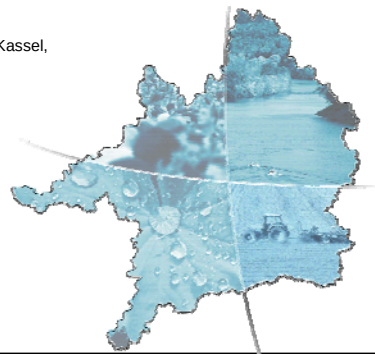


Using a multi-actor framework for simulating the interaction between various actors, water supply and groundwater in response to **Global Change**

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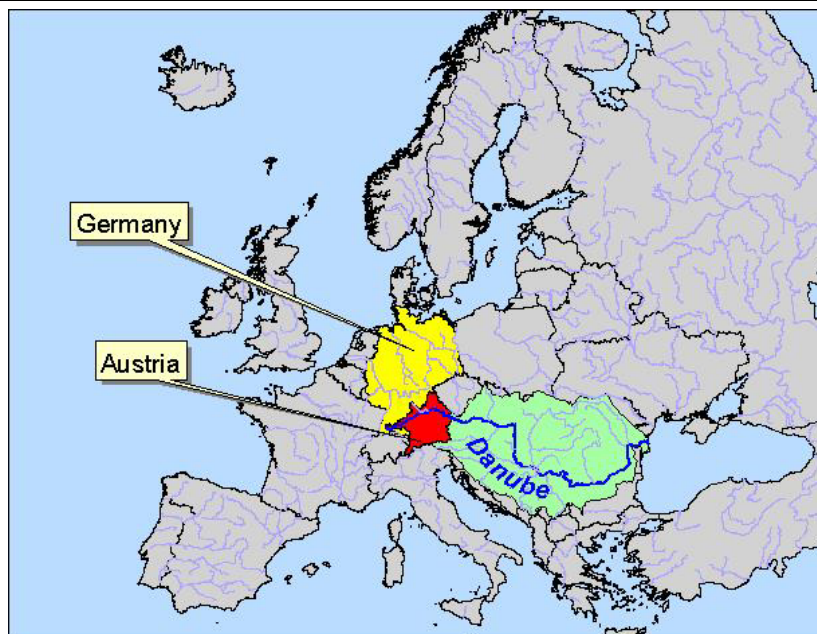


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The Upper Danube Catchment (Germany, Austria, Switzerland)



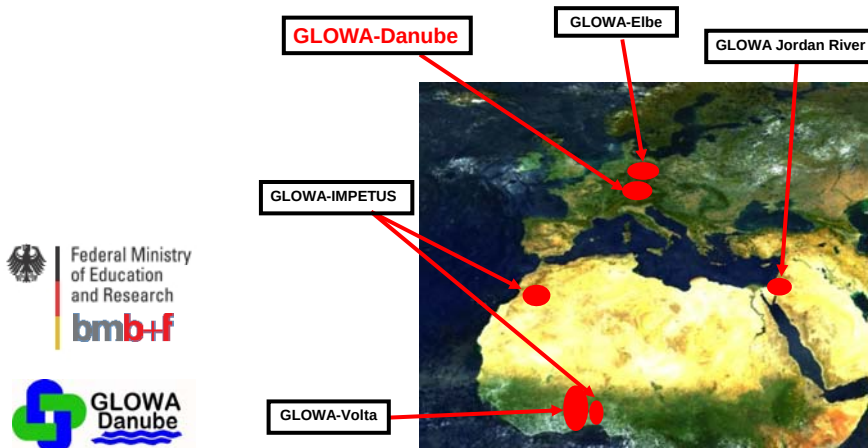
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GLOWA – Global Change in the Water Cycle

- German Federal Ministry for Research and Education – National Global Change Research Initiative.
- Started: 2000, End: 2010
- 5 selected regional case studies (regional scaled catchments ~100,000 km²)



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GLOWA-Danube – Research Network (2001-2010)

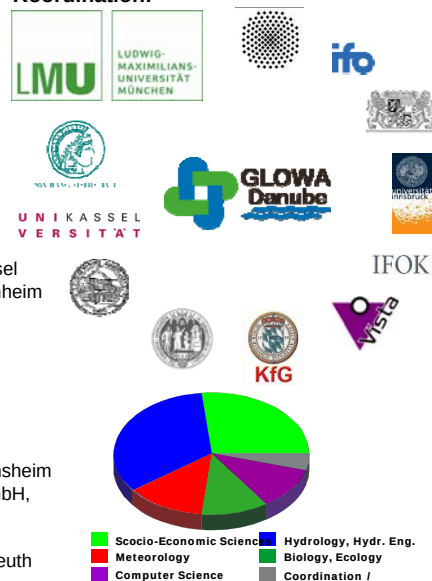
Research Network:

- 8 Universities
- 3 Research Facilities
- 1 State Agency
- 2 Consultants
- = ~ 40 scientist

