

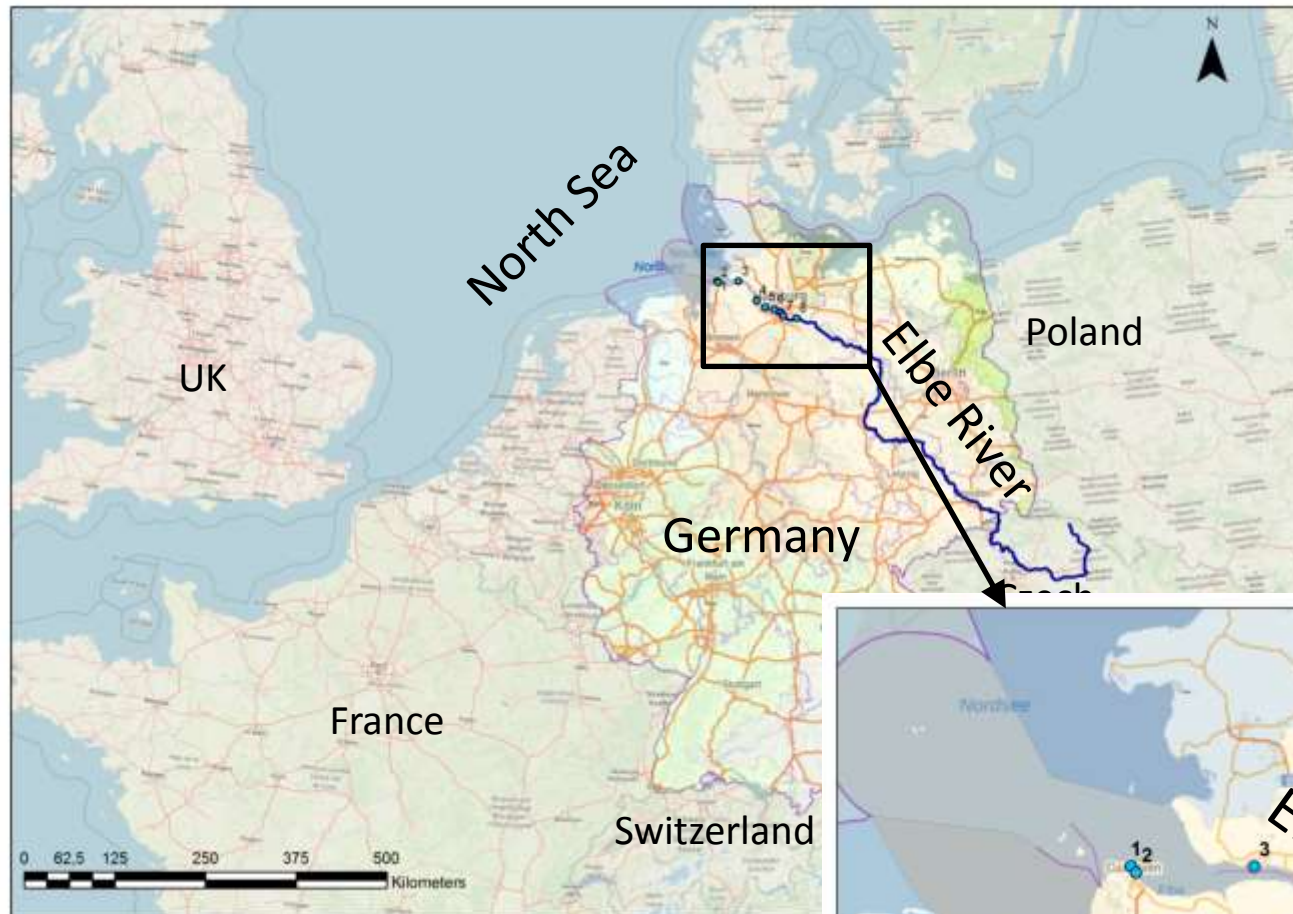
# The role of contaminated sediment monitoring for dredging management in the Elbe estuary

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# The Federal Waterway Elbe



Elbe:  
Total length: 1094 km  
Length estuary: 183 km



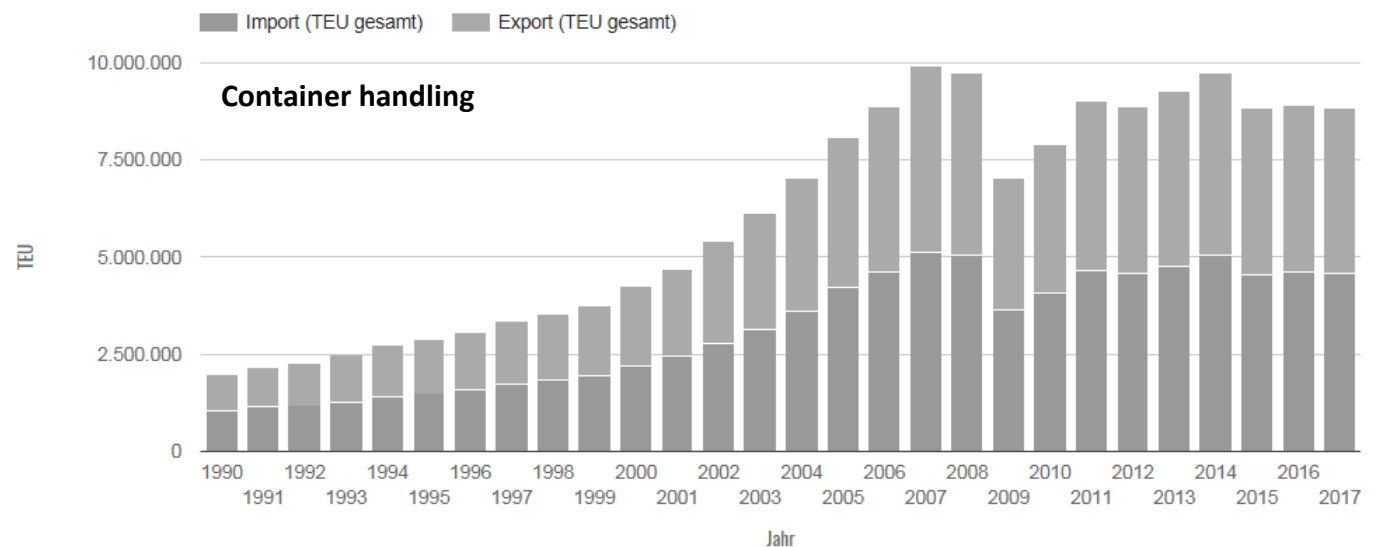
# The Federal Waterway Elbe

The tidal Elbe is an important waterway including the Port of Hamburg, the third largest port in Europe



