Bundesministerium für Bildung und Forschung

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

CT Hydrosphere

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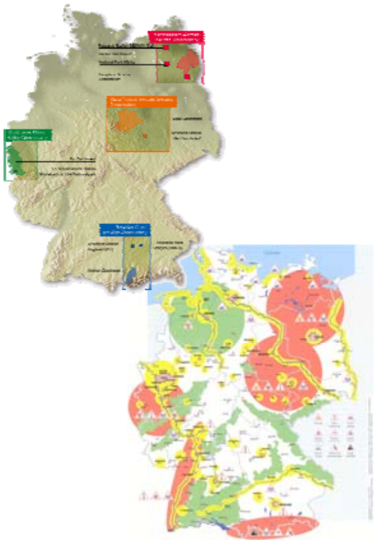
Main Hypotheses for Hydrological Research in TERENO

- Patterns and structures in terrestrial systems play an critical role in determining the hydrological fluxes
- The vadose zone is the key compartment and soil moisture a key variable
- Climatic changes will lead to higher runoff in winter, shorter retention times, and will critically alter groundwater and surface water hydrology
- Climatically driven extremes (like extended drought events) affect the aquatic ecosystems as well as freshwater supply
- Landuse changes (e.g. toward a growing bioenergy sector) will affect water quality
- Effects of changing climate and landuse are regionally differentiated.
- Novel monitoring technologies of non-invasive, multiscale observation and data assimilation techniques will improve the quantification of hydrological fluxes.

Main Rational and Focus



- Provision of access to data which represents the wide range of hydrological regimes found in Germany
- Provision of access to data required to address key questions in water resources research
- Provision of an infrastructure for testing and development of new sensor technologies for monitoring the hydrological cycle

Investigation of regional hydrological effects of climate change and landuse change

To plan for the future, people need to know how their local conditions will change, not how the average global temperature will climb

Q. Schiermeier, „The real holes in climate science"

Nature, 463, 2010

The TERENO Hydrological Observatories

Ammer Observatory

- Bavarian/pre-Alps Observatory
- 709 km²
- Annual Precip 1,100 – 2,000 mm
- Mean Annual Temp 7 °C

Rur Observatory

- Eifel/Lower Rhine Valley Observatory
- 2,354 km²
- Annual Precip 700 – 1,100 mm
- Mean Annual Temp 7 – 10 °C

Bode Observatory

- Harz/Central German Lowland Observatory
- 3,300 km²
- Annual Precip 450 – 1,600 mm
- Mean Annual Temp 9 °C

Uecker Observatory

- German Lowland Observatory
- 2,426 km²
- Annual Precip 550 mm
- Mean Annual Temp 8 °C

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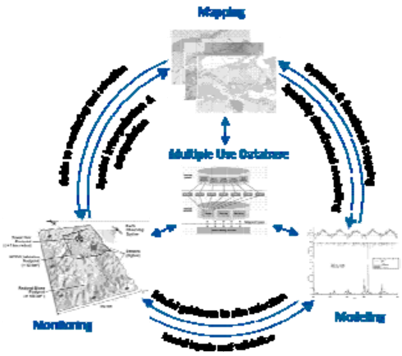
General Methodological Approaches

- River discharge monitoring following nested catchment approach
- Water quality monitoring
- Monitoring of spatial-temporal variability of groundwater recharge, study of groundwater flow systems and related solute transport
- Establishment of intensive soil moisture monitoring sites (wireless sensor networks, remote sensing)



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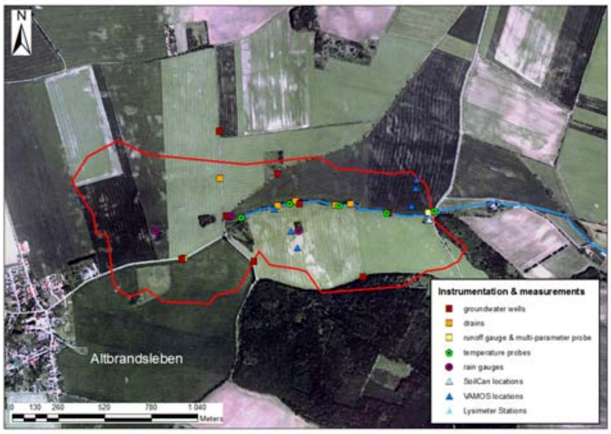
Parameter and Instruments

