Modelling Future Deltaic Systems

Marieke Kootte

Hoogwater

hoogwater / stormvloed
verhoogde waterstand

Modelling Future Deltaic Systems

Zwolle
Deventer
Zutphen

Henk Schuttelaars
Delft Institute of Applied Mathematics
- EEMCS

In this flagship, there is a close collaboration with
- CEG
- BK
- TPM

Marieke Kootte

bron: Rijkswaterstaat

Motivation

The aim of the research in this flagship is to

- Model
- Gain fundamental understanding

of deltaic systems which allows for the assessment of effects of climate change and human interventions (re-design) on

- Safety
- Economic values
- Ecological values

Often competing effects!

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Motivation

The aim of the research in this flagship is to

- Model
- Gain fundamental understanding

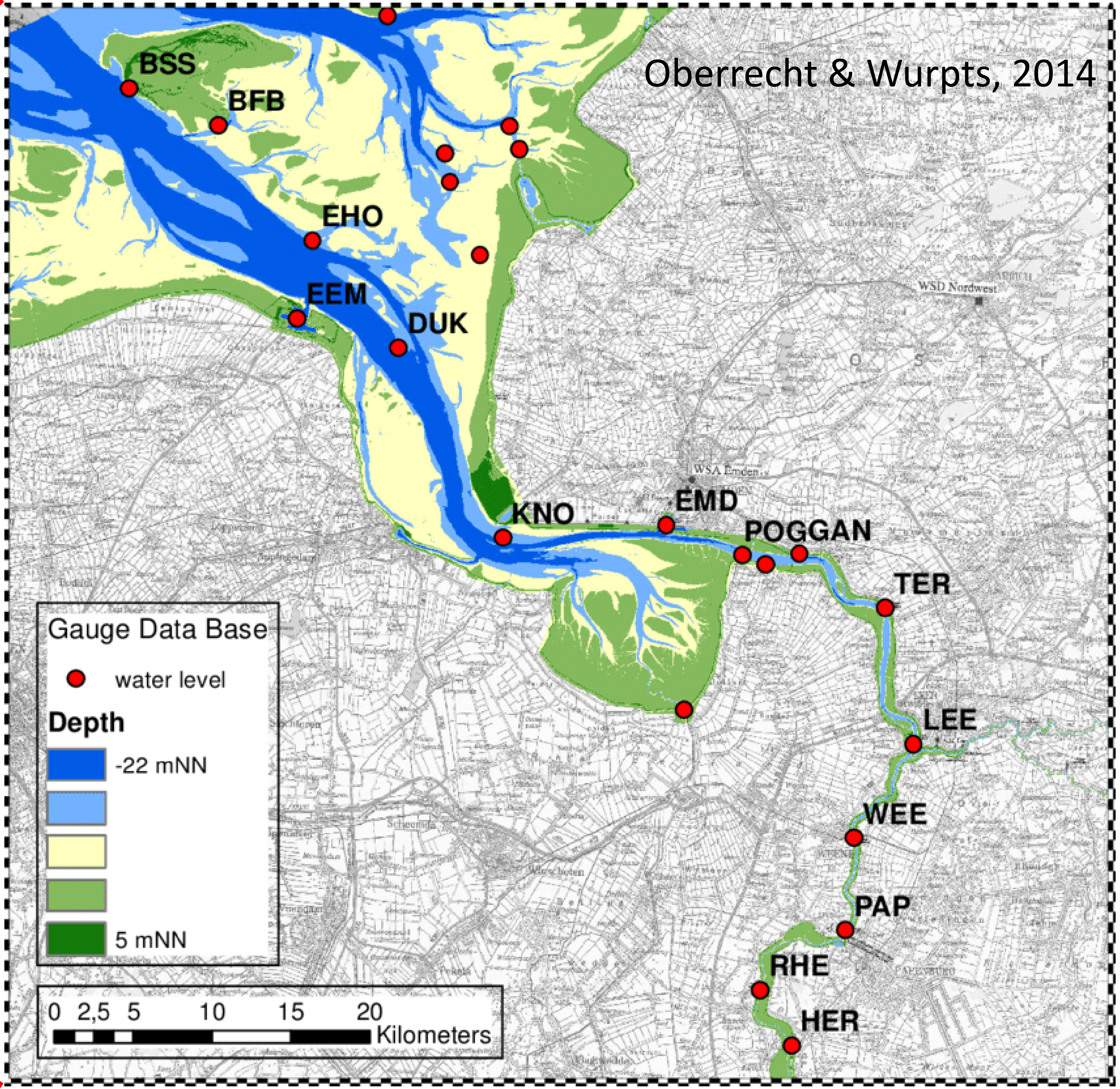
of deltaic systems which allows for the assessment of effects of climate change and human interventions (re-design).

