Spatial prediction of contributing areas for diffuse pollution losses to surface waters – a case study for herbicides

Martin Frey

Christian Stamm

Eawag: Swiss Federal Institute of Aquatic Science and Technology

Introduction

Goal of my project:
Predict areas which contribute to herbicide losses to surface waters

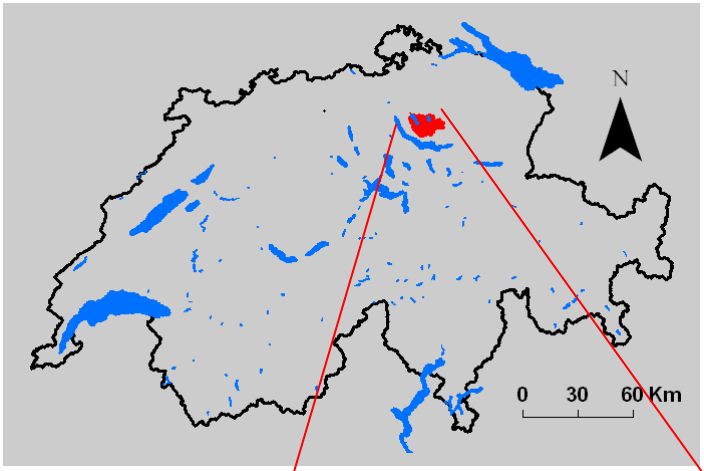
Connection to P issues

- mainly the same runoff mechanisms (fast flow processes)
- the predicted risk for herbicide areas correspond to risk areas for phosphorus losses

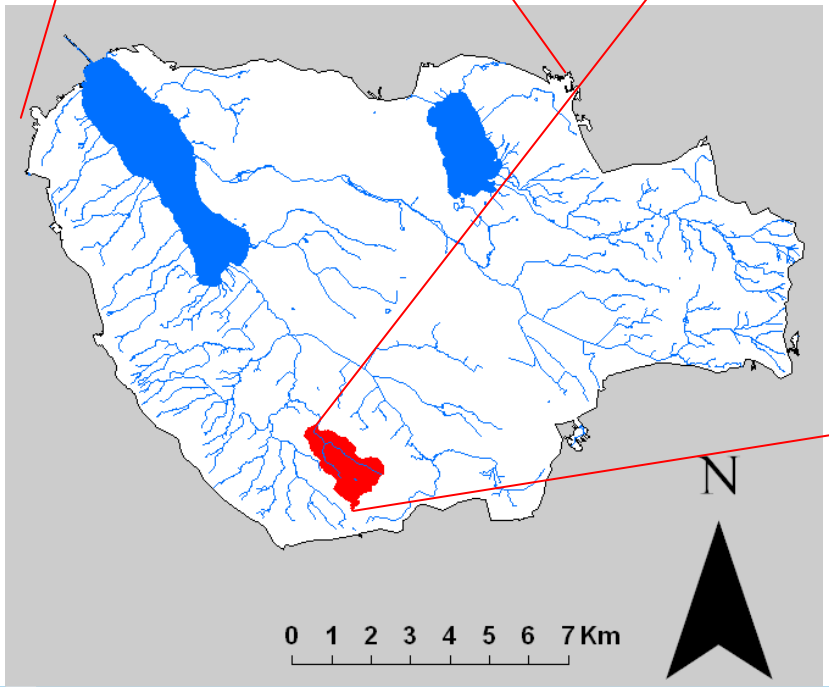
Approach
hydrological modeling of risk areas

