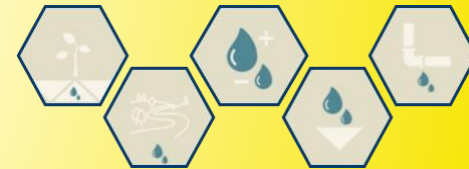


## 2<sup>nd</sup> International LIFE REWAT Summer School

*Digital water management and water-related  
agroecosystem services: geostatistics, hydroinformatics and  
groundwater flow numerical modelling*

September 9<sup>th</sup>—20<sup>th</sup>, 2019  
Scuola Superiore Sant'Anna  
Pisa, Italy



## 2<sup>nd</sup> FREEWAT International Workshop

# Modeling the hydrological impact of land use change in karst systems using the LuKARS plugin for FREEWAT

Daniel Bittner

Technical University of Munich, Germany



**FREEWAT**  
Free and Open Source Software Tools for Water Resource Management  
EU HORIZON 2020 Project

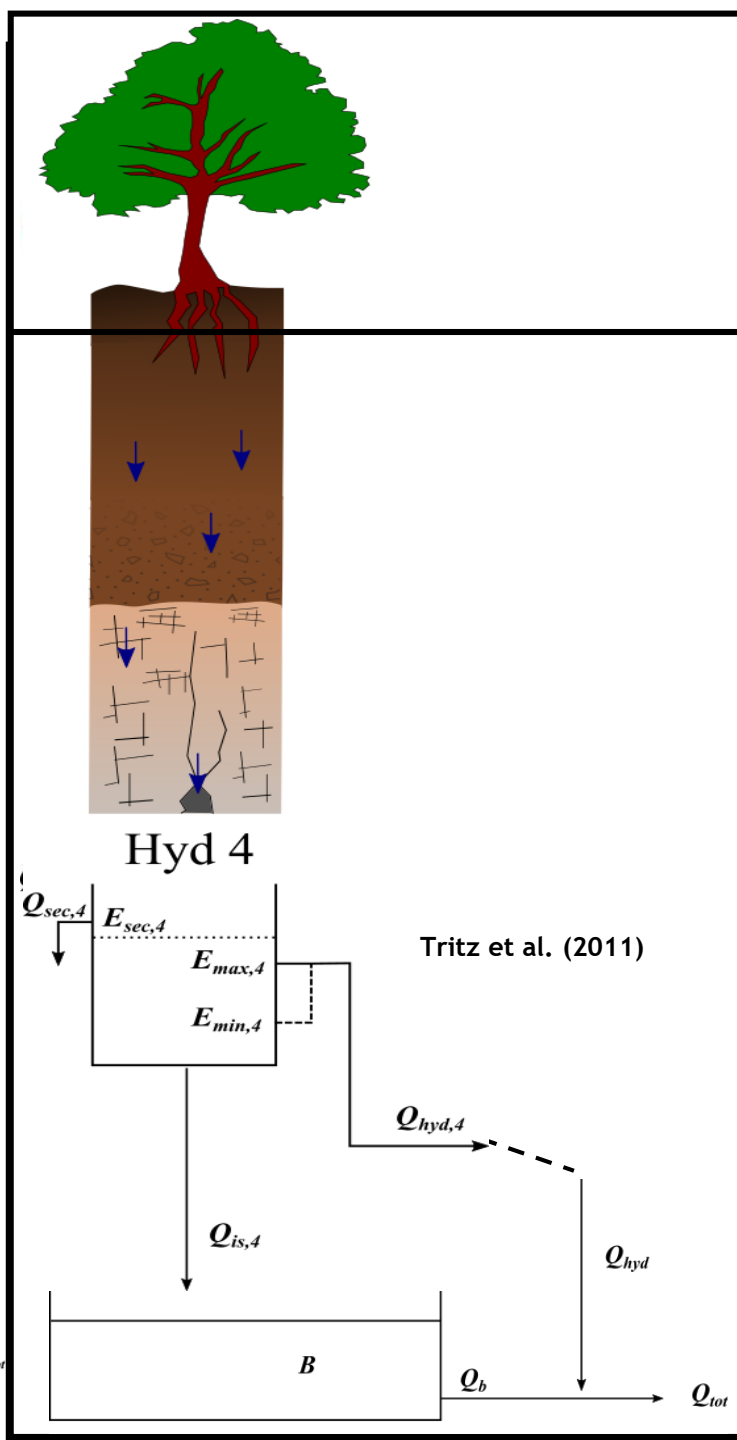
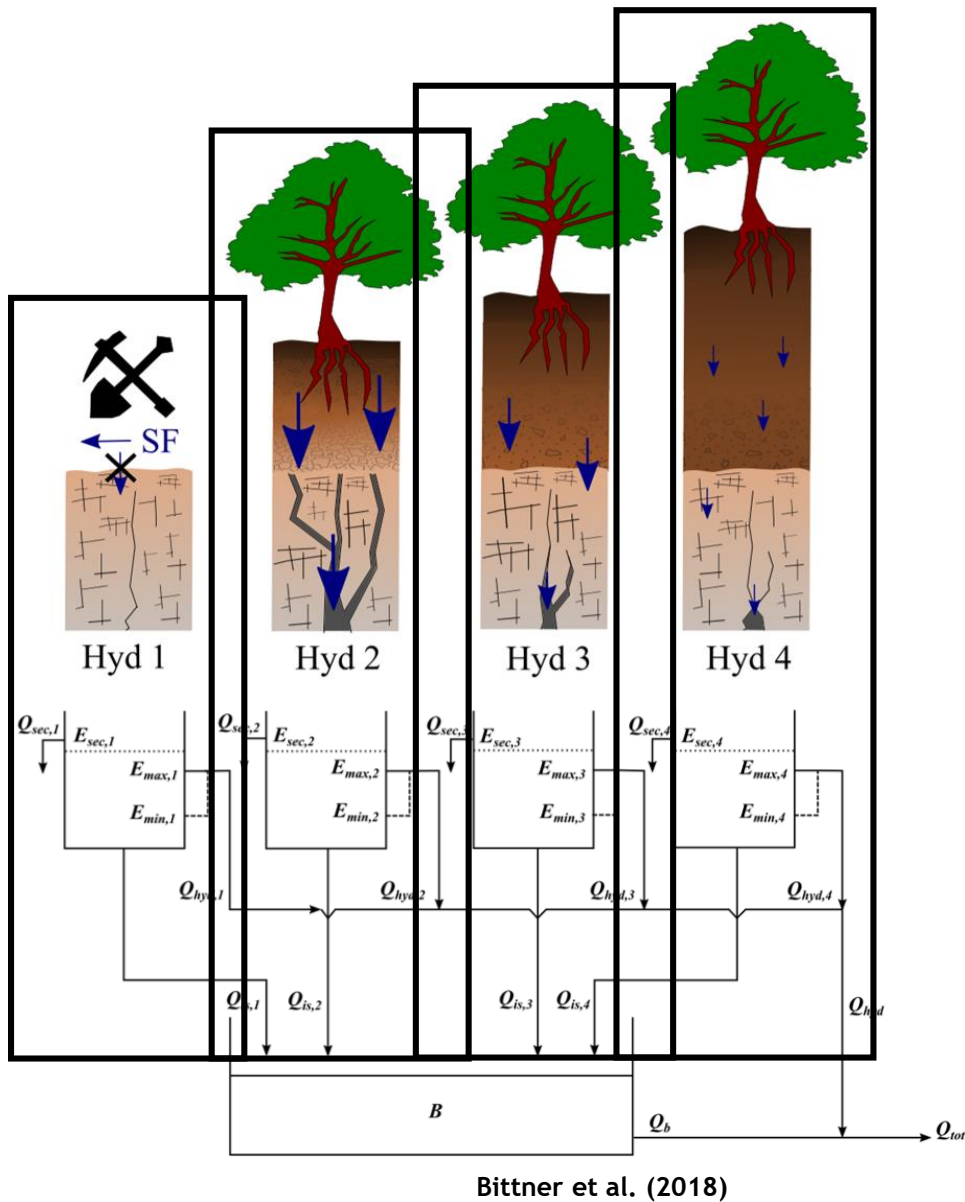
# Modeling the hydrological impact of land use change in karst systems using the LuKARS plugin for FREEWAT