We need fundamental knowledge of these systems to

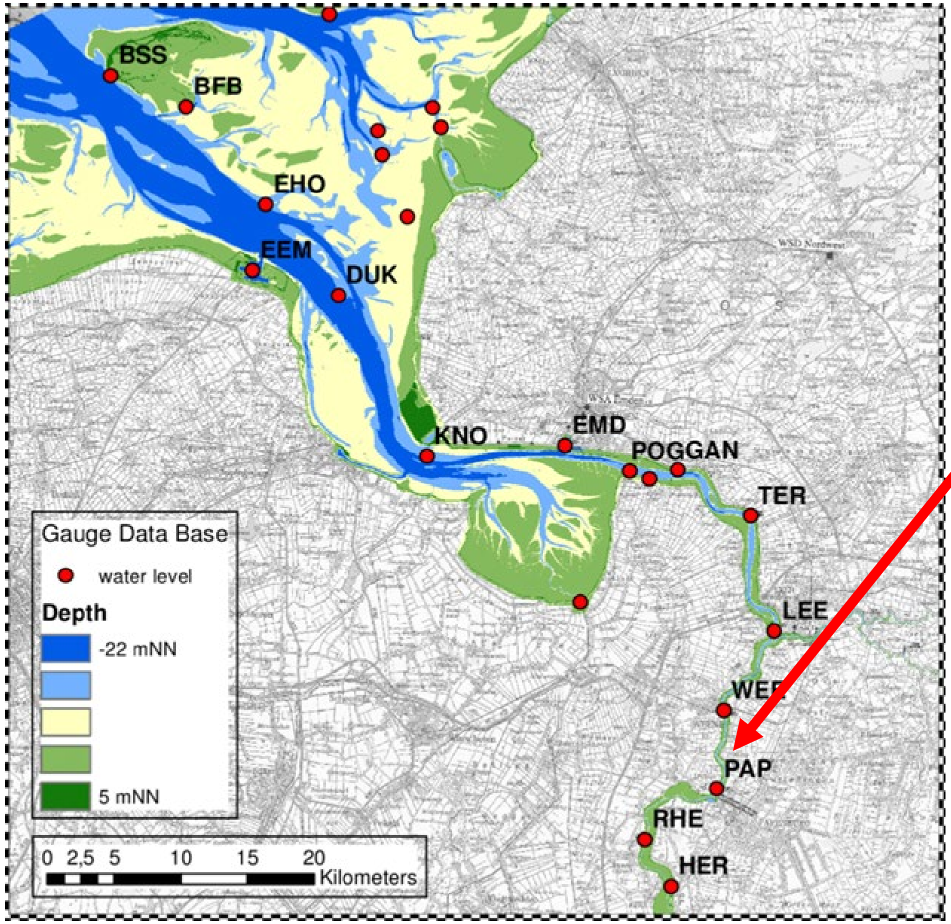
- Minimize possible impacts
- Mitigate unforeseen impacts

Example – Ems Estuary (1/2)

Example – Ems Estuary (2/2)



Ems Estuary – Economic Activity (1/3)