More than 60,000 ships per year

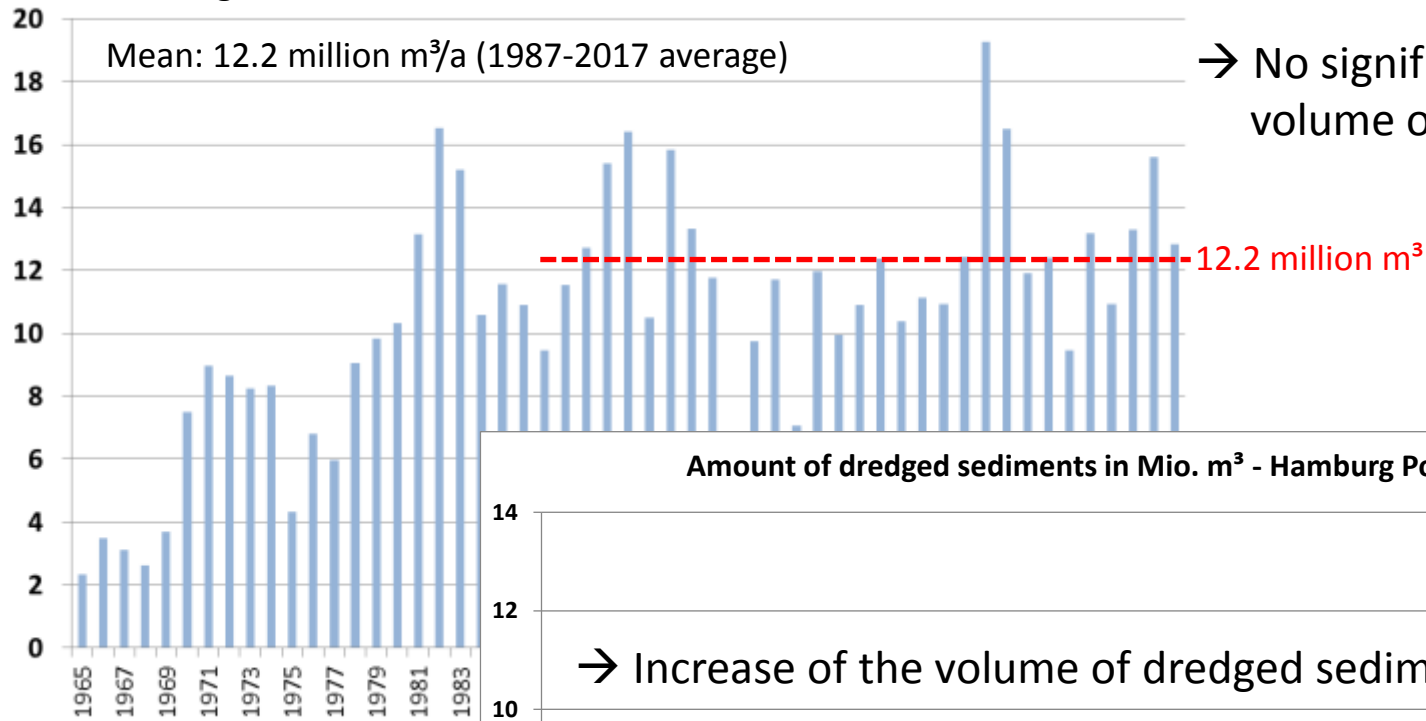
→ Important to maintain the waterway





# Dredging in the Elbe estuary

Amount of dredged sediments in million m<sup>3</sup> - Federal Waterways and Shipping Authorities