Daniel Bittner, Technical University of Munich,  
Chair of Hydrology and River Basin Management

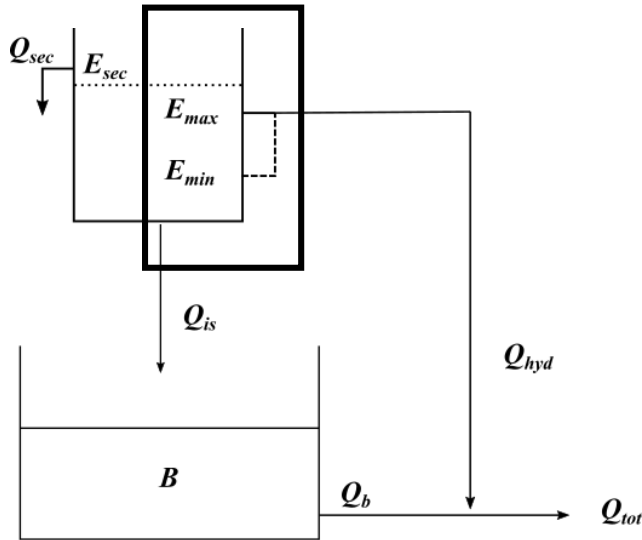
# LuKARS - Land use change modeling in KARSt systems)

