
Evaluation of measures to reduce groundwater nitrate concentrations by coupled regional groundwater modeling

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L UWQ 15

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background conflict water supply - agriculture

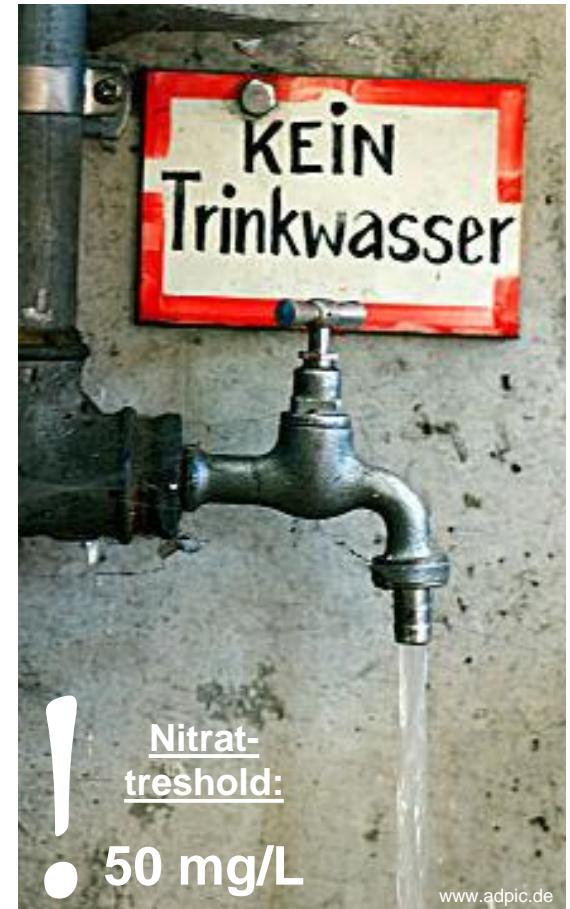
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Nitrogen
fertilizers



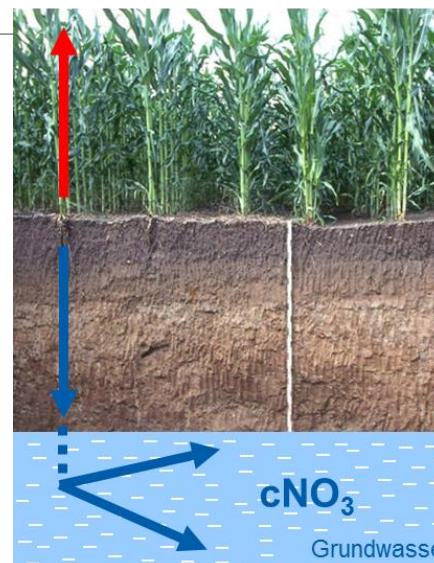
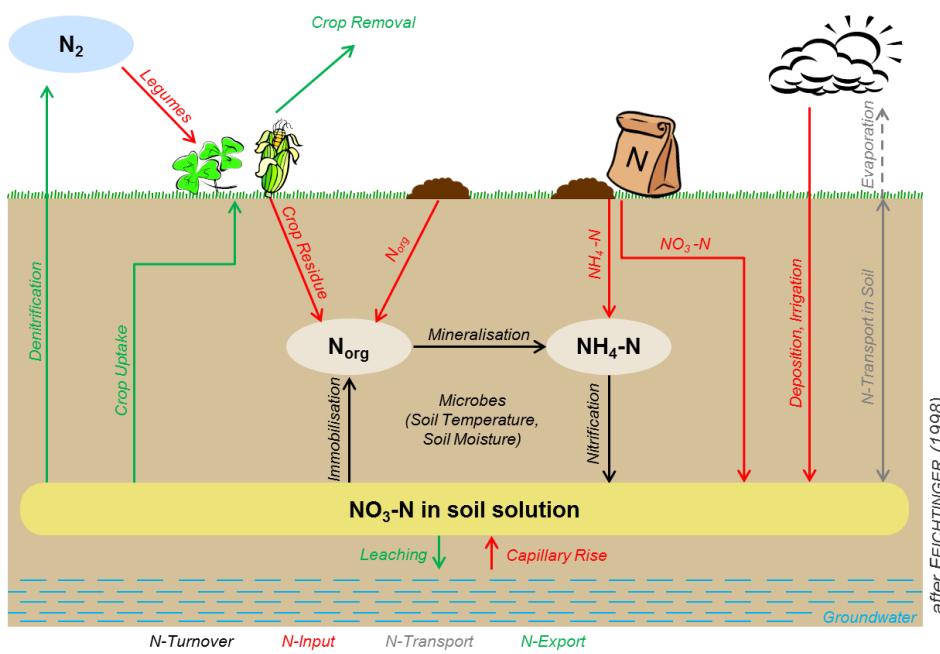
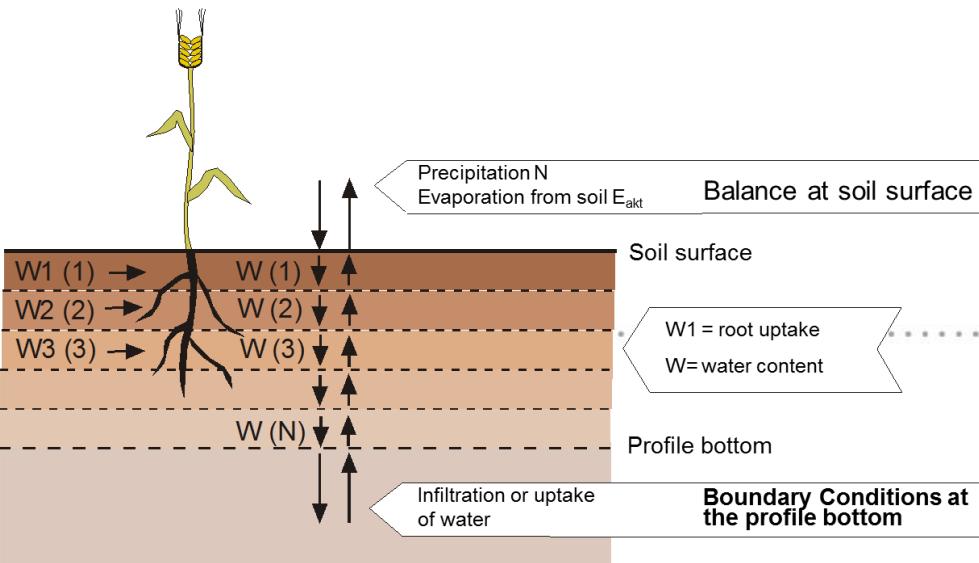
nitrate leaching
into groundwater



