SEDIMENT MANAGEMENT CONCEPT OF THE PORT OF HAMBURG

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1 SITUATION AND HISTORY

The Port of Hamburg is situated some 120 km upstream from the Elbe mouth and the North Sea. Like in any other North Sea estuary permanent dredging is necessary to maintain the required water depths for safe navigation. Sediments come from both upstream and the sea and mix in the estuary. Responsible for fairway maintenance are both the German Federal Waterways Administration WSV and HPA. Annual dredging amounts total to 15-20 Million m³. This amount is comparable to other estuaries, like the Rhine or the Scheldt.

Figure 1 Port of Hamburg and Elbe estuary

Dredging has a long tradition in the Port; Hamburg bought its first steam dredger in the mid 19th century. In former times dredged material was used for land reclamation, agriculture, etc. In the late 1970's contamination of Elbe sediments was realised. Subsequently a comprehensive Dredged Material Management Concept was developed and realised. It consists of treatment and safe disposal in special landfill sites.

When Elbe sediment contamination started to improve in the 1990's open water placement (relocation) of dredged sediments was introduced. Based on monitoring results and studies ecological mitigation measures, like an environmental window, restrict this option to the cold season. Contamination limits follow the recommendations of Elbe environmental ministers.

2 SEDIMENT QUANTITY

In the early 2000 years dredged needs increased significantly. Reasons for this are manifold, like construction of a new industrial area into the Mühlenberger Loch and a new container terminal, deepening of the fairway, more intense dredging needs, etc.

In order to tackle the resulting challenges HPA together with WSV developed a River Engineering and Sediment Management Concept in 2008. The concept is based on several pillars. River engineering measures are intended to reduce the tidal range and thus tidal pumping. Deepening of the river, loss of inundation areas due to realignment of dikes the estuary etc. had led to loss of some of its central functions; its sedimentation patterns had changed. Instead on marsh lands sediments now settle in harbour areas with low flow velocities. Constructing new shallow areas shall give more room to the river again. In order to be effective these long term measures have to be quite large, but they can serve other needs as well.

On the short term a change practice of dredged material placement is necessary. Until realisation of increasing dredging needs dredged sediments were relocated to sites near to where they were dredged. But so called dredging cycles exist. Depending on the river discharge relocated sediment are partly brought back with the tide. Only very high discharge leads to export in direction of the North Sea, to where sediments come from. This means that dredging vessels have to sail longer distances to break these cycles.

To enhance maintenance a so called sediment trap was built in 2008. At a stretch downstream of the port the river is deepened by 2 m, thus widening the river profile. The main purpose to keep marine sediments from getting into the port area was achieved only partially, but the sediment trap has proven to be a valuable instrument for organising the dredging operation.

WSV changed its dredging practice, to break dredging cycles sediments are not placed any more in the district of the WSA Hamburg. Based on a permit from the federal state of Schleswig-Holstein HPA was allowed to relocate sediments to a site in the North Sea. This permit expired end of 2011. Together these measures have led to decreasing dredging amounts.

3 SEDIMENT QUALITY

The great challenge for managing Elbe sediments was and still is contamination of sediments. It was the reason for setting up costly treatment and disposal facilities 25 years ago, and is today significant restriction for open water placement. In the 1980's point discharges existed in Hamburg. Today here as well as in the entire catchment many treatment facilities exist; point sources only play a minor role for sediment contamination. 30 years ago due to chlorine production mercury was the big Elbe problem with concentrations 100-fold and more above back ground values. Today mainly organic contamination with DDT, HCB, etc. is the problem.

To give an example: Mean DDT concentration at the DE-CZ border is about 200 µg/kg, about 80 µg/kg in the middle stretch of the German Elbe and about 10 µg/kg in the Hamburg port area. The upper German guidance value for placement in the North Sea region is 3 µg/kg.

4 OUTOOK

This problem can only be solved at river basin scale. Therefore Hamburg supports the Elbe Commission's sediment management work. For example the Port gives 10 Million Euro to a fund for remediation measures in the Elbe basin. Nevertheless it will take time until all (secondary) contamination sources are remediated.

Hamburg operates its land treatment facilities, spending some 30 Million Euros each year for up to 1 Million m^3 and thus relieving Elbe and North Sea from tons of contaminants.

But what to do with some 4 Million m^3 which have to be relocated in the aquatic system? The city can't operate a "contaminant filter for the Elbe" before it reaches the sea, but it has to operate the port for the sake of Hamburg's, the region's and Germany's economy.

