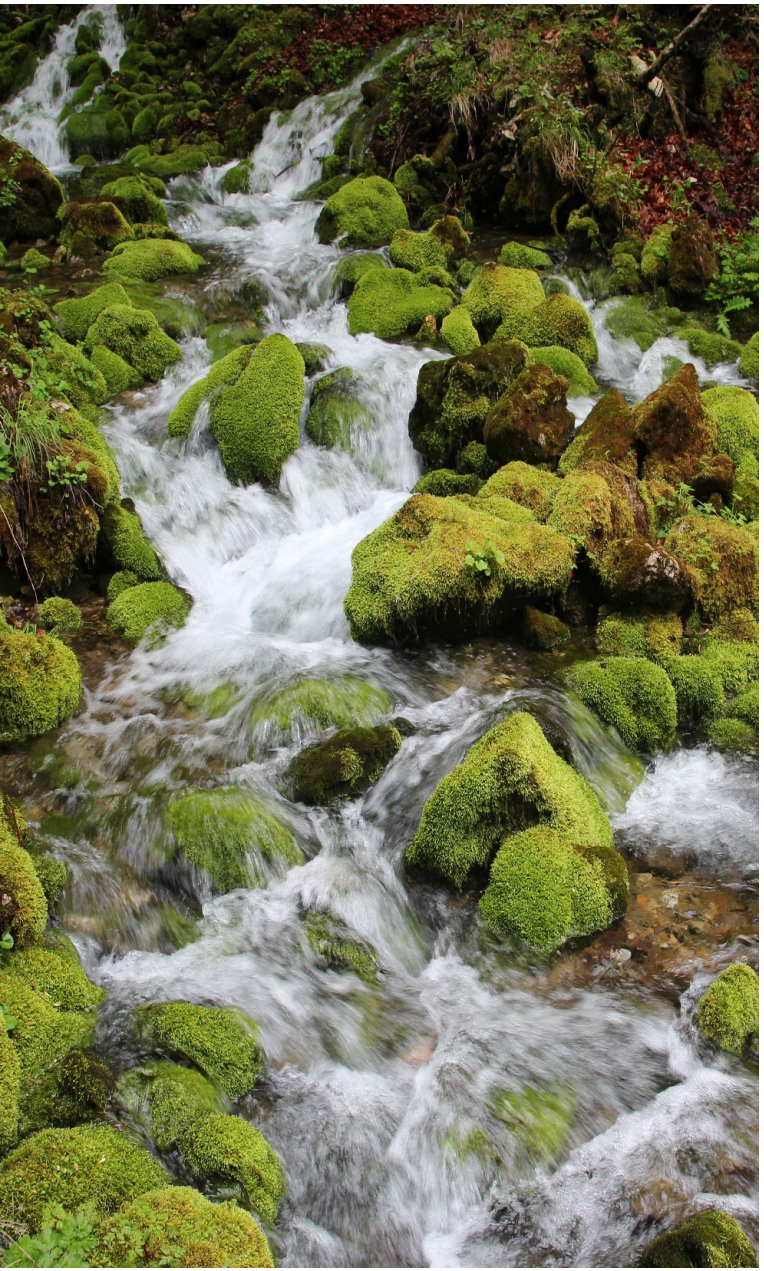

Groundwater recharge modeling – is distributed soil information important in hydrological models?