Nitrat-
threshold:
● 50 mg/L

approach

- **1d vertical movement** of water and nitrate mass in the unsaturated and **2d horizontal flow** of water and solutes in the saturated zone (i.e. no relevant horizontal vadose zone flow)
 - 3d equation of variable saturated groundwater flow and solute transport computationally prohibitive if applied within a regional optimization context
- **sequential coupling** between SIMWASER/STOTRSIM and FEFLOW
 - parameterizations for **thick coarse sand and gravel layers**
 - includes the most relevant processes of plant development
 - calibrated to lysimeter data sets
 - applied to **hydrotopes** which are unique combinations of soil type, weather conditions and agricultural management
 - justified if the groundwater table is below the root depth



Simulation-models

1D SIMWASER/ STOTRASIM

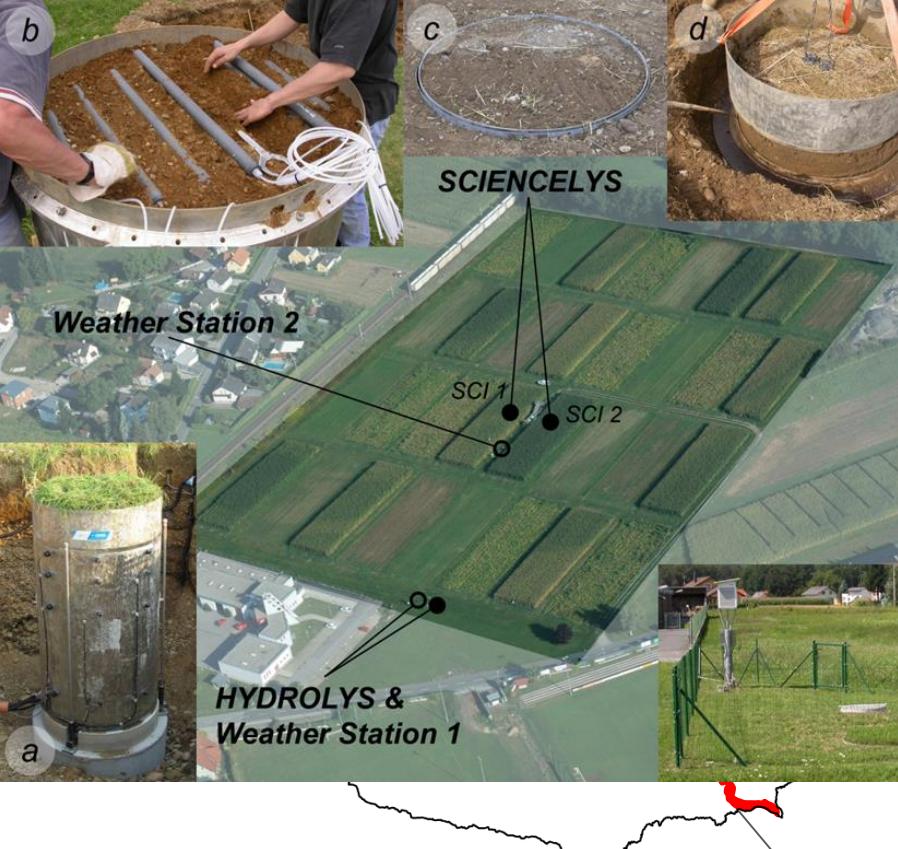
(agriculture,
grassland,
lawn)

