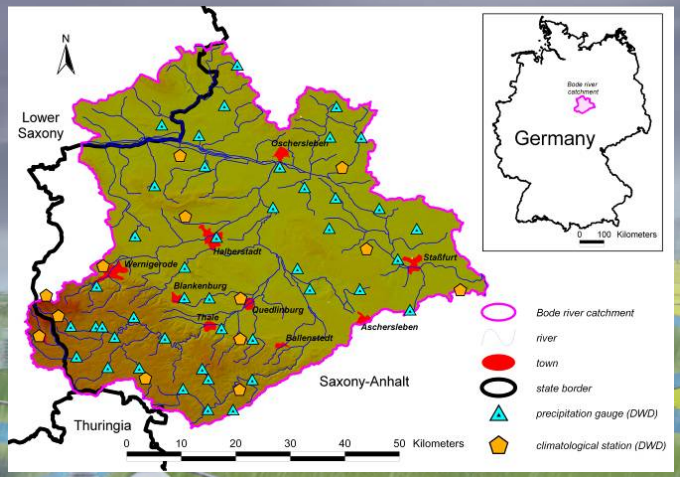


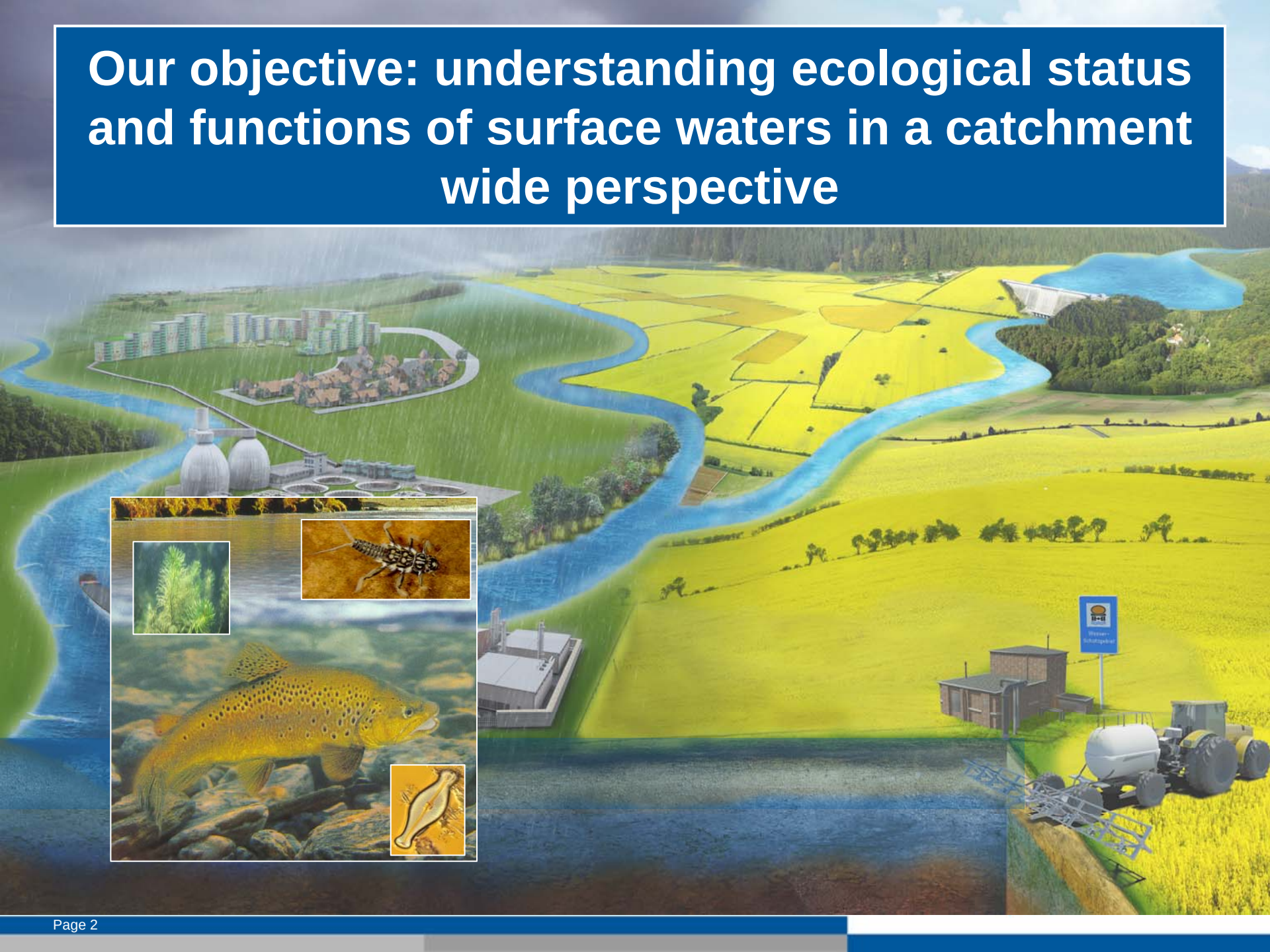
The Bode-Screening – Assessment of the ecological conditions of the Bode river system

Dietrich Borchardt, Michael Rode , Markus Weitere, Karsten Rinke & Co

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ

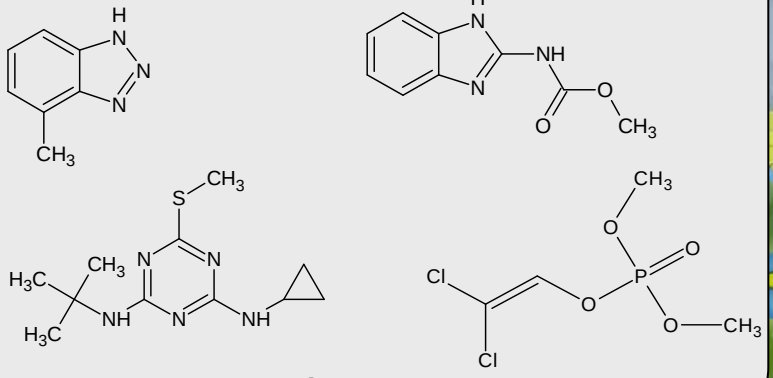
24th. September, 2011, Blankenburg

Our objective: understanding ecological status and functions of surface waters in a catchment wide perspective



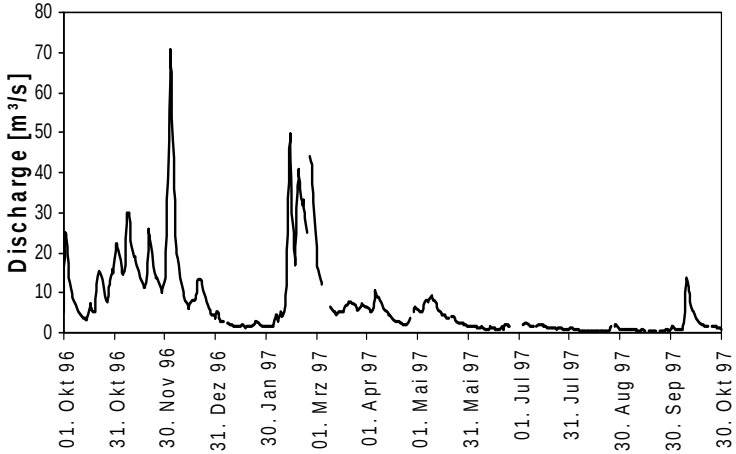
Understanding surface waters as receptors…

Multitude of chemicals

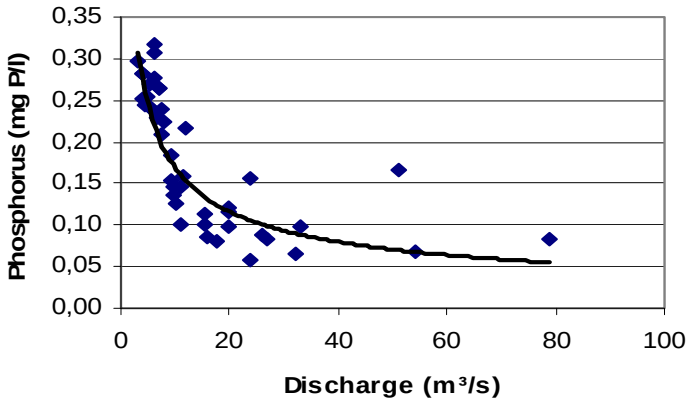


"Key toxicants"

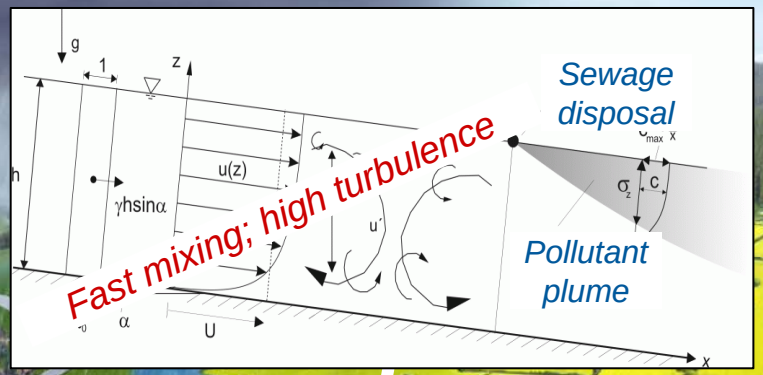
Hydrograph (average hydrological year)

