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Development of an experimental method for the assessment of contaminated natural sediment

Catrina Cofalla, Stefanie Lorke, Holger Schüttrumpf

Institute of Hydraulic Engineering and Water Resources Management (IWW),
RWTH Aachen University, Mies-van-der-Rohe-Str. 1, 52056 Aachen, Germany

Sebastian Hudjetz, Markus Brinkmann, Henner Hollert

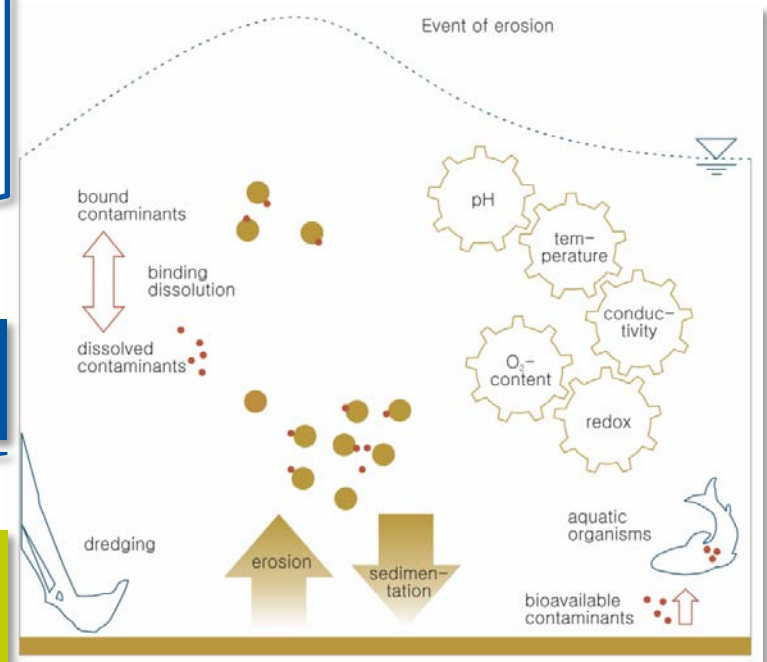
Institute of Environmental Research (IER), RWTH Aachen University,
Worringerweg 1, 52056 Aachen, Germany

Motivation

- Deposits of contaminated sediment in water systems
- Erosion due to floods events or dredging operation
- Influence of environmental parameters
- Effects for aquatic organisms