GW-Recharge NO₃-Leaching

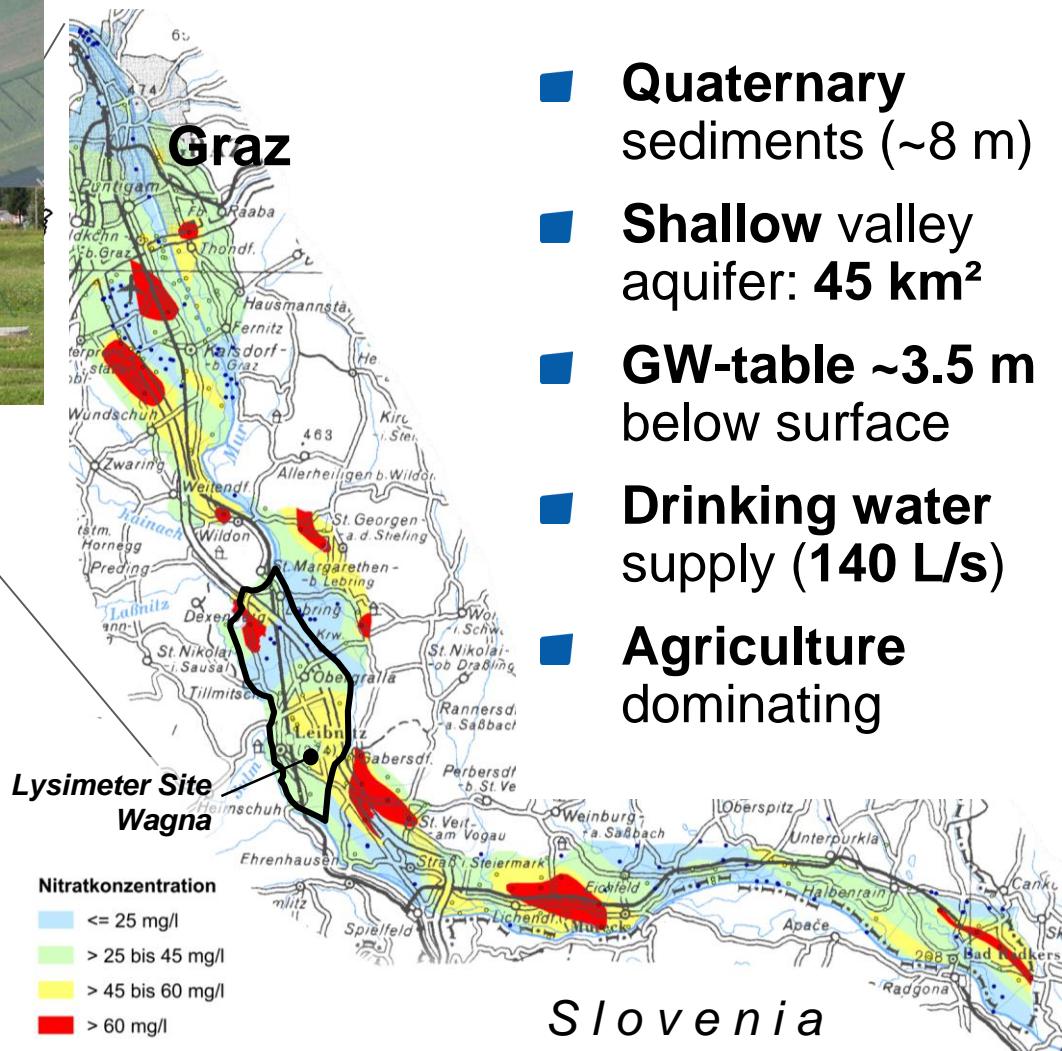
Spatial and temporal NO₃-distribution

2D FEFLOW

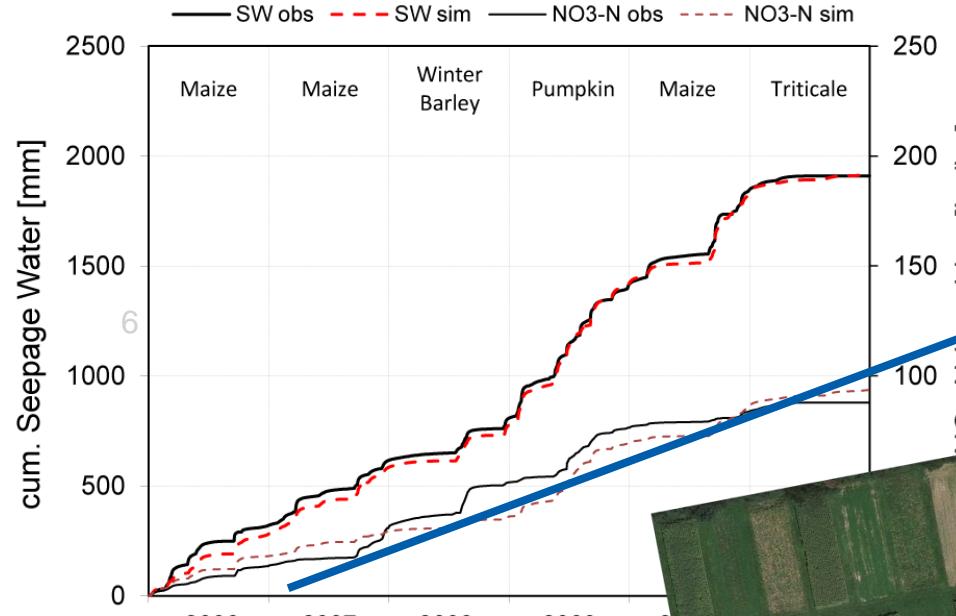
(groundwater)