Study Site

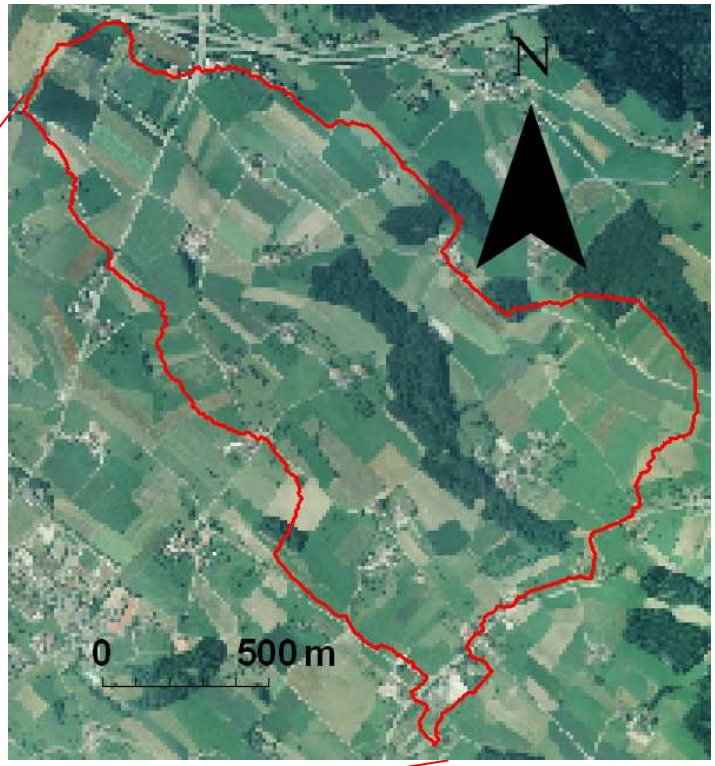
Switzerland



Lake Greifensee area



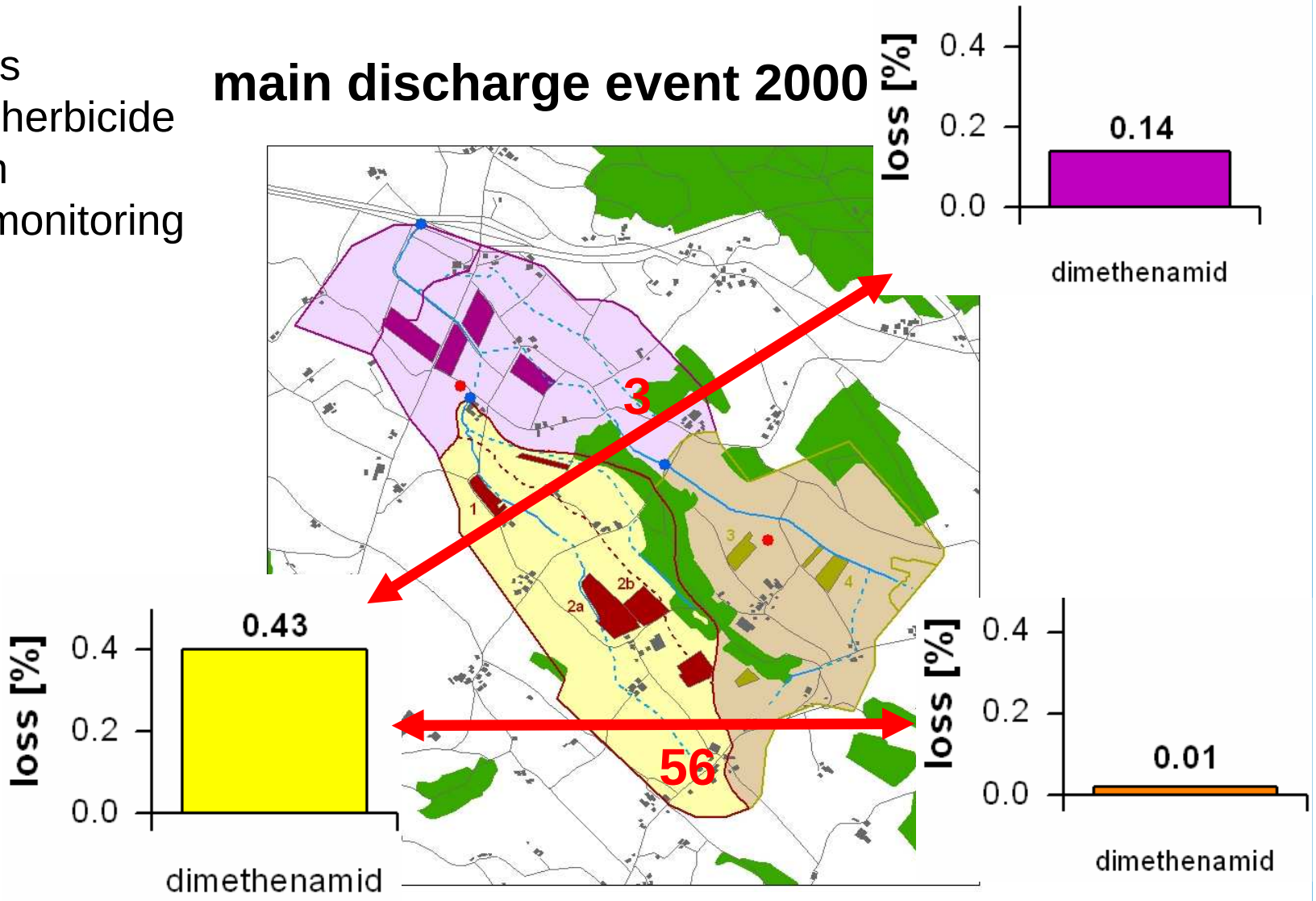
Ror catchment



Spatial Variability of Losses

Field studies
- controlled herbicide application
- intensive monitoring

main discharge event 2000



Leu *et al*, Environ. Sci. & Technol., 2004

Simulation program SMDR-Model

A tool for watershed management

Objective: prediction of saturated areas which contribute to fast flow processes (herbicide and phosphorus losses)

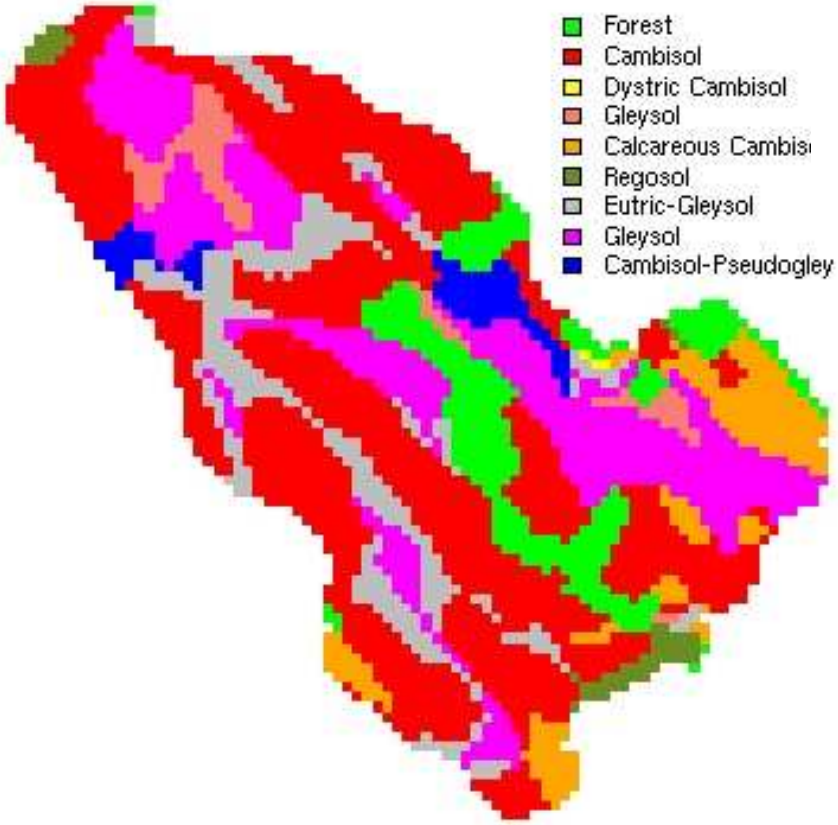
- flow calculated by a simplified Richards equation (gravity flow, lateral gradient controlled by the topography)
- macropores flow above a critical water content
- implementation of an artificial drainage system
- consideration of the connectivity