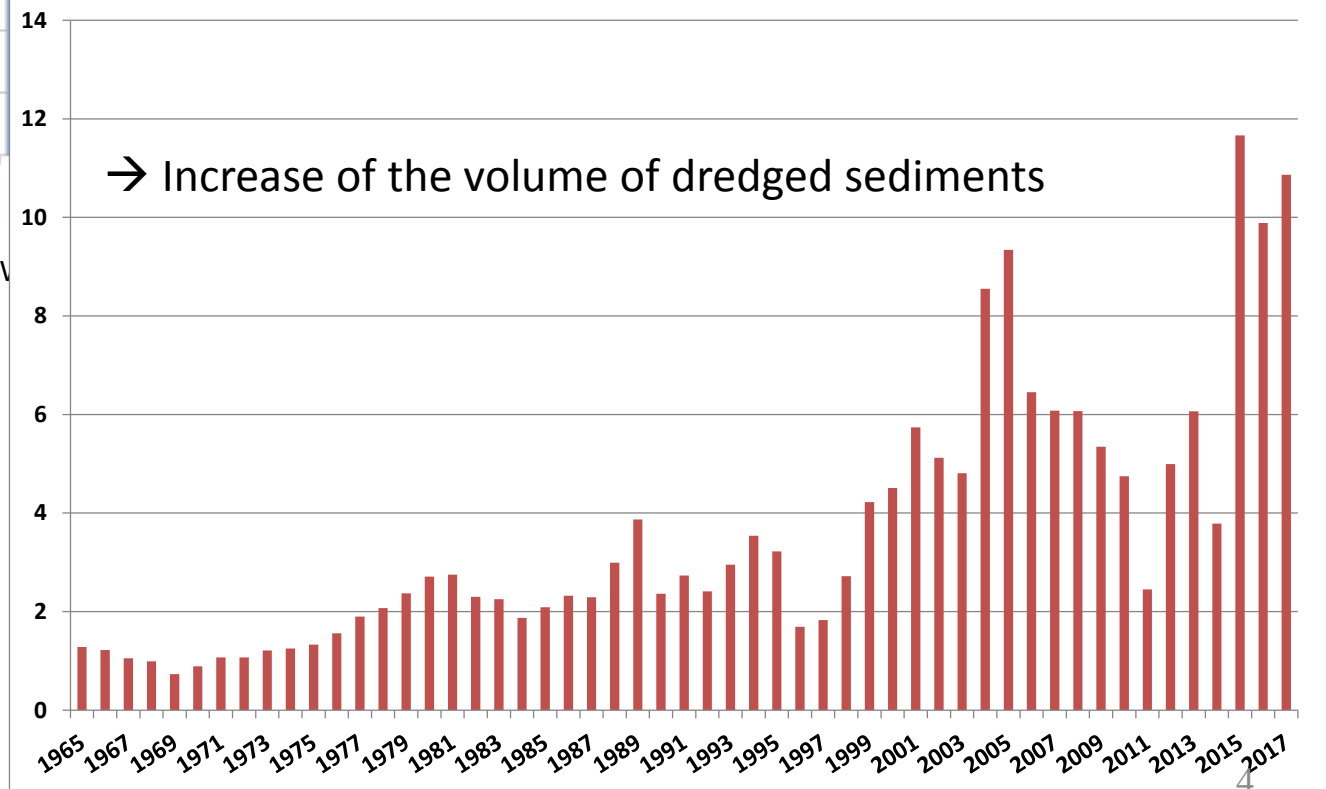
Graph modified after: Federal V

Shift of dredging sections into the estuary over time



Increasing volume of dredged sediments in the Port of Hamburg

Amount of dredged sediments in Mio. m<sup>3</sup> - Hamburg Port Authority



# Dredging in the Elbe estuary

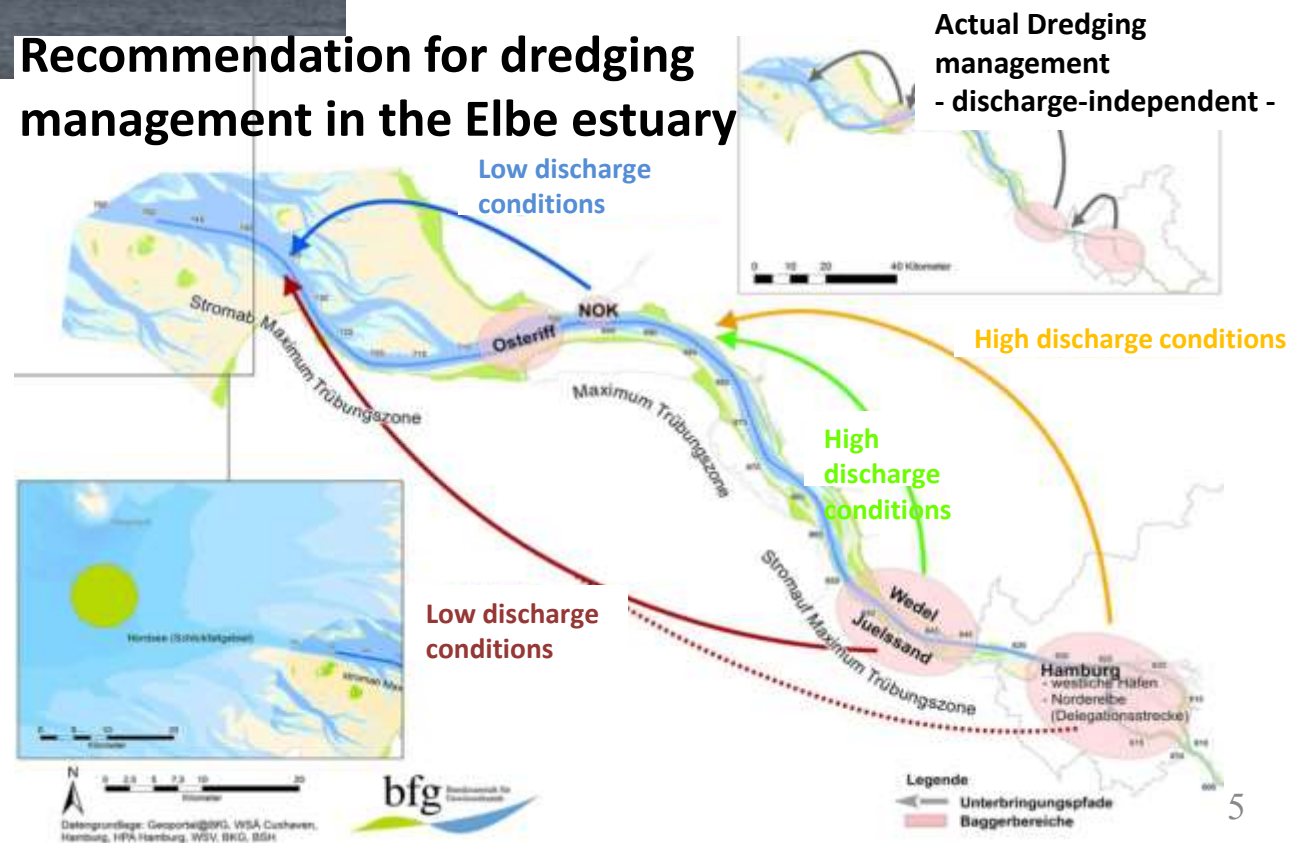
## Dredger in the Elbe estuary



## Dredging management strategies are essential

### Recommendation for dredging management in the Elbe estuary

How can contaminants help to develop management strategies?



In Germany the impact of relocations has to be estimated

## Questions:

The fate of dredged sediments after relocation

The impact of the sediments on the environment (chemical and ecological)

## Requirement:

Understanding the system

## Approach to answer the questions:

Monitoring the system and the dredging activities

## Result:

Optimization of dredging management



Contaminants act as tracer and help to understand transport pathways

# The Role of contaminants in dredging management

## Monitoring activities in the Elbe estuary – understanding the system

### Monitoring stations



- 1 Cuxhaven, Kugelbake (BfG)
- 2 Cuxhaven (FGG Elbe)
- 3 Brunsbüttel (BfG)
- 4 Grauerort (FGG Elbe)
- 5 Bützfleth (BfG)
- 6 Wedel (BfG)
- 7 Seemannshöft (FGG Elbe)
- 8 Bunthaus (FGG Elbe)
- 9 Geesthacht (BfG)

### Monitoring stations (BfG or River Basin Community Elbe (FGG Elbe)):

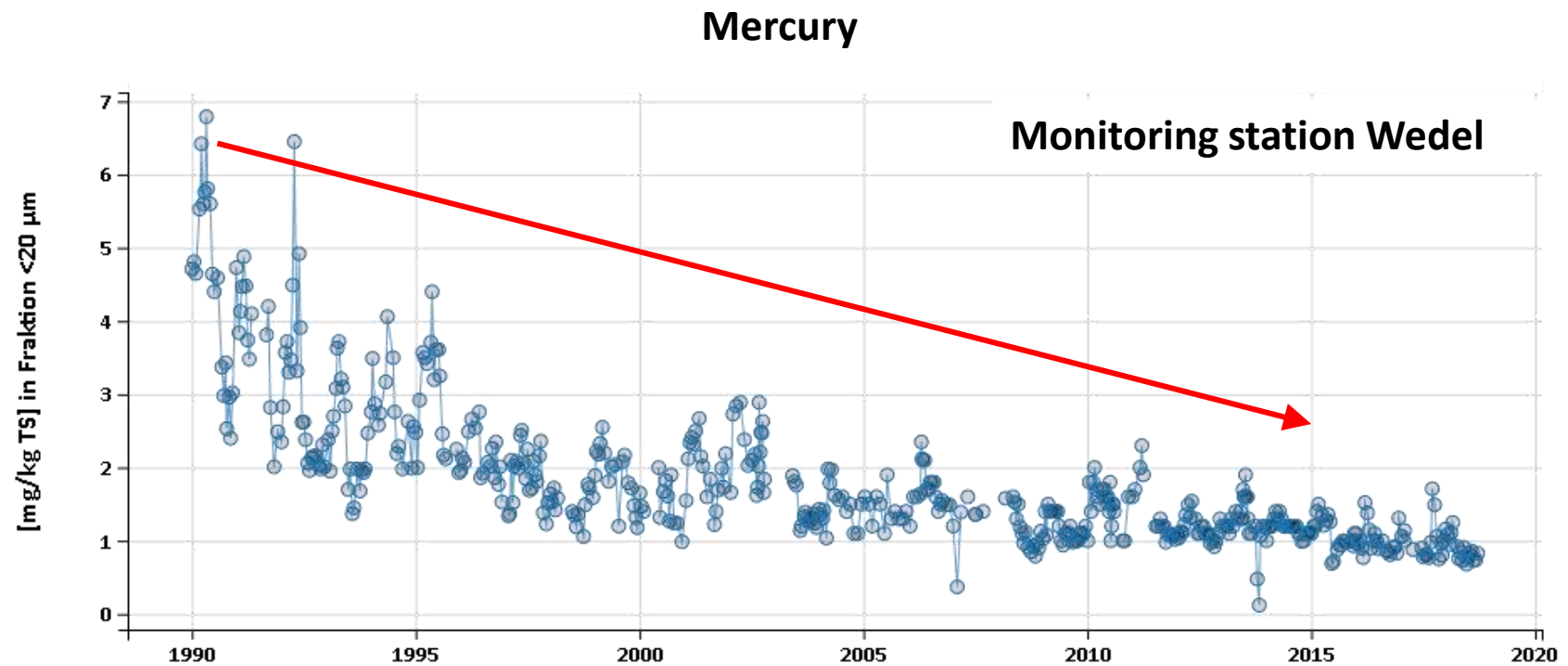
- Monthly sampled suspended particulate matter (SPM) or fresh sediments (not older than 4 weeks)
- Partly operated since the 80s → long time series



