.

Morris Method: Screening

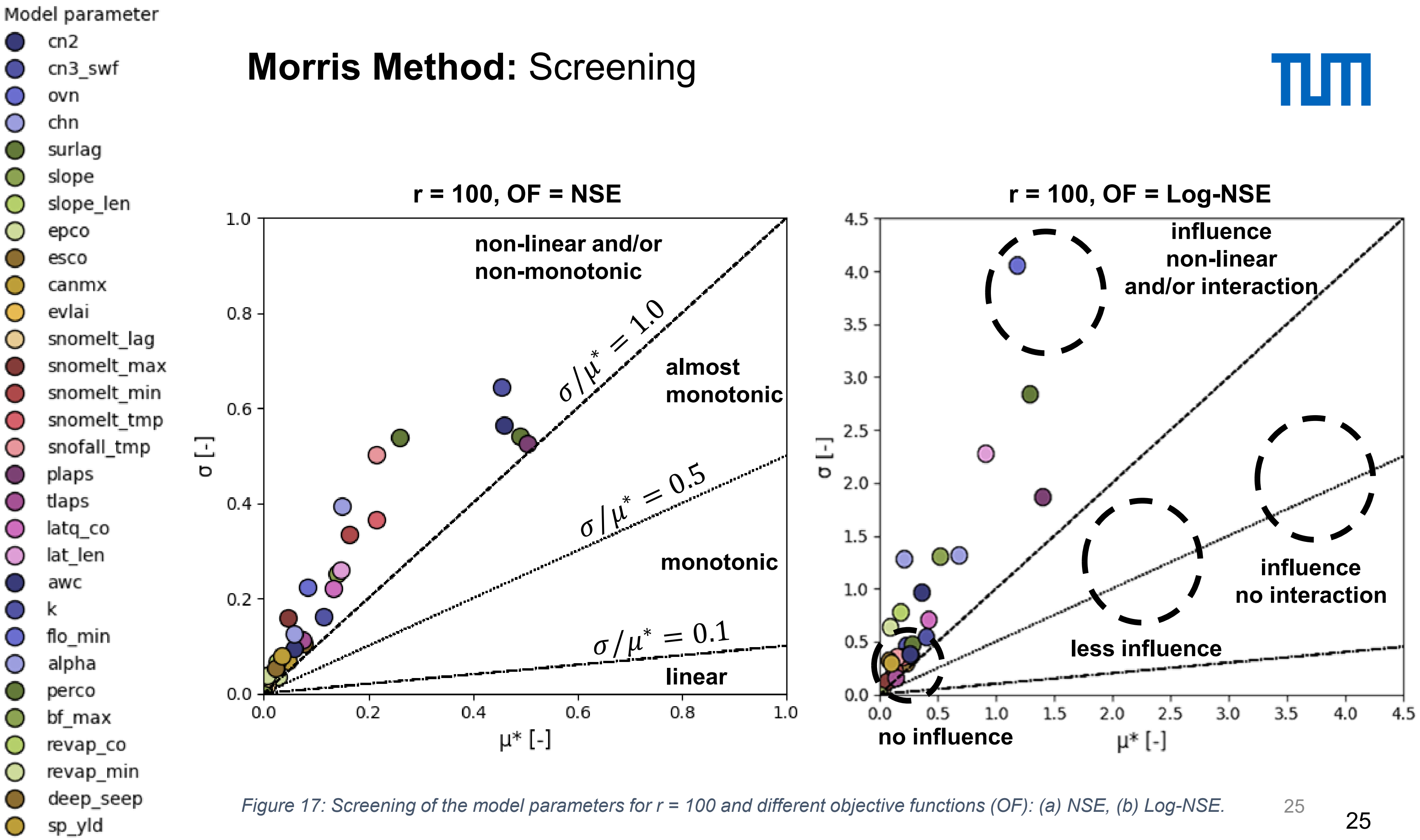

Figure 17: Screening of the model parameters for r = 100 and different objective functions (OF): (a) NSE, (b) Log-NSE.

Blue and green water calculation in SWAT

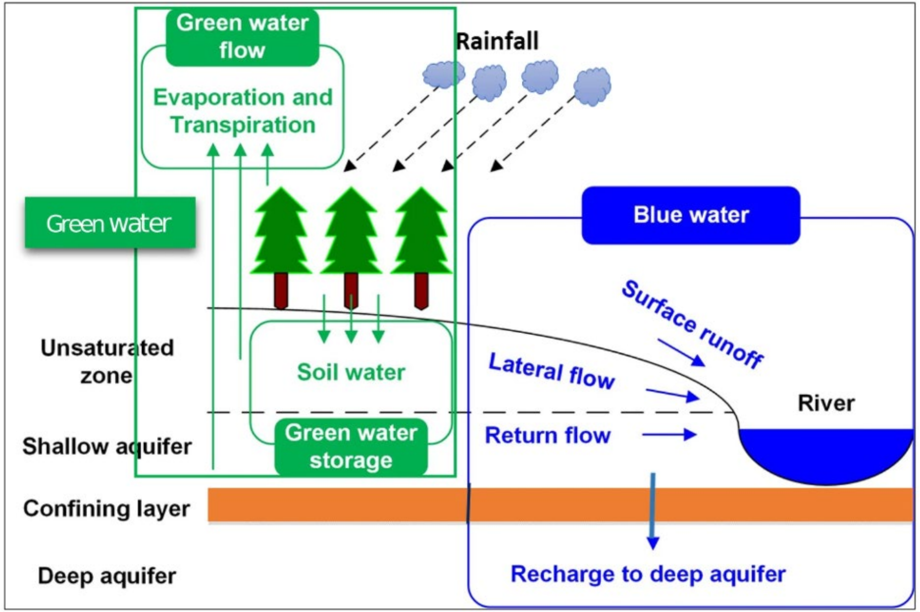

Figure 9: Schematic diagram of blue and green water components (Hordofa et. al. 2023).