Hydrometeorological Climate Stations: Precipitation, Temperature, Global Radiation, Wind, Soil Moisture, Matricpotential, Soil Temperature

Discharge Gauges:
Discharge, Temperature, Conductivity, Automatic Samplers (Sediment, Total P, DOC, K, Cl, …)

Multi-Parameter-Probes:
Temperature, Conductivity, Nitrate, pH, Turbidity,

Groundwater Gauges:
Groundwater Level, Temperature, Conductivity



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Carbon cycling in the environment: The role of dissolved organic carbon (DOC)

K. Rinke, S. Zacharias

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DOC = Dissolved organic carbon

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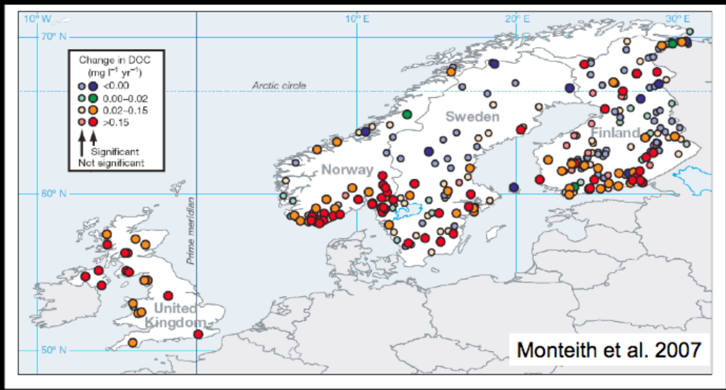
Rising levels of DOC



Northern Europe and North American:
DOC increased in >70% of systems in 14 years

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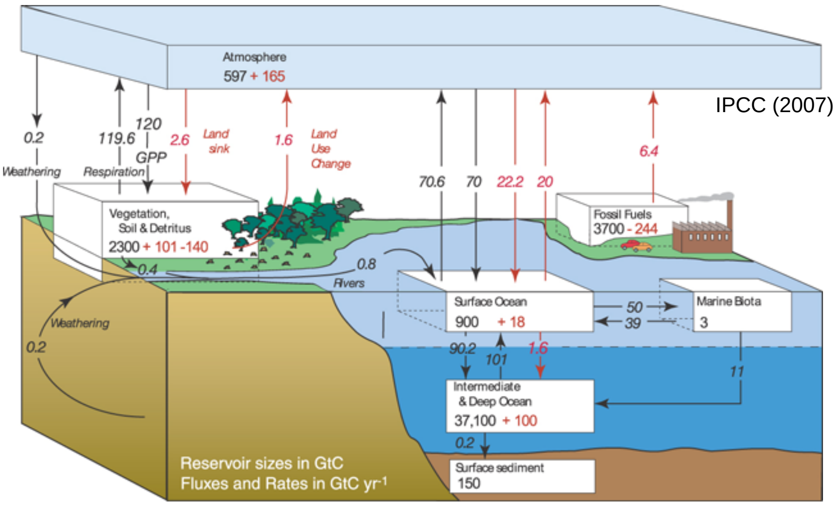

Pools

DOC Ocean 700 Gt

CO2 Atmosphere 750 Gt

Terrestrial plants 600 Gt

Fluxes

Lake sediments 0.04 Gt a^{-1}

Peatlands 0.1 Gt (?) Gt a^{-1}

Reservoirs 0.6 Gt a^{-1}

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Why diving into the hydrosphere…?