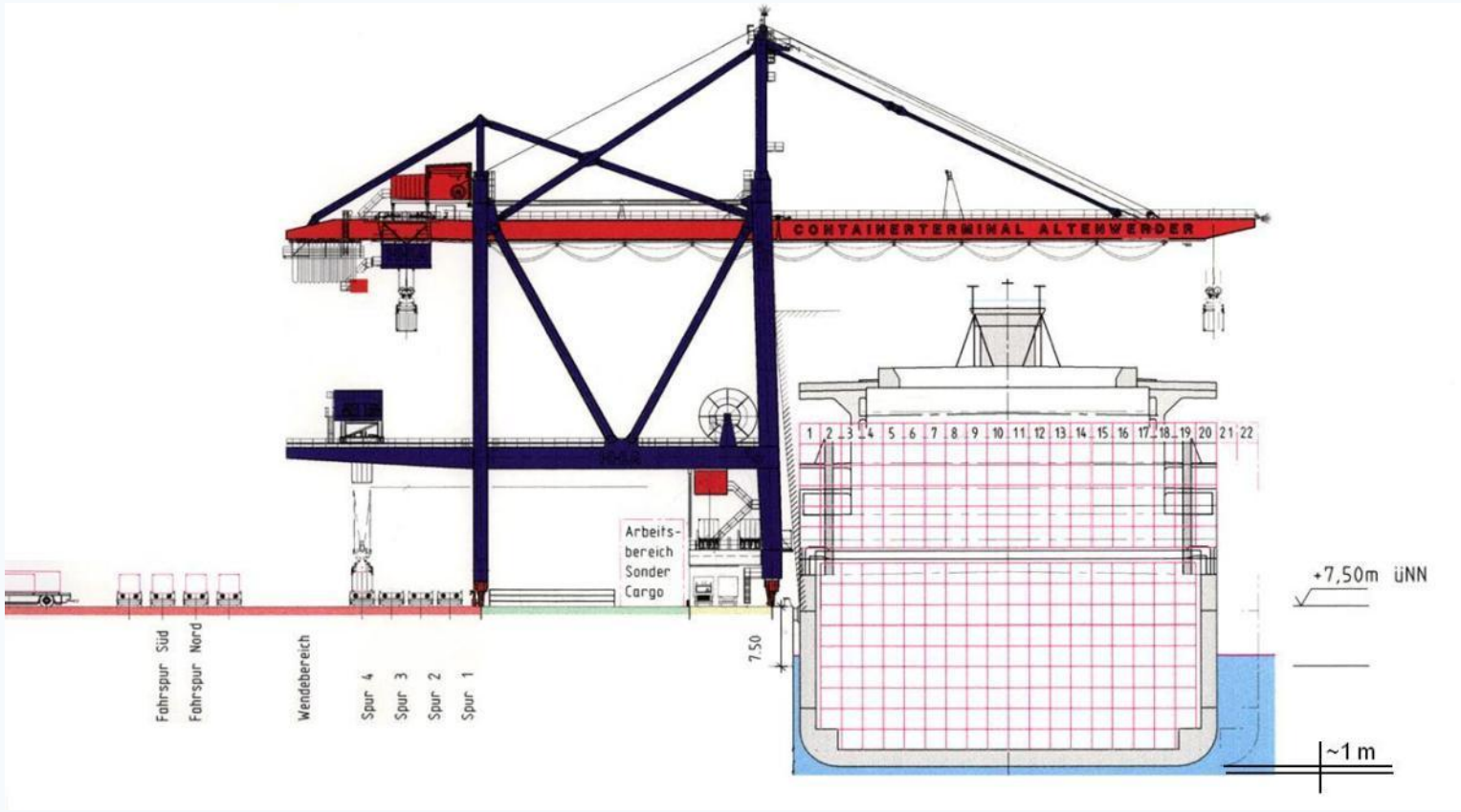
Right now a so called system study is made to identify different open water placement options between Hamburg and the North Sea. Already now it's clear that there is no "everything is fine" solution. In the end it will be a decision by "society" which risk it will wish to live with.