# The Role of contaminants in dredging management

## Monitoring activities in the Elbe estuary – understanding the system

### Time series



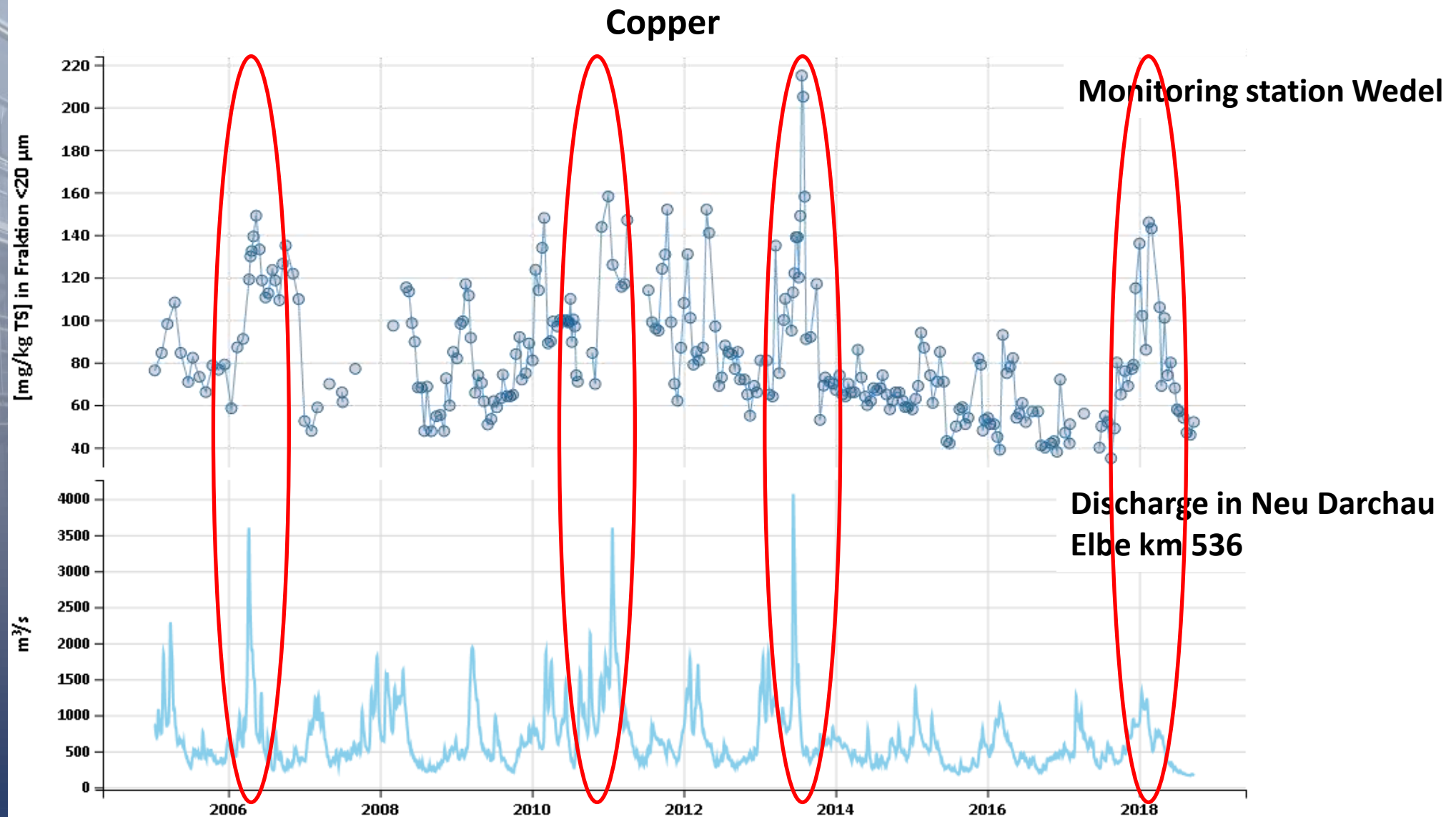
→ Decreasing contaminant concentrations over time