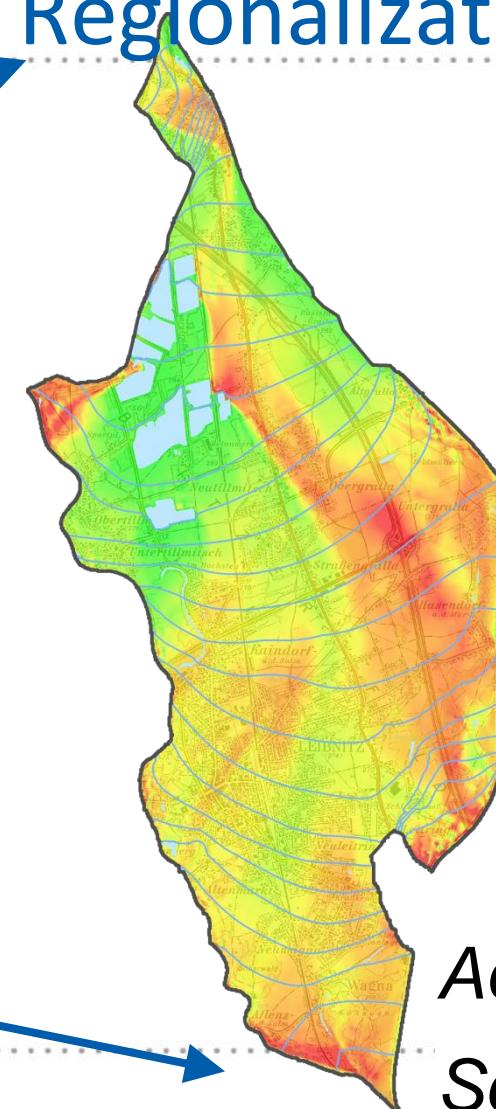
- Nitrate
- Threshold value 50 mg/L



Model Calibration:
SIWASER/STOTRASIM



Regionalization



Point Scale

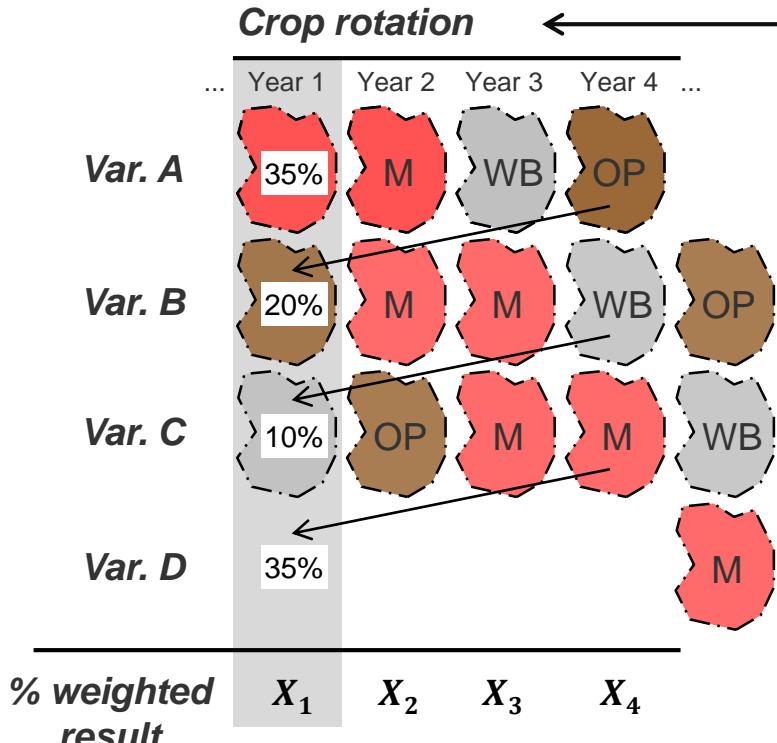
Field Scale

Aquifer
Scale

Input-Parameter Land-use Crop rotation tool StotraPGen

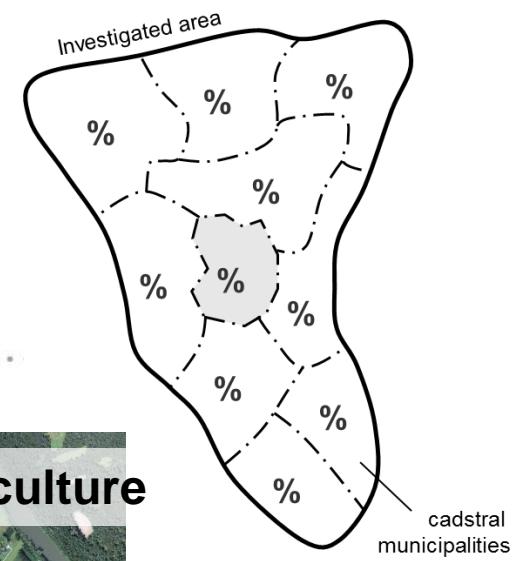
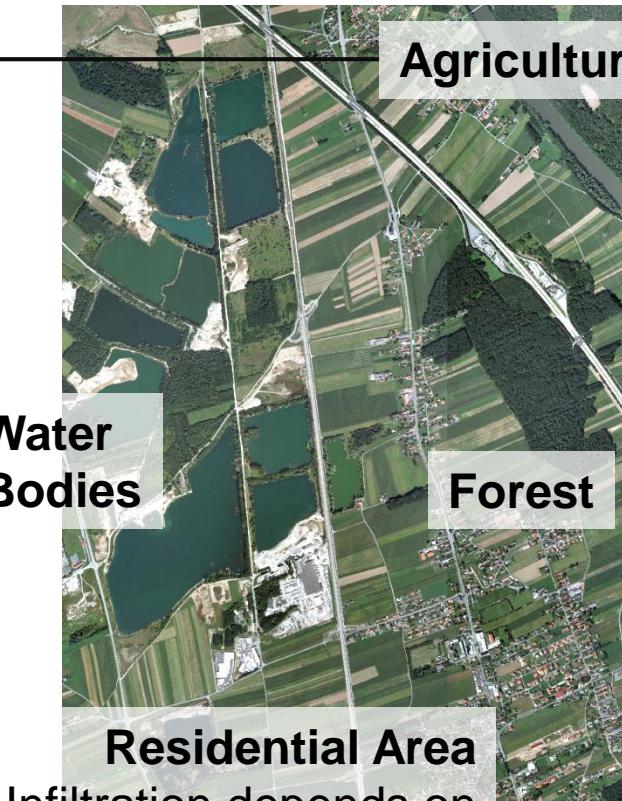
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% from IACS for each year
(dt. INVEKOS)