- Conceptual, semi-distributed modeling approach suggested by Bittner et al. (2018)
- Hydrotope-based (distinct landscape units characterized by homogeneous hydrological properties as a result of similar land use and soil types)
- Each hydrotope shows distinct hydrological responses to rainfall events depending on its soil properties
  - Separation of flows to gw recharge and quickflow
- Land use changes considered as changing hydrotope properties and/or varying evapotranspiration

# Model concept



# Physically-based parameters



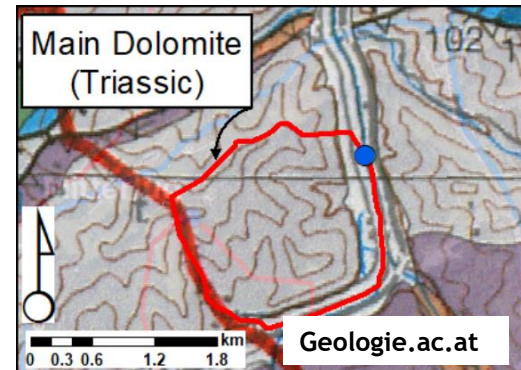
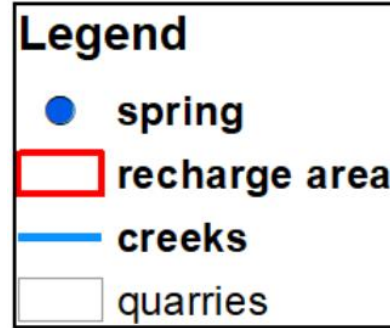
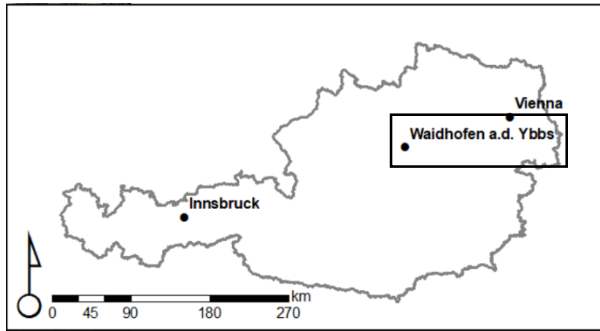
$E_{min}, E_{max}$

determined based on hydropedological fieldguide (DWA, 2019)

