

# Mobilization, transport and deposition of contaminated sediments in the River Spree (Berlin)

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The lake "Rummelsburger See" is a former anabranch of the Spree River located in the centre of Berlin...



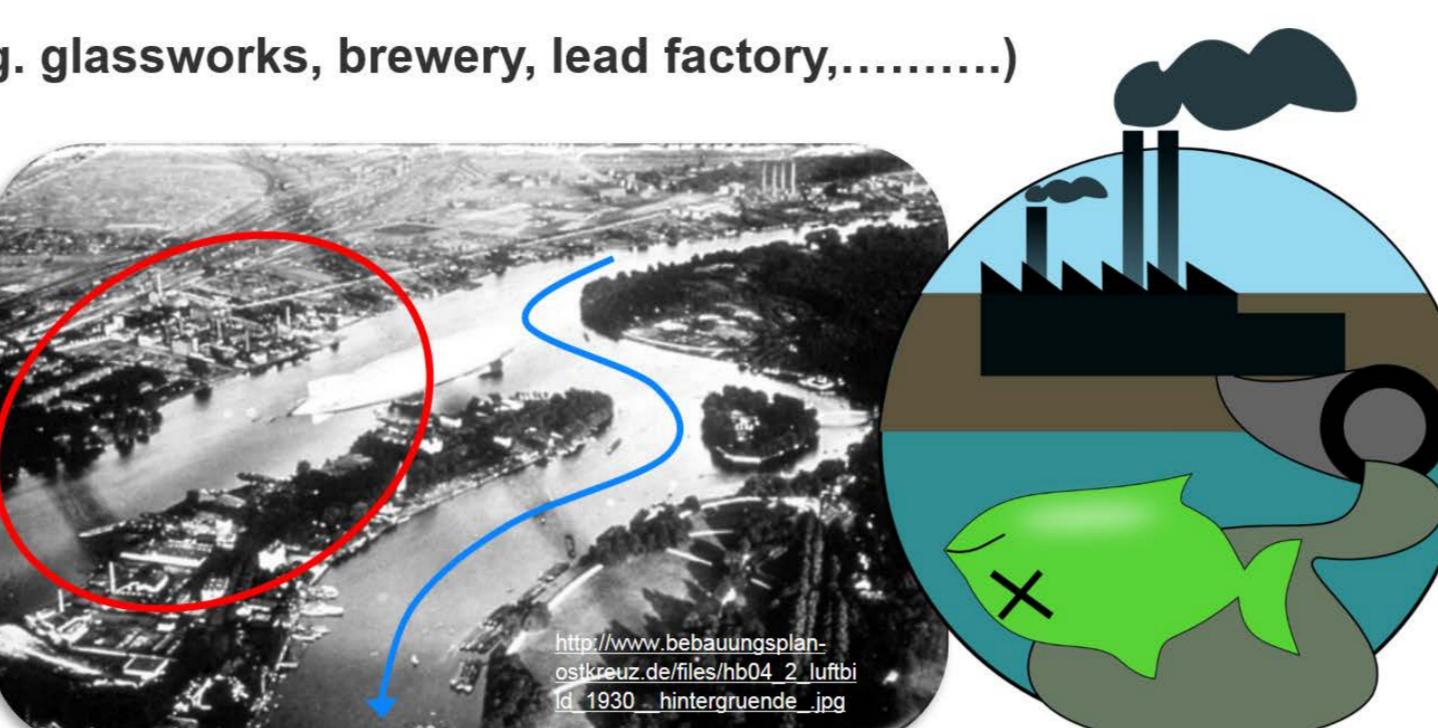
Currently, the area is being developed as a residential district and for local recreational use

...covering an area of more than 450,000 m<sup>2</sup>, with a length of 1.6 km, a mean depth of 2.5 m and a maximum depth of about 4.5 m

The industrial development at the surroundings started around 1850...