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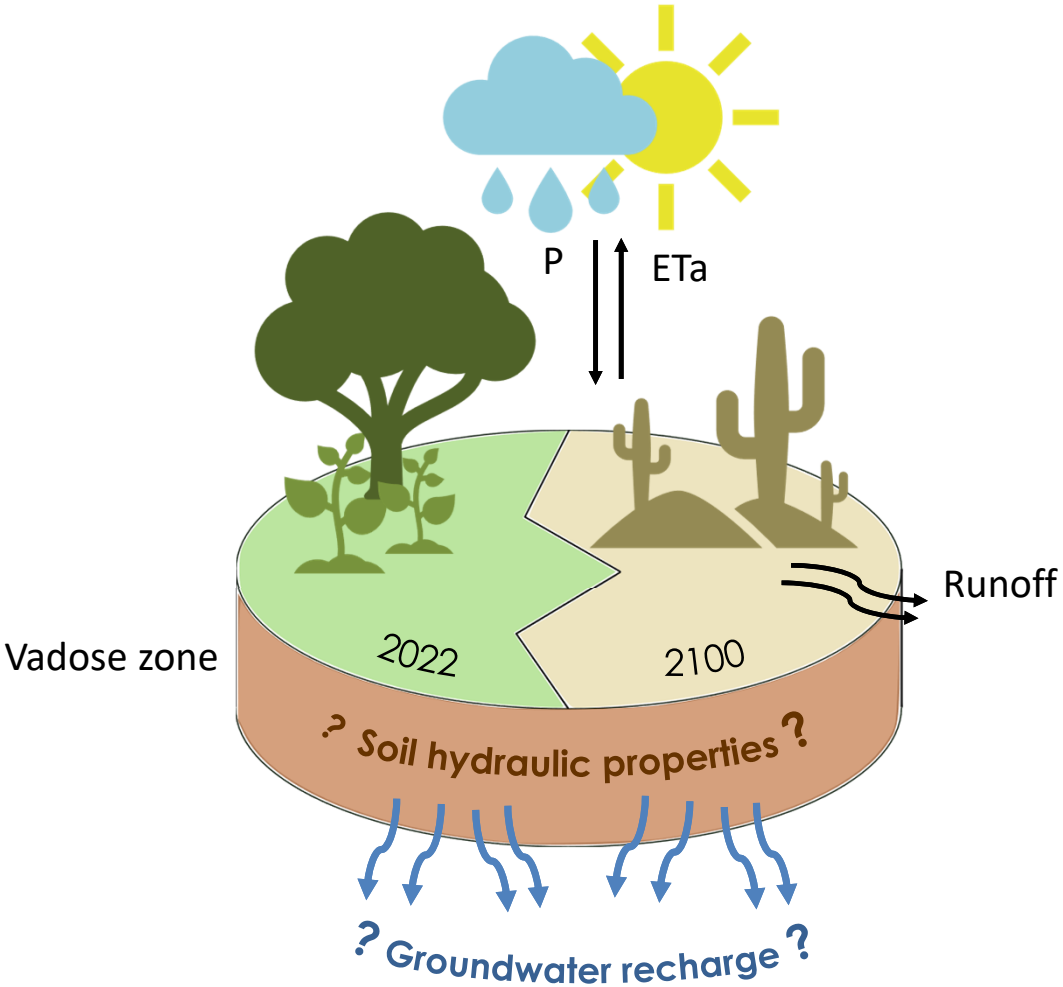
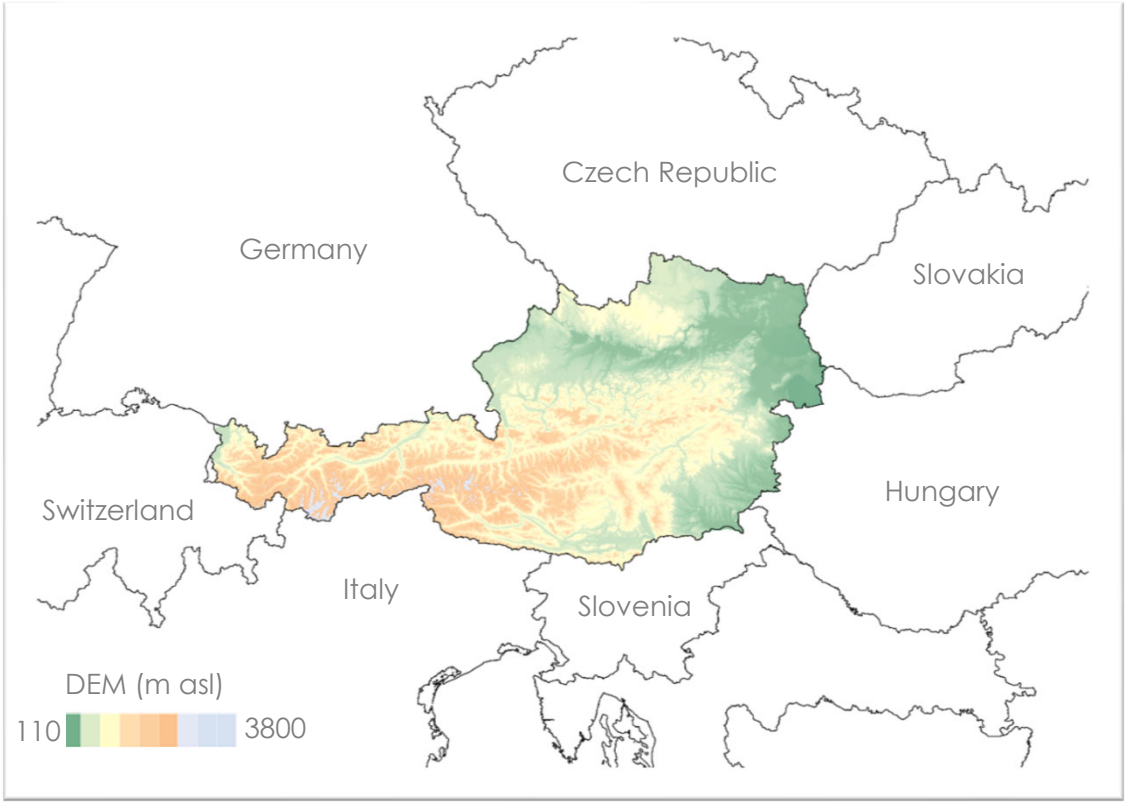
EGU General Assembly 2022

OBJECTIVES


P
ETa
Runoff
Vadose zone
2022
2100
? Soil hydraulic properties ?
? Groundwater recharge ?