$$\mathrm{BW} = \mathrm{WY} + \mathrm{GS}$$

$$\mathrm{GW} = \mathrm{GWF} + \mathrm{GWS} = \mathrm{ET} + \mathrm{SW}$$

Where, GWF is green water flow and GWS is green water storage. GS is the difference between total amount of water recharge to aquifers (GW_RCHG) and the amount of water from aquifer that contributes to the main channel flow (BF) (Veettil and Mishra 2016).

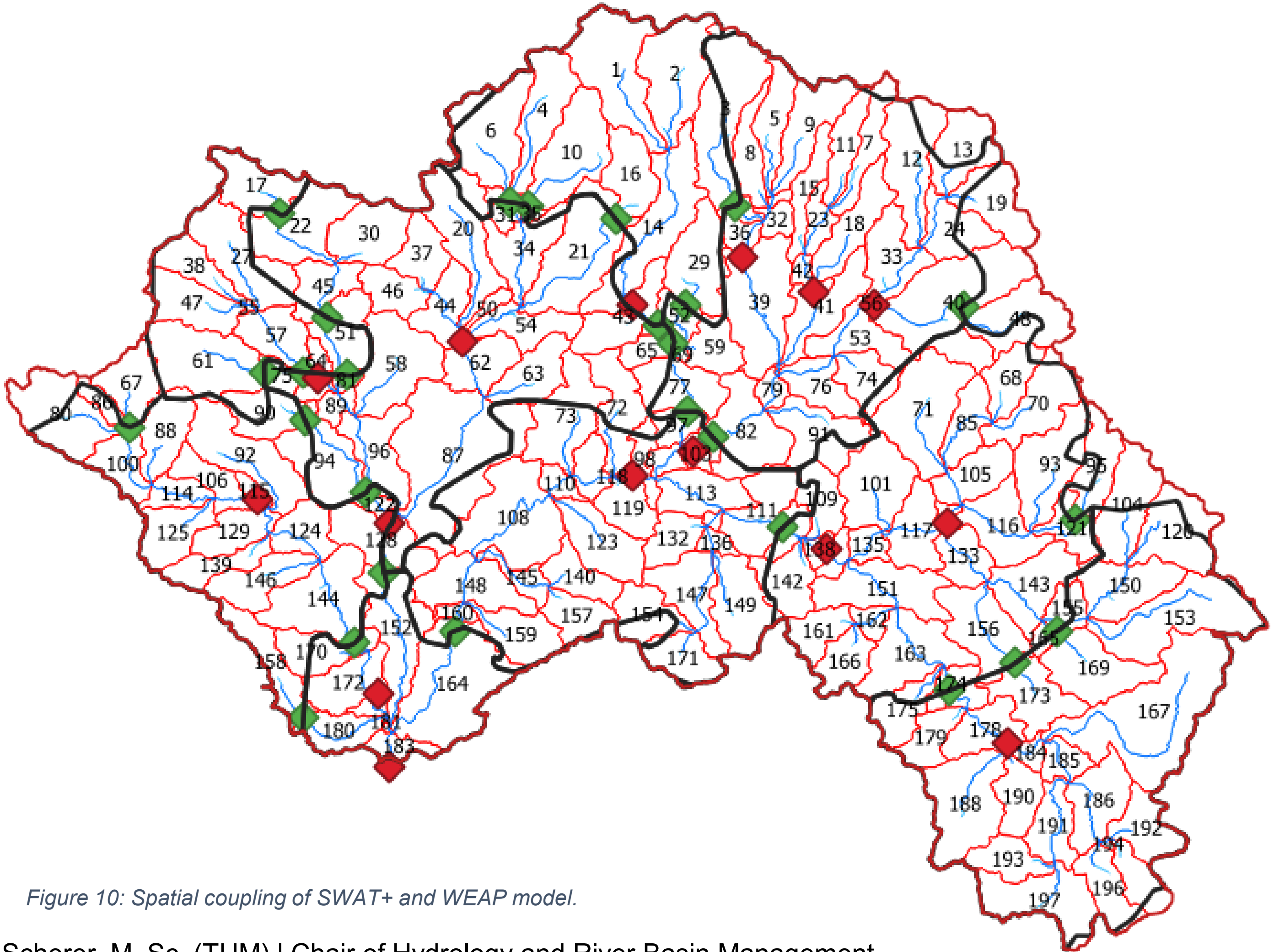

Figure 10: Spatial coupling of SWAT+ and WEAP model.