W3M 22-25 September 2005 in Wierzba

Water Quality Modelling for the wetland region Spreewald/Germany

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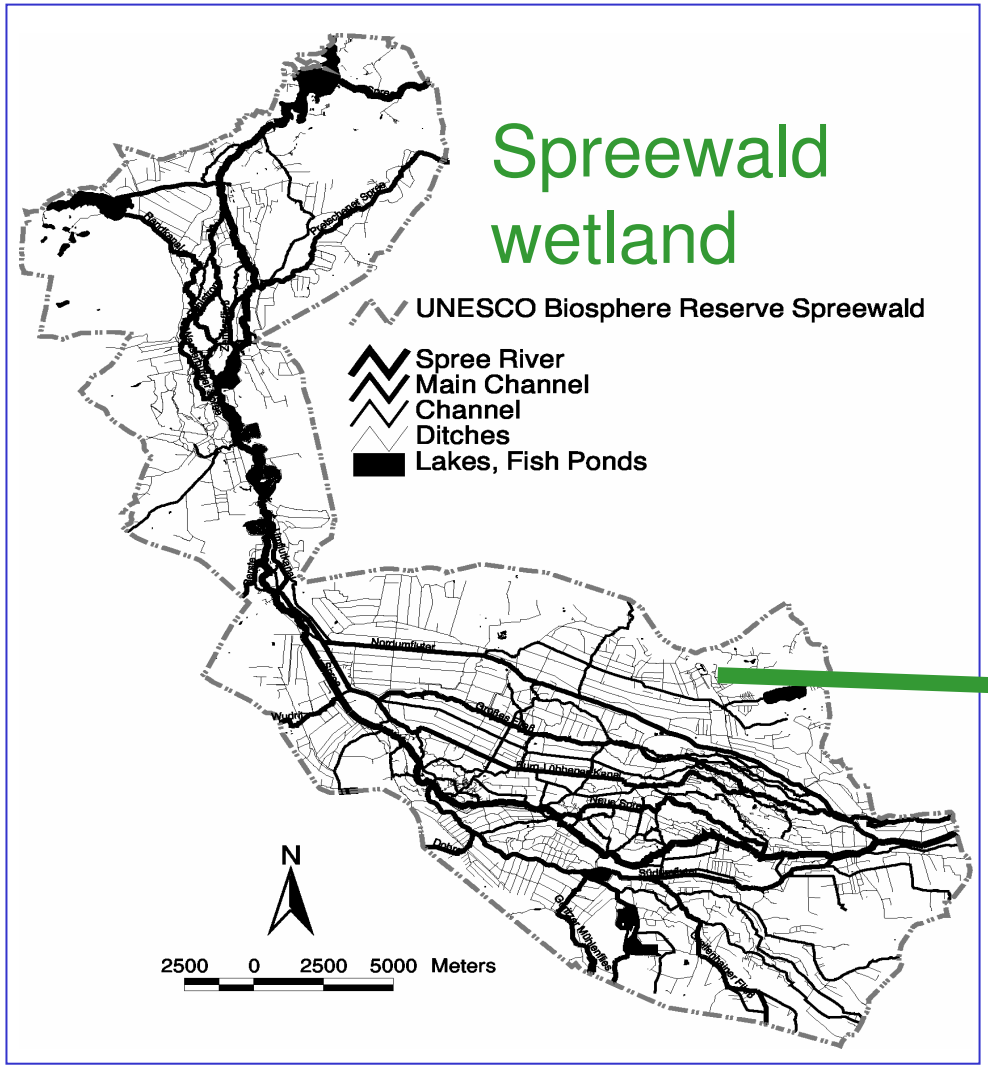
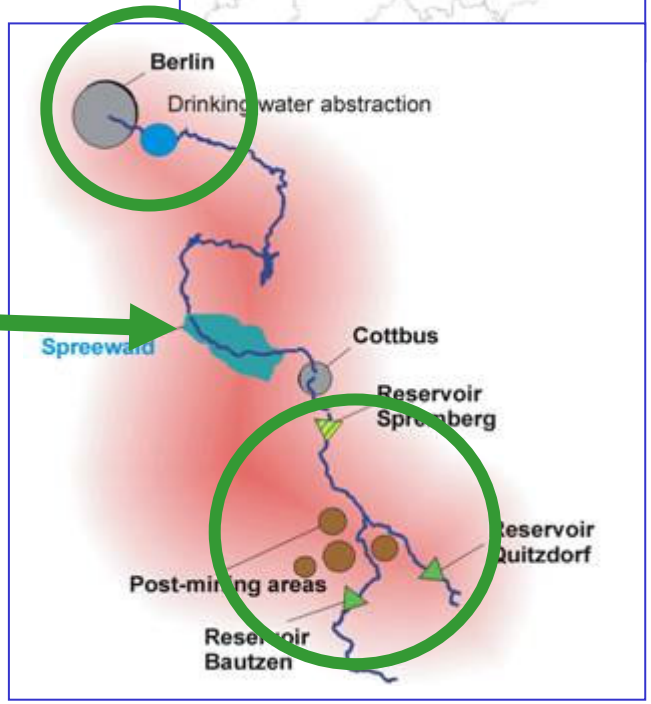
- **Water quality processes in the Spreewald wetland**
- **Water quality modelling for the Spreewald wetland**
- **Model results for sulphate retention capacity**
- **Conclusions**

