Treating an artificial catchment as ungauged: Increasing the plausibility of an uncalibrated, process-based SVAT scheme by using additional soft and hard data

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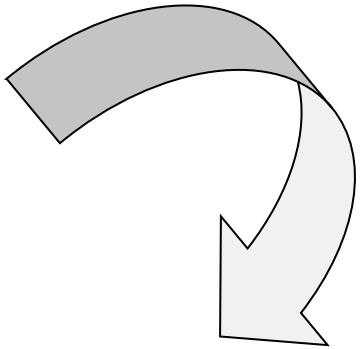
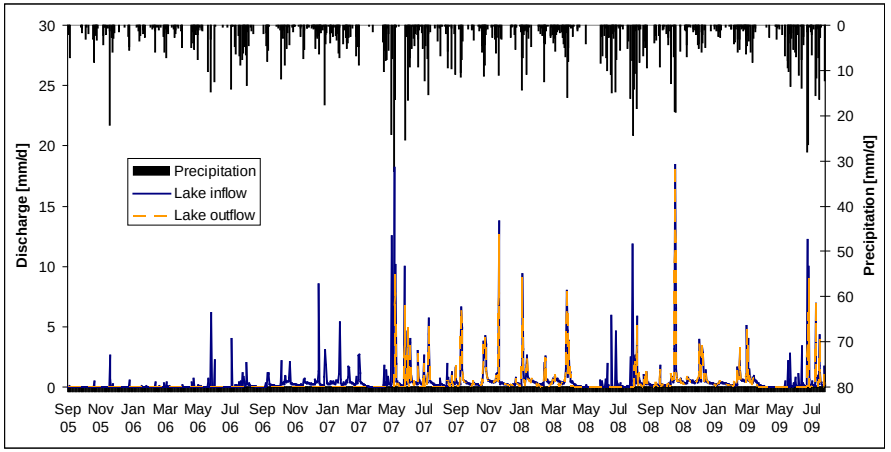
Motivation

Prediction of water fluxes in ungauged catchments



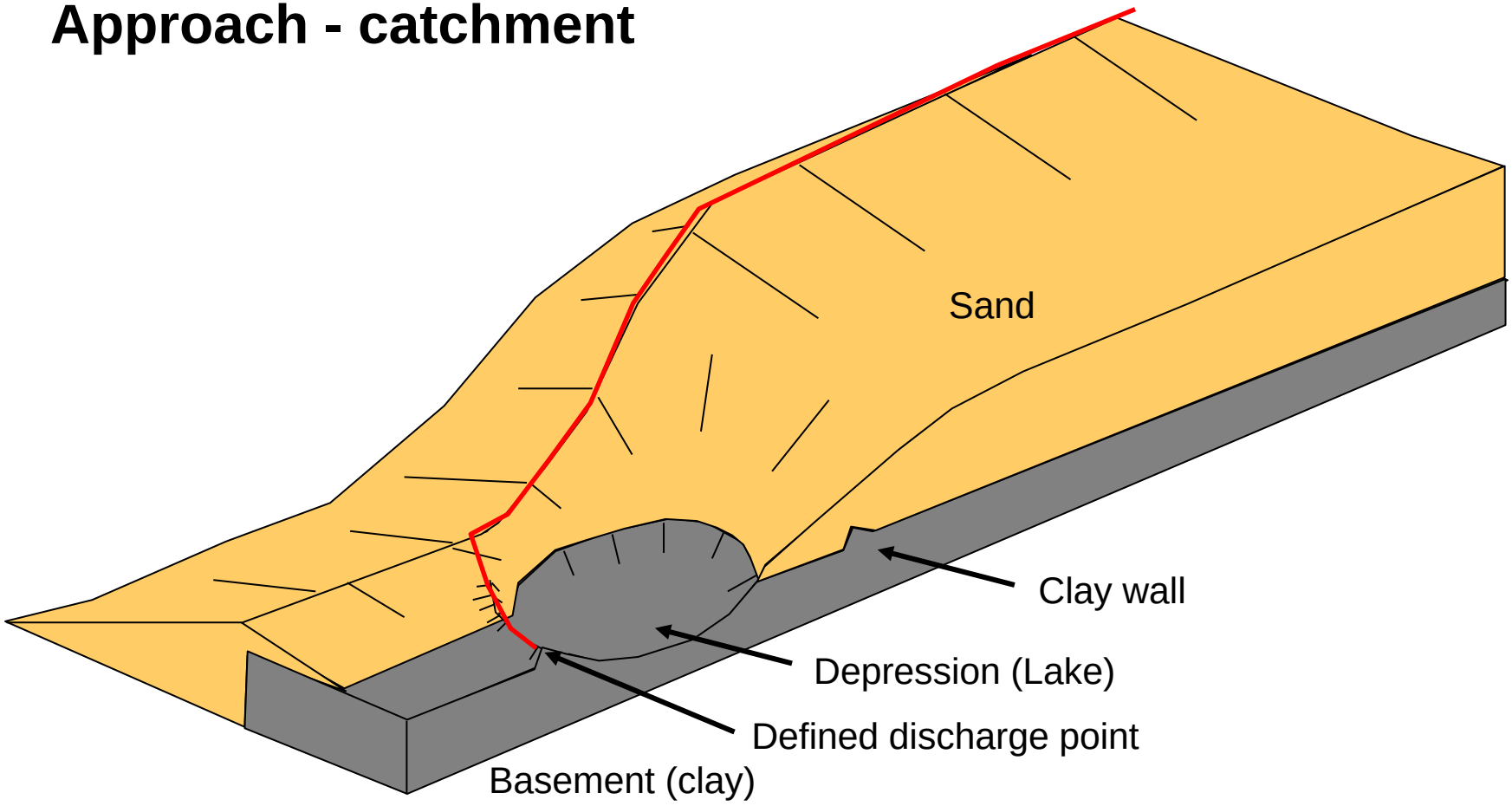
- Feasibility of *a priori* predictions?
- How do we benefit from additional information?