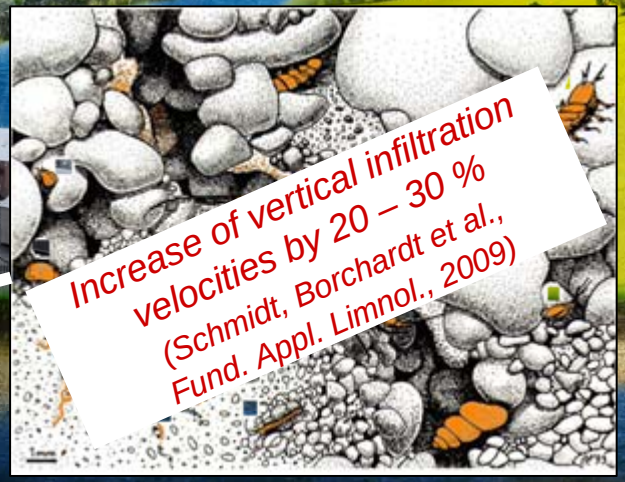


Phosphorus - Discharge - Relationship



Understanding running waters as reactors…





Focal themes and sampling locations

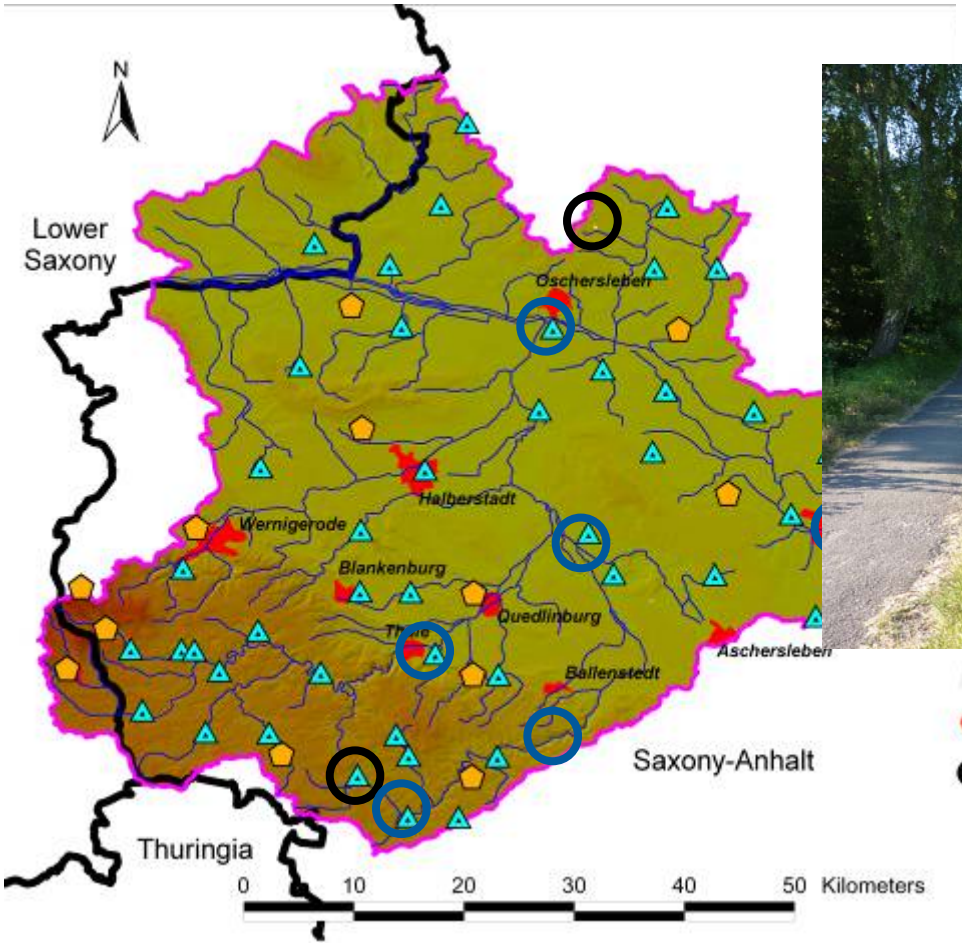
Urban watersheds and their contribution to the contamination of benthic habitats

Carbon dynamics of coupled stagnant and running water systems

Water quality along land-use gradients

Food-web interactions and biological control of eutrophication

Water quality along land-use gradients



river
town
state border
precipitation gauge (DWD)
climatological station (DWD)

Online Water Quality Measurement Stations

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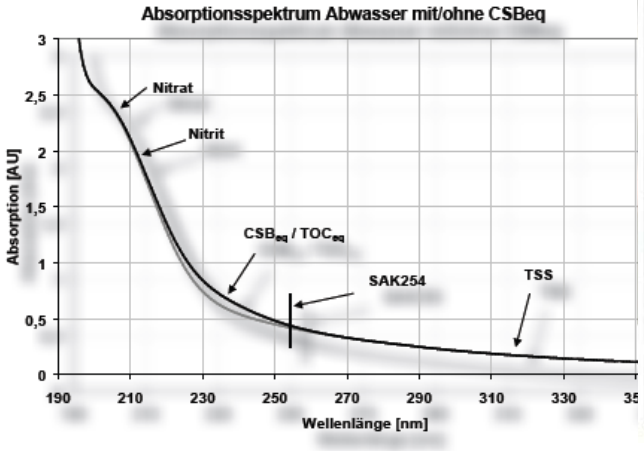
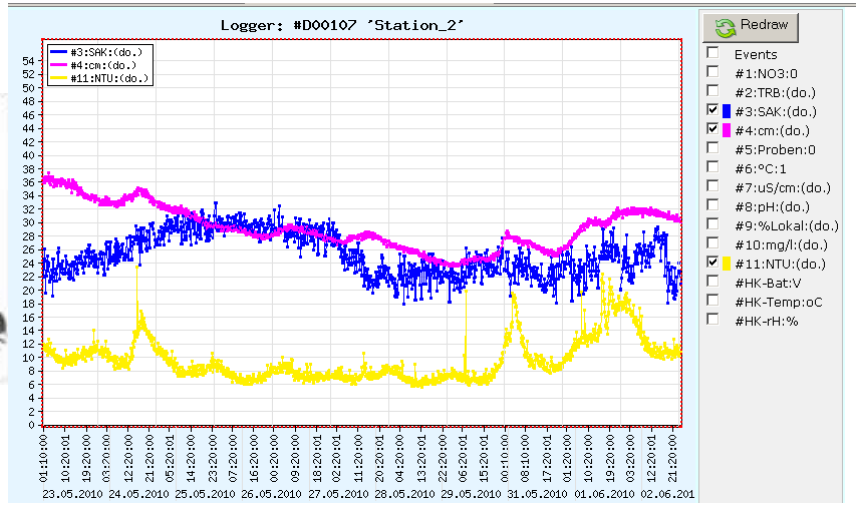
Measurement Sensors and Automatic Samplers

Sensors



Online-Data



Sampler

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Additional parameters

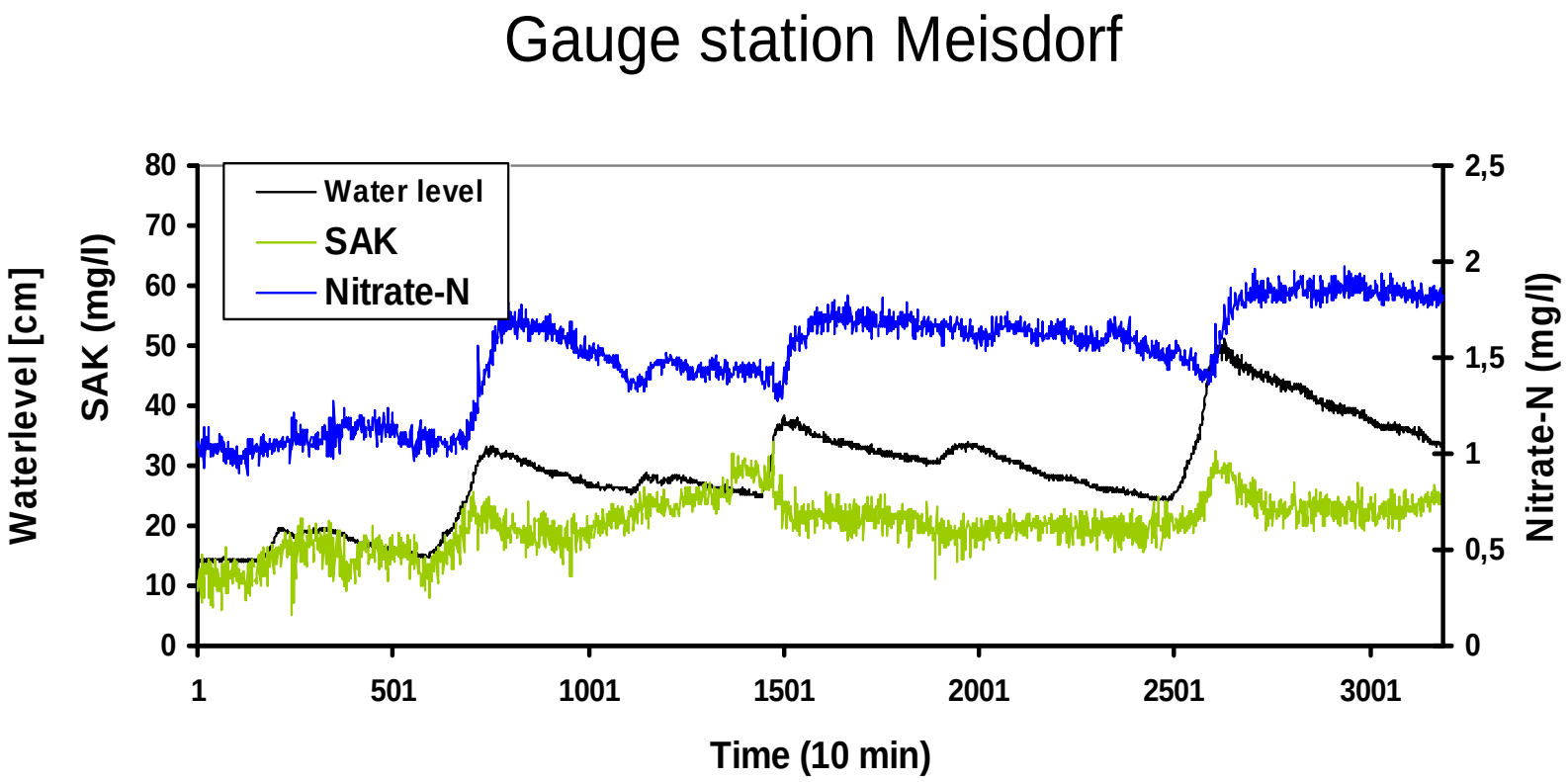
Sampling with automated samplers:

- Phosphorus components (TP, SRP) for load and nutrient turnover (low flow and highflow)

- Delta ^{18}O and Deuterium for Runoff component analyses (together with WG Isotope Hydrology)

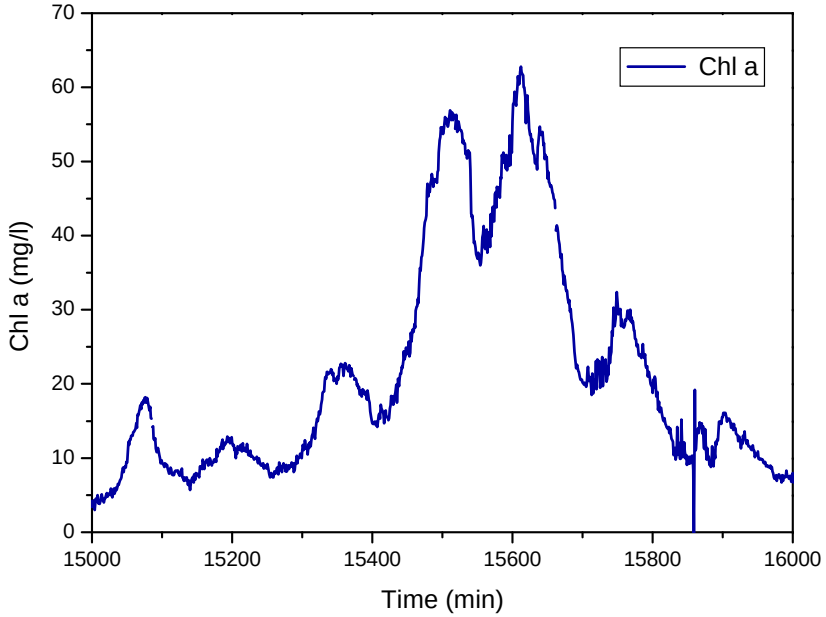
- ^{15}N and ^{18}O measurements of nitrate (low flow periods), differentiation between algal uptake and denitrification