Spree river basin management

Introduction

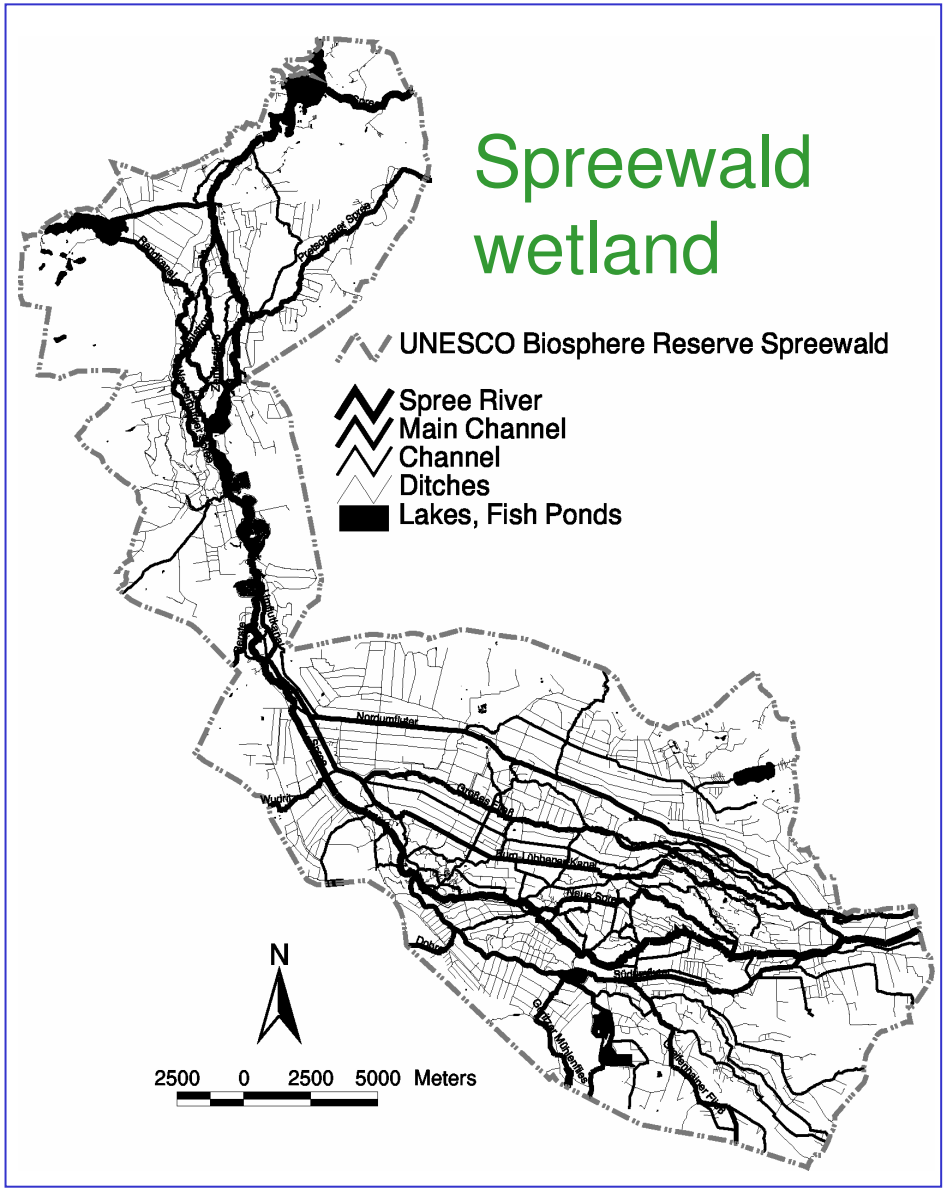




Wetland characteristics

Material and Methods

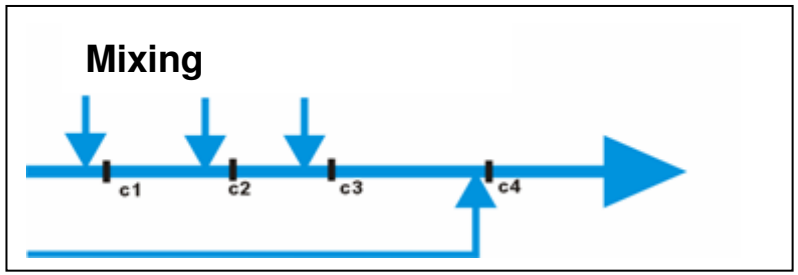
- channel network with high density (1,600 km/ 320 km^2)
- 30% covered by peat,
- water consumptive area in summer time
- high groundwater tables, groundwater-table control by weirs
- low flow velocities
- different flooding regimes during summer and winter with partly flooding of soils in some areas