1. Department Geographie, LMU München
2. Department Informatik, LMU München
3. Department Meteorologie, LMU München
4. Center for Environmental Systems Research, Kassel
5. Institut für Landw. Betriebslehre, Universität Hohenheim
6. Kommission für Glaziologie, Bayer. Akad. d. Wiss.
7. Institut für Geophysik, Universität Innsbruck
8. Institut für Wasserbau, Universität Stuttgart
9. Institut für Geographie, Universität zu Köln
10. Max-Planck Institut für Meteorologie, Hamburg
11. Ifo – Institut für Wirtschaftsforschung, München
12. Bayerisches Landesamt für Umwelt, Hof
13. Institut für Organisationskommunikation IFOK, Bensheim
14. VISTA – Geowissenschaftliche Fernerkundung GmbH, München

Phase 1: Institut für Pflanzenökologie, Universität Bayreuth
Phase 1 und 2: IAWG, Ottobrunn

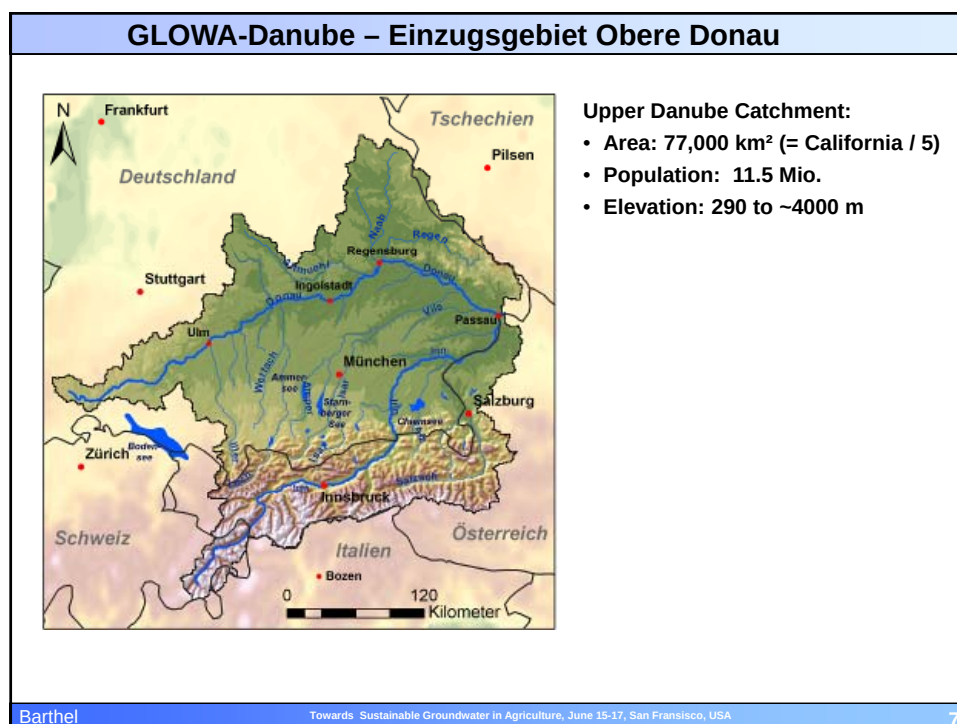
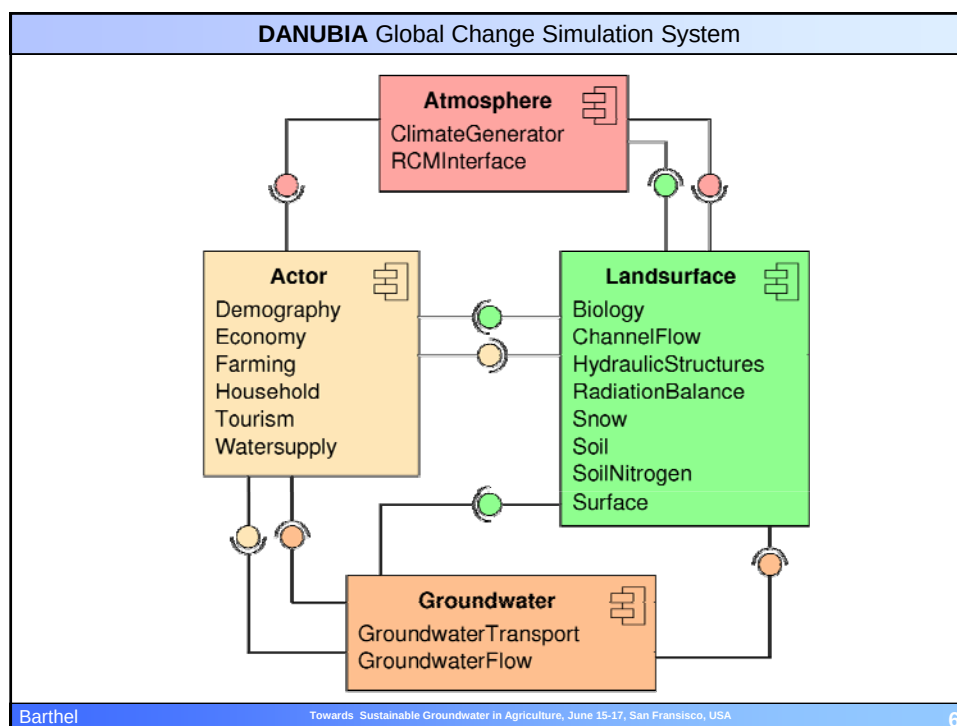
Koordination:

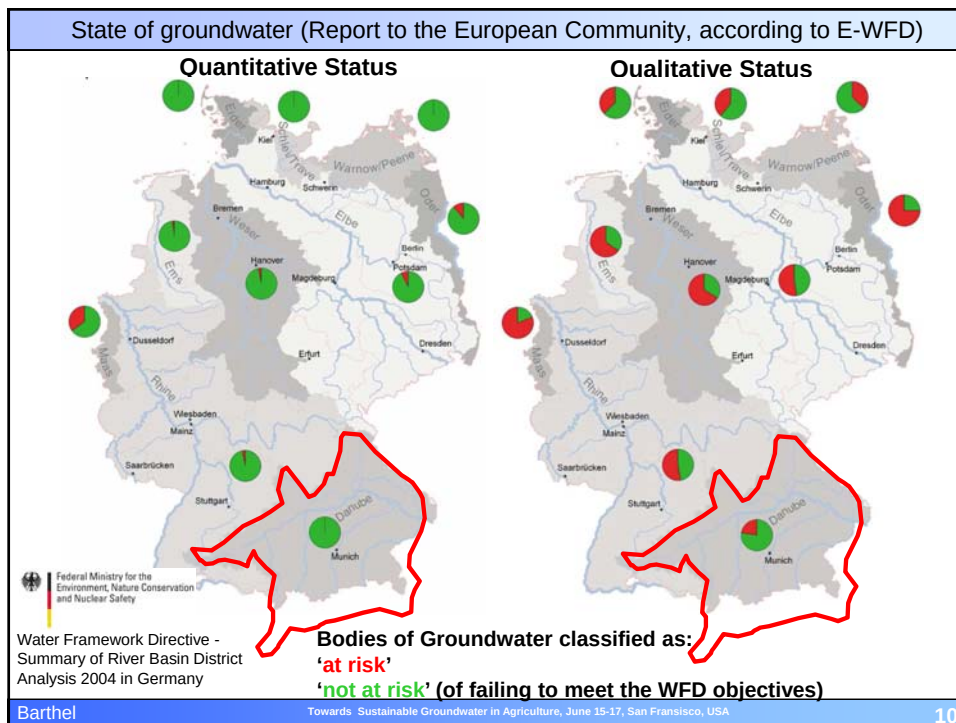


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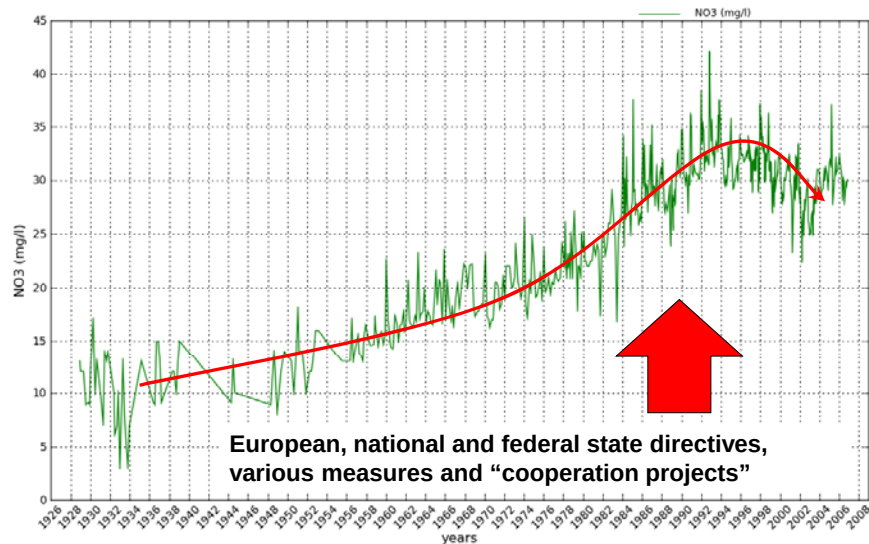
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Groundwater Quality Problems and Trends: Nitrate

~ 85% of groundwater pollution from agriculture



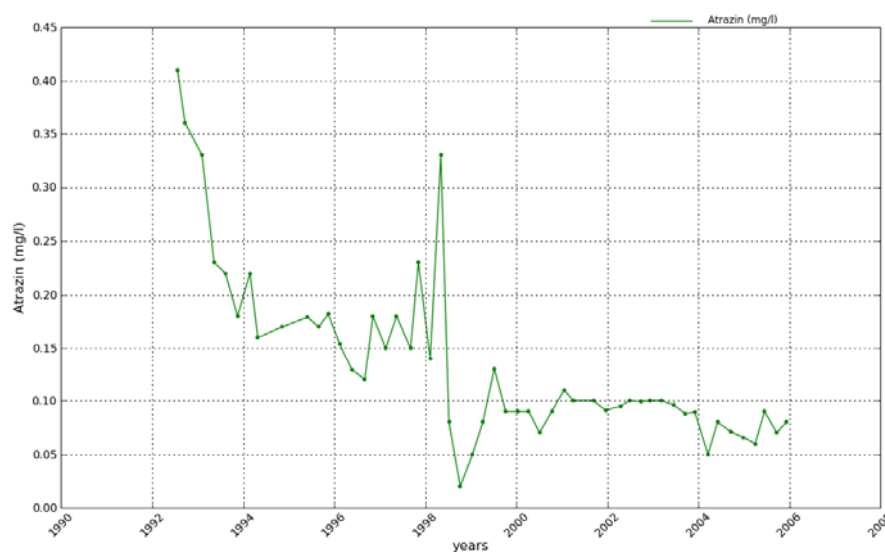
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Groundwater Quality Problems and Trends: Atrazine