Online data of e.g. SAK, Nitrate-N and Water Level

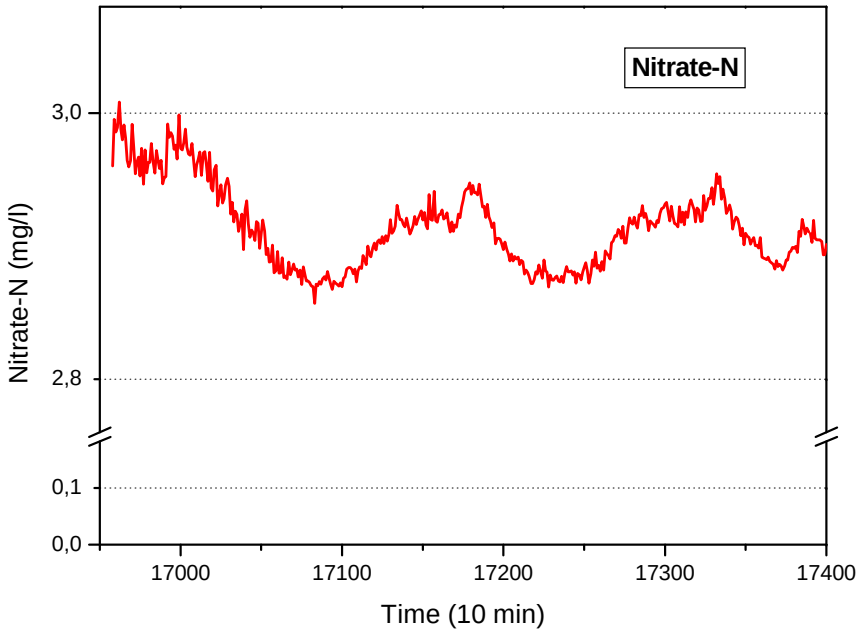


Primary production and nitrate uptake at gauge station Stassfurt

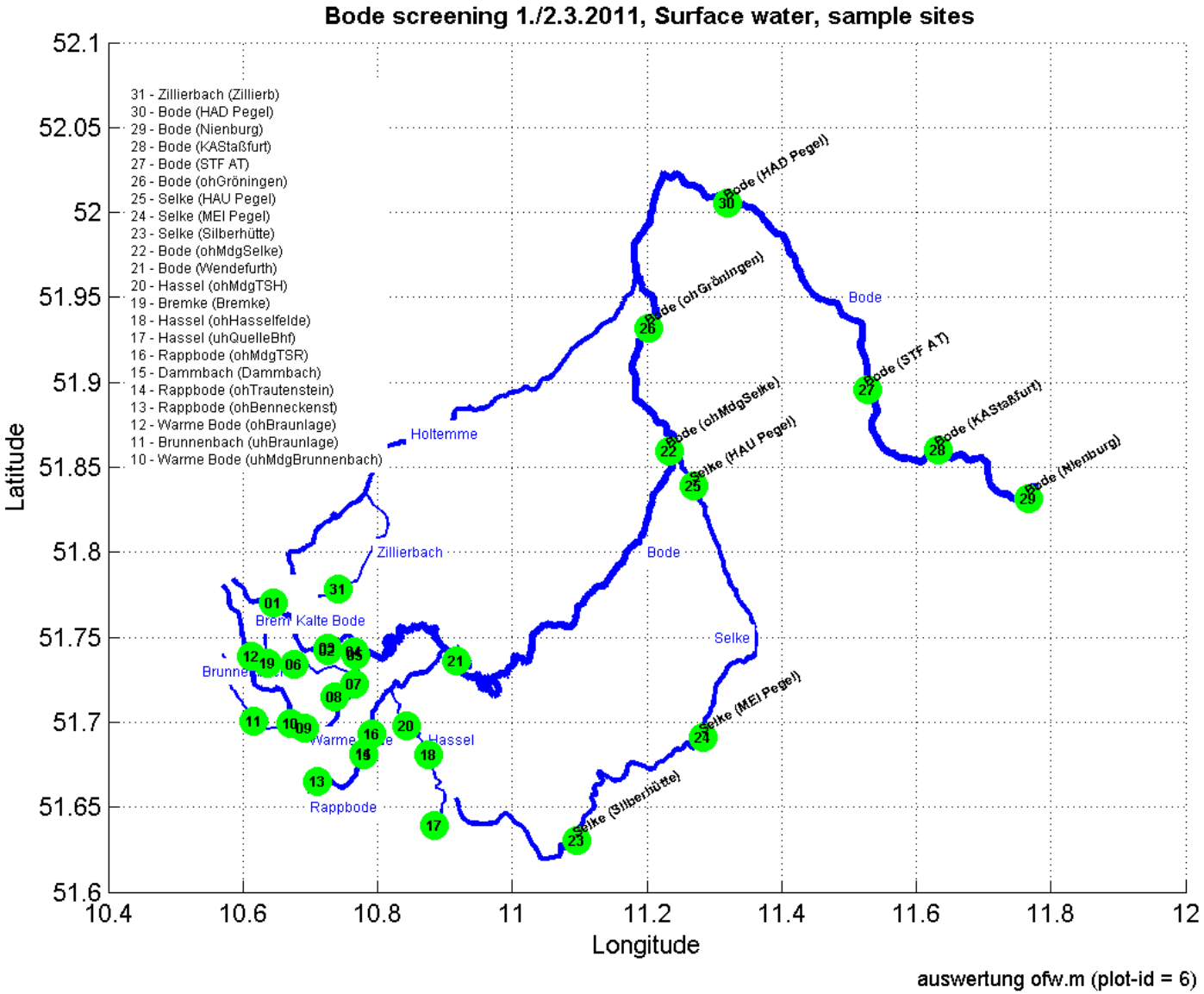
Chla



Nitrat-N



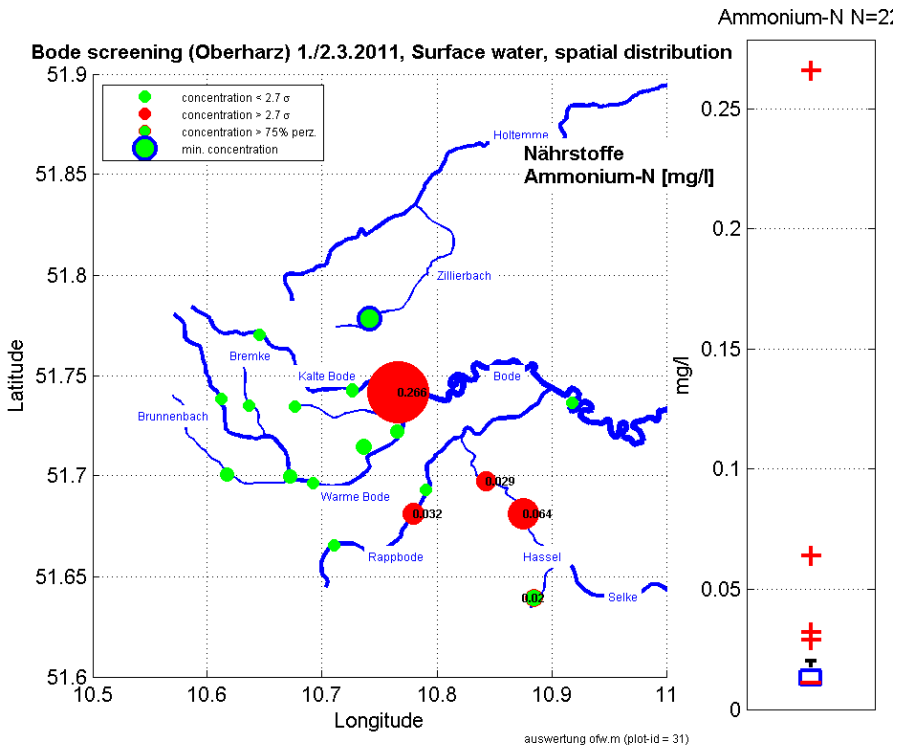
Qualified sampling (dry weather period, base flow, cold temperatures)