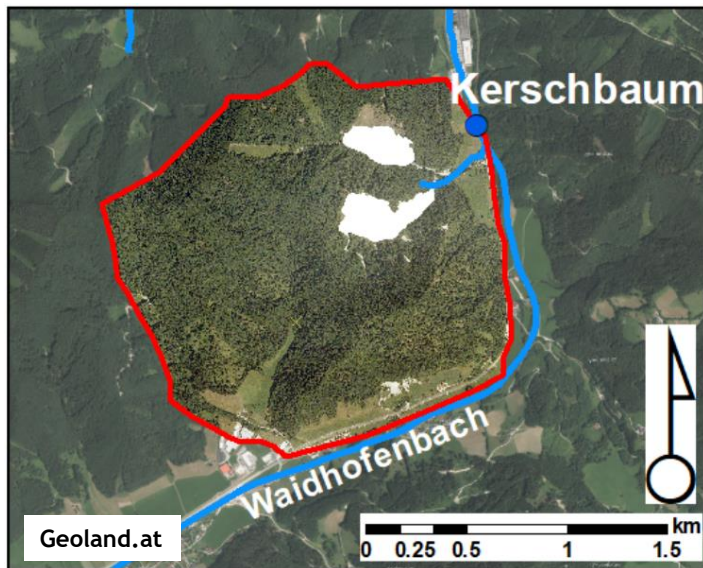
$k_{hyd}$

decreasing from high to low permeability

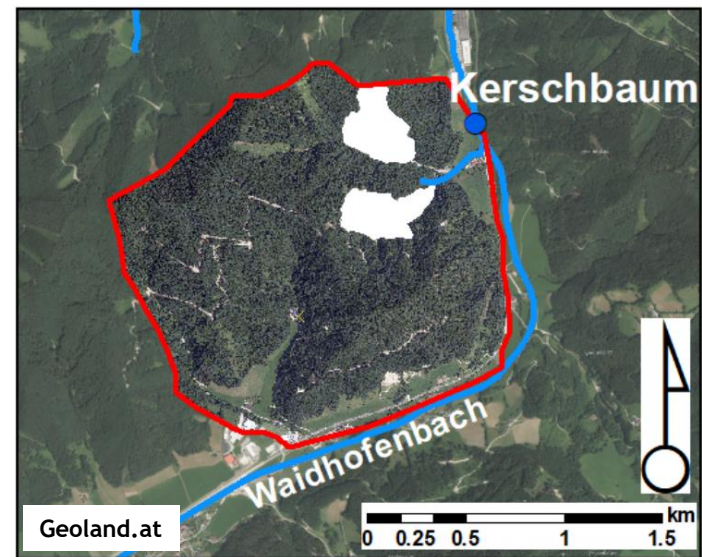
# Case study



2007



2010 - 2013



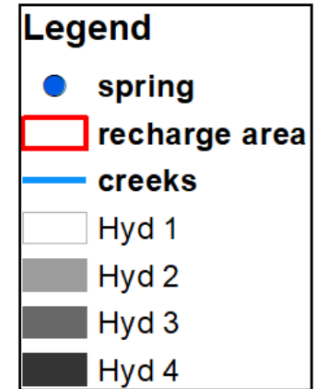


# Case study

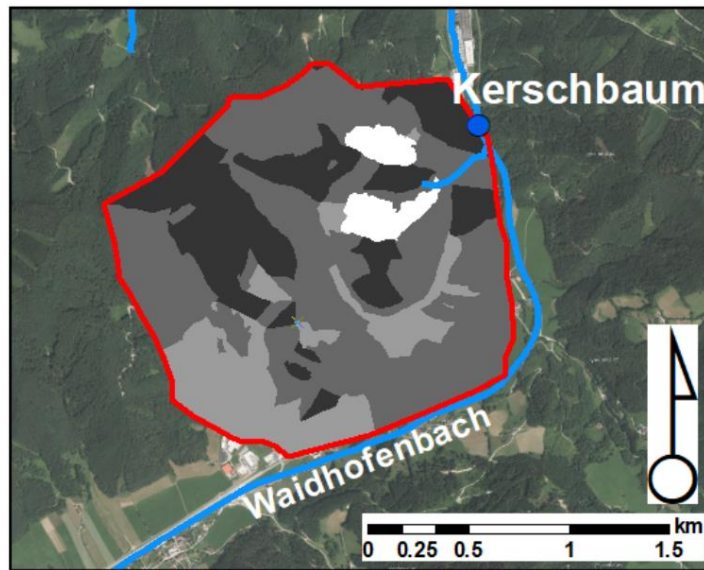
Required data:

Spatial data: detailed classification of the dominant hydrotopes in the recharge area

Time series: Q and P (optional: T and snow depth)



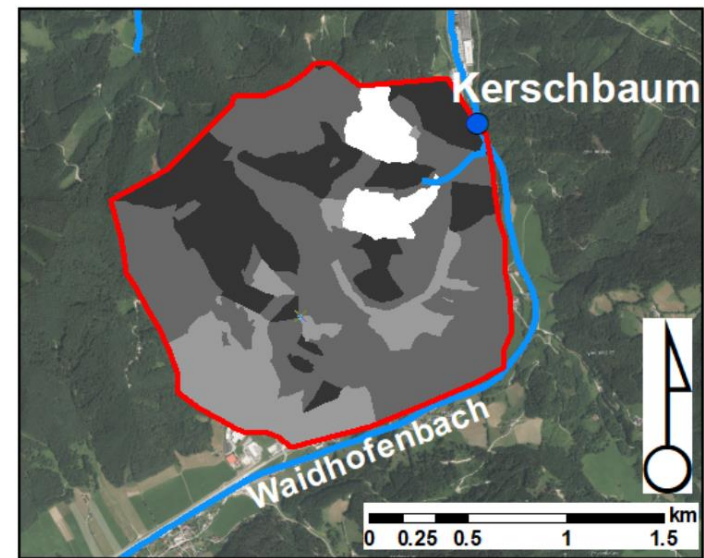
**2007**



Bittner et al. (2018)



**2010 - 2013**



Bittner et al. (2018)

# Freewat implementation

QGIS 2.18.21 - farm

Projekt Bearbeiten Ansicht Layer Einstellungen Erweiterungen Vektor Raster Datenbank Web

FREEWAT Verarbeitung Hilfe

- Data-Preprocessing (akvaGIS)
  - Model Setup
  - MODFLOW Boundary Conditions
  - Solute Transport Process
  - Water Management and Crop Modeling (FARM PROCESS)
  - Calibration/Sensitivity
  - Tools
  - DataBase
  - Post-processing
  - OAT
  - Land use change modeling in KARst systems (LuKARS)
  - About
- Run model