- **Prohibited** in the European Union (Germany 1991, Austria 1995, France 2004)



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Summary: Groundwater and Agriculture in the UDC

- The UDC is a **water rich region**, water scarcity is not a issue
- **Many different stakeholders** with conflicting interests (economical, ecological, social)
- **95% of drinking water** (domestic use) **from groundwater**
- **Agriculture:**
 - 50% of area cultivated land
 - Irrigated land less than 1% of cultivated land
- **Subsidies** (national, European): 15% of turnover, 65% of profit
- **Very strict water law** on three levels: European, National, Federal State Laws.
- **Information, Education, Cooperation projects** with farmers proved to be more successful than law enforcement

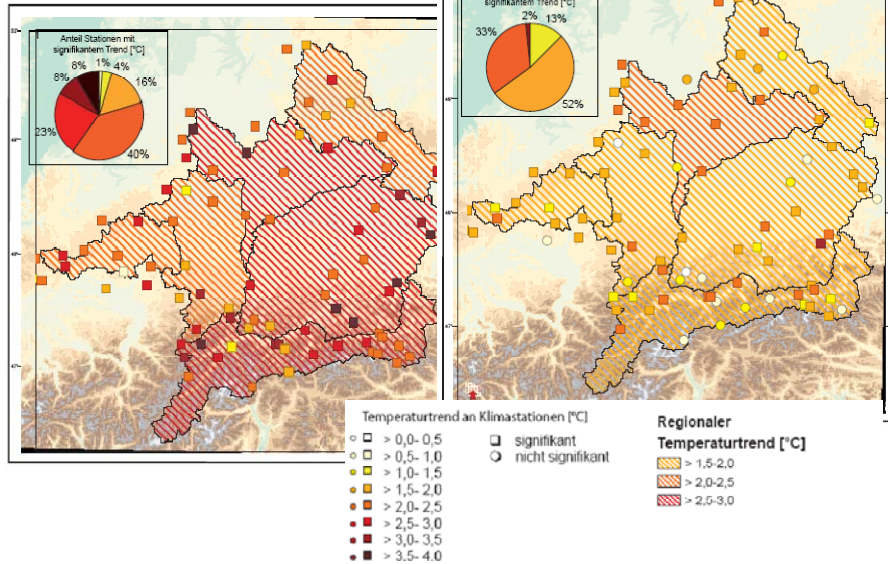
Regional Consequences of Global Change

1) Observations

Climate Change – Observations: Temperature (1960-2006)

Summer Temperatures: **+ 2 degrees**

Winter Temperatures: **+ 1.5 degrees**



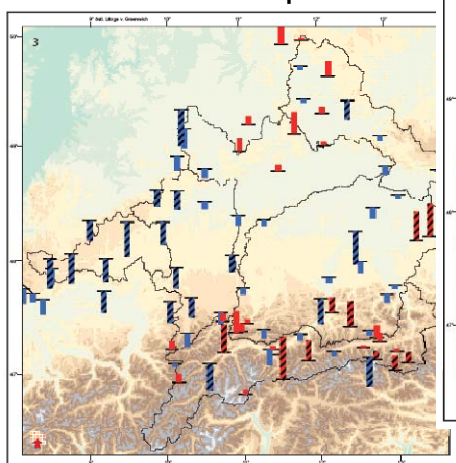
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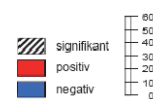
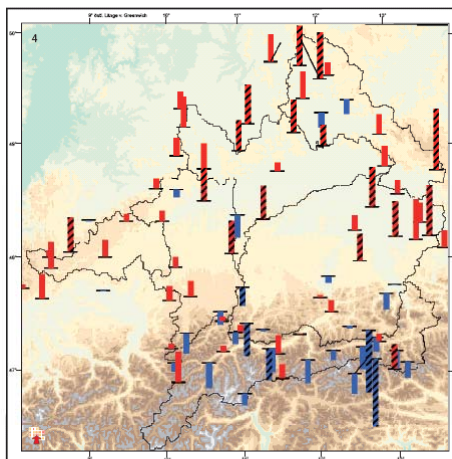
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Climate Change – Observations: Precipitation 1960-2006