Approach - catchment

- Chicken Creek artificial catchment (initial state of development)
- Lausatia, East Germany, 6 ha, artificially created, post mining landscape
- Humid, temperate climate, annual average temperature: 9.3°C, variation of annual precipitation 335-865 mm/a

Approach - catchment



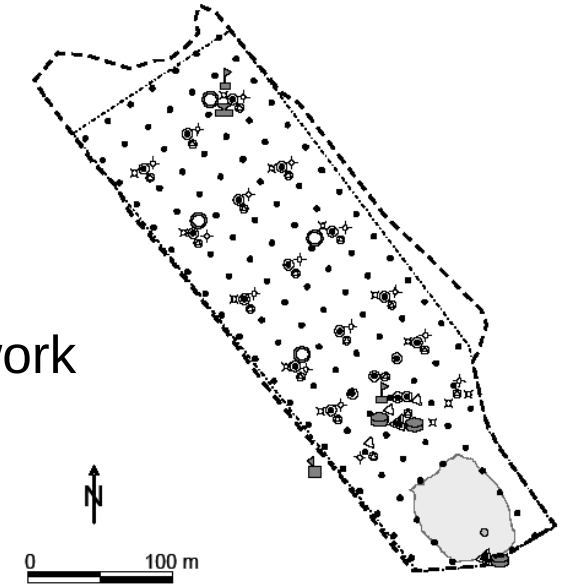
Lausatia, East Germany, 6 ha, artificially created, post mining landscape

Approach – data availability / organisation

- Modellers have no access on observational network

5 modelling stages:

1) Standard data set (dem, climate data, soil texture, vegetation cover, climate data)
2) Field visit, discussion among different modellers
3) Additional data (infiltration tests, soil hydraulics)
4) Additional data: state variables (soil moisture)
5) Event runoff data of a subcatchment



Gerwin et al., 2009

Framework – model intercomparison

Holländer et al., 2009, HESS 13, 2069-2094
Bormann et al., 2011, Bodenkultur 62(1-4), 23-29
Holländer et al., in prep. for HESS

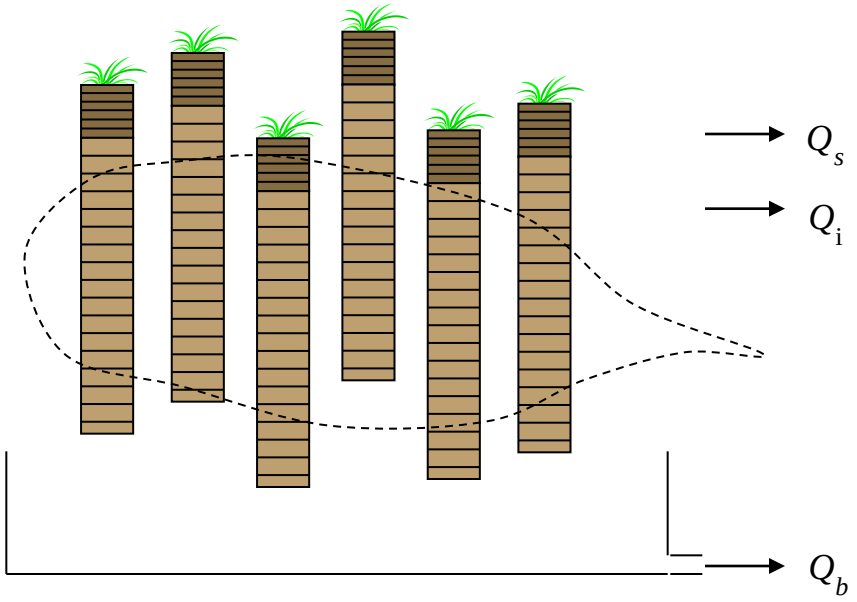
→ 10 modeller groups
→ 10 different models
→ Mainly process based models

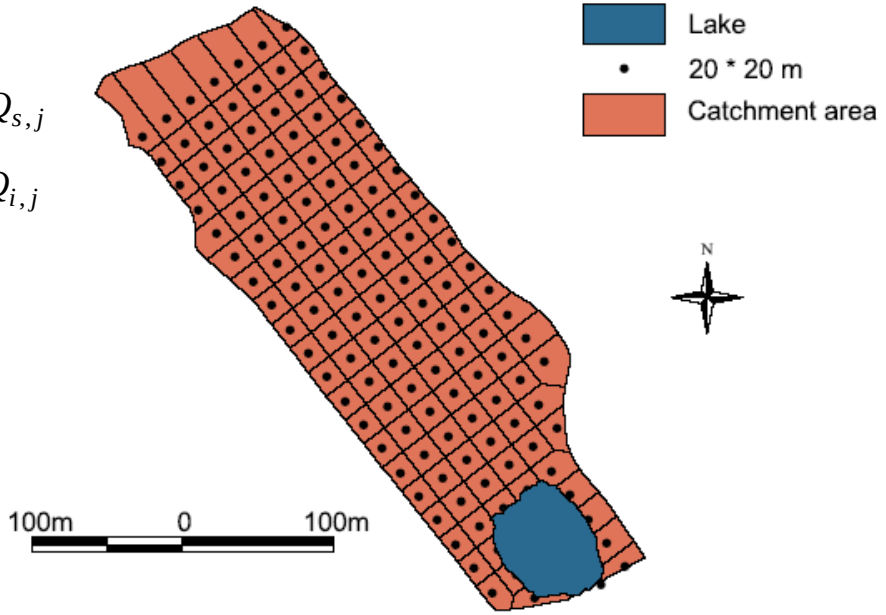
→ Target: runoff behaviour

idw-online.de

Model approach: SIMULAT model

- 1-dimensional, physically based SVAT-model
- Diekkrüger & Arning (1995), Bormann (2008)
- Richards' equation, Penman-Monteith





Assumptions

→ Surface runoff not as important as subsurface flow

→ Routing of runoff is of minor importance (daily time step)