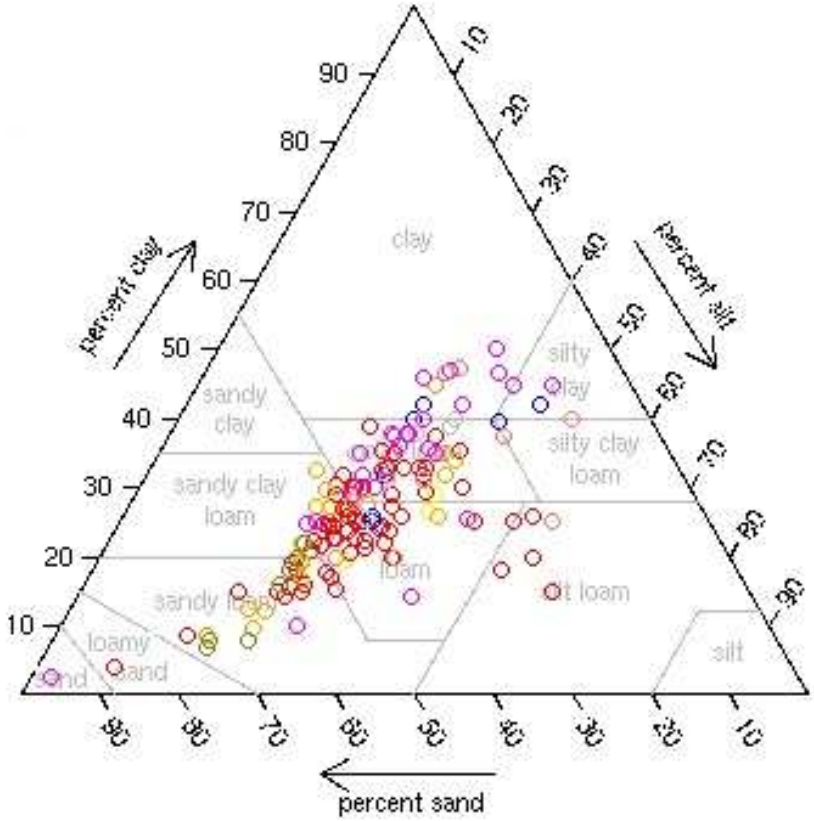
Parameterization

Soil map

→ hydrological properties from pedotransfer function based on the soil texture

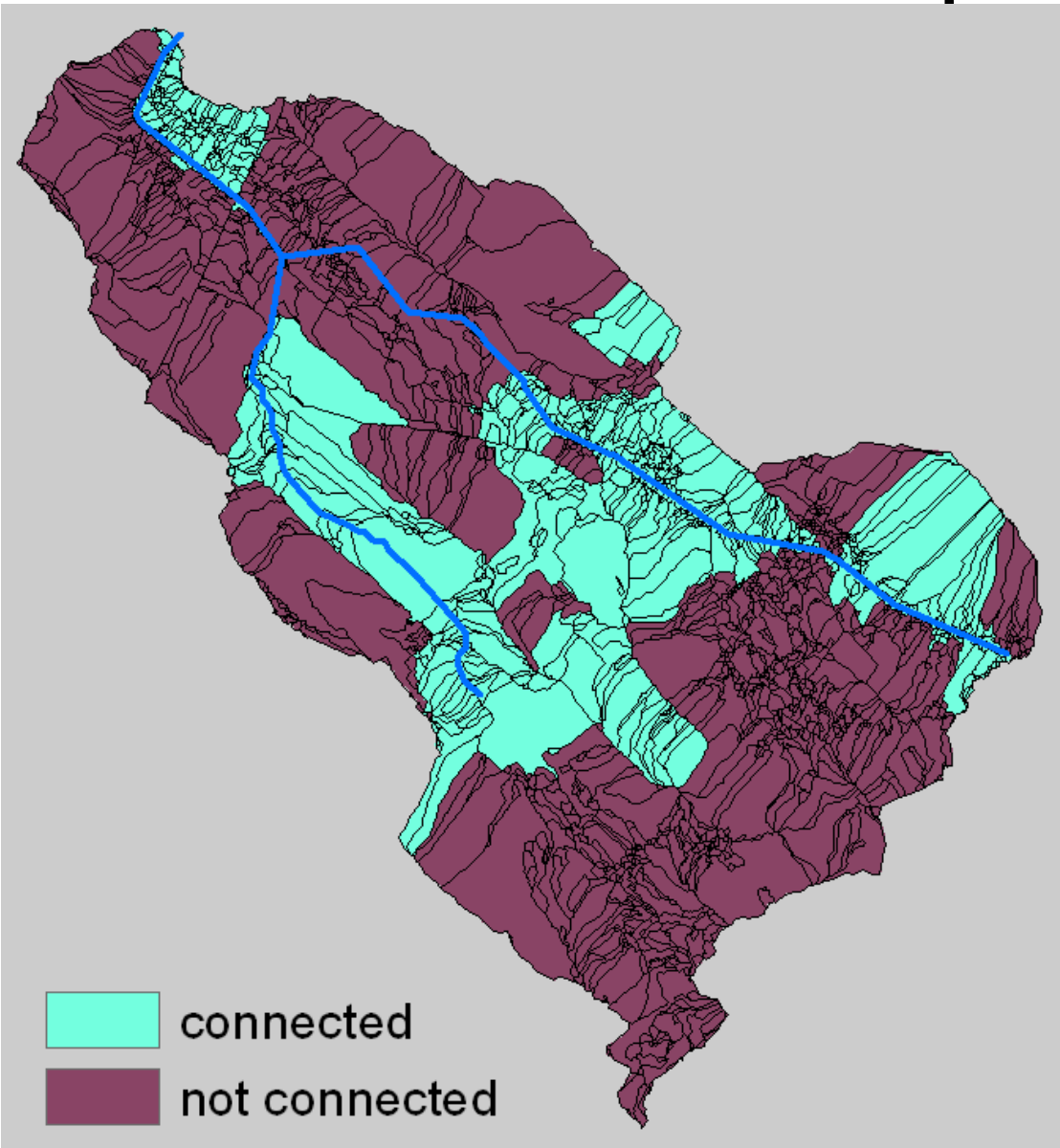
→ Percolation rate based on the soil type





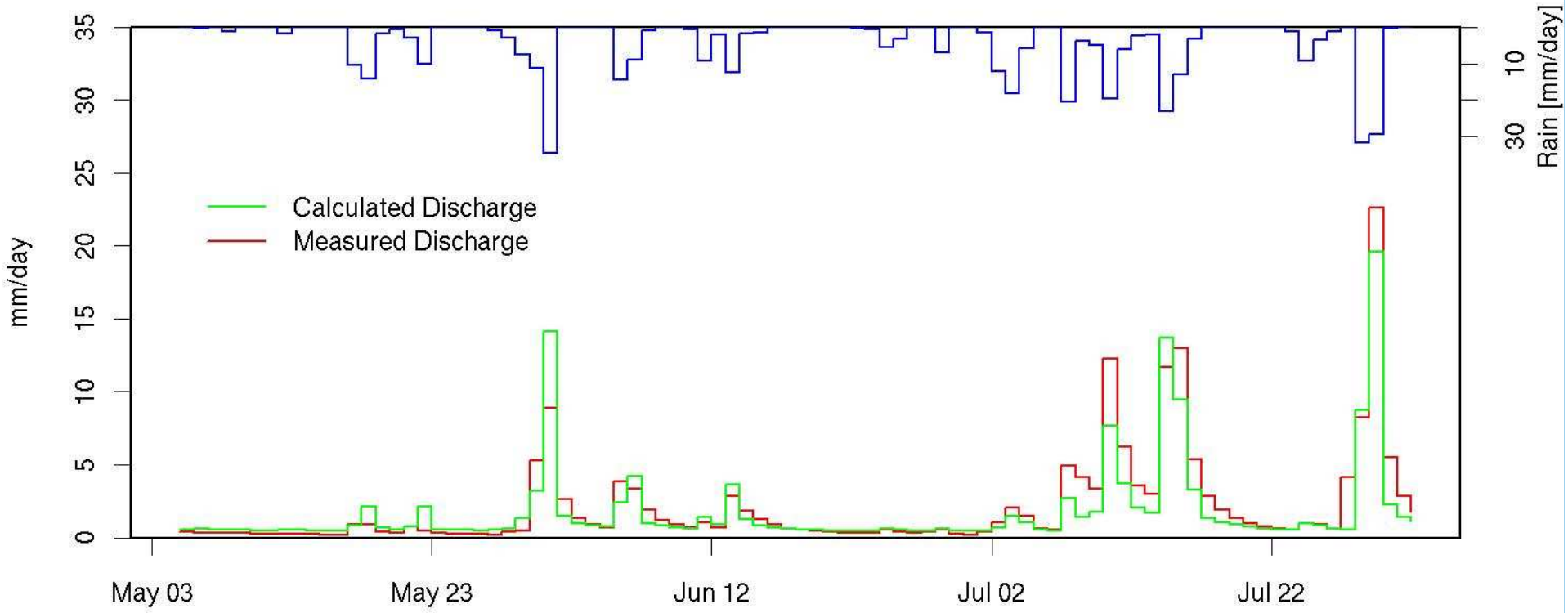
Connectivity

Result of the spatial analysis



- large part (66 %) of the surface is not connected
- not connected runoff water flows to internal sinks
  (potential risk areas if drained)