Shipyard (1795)

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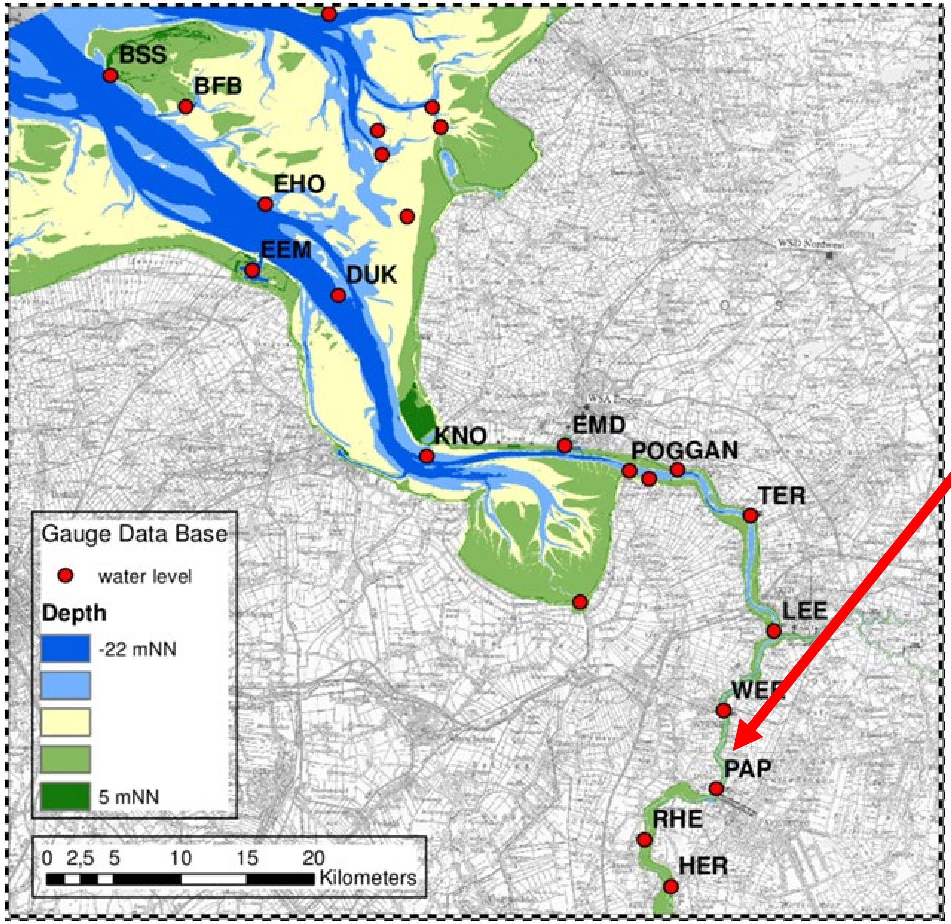
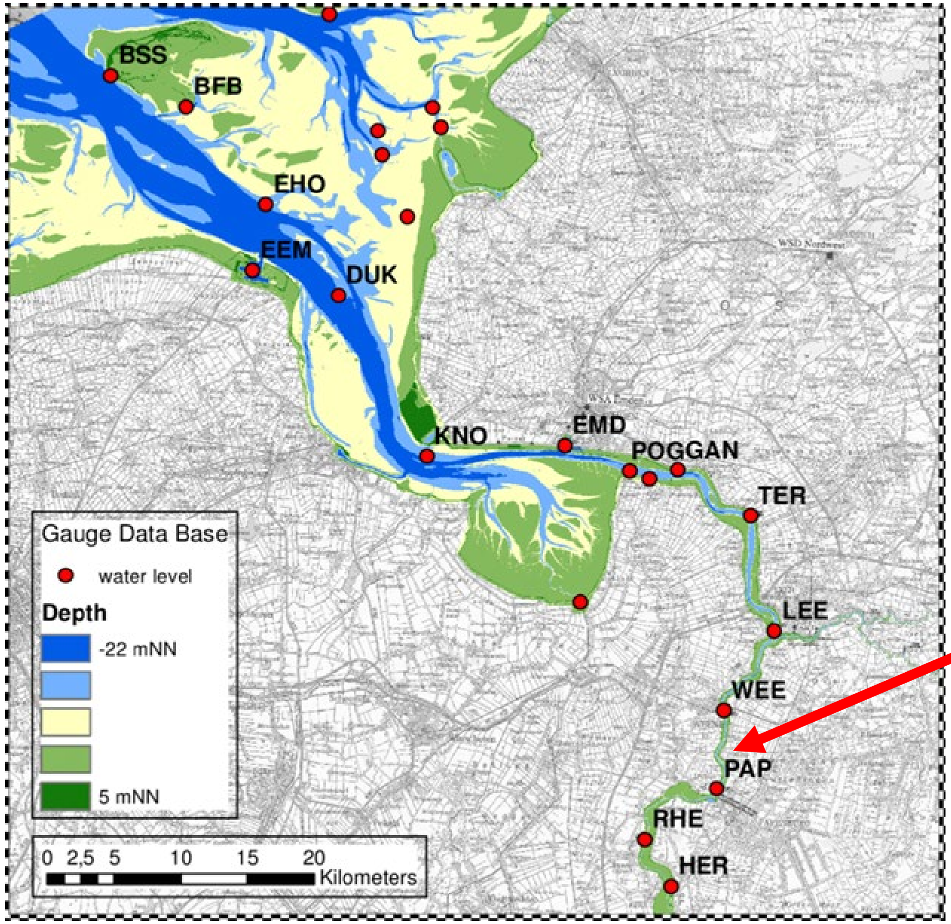
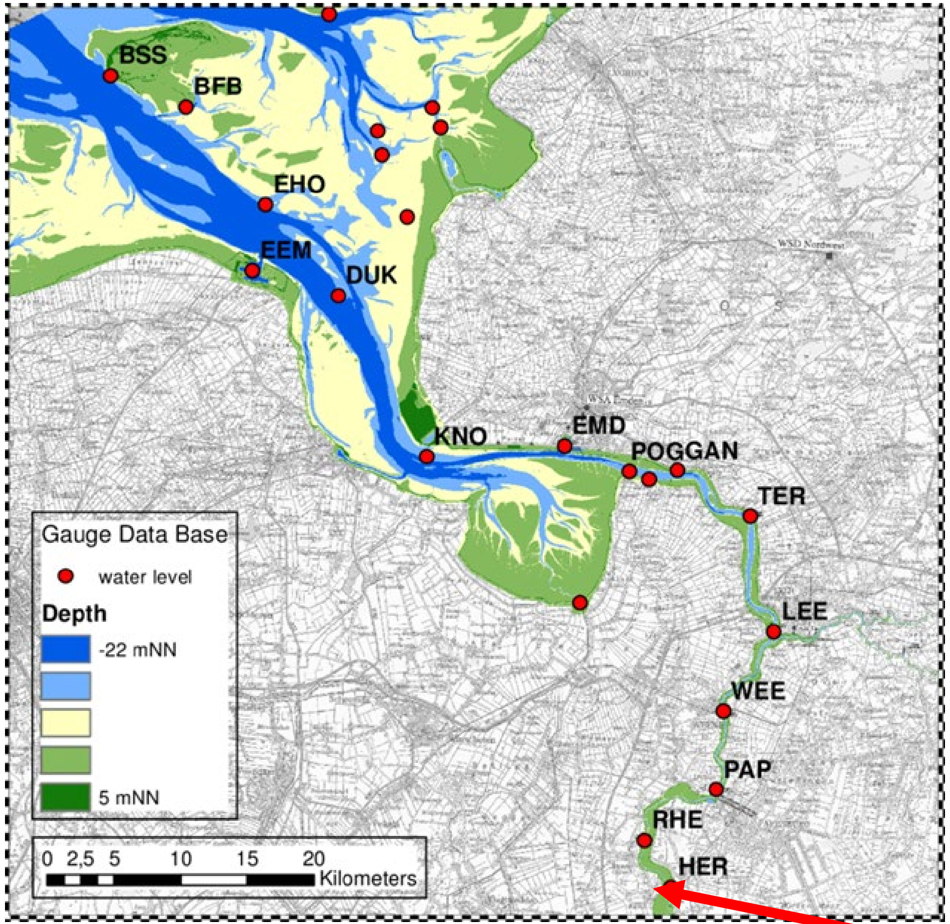
Ems Estuary – Economic Activity (2/3)