Summer Precipitation



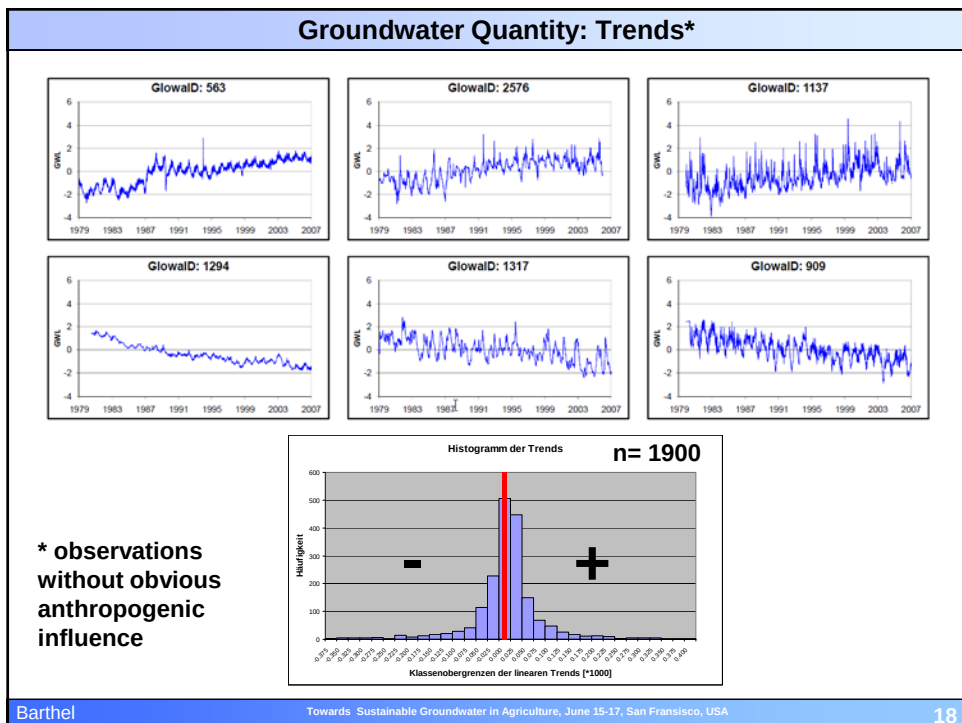
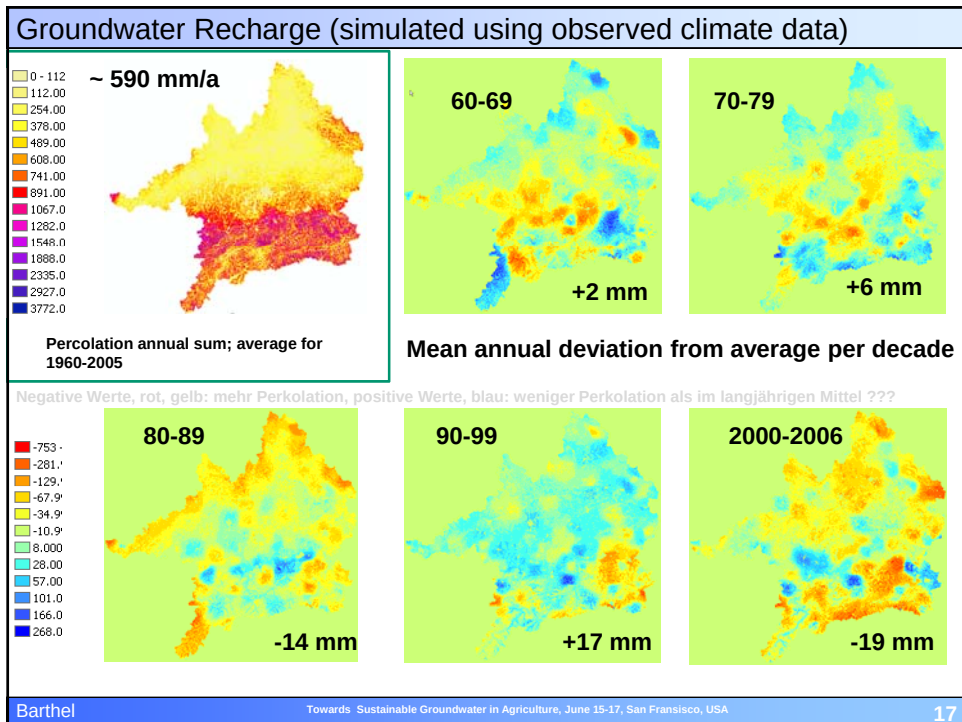
Winter Precipitation



