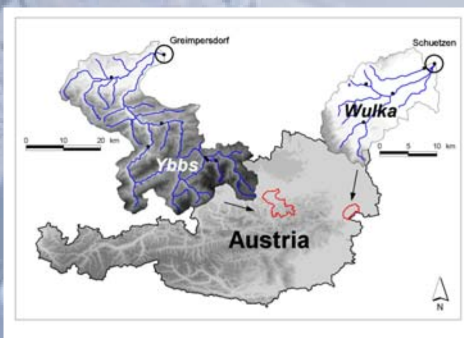
Denitrification in groundwater – results from investigations in two Austrian case study regions

C. Schilling, M. Zessner, D. Gutknecht, A.P. Blaschke, O. Gabriel, J.O. Skøien, H.Kroiss

Vienna University of Technology
Institute for Water Quality, Resource and Waste Management
Institute for Hydraulic and Water Resources Engineering

Location of case study regions



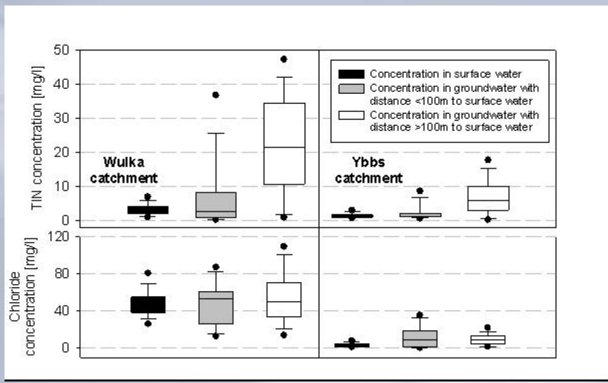
	Wulka	Ybbs
Size [km^2]	383	1104
Average slope	8%	30%
Elevation distribution [maS]	125-742	262-1881
Fraction of arable land [%]	66	49

Technische Universität Wien

Results from observations in catchments

Observation of TIN-concentrations in groundwater and surface water of the Wulka and the Ybbs catchment

Groundwater observation wells were grouped in respect to distance to surface water



Technische Universität Wien

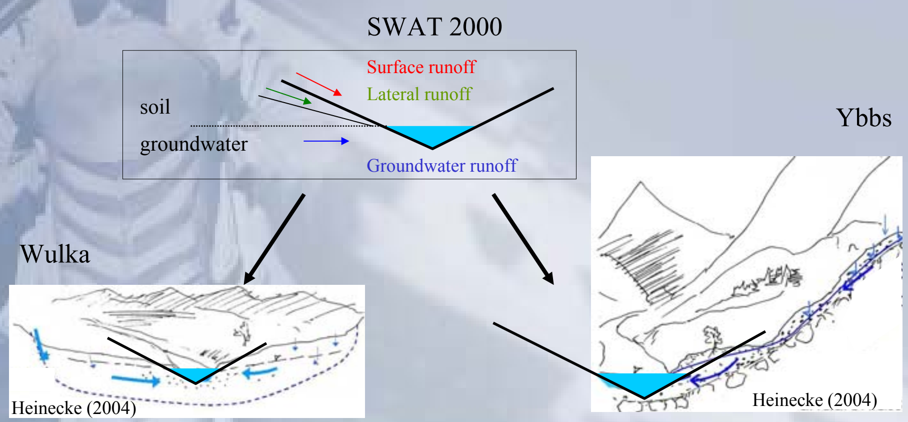
Water balance calculations using SWAT 2000

Goals:

- *Differences in catchment hydrology* between both catchments
- Identification of *runoff components* (and their specific fractions) contributing to river discharge

	Wulka 1992-1999	Ybbs 1992-2000
Average precipitation [mm/a]	699	1377
Average evapotranspiration [mm/a]	539	468
Average groundwater recharge [mm/a]	118	494
Surface runoff [mm/a (%)]	3 (4)	139 (16)
Lateral runoff [mm/a (%)]	11 (13)	285 (31)
Groundwater runoff (baseflow) [mm/a (%)]	46 (57)	485 (53)
Runoff from drained areas [mm/a (%)]	21 (26)	-

Comparison of Concepts

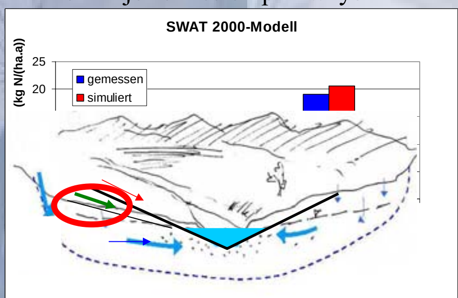


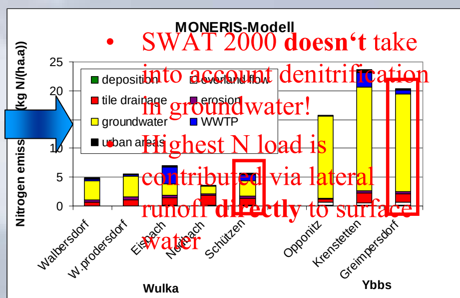
Technische Universität Wien

Nitrogen emission estimation

Goal:

- Estimation of total nitrogen emissions from both catchments and identification of major emission pathways





- SWAT 2000 **doesn‘t** take into account denitrification in groundwater! Highest N load is contributed via lateral runoff **directly** to surface water

Technische Universität Wien

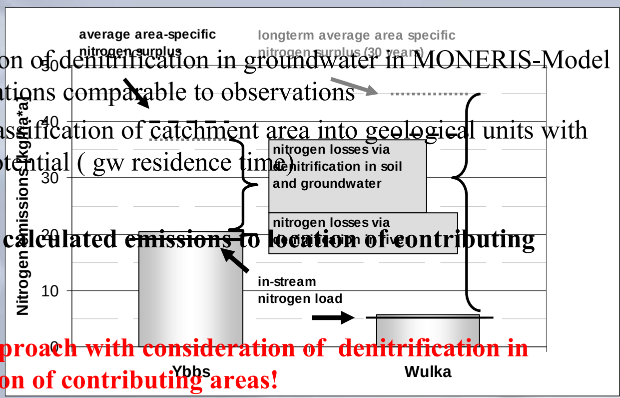
Comparison with calculated N emissions using MONERIS

verification:

•Approximate consideration of denitrification in groundwater in MONERIS-Model results in emission estimations comparable to observations

•Approach is based on classification of catchment area into geological units with specific denitrification potential (gw residence time)

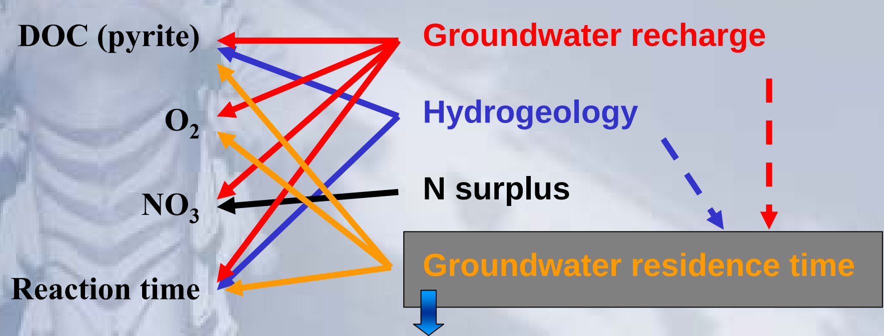
→ **no spatial relation of calculated emissions to location of contributing catchment areas !**



→ development of an approach with consideration of denitrification in groundwater and location of contributing areas!

Technische Universität Wien

Factors influencing denitrification in groundwater



Calculation of diffuse N emissions with spatial reference and consideration of denitrification in groundwater…

Technische Universität Wien

Quantification of diffuse N emissions using calculated groundwater residence time distributions

Input data:

mean, interpolated groundwater surface (Grid), geological maps and digital river network

Calculation of:

- groundwater flowpaths and their lenght till infiltration into surface water body

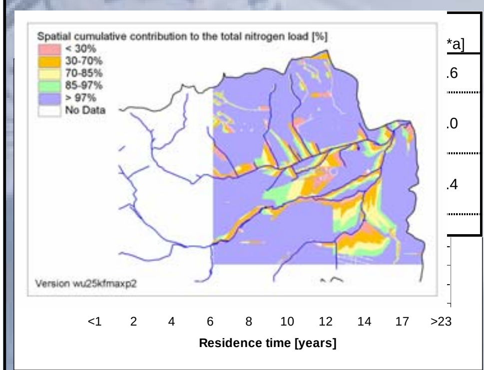
-Groundwater residence time with consideration of hydraulic conductivity derived from geological units

- denitrification in groundwater as function of groundwater residence time and assumed half life times (exponential decay, substrate limitation is assumed)

Technische Universität Wien

Results

Wulka



• Using half life time of 4 years for denitrification in groundwater of Wulka catchment results in comparable emissions calculated using the MONERIS model / load calculations from observations; Ybbs catchments diffuse emissions underestimated

• >90% of diffuse N emissions from areas with GRT of <9 years

• these areas are located in <2000m distance to surface water

Technische Universität Wien

Summary and conclusions

- denitrification in groundwater could be observed based on observations in groundwater and surface water in both catchments
- differences between both catchments were found in denitrified nitrogen load in soil and groundwater
- hydrology has a significant influence on (N) concentrations in groundwater, on denitrification in soil and groundwater and on nitrogen emissions to surface water
- groundwasser is the major emission pathway for N - emissions to surface water in in both catchments

Technische Universität Wien

Summary and conclusions II

- areas near to the river contribute significantly to diffuse N-load in surface water due to low groundwater residence time
- controlling diffuse N-emissions is possible via N-surplus only with cosideration of the location of areas → denitrification in groundwater is a function of local hydrogeological and geohydraulic conditions
- local groundwater protection (reduction of N-concentrations in gw) requires consideration of other catchment parts (areas) than for reduction of diffuse N-emissions to surface waters
- denitrification in groundwater can be considered in modelling approaches with sufficient spatial resolution using the groundwater residence time and half life time

THANK YOU
for your kind attention!