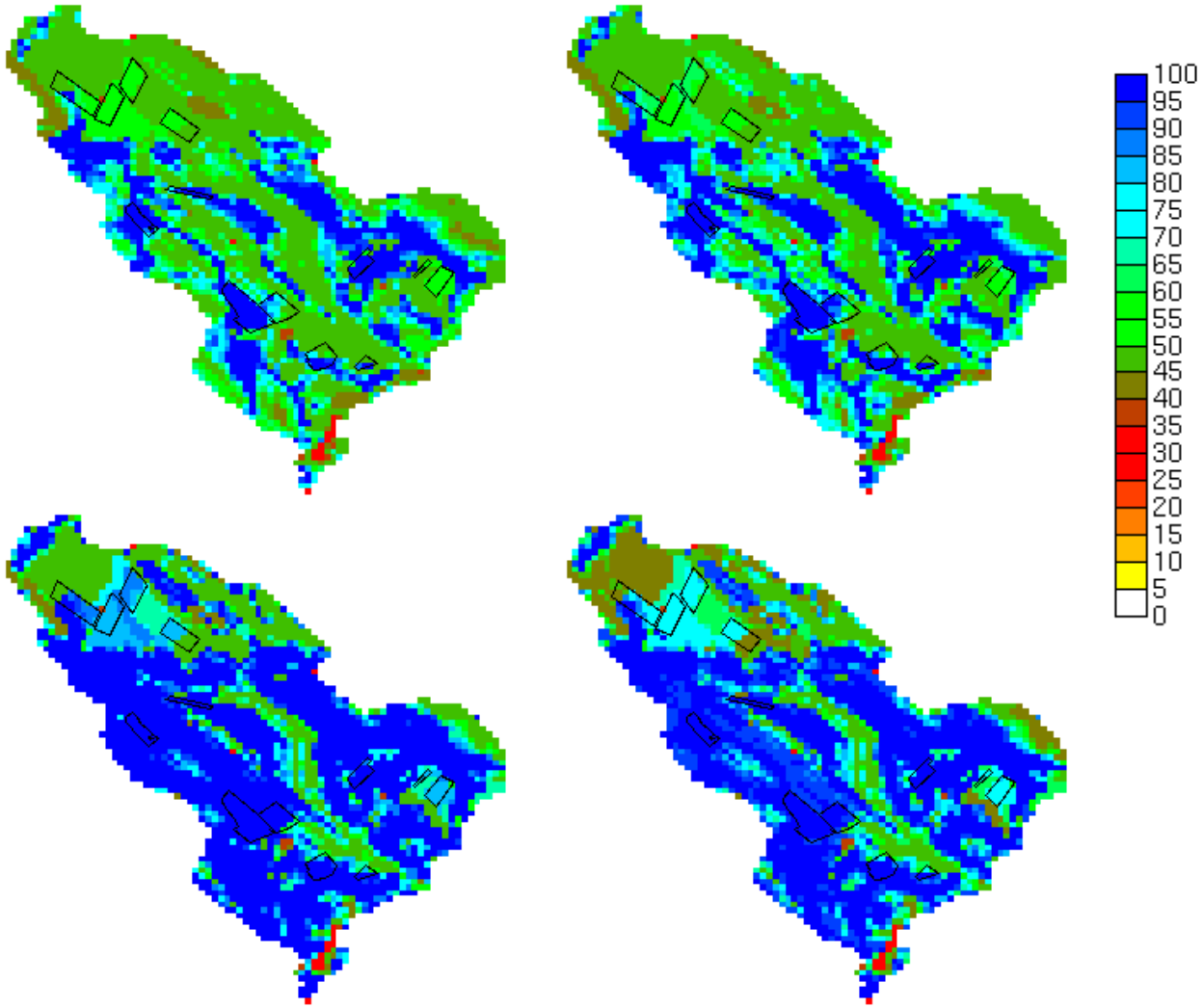
Quality of the Prediction?



- quite good discharge prediction (Nash-Sutcliffe of 0.87)
- quality of the spatial prediction?