Ems Estuary – Economic Activity (3/3)



Redesigning the Ems Estuary – Construction of a weir



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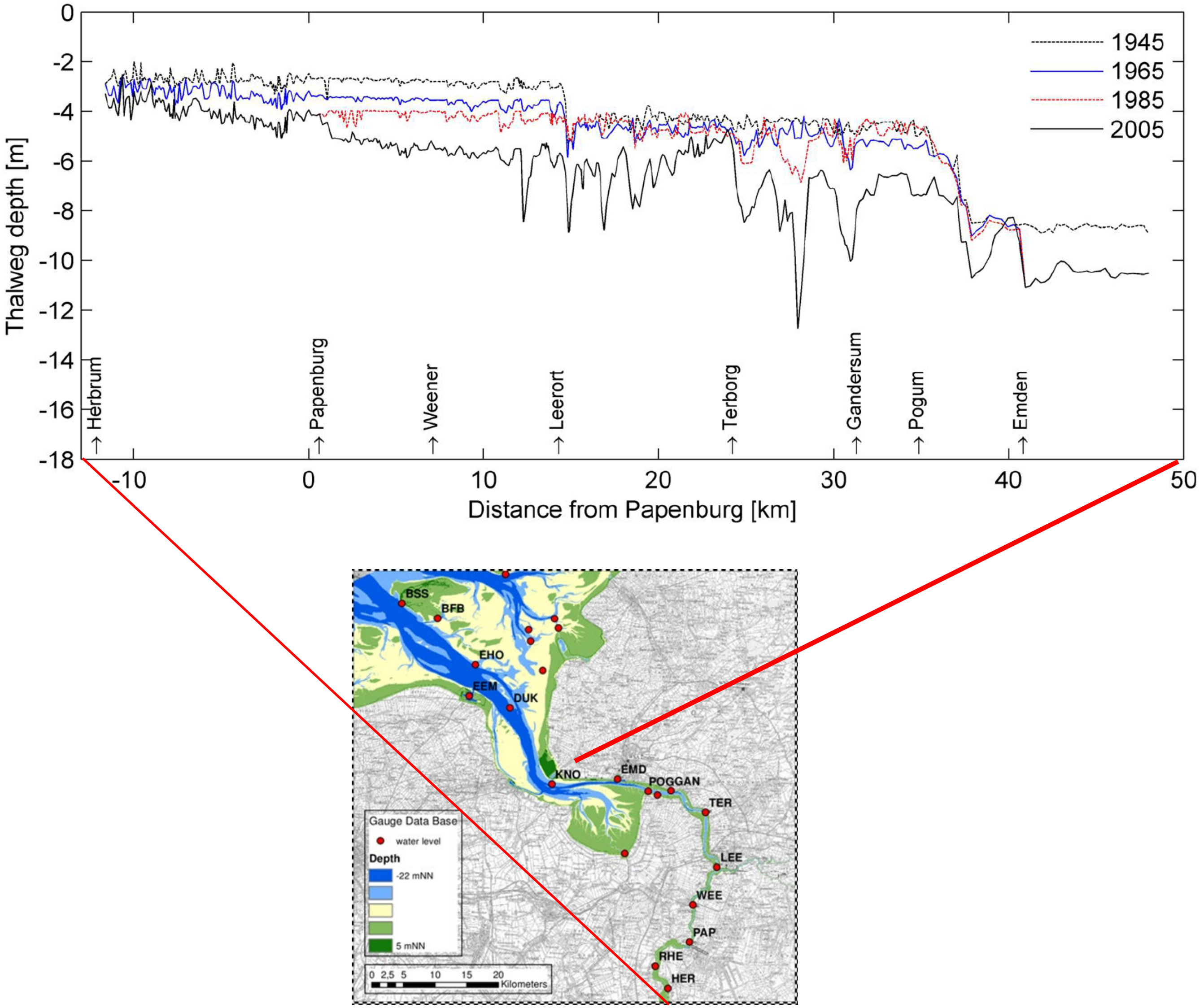
Redesigning the Ems Estuary – Channel deepening

Water depth



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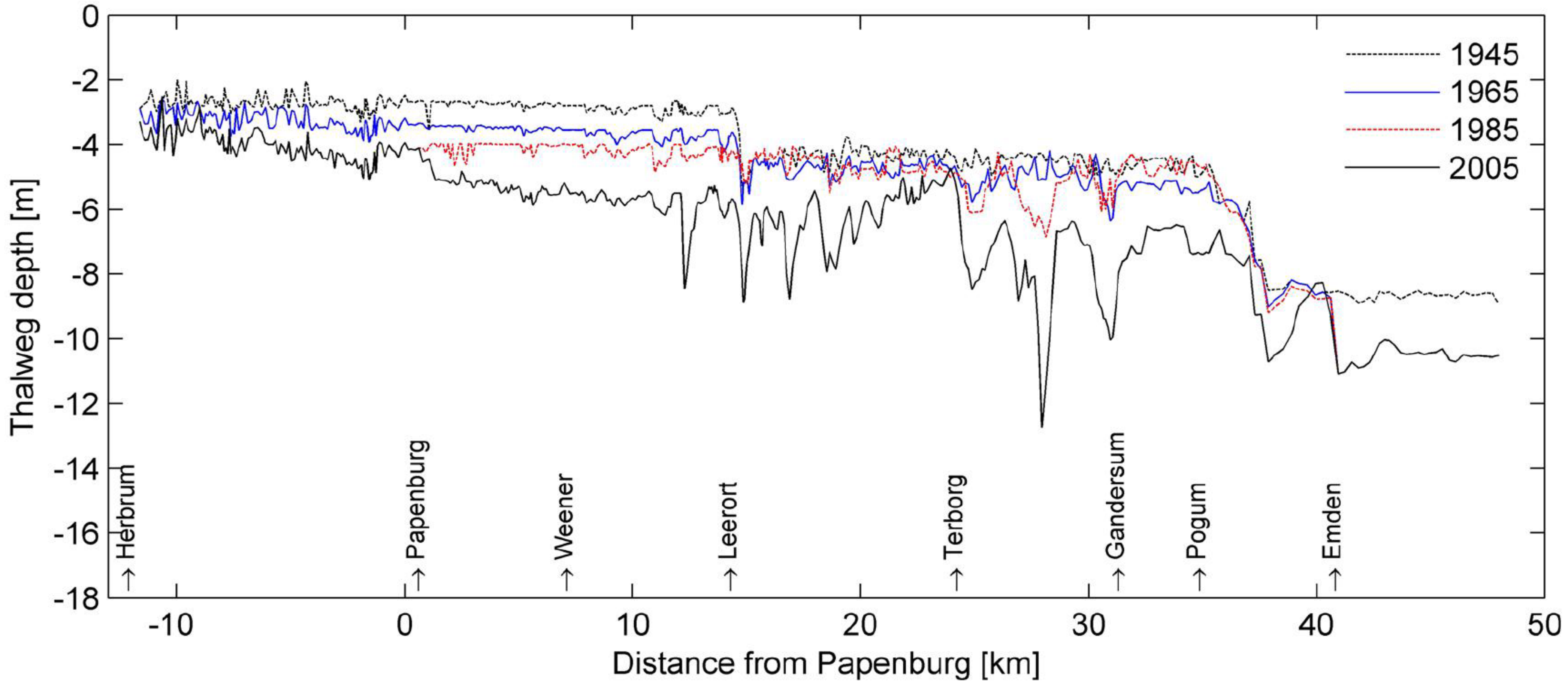
Redesigning the Ems Estuary – Channel deepening

