THE ELBE CONCEPT

Recommendations for a good sediment management practice in the Elbe

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01 The Concept

- The Elbe – an international river
- View on the system and methodological approach
- Aspect Quality – Managing contaminated sediments

02 Working with the Concept

- Progress
- Practice
- Challenges & needs
The Elbe – an international river

- **Length**: 1,091 km
- **Area**: 148,268 km²
- **MQ North Sea**: 877 m³
- **Population**: 25 Mio people (D, CZ)
- **Industry/Mining**: over centuries
- **Agriculture**: 56% of the catchment

Integrated sediment management concept (2014)

1st Elbe management plan (2010-15)
Deficient hydromorphological conditions and contamination as supra-regional issues
Unbalanced sediment conditions and contaminated sediments among main reasons


The Sediment Management Concept of the ICPER - Recommendations for a good sediment management practice in the Elbe

⇒ IKSE / MKOL, Magdeburg, 2014 (DE/CZ)

⇒ Heininger et al. in Heininger & Cullmann (Eds.) “Sediment matters”, Springer, 2015

Many works 1990 – 2008: a solid foundation!
Integrated Concept for the whole River Basin

- Considers management goals – management planning – planning of measures – implementation of measures
- Risk-based, i.e. conclusions rely on the analyses of risks from insufficient status of the sediment budget, ecological functions, ecosystem services / uses depending on sediments
- Considers and integrates the spatial interdependencies of the catchment (upstream – downstream, main river - tributaries, river – sea, river – floodplain …)
- Considers sediment in terms of quantity, quality, and hydro-morphology and their interaction
- Integrates environmental and use-oriented aspects (example: navigation!)
- Takes a participative approach within institutional framework set by the WFD
The components for analyzing the Elbe system in terms of sediment management are:

- The impounded inland reach (CZ)
- The free-flowing inland reach (CZ /DE)
- The tidal reach (DE)
- Reference monitoring sites
- Relevant tributaries
Conceptual set up – Overview

Recommendations for Consideration in River Basin Management Planning Prioritization including cross checking

Risk analysis
- Quality deficits
- Navigation handicaps
- Hydromorphological deficits

Status evaluation
- Quality status
- Quantity status
- Hydromorphology status

Indicator definition
- 29 Elbe relevant hazardous substances
- Flow rate
- Sediment continuity
- Suspended sediment load
- Sediment balance / Impact on Morphology
- Suspended sediment concentration
- River bed grain size distribution
- Depth and width variation
- Bed load
- Bank structure / Bank stability
- Ration recent / morphological rip. zone

Goal definition
- Guarantee the good ecological and chemical status of the ecosystem, its functions and services to the society:
  - Healthy aquatic ecosystem
  - Value of life and human health
  - Agricultural use of floodplains
  - Navigable waterways

source: ICPER 2013; Heininger et al. 2015
Conceptual set up – Overview

Recommendations for River Basin Management Planning
Prioritization including cross checking

Risk analysis

- Quality deficits

Status evaluation

- Quality status
- Quantity status
- Hydromorphology status

Indicator definition

- 29 Elbe relevant hazardous substances (Table 1)
- Flow rate
- Suspended sediment load
- Suspended sediment concentration
- Bed load
- 6 hydromorphological indicators (Table 4)

Goal definition

- Guarantee the good ecological and chemical status of the ecosystem, its functions and services to the society:
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  - Navigable waterways

source: ICPER 2013; Heininger et al. 2015
Aspect Quality – Managing contaminated sediments

Relevant issues with regard to sediment quality

• Good chemical and ecological status / integrity of the aquatic community
• Protection of floodplain soils against pollution
• Protection of humans against contaminant uptake.

Identification of indicators

Step 1 – potentially relevant contaminants
• Review of all Czech, German and international (e.g. OSPAR) regulations (laws, ordinances, guidelines) for their chemical risk requirements
• Resulting pool of chemicals which are persistent, bio-accumulative, adsorptive

Step 2 – Elbe-relevant contaminants
• Those contaminants from Step 1 which occur in the Elbe basin (data 2003 – 2008; reference monitoring sites; minimum one year (mean); at least one Elbe site or one site of Category 1 tributary)
### 29 Elbe-relevant contaminants & classification scheme