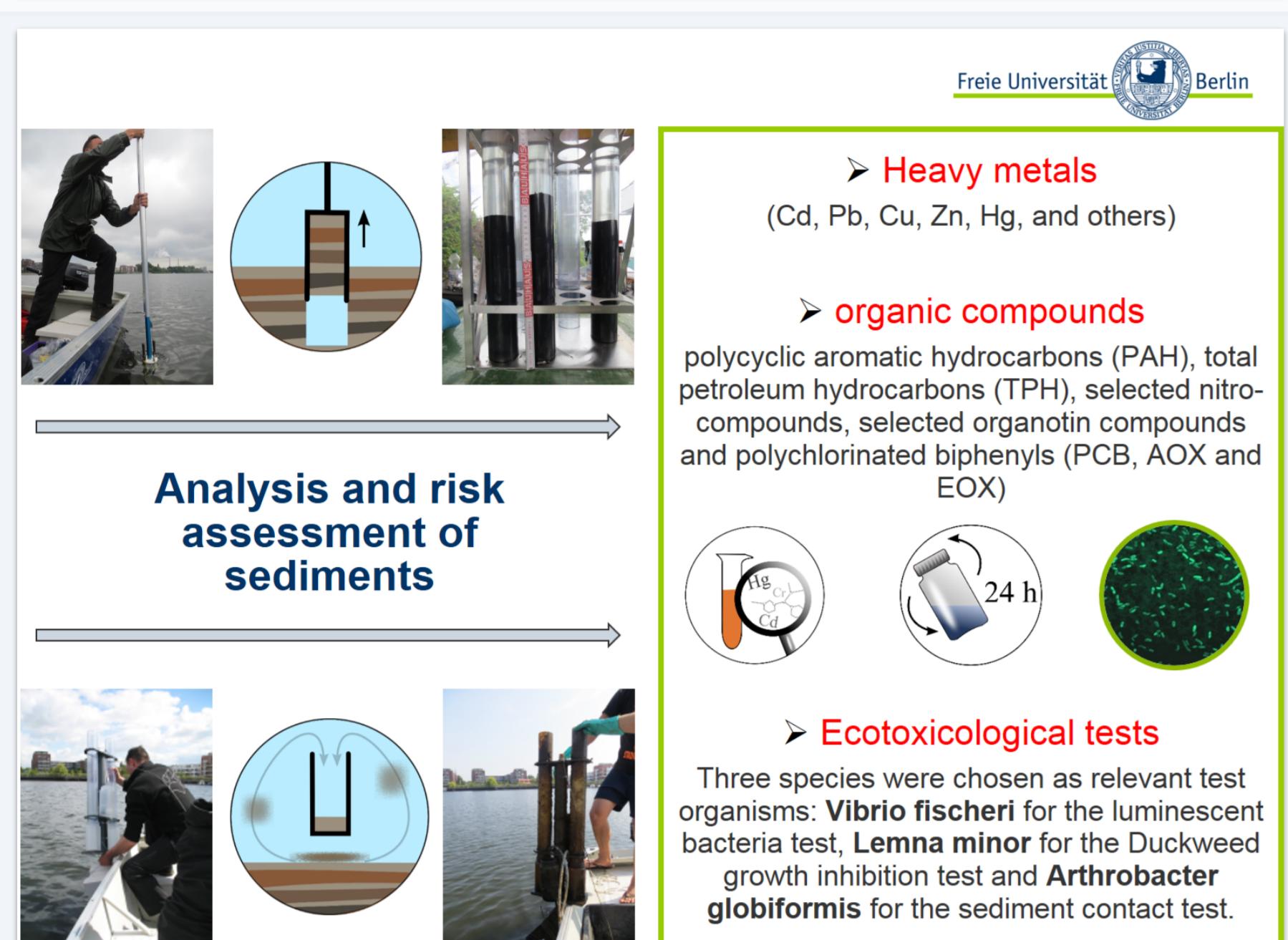
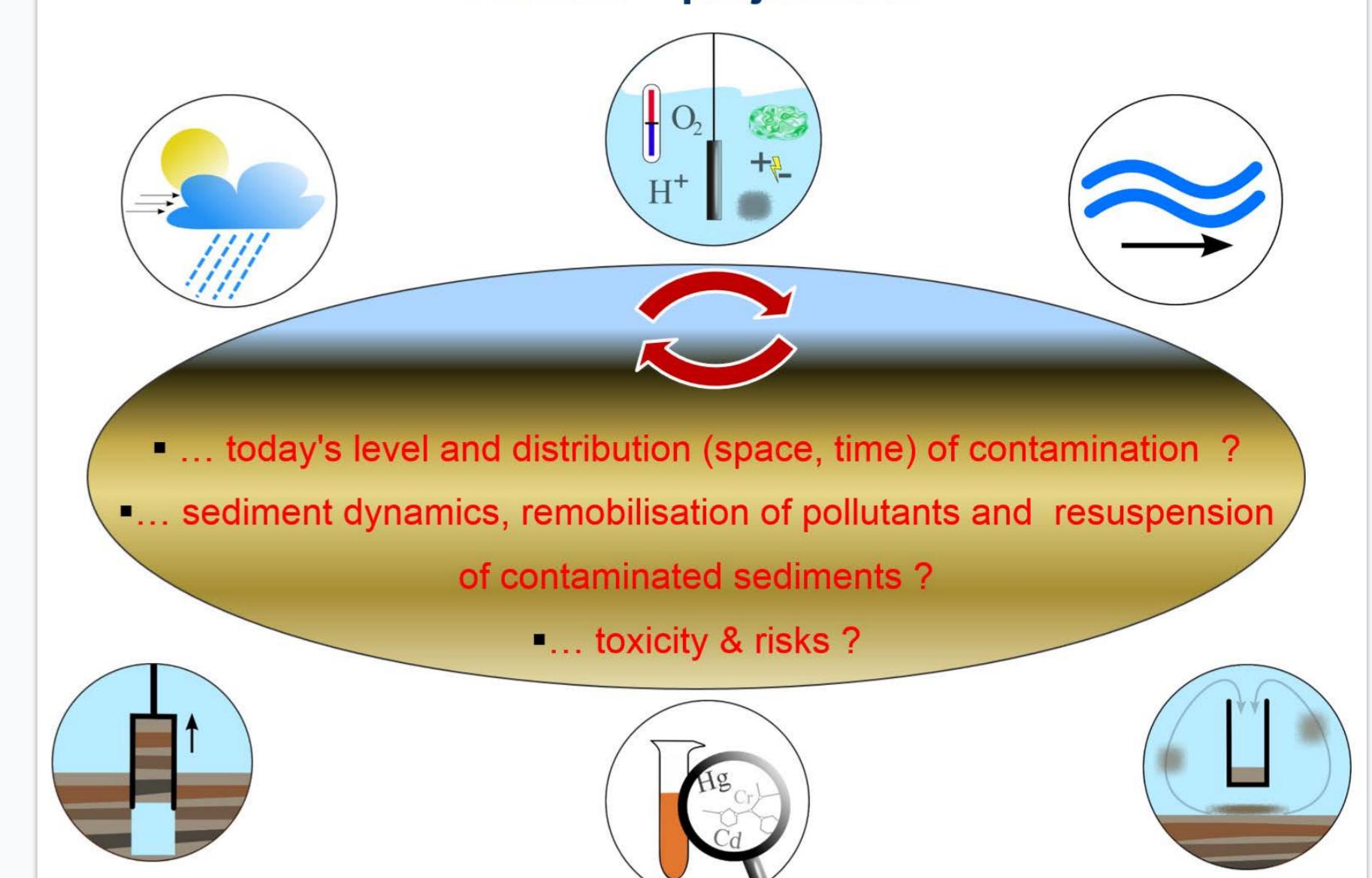
(e.g. glassworks, brewery, lead factory,.....)