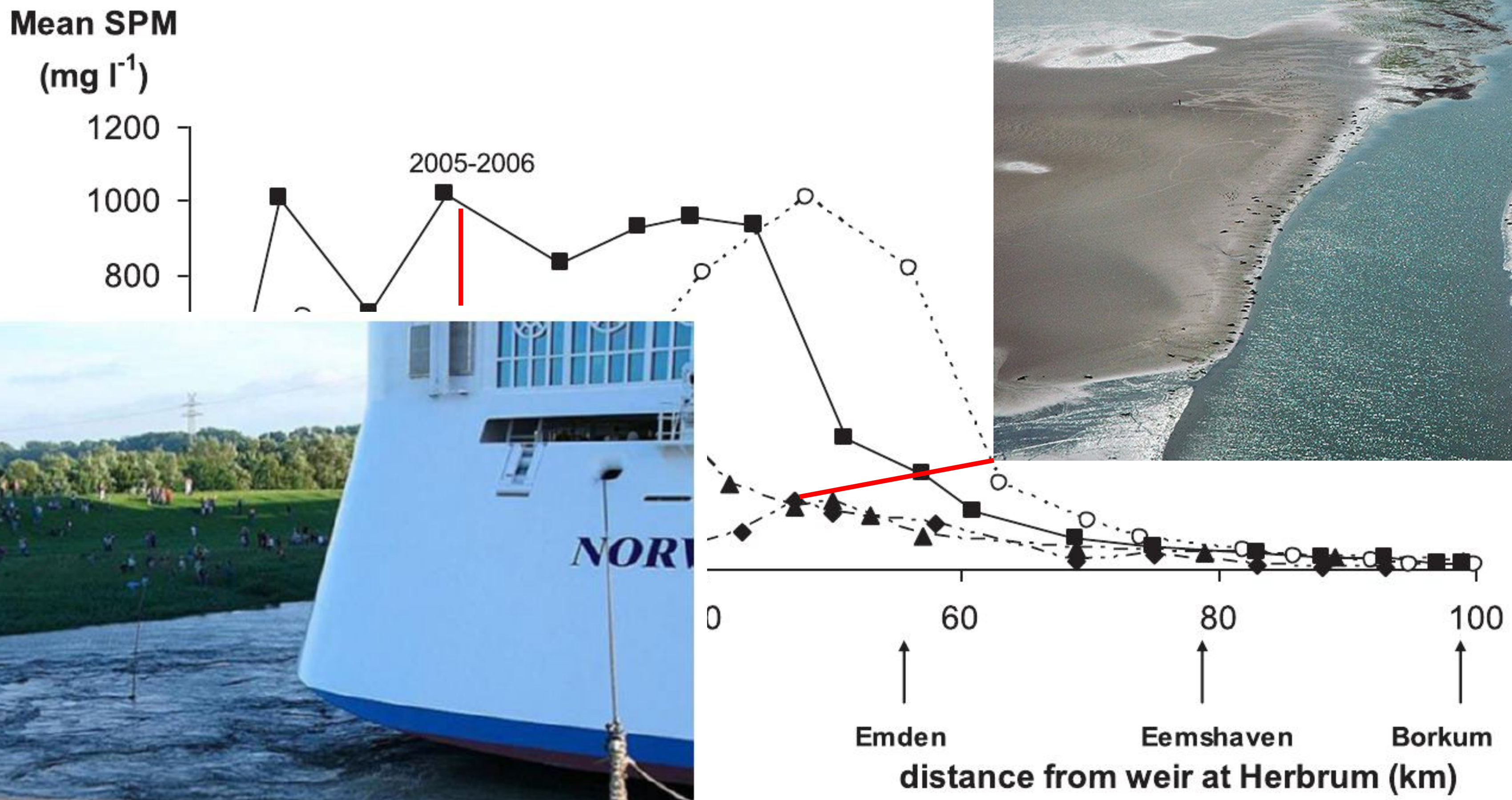
Water depth



Van Maren et al. (2015)

Redesigning the Ems Estuary – Impact

Landward side



De Jonge et al, 2014

Research Question

- Observations:
  - Low Turbidity before the 90's
  - High Turbidity since the 90's

- Research Questions:
  - Can we model this change (over decades)?
  - Can we understand it (identify dominant mechanisms)?
  - Can we propose measures to mitigate these changes?

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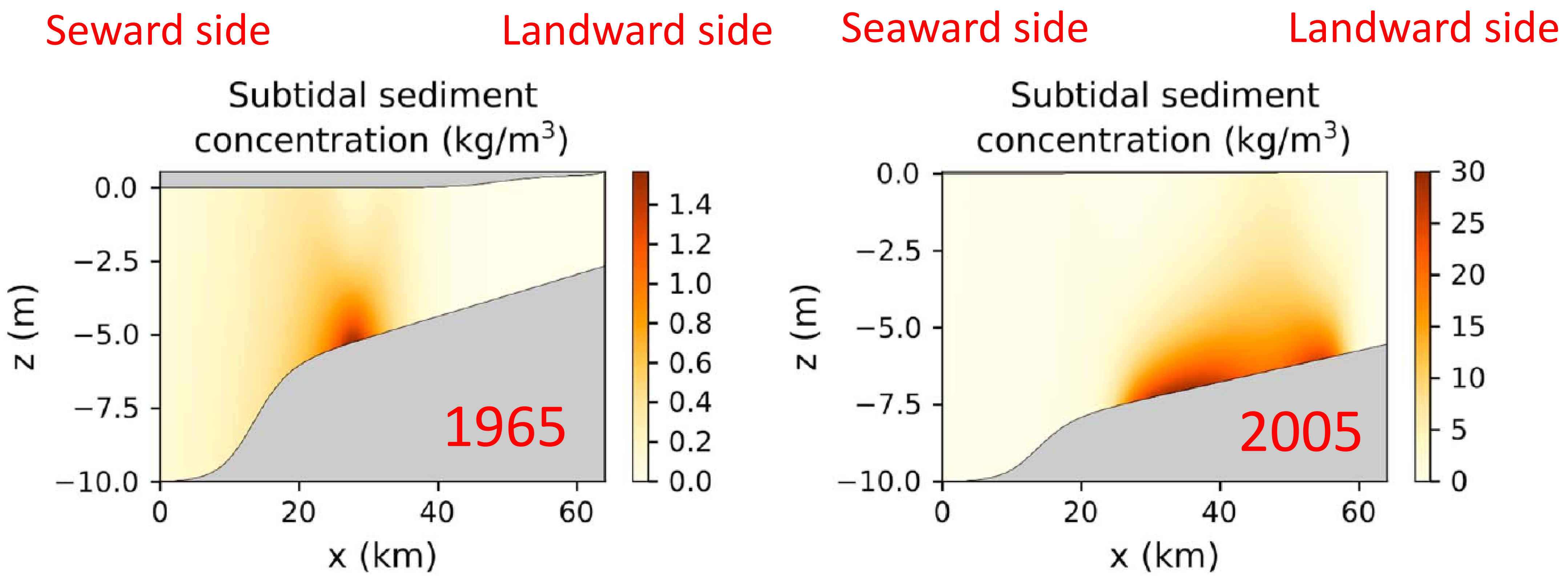
Can we model this?