M.....Maize
WB...Winter Barley
OP....Oil Pumpkin

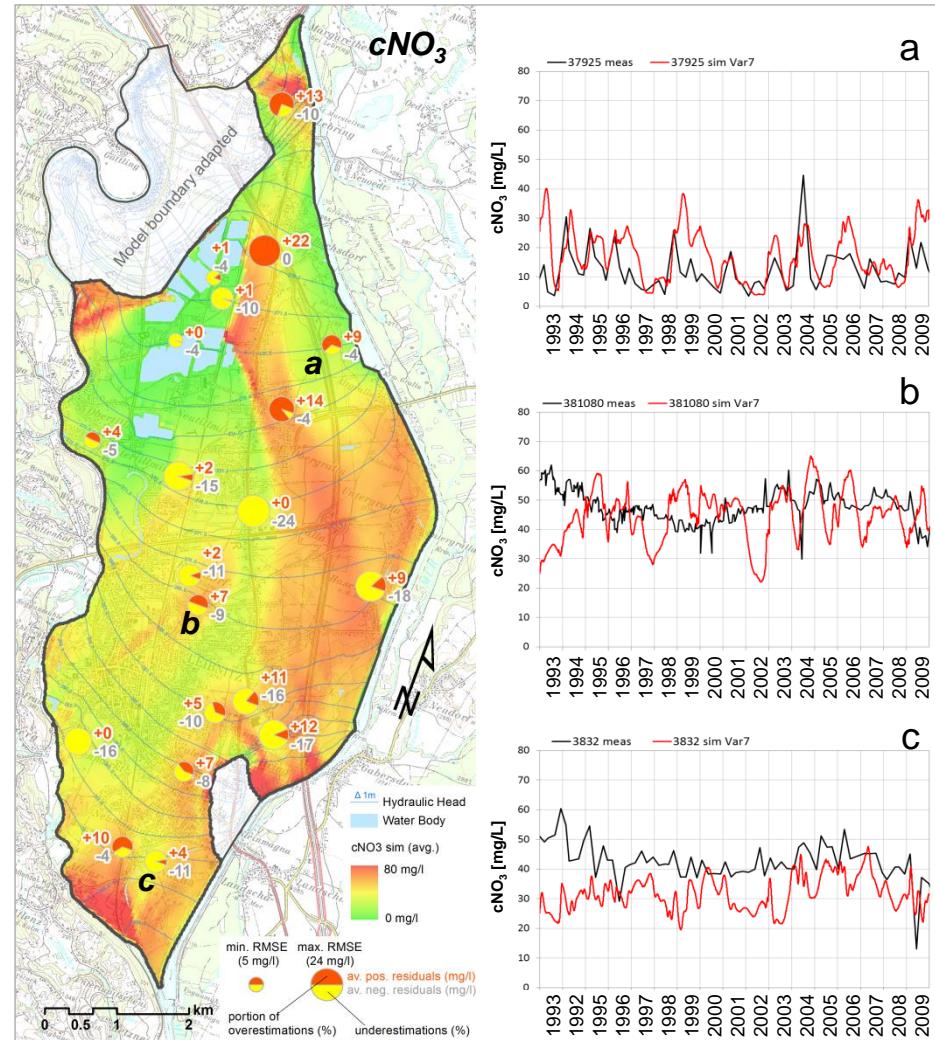
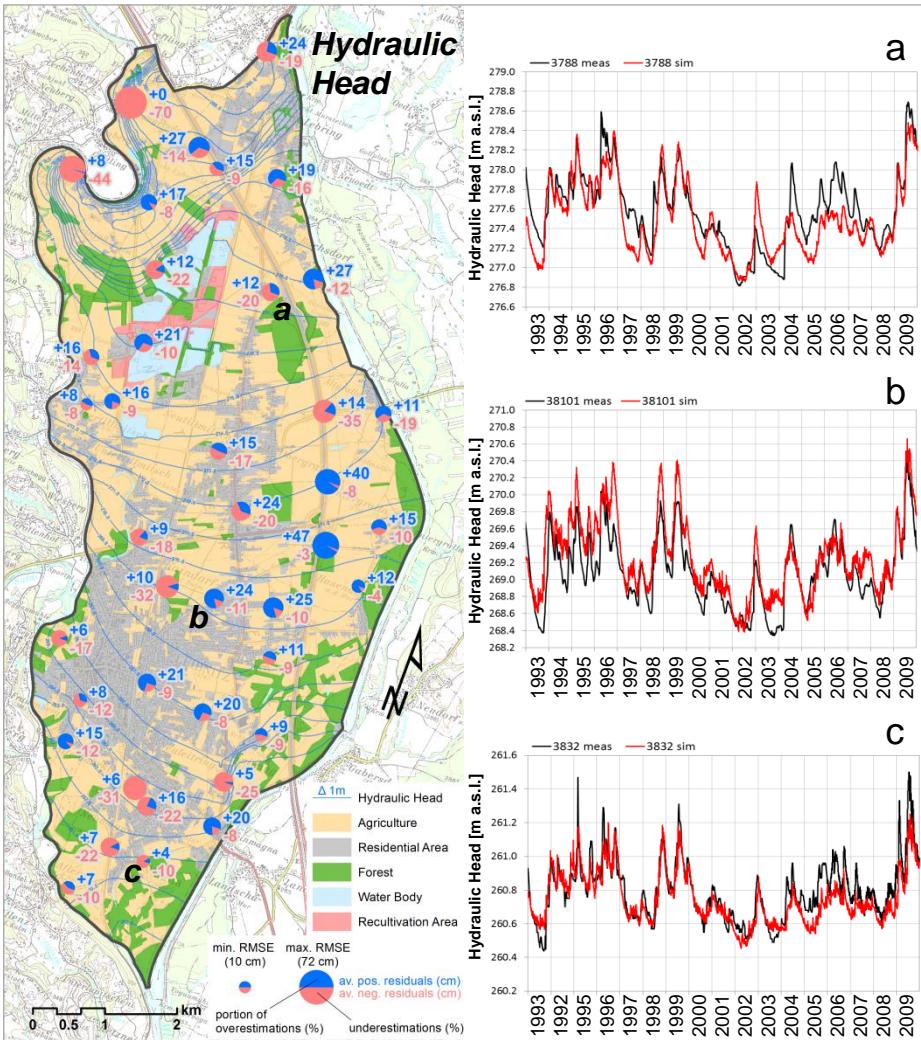
THE INN



