ON BEHAVIORAL PREDICTIONS AND NON - BEHAVIORAL OBSERVATIONS

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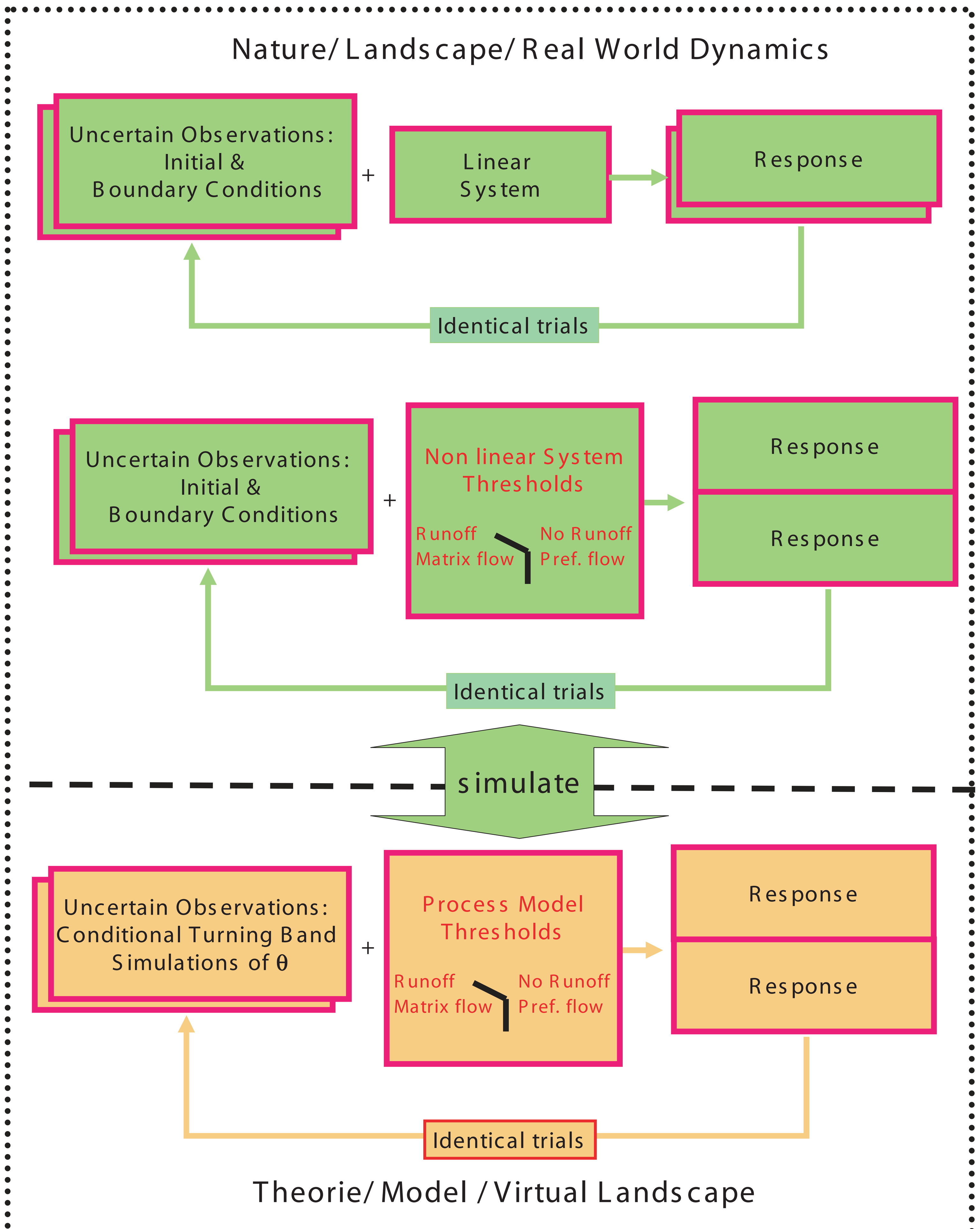
What constitutes a Model??

- Equations & Process Concepts
  - Assumption/Theory on nature of dominating processes
  - Principle constraint for model behavior
  - Constrain/Determine field observations / development of observation techniques
- Parameters
  - Measurements/Calibration
  - Ill posed problems
  - Equifinality
- Data on Inputs/States/Fluxes
  - Forcing & Target variables
  - Measurements/Errors/Reproducibility under identical conditions?