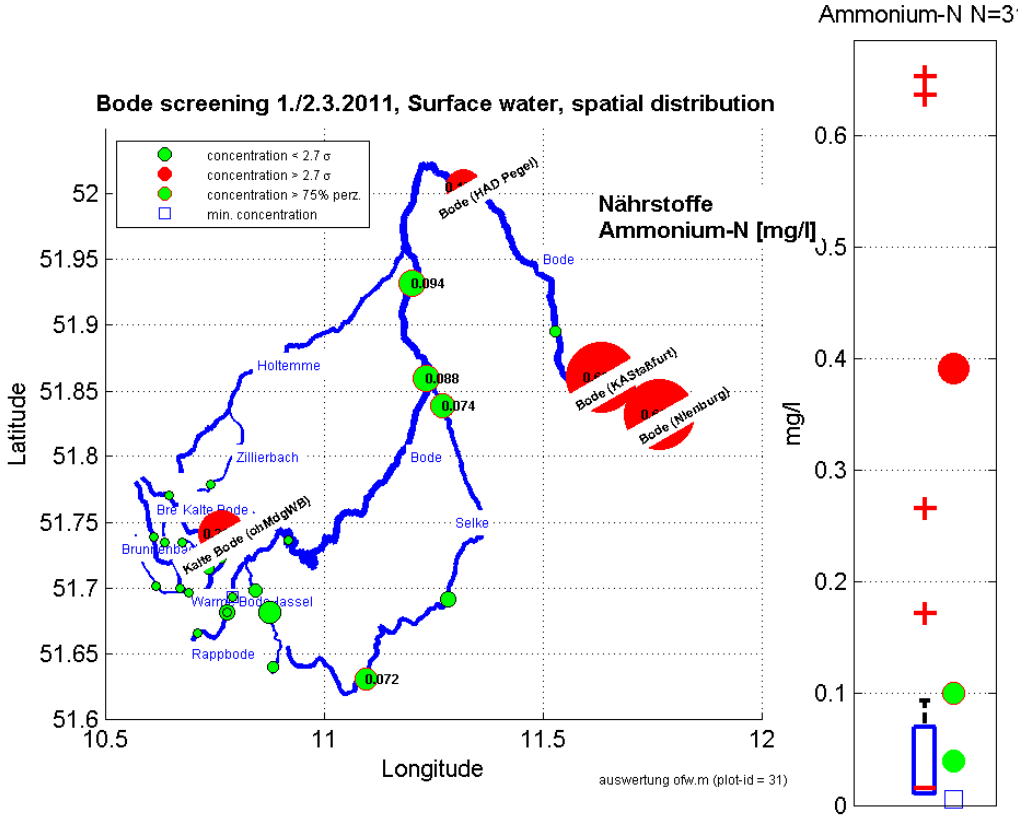


Parameters

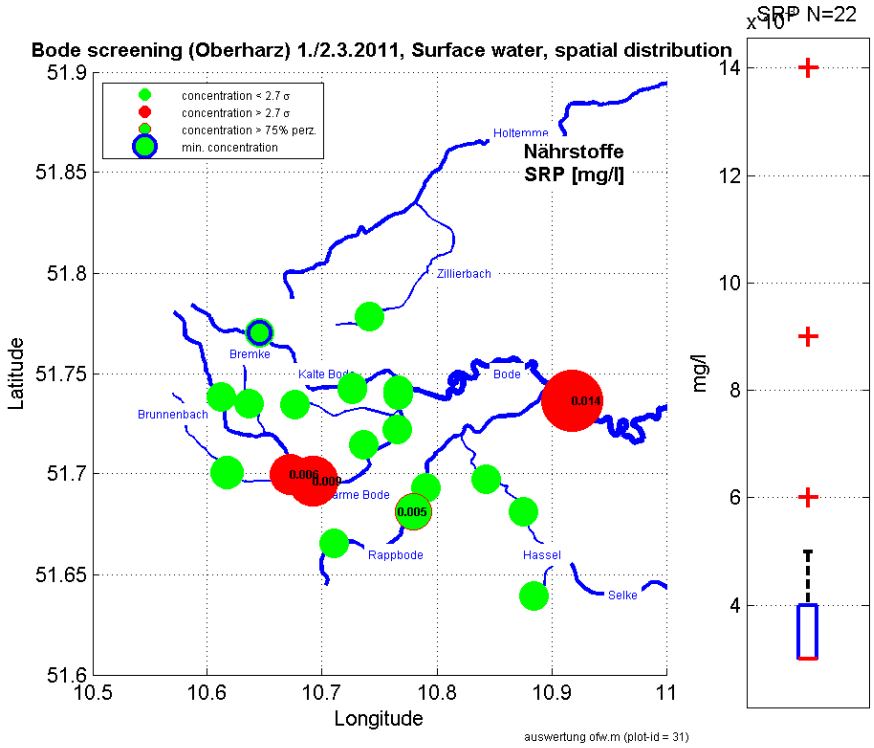
- Basic parameters:
  - Alkalinity (KS 4.3)
  - pH
- Anions:
  - Chloride
  - Sulfate
- Sensor-Data:
  - Conductivity
  - Turbidity
  - Chlorophyll
- Carbon:
  - TIC
  - pCO_2
  - DOC
  - SUVA 254
  - POC (TOC – DOC)
  - $POC_{Sediment}$
- Macro-nutrients:
  - Silikate
  - Ammonia
  - Nitrate
  - SRP
  - TP surface flow & sediment
  - N:P Stöchiometry
- Biofilms:
  - POC
  - Stöchiometry
- Potentiall hazardous substances:
  - Arsenic
  - Cadmium
  - Copper
  - Nickel
  - Lead
  - Zinc

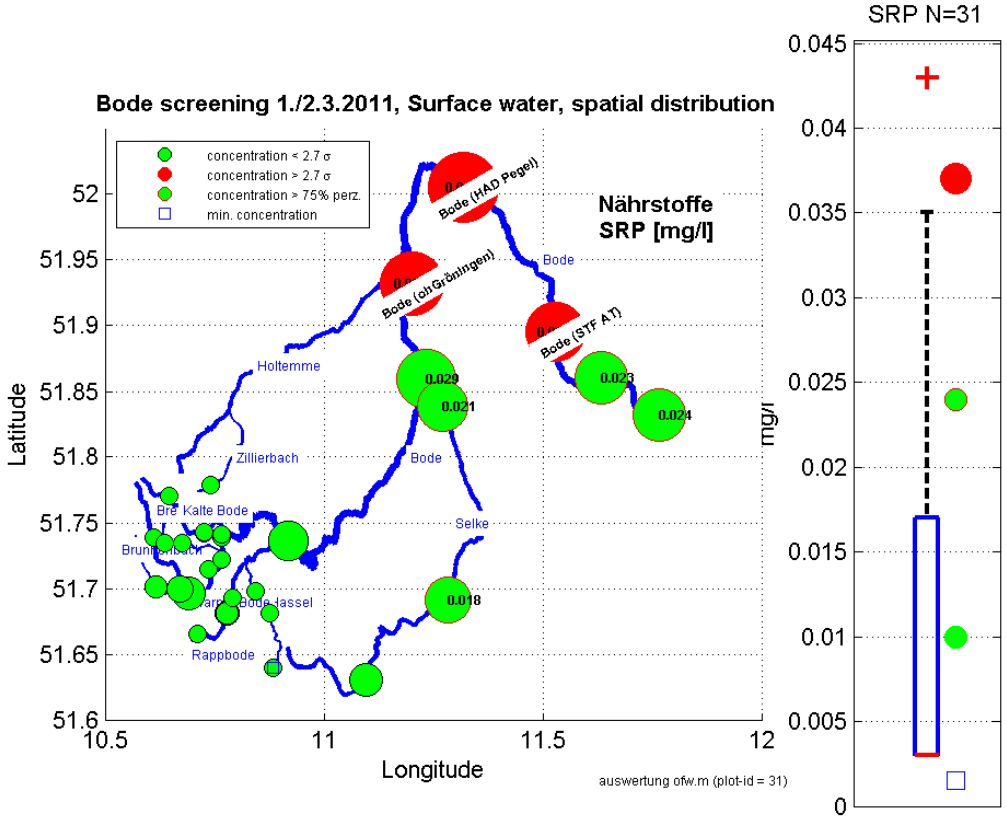
Example: Ammonia



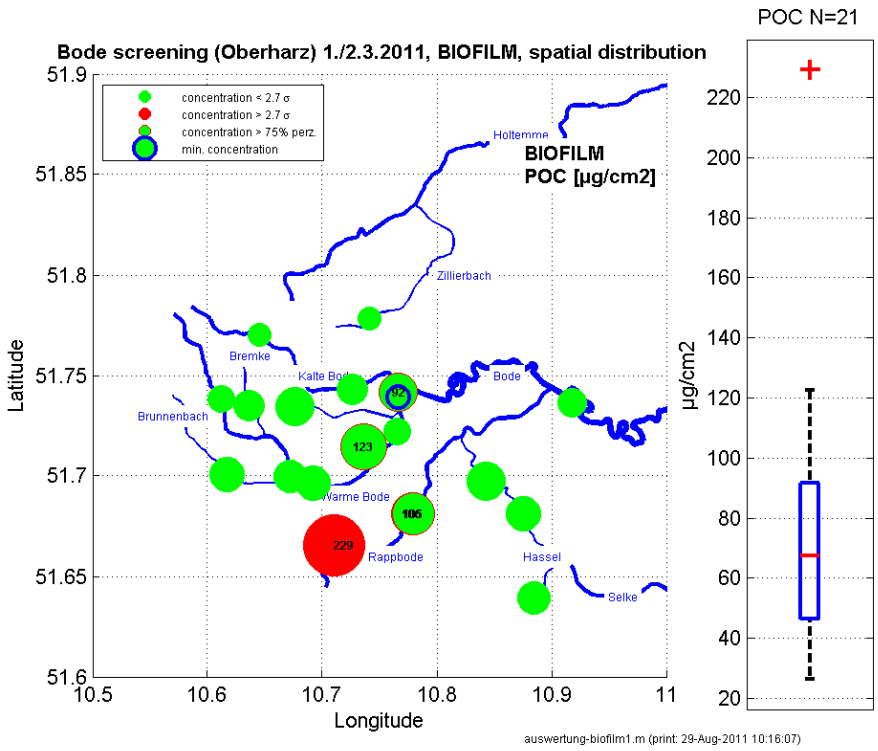


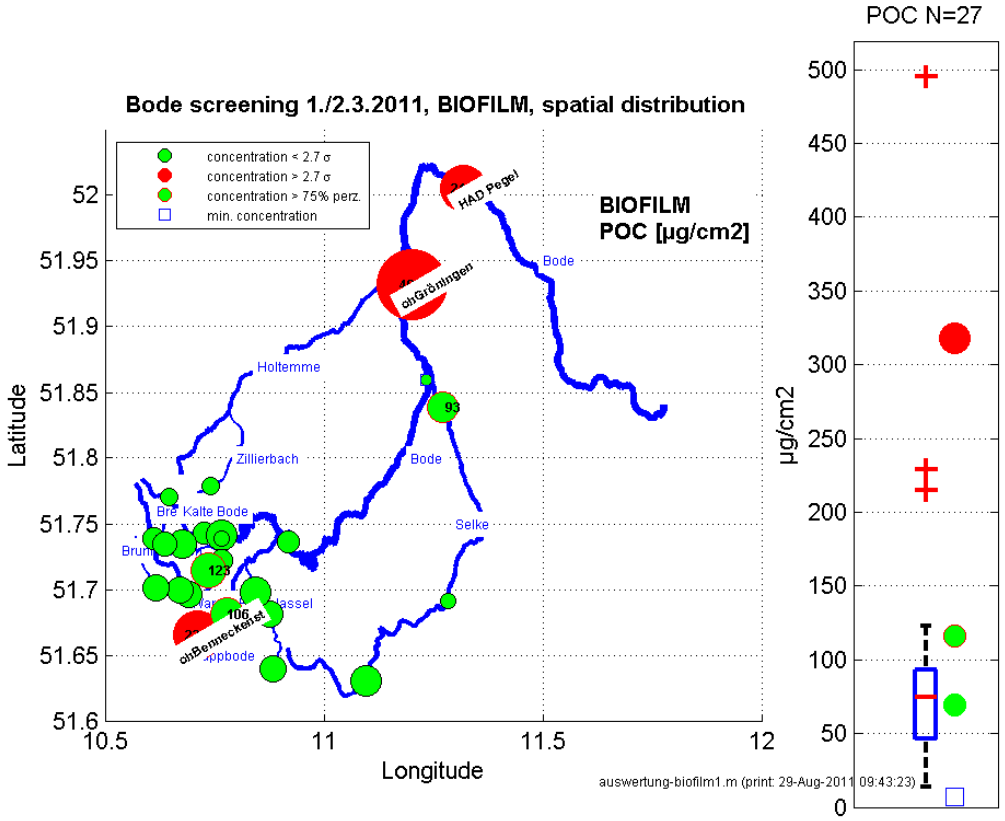
Example: Soluble Reactive Phosphorus



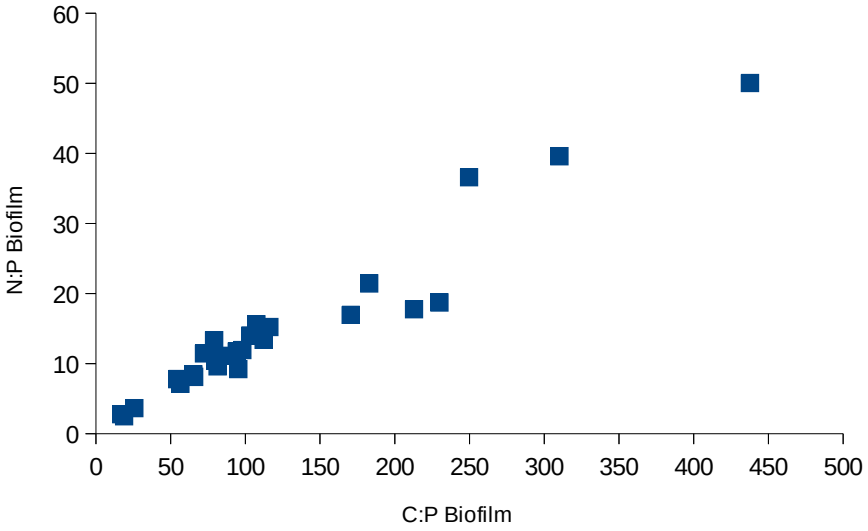


Biofilm: POC


Bode screening (Oberharz) 1./2.3.2011, BIOFILM, spatial distribution
concentration < 2.7 σ
concentration > 2.7 σ
concentration > 75% perz.
min. concentration
BIOFILM
POC [µg/cm2]
Holtemme
Zillierbach
Bremke
Kalte Bode
Bode
Brunnenbach
Warme Bode
Rappbode
Hassel
Selke
123
106
229
Latitude
Longitude
51.9
51.85
51.8
51.75
51.7
51.65
51.6
10.5
10.6
10.7
10.8
10.9
11
POC N=21
µg/cm2
220
200
180
160
140
120
100
80
60
40
20
auswertung-biofilm1.m (print: 29-Aug-2011 10:16:07)