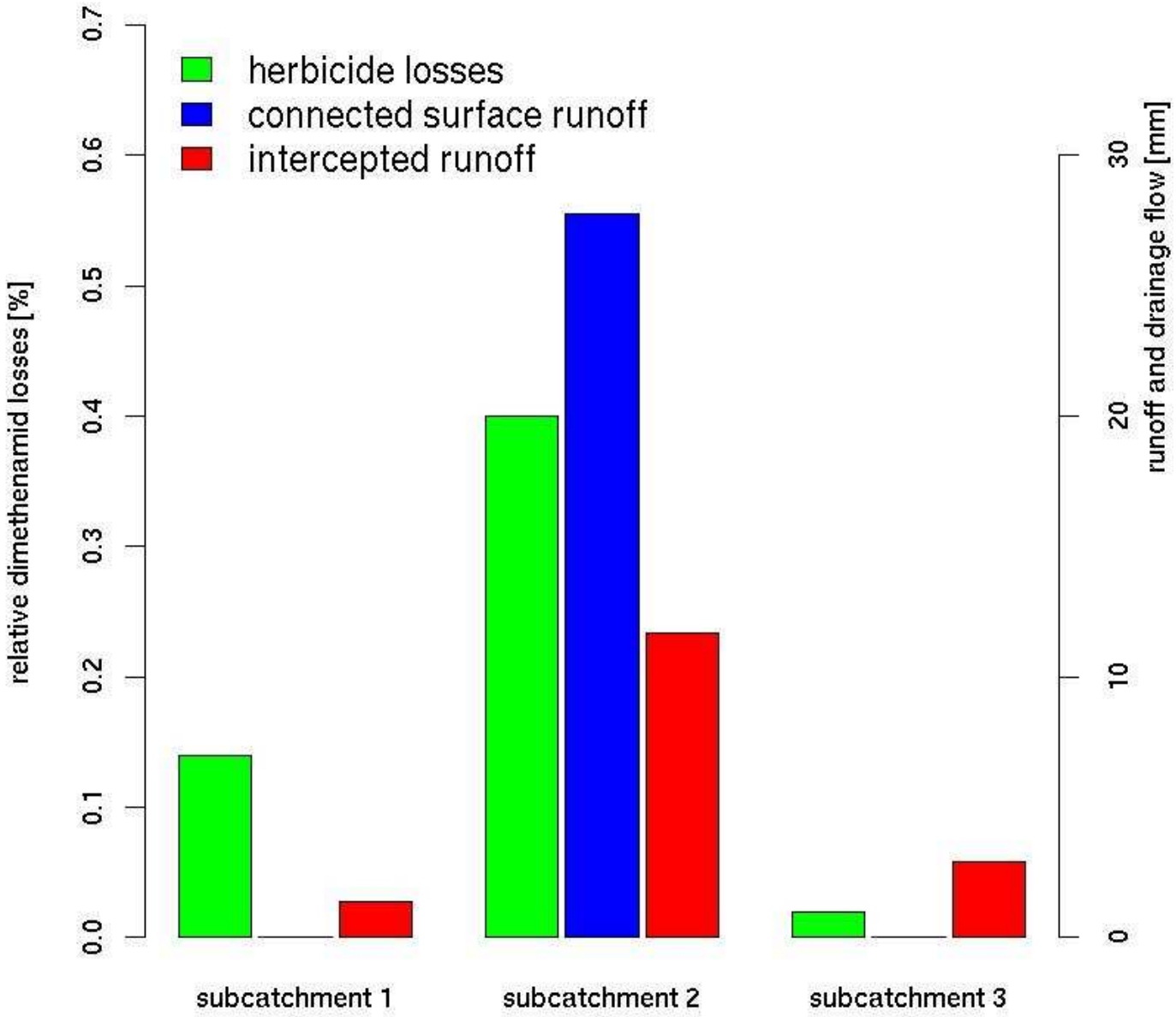
Spatial prediction

Surface saturation



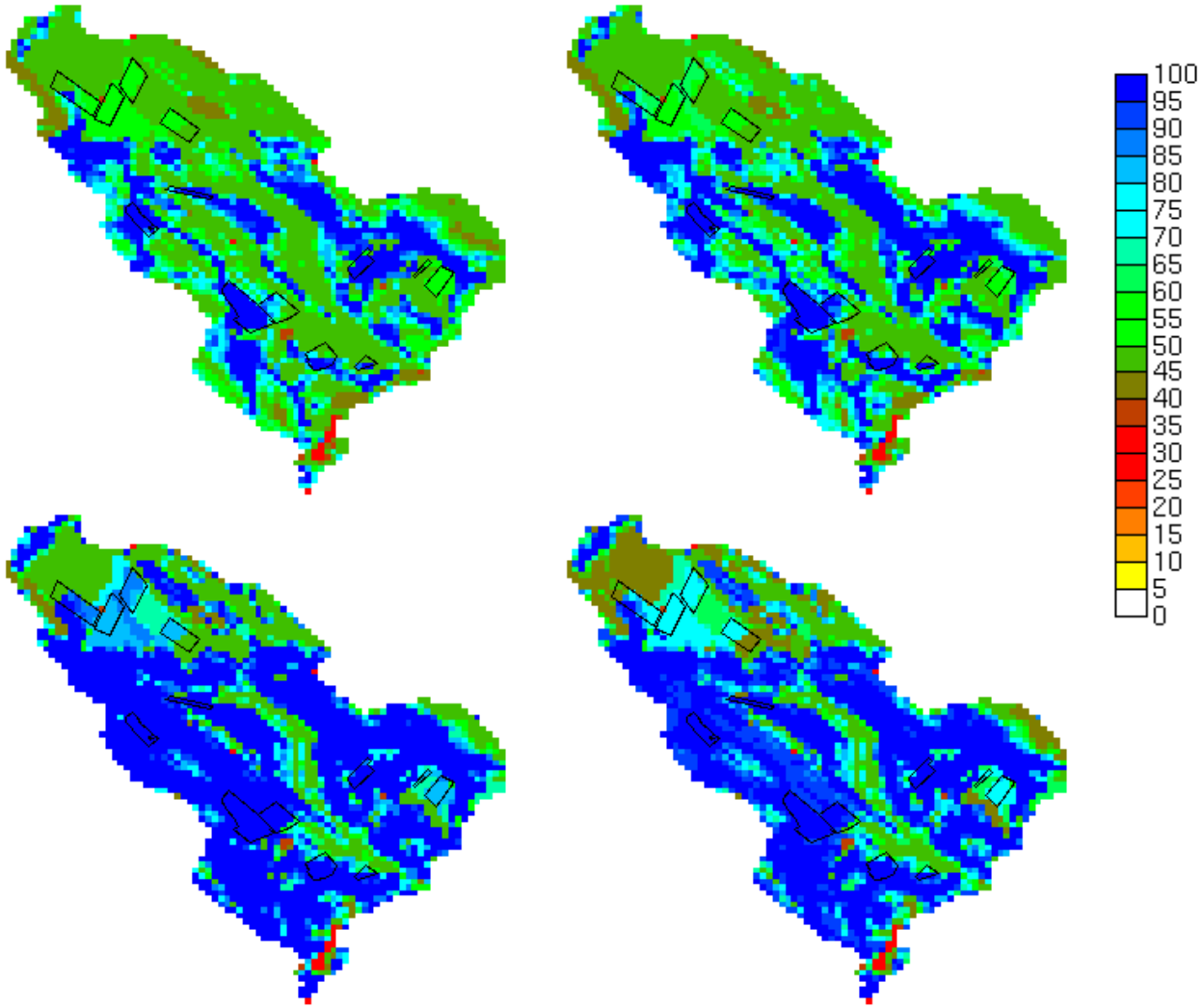
- qualitative reasonable wetness distribution
- different saturation on herbicide fields