# The Role of contaminants in dredging management

## Monitoring activities in the Elbe estuary – understanding the system

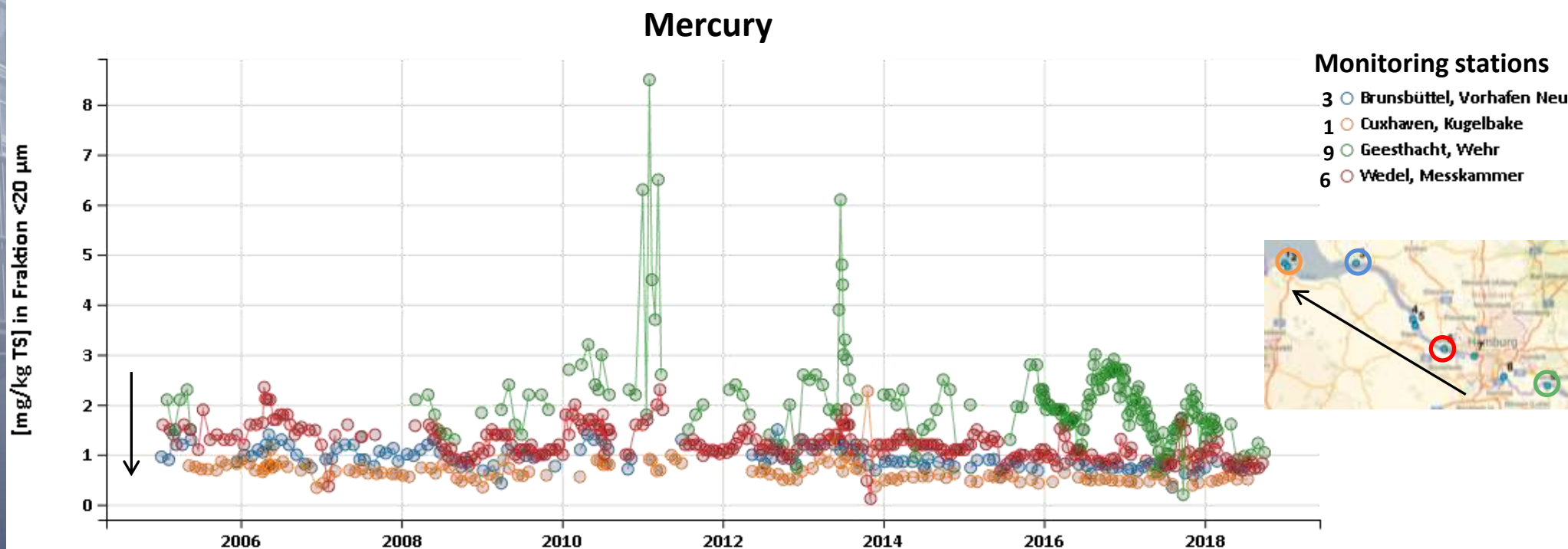
### Time series



→ Contaminant concentrations are discharge-dependent

# The Role of contaminants in dredging management

## Monitoring activities in the Elbe estuary – understanding the system

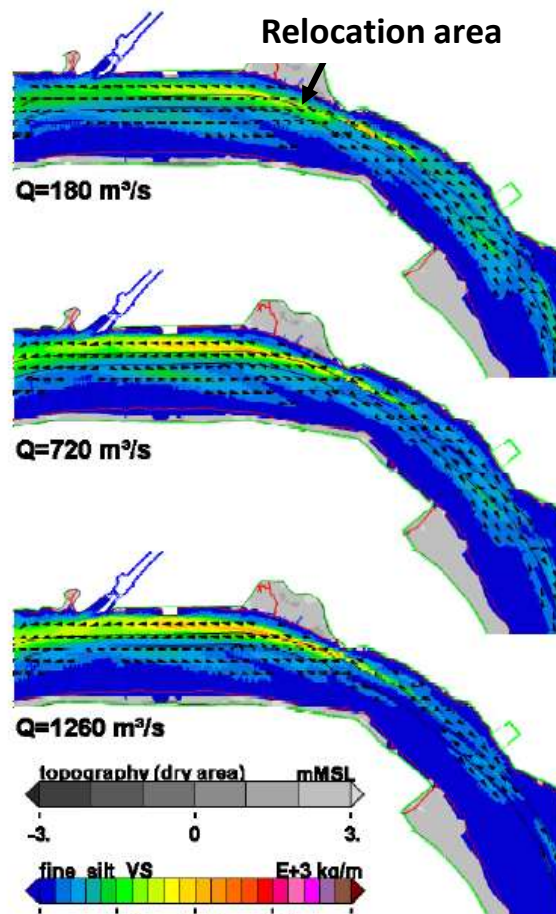


→ Decreasing contaminant concentrations within the estuary

→ Contaminant input from the upper Elbe

# The Role of contaminants in dredging management

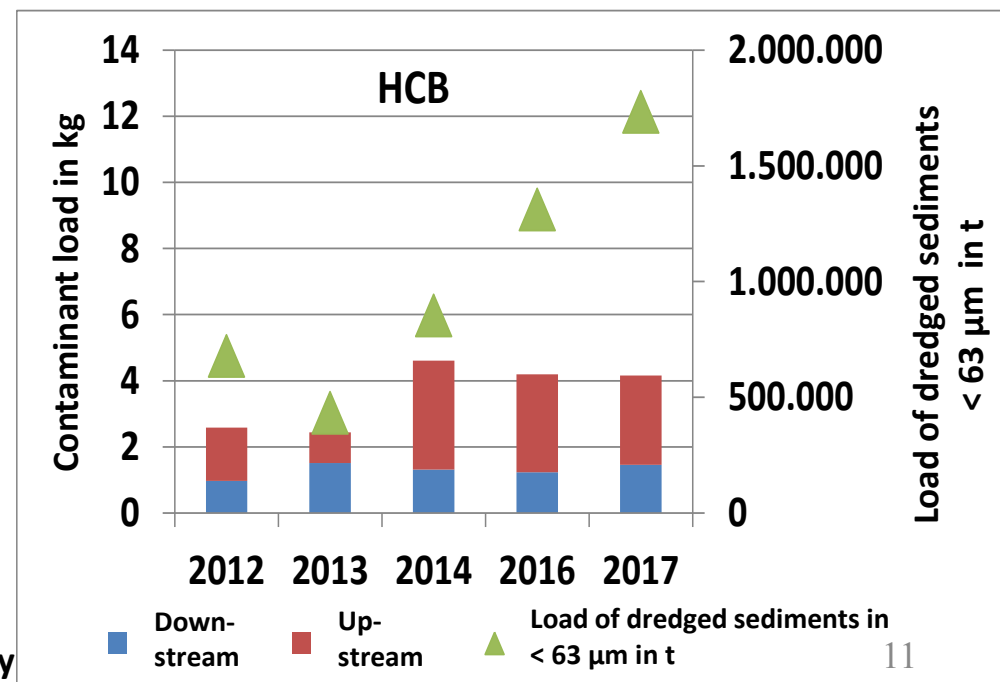
## Monitoring activities in the Elbe estuary – understanding the system



Source: Federal Waterways Engineering and Research Institute (BAW)

Q [m³/s] in Neu Darchau	Down- stream [%]	Up- stream [%]
180	10	90
720	43	57
1260	80	20

