

# The flood-prone transport of historical contaminants to the Elbe Estuary: Modelling deposition and monitoring ecosystem effects

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## Contaminated Sediments in the Elbe

Ecological risks from contaminants in the Elbe catchment derive mainly from mobile, historically polluted sediment, coming from the Czech Republic, the tributaries Mulde and Saale, and from groyne fields (Heise et al. 2007). No information is available yet on whether high water discharge situations will lead to deposition of particle bound contaminants (from upstream Areas of Risk) in the ecologically important mudflats of the estuary, impairing sediment quality and increasing ecotoxicity.



Fig. 1: Elbe estuary - areas of field surveys

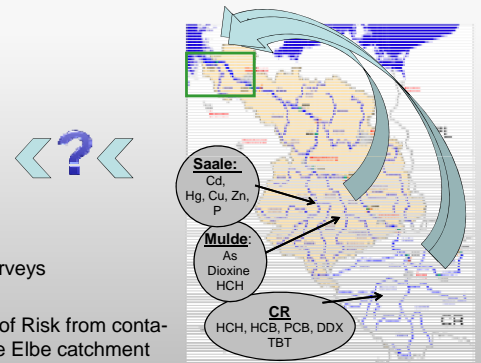


Fig. 2: Areas of Risk from contaminants in the Elbe catchment

## Modelling of Transport

Using the 3-dimensional hydrodynamic model UnTrim in combination with the morphological module SediMorph, BAW modelled contaminant transport in the estuary. Fig. 4 depicts major sedimentation areas for particle-bound heavy metals: harbour basins, the freshwater mudflat „Mühlenberger Loch“ and the coastal mudflat „Neufelder Watt“ (Fig. 1).

Contaminant transport in the catchment area is modelled using a flexible mesh model (MIKE 21 FM). The model reflects the accumulation of contaminants with the fine material in the groyne fields along the Elbe River (Fig. 3)

## Estuary

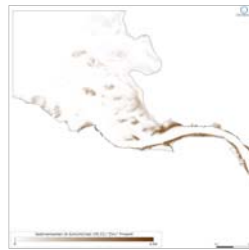


Fig. 4: Spatial distribution of Zinc in the harbour area (right) and at the mouth of the Elbe (left) after modelling the inflow of 1500 mg/kg Zinc to the system under high water conditions.

## Catchment

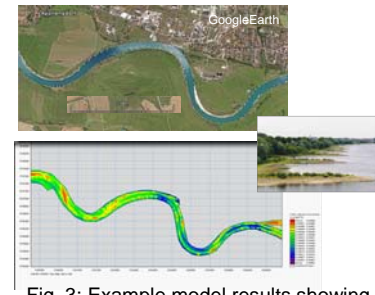


Fig. 3: Example model results showing the accumulation of sediment-sorbed HCB in groyne fields (photo: R. Schwartz) downstream of Wittenberg

## Monitoring of Effects

Particle-bound contaminant loads in the Elbe River are strongly dependent on high discharge events (Data: Arge-Elbe) (Fig. 5).

In multiple sampling surveys of 2009 and 2010, freshly deposited material was gathered from mudflat areas in the estuary under normal and high water conditions. No correlation was observed between ecotoxicity and water discharge (Fig. 6).

After the hundred-years flood in 2002, ecotoxicity of sediments was strongly increased in the area of Neufelder Watt and Otterndorf. Data are based on 4 biotests. Results were integrated in toxicity classes, ranging from green (no toxicity) to red (strongly toxic) (Fig. 7).

Flood event in 2002



Fig. 7: Ecotoxicological effects before and after the Elbe extreme high water discharge 2002

## Estuary

Various samples 2009/2010

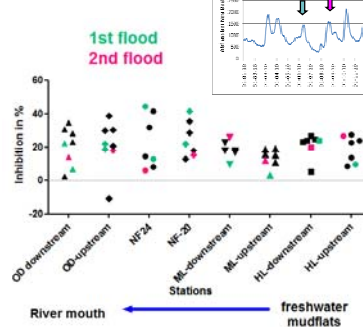


Fig. 6: Ecotoxicological effect of elutriates from freshly deposited material in the Microtox-Test. Flood event samples shown in green and red.

## Catchment

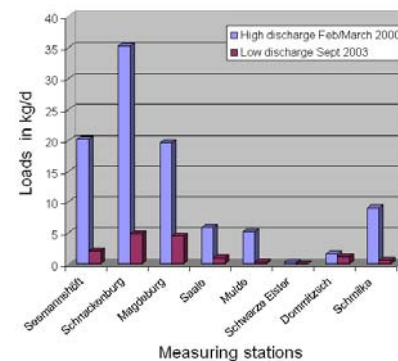


Fig. 5: Cd-loads of the Elbe River during different discharge conditions (Data: ARGE-Elbe)

## Summary and Conclusions: Impact of high water discharge on estuarine sediment quality?

- Model-based simulation of contaminant transport in the catchment and estuary so far reflect reality in terms of sedimentation of fine sediment, and, hence, contaminant accumulation in groyne fields, harbour basins, and mud flats. Additional model runs with different contaminants will aid in understanding contaminant mobility in the catchment and in the estuary under high water conditions.
- In the aftermath of the 100 yrs-flood event in 2002, mudflats in the Elbe mouth showed increased toxicity (4 biotests), potentially related to historic polluted sediments from upstream areas.
- During mean high water discharges in 2010, no increased toxicity was detected. Future surveys during high water discharge events will determine whether the toxicity increase observed in 2002 was an exception or whether only extreme high water events have the potential to impair sediment quality in the estuary.