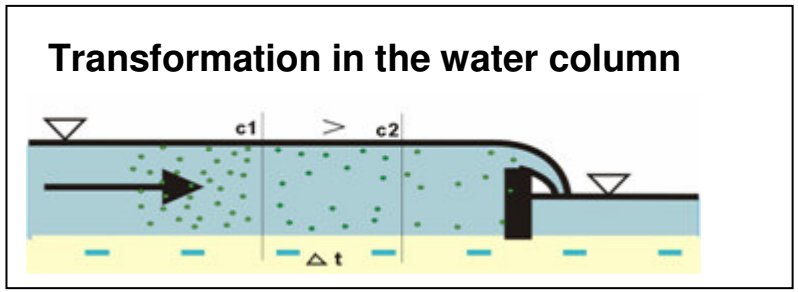


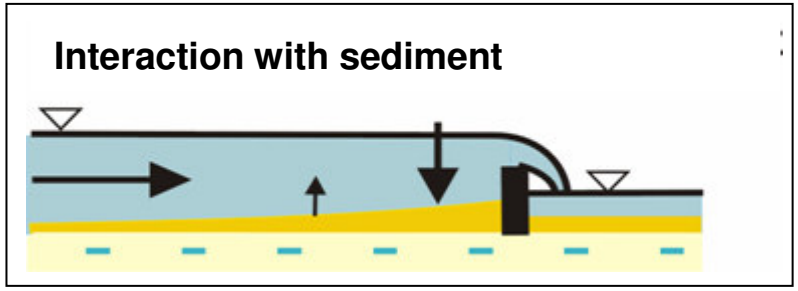
Wetland water bodies

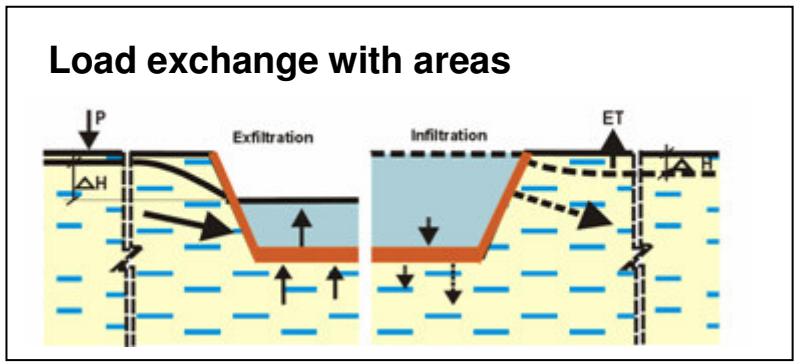
Main water quality processes

Material and Methods







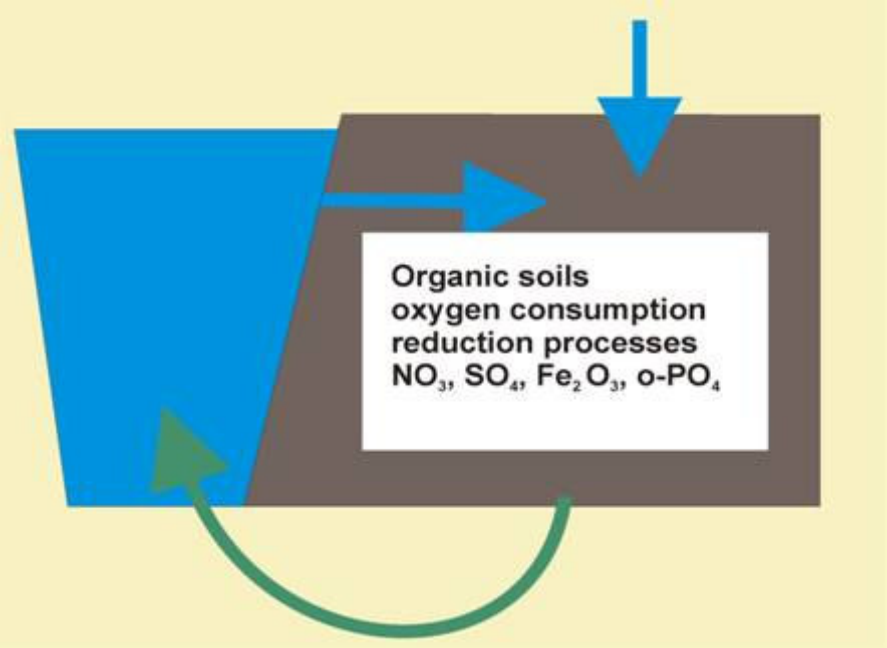


- Q, c - external and internal inputs, water distribution by weirs, altering flow directions
- t,v,h - hydraulic structures, light, temperature
- c - pore water concentrations
- c - water column
- Q,c - land area - channel water exchange

Spreewald „wet land“ functioning

Material and Methods

Water inflow into the land areas (infiltration, overflow)



Advective matter retention (solubles and particles)

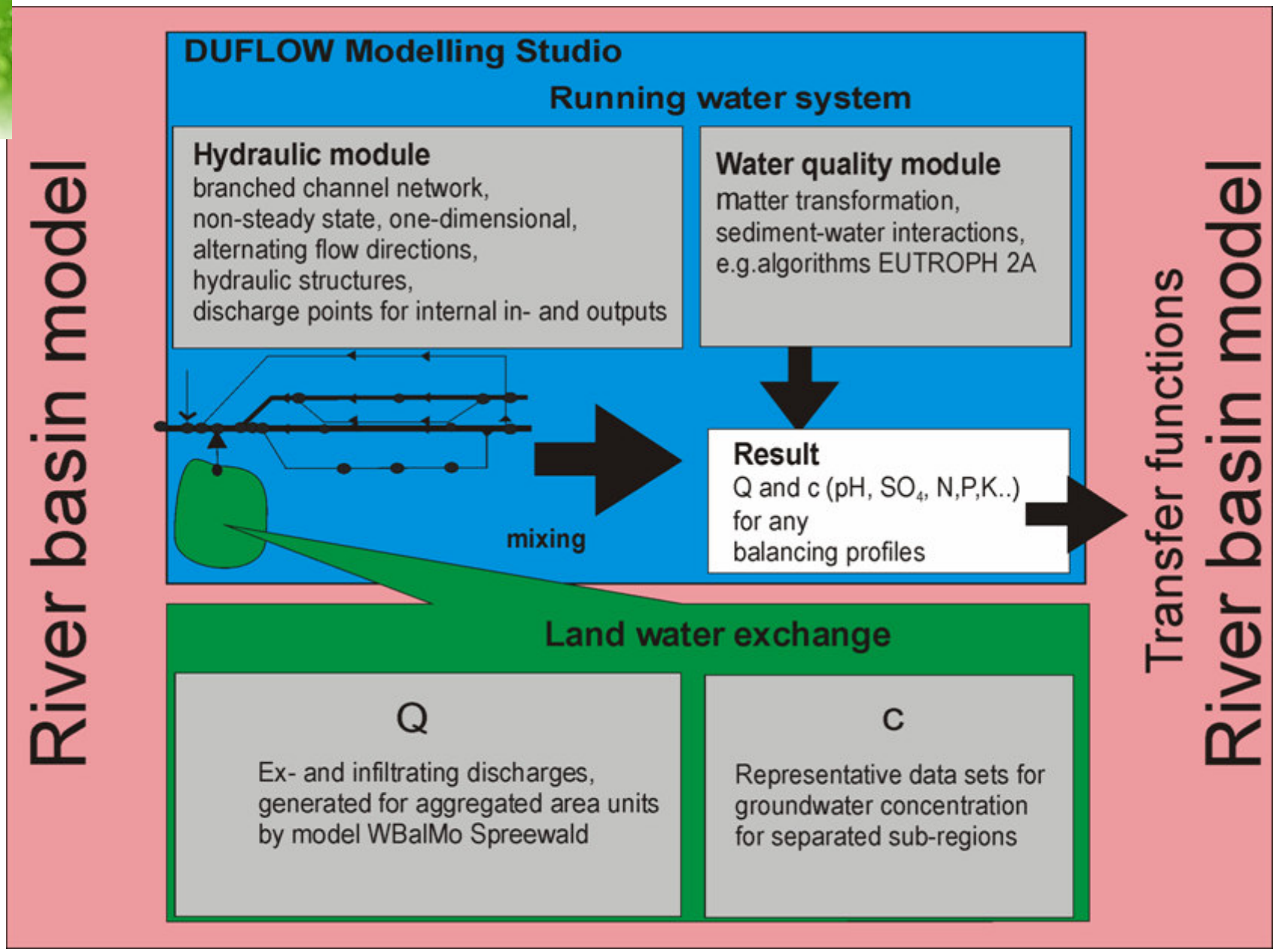
Matter transformation (land areas, channel bottom)

