

Coupled Simulation of Heterogeneous Hydrological Systems: Numerical Modeling of Runoff Generation in Lowland Areas

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Background

The quantification of available water resources in a lowland area is an essential prerequisite for their sustainable use and for assessment of their ecological value.

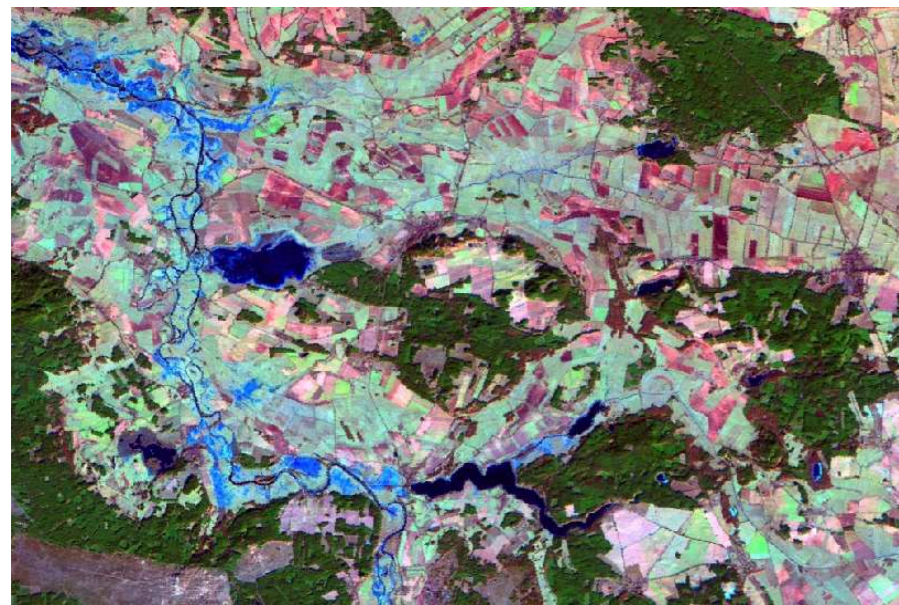


Fig. 1a Landsat Theme — February
(Channel 5/4/3)

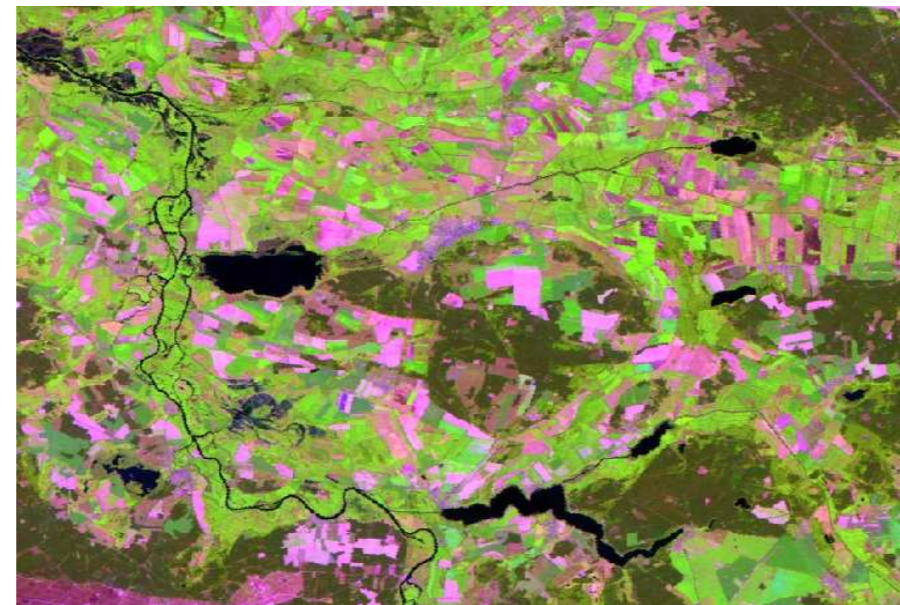


Fig. 1b Landsat Theme — June
(Channel 5/4/3)

Specific hydrological processes in lowland river systems:

- generation of saturated areas and their space/time variability (Fig. 1a+b)
- water fluxes between groundwater and surface water (Fig. 2a+b)

Existing hydrological models do hardly reflect these heterogeneous processes and are therefore not very suitable for simulation of runoff generation in lowland areas.

