Understanding and modeling the interaction of Groundwater and Surface Water on *large* spatial and temporal *scales*

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Questions

- What makes the GW-SW interaction at the regional scale different from smaller scales?
- What are the *relevant processes* of the GW-SW interaction at the regional scale?
- What *process descriptions* (models in the broadest sense) are suitable to the regional scale to provide adequate results?

- **Regional (or large) Scale:**
  - River Basins (or geographically, politically defined areas) **> ~10000 km²**

1. Integrated Water Resources Management IWRM

An integrated view on the water cycle must account for relations between:

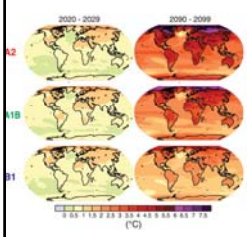
- **Sources** and **sinks** (flow and transport)
- **Suppliers** and **consumers**
- **Ecological** and **economical** flows
- …

➔ Large distances - long travel times

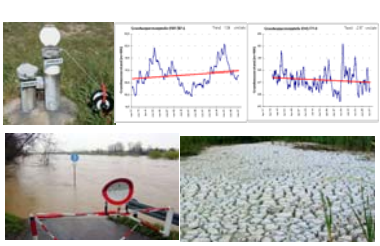
2. Political and Socio-Economic requirements

- Political Framework
  - E.g. the European Water Framework Directive → RBMPs
- International Programs
  - e.g. HELP: Hydrology for the Environment, Life and Policy
  - E.g. Global Water Initiative
  - …
- Transboundary Water Management Issues & Conflicts
  - …

3. Climate Change



Global

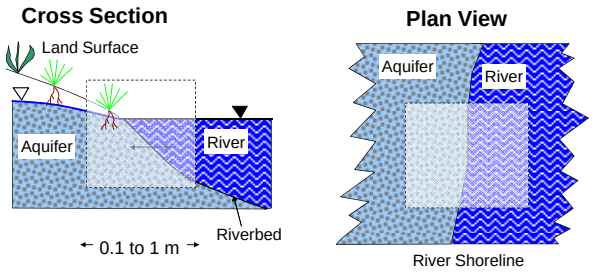


Local

Processes at the Regional Scale?

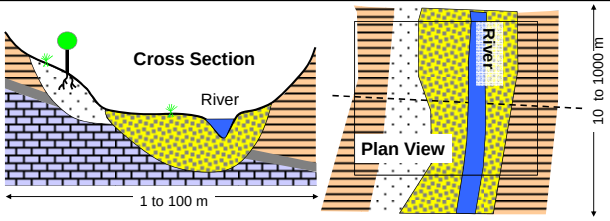
- The **basic processes** are essentially the same on all scales, however,
  - The relative relevance of different processes changes
  - For practical reasons many processes must be neglected or simplified
- Development of process descriptions for the large scale can either
  - Start from an analysis of the essential processes
  - Start from the objectives of large scale modeling and available data etc.

The "point" scale



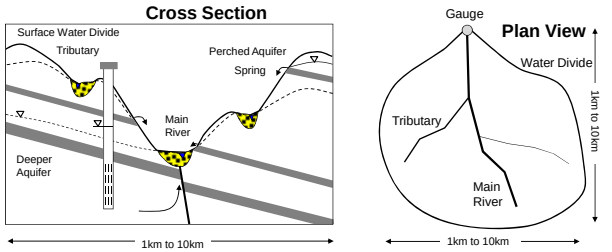
- Direct, detailed measurement of physical, chemical and biological **properties** is possible an thus
- Detailed quantitative description of **processes** is possible

The „local scale"



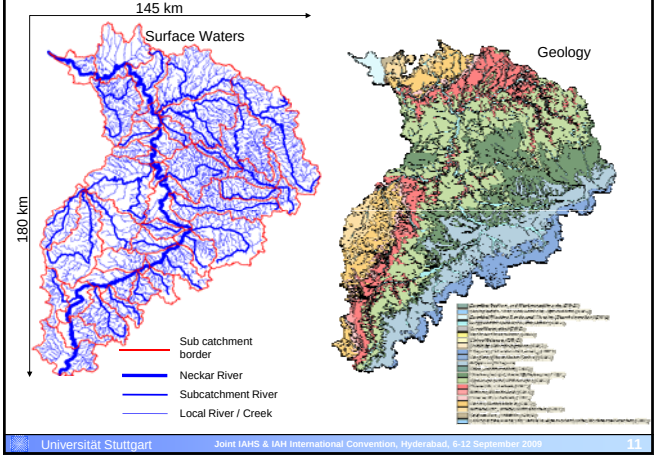
- Increasing influence of adjacent aquifers and water bodies
- Larger distance between observations:
  - assumptions on distribution of properties
  - spatial interpolation and aggregation
  - ➔ increasing heterogeneity
  - ➔ increasingly lumped process description