Sediment Management Concept of the Port of Hamburg

Axel Netzband

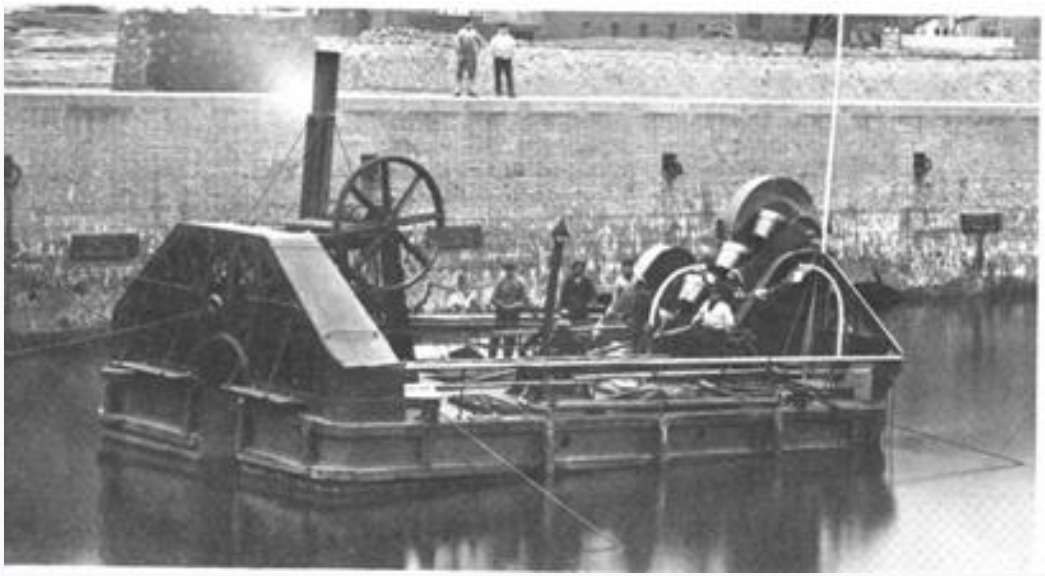
Hamburg Port Authority

Need for Water Depth Maintenance



Sedimentation rates up to several meters / year

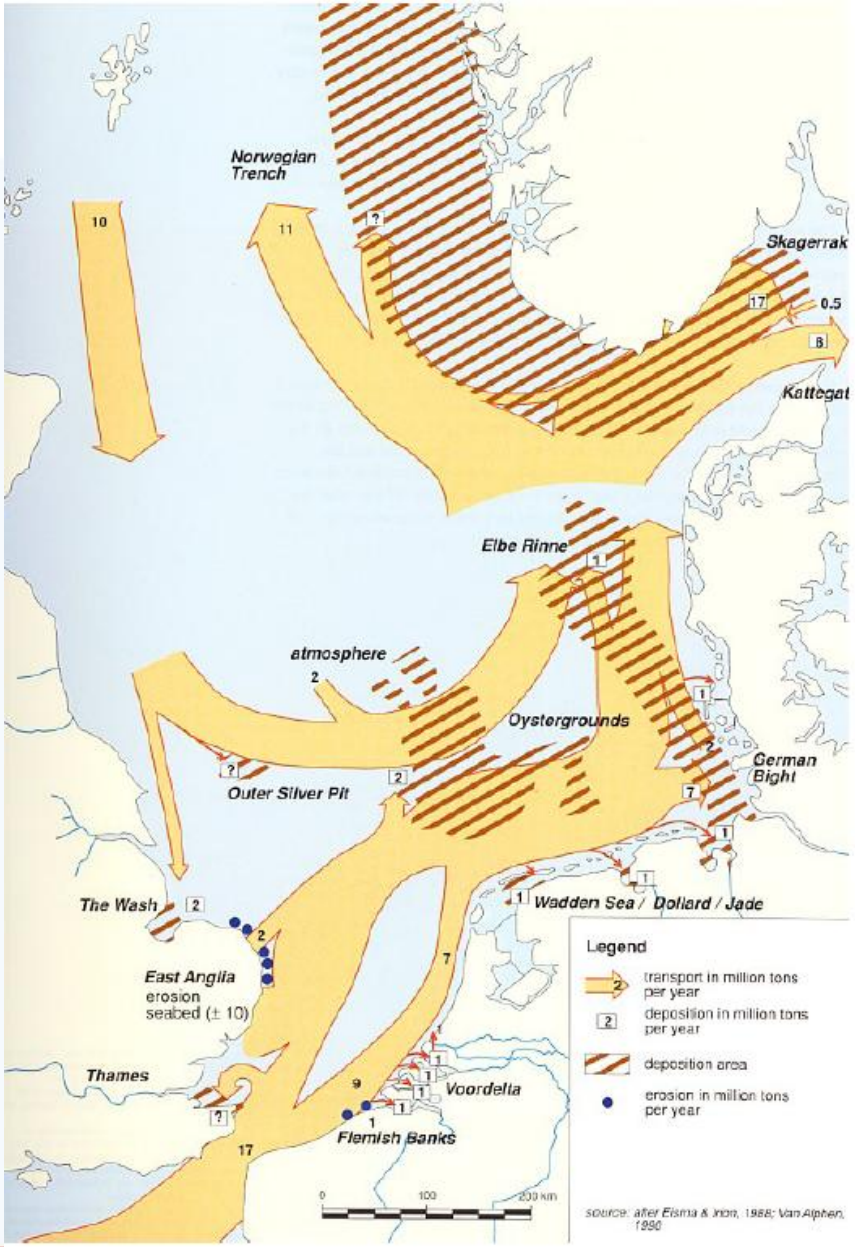
Dredging with long history



First mechanical dredger 1834

Land reclamation in 1950‘s


Baltic Sea
North Sea
Hamburg
Berlin, Germany
Giant Mountains,
Czech Republic
Prague, Czech Republic
Source: Googlemaps



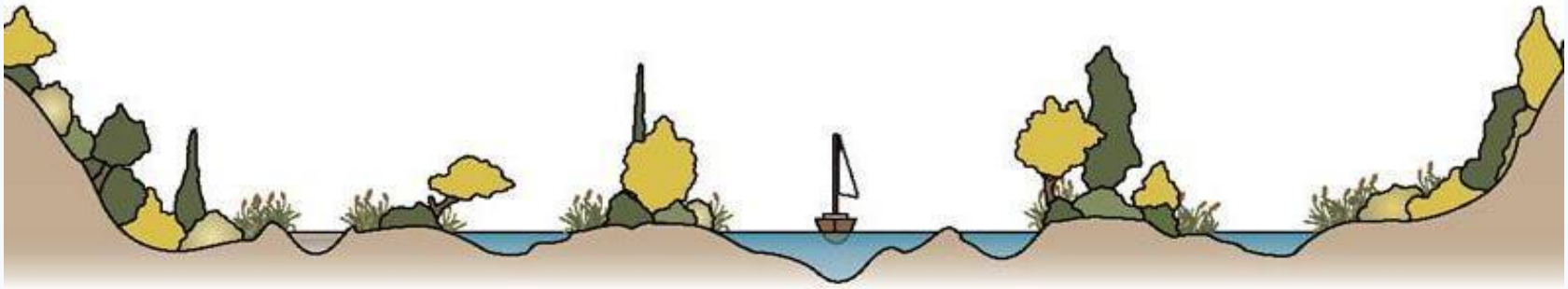
Natural Suspended Matter Transport in the North Sea

Source: Kappenberg (2007)