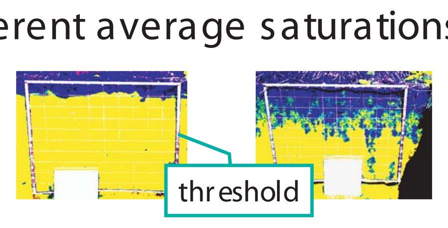
Behavioral predictions require reproducible observations

- Does a set of field observations of initial and boundary conditions constrain system behavior to yield „identical" response within „identical" trials??



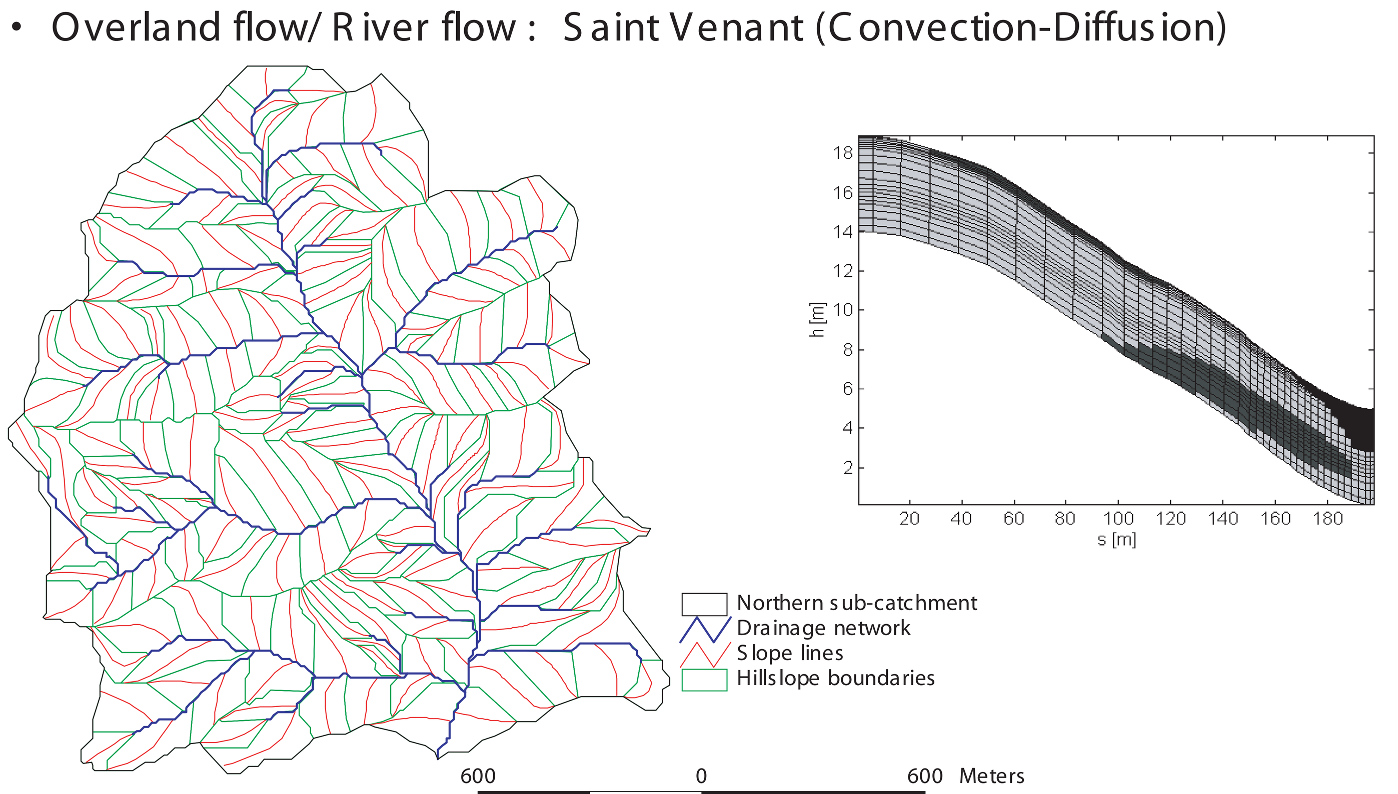
Process Models as virtual Landscapes

- Simulate identical replicas of discharge measurements for identical sets of observed initial & boundary conditions
- Shed light on reproducibility of measurements in different average saturations states in the presence of threshold processes