For almost a century, untreated industrial and municipal wastewater was piped into the water body.

...as a consequence both the quality of water and sediment have been decreased dramatically over the last 150 years.

RUBUS - project aim



## Analysis and risk assessment of sediments

Heavy metals  
(Cd, Pb, Cu, Zn, Hg, and others)

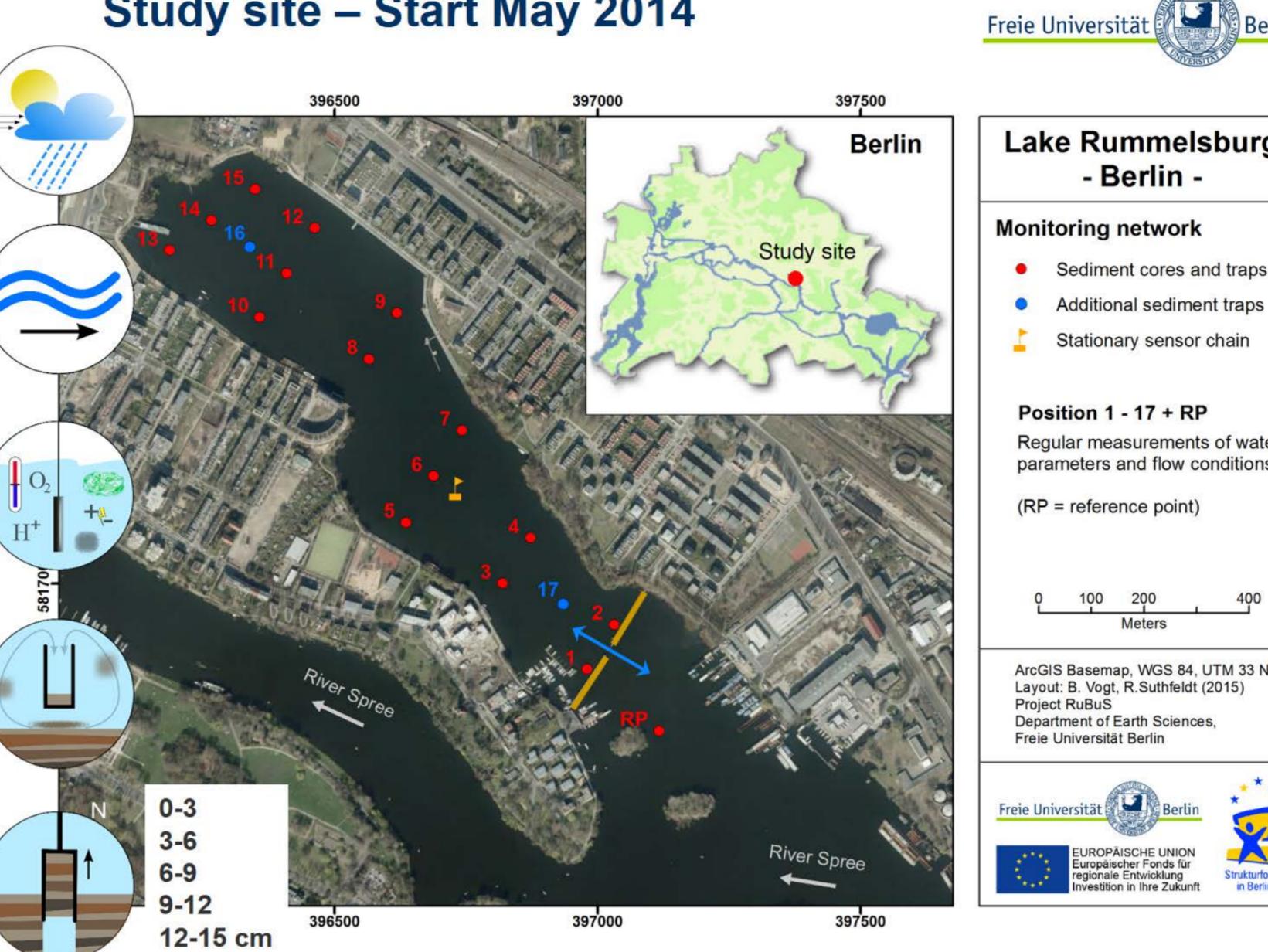
organic compounds

polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), selected nitro-compounds, selected organotin compounds and polychlorinated biphenyls (PCB, AOX and EOX)

Ecotoxicological tests

Three species were chosen as relevant test organisms: *Vibrio fischeri* for the luminescent bacteria test, *Lemna minor* for the Duckweed growth inhibition test and *Arthrobacter globiformis* for the sediment contact test.