The "sub-catchment scale"

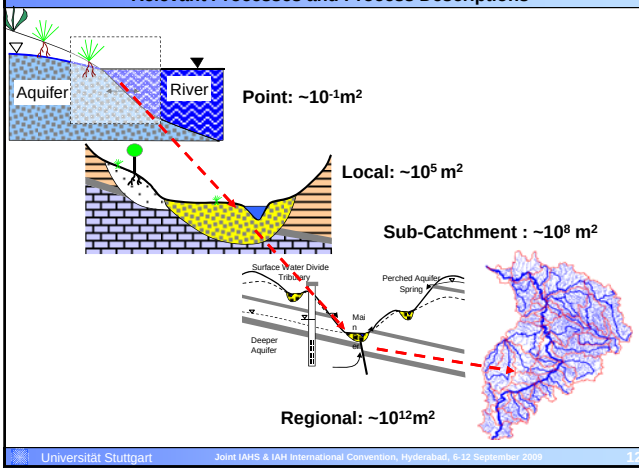


- Low spatial frequency of observations
- Increasing relevance of topographical effects and regional flow
- Alluvial valley fills may no longer be the most important aquifer

Regional Scale: Example: Neckar Catchment, Germany ~14000 km²



Relevant Processes and Process Descriptions

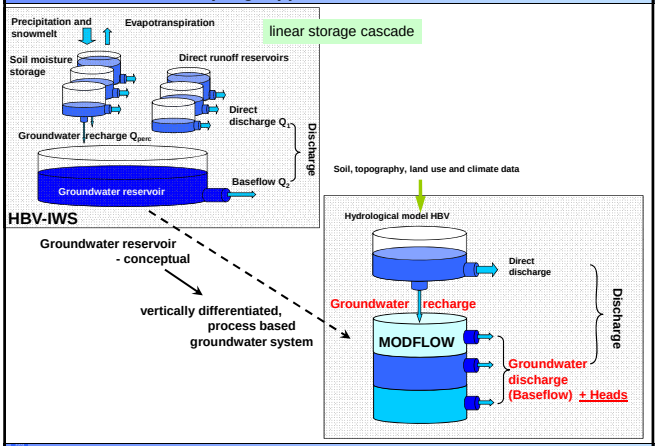


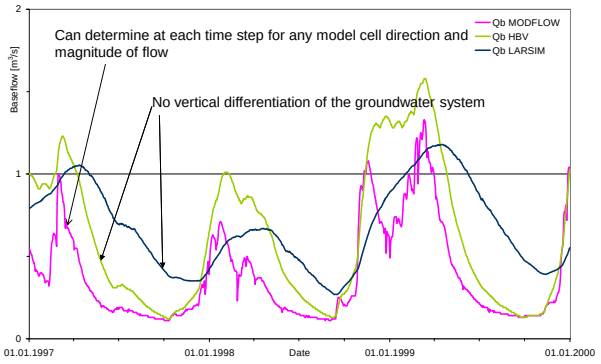
Process descriptions and Models

3 main options:

1. Full upscaling of process descriptions
2. Replace “processes” by “balances”: in = out + storage …
3. Define **specific process descriptions** for the regional scale *including*
   - Spatially distributed, enhanced concepts to estimate **Groundwater Recharge** and “**Base Flow”** on the regional scale
   - Consideration of processes in the deep unsaturated zone
   - Multi-criteria model development, calibration and validation

Coupling Approach in RIVERTWIN





Enhancement through chemical data

Gauge Neuenstadt / Brettach

Conclusions

- The analysis of **GW-SW interaction at the regional scale** is necessary to meet the requirements of IWRM, WFD and investigations concerning the effect of Global (Climate) Change.
- Detailed, physically based process descriptions might not be required for most **practical regional scale management problems**, however they **may** in some cases increase options for validation and thereby increase predicative capabilities and decrease uncertainty of models

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