Modeling Contaminated Sediment in the Elbe River Basin: Integrating Field Data & Observations

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**WFD and the Elbe River Basin**

- **Water Framework Directive**
  - EU Water bodies: Good chemical & ecological status by 2015
  - Some sections of the Elbe will likely fail WFD goals

- **Elbe Basin Sediments**
  - Areas of low sediment quality due to historical contamination.
  - Effect management measures (fishing, dredging)

- **Elbe Sediment Modeling**: Hydrodynamics, suspended sediment, and particle-bound contaminants
  - Describe erosion and deposition along and between groyne fields
  - Estimate transport of particle-bound contaminants – particularly from tributaries
Substances of Concern in the Elbe River Basin

Cd, Hg, Cu, Zn, Pb
As, Dioxin, HCH
HCH, HCB, PCB, DDX, TBT
Groyne Fields: Alter the Elbe’s Hydraulics

- **History:** Built in 17th century for flood prevention, land acquisition & customs collection

- **Today:** Improve navigability in low water
  - KM 0-~125: No groynes
  - KM >~125: 6900 groynes (92% of banks)

- **Assumptions:**
  - Groynes trap fine sediment
  - High water: mobilize fines & sorbed contaminants

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Role of Groyne Fields in Sediment Transport?

- **Field**: Very little fine sediment in groyne fields (upstream of Magdeburg)
- **Modeling**: Groynes fill quickly with fine sediments

**Data:**
- Field Summer 2010: Toxicity & Chemistry data
  - Wittenberg (km 214) – Magdeburg (km 327)
- Ongoing: Suspended sediment loads
Sediment Sampling: Targeting Sinks/Sources

- Sources/Sinks
  - Tributaries (Saale, Mulde)
  - Side-structures

- Sampling Program (n=25)
  - Sediment Chemistry
  - Toxicity:

<table>
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<th>V. fischeri</th>
<th>A. globiformis</th>
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<td>Bioluminescent Bacteria</td>
<td>(Soil Bacteria)</td>
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<tr>
<td>Reduced Luminescence: Evidence of Contamination</td>
<td>Reduced Respiration: Evidence of Contamination</td>
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<tr>
<td>30-Min Elutriate Test</td>
<td>2-Hour Contact Test</td>
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Sediment Toxicity: Groynes & Small Harbors

Reduction in Bioluminescence (Ctrl Adj.)

Station

57/58 63 67/68 70 oben 71 unten 72 77 78/79 oben 80 unten 81 83 85 87 89 91 92 93 97 98 99 101 102

A. globiformis

V. fischeri

Toxicity

Elevated
Moderate
Low
PCA Results: V. Fischeri & Organics
Substances of Concern in the Elbe River Basin

- Cd, Hg, Cu, Zn, Pb
- As, Dioxin, HCH
- HCH, HCB, PCB, DDX, TBT
Suspended Sediment Characteristics

Recent Field Data

Magdeburg Suspended Sediment Load (ton/day)

% Mud and Fine Silt (<20um)

Year

2006 2007 2008 2009
Groynes Likely a Secondary Source

Negative Values: Loads Decrease Downstream
Positive Values: Loads Increase Downstream
Different Sources, Different Processes

Load Difference Schnackenburg-Magdeburg (kg/year)

- **β-HCH**
- **g-HCH**
- **p,p'-DDD**
- **HCB**
Conclusions

- **Coastal Area:**
  - Schnackenburg close to estuary - different contamination patterns

- **Groynes:**
  - Sediments & sorbed contaminants are likely resuspended during high water events (M’burg-S’burg)
  - Sediments are bioavailable and can be toxic (Wittenberg-Magdeburg)
  - Decreased Fines (2006-2008) likely related to coarsening observed in groynes

- **Information Gaps:**
  - More data needed on sediment grain size/density in groynes To be collected this summer
Thanks for your Attention!

Acknowledgements:
• Michael Bergemann (Behörde für Stadtentwicklung und Umwelt Amt für Umweltschutz Abt.)
Model Elbe hydraulics and suspended sediment - Czech border–Schnackenburg (km 474.6)

Describe erosion and deposition along and between groyne fields

Estimate transport of particle-bound contaminants – particularly from tributaries

Evaluate multiple scenarios (remediation, floods)