Study site – Start May 2014

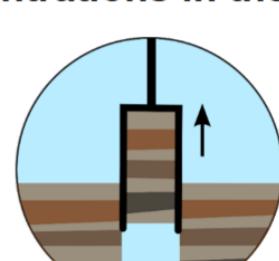


Assessment of Sediment Quality

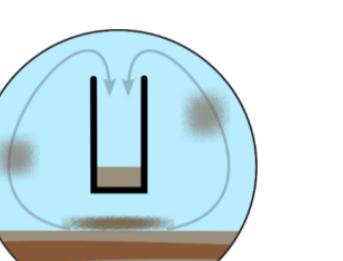


Assessment of concentrations in the samples

a) Solids: Sediment



and suspended particles



→ Sediment Quality Guideline of de Deckere et al. (2011)

empirical and statistical derived sediment quality guideline considering biological effects (physico-chemical properties, concentrations of chemicals, macrobenthic community assemblages and ecotoxicological data)

Above the consensus 2 value only 5% or less of the benthic taxa is able to survive and toxic effects are expected. → potential risk

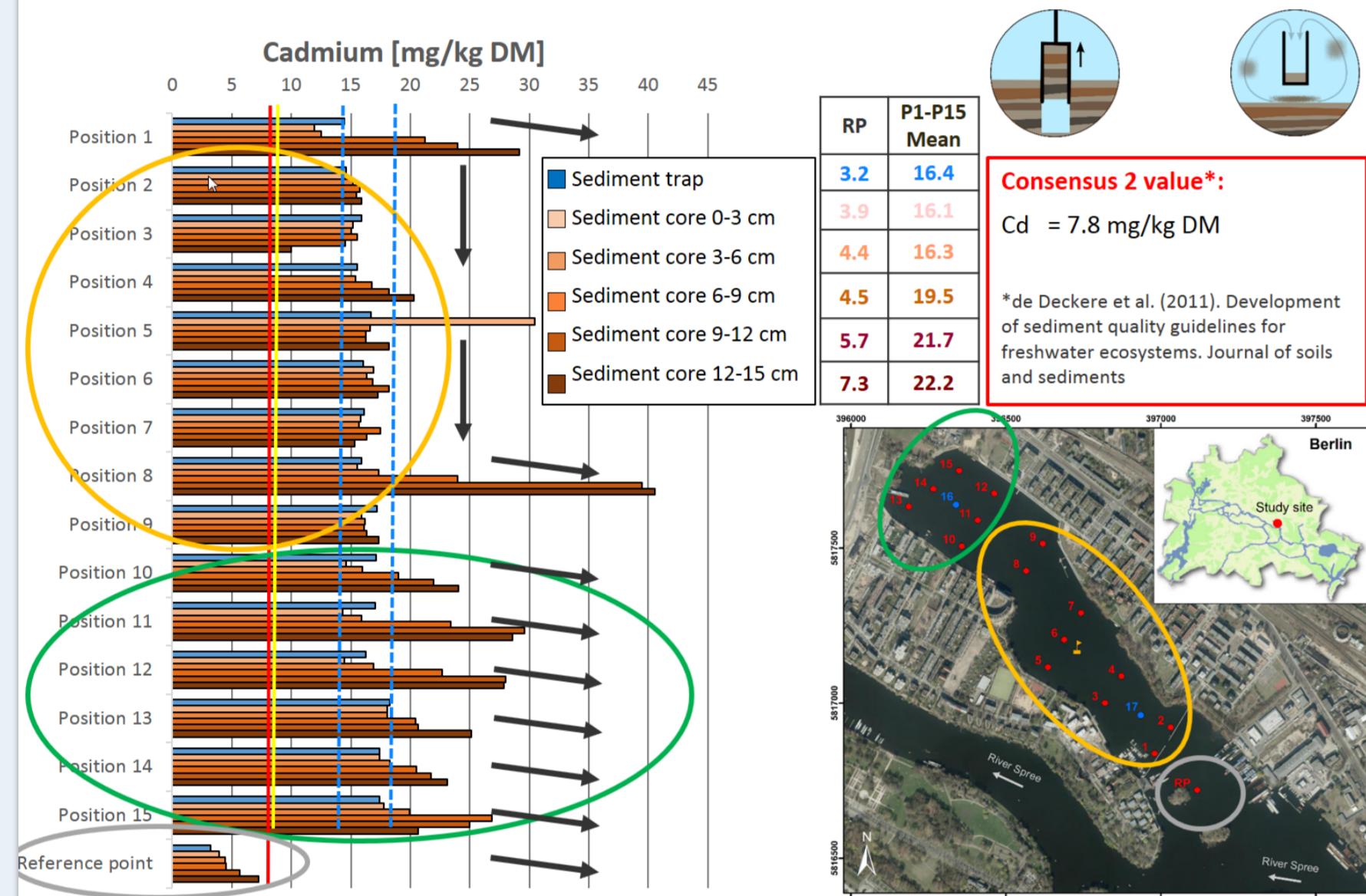
de Deckere, E., De Cooman, W., Leloup, V., Meire, P., Schmitt, C., & Peter, C. (2011). Development of sediment quality guidelines for freshwater ecosystems. *Journal of soils and sediments*, 11(3), 504-517

b) Aqueous phase: substances dissolved in the water (batch-test)