Model concept

- Catchment consists of hill slopes and river net
- Hillslope Processes: 2d Darcy - Richards with macropores (threshold app.)
- ET: Penman-Monteith
- Overland flow/River flow: Saint Venant (Convection-Diffusion)



Non behavioral observations in a Loess Landscape

Catchment characteristics

- 3.5 km² large, up to 15 m huge Loess layers, Semi humid climate
- Spatial organisation of Soils: Typical Loess catena due to erosion & sedimentation
- Spatial organisation of Macropores: Higher amount of worm burrows in moist but drained Colluvisol soils at the valley floors (Zehe & Flühler, 2001)
- Dominance of Hortonian Runoff production, no subsurface storm flow

Data base (Fig. 1)

- Precipitation/Discharge/Meteorological Data: 6 gages/2 gages/1 station
- Soil moisture: 61 TDR stations
- Soil hydraulic properties/Macroporosity: several transects à 200 samples/15 sites
- Crop pattern/LAI/Root depth/Mannings n: Visual inspection/Irrigation experiments

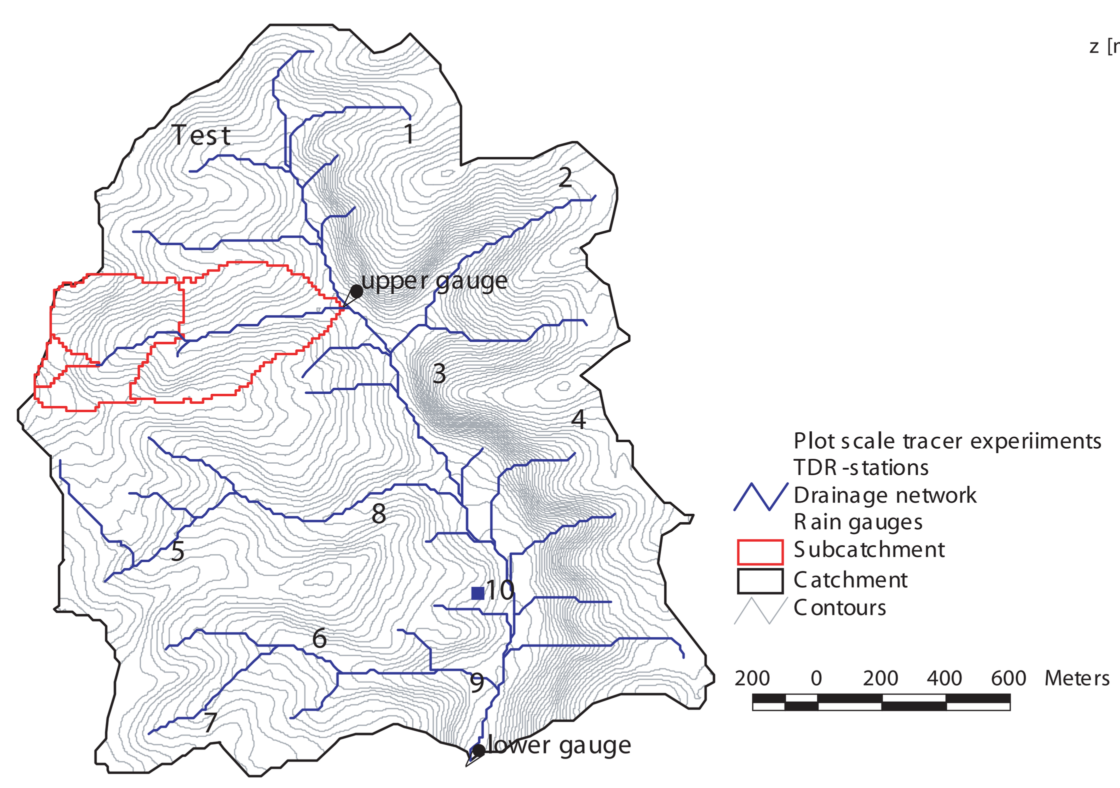


Fig.1: Measurement Network

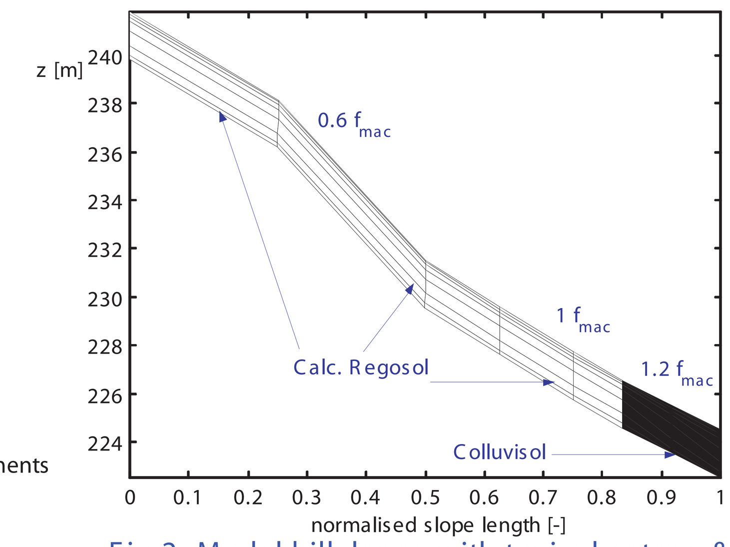


Fig.2: Model hillslopes with typical catena & macroporosity pattern

Model calibration

- Use model slopes with typical catena & pattern of macroporosity (Fig. 2)
- Estimate average hillslope macroporosity f_m for largest observed flood event (Fig. 3)

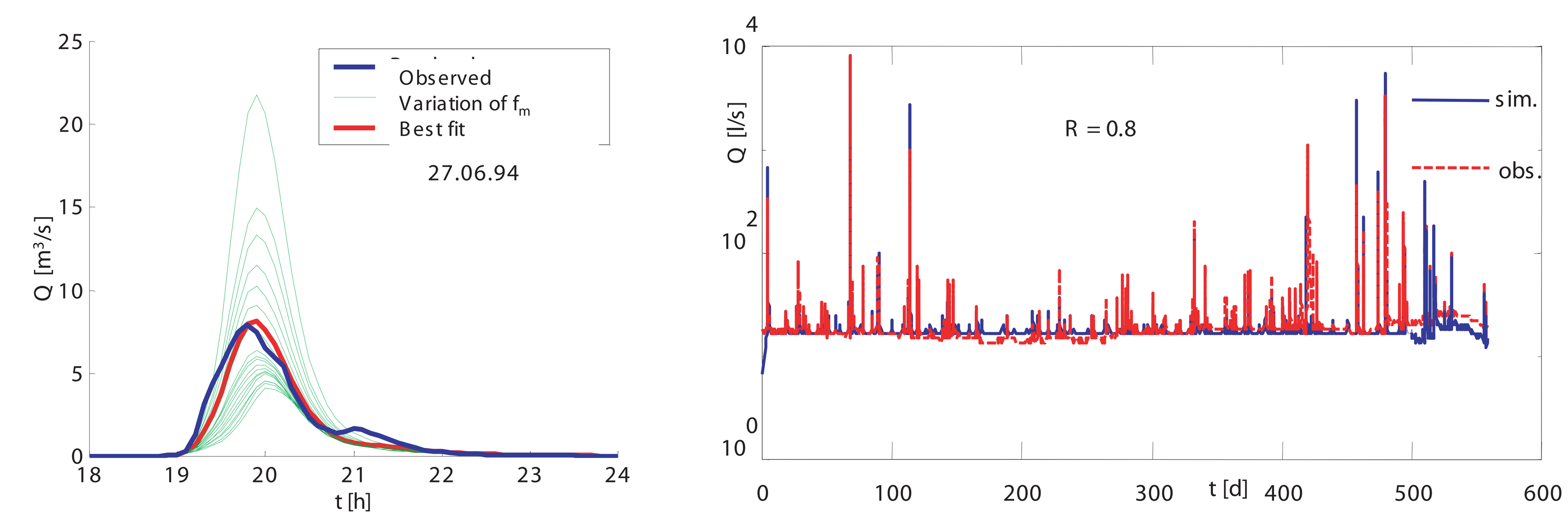


Fig.3: Calibration for largest flood event #1 in June 94 (left panel) and continuous simulation for 1.5 y