Verification with herbicide loss data



Spatial prediction

Surface saturation

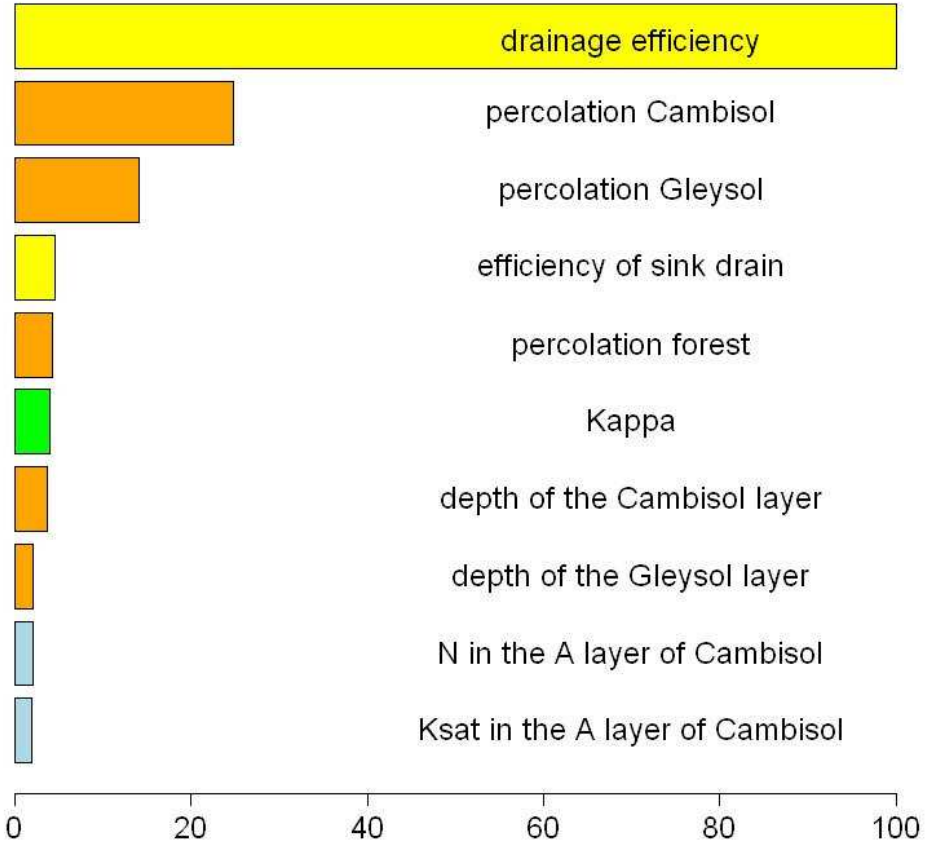


Questions

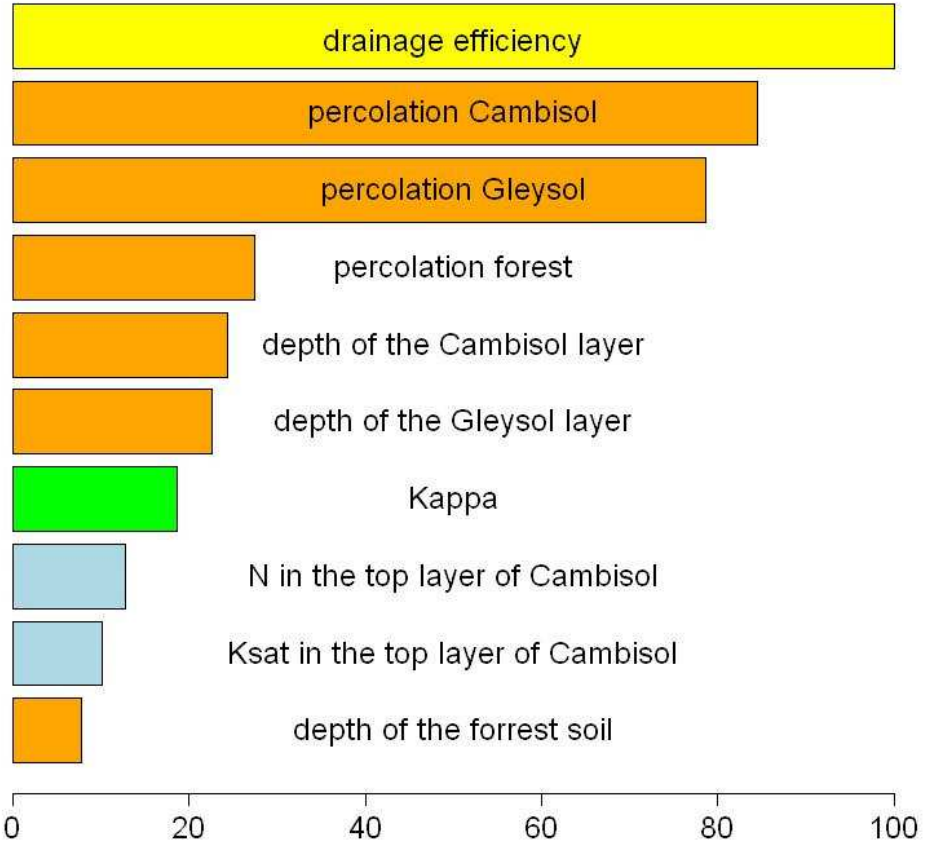
- too efficient drainage system?
- inaccurate drainage map
- unrealistic high saturation in the bottom layers

Sensitivity Analysis

discharge



saturation



Conclusion

Connectivity important for the prediction of contributing areas

- large areas are not surface connected with the river system
- sinks possible hotspots

Limitation in the prediction of contributing areas caused by limited data

- lower boundary condition (dimension and spatial distribution)
- uncertain information about the dimension and the efficiency of the drainage network

Uncertainty in the hydrological soil parameter less important

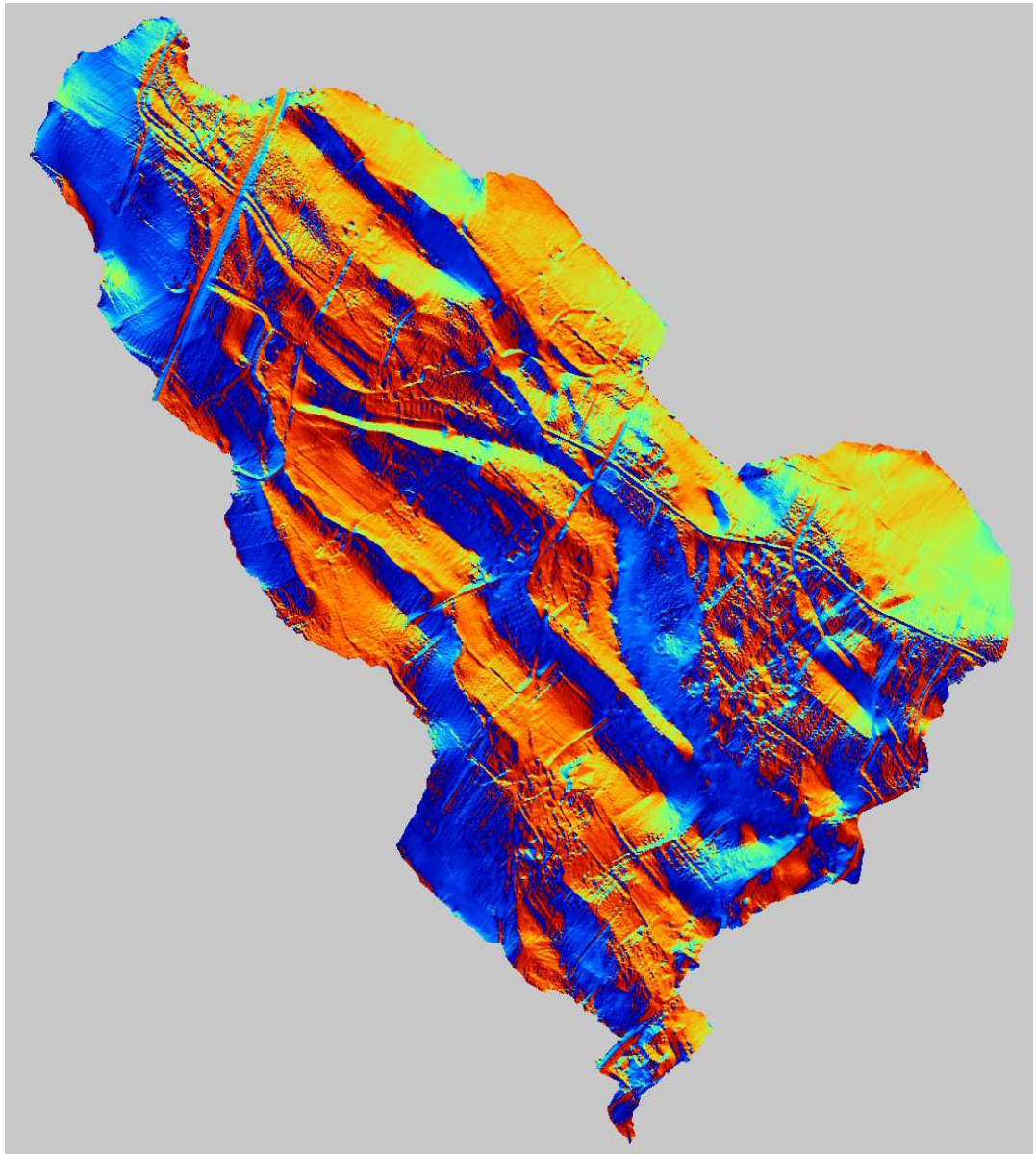
Acknowledgement

- Thanks to Peter Reichert, Manuel Schneider, Anne Dietzel, Karim Abbaspour, Christian Leu, Heinz Singer and the whole Uchem group at the EAWAG