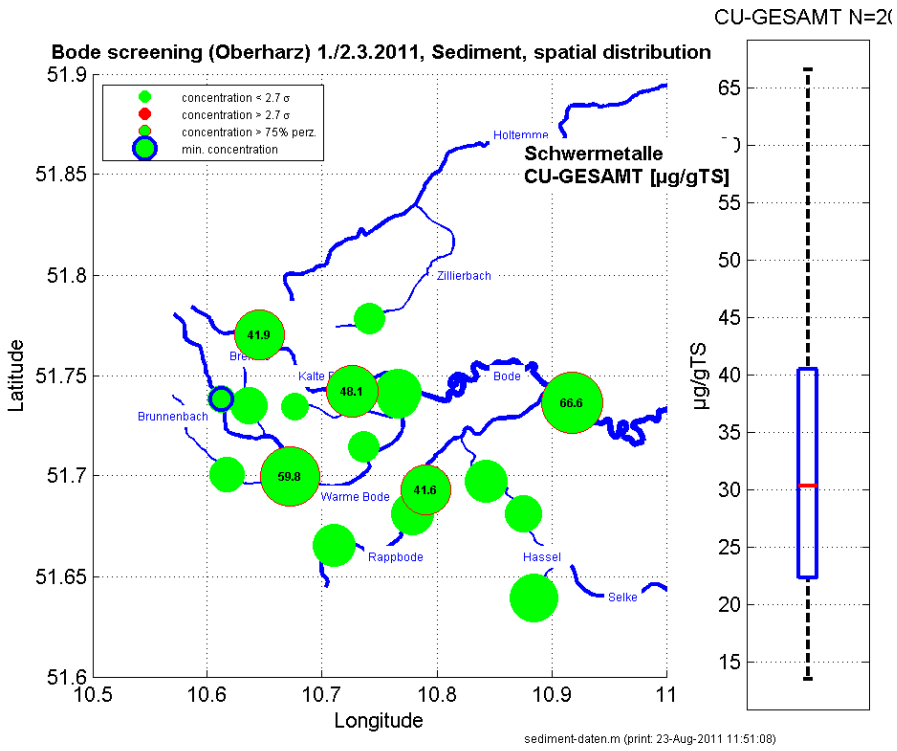

Bode screening 1./2.3.2011, BIOFILM, spatial distribution
concentration < 2.7 σ
concentration > 2.7 σ
concentration > 75% perz.
min. concentration
BIOFILM
POC [µg/cm2]
HAD Pegel
ohGröningen
Bode
Holtemme
Zillierbach
Kalte Bode
Selke
Hassel
93
123
106
Latitude
Longitude
52
51.95
51.9
51.85
51.8
51.75
51.7
51.65
51.6
10.5
11
11.5
12
POC N=27
µg/cm2
500
450
400
350
300
250
200
150
100
50
0
auswertung-biofilm1.m (print: 29-Aug-2011 09:43:23)

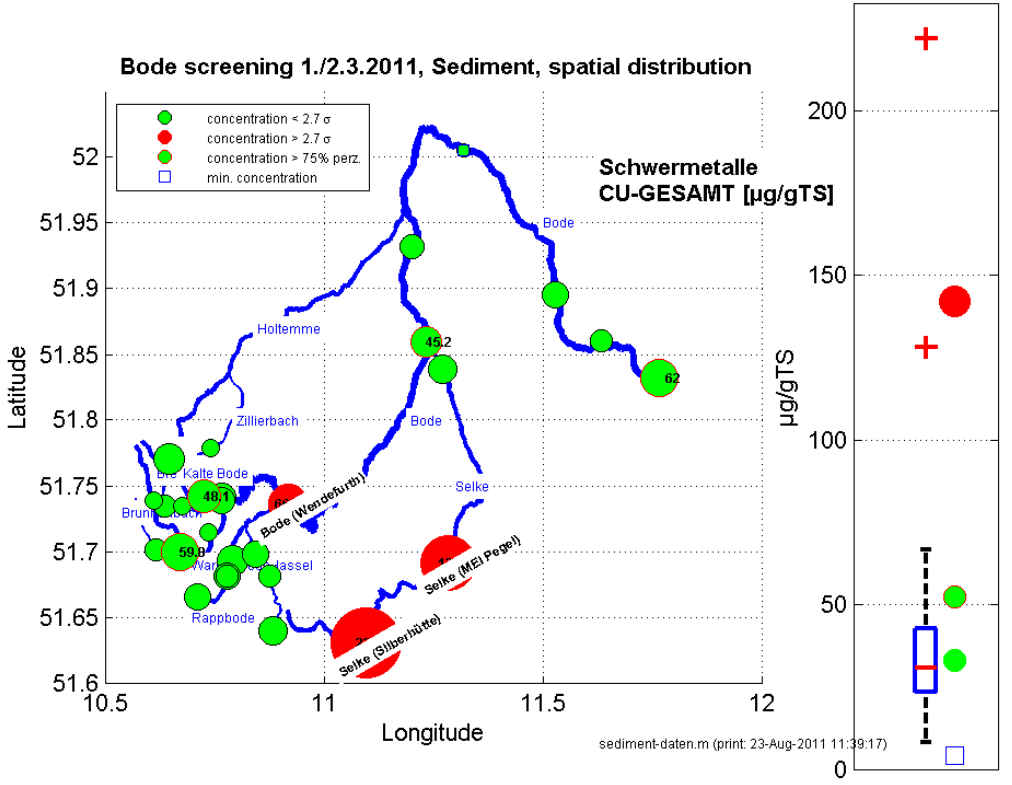
Biofilm: Stöchiometry



N:P Quota highly correlated with C:P Quota
(→ Nutrient limitation solely by P)

Heavy metals: Copper$_{Sediment}$

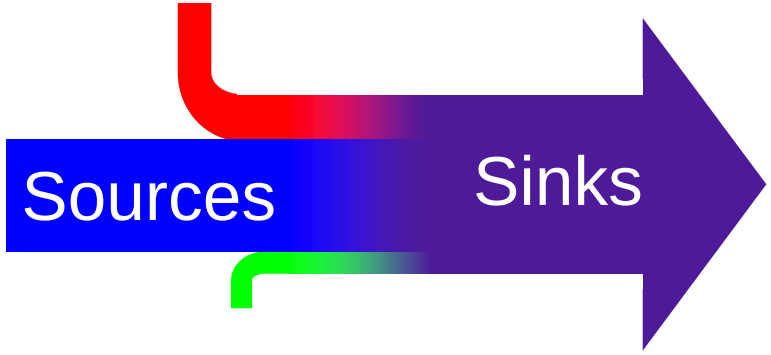




Urban watersheds and contamination of sediments

Hypothesis and modelling approach:

Source contribution of key contaminants can be assessed by linear mixing models



Element concentrations C, N, P, Al, Co, Fe, Ti, V, Cd, Cr, Cu, Ni, Pb, Zn

$$x_{ij} = \sum_{k=1}^{p} g_{ik} f_{kj}$$

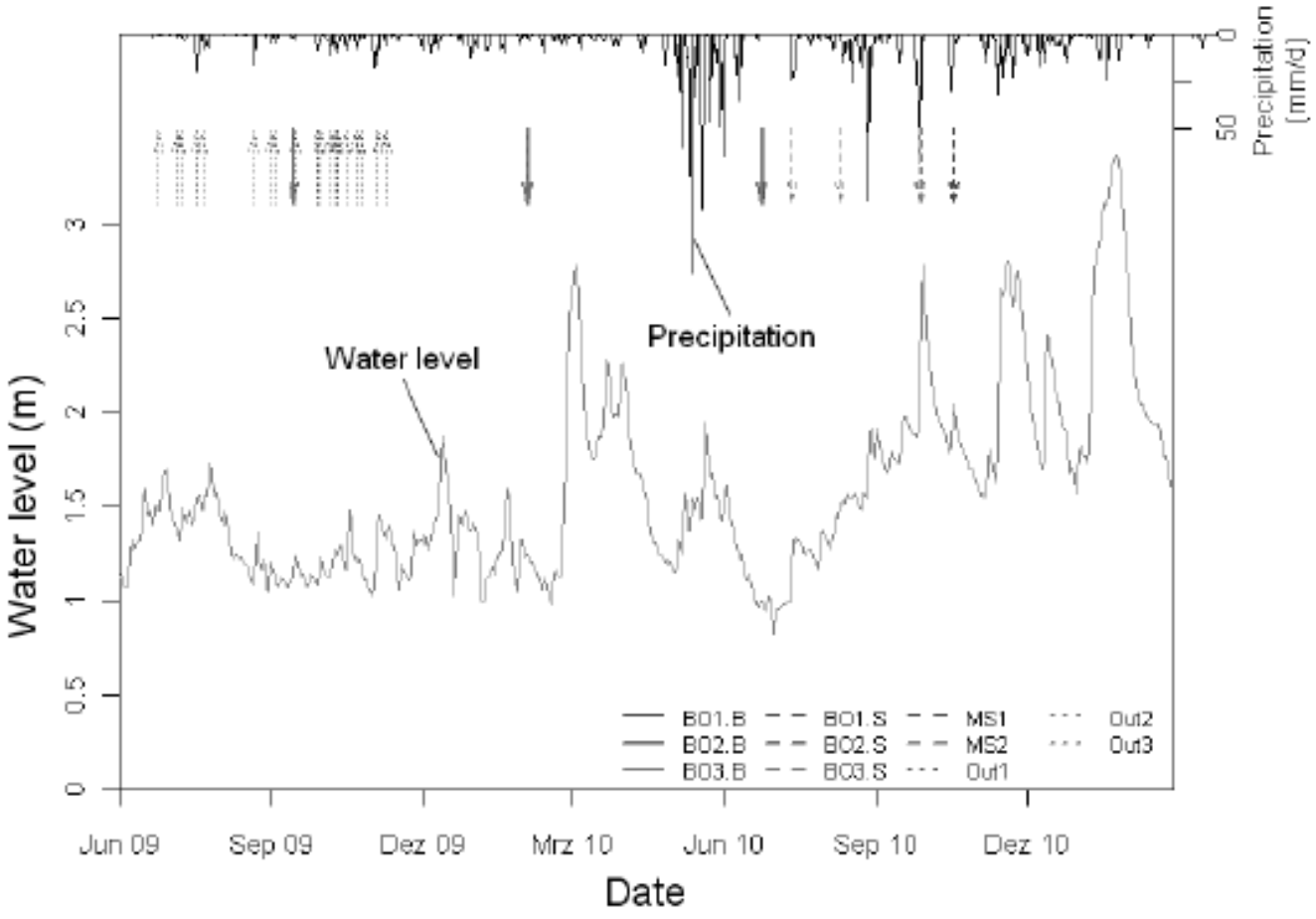
i = 1, …, n sample, *j = 1, …, m* Element and *k = 1, …, p* source

x – concentration in receptor, *g* – contribution and *f* – concentration in source

Telse David, Dietrich Borchardt, Wolf von Tümpling, Peter Krebs (2011). Urban wet weather discharge as source of sediment associated elements in a river bed. Water and Environment (subm.).