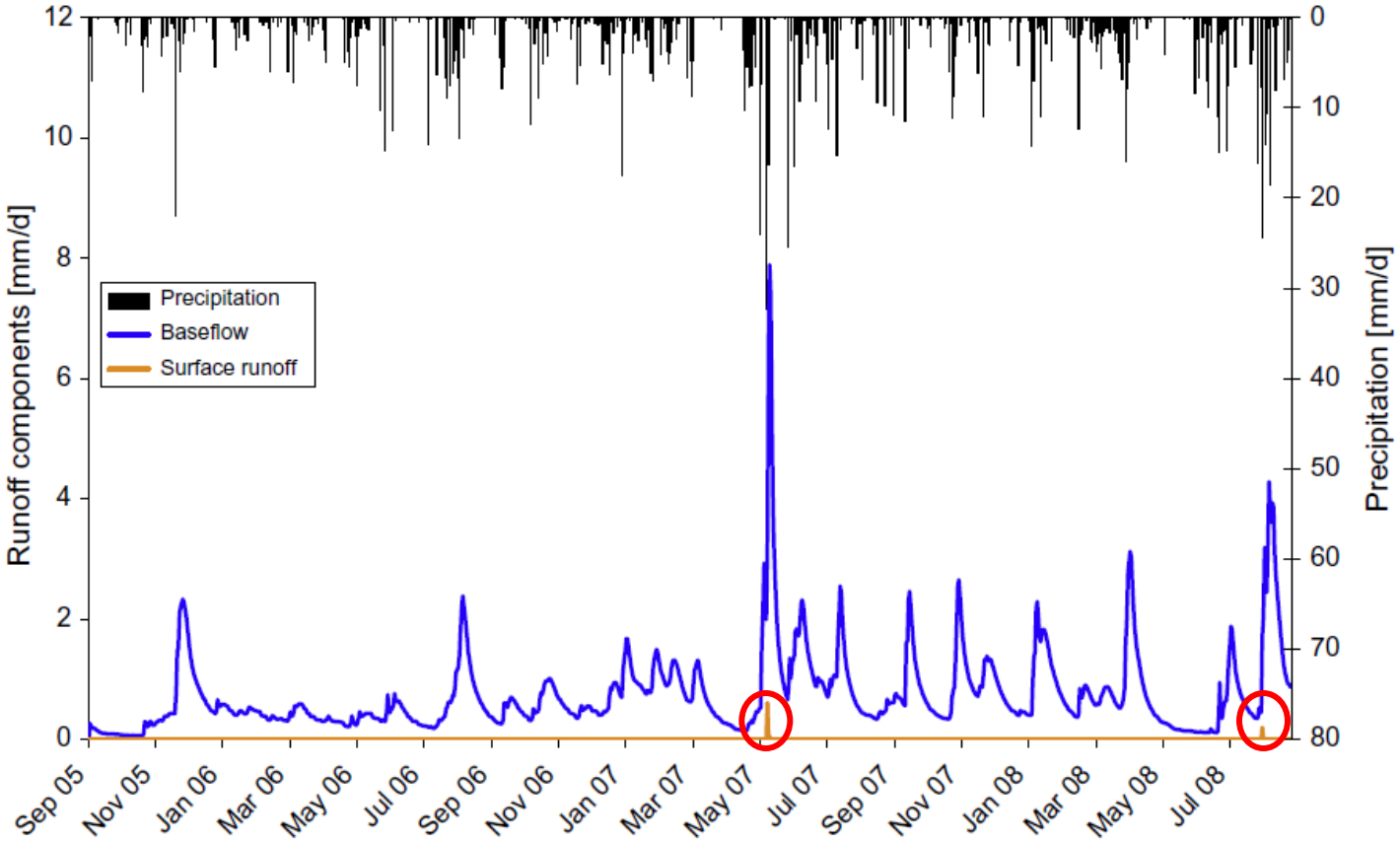
→ Catchment is unsaturated in the beginning: no groundwater, soil is relatively dry, lake is empty

