Actual status of DSS – Developments in central Europe
- Neckar and Danube River Basins

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Outline

1. Research Catchments and Projects :
   Upper Danube Catchment: GLOWA-Danube (BMBF)
   Neckar Catchment: RIVERTWIN (EC)

2. Water Resources Management Tasks in Southern Germany
   - Decisions that have to be supported → DSS objectives

3. Integration Approaches and DSS Design
   - DANUBIA DSS: GLOWA-Danube
   - MOSDEW DSS: RIVERTWIN

4. Status and Results

5. Lessons Learned and Outlook
Projects and Catchments

RIVERTWIN: Neckar Catchment, 14,000 km²

GLOWA-Danube: Upper Danube Catchment, 77,000 km²

Germany

Neckar Catchment

Upper Danube Catchment

Danube Catchment (~800,000 km²)

Global Change of the Water Cycle – GLOWA [www.glowa.org]

German Collaboration in Global Change Research

GLOWA-Danube
Integrative Techniques, Scenarios and Strategies for the Water Cycle in the Danube Watershed

GLOWA-Elbe
Global Change Impact on Environment and Society in the Elbe Region

GLOWA-Jordan
Global Change and the Integrative Water Resources Management in Arid Regions

IMPETUS
An Integrated Approach to The Efficient Management of Scarce Water Resources in West Africa

GLOWA-Volta
Sustainable Water Use, Changing Land Use, Rainfall Reliability and Water Demands in the Volta
GLOWA-Danube (www.glowa-danube.de): Summary

- **Consequences of Global Change in the Upper Danube Catchment** (Water Supply, Land Use, Agriculture, Economy, Tourism ...)

- **Decision Support System 'DANUBIA',** comprised of 16 fully coupled individual models

- **Integrated / Interdisciplinary Approach:** 12 research groups from different disciplines (Meteorology ... Tourism Research)

- **Subproject Groundwater and Watersupply at Stuttgart:**
  - Groundwater flow model plus a module for Nitrogen Transport
  - Watersupply and distribution model

RIVERTWIN (www.rivertwin.org)

'A Regional Model for Integrated Water Management in Twinned River Basins'

- Apply the principles of the **European Water Framework Directive (WFD)** to other continents.
- Develop the **integrated water and land use management tool MOSDEW**

- **Three research basins:**
  - **Neckar** basin (Germany);
  - **Ouémé** basin (Benin);
  - **Chirchik** basin (Uzbekistan).
## Project Overview

<table>
<thead>
<tr>
<th></th>
<th>RIVERTWIN</th>
<th>GLOWA-Danube</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Funding</strong></td>
<td>European Commission</td>
<td>German Ministry of Research and Education</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>01.03.2004 to 28.02.2007: 3 years</td>
<td>01.01.2001 to 30.04.2010: 9 years in three phases</td>
</tr>
<tr>
<td><strong>Budget</strong></td>
<td>~ 3 Million Euro</td>
<td>~ 16 Million Euro</td>
</tr>
<tr>
<td><strong>Partners</strong></td>
<td>6 (Neckar only)</td>
<td>12</td>
</tr>
<tr>
<td><strong>Scientists</strong></td>
<td>~ 15 (Neckar only)</td>
<td>~ 40</td>
</tr>
<tr>
<td><strong>Stakeholders / Administration</strong></td>
<td>Included in DSS development from the beginning</td>
<td>Included in DSS development at a later stage (first results)</td>
</tr>
<tr>
<td><strong>Overall Objective</strong></td>
<td>Research and Development of practical tools</td>
<td>Research mainly: Advanced DSS Technology</td>
</tr>
</tbody>
</table>