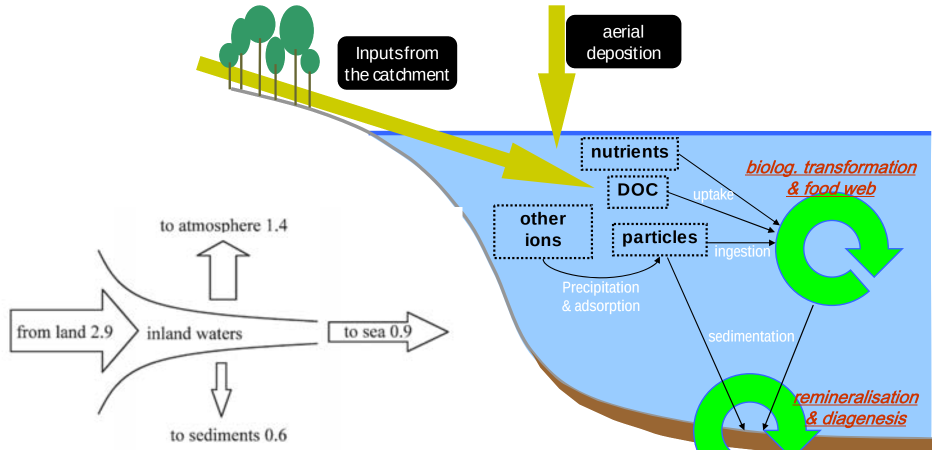
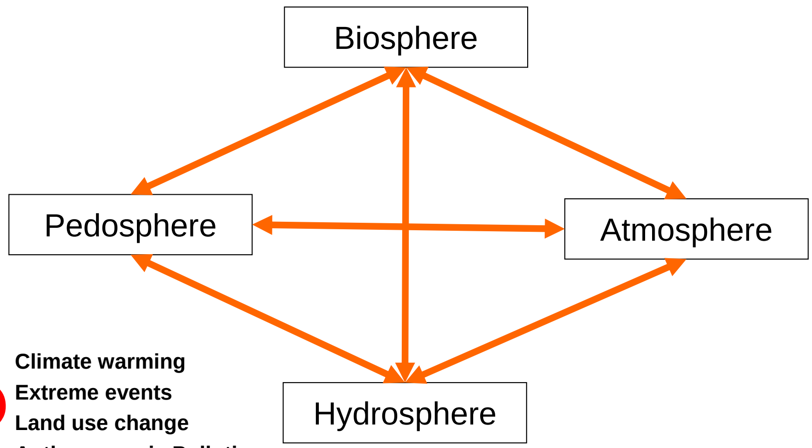


Fig. 5. Revision of the 'active pipe' hypothesis advanced by Cole et al. (2007). Revised values are explained in the text and represent annual transport of carbon (Pg, 10^{15} g).

Carbon cycles across compartments of the environment



?

Climate warming
Extreme events
Land use change
Anthropogenic Pollution
Biodiversity loss
...

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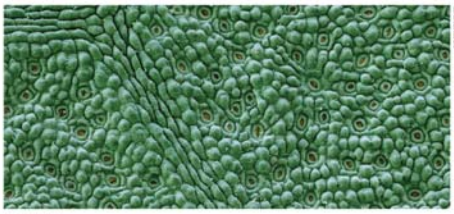
An interplay between atmosphere, biosphere, and hydrosphere

(Mathews 2006, Nature)



GLOBAL CHANGE

The water cycle freshens up

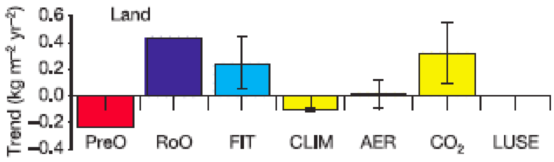


Figure 3 | Attribution of post-1960 overall runoff trend. The first two bars are the observed precipitation (red bar) and runoff (dark blue bar) trends. The remaining bars are the attributed runoff trends for the best fit (FIT; light blue bar) and its individual components (yellow bars). The 5 to 95 percentile ranges are shown.

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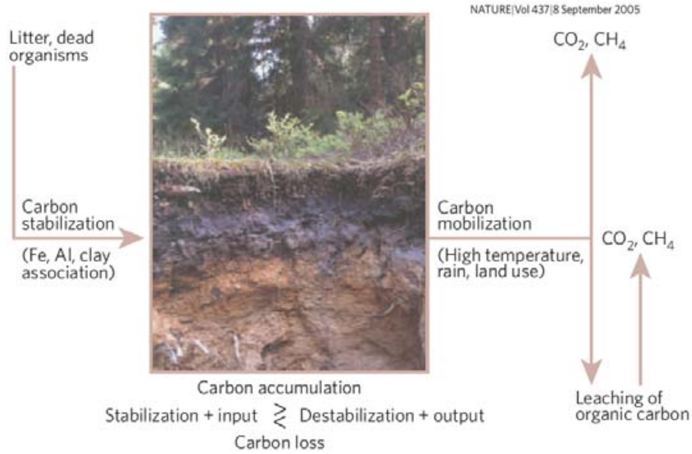
Loss of terrestrial carbon releases DOC into the hydrosphere