→ Sparse vegetation: transpiration, interception of minor importance

→ No consideration of frozen soils, macropores

→ PTF (Rawls & Brakensiek, 1985) to derive soil hydraulic parameters

Results – stage 1



	mm/a
Precip	483
AET	213
Runoff	289
Rsurf	0.3
Rint	0
Rsub	288
ΔStor	10

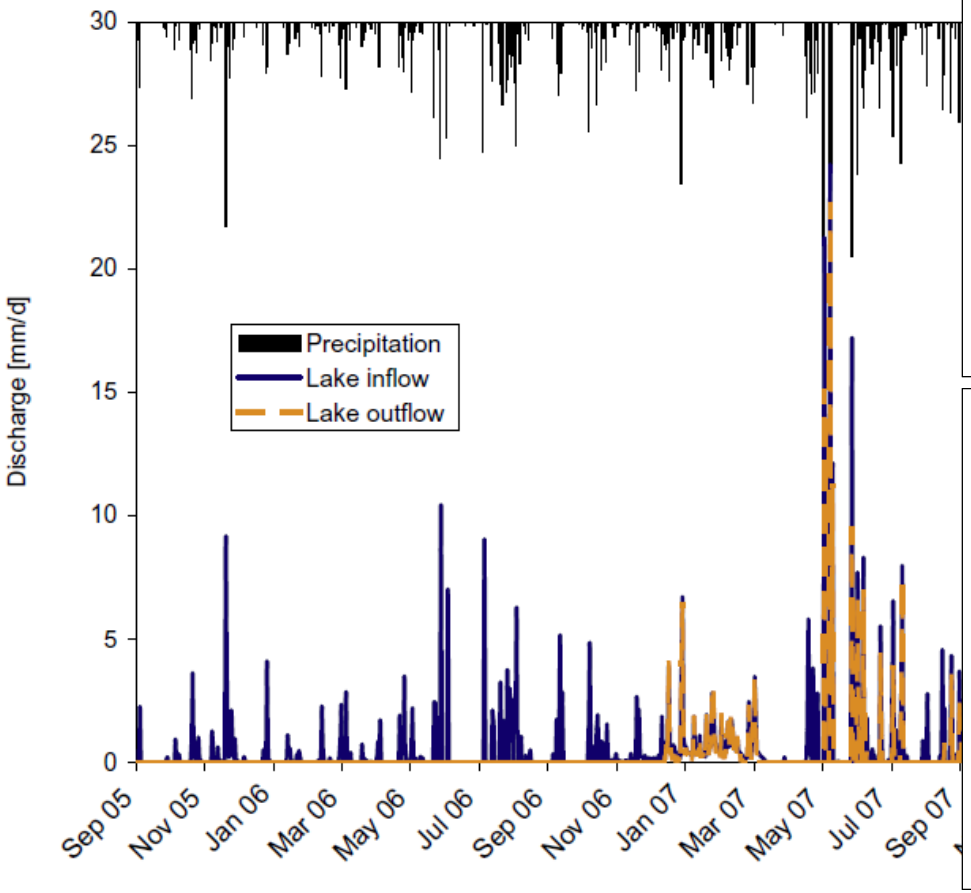
Modifications after stage 1

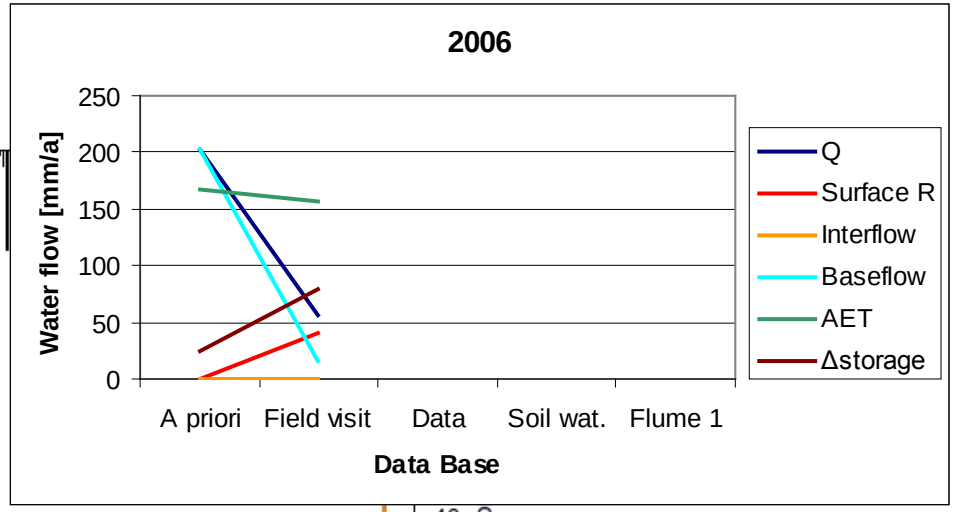


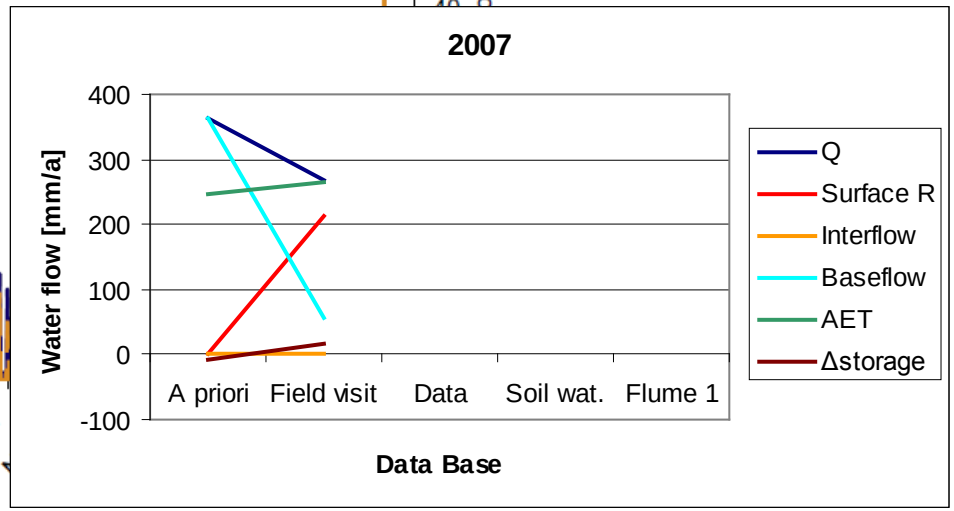
Field visit, discussion with modelling colleagues
Revised process understanding:
- Importance of surface runoff (gullies, soil crusting)
- Increasing importance of vegetation

→ Changes in parameterisation
(soil crusting, increasing plant cover, subsurface storage)