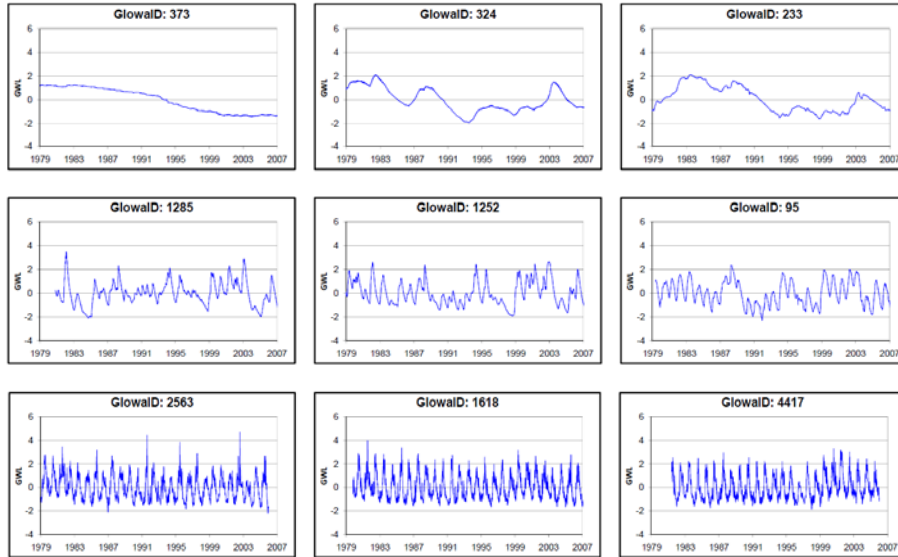
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Groundwater response to Climate (Heads): Response Types



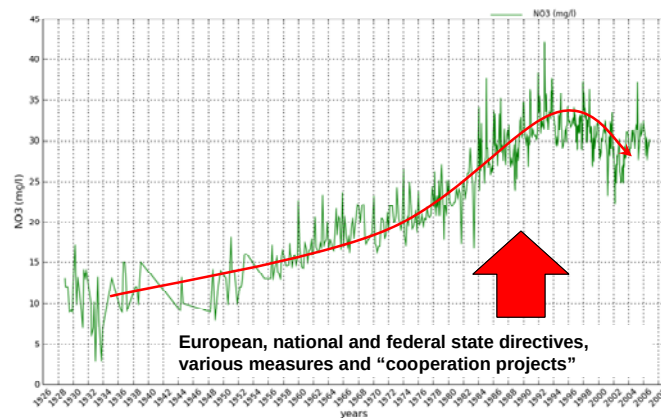
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Climate Change Observations: Groundwater Quality

- Identification and quantification of **cause and effects** is extremely difficult
- Very little research on direct impacts of climatic change on groundwater quality has been carried out



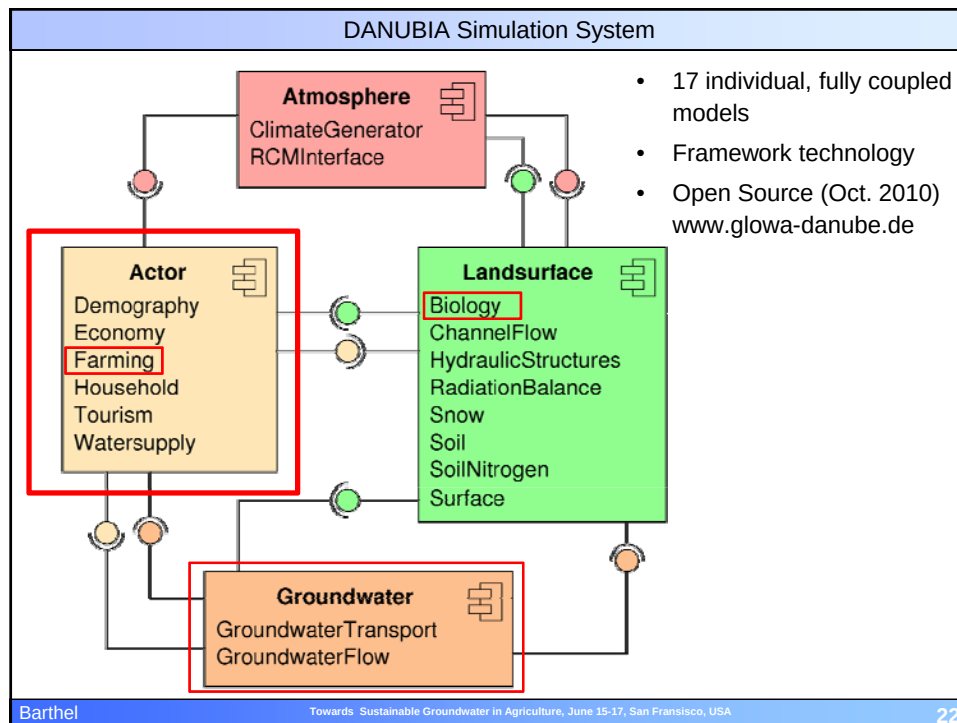
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Regional Consequences of Global Change

2) Simulation Strategies and Models



Why multi-actor modeling?

- A) The assumption that socio-economic conditions do not change within 100 years does not make sense.
- B) Spatial variability of natural and socio-economic conditions requires spatially explicit modeling

Multi-Actor-Modeling of Global Change

- An **Actor** is an autonomous entity which is capable of reacting to system changes in an individual way → An actor makes decisions.
 - Household-, Farming-, Tourism-, Watersupply-, Economy, Demography-Actors
- **Actor-Types:** used to differentiate between different possibilities and preferences:
 - Example: Household-Actor - „traditional Type “ – „post materialist Type“
- Actors make decisions: they chose from available „ **Actions and Plans** “
 - Example: Farming-Actor - Actions: Planting, Harvesting, Irrigating, Plans: chose crops for the next year → Landuse
- An **Actor-Model** simulates socio-economic processes as the sum of the individual decisions made by the different Actors and Actor Types
 - “process based”, spatially and temporally explicit modeling rather than data driven, empirical modeling

Regional Consequences of Global Change

3) Regional Global Change Scenarios

Elements of a regionalized Global Change scenario

- Global emission scenario (e.g. A1B - IPCC)
- Global Circulation Model (e.g. ECHAM5...)
- **Downscaling (Global → Regional)**
- Socio-Economic Trends (demography, environmental policies, prediction of demands ...)
- 'Storylines' (e.g. more draughts → more reservoirs ..., or increase energy crop production by 200% ...)