ENVIRONMENTAL SCIENCE

Carbon unlocked from soils

E. Detlef Schulze and Annette Freibauer

NATURE|Vol 437|8 September 2005



Loss of SOC: 66 - 550 g C m^{-2} a^{-1}
(equals 8% of UK emmission of CO2 = CO2 reduction 1990-2002)

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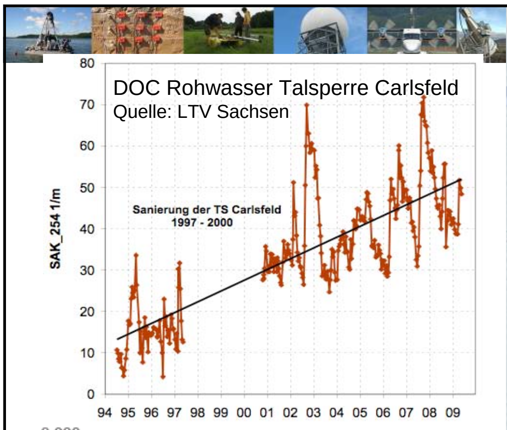
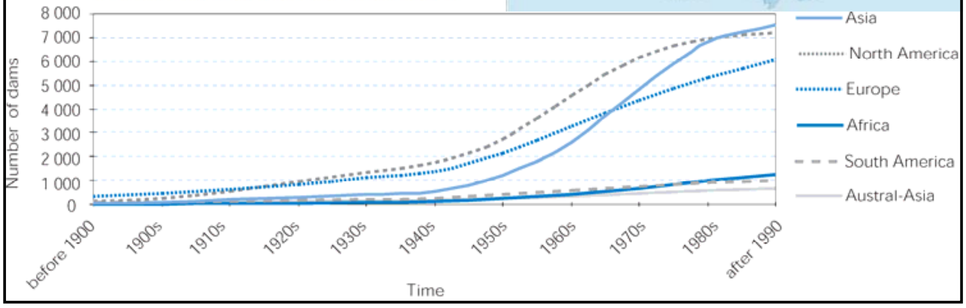
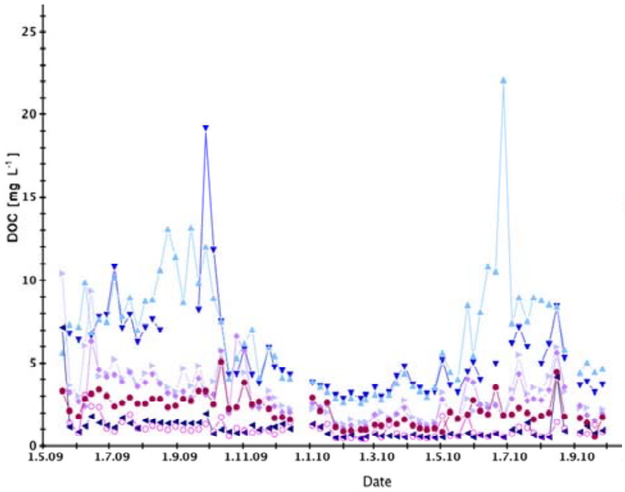
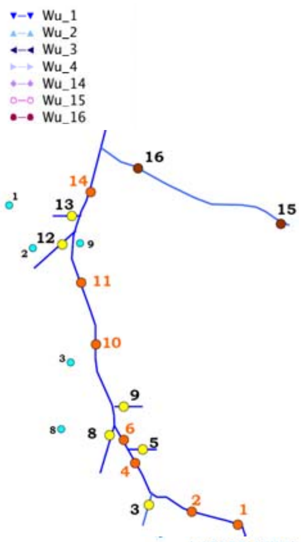