Dialog

Set-up model input Define parameters Hilfe

Set up LuKARS model

Take over sensors from OAT

Precipitation

Temperature

Discharge Q

Define hydrotopes

Number of hydrotopes 0

Input .shp hydrotape 1 hydrotape1

Input .shp hydrotape 2 hydrotape1

Input .shp hydrotape 3 hydrotape1

Input .shp hydrotape 4 hydrotape1

Snow Model

On Off

Interception

On Off

Evapotranspiration

On Off

hyd melt factor melting threshold [°C] hyd interception threshold

1 2 3 4

Warm-up period

from 01.01.2000

to 01.01.2000

Calibration period

from 01.01.2000

to 01.01.2000

Validation period

from 01.01.2000

to 01.01.2000

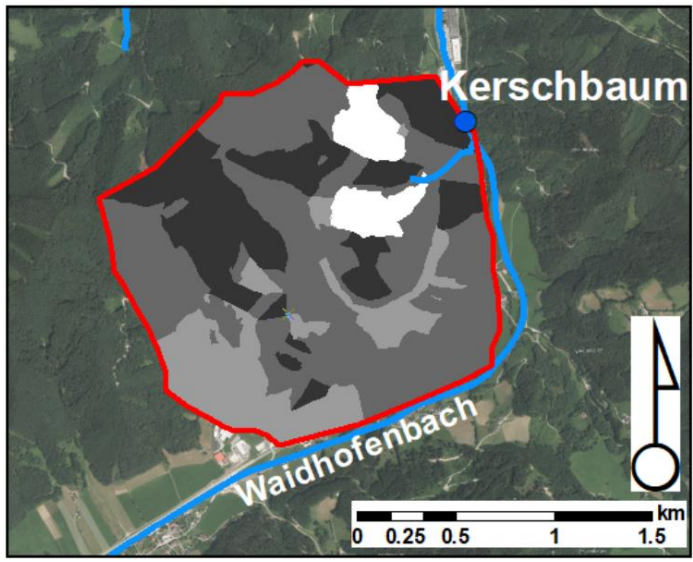
Prediction period

from 01.01.2000

to 01.01.2000

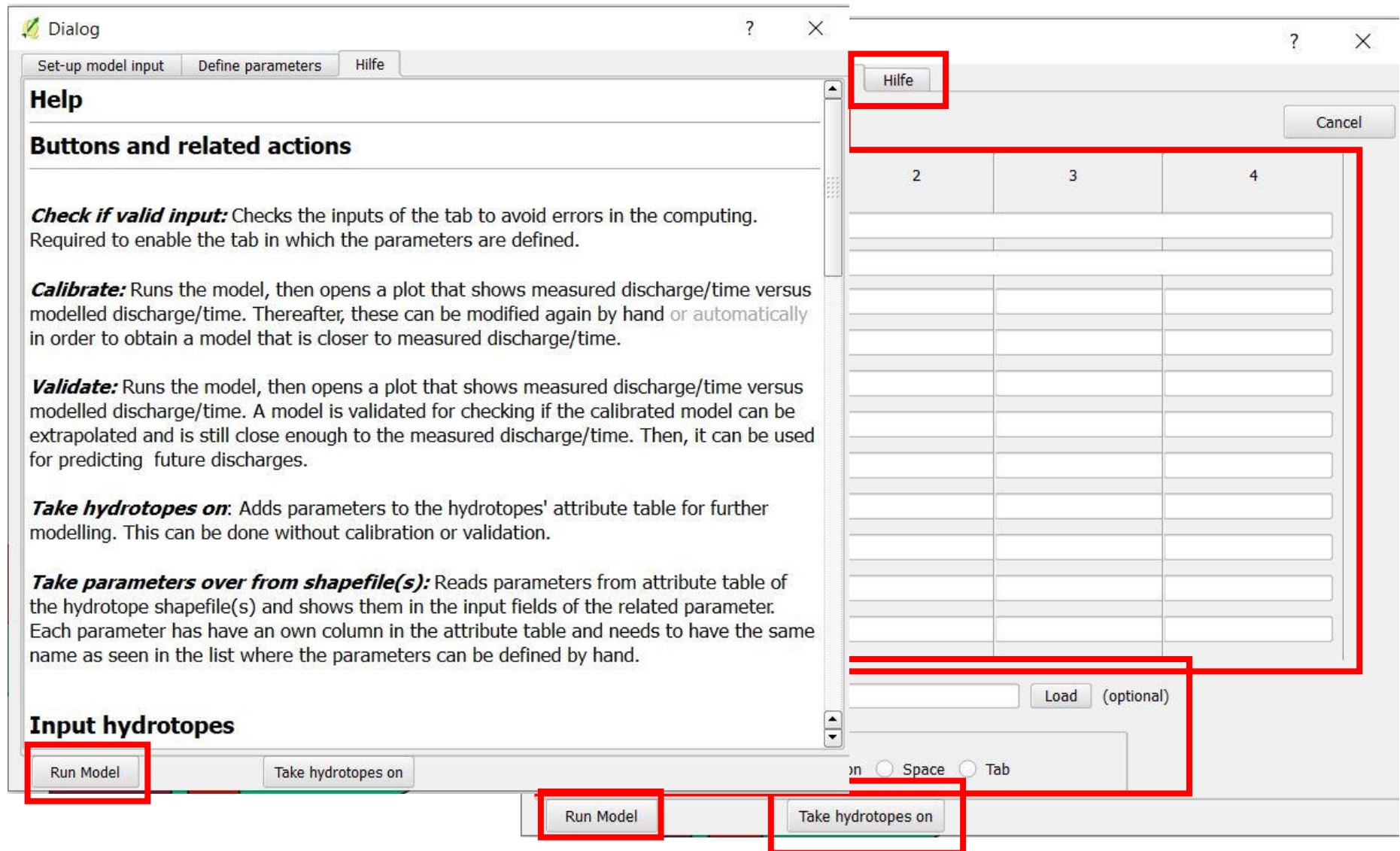
Check if valid input

Run Model Take hydrotopes on

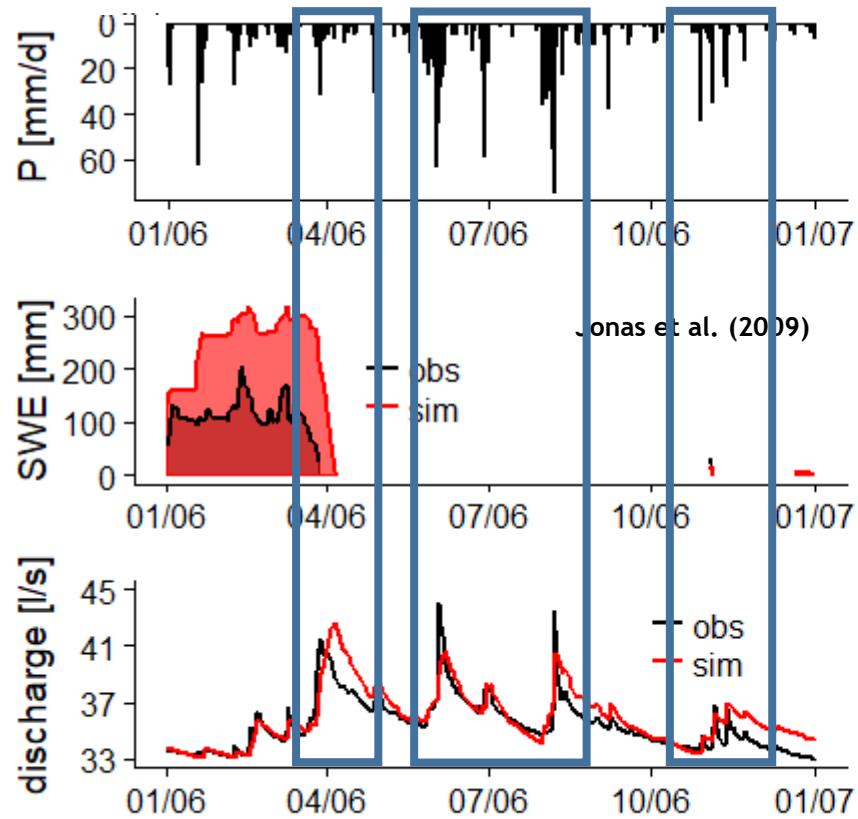




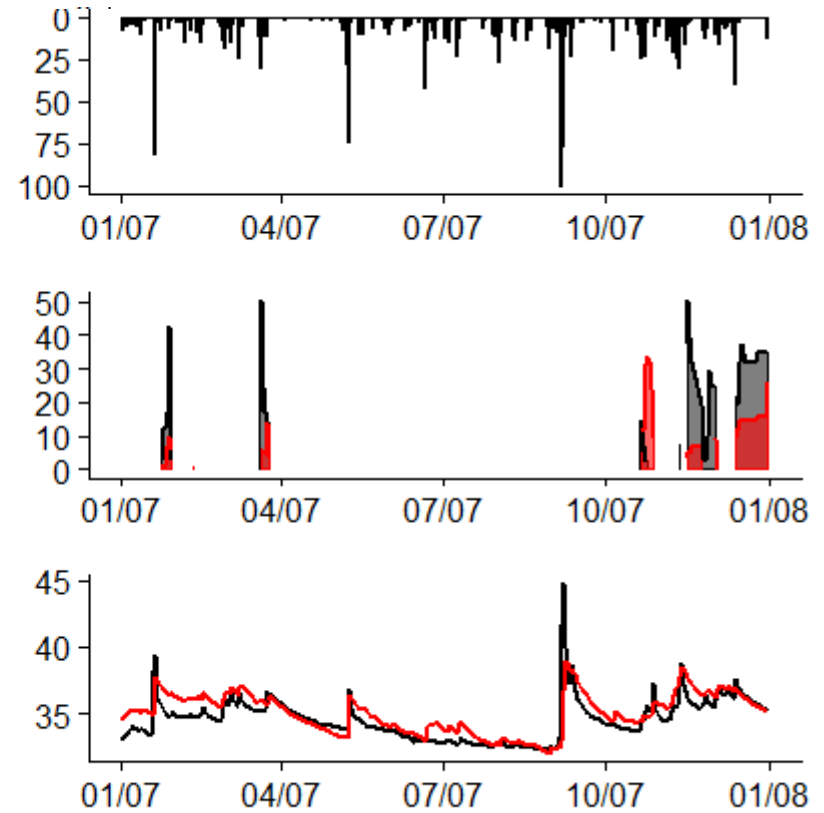
# Freewat implementation



# Modeling results

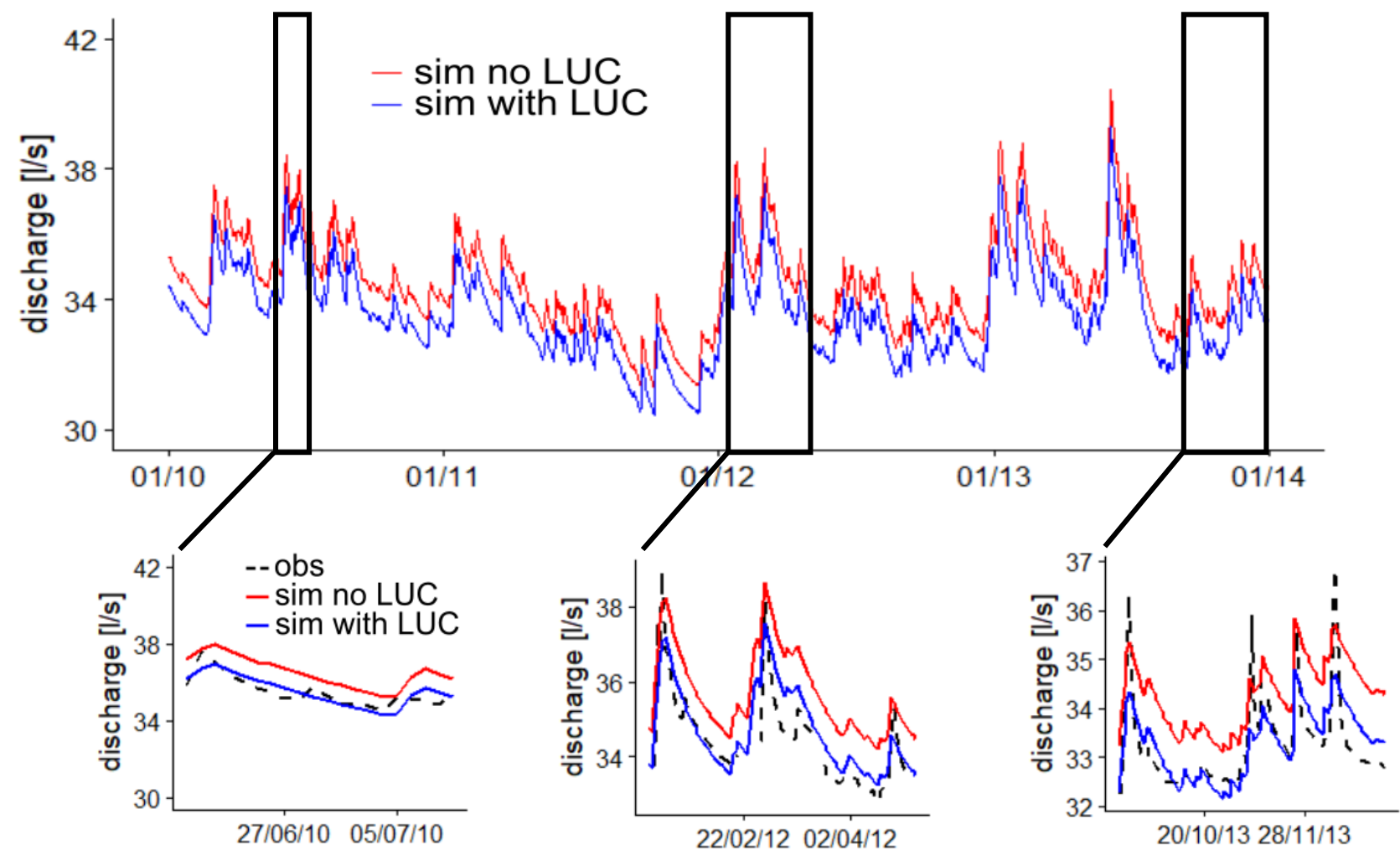