Interdisciplinary research question

Individual environmental risk assessment considering multiple stressors



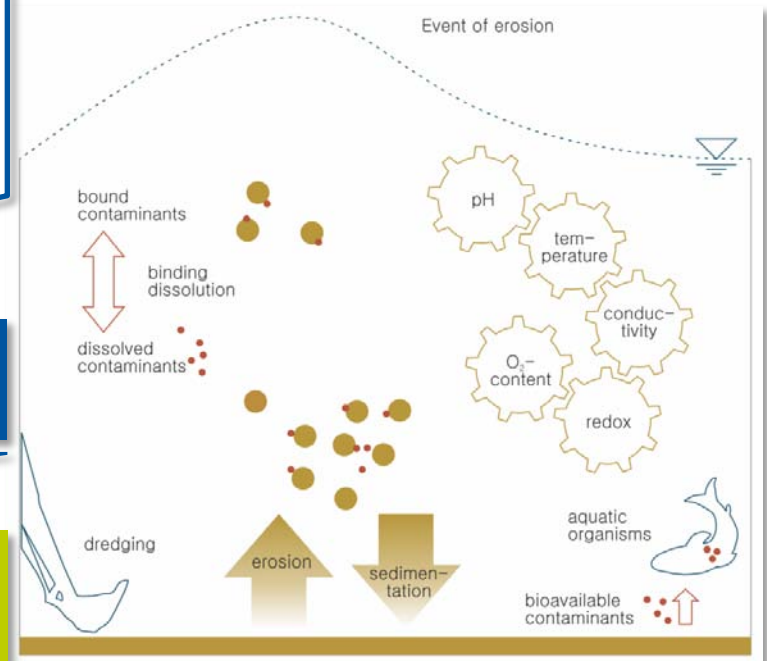
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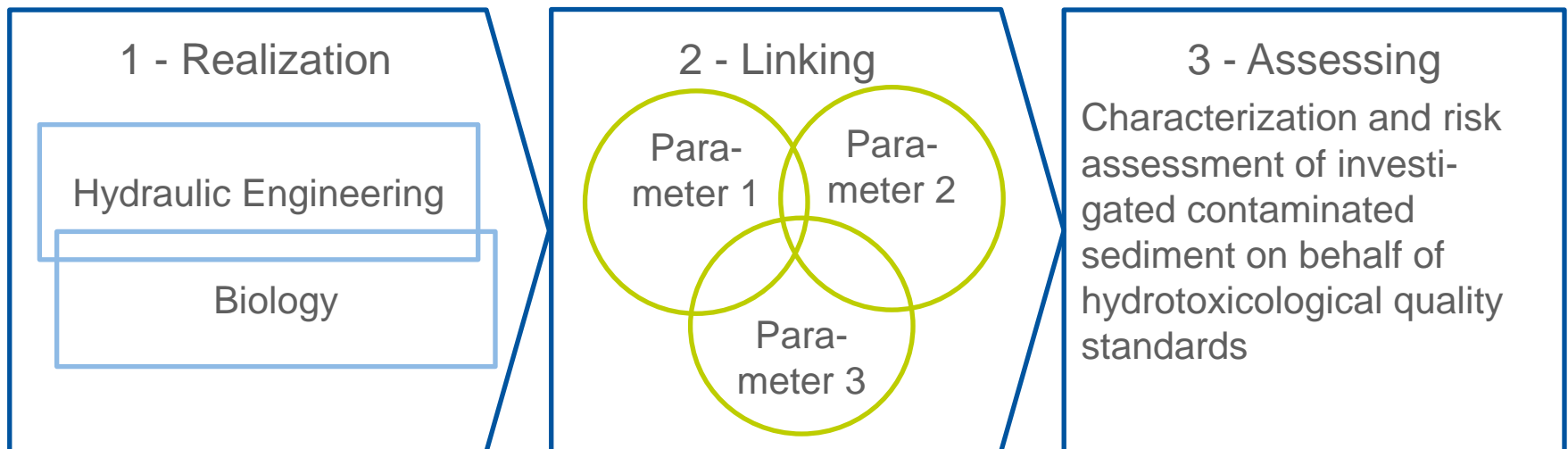
Interdisciplinary research question

Individual environmental risk assessment considering multiple stressors

No integrated and sustainable methods available!



- foster the knowledge base of **contaminated cohesive sediment transport** in combination with a real-time **exposure of fish** in order to assess the ecotoxicological impact
- Improve **interdisciplinary understanding** of processes and interactions
- Experimental method



- Selected parameters are assigned to **five groups of parameters**
- Using **natural components** → investigating natural variations and complexity

Sediment:

- Rhine
- Moselle

Contaminants:

- copper
- polycyclic aromatic hydrocarbons (PAH)

Environmental conditions:

- temperature
- oxygen content
- pH value
- redox potential

Hydrodynamics:

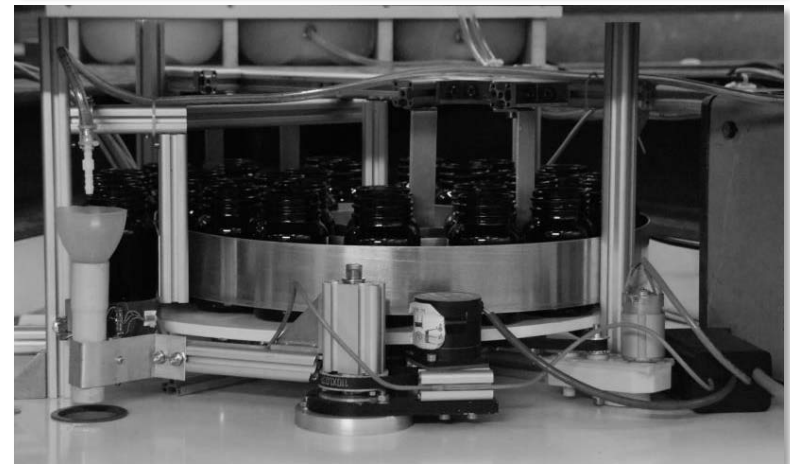
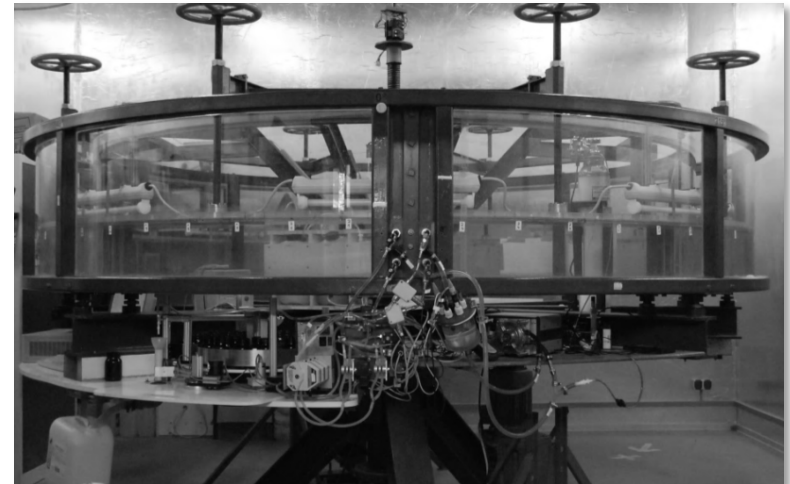
- optimised flow
- progress of bed shear stress
- distribution bed shear stress