Tool validated at scale of agricultural test field

Western Leibnitzer Feld model calibration / current situation

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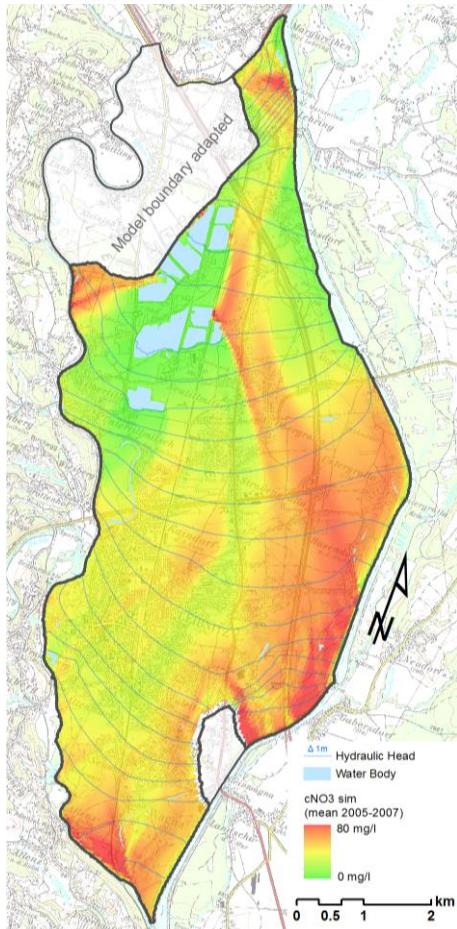