Water outflow into the channels (exfiltration as groundwater)

Sink and source

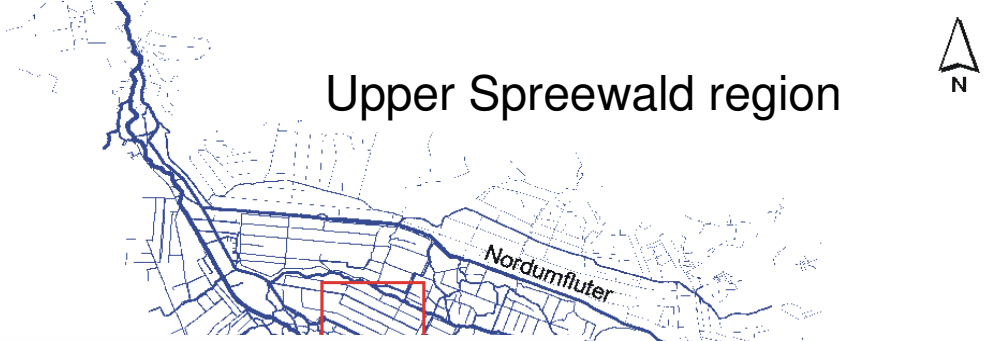
Model conception

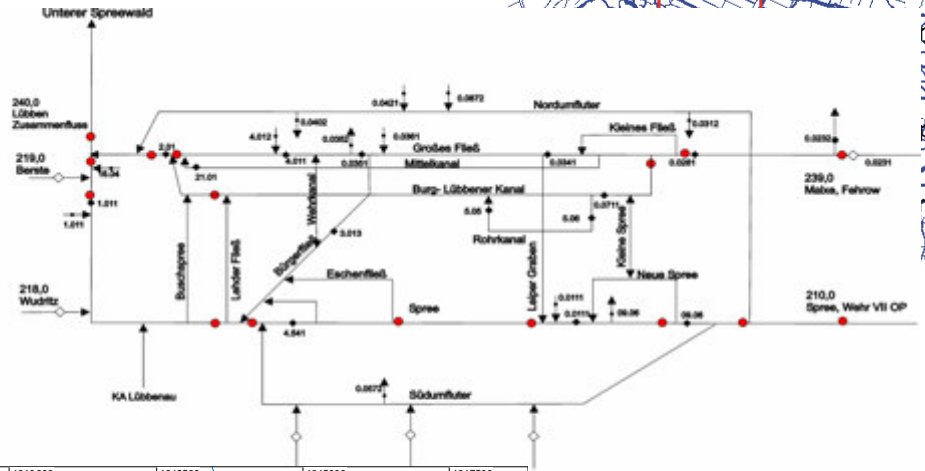
Material and Methods



Model structures

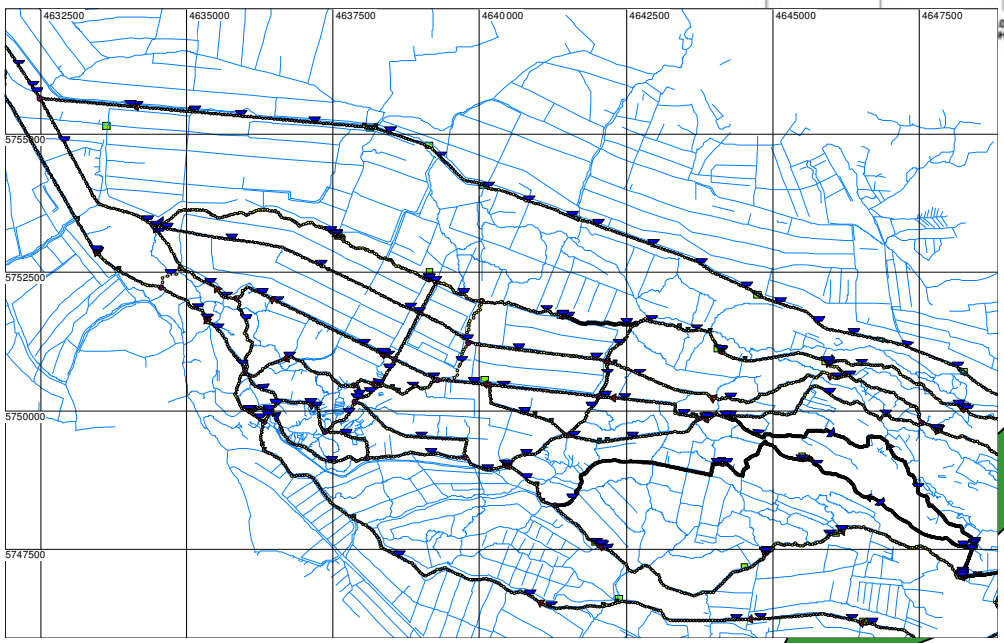
Upper Spreewald region



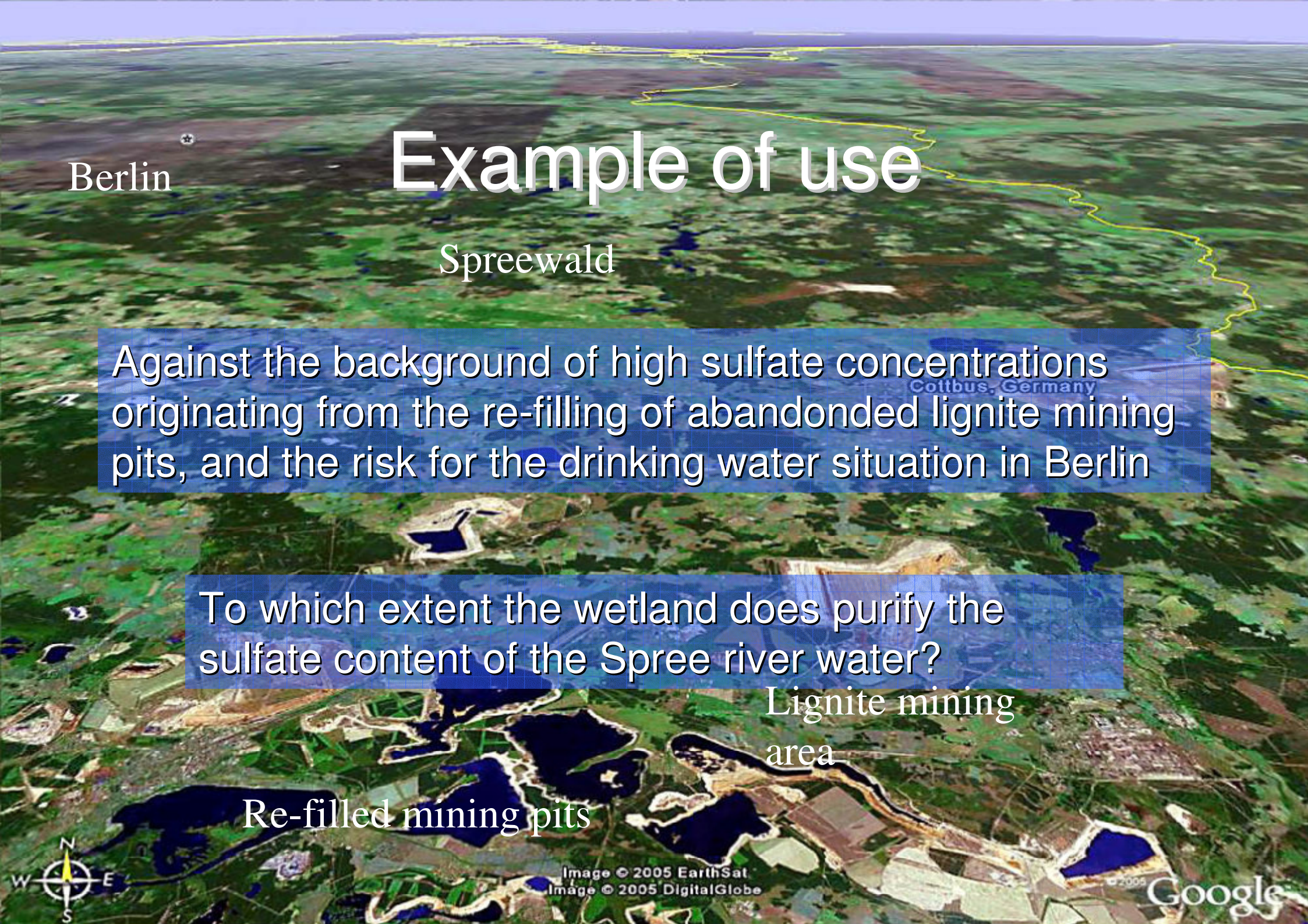


River structure diagram and nodes for land area water exchange

Duflow



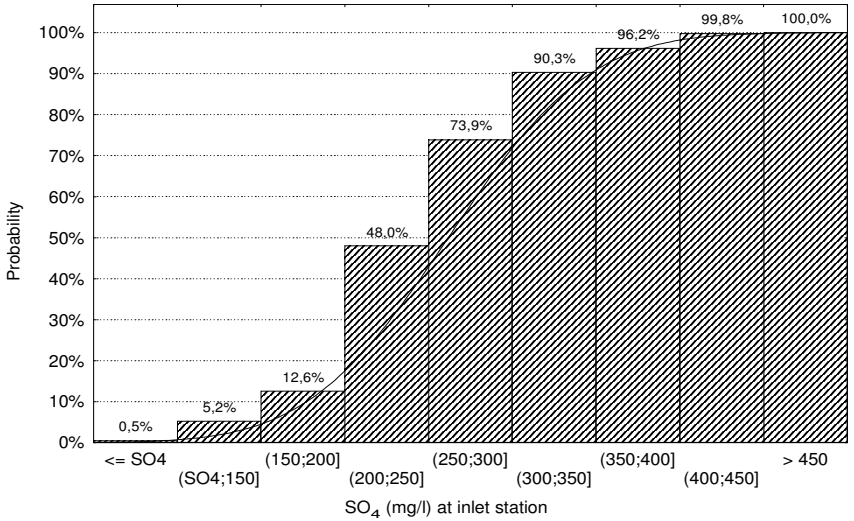
Results


Berlin
Example of use
Spreewald
Against the background of high sulfate concentrations originating from the re-filling of abandonded lignite mining pits, and the risk for the drinking water situation in Berlin
Cottbus, Germany
To which extent the wetland does purify the sulfate content of the Spree river water?
Lignite mining area
Re-filled mining pits
Image © 2005 EarthSat
Image © 2005 DigitalGlobe
Google