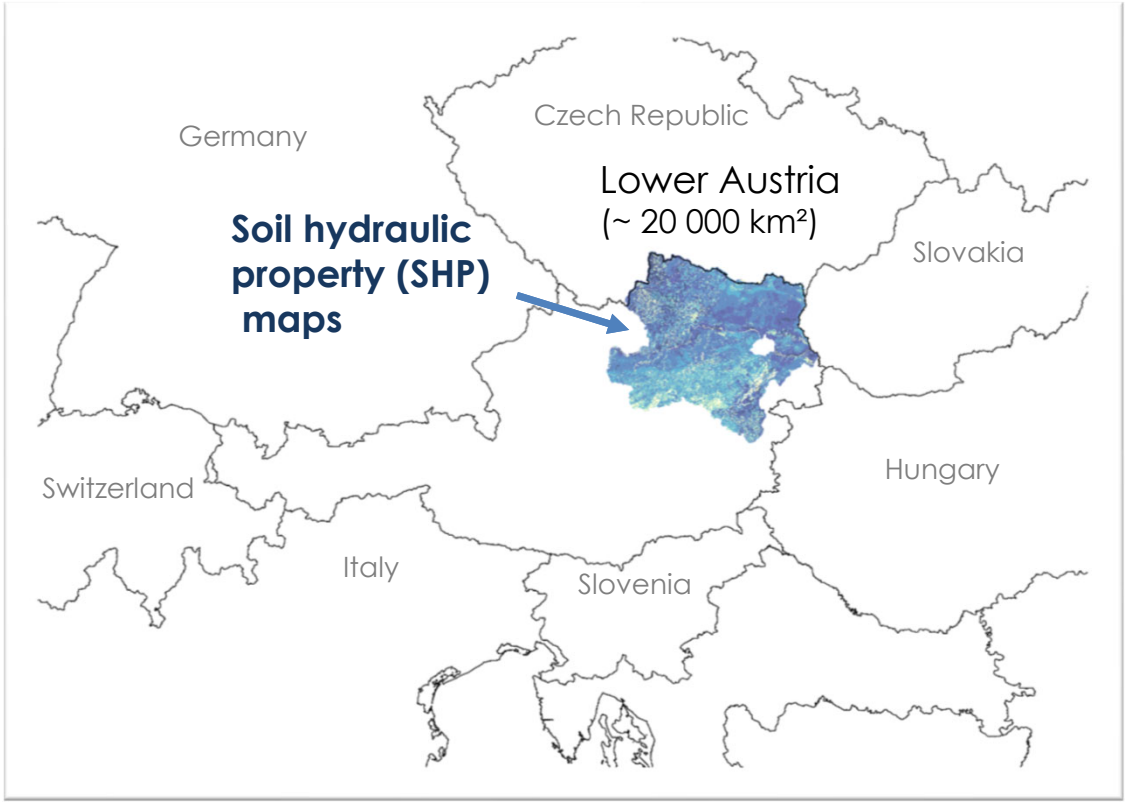
Study Area & Soil Data

Austria (~ 84 000 km²)



Study Area & Soil Data

Austria (~ 84 000 km²)



- soil water storage (s)
- capillary flow (g)
- total pore volume (pv)
- Ksat

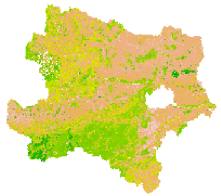
3 depth layers (0 – 100 cm)

SHP maps from Hydrobod II project (Sotier et al. 2017)

Machine Learning (ML) Based Regionalization

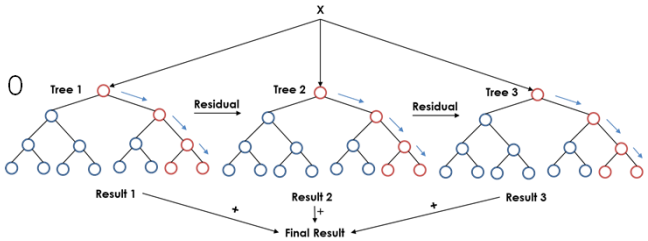
Input

SHP



Predictors:
environmental
covariates

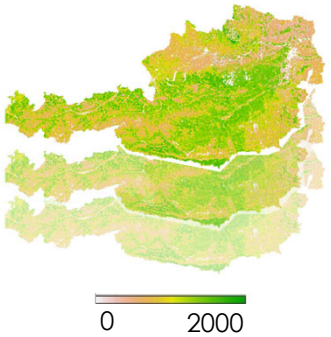
ML model training



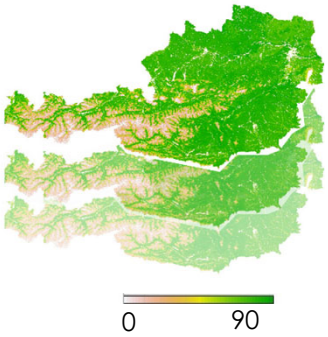
XGBoost
(eXtreme Gradient Boosting)

transfer to
study area

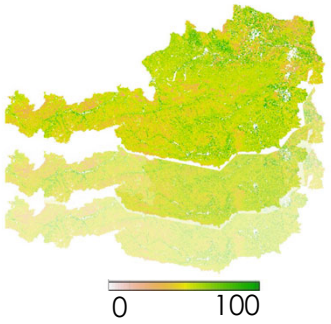
Ksat (mm/d)



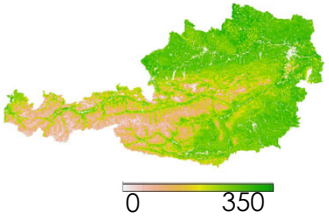
pv (mm/d)



g (mm/d)



s (mm)