In Dijkstra et al (2019) a model is developed that captures these changes without recalibrating the model



Physical Mechanism

<u>Mechanism</u>: the system has become resonant (M4 tide) due to deepening and reduced friction, which resulted in an enhanced import of sediments from the sea

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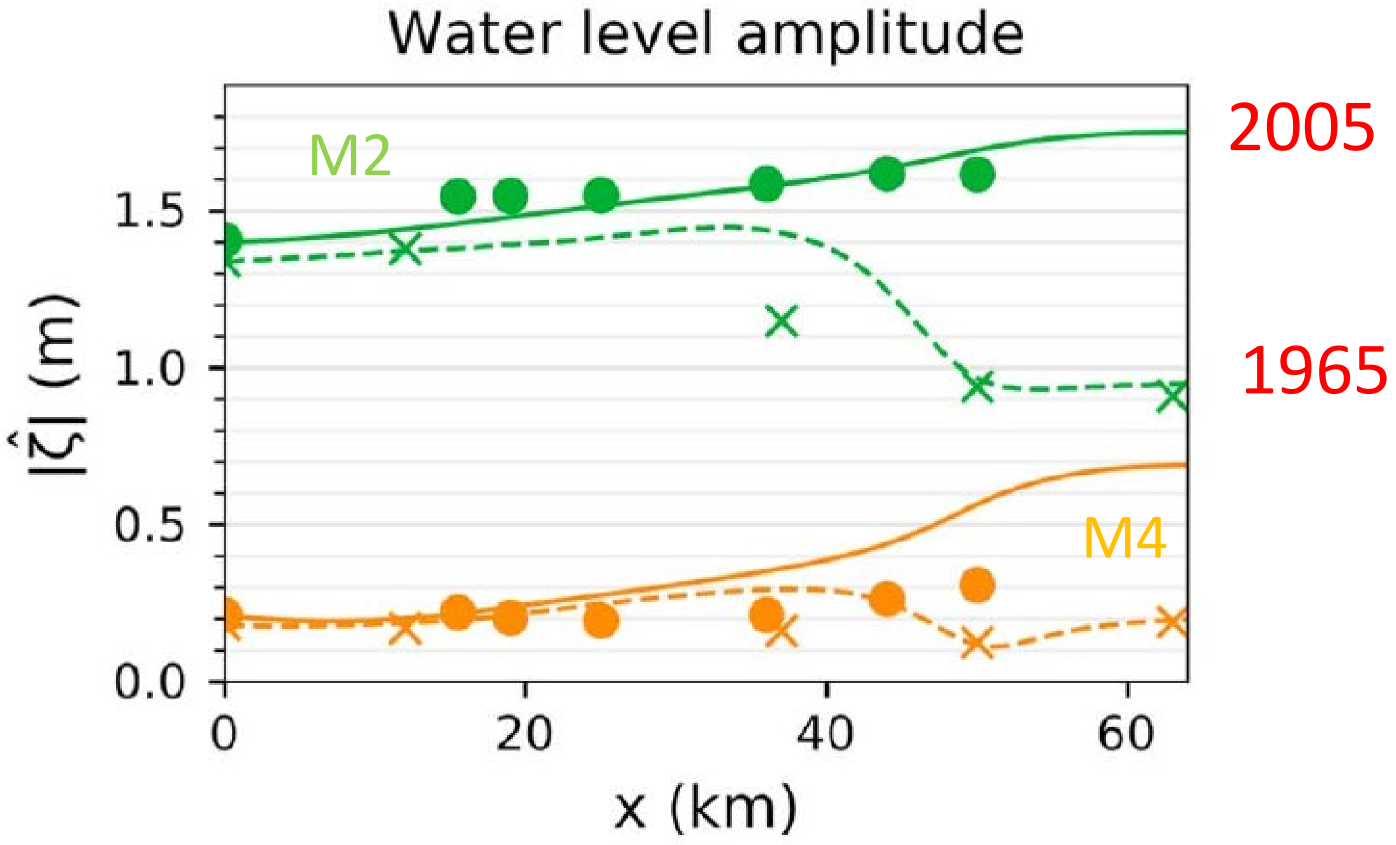
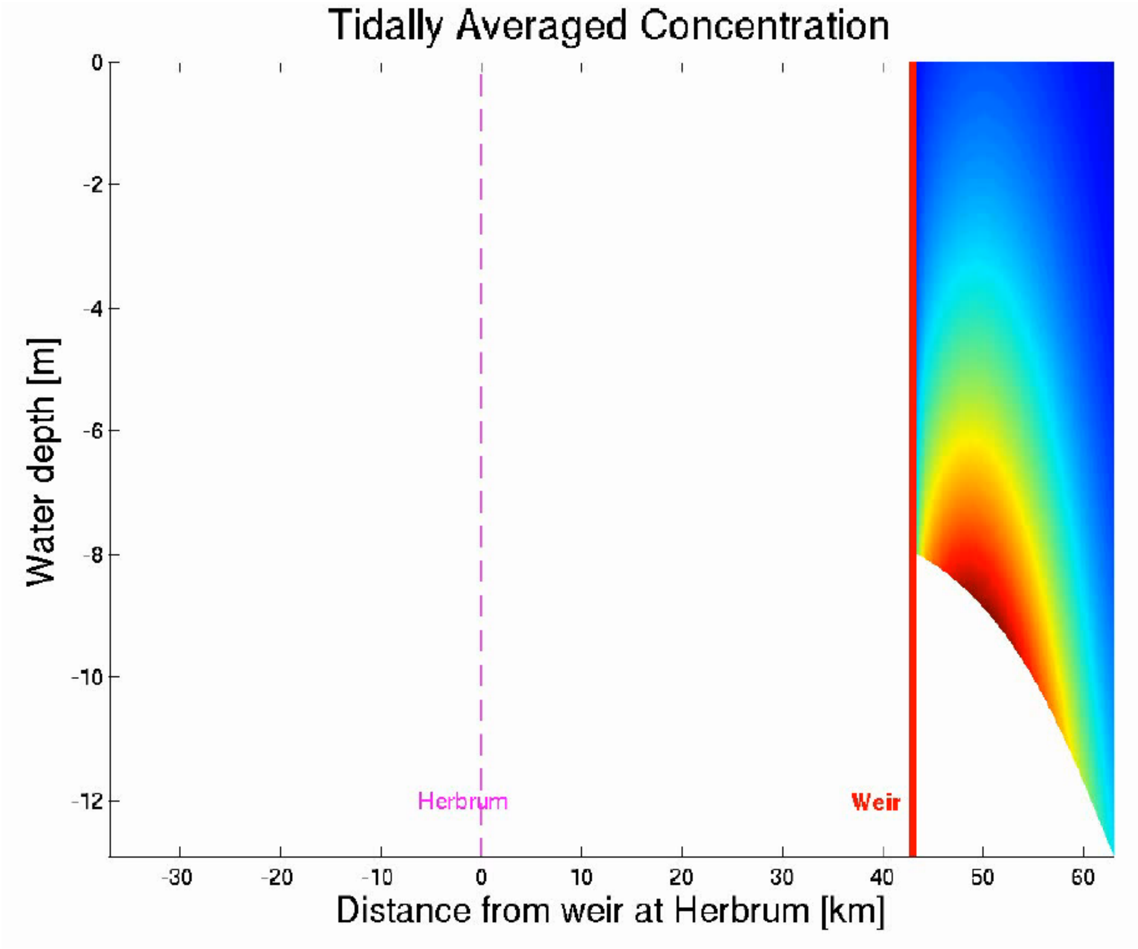