Goals

- System understanding of runoff generation processes in a selected lowland catchment
- Simulation based on an existing decoupled model
- Description and quantification of specific processes:
 - fluxes between groundwater and surface water
 - groundwater-dynamics
 - spatial variability of generated saturated areas

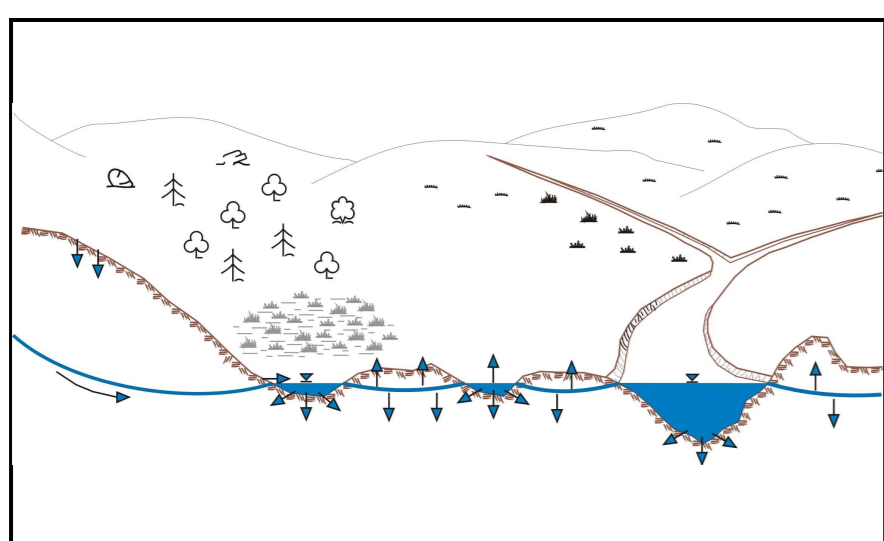


Fig. 2a Runoff Generation Processes for lowland areas — wet conditions

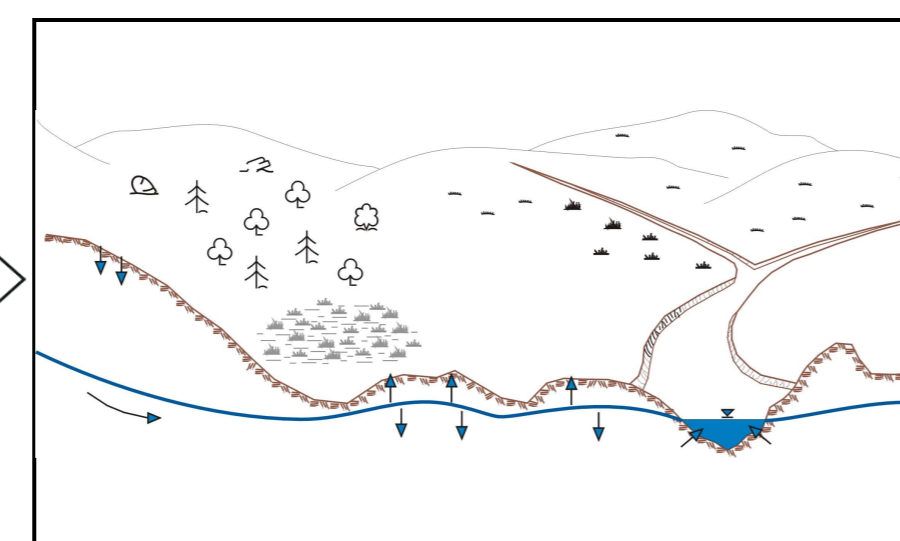


Fig. 2b Runoff Generation Processes for lowland areas — dry conditions

The application of the decoupled model will be used to judge the efficiency and advantage of a fully coupled and numerical innovative (advanced) model that is studied in the Kornhuber and in the Bänsch group.

Research Strategy

- Description of water cycle by use of:
 - experimental investigations, e.g. water table fluctuations (Fig. 3)
 - simulations based on process-oriented hydrological models
- Providing of initial and boundary conditions and the variability of certain processes for model-input (based on in-situ measurements of meteorological and hydrological variables and their variability)