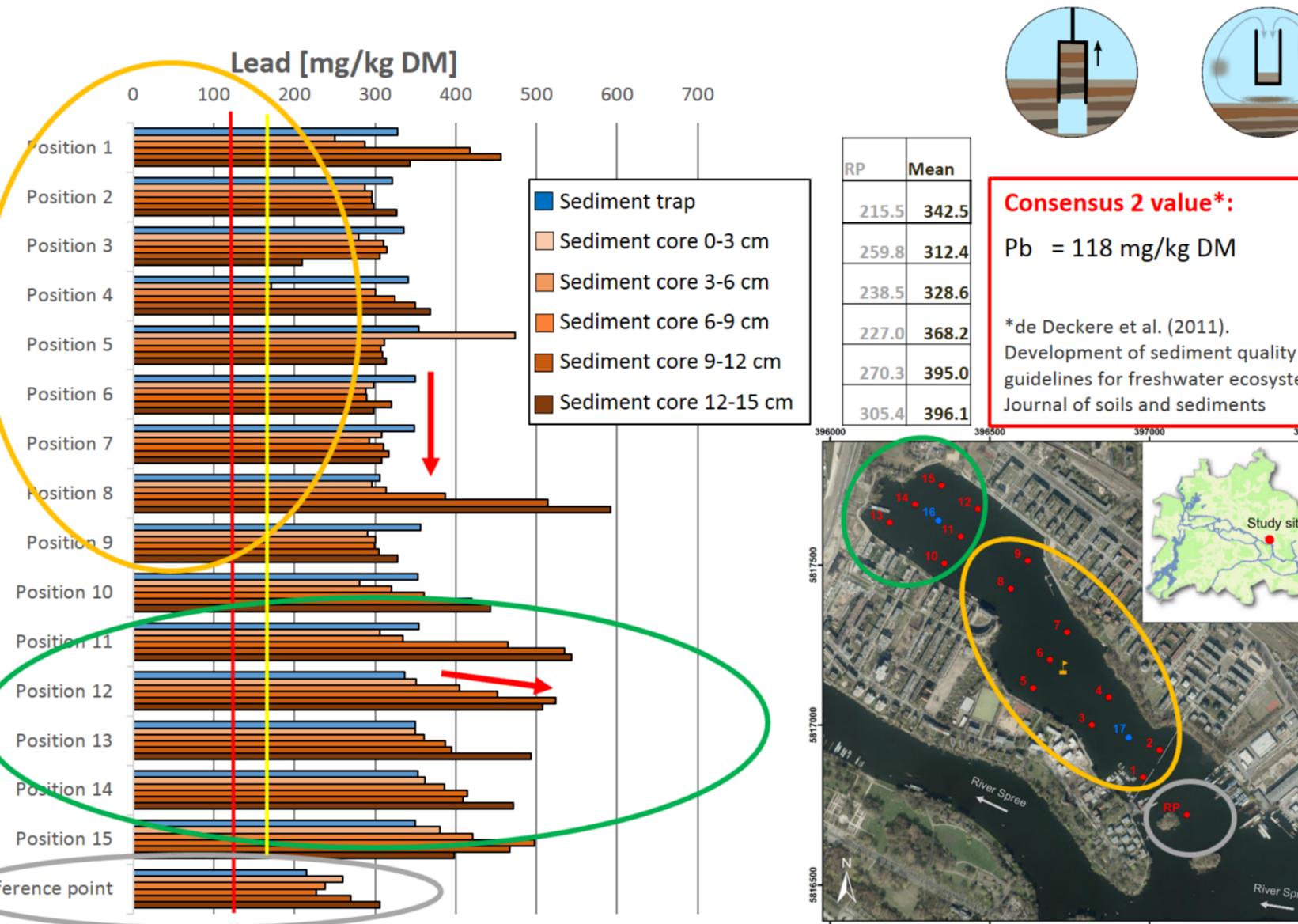
→ European Environmental Quality Standards (EQS)

Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy

## Spatio-temporal pattern of sediment contamination – solids - Cd



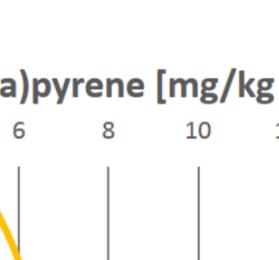
## Spatio-temporal pattern of sediment contamination – solids - Pb



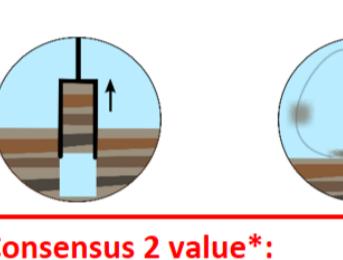
## Spatio-temporal pattern of sediment contamination – solids - BAP



→ Consensus 2 value\*:



Benz(a)pyrene = 0.6 mg/kg DM  
\*de Deckere et al. (2011). Development of sediment quality guidelines for freshwater ecosystems. *Journal of soils and sediments*