Results – stage 2







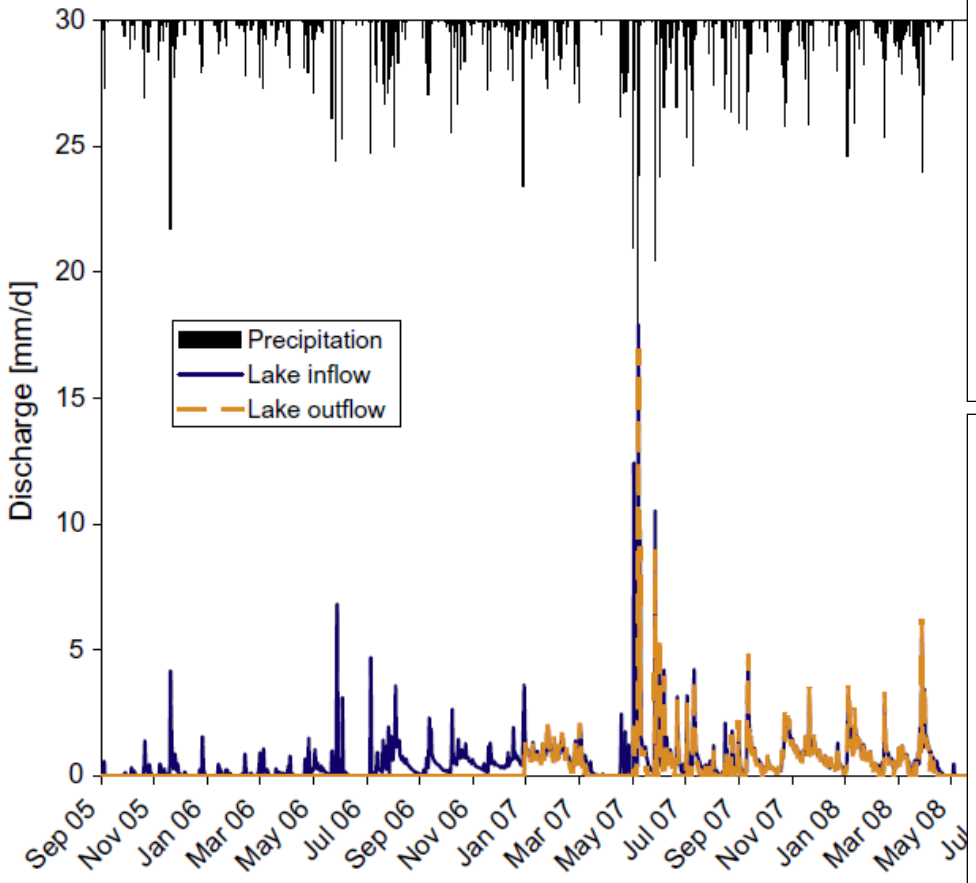
Spiky hydrograph, dry periods

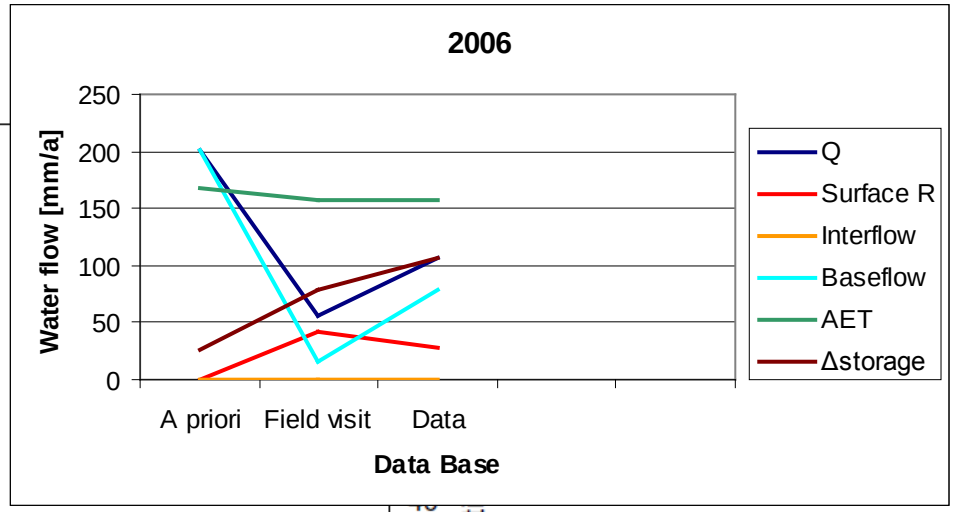
Modifications after stage 2

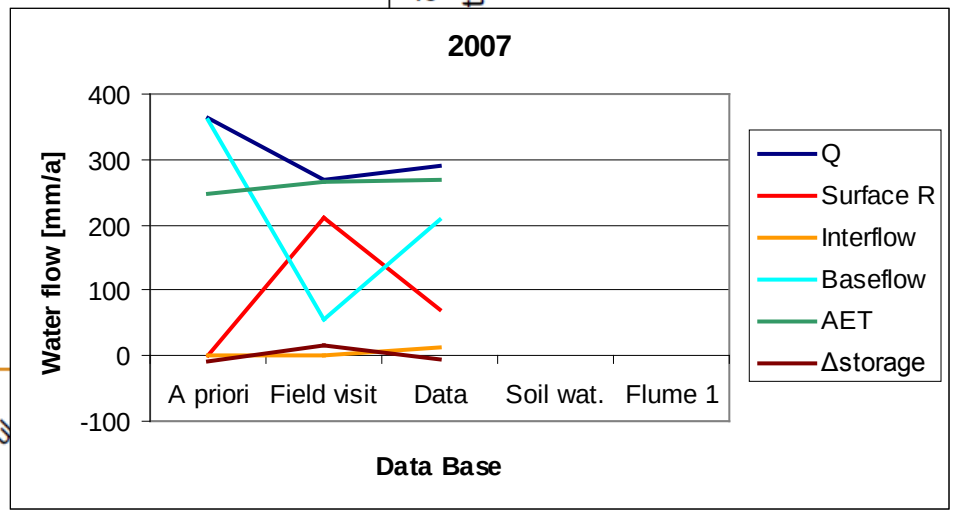
Additional data:
- Measurements on bulk density, Ksat, infiltration capacity

→ Revision of parameterisation (soil): surface Ksat (increased μ)
→ Confirmation of revised process understanding