GLOWA-Danube Global Change Scenarios			
Choice 1: Climate Trends	Choice 2: Climate Type	Choice 3: Social Trends	Choice 4: Interventions
IPCC regional	Baseline	Baseline	Information Cooperation
REMO regional	5 warm Winters	Free is fair	Subsidies for Water saving techn.
MM5 regional	5 hot Summers	Shared destiny	Build reservoirs
Trend Extrapolation	5 dry years		...

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Socioeconomic and political scenarios
Why: Society and individuals will react to climate change - but how? • Future 1: „Free is Fair“ – Competition and free market, – Individual freedom, – Minimum of public welfare, – Individuals responsible for themselves. • Future 2: “Shared Destiny” – Classical welfare state, – social justice, equal opportunities, – Government has strong influence on economy. • Future 3: “business as usual” de Vries, Perry 2007

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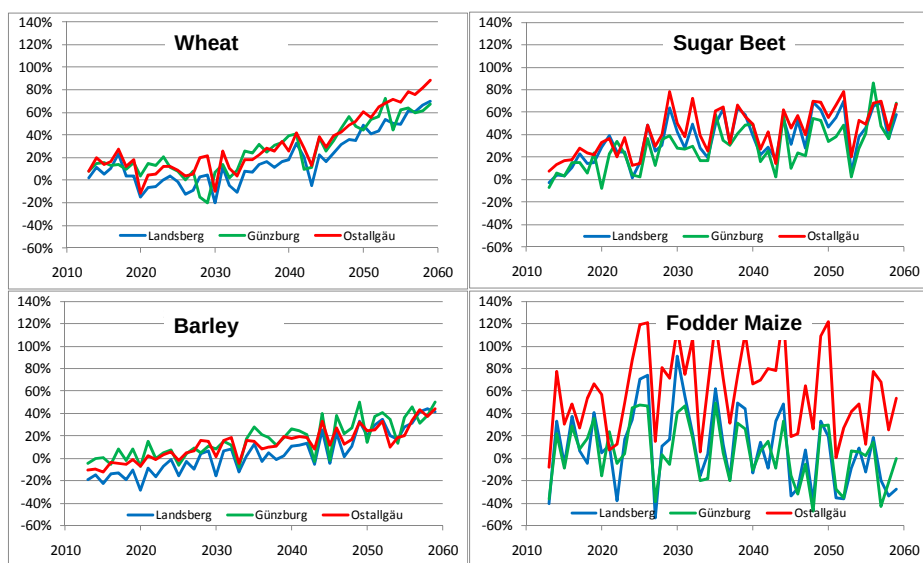
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Regional Consequences of Global Change

4) Results

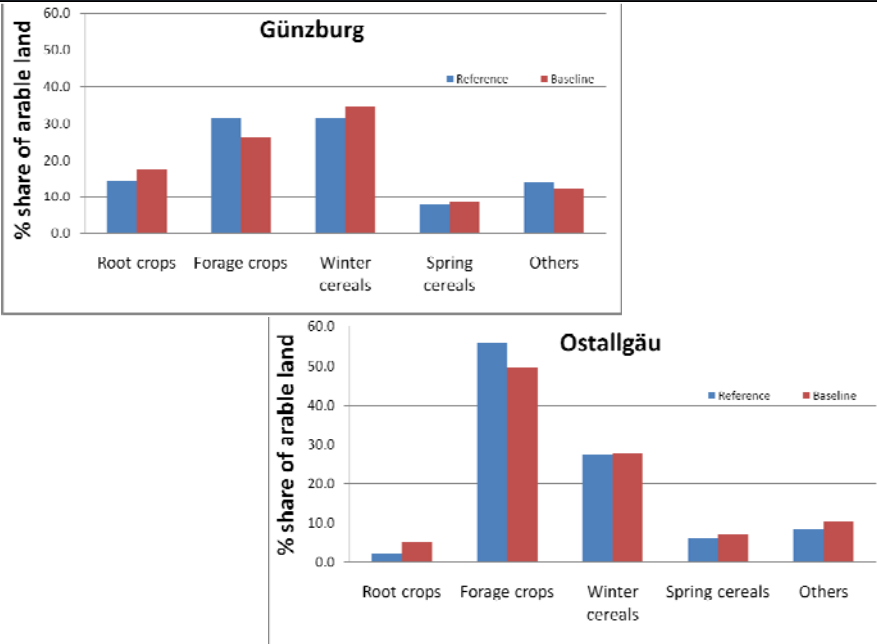
Crop Production (3 selected districts)