## Spatial distribution and concentration of selected organic compounds at the upper layer of sediment cores

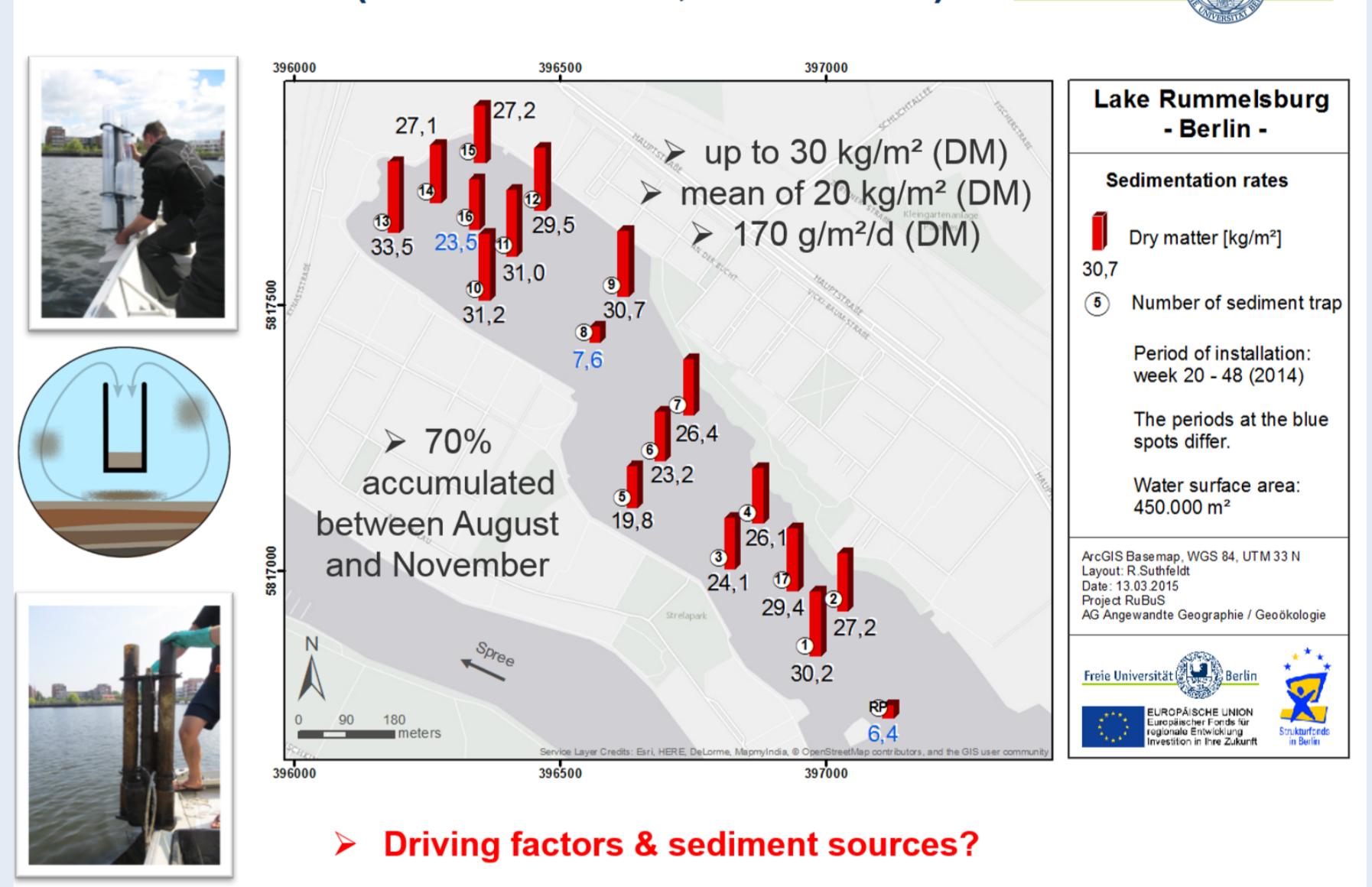


## Risk assessment of selected samples concerning their ecotoxicity

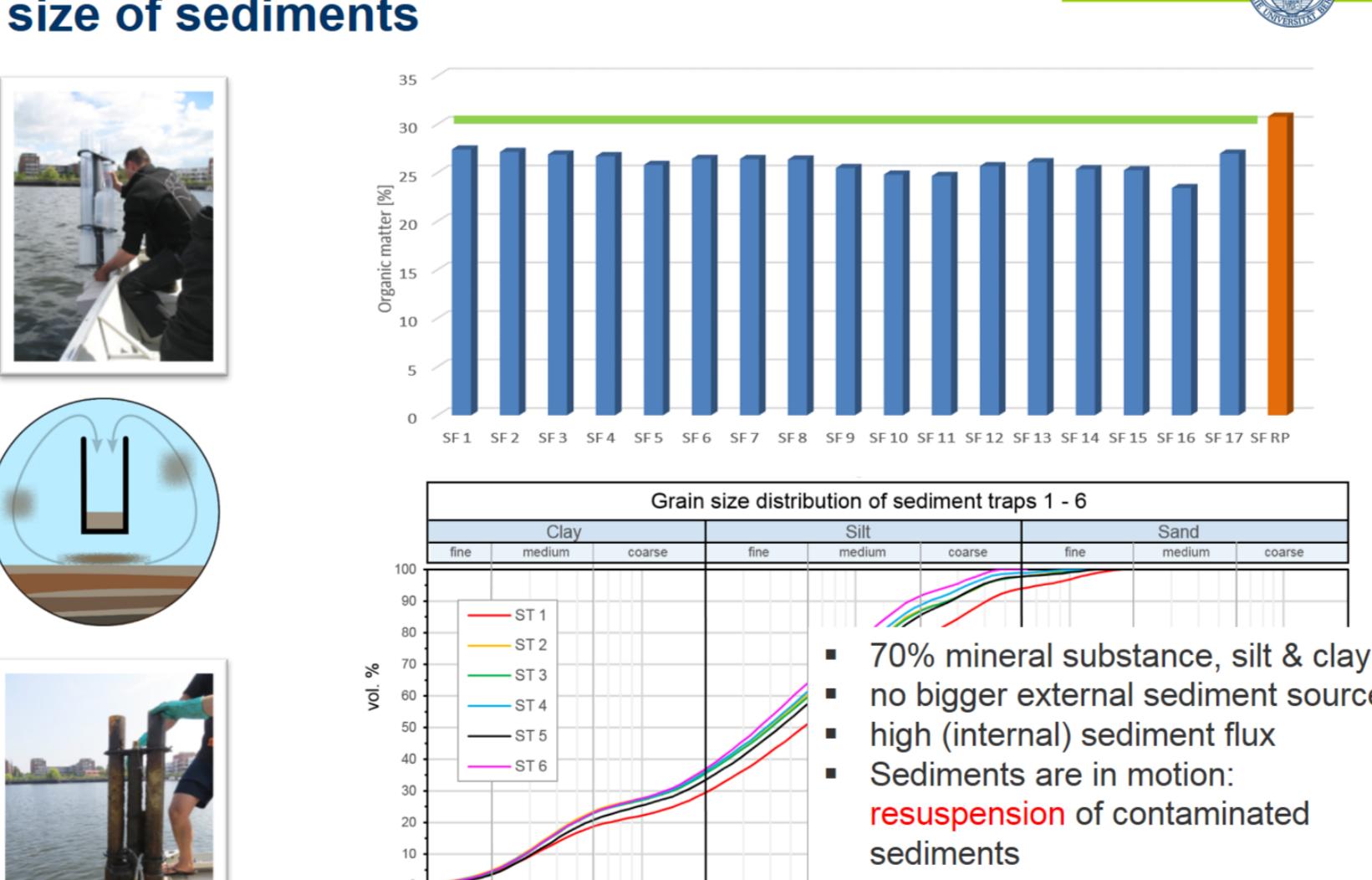


| Sample             | Antrobacter globiformis | Lemna minor | Vibrio fischeri | Results  | Contaminant loads       |  |
|--------------------|-------------------------|-------------|-----------------|----------|-------------------------|--|
|                    | Sample matrix           | pT-value    | Sample matrix   | pT-value | Solid matter - Sediment | Eluate - Sediment  |
| BK sediment core   | Sediment                | 3           | Eluate          | 2        | critically charged      | low  |
| SF sediment trap   | Sediment                | 2           | Eluate          | 0        | harmless                | no results   |
| BK 1.2             | Sediment                | 3           | Eluate          | 2        | critically charged      | Highest load TBT   |
| BK 1.5             | Sediment                | 4           | Eluate          | 2        | critically charged      | no results   |
| BK 6.1             | Sediment                | 0           | Eluate          | 0        | not charged             | Highest load of heavy metals   |