Organisms:

- rainbow trout
- biomarker

Realization in the test facility

- Annular flume
 - Generate an endless and stationary current
 - Experimental characterization of cohesive sediment behavior
- Climate chamber
 - Maintain constant and stable environmental conditions throughout all experiments
 - Monitored with adequate instrumentation



Sediment type

- Type 1

System: River Rhine

Dredging location: Koblenz-Ehrenbreitstein

Moderately polluted

- Type 2

System: River Moselle

Dredging location: barrage Palzem, Stadtbredimus (L)

Polluted with organic contaminants (mostly PAHs)



Contaminants

- Artificial contamination
 - Spiking with copper
 - Used sediment: Type 1
- Natural contamination
 - Polycyclic aromatic hydrocarbons (PAH)
 - Used sediment: Type 2
 - (results not shown)



Organisms

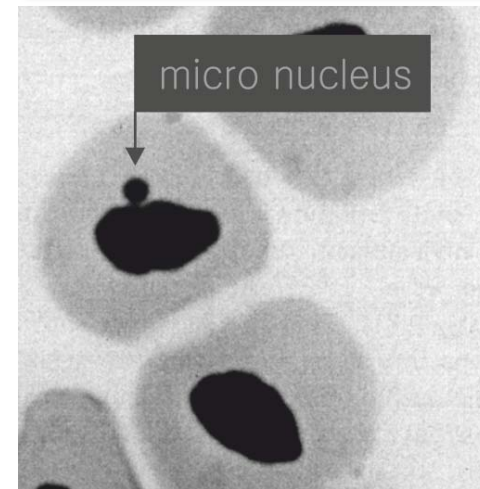
- Rainbow trout
- Exposure in the annular flume
- Evaluation of biomarkers after exposure

Biomarkers

- Biomarker of exposure
 - e.g. EROD activity
 - PAH metabolites
- Biomarker of effect
 - e.g. Induction of micro nucleus