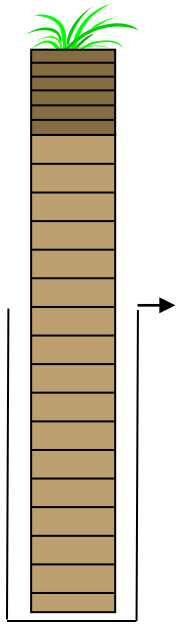
Results – stage 3





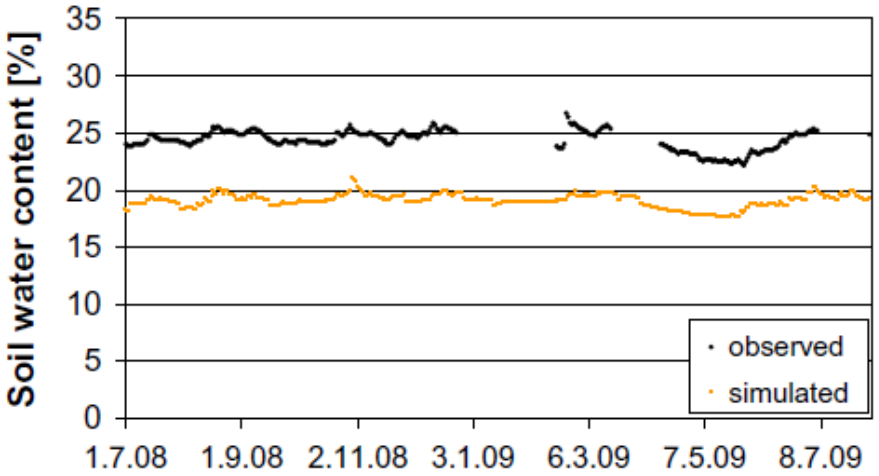


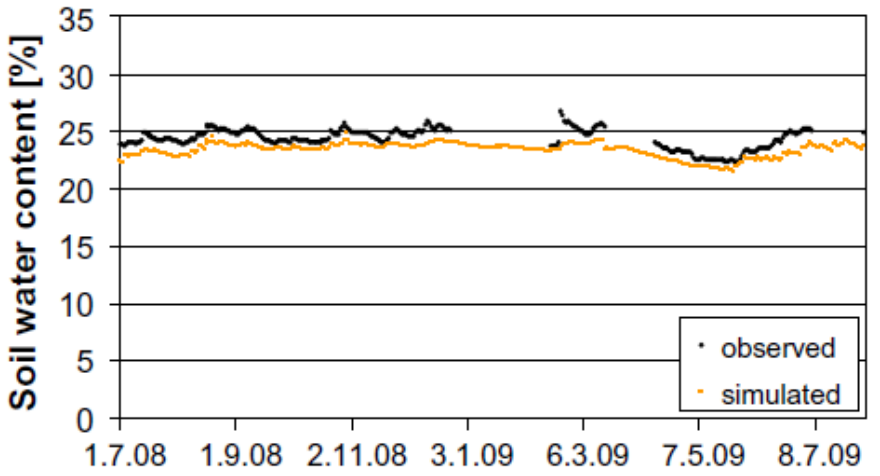
Modifications after stage 3



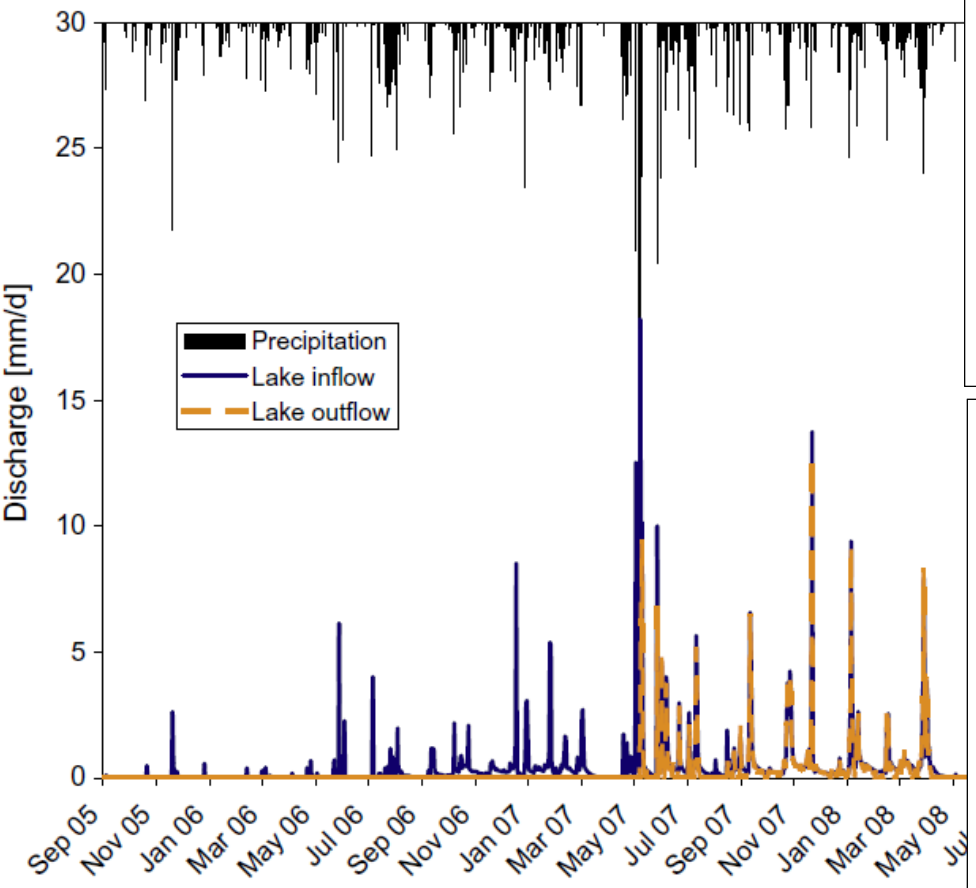
Additional data:

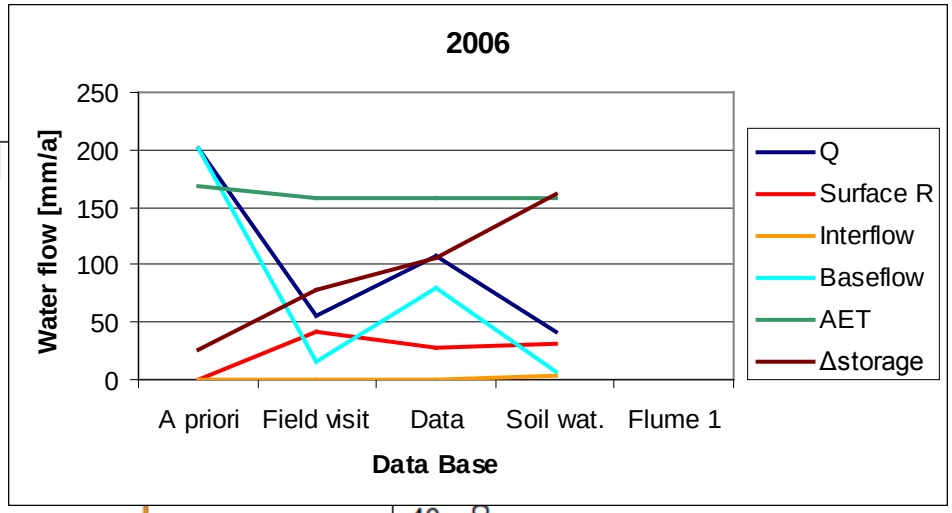
→ Calibration against point scale state variables (4 soil moisture pits)
→ Increase in subsurface storage capacity