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Measure-</th>
<th>Lower</th>
<th>Source</th>
<th>Upper</th>
<th>Source</th>
</tr>
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<tbody>
<tr>
<td>Mercury</td>
<td>mg/kg</td>
<td>0,15</td>
<td>OSPAR</td>
<td>0,47</td>
<td>23/2011 Sb.</td>
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<tr>
<td>Cadmium</td>
<td>mg/kg</td>
<td>0,22</td>
<td>EU standard fish</td>
<td>2,3</td>
<td>23/2011 Sb.</td>
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<tr>
<td>Zinc</td>
<td>mg/kg</td>
<td>200</td>
<td>BBodSchV</td>
<td>800</td>
<td>OGeWV 2011</td>
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<tr>
<td>Copper</td>
<td>mg/kg</td>
<td>14</td>
<td>de Deckere et al. 2011</td>
<td>160</td>
<td>OGeWV 2011</td>
</tr>
<tr>
<td>Nickel</td>
<td>mg/kg</td>
<td>3</td>
<td>23/2011 Sb.</td>
<td>53*</td>
<td>HGW nach Prange et al. 1997</td>
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<tr>
<td>Arsenic</td>
<td>mg/kg</td>
<td>7,9</td>
<td>de Deckere et al. 2011</td>
<td>40</td>
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<tr>
<td>Chrome</td>
<td>mg/kg</td>
<td>26</td>
<td>de Deckere et al. 2011</td>
<td>640</td>
<td>OGeWV 2011</td>
</tr>
<tr>
<td>α-HCH</td>
<td>μg/kg</td>
<td>0,5</td>
<td>GÜBAK</td>
<td>1,5</td>
<td>GÜBAK 2009</td>
</tr>
<tr>
<td>β-HCH</td>
<td>μg/kg</td>
<td>5</td>
<td>RhmV</td>
<td>5</td>
<td>RhmV 2009</td>
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<tr>
<td>γ-HCH</td>
<td>μg/kg</td>
<td>0,5</td>
<td>GÜBAK</td>
<td>1,5</td>
<td>GÜBAK 2009</td>
</tr>
<tr>
<td>p,p´-DDT</td>
<td>μg/kg</td>
<td>1</td>
<td>GÜBAK</td>
<td>3</td>
<td>GÜBAK 2009</td>
</tr>
<tr>
<td>p,p´DDE</td>
<td>μg/kg</td>
<td>0,31</td>
<td>de Deckere et al. 2011</td>
<td>6,8</td>
<td>de Deckere et al. 2011</td>
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<td>p,p´DDD</td>
<td>μg/kg</td>
<td>0,06</td>
<td>de Deckere et al. 2011</td>
<td>3,2</td>
<td>de Deckere et al. 2011</td>
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<tr>
<td>PCB-28</td>
<td>μg/kg</td>
<td>0,04</td>
<td>de Deckere et al. 2011</td>
<td>20</td>
<td>OGeWV 2011</td>
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<tr>
<td>PCB-52</td>
<td>μg/kg</td>
<td>0,1</td>
<td>de Deckere et al. 2011</td>
<td>20</td>
<td>OGeWV 2011</td>
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<tr>
<td>PCB-101</td>
<td>μg/kg</td>
<td>0,54</td>
<td>de Deckere et al. 2011</td>
<td>20</td>
<td>OGeWV 2011</td>
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<tr>
<td>PCB-118</td>
<td>μg/kg</td>
<td>0,43</td>
<td>de Deckere et al. 2011</td>
<td>20</td>
<td>OGeWV 2011</td>
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<tr>
<td>PCB-138</td>
<td>μg/kg</td>
<td>1</td>
<td>de Deckere et al. 2011</td>
<td>20</td>
<td>OGeWV 2011</td>
</tr>
<tr>
<td>PCB-153</td>
<td>μg/kg</td>
<td>1,5</td>
<td>de Deckere et al. 2011</td>
<td>20</td>
<td>OGeWV 2011</td>
</tr>
<tr>
<td>PCB-180</td>
<td>μg/kg</td>
<td>0,44</td>
<td>de Deckere et al. 2011</td>
<td>20</td>
<td>OGeWV 2011</td>
</tr>
<tr>
<td>PeCB</td>
<td>μg/kg</td>
<td>1</td>
<td>GÜBAK</td>
<td>400</td>
<td>23/2011 Sb.</td>
</tr>
<tr>
<td>HCB</td>
<td>μg/kg</td>
<td>0,0004</td>
<td>de Deckere et al. 2011</td>
<td>17</td>
<td>23/2011 Sb.</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>mg/kg</td>
<td>0,01</td>
<td>EU standard fish</td>
<td>0,6</td>
<td>de Deckere et al. 2011</td>
</tr>
<tr>
<td>Anthracene</td>
<td>mg/kg</td>
<td>0,03</td>
<td>de Deckere et al. 2011</td>
<td>0,31</td>
<td>23/2011 Sb.</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>mg/kg</td>
<td>0,18</td>
<td>23/2011 Sb.</td>
<td>0,25*</td>
<td>de Deckere et al. 2011</td>
</tr>
<tr>
<td>Σ 5 PAK</td>
<td>mg/kg</td>
<td>0,6</td>
<td>GÜBAK</td>
<td>2,5</td>
<td>23/2011 Sb.</td>
</tr>
<tr>
<td>TBT</td>
<td>μg/kg</td>
<td>0,02</td>
<td>23/2011 Sb.</td>
<td>20*</td>
<td>GÜBAK 2009</td>
</tr>
<tr>
<td>Dioxins/Furans</td>
<td>ng TEQ/kg</td>
<td>5</td>
<td>2. Bericht der BLAg Dioxine 1993</td>
<td>20</td>
<td>Evers et al. 1996</td>
</tr>
</tbody>
</table>