Mitigation by changing the length (1/4)

Mitigation Possibility: get the system out of resonance, for example by changing the length

Landward side

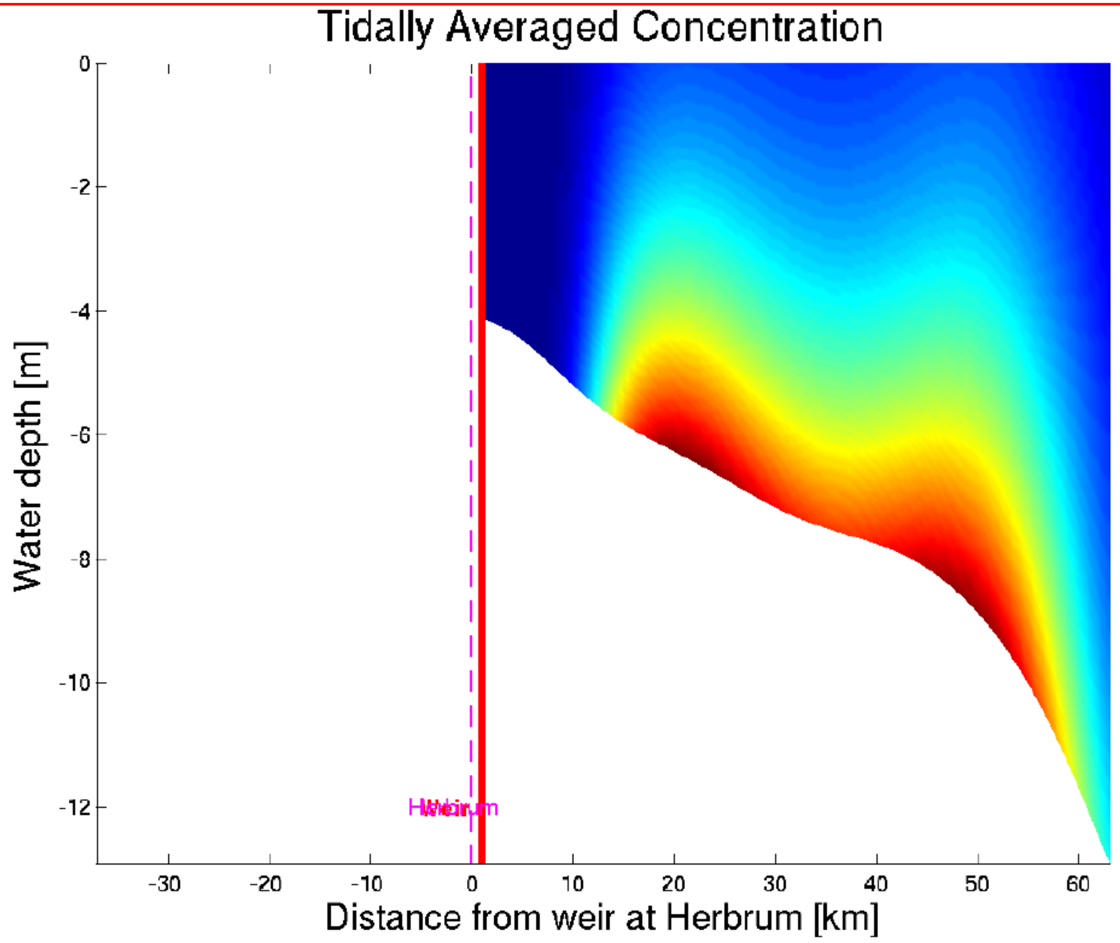


Seaward side

Mitigation by changing the length (2/4)

<u>Mitigation Possibility</u>: get the system out of resonance,
for example by changing the length