Contaminant load transported upstream and downstream



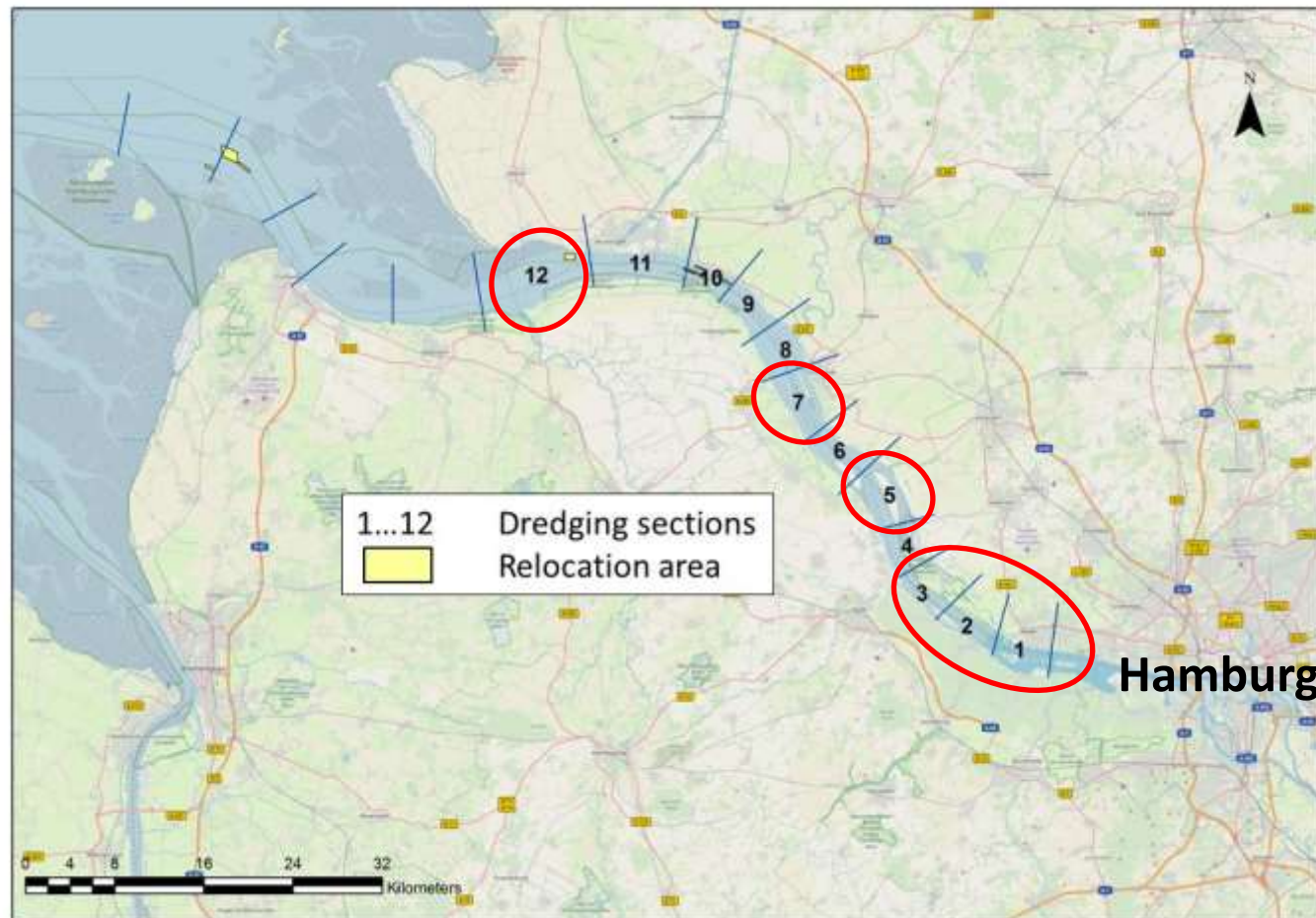
- Since 2013 very low discharge conditions in the upper Elbe River
- Increasing load of sediments to be dredged
- Decreasing contaminant load
- Repeated dredging of same sediments
- Long residence time of contaminants in the estuary



# The Role of contaminants in dredging management

## Monitoring activities in the Elbe estuary – understanding the system

### Monitoring of dredging activities – dredged material and relocation sites



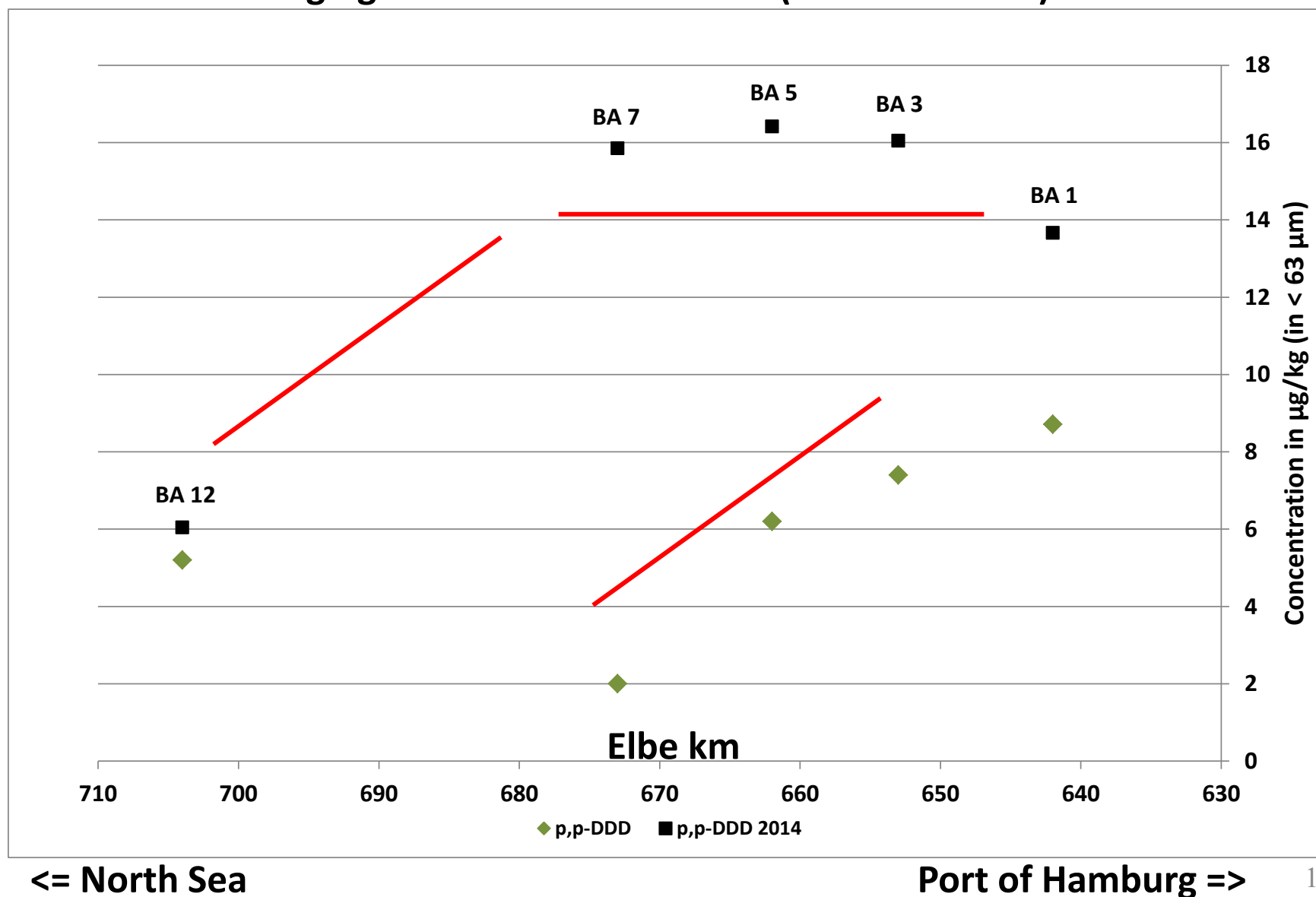
Grab sampler  
used at dredging  
sections (annual)