| BK 6.5             | Sediment                | 0           | Eluate          | 0        | not charged             | Highest load of heavy metals   |
| BK 11.5            | Sediment                | 3           | Eluate          | 1        | critically charged      | High PAH, high load of TPH   |
| BK 12.5            | Sediment                | 2           | Eluate          | 1        | harmless                | High load of heavy metals  |
| BK 14.5            | Sediment                | 1           | Eluate          | 2        | harmless                | Medium load  |
| BK RP-1            | Sediment                | 0           | Eluate          | 0        | not charged             | Reference sample, almost no organic compounds, low level of heavy metals (lower compared to the survey area) |
| SF 2 sediment trap | Sediment                | 0           | Eluate          | 0        | critically charged      | Highest load TPT of sediment traps   |
| SF 9 sediment trap | Sediment                | 3           | Eluate          | 1        | critically charged      | Highest load TPH of sediment traps   |

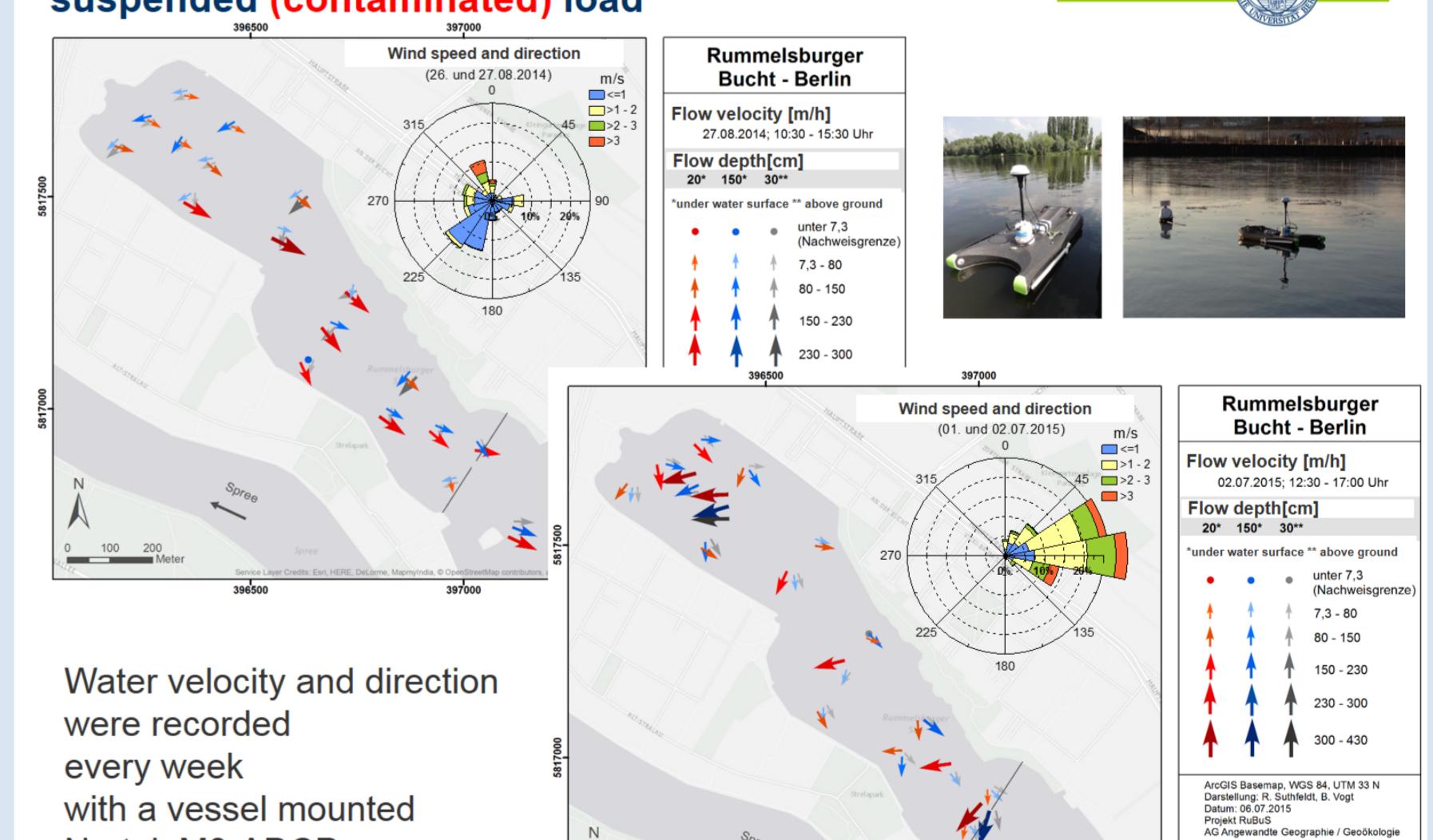
## Sedimentation (over 28 weeks, 05-11.2014)