Crop production compared to reference period (1996-2005)



Climate Scenario: REMO-Baseline, Socio economic scenario: Performance

Farming-Actor Decisions: Land use changes

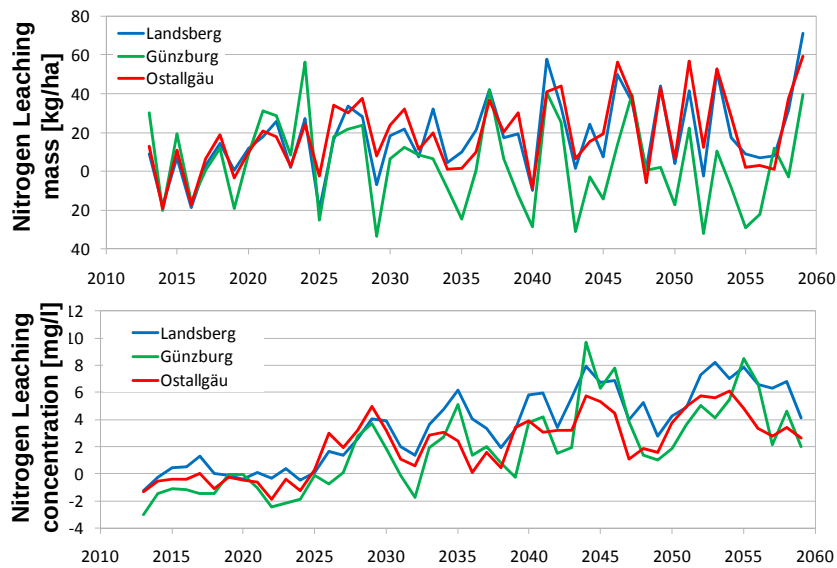


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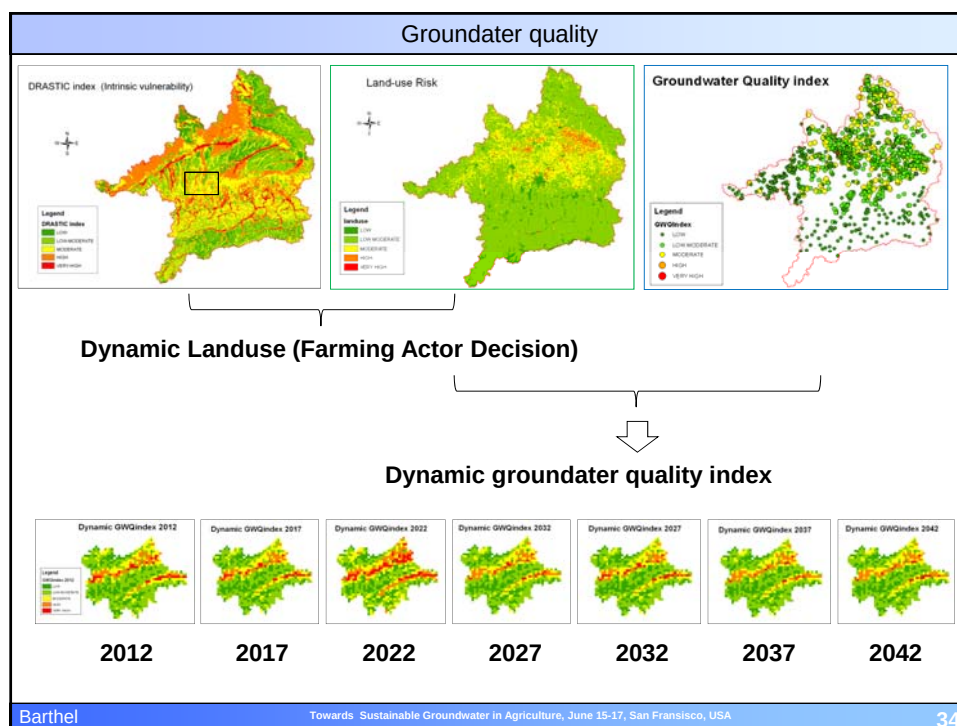
Nitrate concentration in soil water (Nitrogen Leaching)



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Key consequences for policy / policy makers / decision makers

- When offered simulation results on the **consequences of climate change** by scientists we recommend to think about the following issues:
 - Get involved in the definition of regionalized scenarios and in the model development as early as possible - otherwise you might not be able to use the results.
 - Prediction of consequences of Climate Change requires good simulation models but also meaningful, consistent, **integrated scenarios**. Ask for a choice of scenarios!
 - Scenarios should address spatial and temporal variability of changes, including extremes.
 - Downscaling of global models to **regional conditions** is a yet largely unsolved problem. Ask for different options.
 - Climate Change research must be **integrated**.. Ask if the models can capture the existing dependencies and feedbacks!
 - Before accepting model results, ask, if the developments in the past are fully understood and can be captured by the models. Are the models valid under different boundary conditions?
 - In particular consequences of Climate change for groundwater quality are largely unknown. Ask for more research!

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Using a multi-actor framework for simulating the interaction between various actors, water supply and groundwater in response to global change

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Thank you!