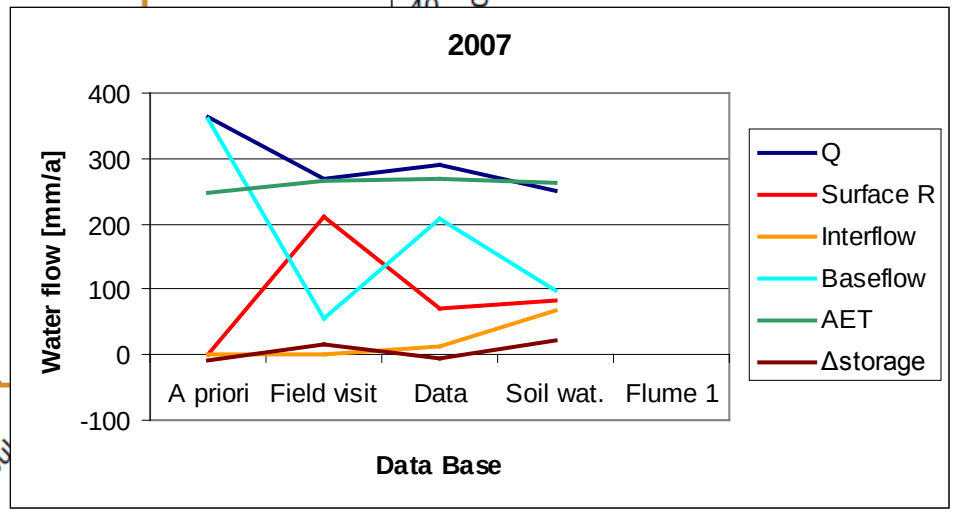




Results – stage 4

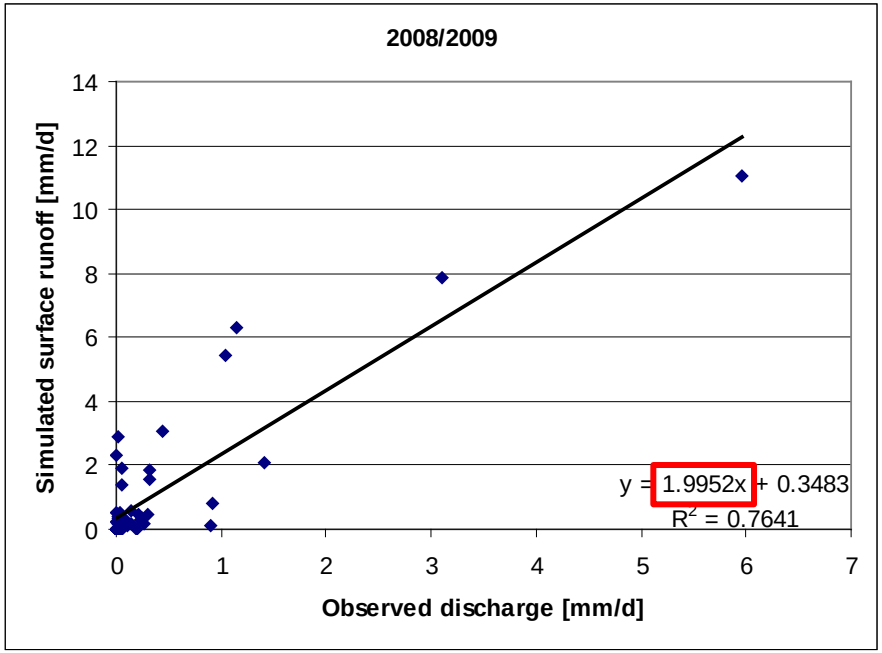


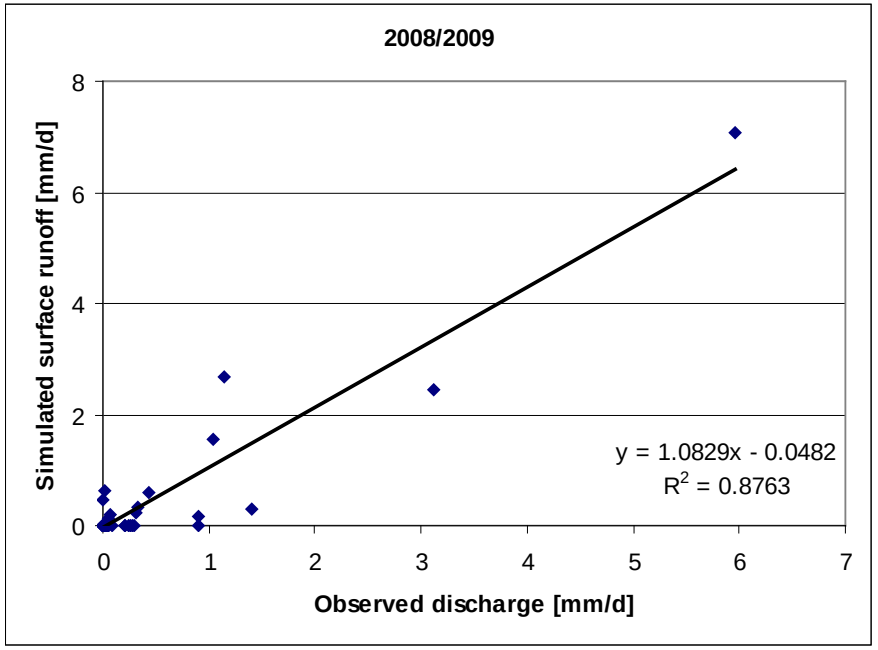




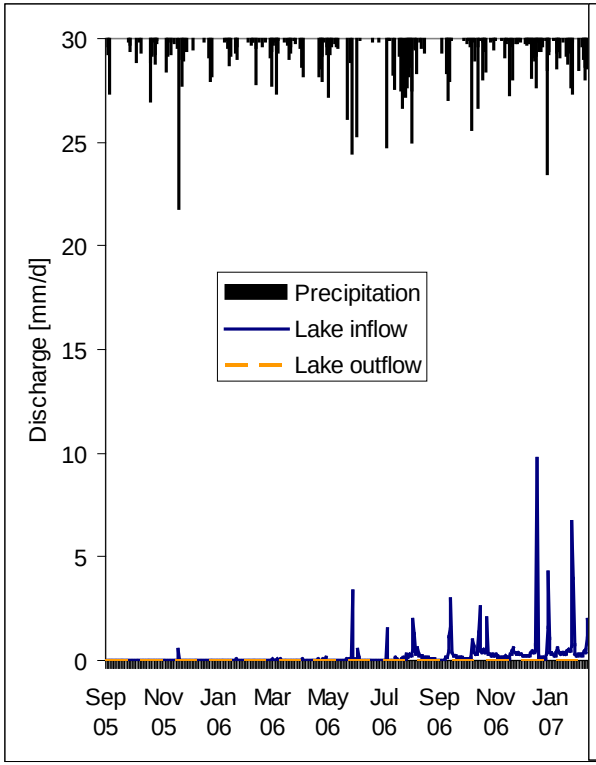
Modifications after stage 4

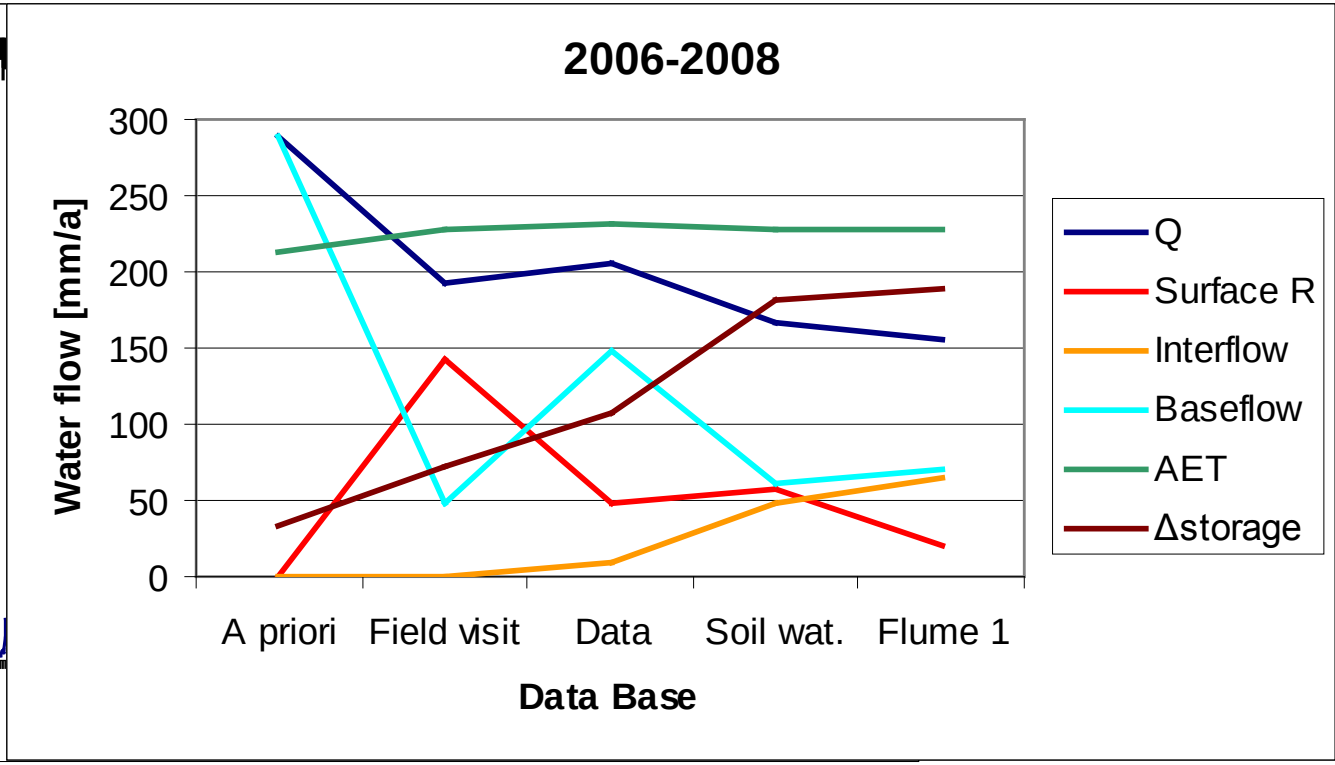
→ Calibration against subcatchment event runoff
→ Reduction of spatial variability of surface Ksat (σ!), approaching the results from infiltration experiments





Results – stage 5





→ Change in runoff dynamics
→ Change in water balance terms
→ Partly compensation of effects during (iterative) modelling steps

Conclusion

→ A priori model application results in uncertain simulations
(model philosophy + parameterisation + modeller + *observations*)
→ *learning process*

→ Any additional information is useful
- Soft information (field visit) is valuable (*necessary*) information for improving process understanding (*what to measure*)
- Hard data is useful for parameterisation and calibration

→ Difficulties under non-stationary conditions (esp. initial conditions)

→ Model intercomparison: Modeller's decisions seem to be as important as choice of the model

Thanks a lot for you attention!

Bormann (2011) Treating an artificial catchment as ungauged: increasing the plausibility of an uncalibrated, physical based SVAT scheme by using additional soft and hard data. Physics and Chemistry of the Earth, 36, 615-629