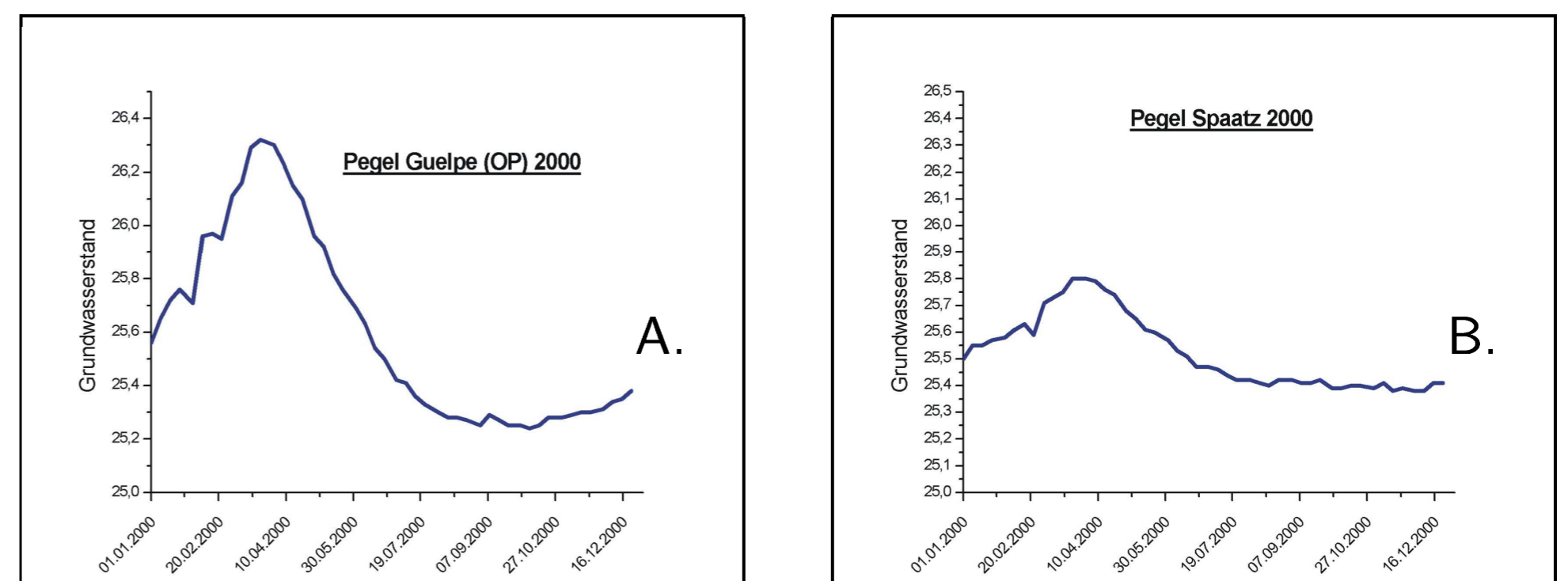


Fig. 3 Groundwater dynamics related to the distance of the river
(A: ca. 200 m from river, B: ca. 4.8 km from river)

- Extension and adaptation of an existing hydrological numerical model (composed of simplified modules for the vadose zone)
- Coupling of a 2D-horizontal finite-difference groundwater model to the surface module in a one-way mode

Work Plan

- Identification of a selected lowland catchment
- Providing of spatial data (*digital terrain data, vegetation cover, soil type, channel geometry etc.*) and time series of a variety of processes (*e.g. precipitation and other meteorological variables, groundwater levels, surface runoff levels and discharge*)