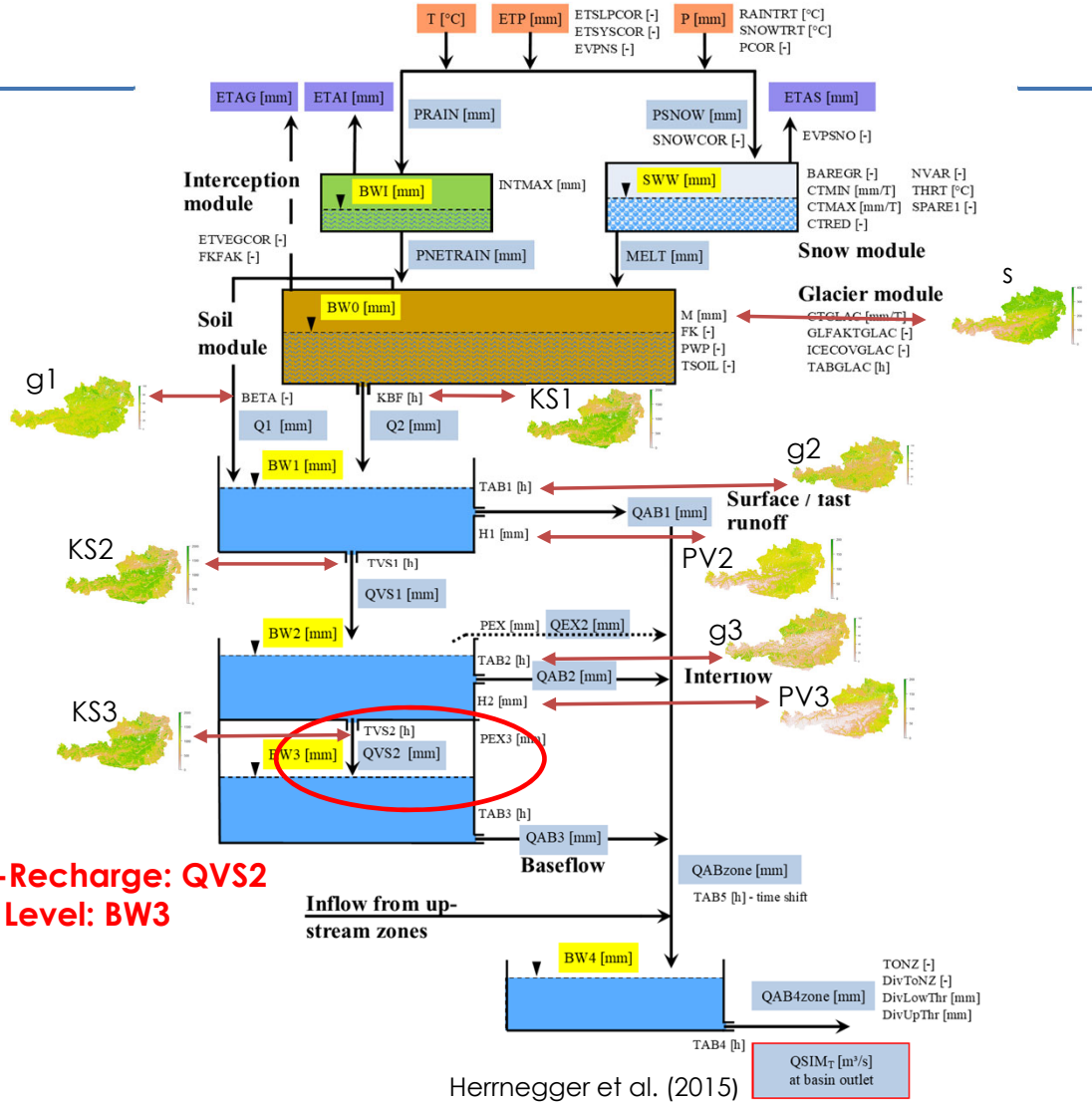


HYDROLOGICAL MODEL

COSERO
(COntinuous SEmi-distributed RunOff)

Input
- Climate Data, Discharge
- DEM, Landcover
- ➢ **Spatially distributed SHP**

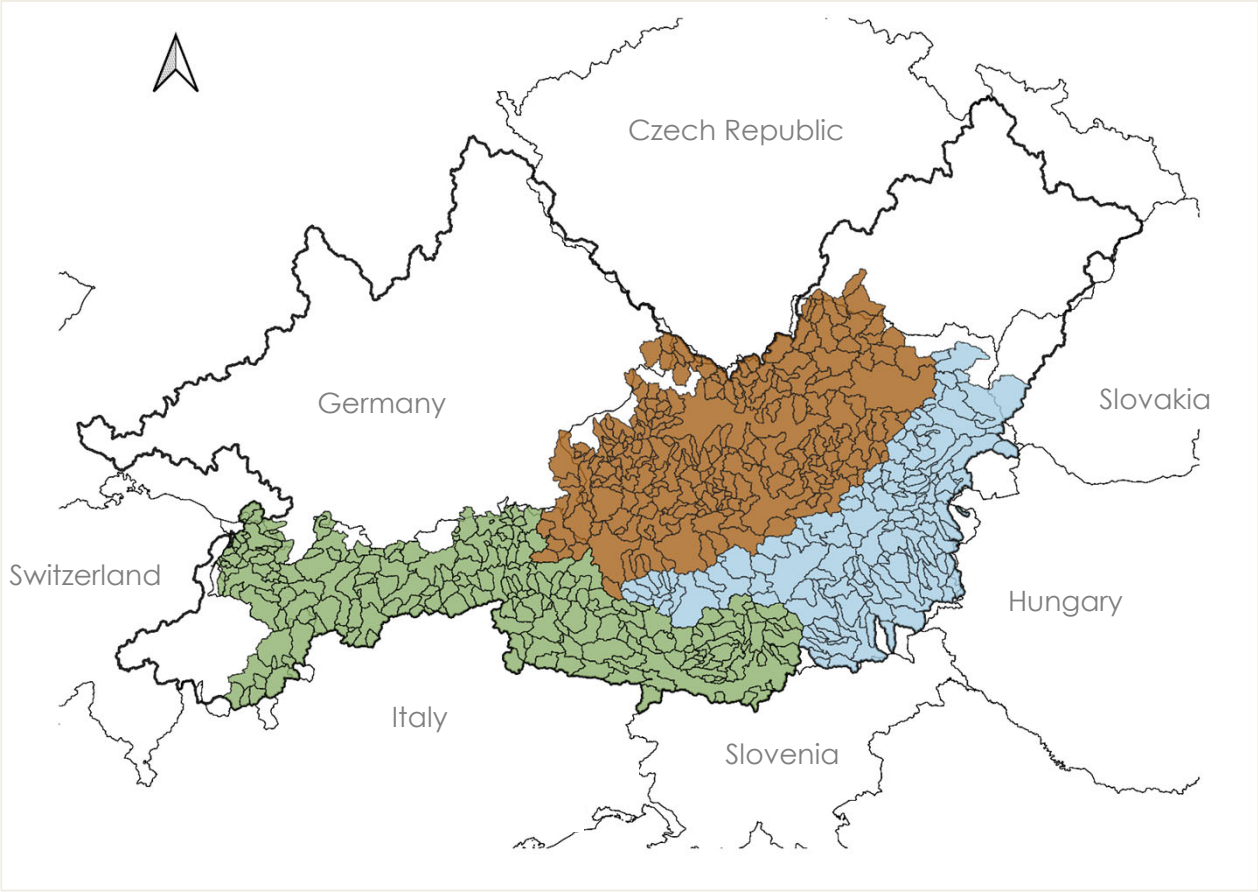
Resolution
- monthly, 1 x 1 km²



GW-Recharge: QVS2
GW Level: BW3

Herrnegger et al. (2015)

Hydrological Model Set-Up



Region LamaH-CE (Klingler et al., 2021)