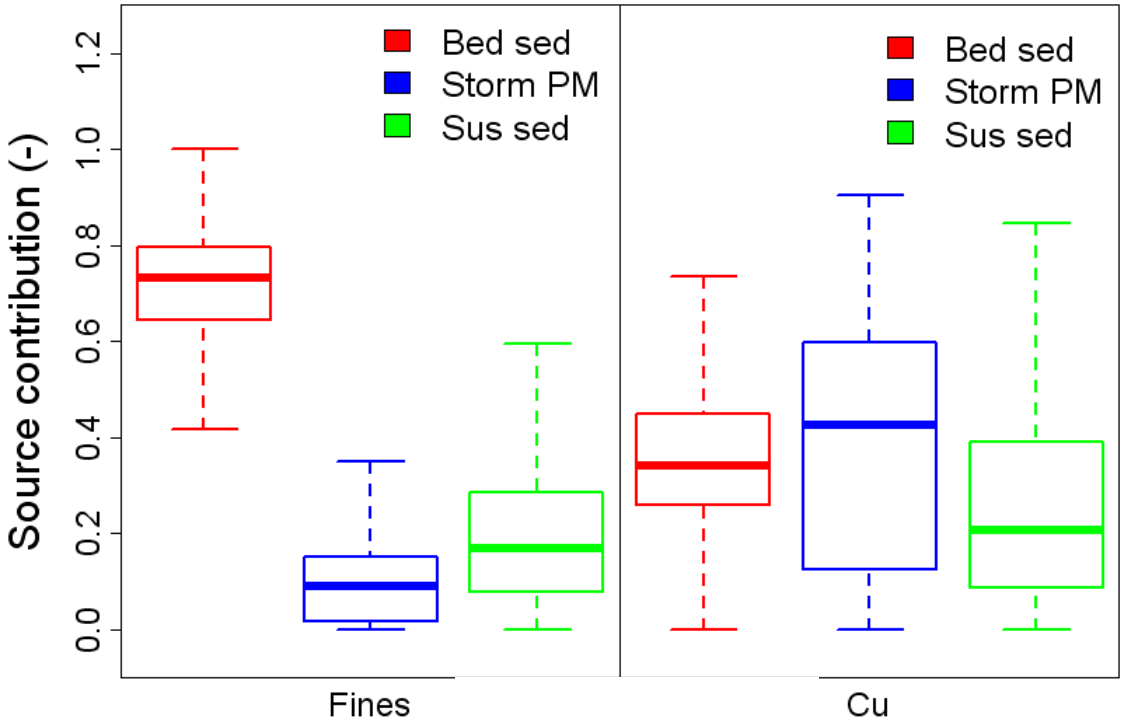
Sampling design urban watershed and contamination of sediments

Rainfall, discharge in the River Bode and overflow events



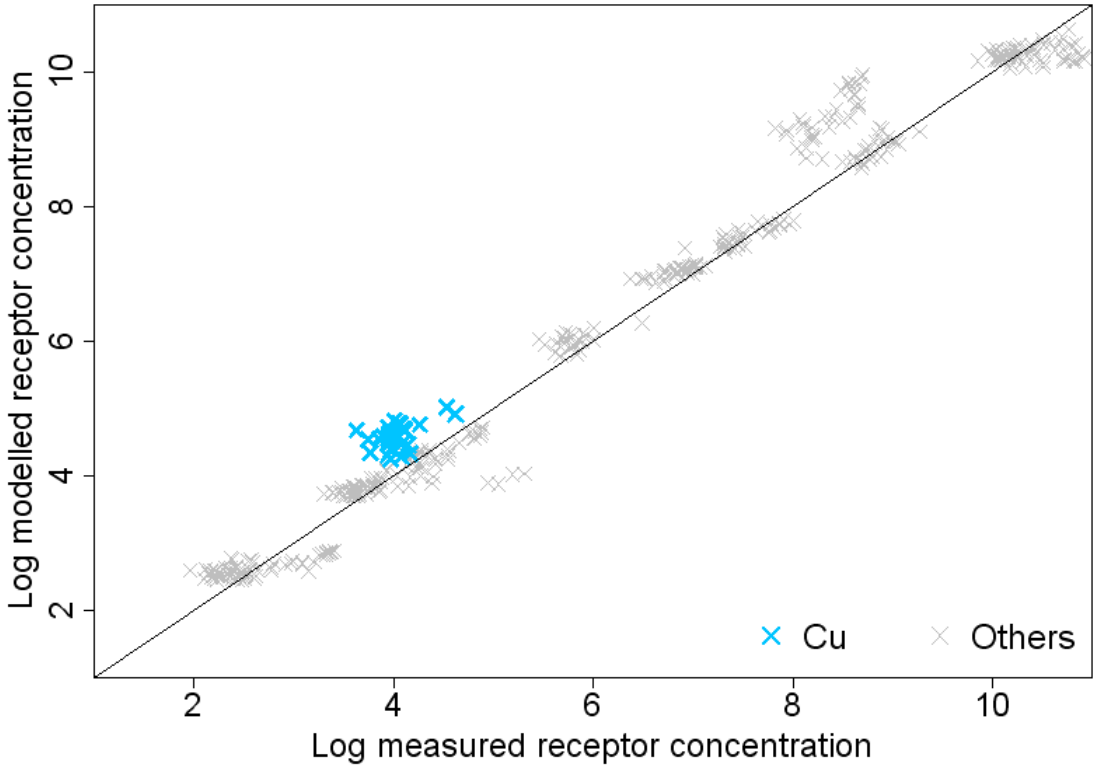
Telse David, Dietrich Borchardt, Wolf von Tümpling, Peter Krebs (2011). Stormwater effluents and element fingerprints of river sediments. Water Environment Research (subm.).

Source contribution of stormwater effluents for suspended sediments and Cu



David, T., Krebs, P., Borchardt D. and W. von Tümpling (2011). Element patterns for particulate matter in stormwater effluents. Wat. Sc. Tech. 63 (12), 3013 -3019.

Modelling of receptor contamination for different elements and verification for Cu



Telse David, Dietrich Borchardt, Wolf von Tümpling, Peter Krebs (2011). Stormwater effluents and element fingerprints of river sediments. Water Environment Research (subm.).

The Rappbode Reservoir Observatory

- located at Rappbode reservoir (Harz Mountains, Germany)
- Investment: about 500.000 €
- Countinuous monitoring of nutrient and carbon fluxes and corresponding ecosystem dynamics

Photo: André Künzelmann (UFZ)

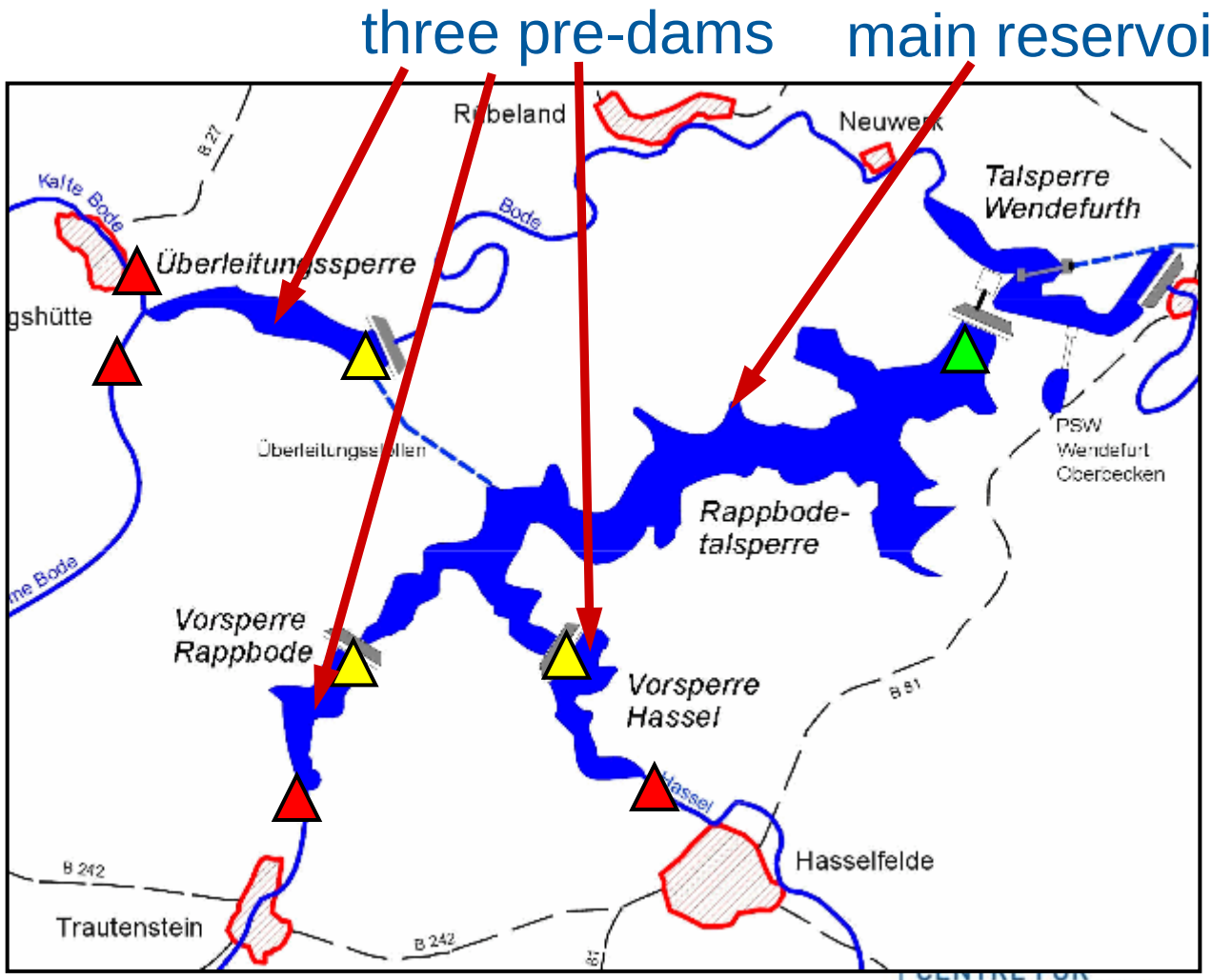
Rappbode Reservoir

- One main reservoir and 3 pre-dams
- Drinking water supply for over 1 Mio people
- Surface area: 395 ha
- Volume: 113 Mio m^3
- Max. depth: 89 m
- mesotrophic