Stress scenarios

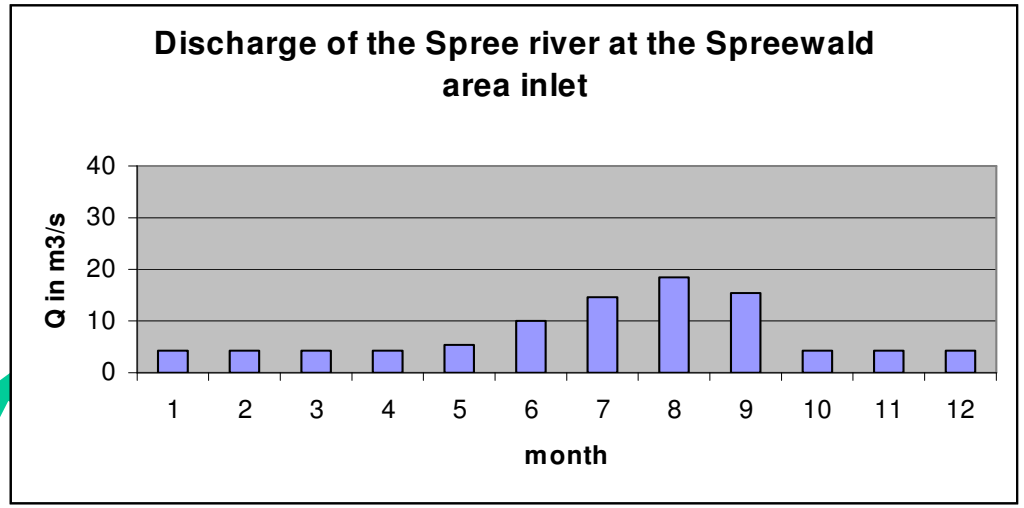
Results

River basin model



WBalMo Spreewald

Climatic water balance 5-percentile



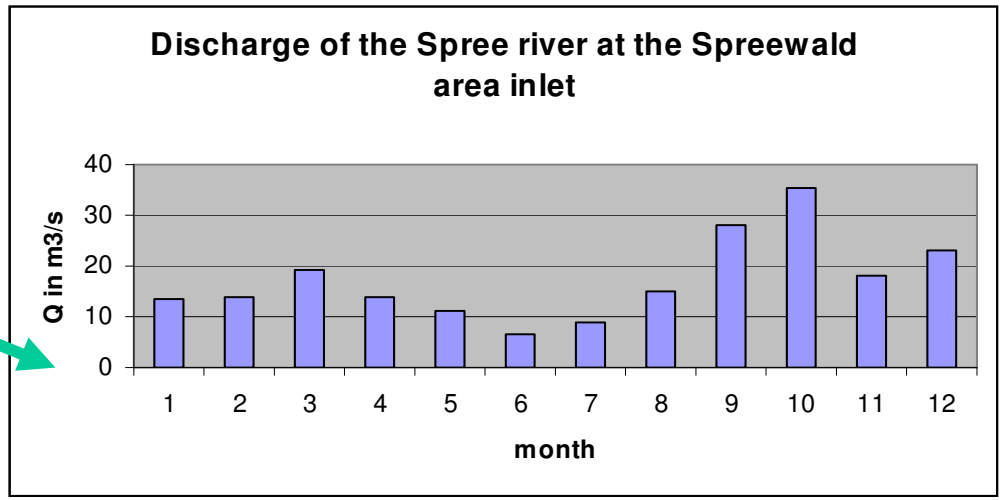
Probability of sulphate concentration at Spreewald area inlet

N= 12 month*100 realisations*7 years= 8400

(N forecasting = 42000)