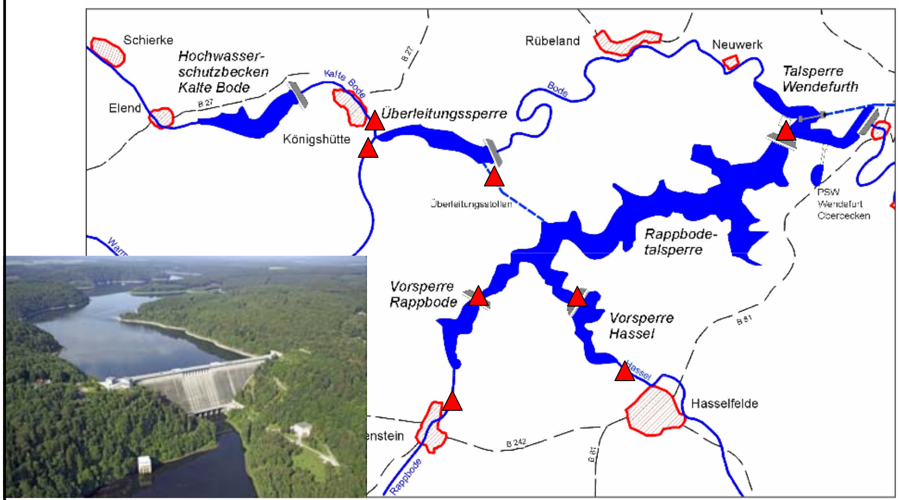


Monitoring Wüstebach (FZJ): DOC (mg/L)

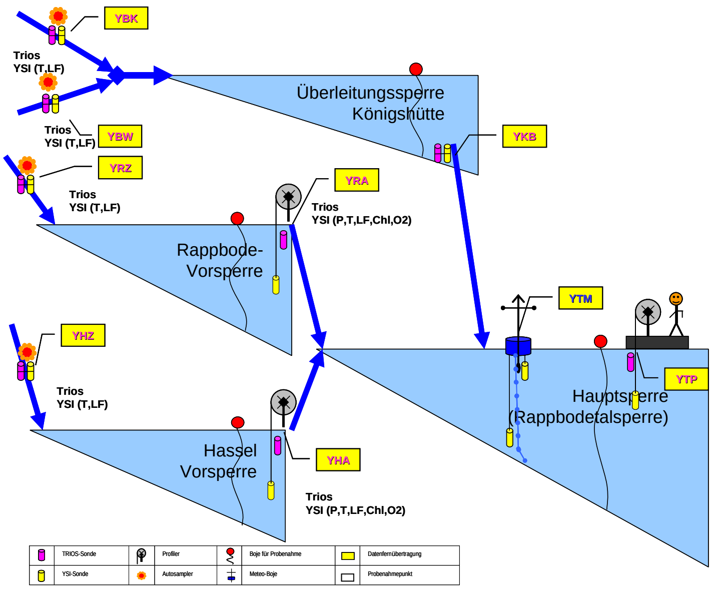




Rappbode reservoir observatory



Talsperrenbetrieb Sachsen-Anhalt
(www.talsperren-lsa.de)



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UFZ TERENO – From Challenge to Products
Example: Dissolved organic carbon

Research Challenge

Defining mass flux and energy balance in natural systems under climate change and landuse change

Hypothesis

Soluble C transport from terrestrial environments represents a substantial component of the ecosystem carbon balance in northern latitudes and an increase in temperature (2 K) leads to higher DOC loads in surface water system

Activities and Integration of Research

- *Monitoring of relevant parameter sets for climate, soil water, groundwater, surface water*
- *Monitoring of DOC fluxes at relevant locations*
- *Modelling of carbon balance*
- *Modelling of water quality aspects (predam effects, management effects, land use/cover, climate effects, …)*
- *Evaluation of the effect of environmental protection measures on DOC loads (forest conversion, revitalisation of wetland)*
- *Evaluation of economical aspects of water quality management (management of drinking water dams, effect of subsidies, …)*
- *Development and provision of dynamic land use scenarios*

Products

- *Water Quality Model*
- *Scientific Recommendations on Water Quality Management*
- *Landuse Scenarios*

Stakeholders

- *Adapted management of drinkwater dams and associated catchments (Dam authorities, Water suppliers, Enviromental ministries, Forest administrations, …)*
- *…*

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