Region West: 227

Region Danube: 243

Region Southeast: 138

608 river basins

borders

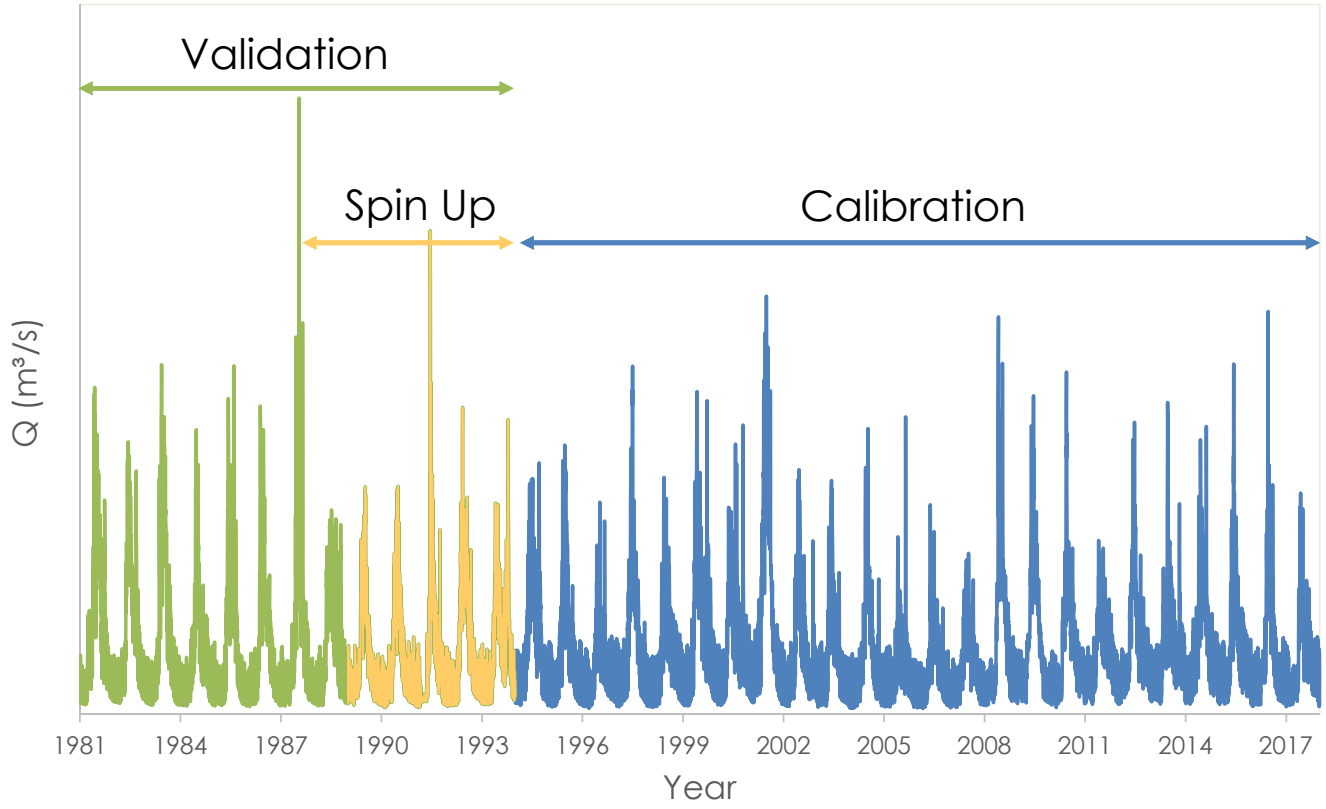
Numerical Experiments / Parameter Optimization

21 parameters
objective function: NSE (70 %) + logNSE (30 %)

I. **Region West - distributed**
spatially distributed SHP*

II. **Drau Catchment - lumped**
lumped SHP

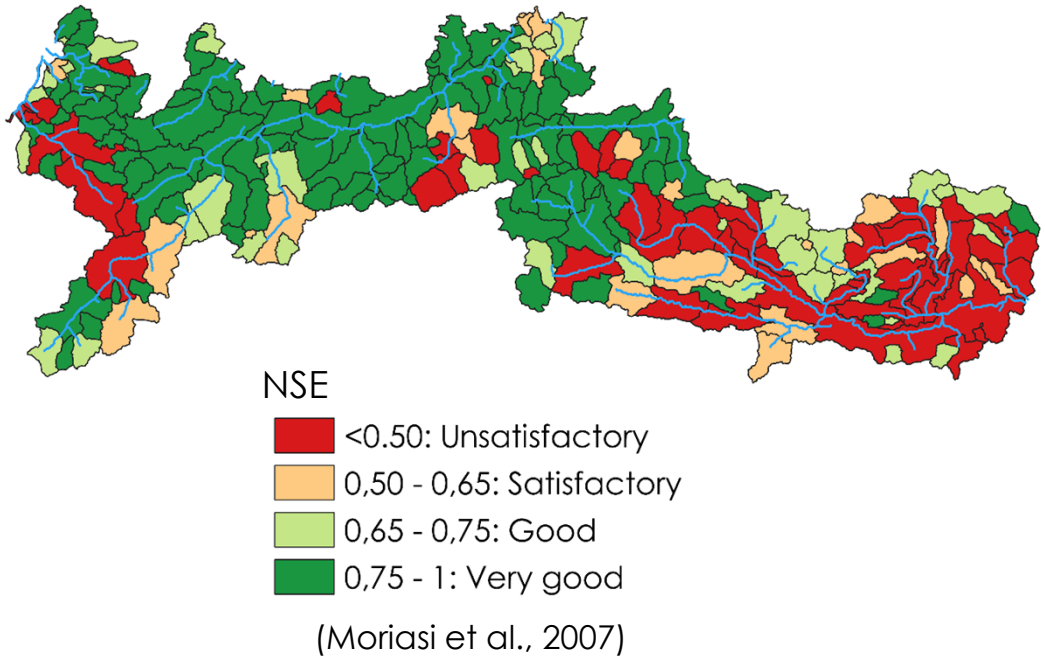
* SHP = soil hydraulic properties



Preliminary Results – Model Performance

Nash-Sutcliffe-Efficiency - Calibration period (1994 – 2017)