from ICONA, 1992; Eisma and Irion, 1988

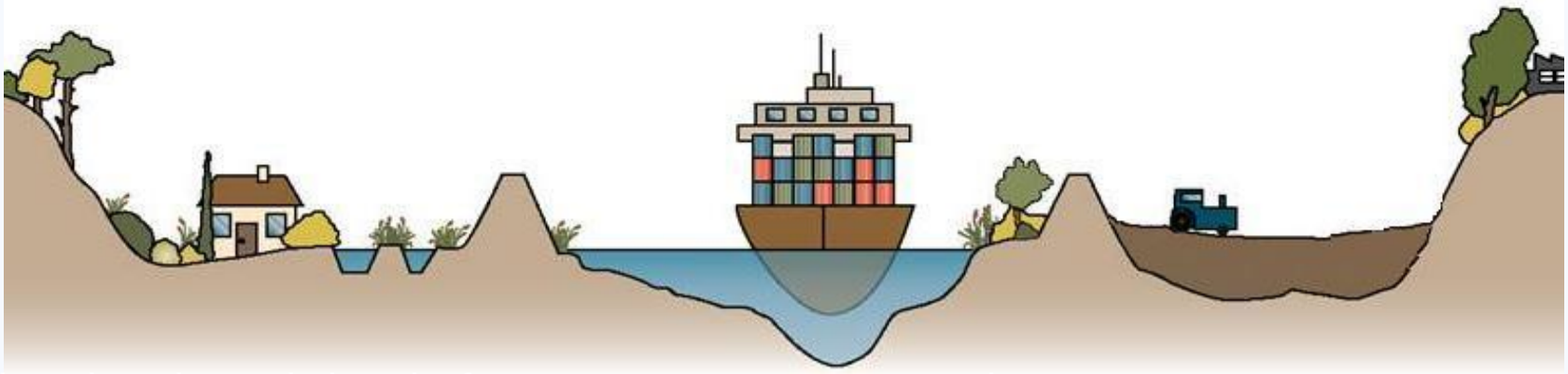
Tidal Elbe glacial valley

1000 years ago



Moraine Marsh Elbe Side branches

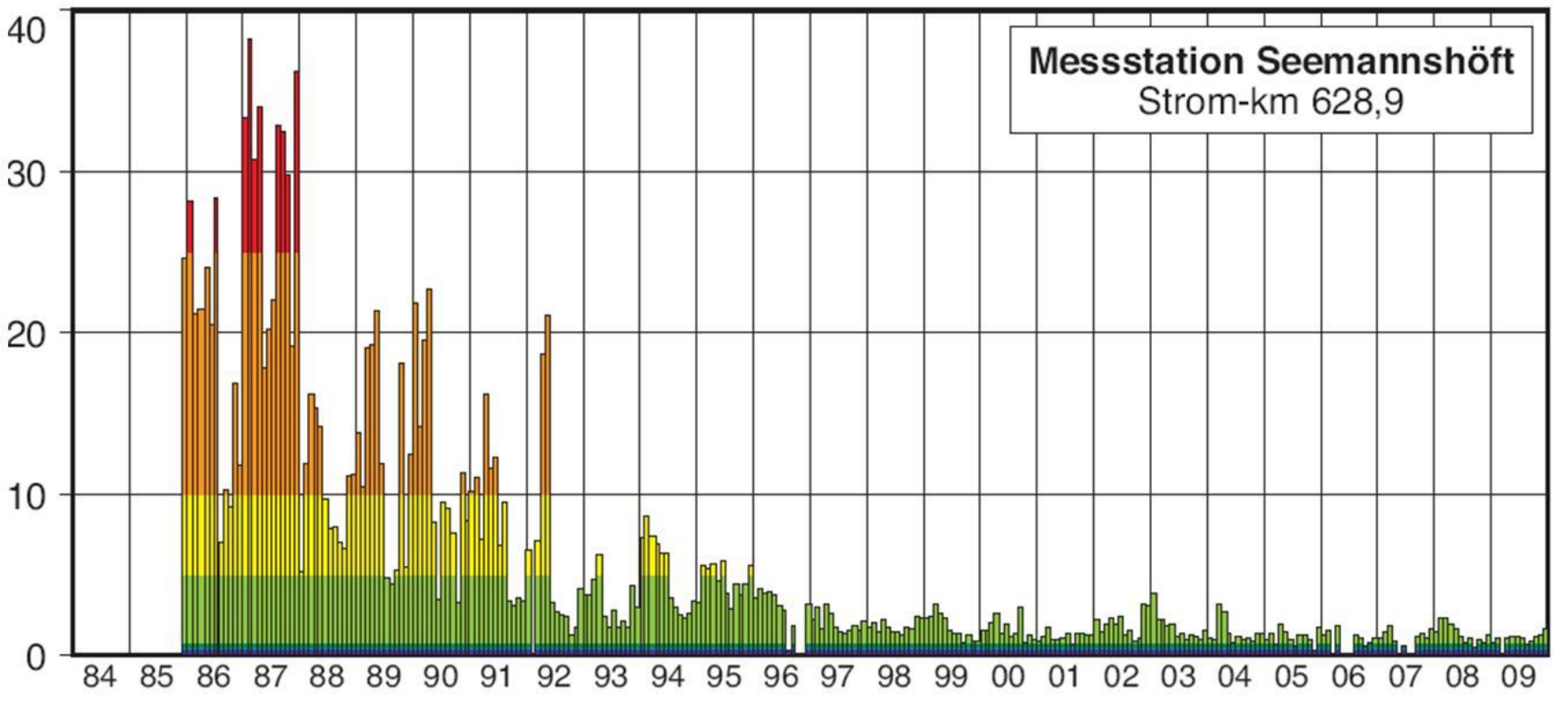
Present



Moraine Settlements Dike Elbe Dike Agriculture Industry

Burden of the past - Sediment contamination

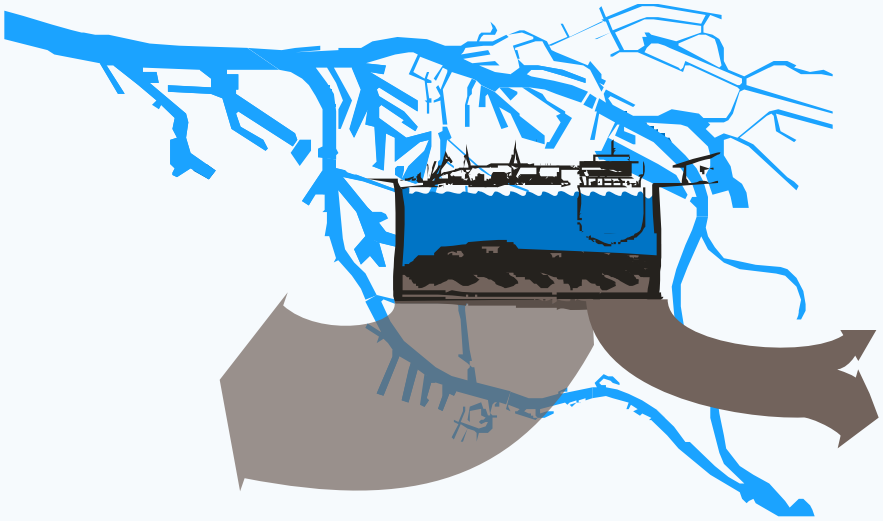
Mercury in fresh Sediments (mg/kg TS)

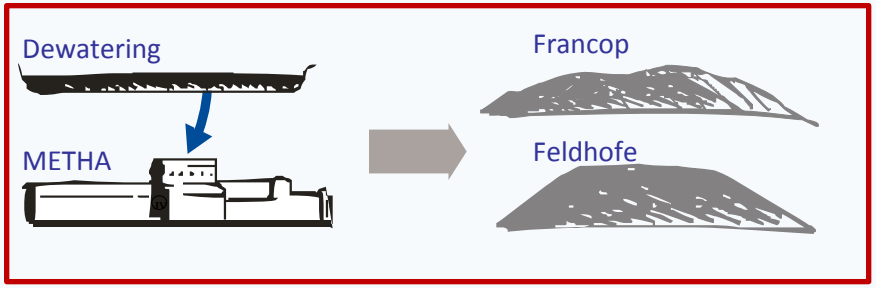


Start of dredged material research


Dredging Volumes
Relocation
12 – 15 Mio. m³ / a
Schleswig-Holstein
Dredging Volumes
Relocation
3 – 5 Mio. m³ / a
Land Treatment
1 Mio. m³ /a
Lower Saxony
Hamburg
WSA Cuxhaven
WSV.de
WSA Hamburg
HPA
Hamburg Port Authority