## Catchment Overview

<table>
<thead>
<tr>
<th></th>
<th>Neckar Catchment</th>
<th>Upper Danube Catchment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area</strong></td>
<td>14,000km²</td>
<td>77,000km²</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>~ 5 Mio. - 360/km²</td>
<td>~ 8.2 Mio. - 100/km²</td>
</tr>
<tr>
<td><strong>Economy</strong></td>
<td>Highly industrialized and urbanized</td>
<td>Less urbanized but still a lot of industrie</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>8.7°C</td>
<td>~7°C</td>
</tr>
<tr>
<td><strong>Precipitation</strong></td>
<td>~950 mm/a</td>
<td>~1100mm/a</td>
</tr>
<tr>
<td><strong>GW Recharge</strong></td>
<td>240 mm/a</td>
<td>300 mm/a</td>
</tr>
<tr>
<td><strong>Landuse</strong></td>
<td>Agriculture* 54%, Forestry 36%, Settlement 10%</td>
<td>Agriculture 55%, Forestry 28%, Settlement 12%, Rocks, Glaciers: 5%</td>
</tr>
</tbody>
</table>

* Agriculture: less than 2% of GDP
### Management Tasks

<table>
<thead>
<tr>
<th></th>
<th>Neckar Catchment</th>
<th>Upper Danube Catchment</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of available Water used</td>
<td>15 to 20 %</td>
<td>4 to 5 %</td>
</tr>
<tr>
<td>Groundwater as source of drinking water</td>
<td>~ 55%</td>
<td>~90%</td>
</tr>
<tr>
<td>Regions of water scarcity (imports required)</td>
<td>&gt; 50%</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>Groundwater quality</td>
<td>very good: 10%, good 50%, poor 40%</td>
<td>very good: 50%, good 40%, poor 10%</td>
</tr>
<tr>
<td>Experienced water related issues</td>
<td>• regional quality problems (ground- and surface water) • regional water scarcity • Floods &amp; draughts in rivers • Surface water ecology</td>
<td>• Water availability and quality generally good • Local quality problems • floods</td>
</tr>
</tbody>
</table>
Water Supply Infrastructure and Inter Basin Transfer

Drinking Water Demand (1998): 700 Mio m³/a (~ 8.5% of GWR) (LfU, 2002)

Water Import: ~120 Mio m³/a (Emmert, 1999)

Why DSS and Integrated Water Resources Management in Southern Germany?

- Densely populated Regions
  - All interventions affect a large number of people and can potentially cause high damages
- How to meet the objectives of the European Water Framework Directive?
  - which interventions are necessary and effective?
- Conflicts between different stakeholders (Water Supply, Ecology, Agriculture, Industry)
  - how to solve and avoid them?
- Increasing number of floods experienced in the last decades
  - what will be the impacts of further climate change?
  - how to prevent such events and how to protect people?
- Draughts
  - a relatively new but alarming issue
  - ecology, navigation, energy production: hydropower and nuclear power plants,
Water Shortages in Southern Germany in Summer 2003

Communities affected by water shortages in 2003

Groundwater Dependent Ecosystems, Groundwater Discharge, 2003

navigation impossible

94 days < Regulation

dry habitats (mussels)

dry riverbeds

dry wetlands

dry riverbeds

Meteo Schweiz, 2004

LfW Bay, 2004
Integration Approaches and DSS Design

### DSS Overview

<table>
<thead>
<tr>
<th></th>
<th>RIVERTWIN</th>
<th>GLOWA</th>
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</thead>
<tbody>
<tr>
<td>Integrated model / DSS</td>
<td>MOSDEW</td>
<td>DANUBIA</td>
</tr>
<tr>
<td>Sectors</td>
<td>Water, Landuse, Economy</td>
<td>Water, Landuse, Economy</td>
</tr>
<tr>
<td>Emphasis</td>
<td>Agriculture / Landuse, River Ecology</td>
<td>Hydrology, Water Supply (Tourism)</td>
</tr>
<tr>
<td>DSS Type</td>
<td>GIS based Expert system</td>
<td>Model based</td>
</tr>
<tr>
<td>Number models included</td>
<td>10, 2-3 socioeconomic</td>
<td>16, 6 socioeconomic models</td>
</tr>
<tr>
<td>Coupling scheme</td>
<td>lose coupling via data sets</td>
<td>fully coupled at run-time</td>
</tr>
<tr>
<td>Application / Scenario based</td>
<td>Climate, Socioeconomic, Interventions</td>
<td>Climate only (until now)</td>
</tr>
</tbody>
</table>
Model Coupling: 1) "strong" coupling (GLOWA-Danube)