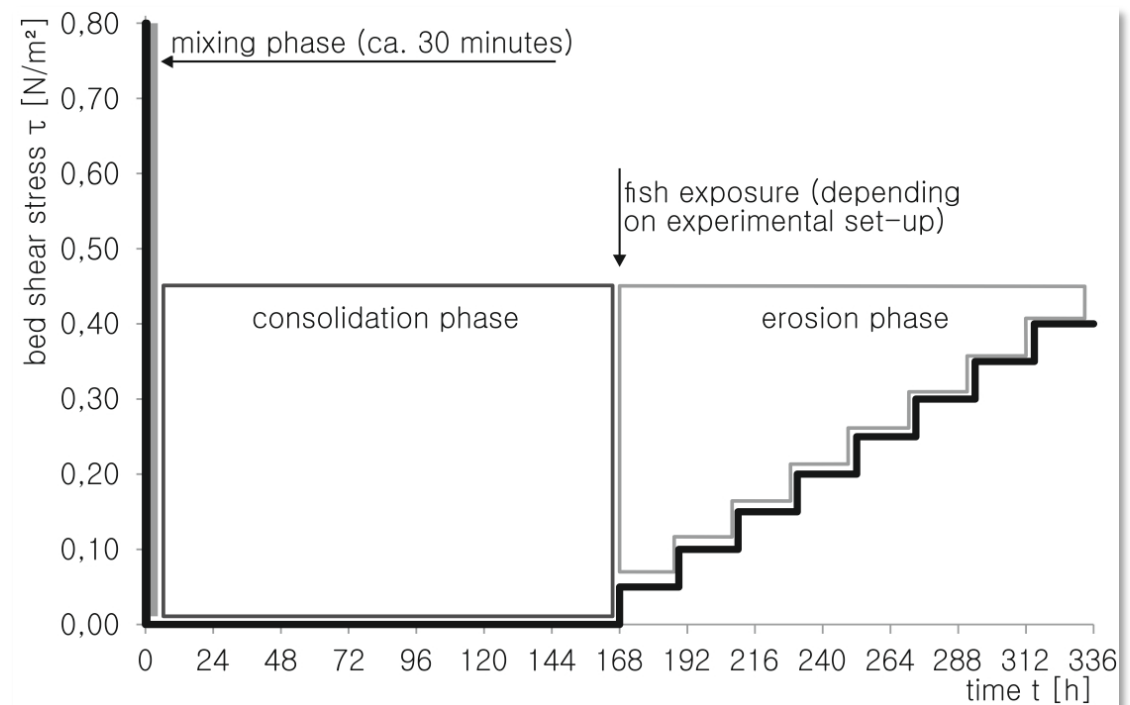
Stressors

- current, sediment and contamination



Hydrodynamics

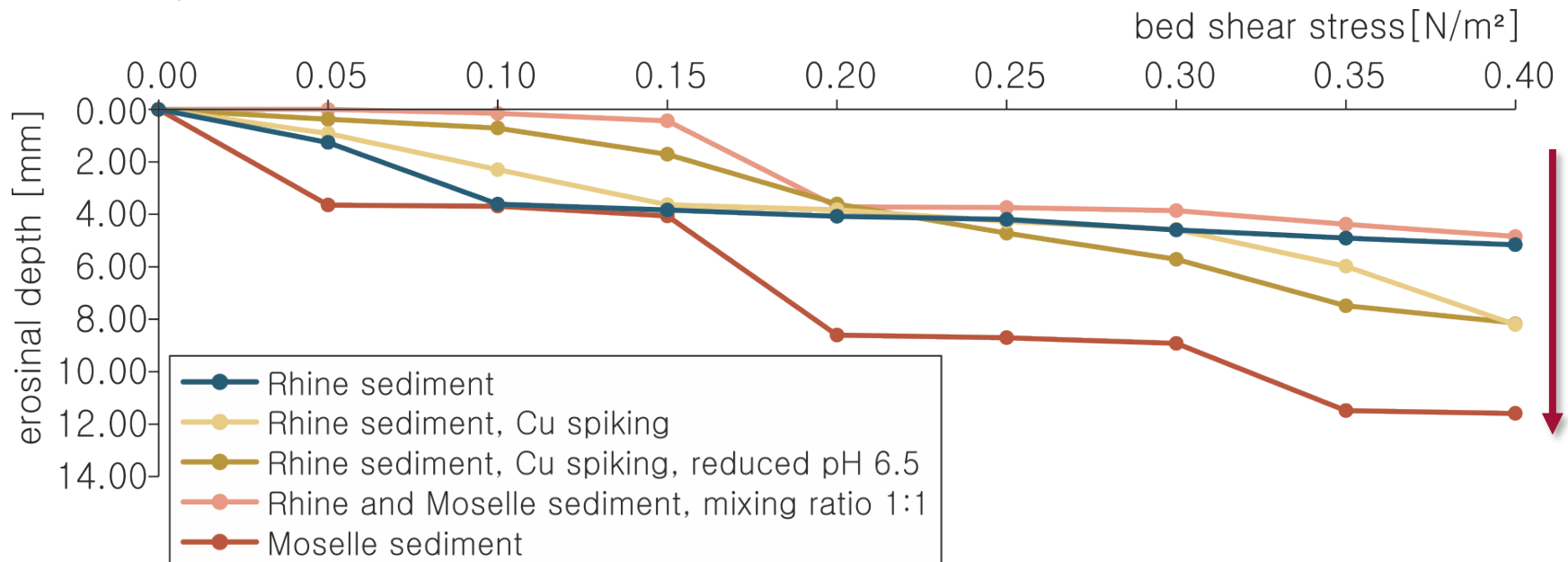
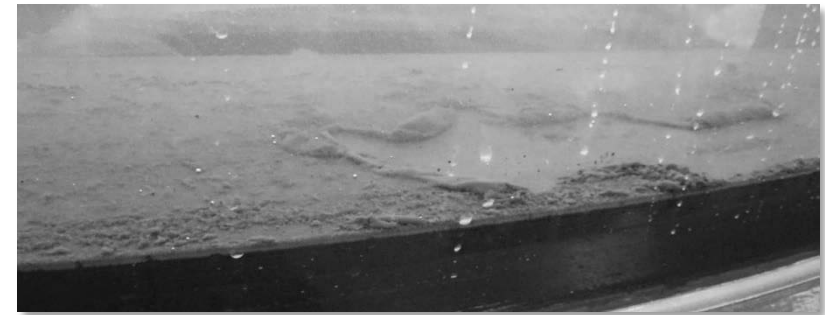
- Variation of flow velocity
- Active stress: bed shear stress [N/m^2]
- Stress variation: classic approach introduced by Mehta & Partheniades (1982)