 Dredging sections with fine-grained sediments

# The Role of contaminants in dredging management

## Monitoring activities in the Elbe estuary – understanding the system

### Contaminant concentrations downstream dredging sections BA 1 to BA 12 (2010 and 2014)

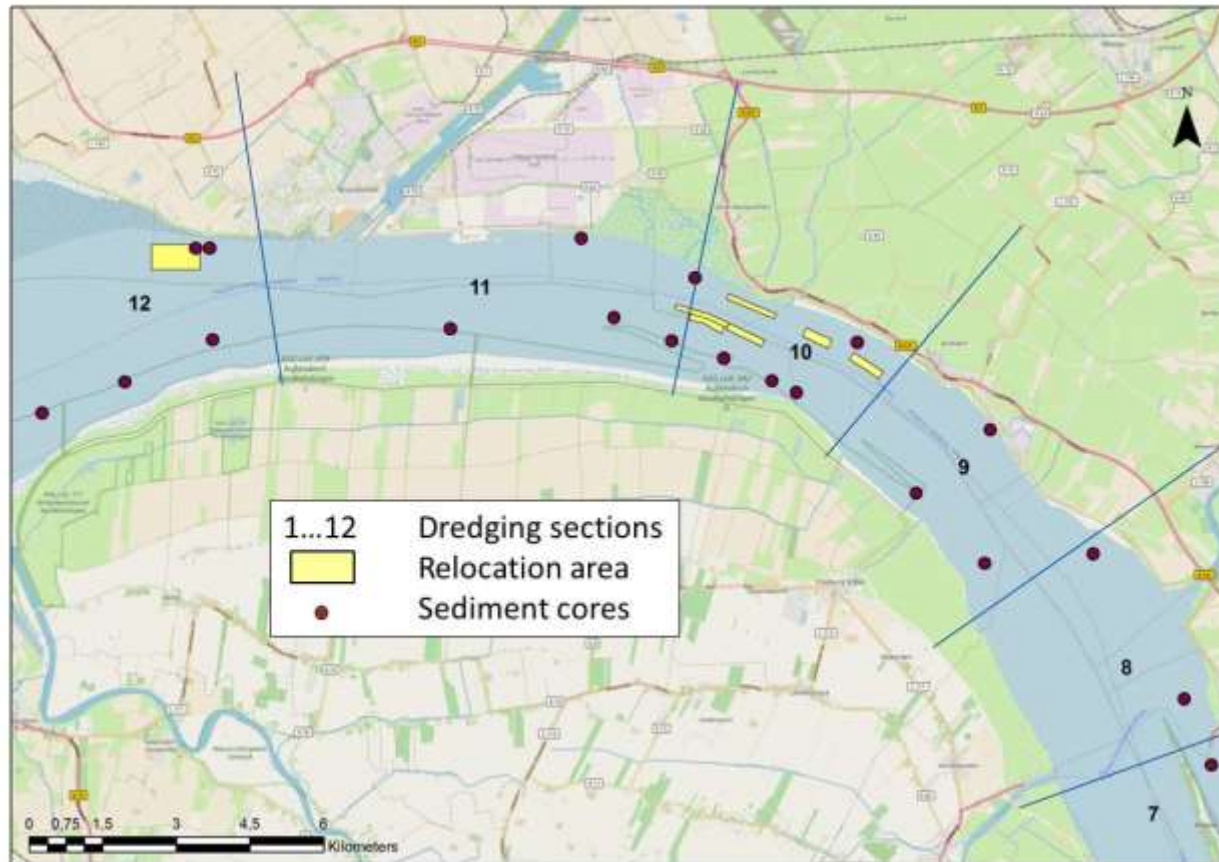




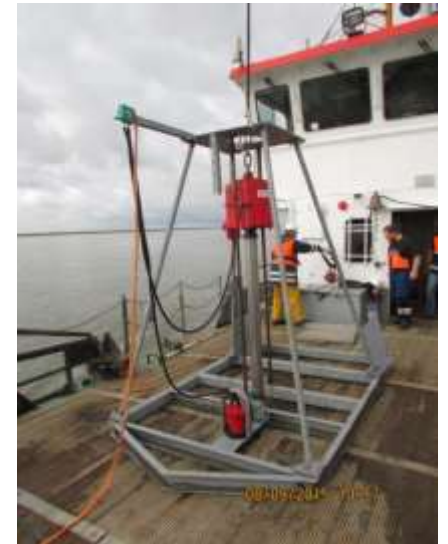
# The Role of contaminants in dredging management