Maximum SO_4-concentration 500 mg/l

Climatic water balance 95-percentile

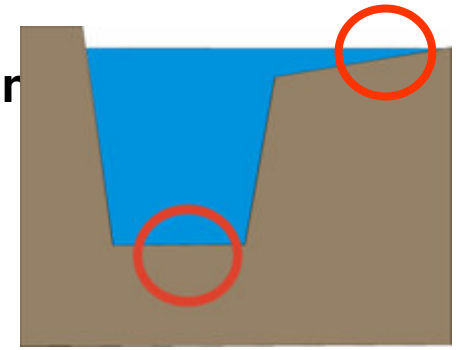


Sulphate transformation in transfer zones

Results

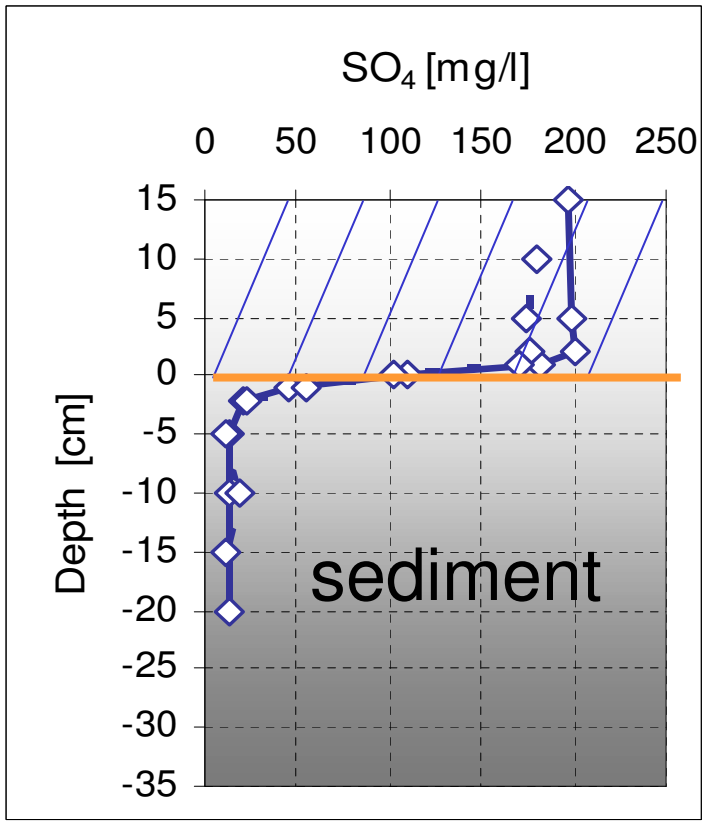
Sulphate in the transfer zor

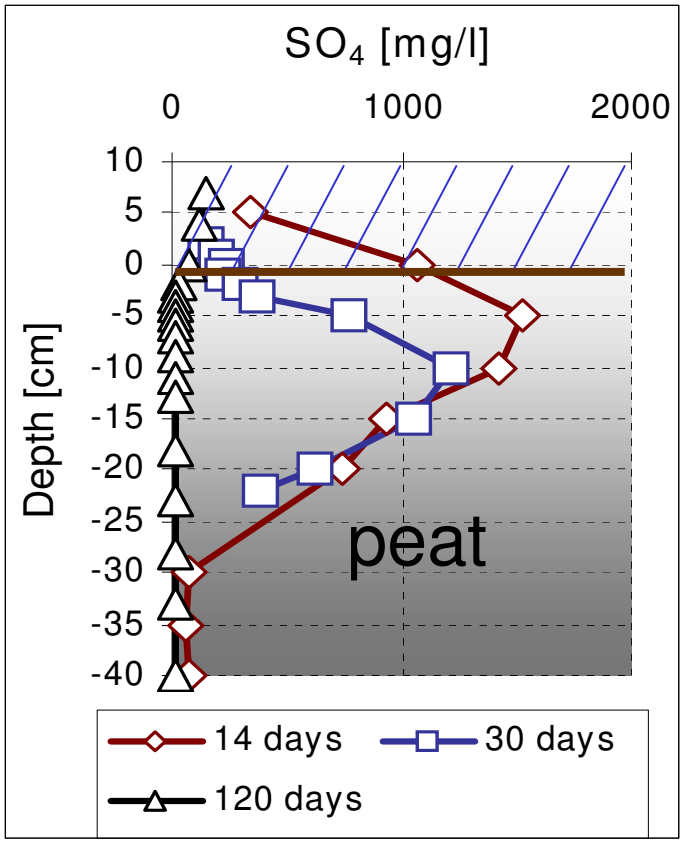
channel bottom –
free water column



Sulphate in the transfer zone

shallow peat soil – flooded water column

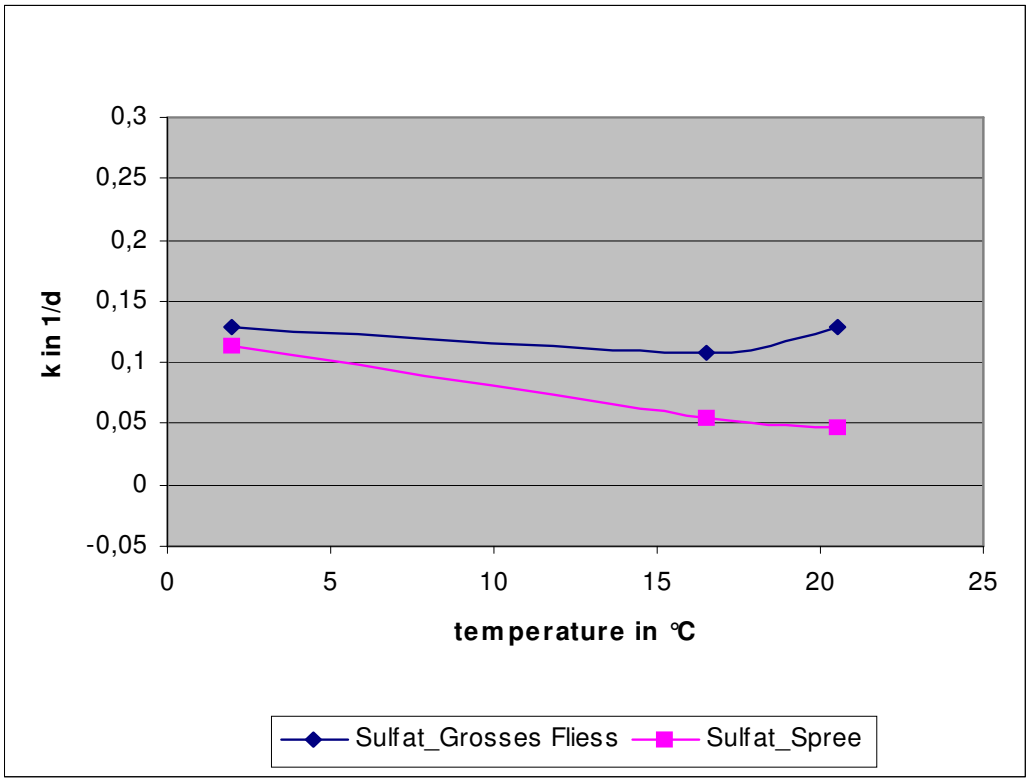




SO_4 transformation in the flow system

$$u \cdot \frac{\delta C_{SO4}}{\delta x} = -k_{SO4} \cdot T_W \cdot C_{SO4}$$

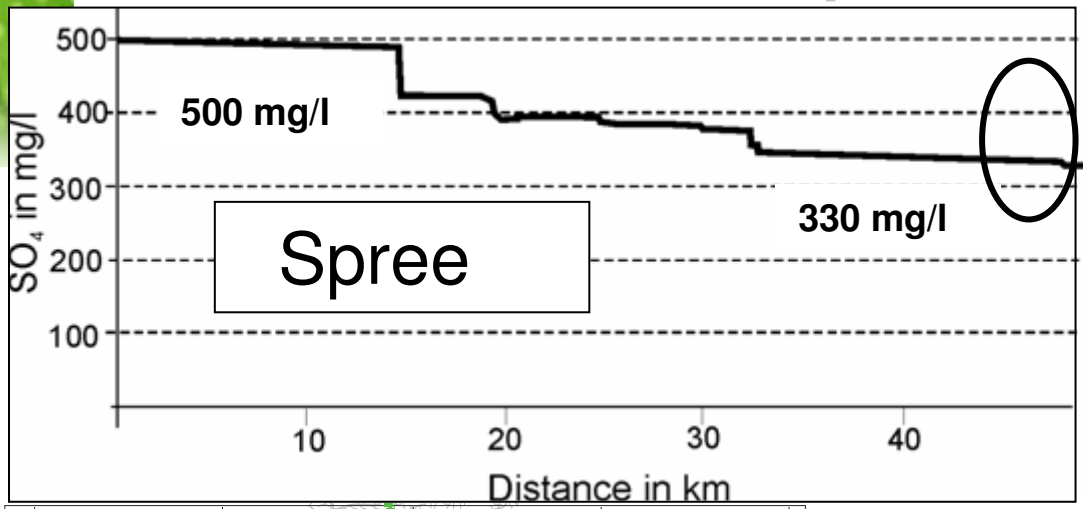
u	flow velocity
C_{SO4}	concentration
k	decay rate
T_w	temperature
X	flow distance