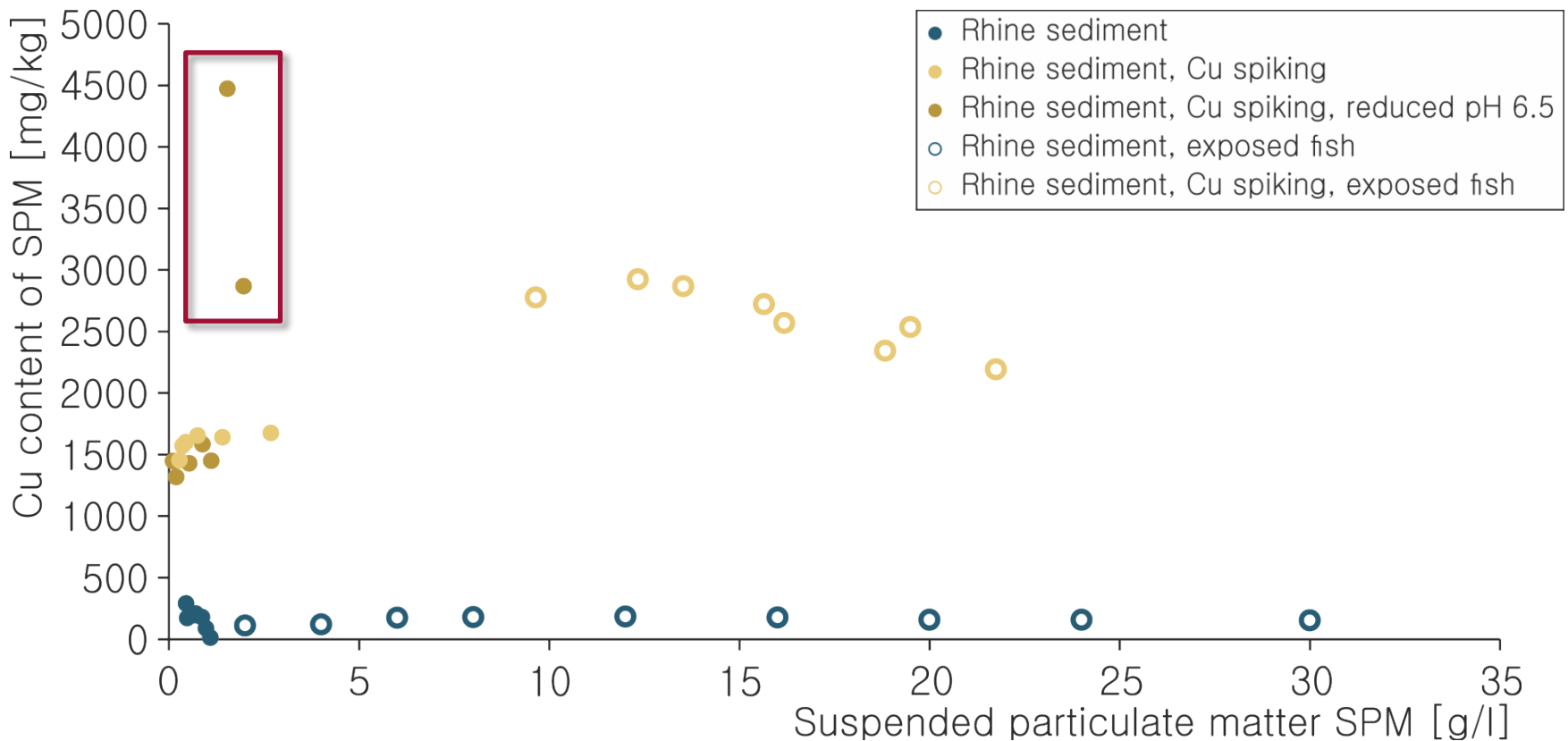
Characterization of natural sediment

- Copper spiking reduced erosional resistance