Dredged Material Management Concept





Relocation

- 3 - 5 Million m³
- cost effective (2-8 €/m³)
- dependancy

Land Treatment

- max. 1 Million m³
- costly (50 €/m³)
- limited

Treatment and Land Disposal

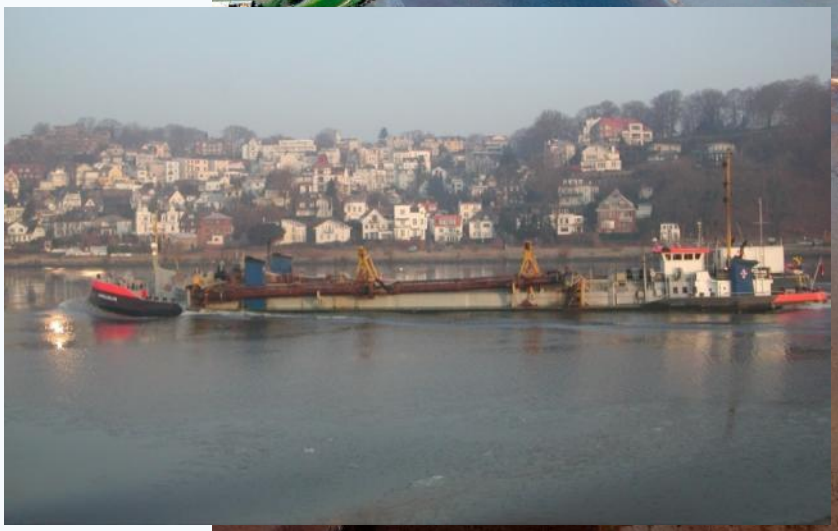
Hamburg Port Authority

METHA Treatment facility

Landfill disposal

Beneficial use

Open Water Placement Nessand



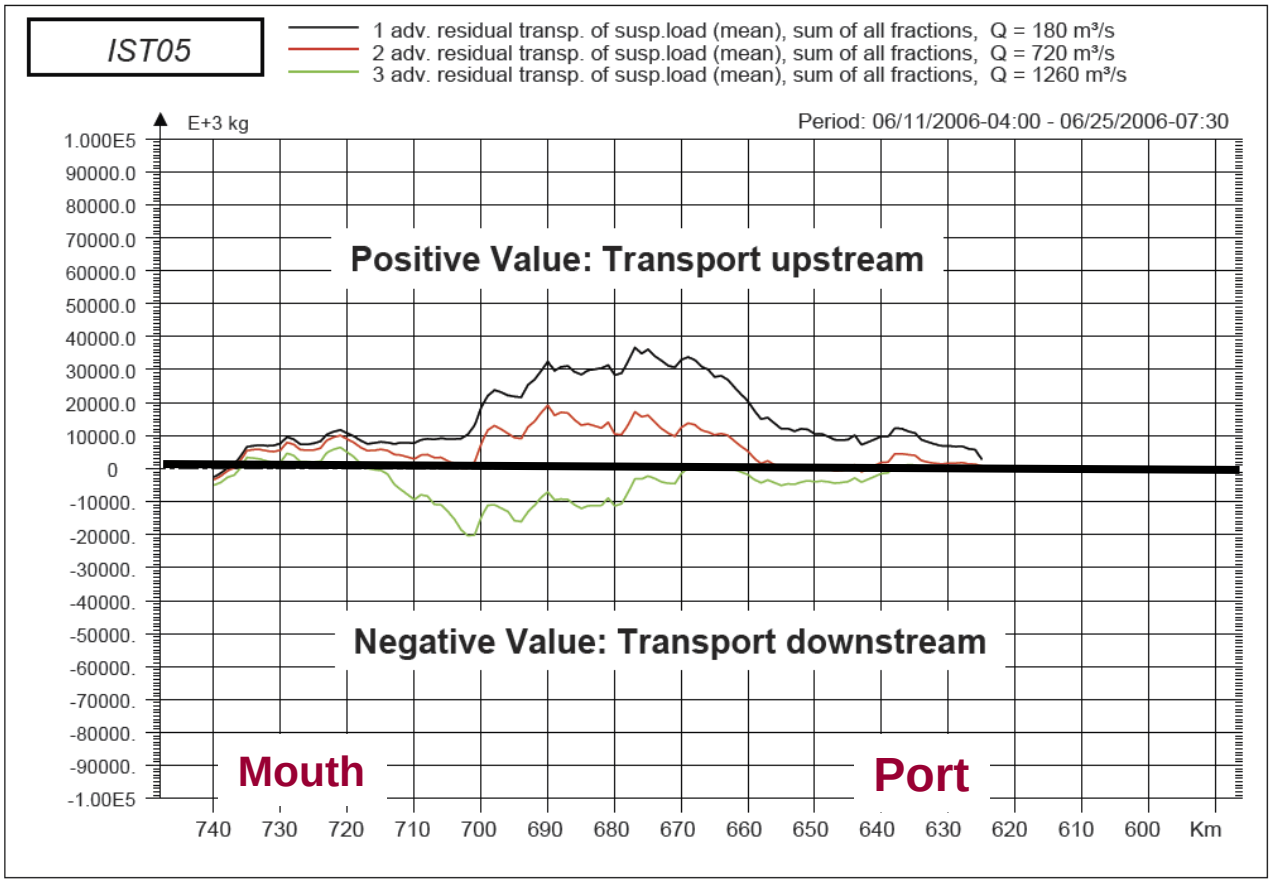
Since 1994. But:

- Environmental Window = seasonal restriction, only 5 / 12 months
- Tidal Pumping