Four inflow stations

Real-time & continuous measurement of
- temperature
- conductivity
- turbidity
- nitrate
- DOC

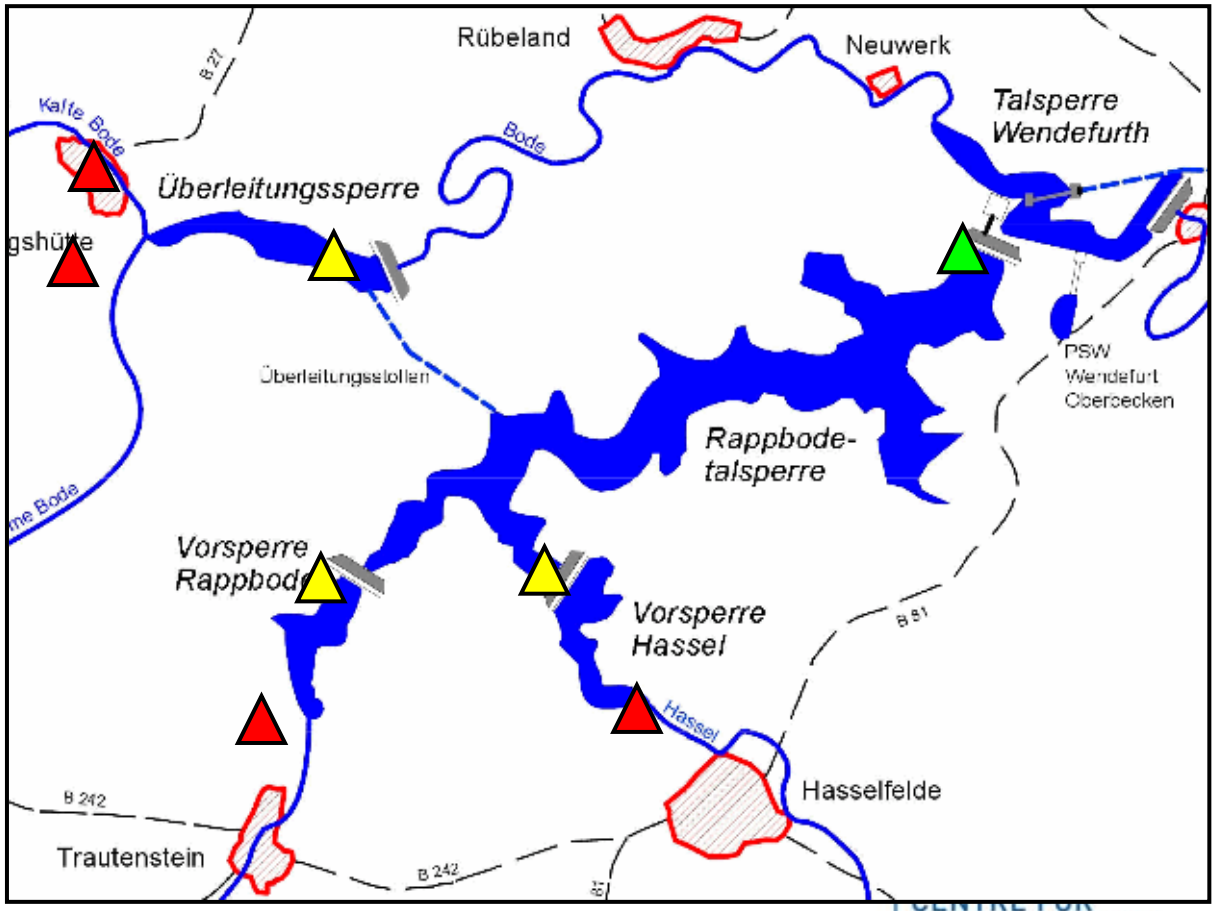
and event-dependent water sampling by automated water samplers



Talsperrenbetrieb Sachsen-Anhalt

Three connecting stations

Continuous measurement of
- temperature
- conductivity
- turbidity
- nitrate
- DOC
- oxygen
- chlorophyll



Talsperrenbetrieb Sachsen-Anhalt

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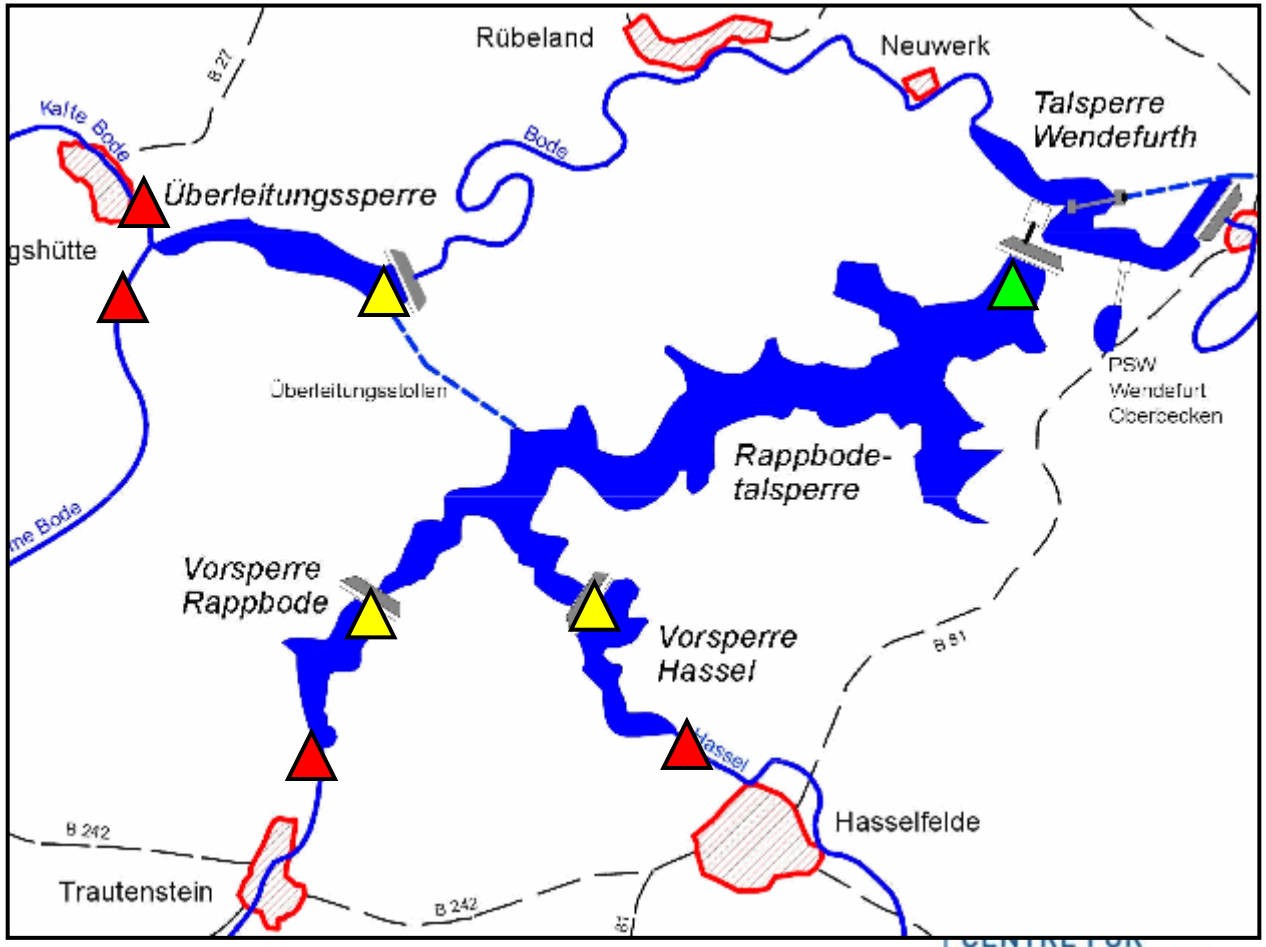
One offshore station

Meteorological buoy (wind, temperature, humidity, radiation)

Continuous measurement of
- temperature
- conductivity
- turbidity
- nitrate
- DOC
- oxygen
- chlorophyll



Talsperrenbetrieb Sachsen-Anhalt

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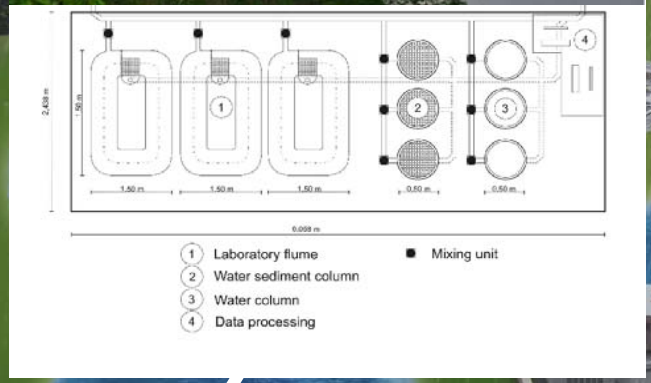
Large investment infrastructures and research platforms

MOBICOS-Mesocosms



Modular mesocosms

- Laboratory flumes
- Water-sediment-columns
- Water columns
- Single, combined, replicable

„By-pass“ to natural systems

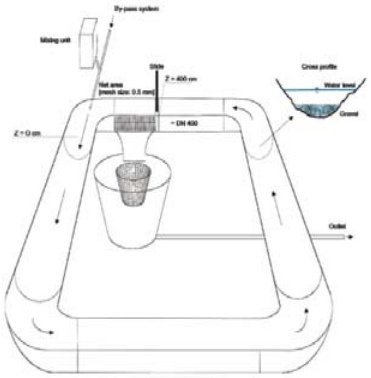
- Flow-controls
- Volume-controls
- Manipulable dimensions (physical, chemical, biological)