**NSE: 0.66**  
**MAE: 0.78 [l/s]**



**NSE: 0.53**  
**MAE: 0.78 [l/s]**

# Modeling results



NSE	-1.1	0.65	-0.41	0.70	-0.78	0.58
MAE [l/s]	1.0	0.36	1.2	0.46	1.1	0.39

# Open questions – next steps

- So far only diffuse recharge is considered – next step is to account for concentrated recharge as typical in (limestone) karst, ideas?
- Any important thing missing in FREEWAT implementation?
- Suggestions for further linking existing FREEWAT features with LuKARS?
- Any further ideas?

**Thanks for your attention**



## LIFE REWAT project partners



## LIFE REWAT project co-financers



## Supported by

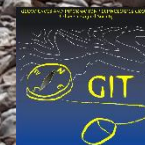


University of Applied Sciences and Arts of Southern Switzerland

**SUPSI**

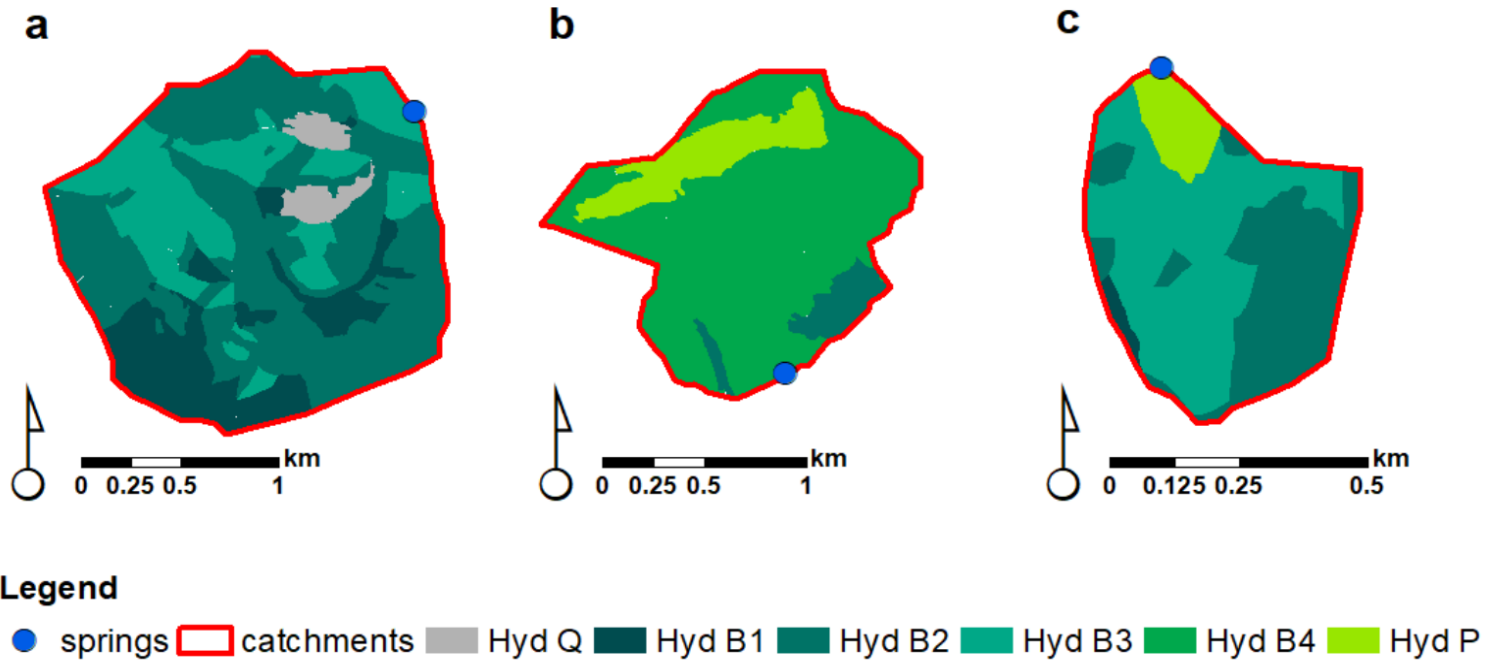


## Patronage





# Hydrotopes in recharge areas



a → Kerschbaum  
b → Hinterlug  
c → Mitterlug

# Hinterlug application