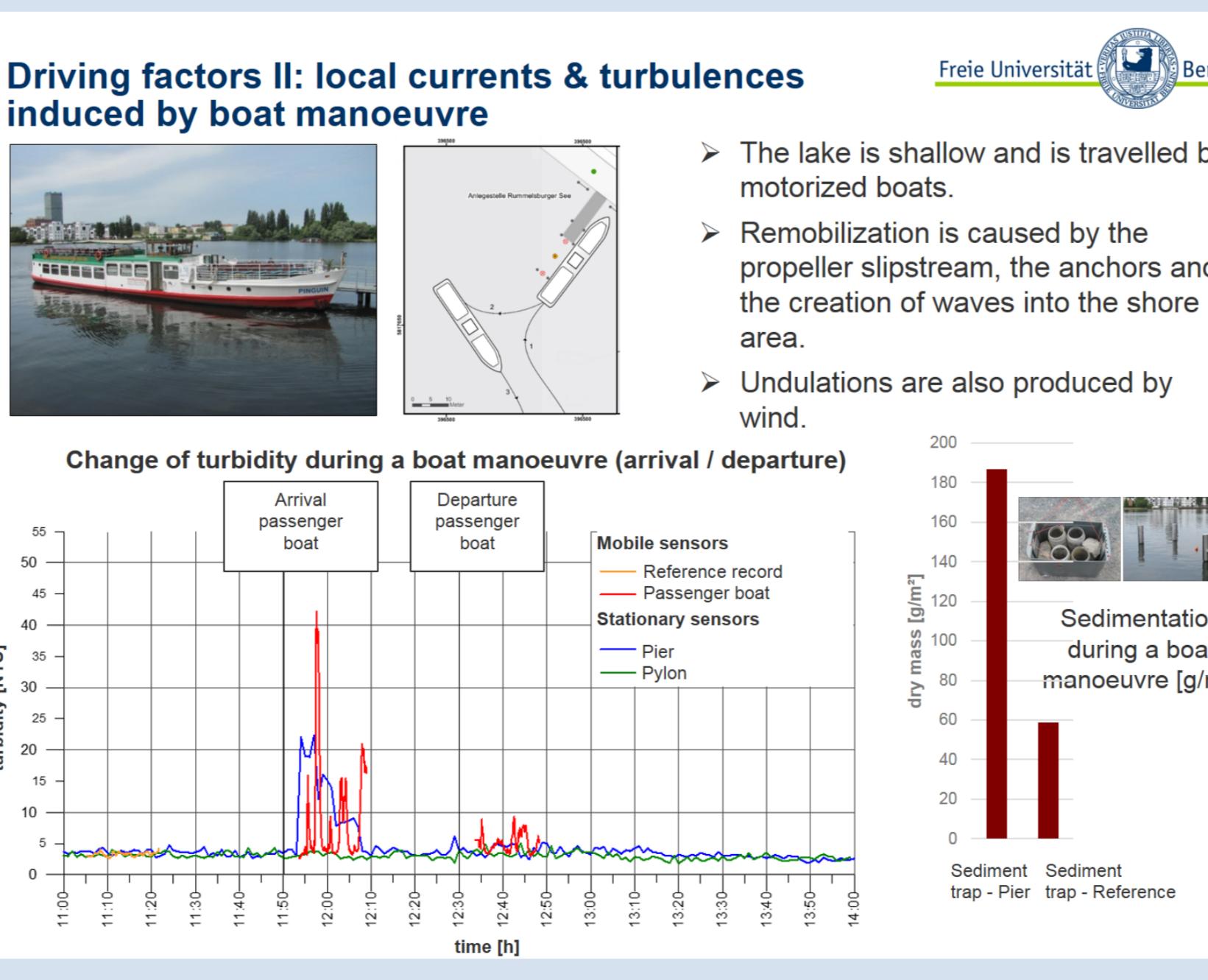
## Sediment traps: organic matter and grain size of sediments



## Wind direction, flow pattern & transport of suspended (contaminated) load



## Driving factors I: local currents & turbulences induced by wind & stormwater inflow



## Summary



### Sediment and suspended particles

High concentration of organic and inorganic pollutants in the sediments → Consensus 2 values are all exceeded (toxic effects can be expected for solid and suspended sediments)

### Spatial distribution in the lake

Sediments: an area with a significant lower (southeast) and another with higher load (northwest) can be defined

Deposited material in the traps: homogeneous distribution

### Eluates after 24h batch test

Heavy metals: 99% lower than EQS or drinking water quality PAH: Benz(a)pyrene always lower than EQS, but other PAH compounds exceed the EQS, almost all traps and cores are contaminated

### Ecotoxicological tests - Luminescent bacteria test

Eluates of suspended particles: all samples but 2 are critical polluted → moderate or increased toxic effect

### Sediment dynamics

Sediments are in motion: resuspension of contaminated sediments, high (internal) flux

Different driving factors: wind-induced waves and turbulences, storm water currents, boat traffic.

The "old" industrial fingerprints are still visible and mobile. They represent a high potential risk for the environment, at least under changing boundary conditions (e.g. pH-value).