Agriculture land use scenarios

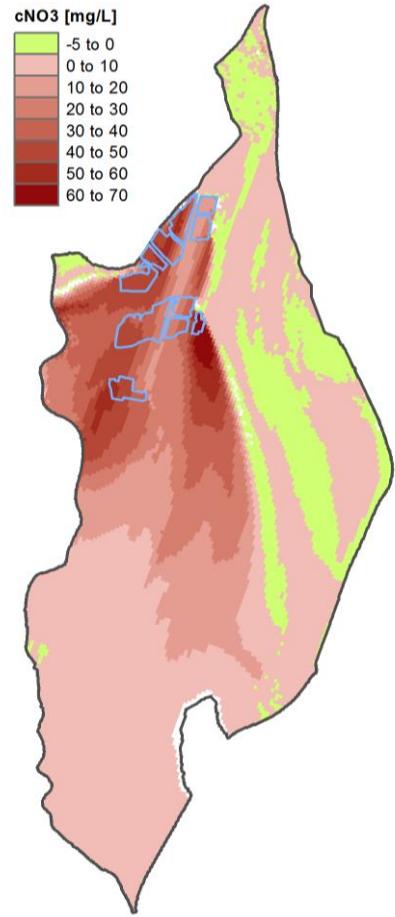
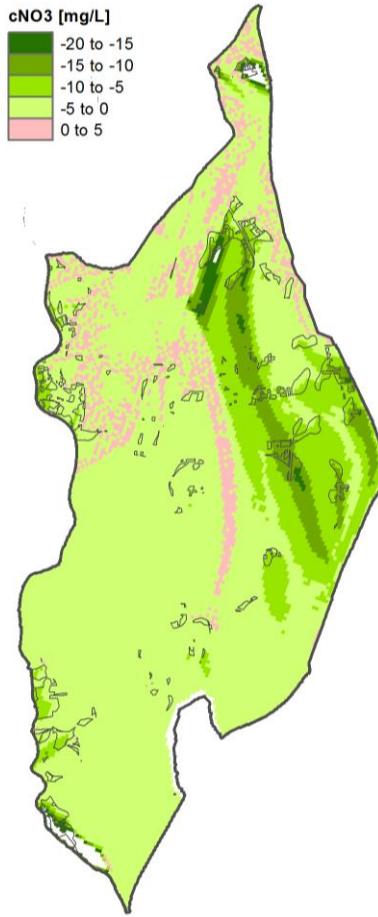
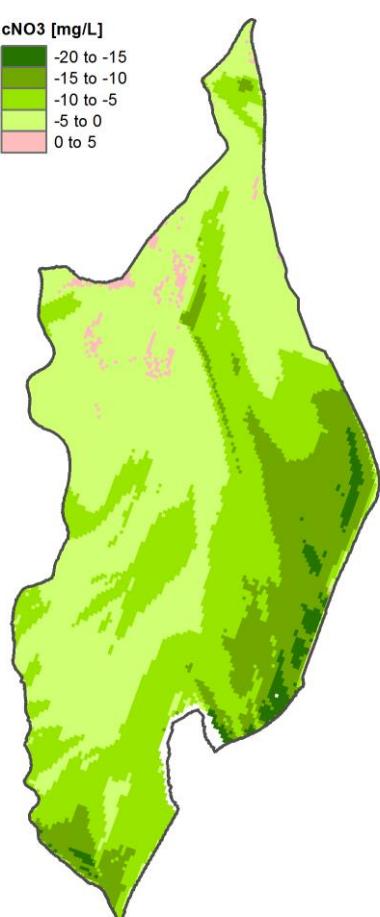
Scenario	Seepage water			Ground-water
	GWNB <i>[mm/a]</i>	N-Input <i>[kg/ha/a]</i>	cNO₃ <i>[mg/L]</i>	
S0 Current situation	291	71	109	37
S1 Regional gw protection program	288	56	84	31
S2 Extensivation (meadows instead of 10% AG _{N(max)})	291	63	95	34
S3 AG instead of gravel dredgings	292	71	108	46