## Monitoring activities in the Elbe estuary – understanding the system

### Monitoring of dredging activities – dredged sediments and relocation sites



20 sediment cores (every two years)  
50 cm – 120 cm depth

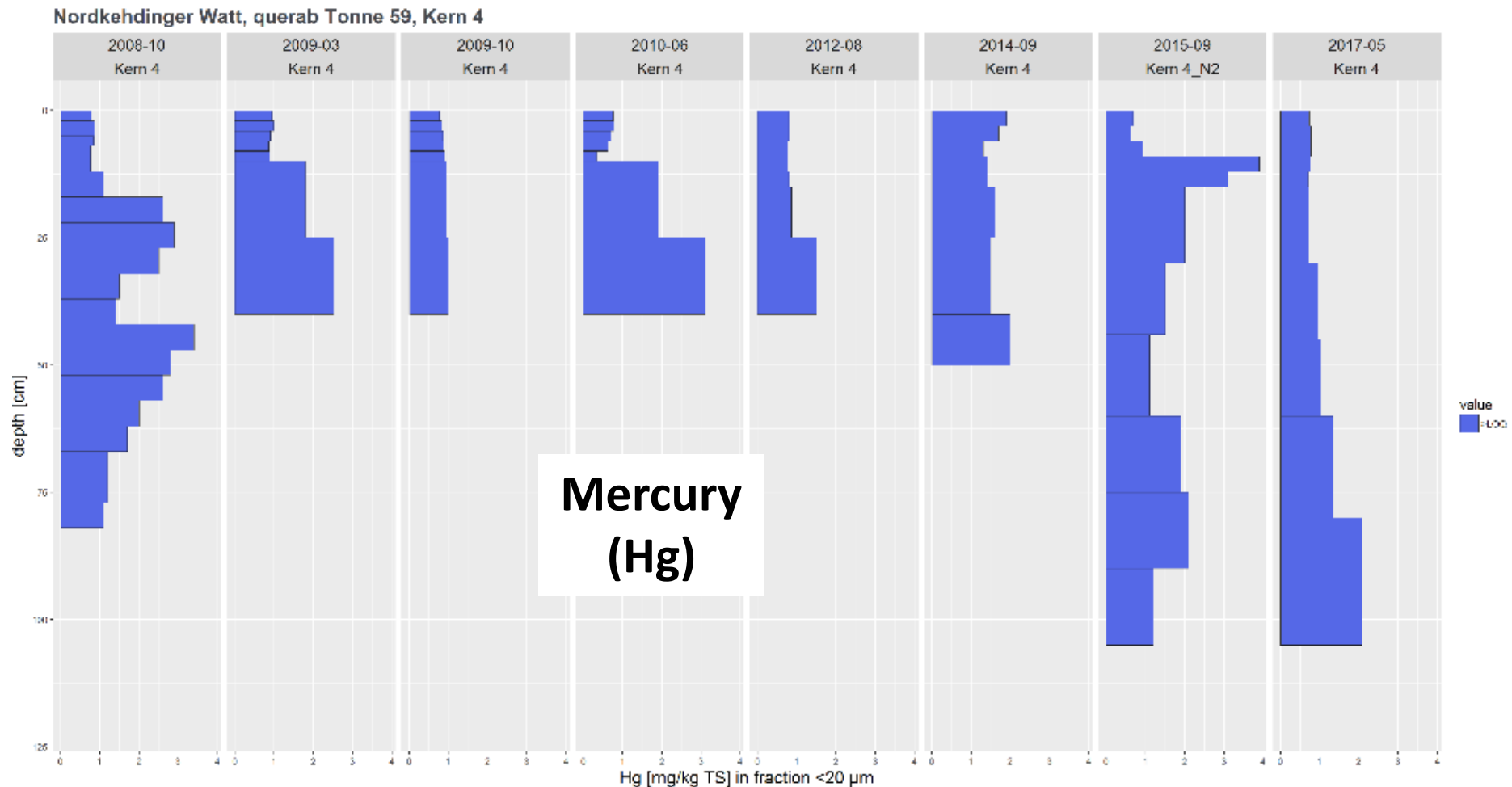




# The Role of contaminants in dredging management

## Monitoring activities in the Elbe estuary – understanding the system

### Contaminant concentrations in sediment cores over time



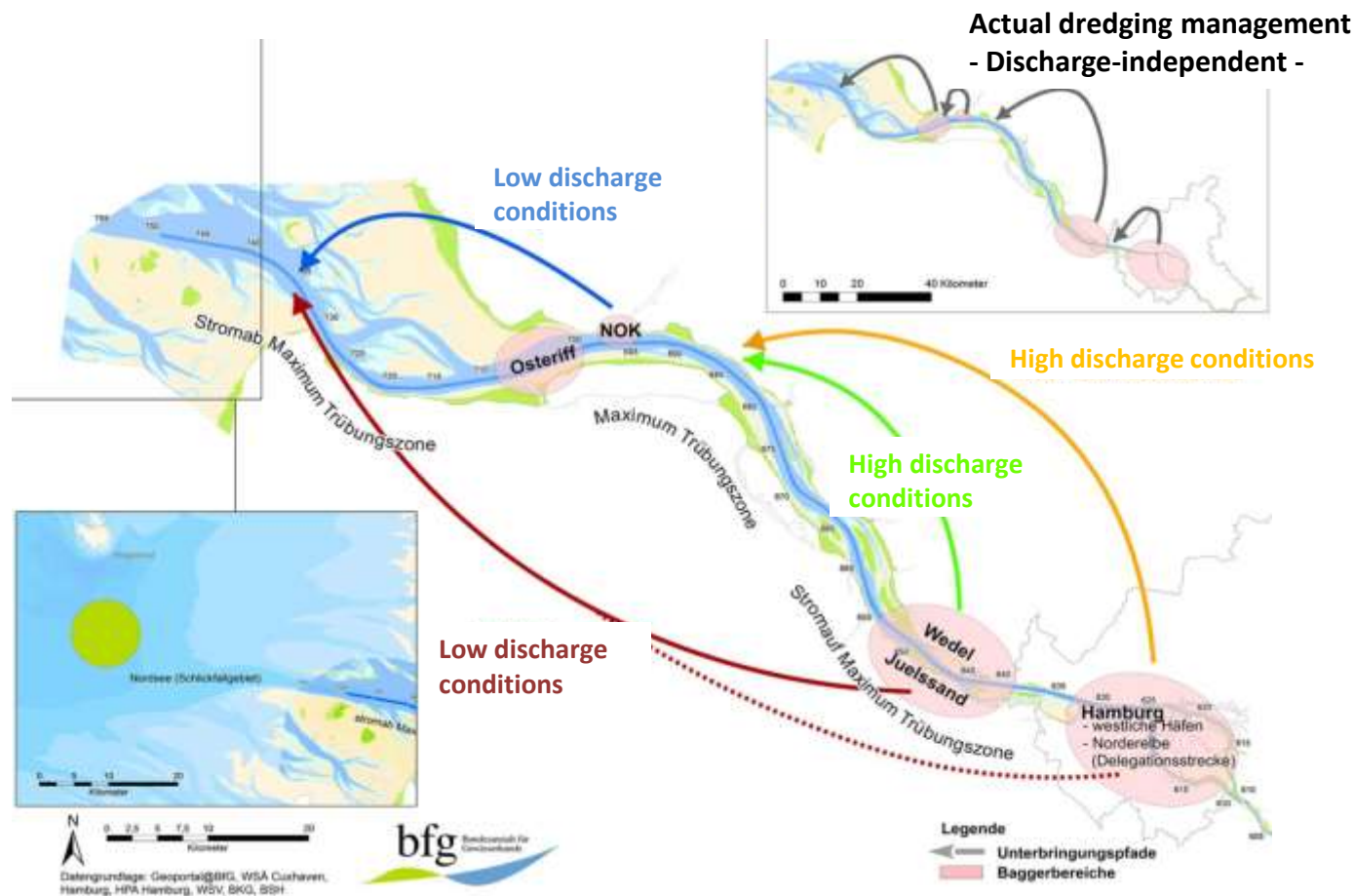
- Concentrations increase with depth
- More or less constant concentrations in the upper layers
  - comparable to current Hg concentrations in the SPM
- Erosion and deposition in balance at most sites

- Decreasing contaminant concentrations over time
- Decreasing contaminant concentrations of sediments downstream the estuary
- Discharge-dependent contaminant concentrations
  - High discharge → high contaminant concentrations
  - the upper Elbe River is the source of contaminants (except for TBT)
  - Low discharge → low contaminant concentrations
- Long-lasting low discharge conditions
  - Huge amount of dredged sediments – dredging in a circle
  - First: accumulation of contaminants in the estuary  
→ High contaminant loads
  - Second: dilution of contaminant concentrations in the estuary by the high amount of little contaminated marine sediments
- Long-lasting high discharge conditions
  - First flush – very high concentrations
  - Concentration level remains high
- Higher contaminant concentrations in deeper layers
- At most sites erosion and sedimentation in balance



**Recommendations for dredging  
management in the Elbe estuary**

## Adaptive dredging management in the Elbe estuary – discharge dependent



The results of contaminant monitoring are one component for dredging management recommendations!





# Thank you for your attention