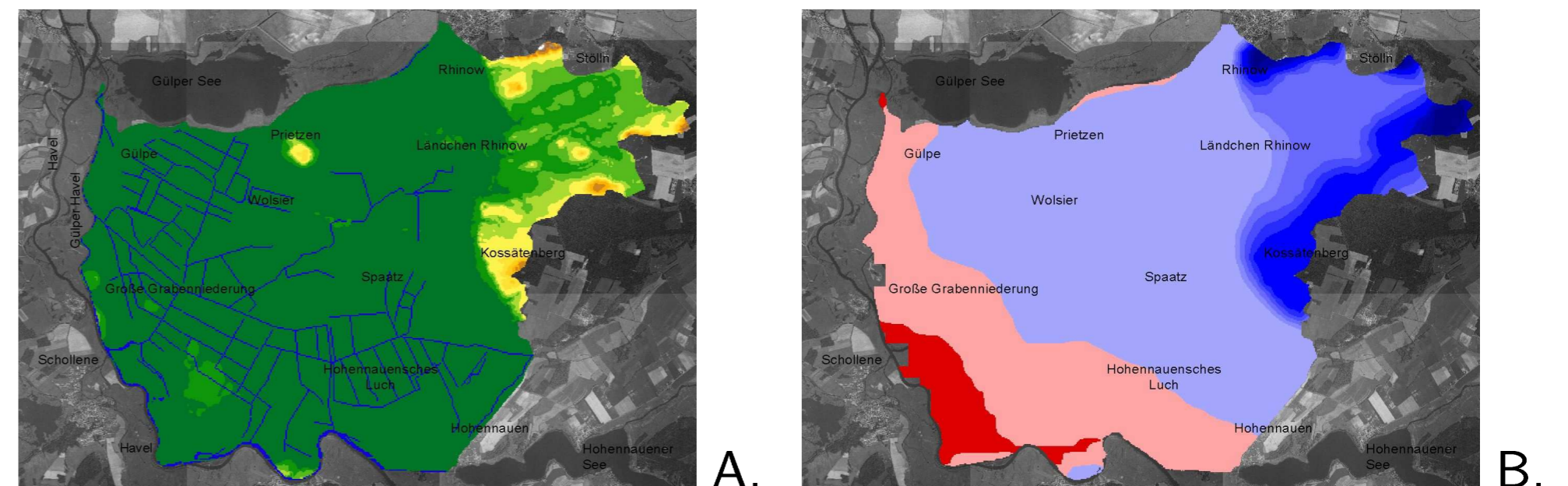


Fig. 4 Examples of areal catchment data:

- A) Digital Elevation Model and River + Channel System
B) Variability of saturated areas (red : saturation always possible
pink: saturated only in spring)

- Additional measurement devices at some locations
- Parameter identification and parameter sensitivity studies based on the collected data
- Implementation of relevant hydrological processes in the model system based on process studies (WaSIM-ETH, MODFLOW, Hydrain)

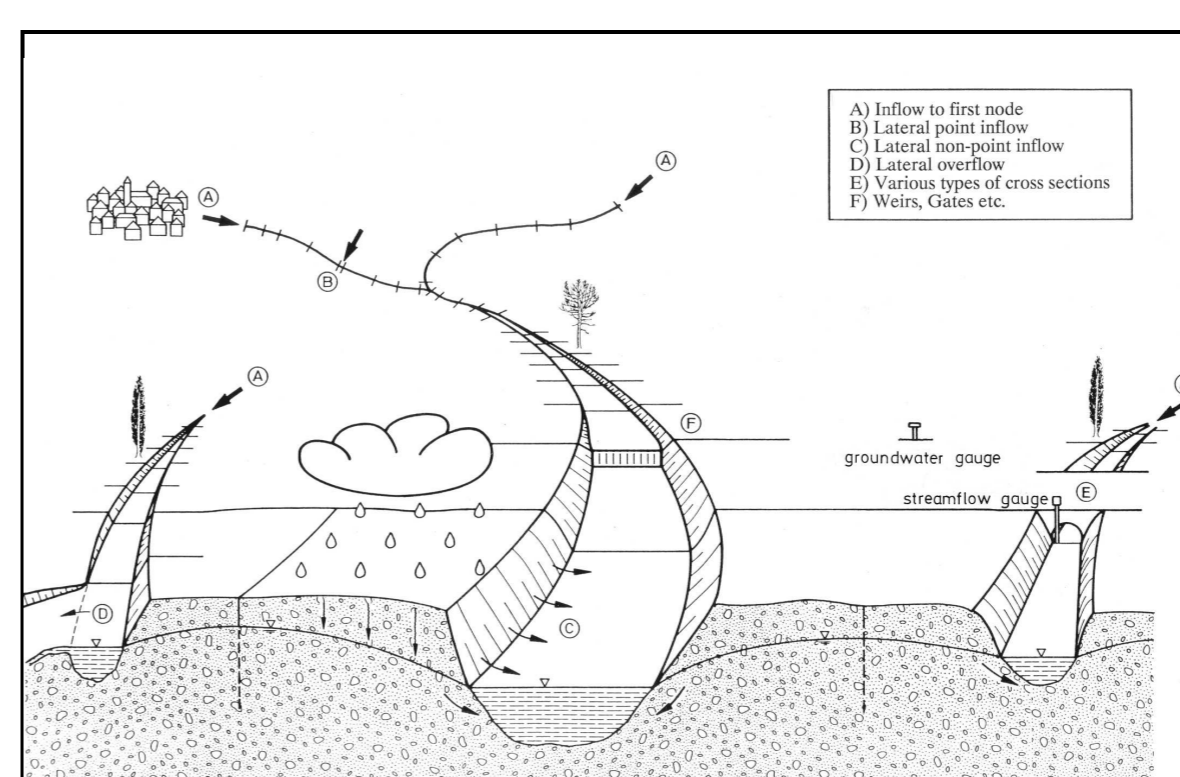


Fig. 5 Runoff generation processes represented in a hydrological model