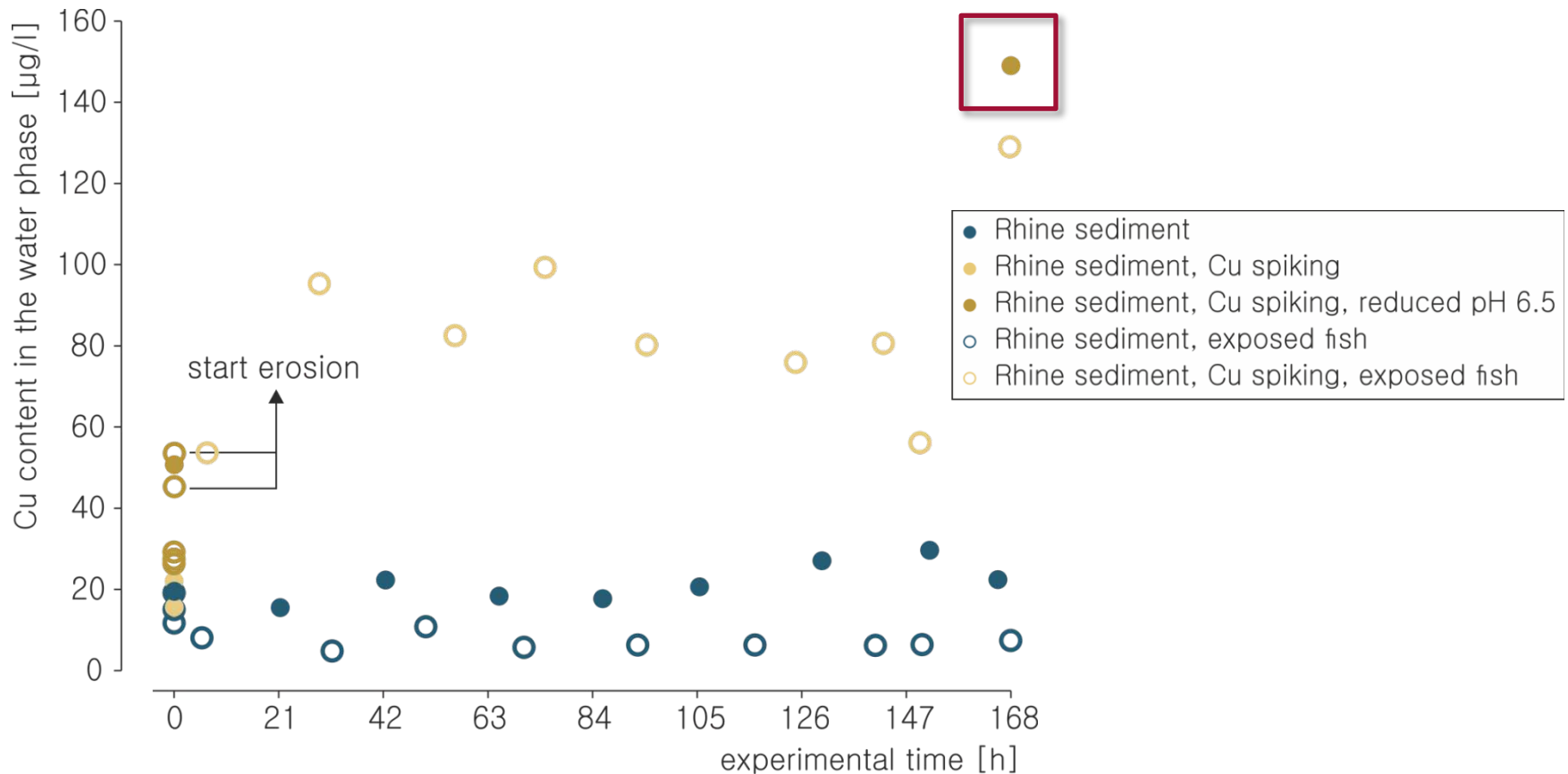
Assumption: more erosion leads to more Cu in SPM and water resulting in more uptake by fish