Experimentally determined decay rate k

Results

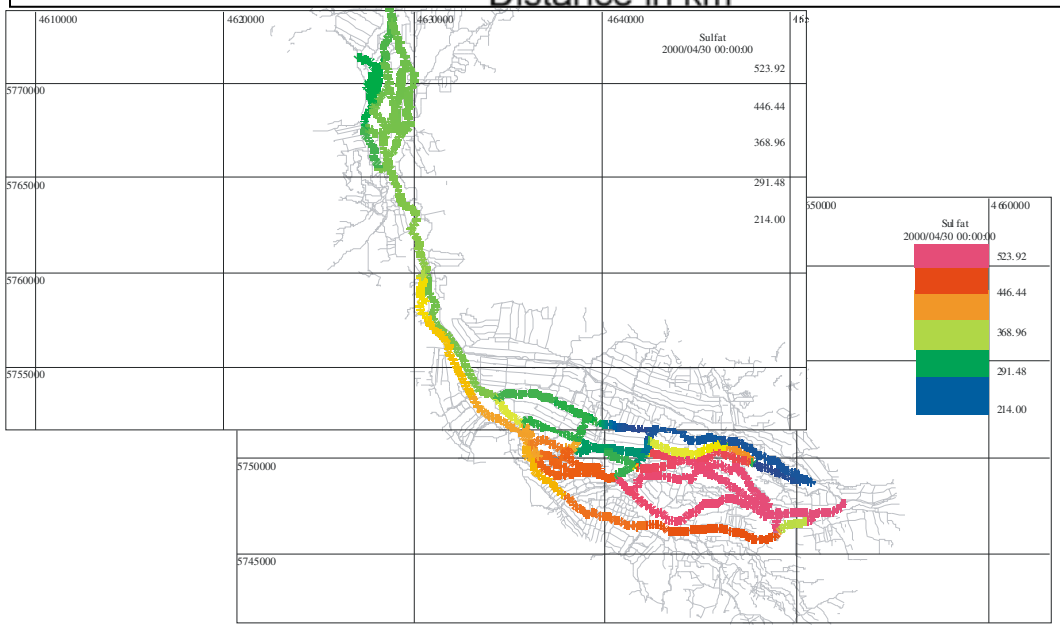
Sulphate distribution within the Spreewald



Summer half year - June

Q_Spree = 7,5 m³/s, C_Spree = 500 mg/l

Q_Malxe = 2,8 m³/s, C_Malxe = 257 mg/l



Load reduction:

26% peat areas

13% decay processes in channels

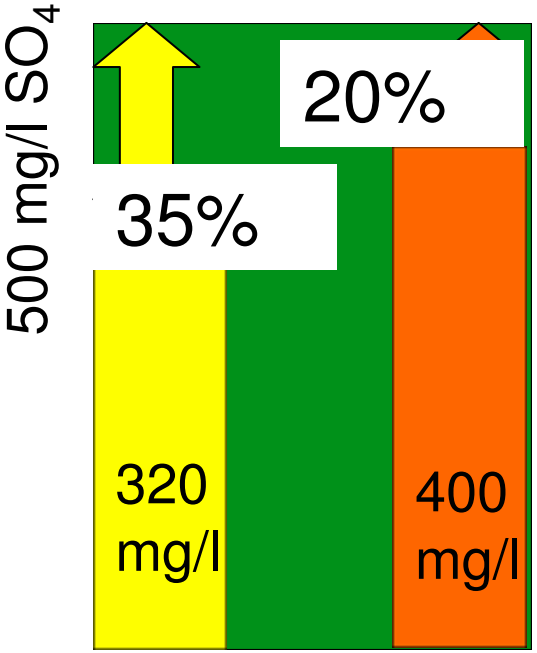
60% mixing

Results

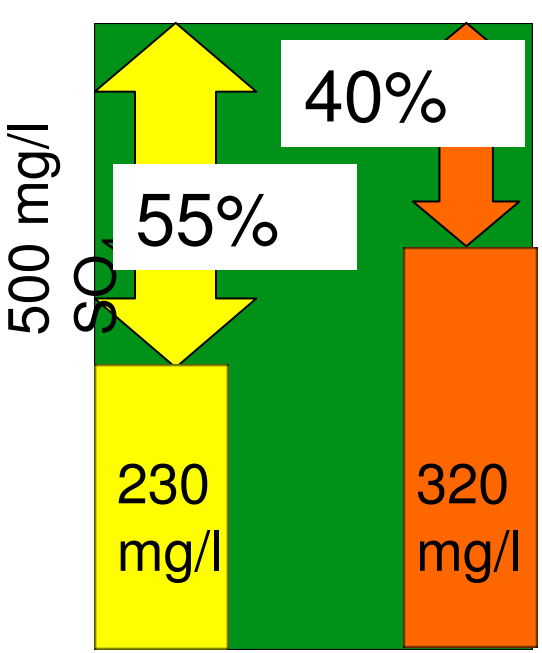
Sulphate retention

Results

wet year
Q (ā) = 25 m³/s



dry year
Q (ā)= 7 m³/s



Total reduction (mixing, transformation in water systems, land area-water exchange)

Spreewald wetland (transformation, land area- water exchange)

Conclusions

- The process-oriented water quality model combined with water balancing model allows to assess the retention capacity of the Spreewald wetland as whole, and for separate river sections, in detail
- The retention capability for sulfate is performed by both, the running water system and the land area-surface water exchange
- The purification effect exists all the time and ranges between 20-40% of input sulfate concentration

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