Model: timestep

Model 3
Model 2
Model 1

Models
1: LandSurface
2: GroundWater
3: RiverNetwork

Variables
a: groundwater recharge
b: groundwater level
c: infiltration
d: river level

Model 1
15 min
Model 2
1 d
Model 3
1 h

LS: 15 min
GW: 1 d
RN: 1 h
Model Coupling: 2) “weak” coupling RIVERTWIN

HBV

data base / reference years

MODFLOW

a: groundwater recharge  b: baseflow  c: river discharge

b=f(a, c, ...)
c=f(b, c, ...)

RIVERTWIN – MOSDEW integrated tool: Models and Scenarios
MOSDEW Integration Scheme and Workflow

10 models

Result data base / reference years / Climate scenarios

scenario composition tool

user

Using MOSDEW

MOSDEW - Webbased Interface-Components

http://www.lipoe.uni-stuttgart.de/projekte/rivertwin

(Meta)-Database

Content Management System (CMS)

Requests (GUI)
Scenario and Output Definition

## rivertwin
Model for Sustainable Development of Water Management

### Landuse vs Growth

<table>
<thead>
<tr>
<th>Scenario</th>
<th>1st Q</th>
<th>2nd Q</th>
<th>3rd Q</th>
<th>4th Q</th>
<th>1st Y</th>
<th>2nd Y</th>
<th>3rd Y</th>
<th>4th Y</th>
<th>5th Y</th>
<th>6th Y</th>
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<tbody>
<tr>
<td>No Intervention</td>
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<tr>
<td>10% Grassland</td>
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<tr>
<td>Animal Aquaculture</td>
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<tr>
<td>Fish Passage</td>
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<td>DVG</td>
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http://mapserver.ilpoe.uni-stuttgart.de/rivertwin/index.php
Open access to scenario results

Scenario A - 2015: Change of total gross margin and diffuse N-pollution (river)
**RIVERTWIN Status**

- Project almost completed (Feb 2007)
- Web User Interface working online and partly filled with data
  - a huge number of results can be created based on different climatic and socio economic scenarios and interventions
- Open questions
  - many results are not fully validated yet (groundwater model)
  - acceptance of results by stakeholders not clear – are stakeholders really interested?
  - not all results are accurate enough to support decisions (groundwater levels)
  - **practical tests pending**
- Summary
  - in a relatively short time a user-friendly, robust tool was developed
  - whether it is good and useful enough to support decisions is unclear

**GLOWA Status**

- GLOWA-Danube Summary:
  - an extremely sophisticated modeling framework has been built
  - the system is working, yet it is not applicable in practice yet
  - Scenario definition and simulation has just started
  - Stakeholder involvement was limited until recently
  - three more years to go will hopefully be enough to make the necessary improvements
Conclusions

• Two decision support systems, one relatively simple, one relatively complex - which one is better?
  – The simpler one can provide results faster and it is easier to use
  – The simpler one can be transferred to other basins more easily
  – The more complex one can be used for more specific and more detailed analysis
  – The more complex one can be used to simulate processes more realistically

⇒ The question which is the better one depends on what you want to do with the system, therefore
  - Include stakeholders early to define the management problems and objectives of modeling clear enough
  - Analysis your management tasks, data availability and other resources very carefully in order to find out which models to use, how complex the system must be and how simple it can be
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Thank you for your attention!

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Integrated participative communication process

- Stakeholders - Deciders
  - definition of aims
  - definition of indicators
  - definition of scenarios
  - decisions/programmes

- Scientists - Modellers
  - simulations
  - reflection
  - adaptation

RIVERTWIN 2007

GLOWA-Danube 2007