source: ICPER 2013
System view – Risk analysis of contaminated sediments

Recommendations for river basin management planning

1. Sub-basin scale evaluation

Classification

$C_X > C_2$ ?

%A > 30% and $C_X >> C_1$ ?

no

%L_X > 10% ?

no

no

Plausibility check
Load balance ?
Uncertainties ?

2. Source evaluation

Point sources
Other sources
Sediments / old sediments
Brownfields

Quality
$C_X(\text{Source}) > RV_X$ ?

no

yes

Quantity
$L_X / LP_X (\text{Source}) > 10\% L_X (\text{Reference site})$ ?

no

yes

Mobility
Source mobile ?

no

source: ICPER 2013; Heininger et al. 2015
## Prioritization criteria

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Quality</th>
<th>Hydromorphology</th>
<th>Navigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quantitative significance of a source (load / potential load)</td>
<td>1. Positive influence on one or both key indicators</td>
<td>Inland Elbe: 1. Maintain, optimize, adapt the regulating system (free-flowing reaches) / stabilize the riverbed in the longitudinal section and river constructions (impounded reaches)</td>
<td></td>
</tr>
<tr>
<td>2. Number of relevant contaminants of Group 1 per source</td>
<td>2. Positive influence on further indicator-parameters</td>
<td>2. Relocate or add sediment</td>
<td></td>
</tr>
<tr>
<td>3. Total number of relevant contaminants per source</td>
<td>3. Effect potential for long river reaches</td>
<td>3. Dredge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Orientation at areas of classes 3, 4, and 5</td>
<td>Tidal Elbe: 1. Reduce the contaminant import from upstream</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Establish an adaptive dredged material management</td>
<td></td>
</tr>
</tbody>
</table>

### General criteria
1. Solving a problem at source or elimination of the underlying cause.
2. If the underlying cause (source) does not exist anymore, the problem should be solved possibly near to the source (“Sweeping the stairs from the top down”).
3. The recommendation has positive effect on one or both of the other aspects.
4. A single investment causes lower follow-up costs in the long run.
5. Degree of difficulty/costs of implementation.
6. Safety/uncertainty in the assessment of success, e.g. because of variability of the system.
7. The criterion for exclusion “Absence of appropriate options for solution” is applied only in exceptional cases when the level of knowledge is very well based/substantiated.
System view – Main pollution areas

1. Industry
2. Side structures
3. Major barrages
4. Old mining
5. Old sites

source: map: RBC Elbe; 1,2,3,5: ELSA; 4: J. Kugler
System view – Material flows

source: Heininger et al. 2015
System view – Example priority pollutant Cd

Types of sources
S – Sediment
P – Point source
L – Legacy / abandoned site
U – Urban Area

Source S
Range
Side structures, downstream km 300 (German kilometrage) 1
Groyne fields, downstream km 350 (German kilometrage) 1

Source S
Range
Side structures, Neratovice 4
Side structures, Pardubice 4

Source S
Range
Old mining, Freiberg area 1
Old mining, Freiberg area 1
Upper Mulde 3

Source P
Range
Old mining, Schlüsselstollen 3

Source L
Range
Old sites, Weisse Elster ?

Source S
Range
Side structures, lower Saale 2
4 major barrages, lower Saale 2

System view – Example priority pollutant Cd

River – Sea

Source S
Range
Side structures, downstream km 300 (German kilometrage) 1
Groyne fields, downstream km 350 (German kilometrage) 1

Source S
Range
Side structures, Neratovice 4
Side structures, Pardubice 4

Source S
Range
Old mining, Freiberg area 1
Old mining, Freiberg area 1
Upper Mulde 3

Source P
Range
Old mining, Schlüsselstollen 3

Source L
Range
Old sites, Weisse Elster ?