Region West - distributed:



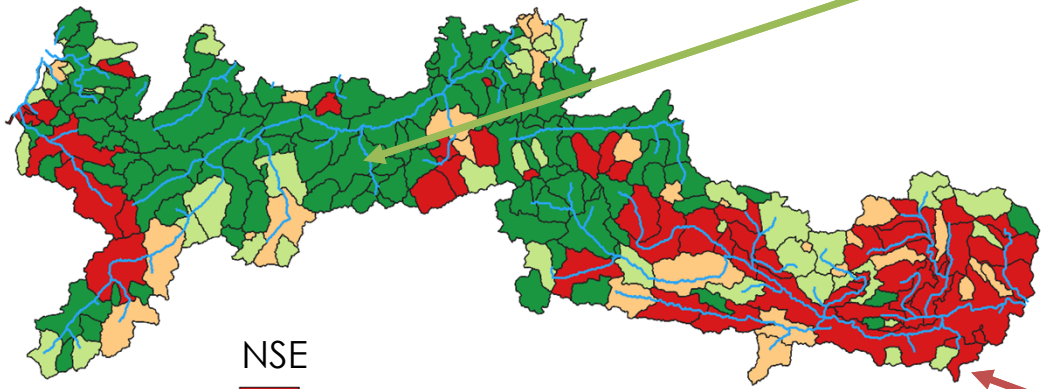
NSE	**median$_{calibr.}$**	**median$_{val.}$**
Basin-by-basin	0.73	0.75
Drau-distributed	0.64	0.66
Drau-lumped	0.63	0.64

KGE	**median$_{calibr.}$**	**median$_{val.}$**
Basin-by-basin	0.79	0.77
Drau-distributed	0.70	0.71
Drau-lumped	0.69	0.69

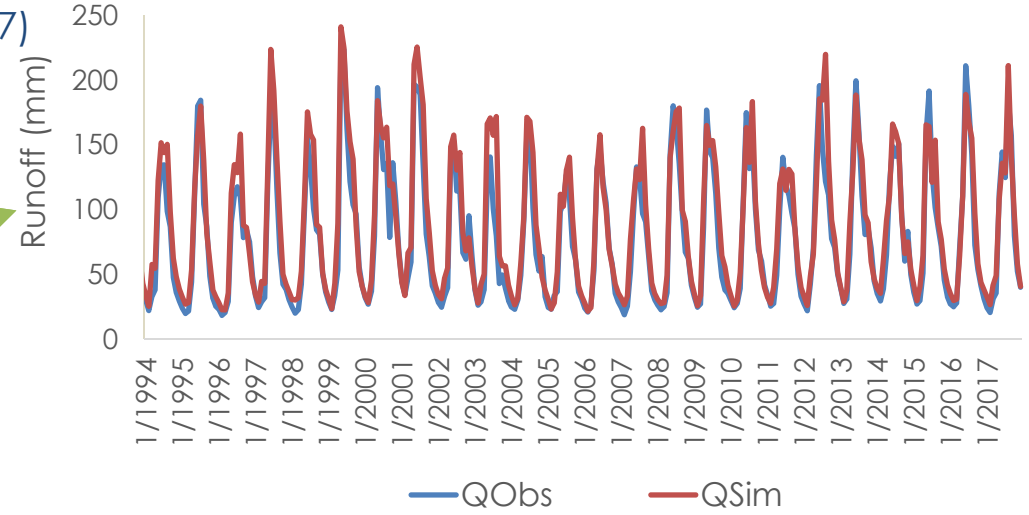
Preliminary Results – Model Performance

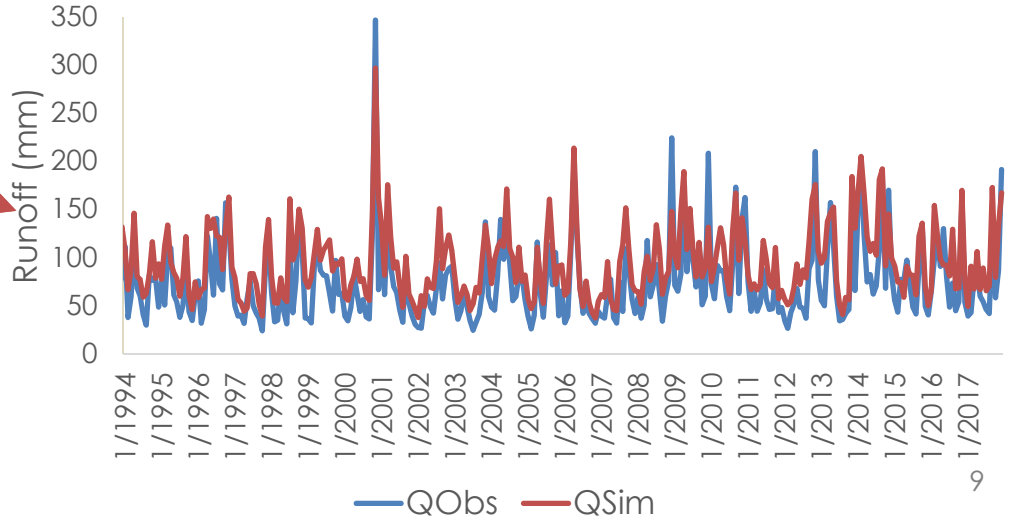
Nash-Sutcliffe-Efficiency - Calibration period (1994 – 2017)

Region West - distributed:



(Moriasi et al., 2007)