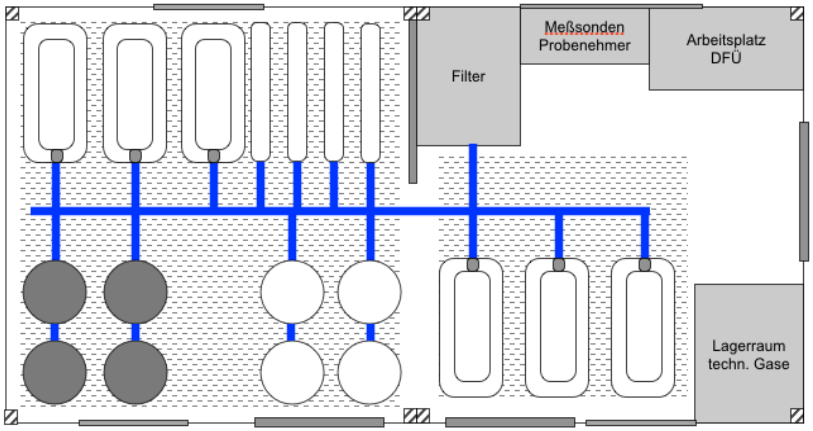
Mobile location across gradients

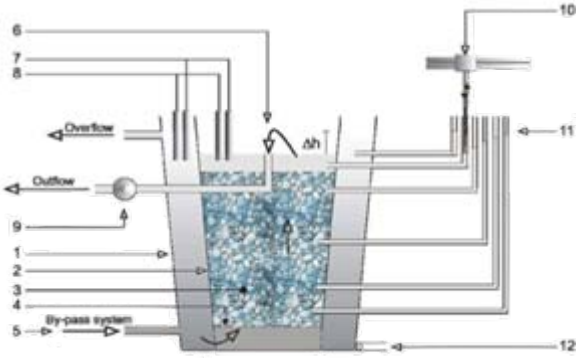
- „Real water“
- „Real sites“
- „Real replicates“

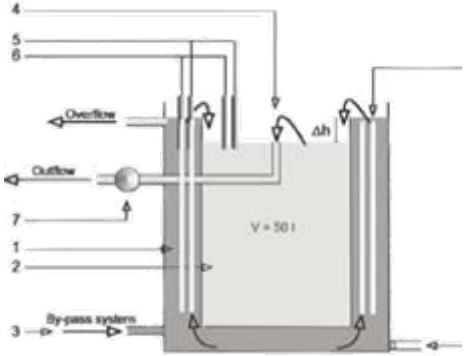
TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

MOBICOS: MObile aquatic MesoCOSms









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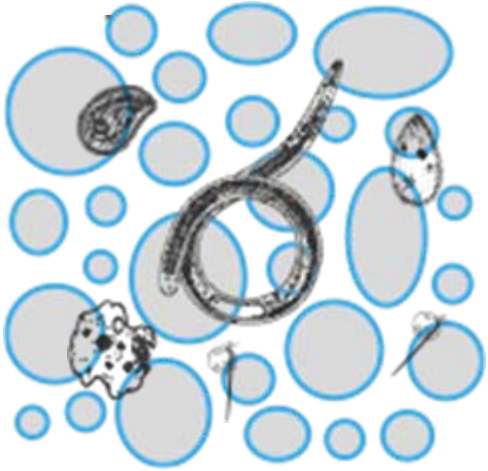
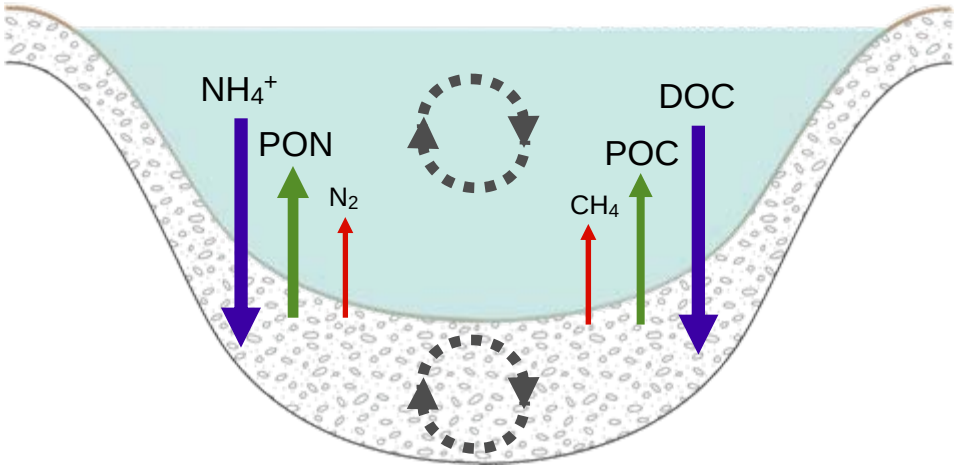
UFZ

1 Inflow
2 Filtration
3 Distribution
4 Experimental flume
5 Effluent

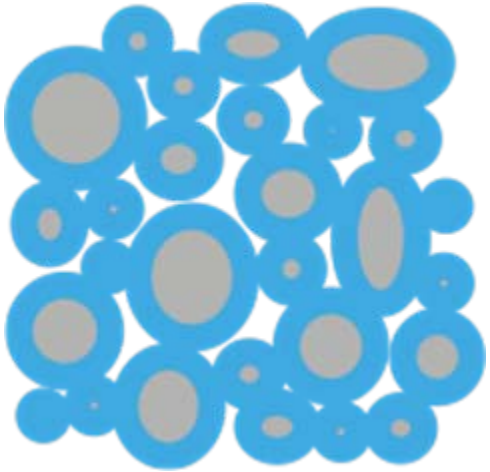
Hyporheic nutrient cycling and trophic transfer (Norf 2011)

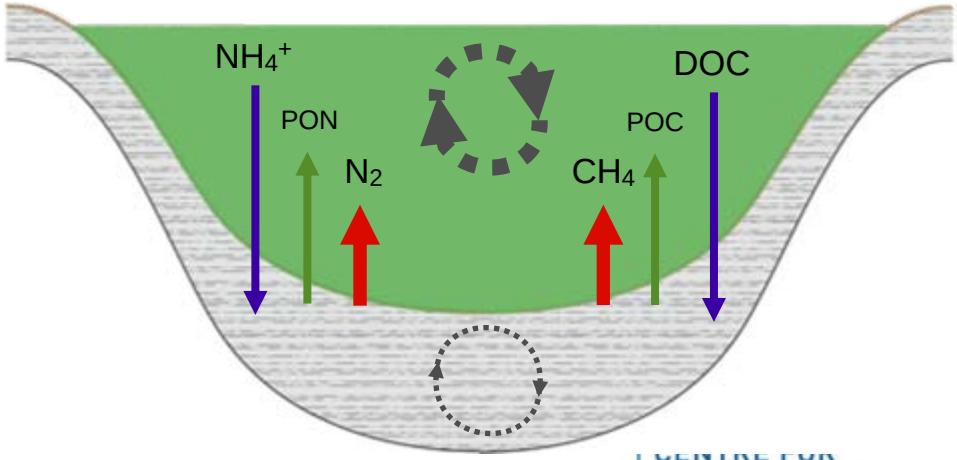
Oligotrophic:

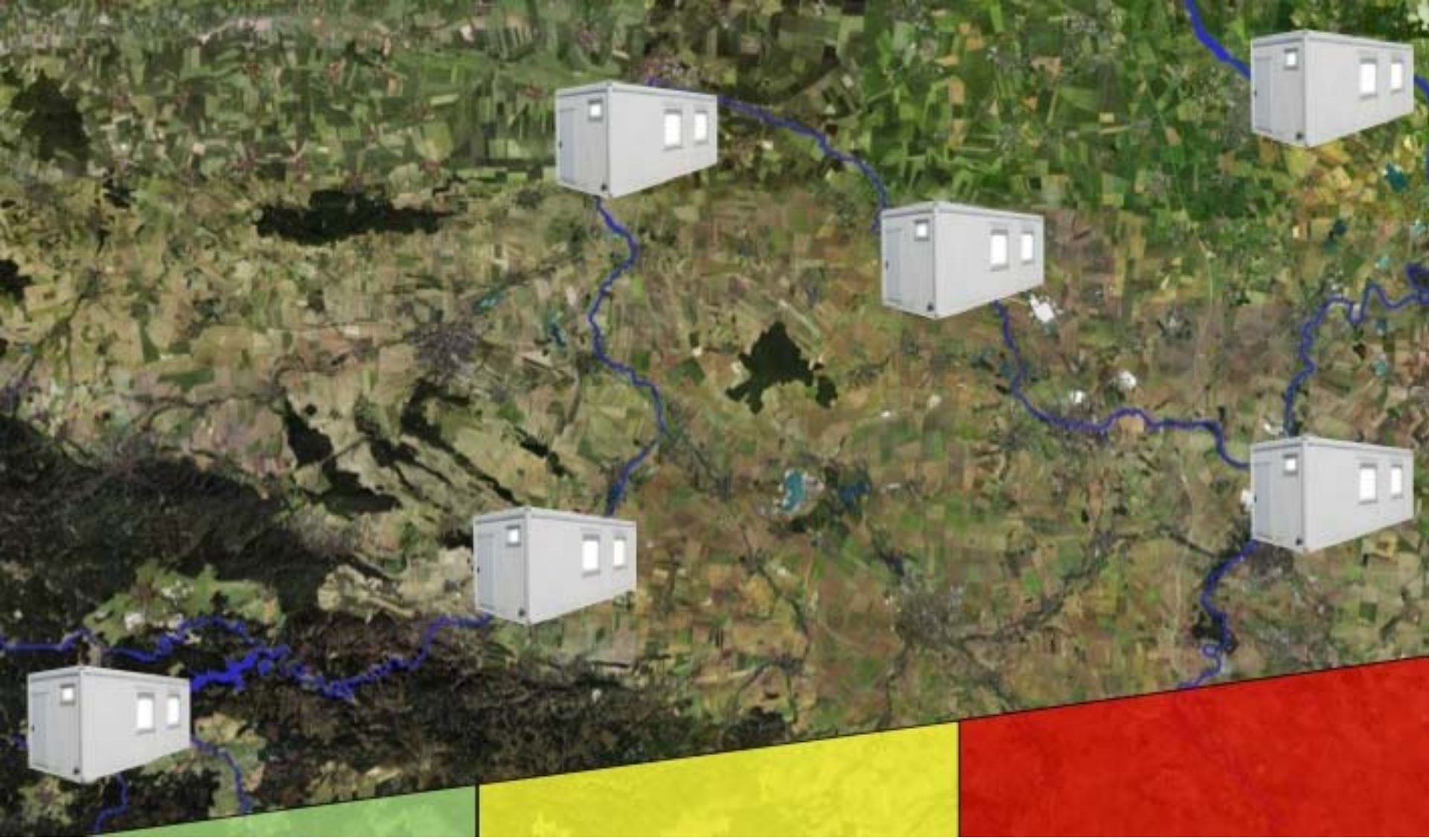




Eutrophic:







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UMWELTFORSCHUNG
UFZ

Perspectives and outlook

- **Monitoring**
  - Continuous hydrological monitoring stations (discharge; water quality etc.)
  - Catchment wide qualified sampling (specific boundary conditions)
  - Hydromorphological mapping
  - Biological components (biota, different trophic levels, biomass)
  - Biological processes (production, respiration etc.)

- **Experiments**
  - MOBICOS (Benthic-pelagic-coupling; hyoprheic zones)

- **Modelling**
  - Multi-object calibration of water quality models
  - Realization of RWQM No1
    - Compartmentilisation approach (surface flow, benthic layer, hyporheic zone(s))
    - Different trophic levels
    - Stoichometrie

- **Synthesis**