Source S
Range
Side structures, lower Saale 2
4 major barrages, lower Saale 2

Types of sources
S – Sediment
P – Point source
L – Legacy / abandoned site
U – Urban Area

source: Heininger et al. 2015
02 Working with the Concept
Dredged material management in the Port of Hamburg

- Regular river maintenance total cost: ~ 75 Mio. € per year!
- Land treatment: 1/5 of volume, but 3/4 of cost!

Low contamination:
Relocation into the North Sea placement
1 - 3 mio m³/a
or relocation within
Tidal Elbe
4 - 8 mio. m³/a

High or specific contamination:
Land treatment & disposal up to 1 mio m³/a

Sources: 1 & 3: ELSA; 2, 4, 5: HPA
Implementation of the Concept

Implementation in the 2nd management cycle

- Permanent consideration in the responsible bodies of ICPER / RBC Elbe
- Report every 2 years on implementation
  - Questionnaire
- International workshop series (CZ/DE)
- Methodological progress
  - Development of tools for efficiency control (e.g. aspect quality: Sediment quality index)
Progress report 2017

Knowledge

• ELSA Project: case studies and financial support

• Stakeholder involvement

Monitoring

• Extreme event monitoring: flood and low water, extreme pollution situations (e.g. accidents)

Practical status

• Improvement of sediment continuity
• Removal of old contaminated sediments

sources: 1: HAW (Heise); 2: HPA; 3: UFZ (Künzelmann); 4: HU (Blohm); 5: ELSA; 6: Tauw
Practice – Removal of old sediments “The Mühlgraben-Case”

- Qualitative sediment management in one of the main source areas

Relevant tributary “Saale”:
- Due to its long industrial and mining history, the Saale catchment has a high relevance for the pollutant situation in the Elbe river

sources: Map: RBC Elbe/ELSA; 1: GoogleMaps
Practice – The example “Mühlgraben”

**Action:** Removal of old contaminated sediments from “Mühlgraben”

**Approach:**
- Detailed characterization of the sediment inventory in terms of quantity and contamination
- Evaluation of the relevance of the secondary structure for the main stream
- Realization as measure of the regional management plan (2nd/3rd cycle)

sources: 1: GoogleMaps; 2 & 3: Tauw
WFD & sediment management – a perfect match?

WFD – The River Basin Concept

- **Holistic approach:** Protection and sustainable management of all surface and groundwater, including transitional and coastal waters
- Covering **all pressures and impacts**
- Water management at **river basin level**
- **River Basin Management Plans:** basic instrument to implement WFD
# Review of the implementation status – Challenges & needs

## Challenges: What does complicate the implementation?
- Complexity of the system …
- Detailed risk analyses and expensive feasibility studies
- Principle of proportionality in management planning
- High, unevenly distributed costs …
- Lack of (basin-wide accepted) socio-economic approaches
- Lack of clear political commitment … Insufficient consultation and cooperation

## Needs: What do we need to encourage implementation?
- “Be well informed – Manage adaptively – Take a participatory approach”
- System knowledge
- Reduce the responsibility ripple
- Prioritization & efficient combination of measures
- Comprehensive stakeholder involvement in decision-making
- Solidarity approach „river basin budget“
- WFD and beyond: Political impulse „pro sediment“
Review of implementation status – Two perspectives

Short Review of the implementation progress by the RBC Elbe, 2018

- Confirmation of the concept as transnational basis and decision support for the determination of measures in the frame of the second WFD management cycle (2016 - 2021).

- However, the implementation remains challenging. Notwithstanding the sediment management concept provides a good conceptual basis, the step towards concrete measures has proven too big.

Legal analysis of political and administration relationships with a special view on contaminated sediments and WFD

- Yes! The Sediment Management Concept meets the spirit of the WFD. RBC Elbe and ICPER are with it on the right way to an integrated, river basin-wide management.

- By contrast, the recent management plan and program of measures (2016-2021) partly fail in meeting the required river basin wide coordination. The plan/program refer to the concept in principle but do not transfer its spirit into adequate management actions.

- In Germany, obtaining the required level of cooperation between the different Federal States and between the Federal Government and the States remains difficult. As a consequence often management decisions are taken just from a single State or the federal point of view, sometimes with considerable problem shifts in the river basin.
Sediment management in Europe

- Rhine (DE, NL, CH, FR, L, AT, BE, FL, IT)
- Elbe (DE, CZ)
- Scheldt (FR, BE, NL)
- Danube (DE, AT, SK, HU, HR, RS, BG, RO, MD, UA)
- Meuse (FR, BE, DE, NL)
- Sava (SI, HR, BA, RS)
Thank you!

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