Landward side



Seaward side

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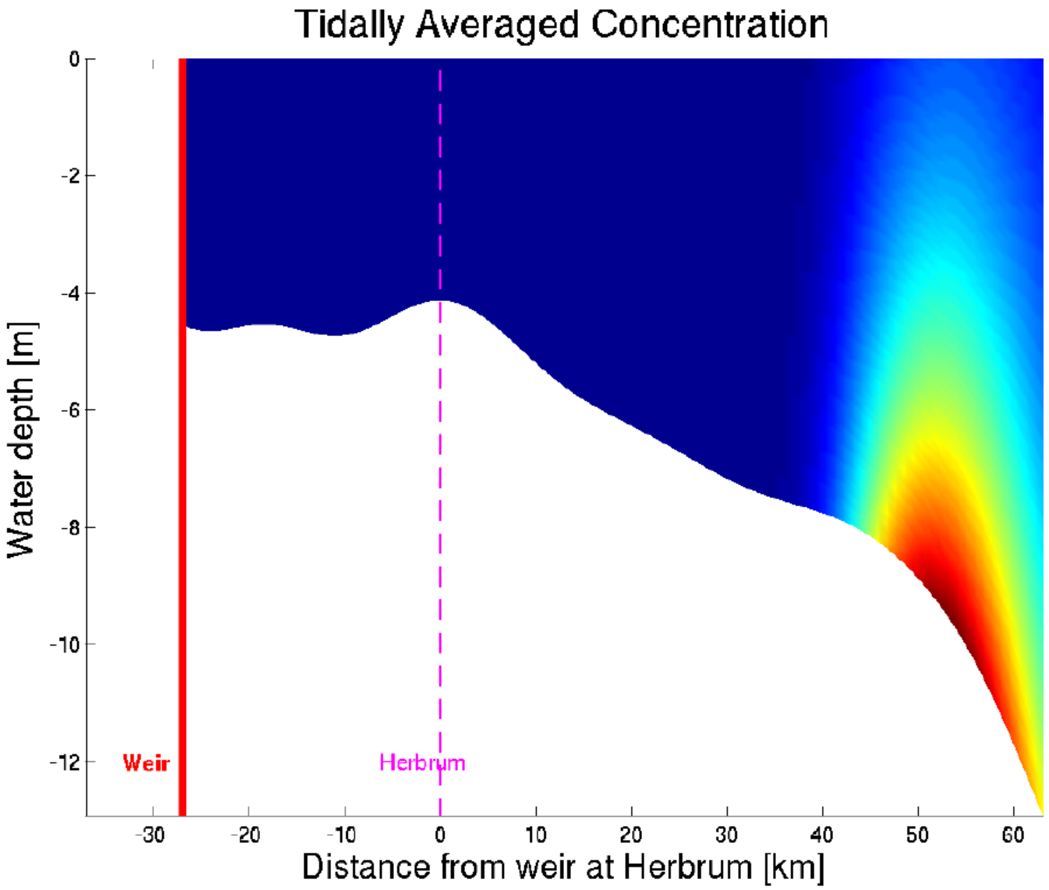
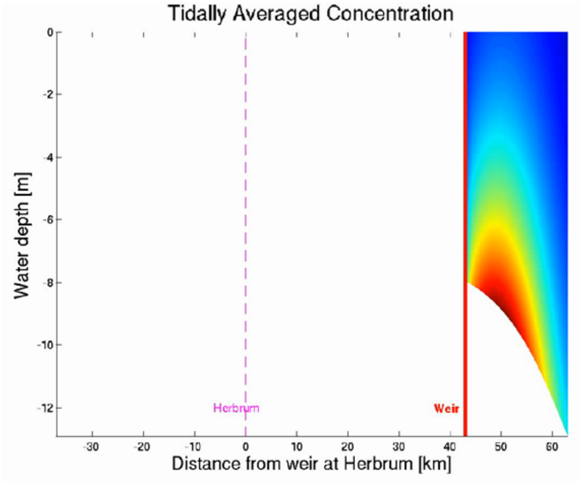


Seaward side

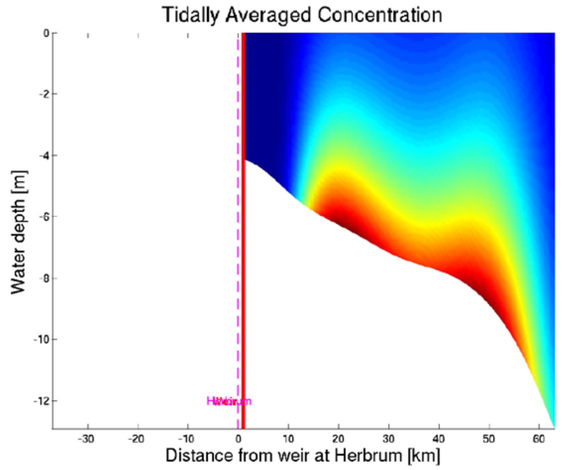
Mitigation by chaning the length (4/4)

Mitigation Possibility: get the system out of resonance,
for example by changing the length

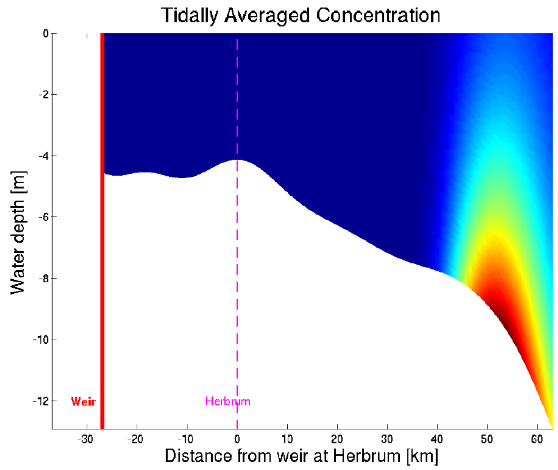
L = 30 km



L = 60 km



L = 90 km



Critical length of approx. 60 km (tipping point)

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Conclusions

- Gaining fundamental insight into the essential mechanisms allows for
  - Clear understanding of impacts of changes, both climate and human-induced
  - Suggestions of mitigation measures (that would otherwise not be considered

- Each system may react differently to changes (so do not generalize observations from one system).

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