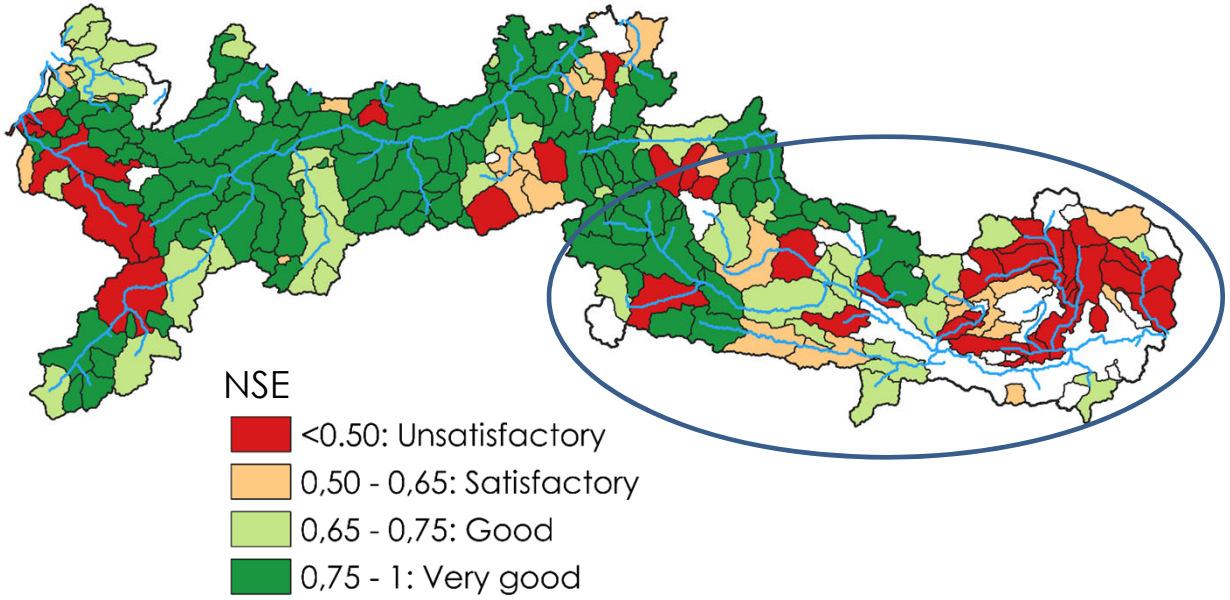


Preliminary Results – Model Performance

Nash-Sutcliffe-Efficiency - Validation period (1981 – 1994)

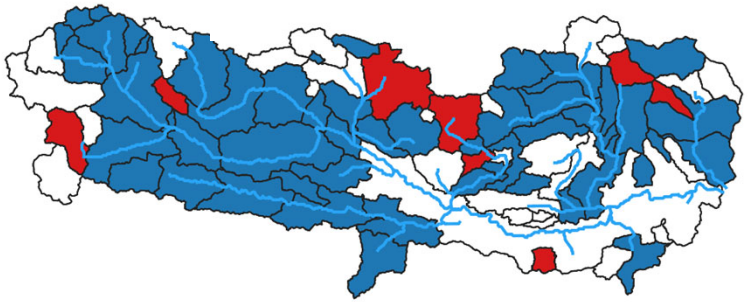
NSE	median$_{calibr.}$	median$_{val.}$
Region West	0.73	0.75
Drau-distributed	0.64	0.66
Drau-lumped	0.63	0.64

Region West - distributed:



(Moriasi et al., 2007)

Drau catchment:



$NSE_{distr} - NSE_{lump}$

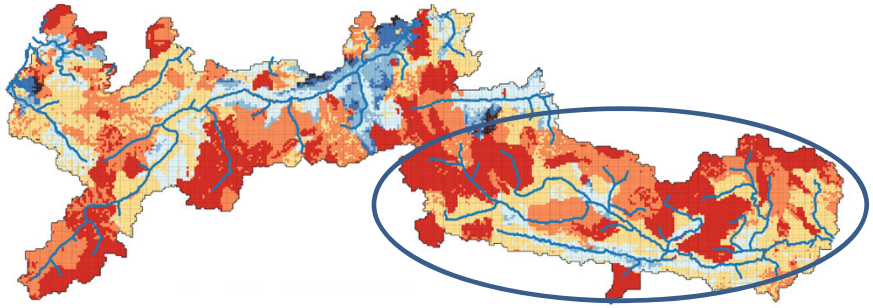
- > 0
- incomplete data for validation period
- < 0

Preliminary Results – Groundwater Recharge

Mean annual simulated groundwater recharge (calibration period 1994 – 2017)

Region West - distributed:

mean = 40 mm, sd = 26 mm

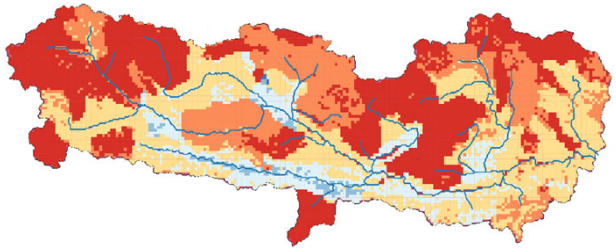


mean annual GWR (mm)