Tidal Pumping

Hamburg Port Authority

Net Transport of Suspended Load

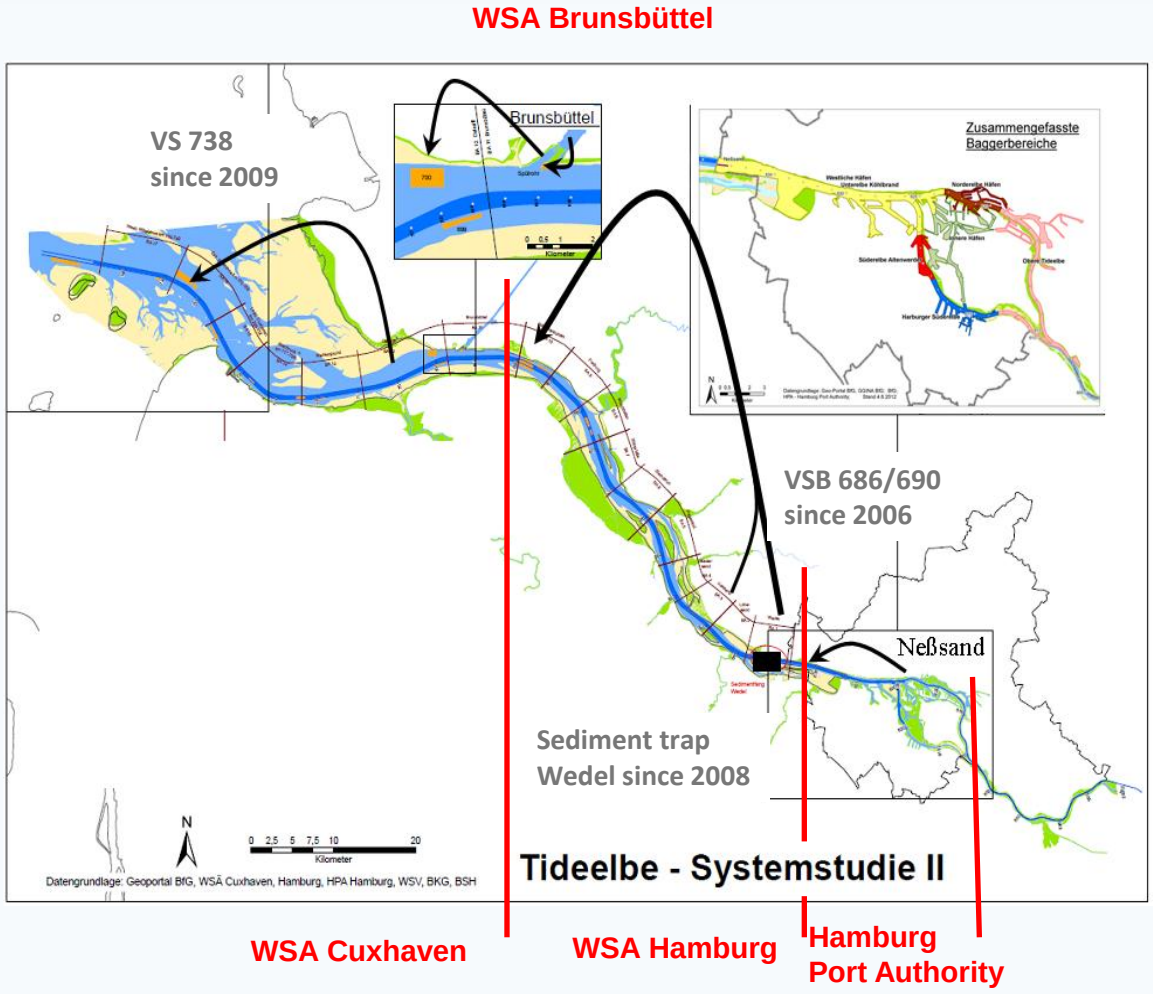


Development of a new, comprehensive maintenance strategy for the Tidal Elbe

Starting point	To avoid fine material accretion in the estuary a certain amount of sediments has to be taken out of the estuarine system
Basis	System Study by Federal Institute of Hydrology (BfG)
Focus	Balance of fine, silty sediments in the Tidal Elbe and dredging operations
Aspects	Morphology and sediment transport, Contaminants, Ecology, etc.
Tools	Scenario analysis - Sensitivity study for placement sites

→ The future maintenance strategy should be flexible and adaptive.

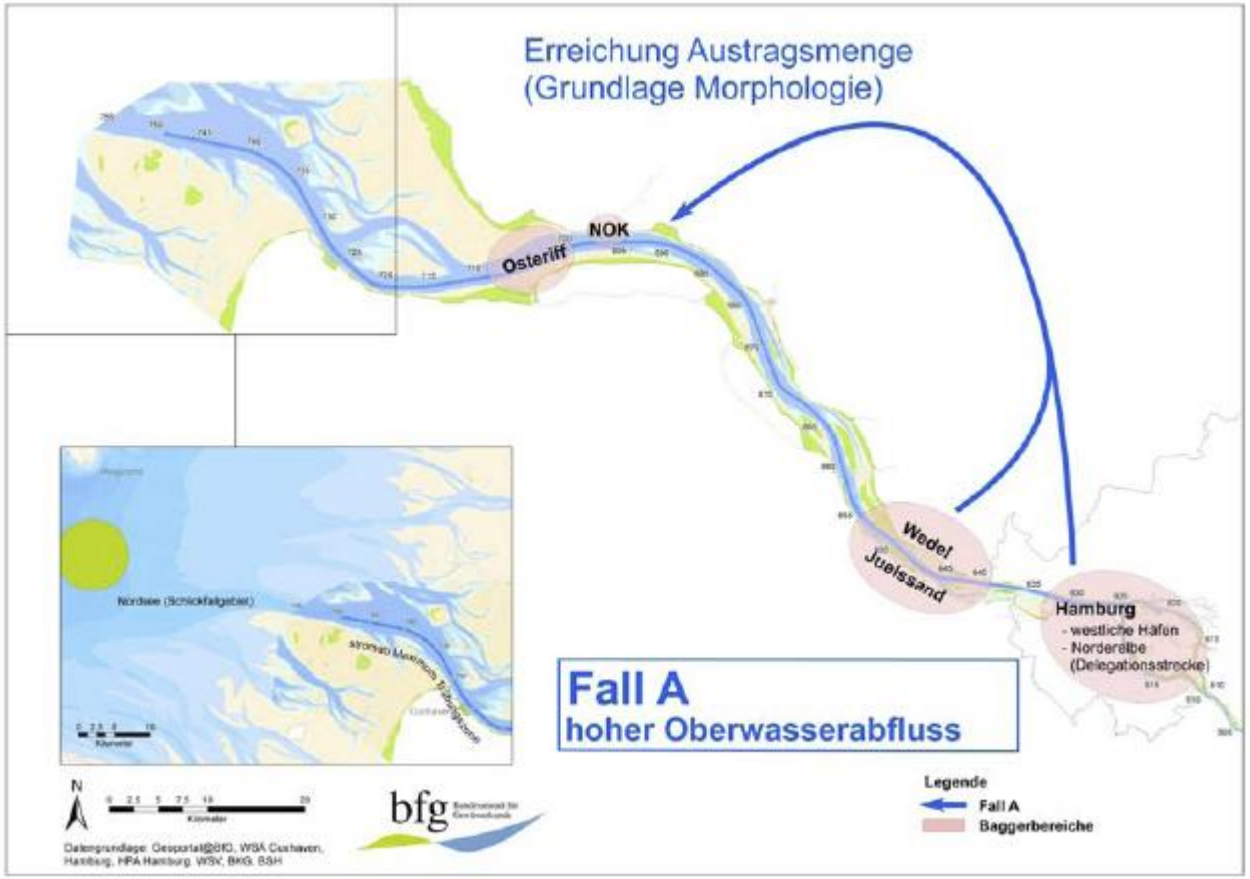
Current state and strategy (for fine sediments)