mean differences: „scenarios – minus current situation“

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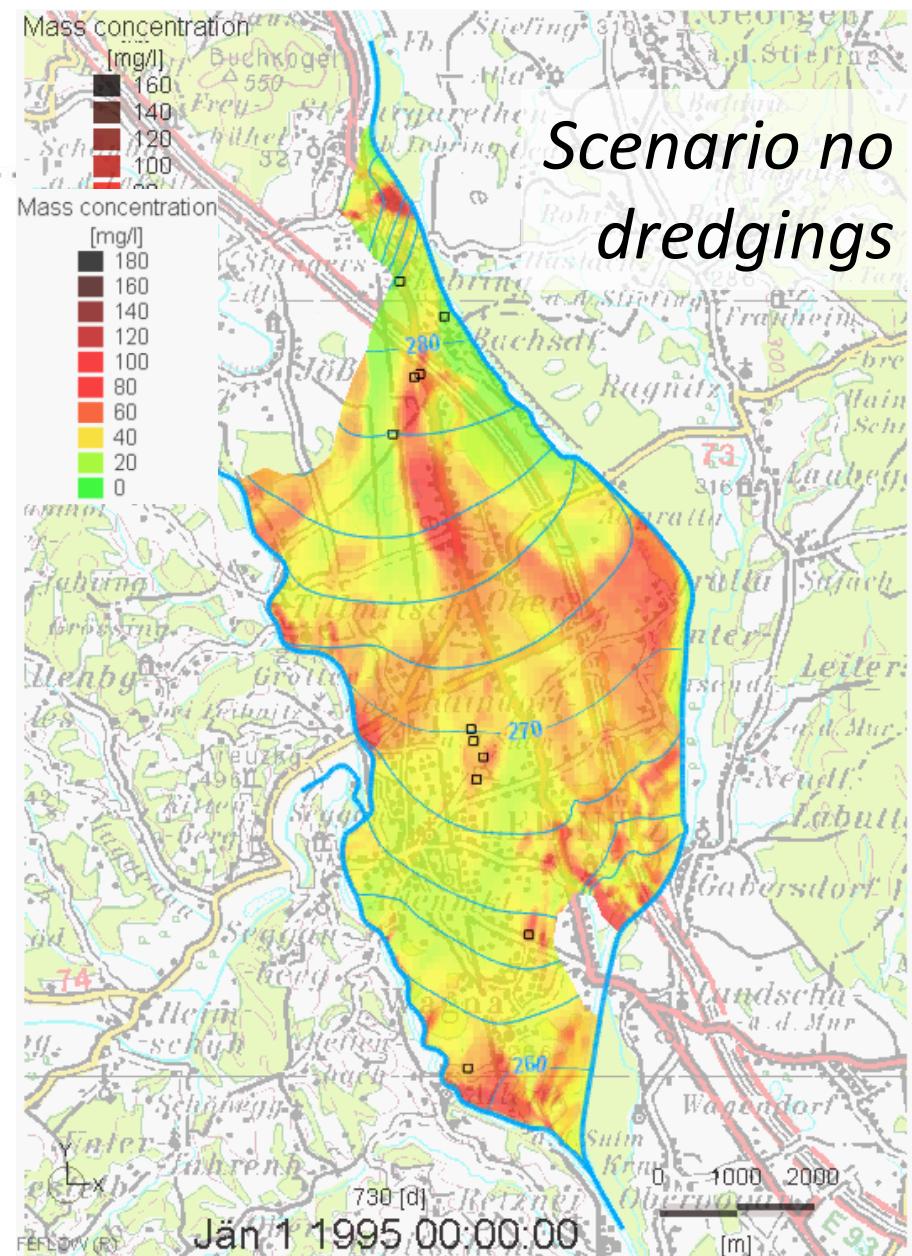
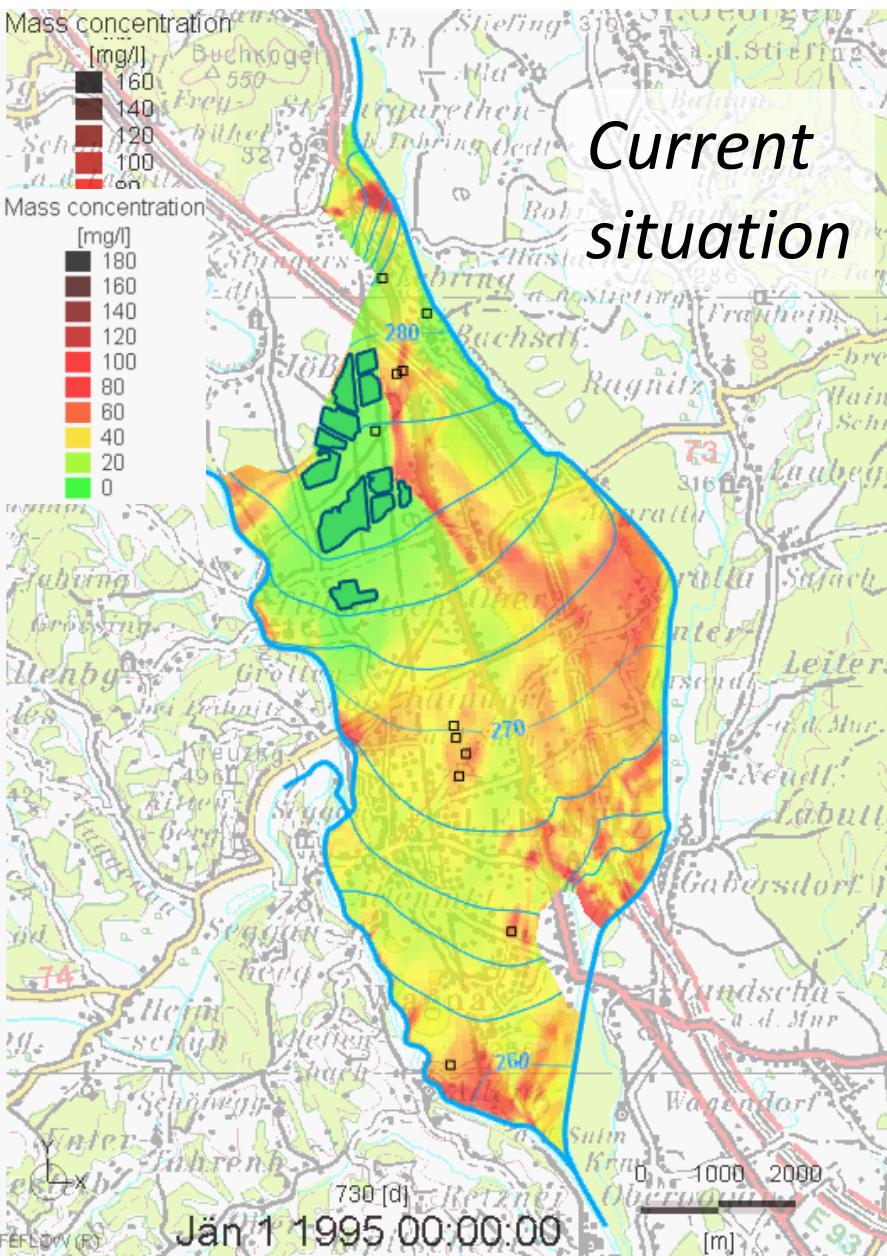
differences „S1-S0“
Regional program



differences „S2-S0“
Extensification

differences „S3-S0“
No dredgings

comparison of scenarios S0 and S4



Conclusions

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- sequential coupling → **appropriate conceptual and numerical approach**
 - currently we are working at the direct coupling (per time step)
- **soil** → uncertainty still high
- **nitrate input function** still uncertain until detailed application rates become available
- **transferable** to other aquifers → crop rotation tool
- **scenarios** → DSS for water resources management
- use of model results to **complement individual measurements** of chemical status of groundwater body

Thank you for your attention!



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RESOURCES

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