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 180

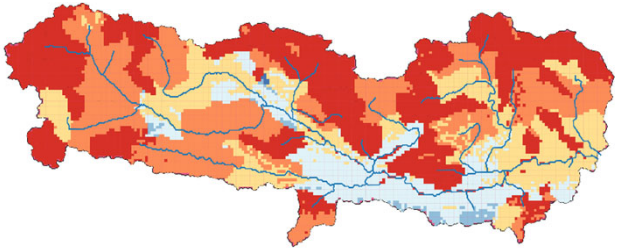
I) Drau - distributed:

mean = 35 mm, sd = 21 mm



II) Drau - lumped:

mean = 34 mm, sd = 21 mm

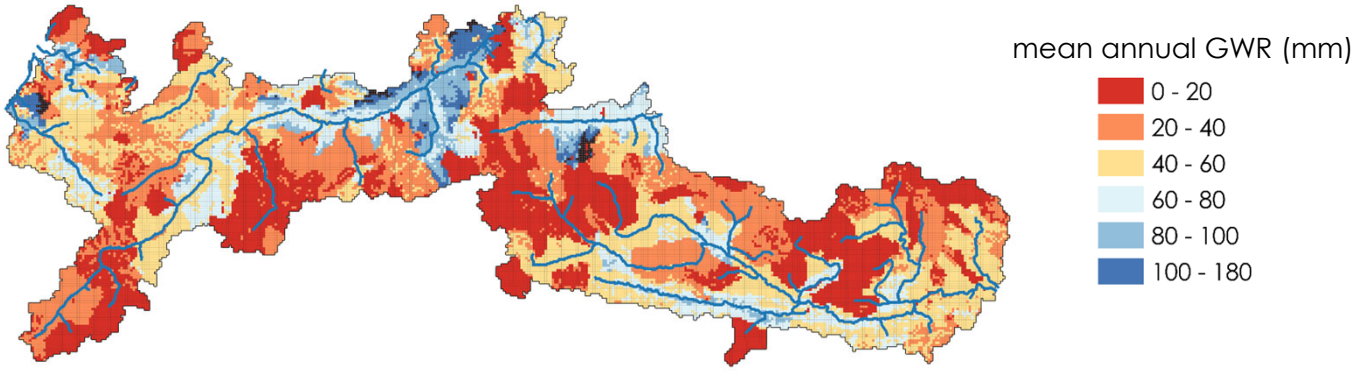


mean annual GWR (mm)

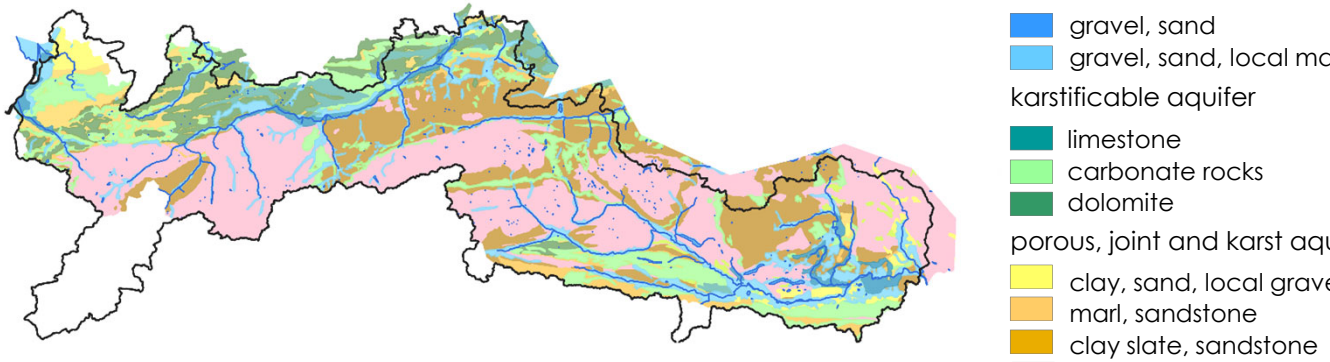
- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 180

PLAUSIBILITY CHECK

Region West - distributed



Hydrogeology



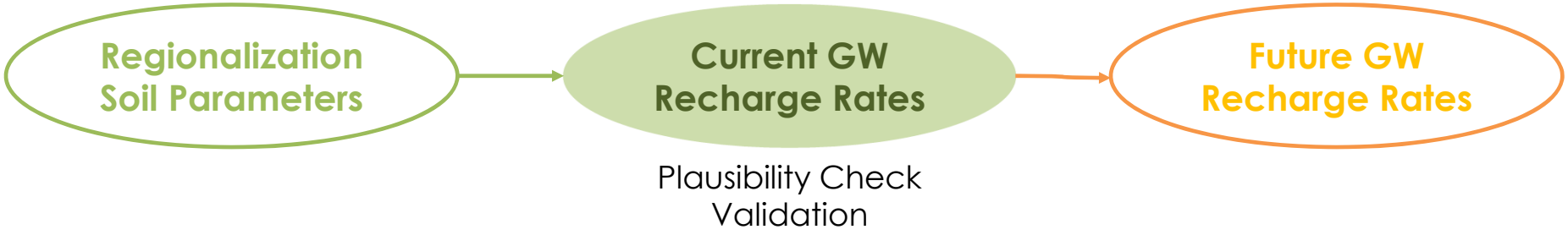
BMLFUW (2007), map 6.2

CONCLUSION

Preliminary results:

- more test regions and in-depth analysis are necessary!
- model performance increases in spatial distributed soil parameter set-up
- spatial patterns of simulated GWR seem plausible, but further analyses are necessary
- reality of spatial distribution of GWR is unknown

OUTLOOK



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Klingler, C., Schulz, K., and Herrnegger, M.: LamaH-CE: LArge-SaMple DAta for Hydrology and Environmental Sciences for Central Europe, Earth Syst. Sci. Data, 13, 4529–4565, https://doi.org/10.5194/essd-13-4529-2021, 2021

Moriasi, Daniel & Arnold, Jeff & Van Liew, Michael & Bingner, Ron & Harmel, R.D. & Veith, Tamie. (2007). Model Evaluation Guidelines for Systematic Quantification of Accuracy in Watershed Simulations. Transactions of the ASABE. 50. 10.13031/2013.23153.

Sotier, B., Klebinder, K., Bauer, T., Markart, G., Strauss, P., 2017., „Hydrologische Bodenkenndaten Niederösterreich – HYDROBOD-NÖ“, zweite Projektphase (Ergänzungsbericht (unveröffentlicht)).

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