Fixed relocation strategy:
From A go to B

from BfG 2013

Future strategy | Case A

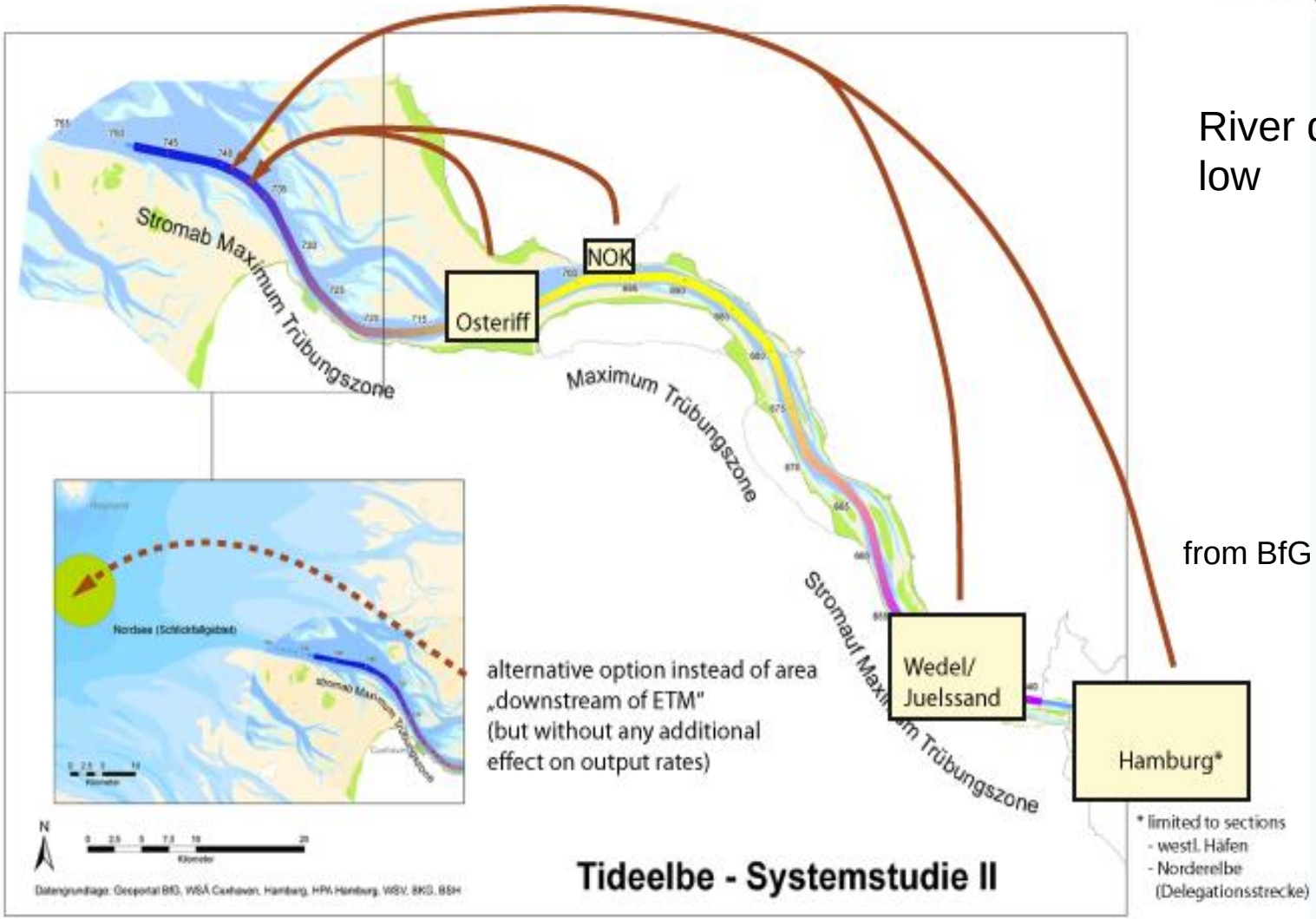


River discharge is high

from BfG 2013

Bundesanstalt für Gewässerkunde

Future strategy | Case B



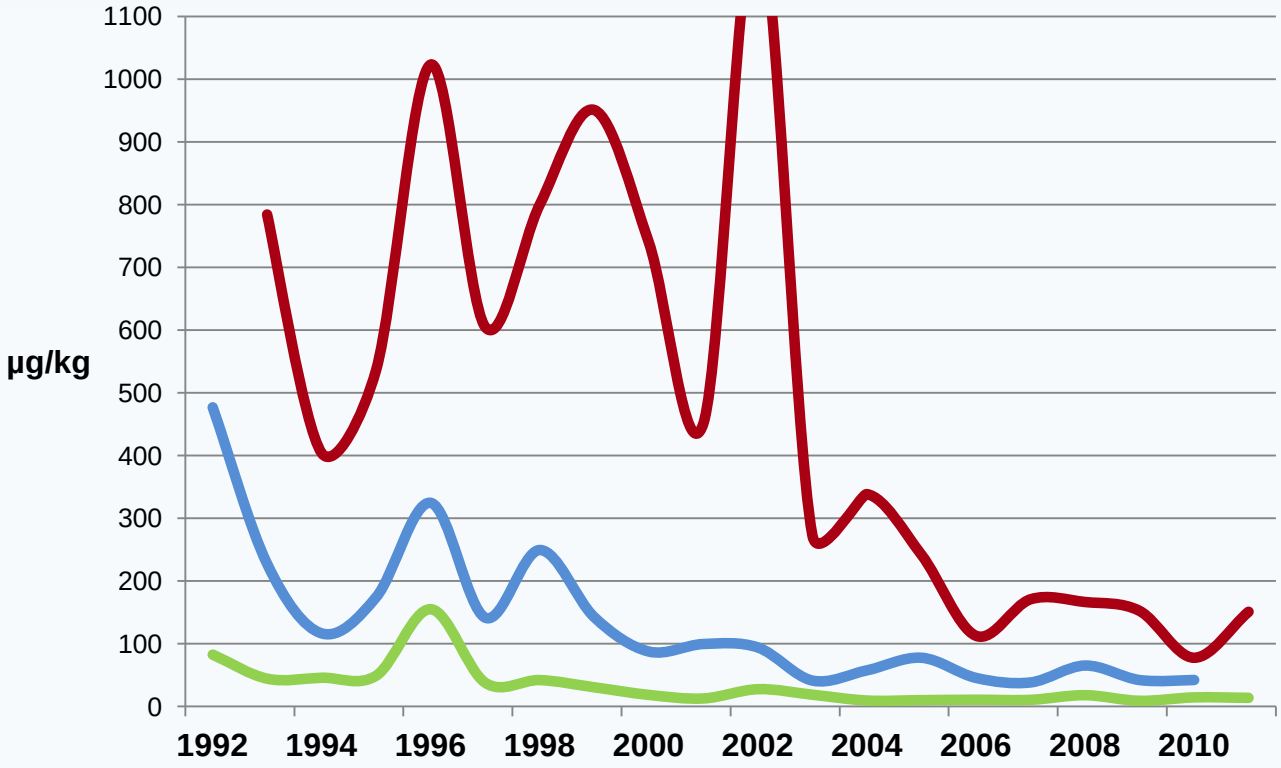
River discharge is low

from BfG 2013

Bundesanstalt für Gewässerkunde

Hexachlorobenzene in fresh Sediments

Yearly mean of monthly samples (µg/kg TS)



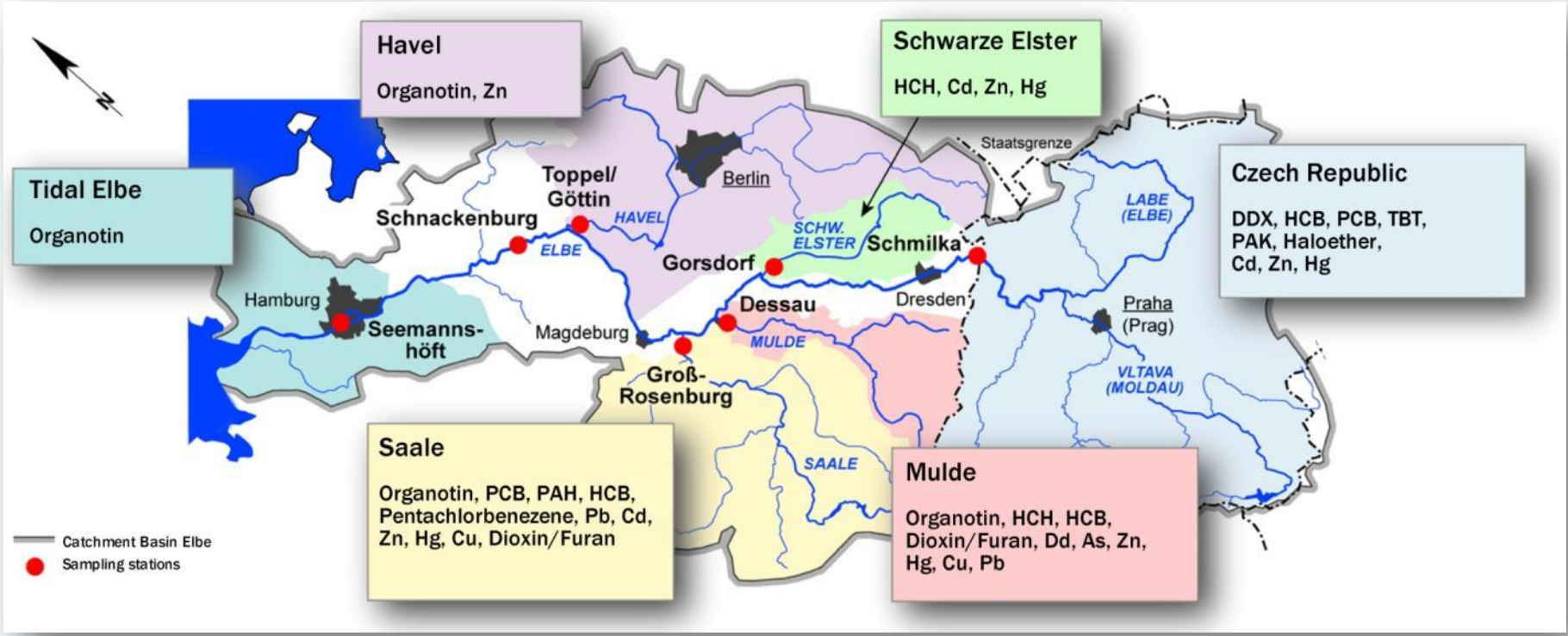
Schmilka CZ-DE

Schnackenburg DDR-BRD

Seemannshöft HH

Hamburg Dredged Material	(20 µm)	≈10 – 30
German Dredged Material Guidance Value R1 / R2	(20 µm)	2 / 6
Dutch Dredged Material Standard for North Sea	(total sample)	20

Contamination source regions in the Elbe Basin



Source: FGG Elbe (modified by ELSA)

Remediation of most significant contaminated sites

Source: Rank 2002

Sources = Burdens of the past.

River Basin Sediment Management = Task for the International Elbe River Community.

EC Water Framework Directive = Legal tool for source control.

International Elbe Sediment Management

- Sediment contamination is still the major challenge for dredged material management in the Tidal Elbe.
- Therefore the Elbe Community Sediment Management Concept is of great importance.
- Hamburg supports remediation measures through its ELSA project.

ELSA
Schadstoffsanierung Elbsedimente

River Engineering Measure

New tidal volume – Kreetsand / Spadenländer Busch

Tidal Elbe Management Concept

River Engineering- and
Sediment Management Concept

RIVER ENGINEERING	OPTIMIZATION of RELOCATION	ELBE REMEDIATION	LAND DISPOSAL UNTIL 2025
▪ Construction of shallow areas for tidal volume ▪ Win-win with flood protection, nature conservation, and climate change adaptation	▪ Relocation of fresh sediments ▪ Flexible, adaptive approach ▪ Sediment traps to concentrate sedimentation	▪ International Elbe Sediment Management Concept ▪ Hamburg supports upstream measures	▪ Third disposal site in Hamburg

Thank you for your attention!

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