- Thanks to Syngenta for financial support of my project

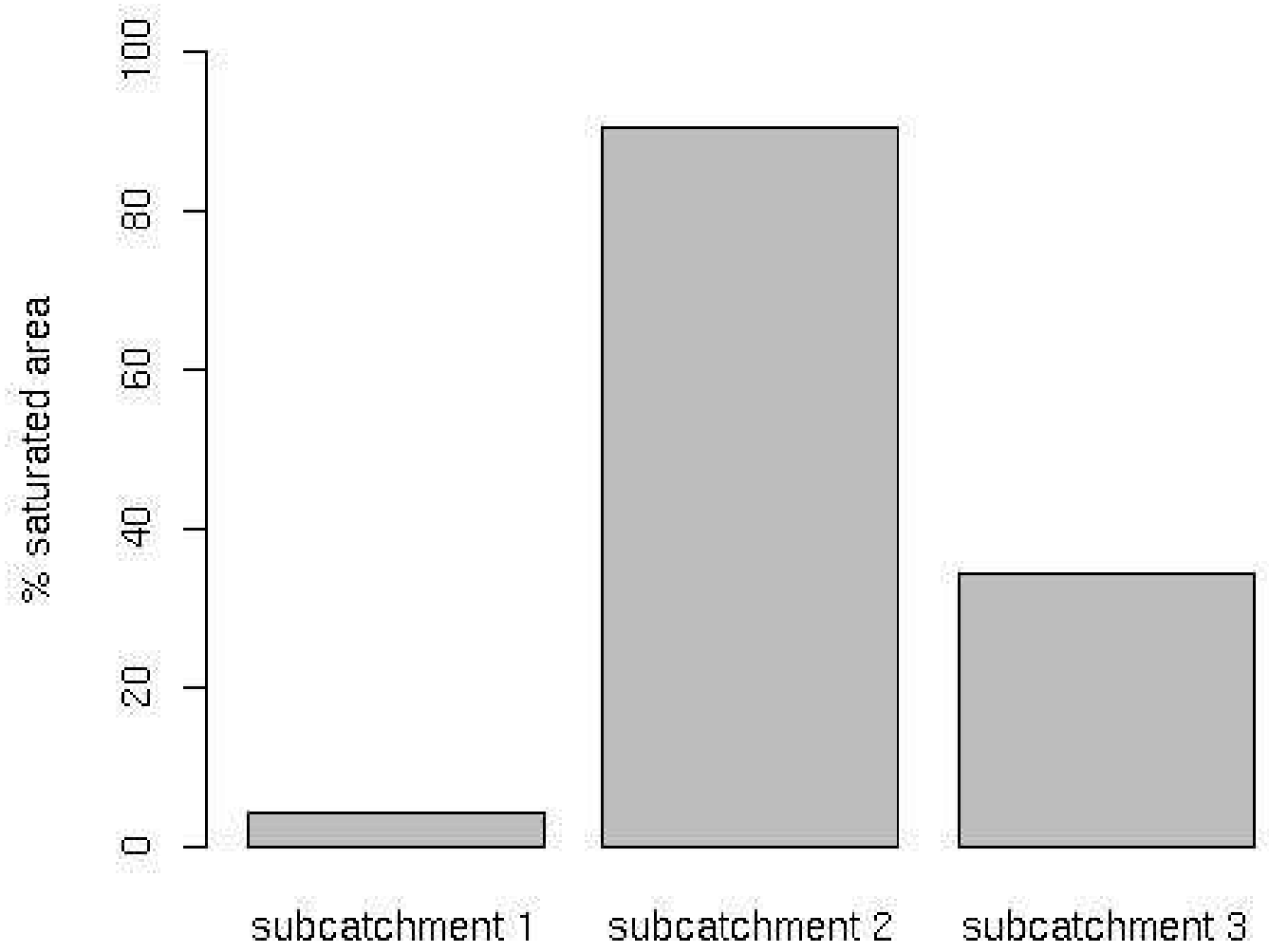
- Thank you for your attention

Connectivity



Spatial analysis of a high-precision 2-meter-resolution DEM based on Airborne-Laser-Scanning with GIS-tools