- As expected: spiked sediment showed higher Cu content
- Reduced pH value resulted in an increasing Cu concentrations in SPM (red box)

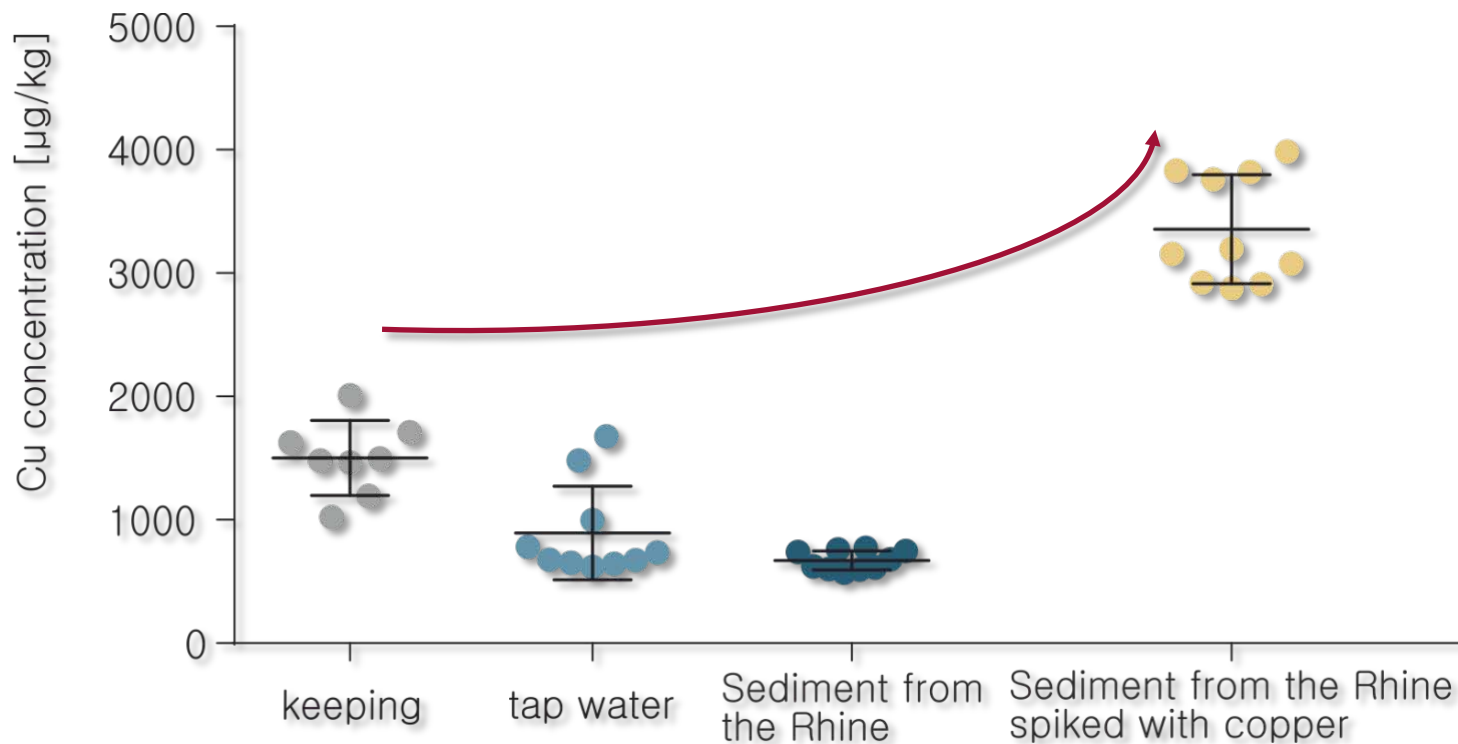


- Also Cu content in water increases
- The pH-reductions leads to an increasing release of Cu