- Simulate identical replicas of discharge measurements for identical sets of observed initial & second largest flood event #2 (August 95)
- Use turning band simulations of initial soil moisture conditioned to 61 point observations as identically observed initial state (30 realizations)
- Differences in realizations reflect uncertainty of the observation of the initial state
- Repeat for average soil moisture ranging from 0.12 to 0.38 m³m⁻³

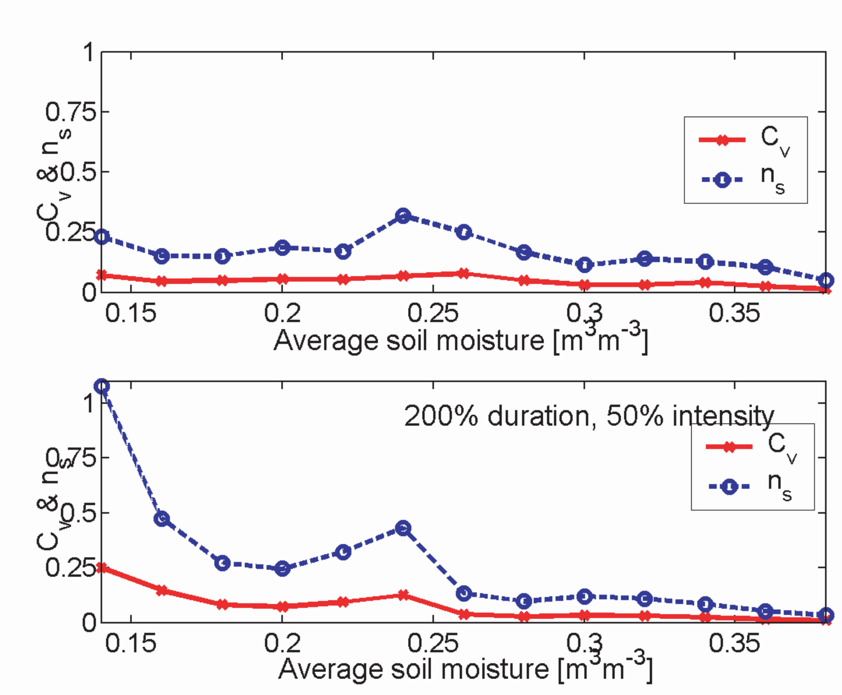


Fig.4: Scaled range & coefficient of variation of flood peaks for original event #2 & reduced intensity

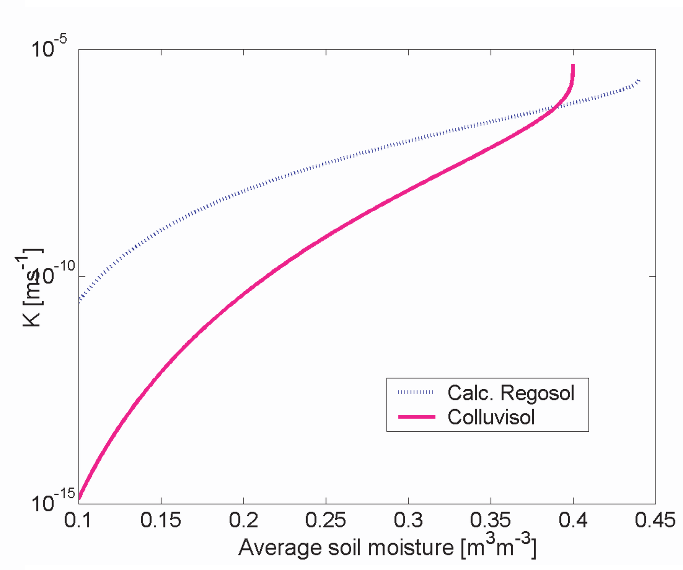


Fig.5: Soil hydraulic properties of Weiherbach soils

$$n_s = \frac{\max(Q^i_{Peak}) - \min(Q^i_{Peak})}{\mathrm{average}(Q^i_{Peak})}$$

Conclusions

- Interplay of uncertain initial conditions leads to state dependent reproducibility of simulated measurement
- Simulated identical replica of measurements give strongly different response if system is close to thresholds
- Immanent limits for reproducibility of measurements and therefore for predictability of hydrologic systems response
- Need better techniques for observing catchment scale state variables

References

ZEHE, E. AND BLÖSCHL, G.: (2004). Predictability of hydrologic response at the plot and catchment scales – the role of initial conditions. Accepted at Water Resources Research

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