High-resolution discharge and groundwater recharge simulations by conceptional hydrological models in the Neckar Basin, Germany

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Outline

• Intended objectives
• Developed models
• Discharge simulations
• Groundwater recharge
• Conclusions and implications
• Outlook
RIVERTWIN - Goals

**Scenarios** of integrated water resources management to support the establishment of River Basin Management Plans (RBMP)

**Integrated regional model** for scenario analysis and evaluation under contrasting ecological and socioeconomic conditions in three river basins

http://www.rivertwin.org/

Gaiser, 2004
Intended objectives

- Coupled and adapted surface water models (HBV/LARSIM)
- High resolution discharge and groundwater recharge simulations
- Impact of climate/socio-economic change on water balance
Decision Support Systems for Soil and Water Resources Management

J. Götzinger

Hydrological Modelling

- Climate
- Discharge
- Groundwater
- Water supply systems
- Expert system

- MODFLOW
- WEAP
- LARSIM / HBV
- MOSDEW
- Integration

- Socioeconomic assumptions and measurements
- Regionalised climate types and -scenarios
- Water quality
- Freshwater ecology
- Cultivation methods yields, diff. pollution
- Agroeconomy

Printz, ILPC, 09/05

Coupling water balance and groundwater models

Soil, topography, land use and climate data

Water balance model

Groundwater recharge

Groundwater model

Discharge

Water quality

Water supply

Ecology

Soil, topography, land use and climate data

Water balance model

Groundwater recharge

Groundwater model

Discharge

Water quality

Water supply

Ecology
HBV in a nutshell

Runoff generation

Soil moisture storage

Runoff production

FC

Evapotranspiration

S: water level

k: „residence time“

Runoff concentration

Q0

Q1

Q2

QPerc

Decision Support Systems for Soil and Water Resources Management

HBV-IWS: Model structure

- Spatially distributed process description
- Transfer functions linking model parameters with catchment characteristics
HBV-IWS: Calibration strategy

- Parameters of transfer functions calibrated directly for a set of subcatchments using discharge at outlet

- Regionalization in the other subcatchments using soil, land use and topography

  distributed predictions
  natural variability
  few free parameters
Rottweil 1987-1990 Validation

- baseflow
- observed
- modelled
Plochingen 1981-1987, kalibriert für Rottweil

observed
modelled
Structure of LARSIM

- resolution: 1 km²
- Knauf
- Penman-Monteith
- Xinanjiang-Model
- linear reservoirs
Neckar Basin

- 14,000 km²
- 91 – 1030 masl
- temperate humid
## Climate scenarios

<table>
<thead>
<tr>
<th></th>
<th>Temperature</th>
<th>Precipitation</th>
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</thead>
<tbody>
<tr>
<td>1988 – 1999</td>
<td>9.3 °C</td>
<td>1074 mm</td>
</tr>
<tr>
<td>Enke dry</td>
<td>10.9 °C</td>
<td>1162 mm</td>
</tr>
<tr>
<td>Enke wet</td>
<td>10.9 °C</td>
<td>1220 mm</td>
</tr>
<tr>
<td>Yang A2</td>
<td>12 °C</td>
<td>1208 mm</td>
</tr>
<tr>
<td>Yang B2</td>
<td>11.9 °C</td>
<td>1311 mm</td>
</tr>
</tbody>
</table>

## Land use scenarios

- **A10**: 6% more dense settlement (50% sealed, 35% grasland, 15% forest)
- **B20**: 5% more loose settlement (30% sealed, 50% grasland, 20% forest)
Monthly mean discharge Rockenau

- 1988-1996 observed
- 1988-1996 modelled
- 1997-2003 observed
- 1997-2003 modelled

MoMQ [m³/s] vs. Month

1.5 2.0 2.5 3.0

1 2 3 4 5 6 7 8 9 10 11 12
Monthly mean discharge Rockenau

- 1988-2003 modelled
- 2001-2030 Enke dry
- 2001-2030 Enke wet
Flow Duration Curve Rockenau Enke

- 1987-2003 modelled
- 2001-2030 dry
- 2001-2030 wet

Discharge [m$^3$/s]

Days
Monthly mean discharge Rockenau

- 1988-2003 modelled
- 2001-2030 Yang A2
- 2001-2030 Yang B2
Flow Duration Curve Rockenau Yang

- 1987-2003 modelled
- 2001-2030 A2
- 2001-2030 B2
MoMQ Rockenau Enke land use scenarios

- 2026-2030 dry
- A10 2026-2030 dry
- B20 2026-2030 dry
- 2026-2030 wet
- A10 2026-2030 wet
- B20 2026-2030 wet
- No Ag 2026-30 wet
Flow Duration Curve Rockenau Enke land use scenarios

- 2021-2030 dry
- 2021-2030 A10 dry
- 2021-2030 B20 dry
- 2021-2030 wet
- 2021-2030 A10 wet
- 2021-2030 B20 wet
- No Ag 2021-2030 wet
Mean annual groundwater recharge Enke

<table>
<thead>
<tr>
<th></th>
<th>1987-2003</th>
<th>2021-2030 dry</th>
<th>2021-2030 wet</th>
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<tbody>
<tr>
<td></td>
<td>137 mm</td>
<td>122 mm</td>
<td>130 mm</td>
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</table>
Mean annual groundwater recharge Yang

<table>
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<tbody>
<tr>
<td></td>
<td>137 mm</td>
<td>160 mm</td>
<td>156 mm</td>
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</table>
Mean annual gw recharge land use scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2021-30 dry</th>
<th>2021-30 A10</th>
<th>2021-30 B20</th>
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</thead>
<tbody>
<tr>
<td>Recharge (mm)</td>
<td>122</td>
<td>120</td>
<td>122</td>
</tr>
</tbody>
</table>

Decision Support Systems for Soil and Water Resources Management

Conclusions and implications

• Conceptual models can provide information about internal state variables – only if the calibration considers catchment characteristics

• Increase in temperature and precipitation will not perturb water balance in the Neckar basin significantly

• Differences in scenario results are relatively small

• Projected urban growth shows no negative impact on water resources
Outlook

• Training workshops and sample model transfer to SIC (Uzbekistan) and DH (Benin) accomplished
• Model set-up for the Ouémé has started
• Multi-response data will be used to check consistency
• Other regionalization method based on the similarity of raster cells
• We have to expect different results from different climate/downscaling/hydrological...models
Hydrological Modelling in the Neckar Basin

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