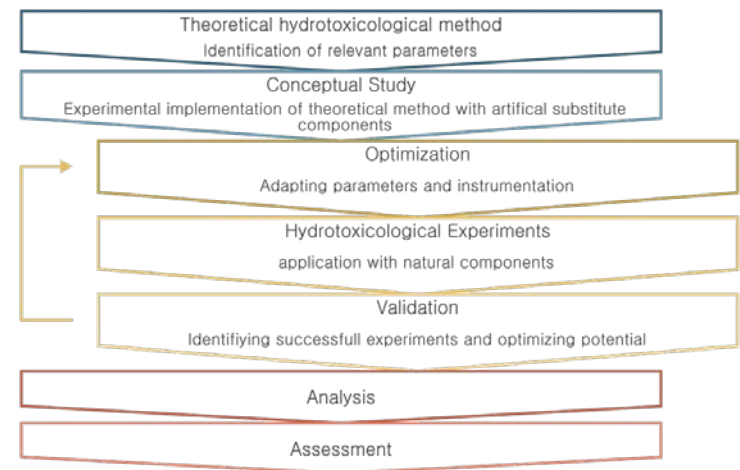


Experiments, results and discussion

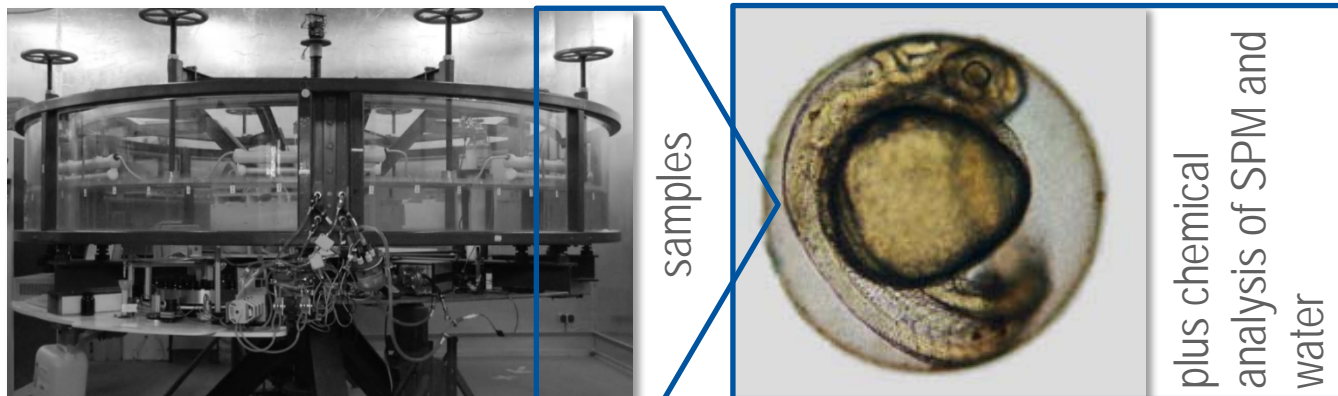
- Copper content of gill samples of rainbow trout
- Sediment origin: Rhine
- Exposure time: 7 days



- **Theoretical** set-up of the hydrotoxicological method
 - Identification of relevant parameters
 - Combining hydraulic engineering and ecotoxicology
- **Conceptual Study**
 - **Optimization** of instrumentation and chosen parameters
- Performance of **hydrotoxicological experiments** using natural components
- **Validation** by identifying successful experiments
- **Analysis** and **assessment**
- **Adaption** of the method to different sites



- Objective: Assessment of water supply systems
 - Identification of contaminants, crucial inlet point and sudden events
- Example: Reservoirs for drinking water in the region Eifel
 - Increasing sedimentation demands sediment management
- Adaption of the hydrotoxicological method
 - Using OECD 236 – Fish embryo acute toxicity (FET) test with zebrafish (*danio rerio*)



Thanks for your attention
Any questions?

Catrina Cofalla
Institute of Hydraulic Engineering and Water Resources Management
RWTH Aachen University
Mies-van-der-Rohe-Str. 1
52056 Aachen, Germany
Phone: +49 241 80-97778
Email: cofalla@iww.rwth-aachen.de