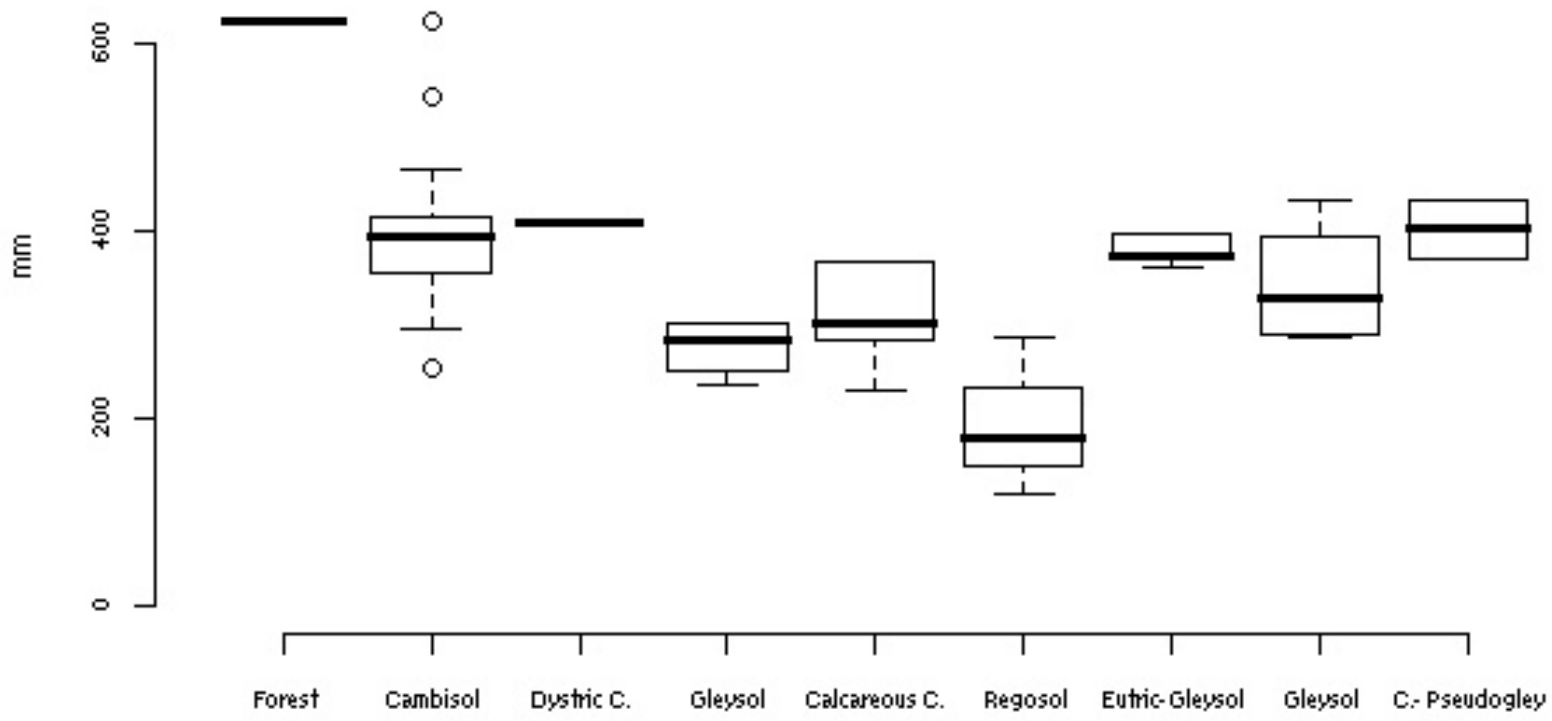
Saturation on the agricultural fields



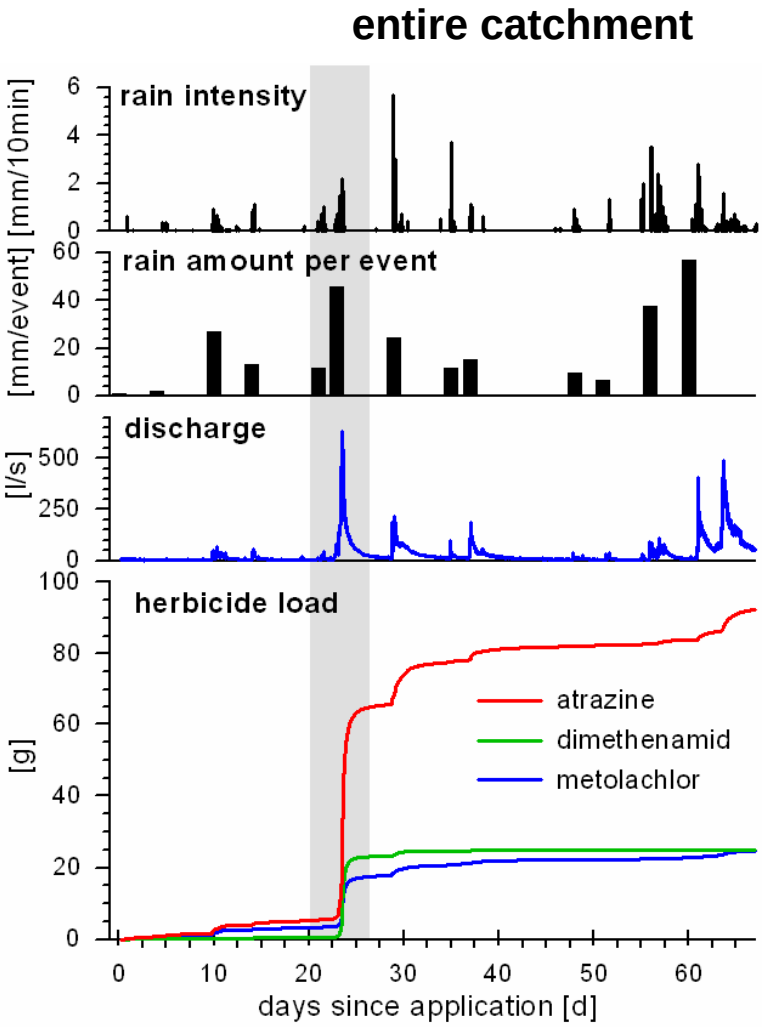
Parameter Distribution

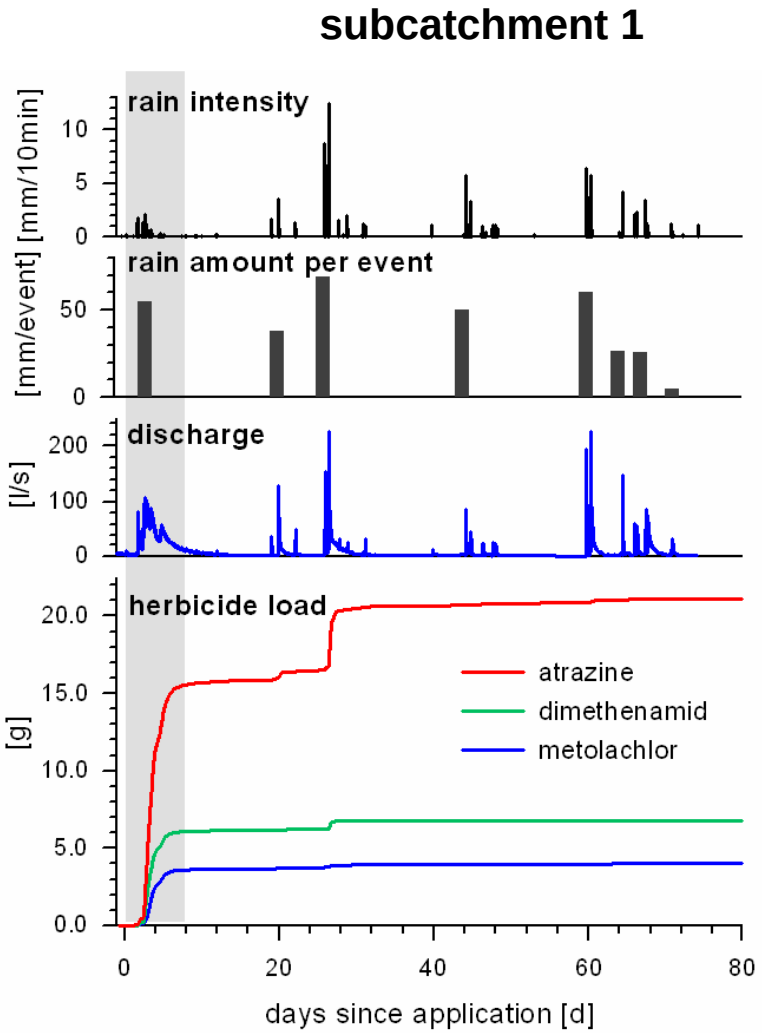
Storage capacity

Parameterization



Catchment outflow





Leu *et al*, Environ. Sci. & Technol., 2004 a Gomides PhD thesis 2005