

Large-scale sediment transport and morphological modeling as a sediment management tool

Dennis Oberrecht



Workshop „Sediment Management in Ports“

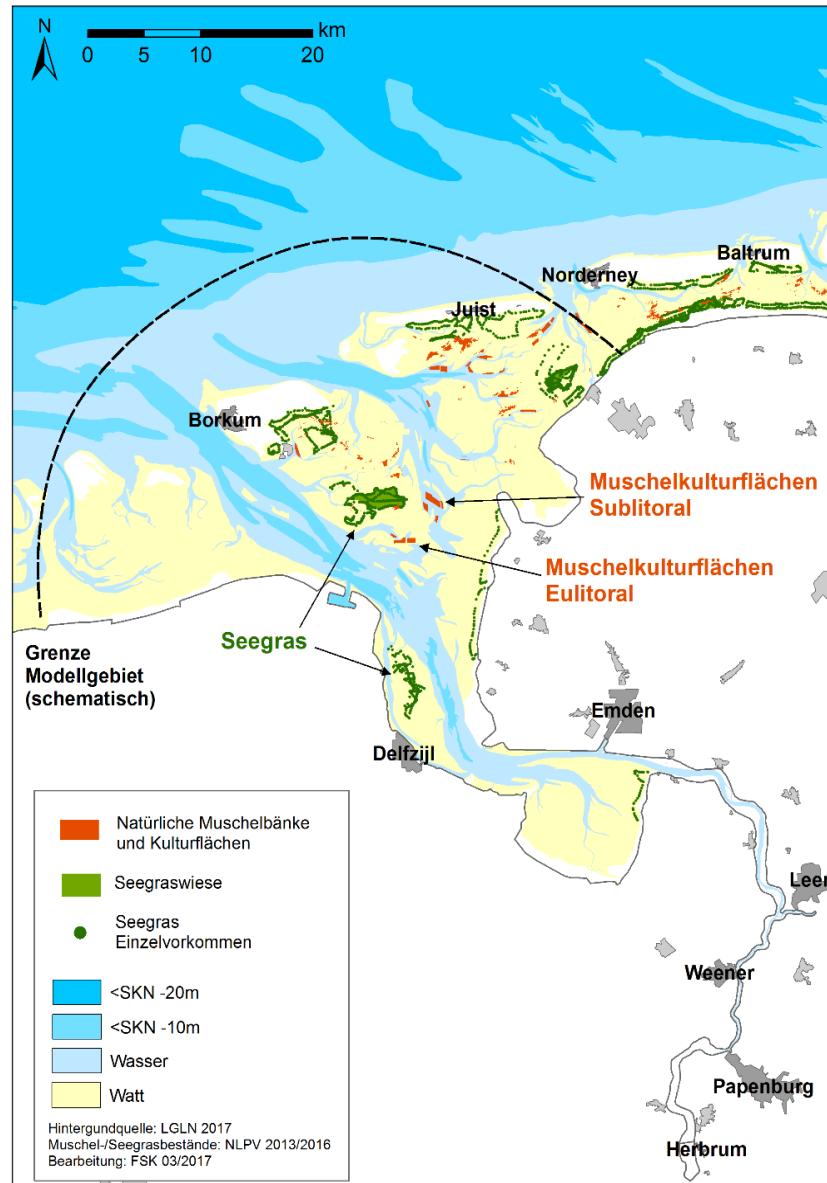
Eemshaven, 29.10.2019

Motivation: Sediment Management

Sectoral approaches

- Fairway and harbor maintenance optimization (WSV, harbor administrations)
- Ecological approach (responsibility: federal states)
 - Reduction of environmental loads due to sediments (e.g. fluid mud)
 - Amplification/restoration of natural dynamics (growing of floodplains and wadden sea sediment import)
 - In a broader sense: usage of dredged matter in ecologically useful / less disturbing manner

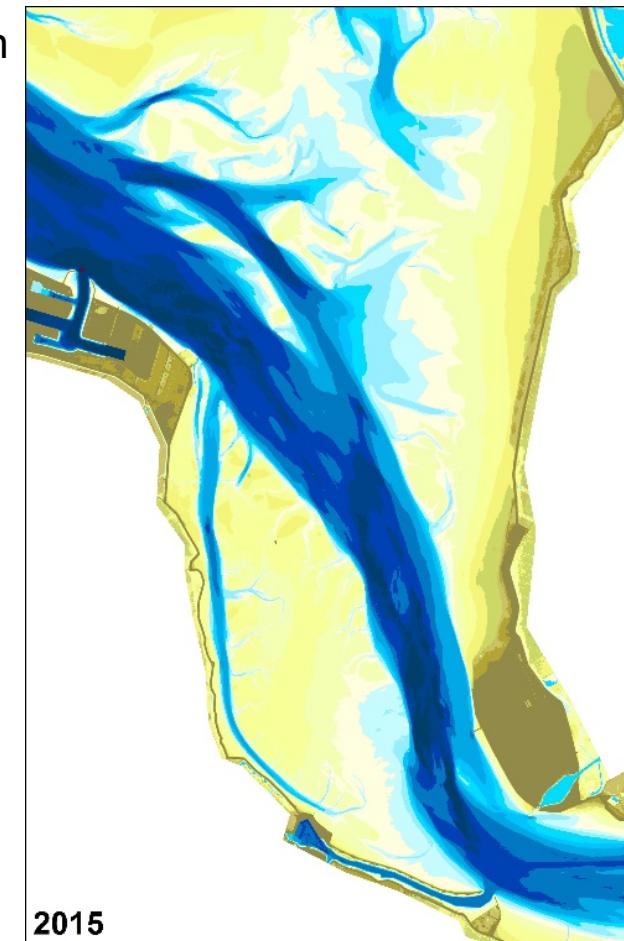
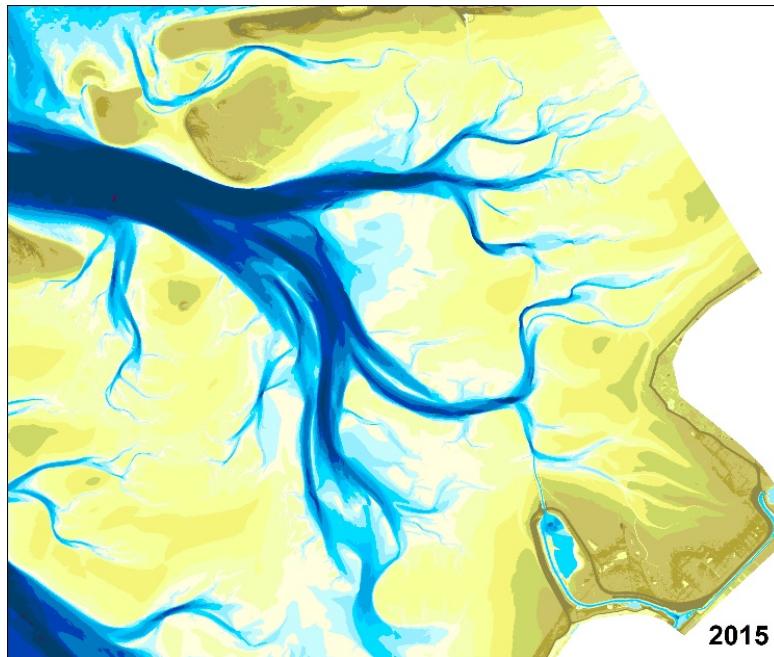
-> Dutch-german overall policy (Leitbild)
officially established in spring 2019



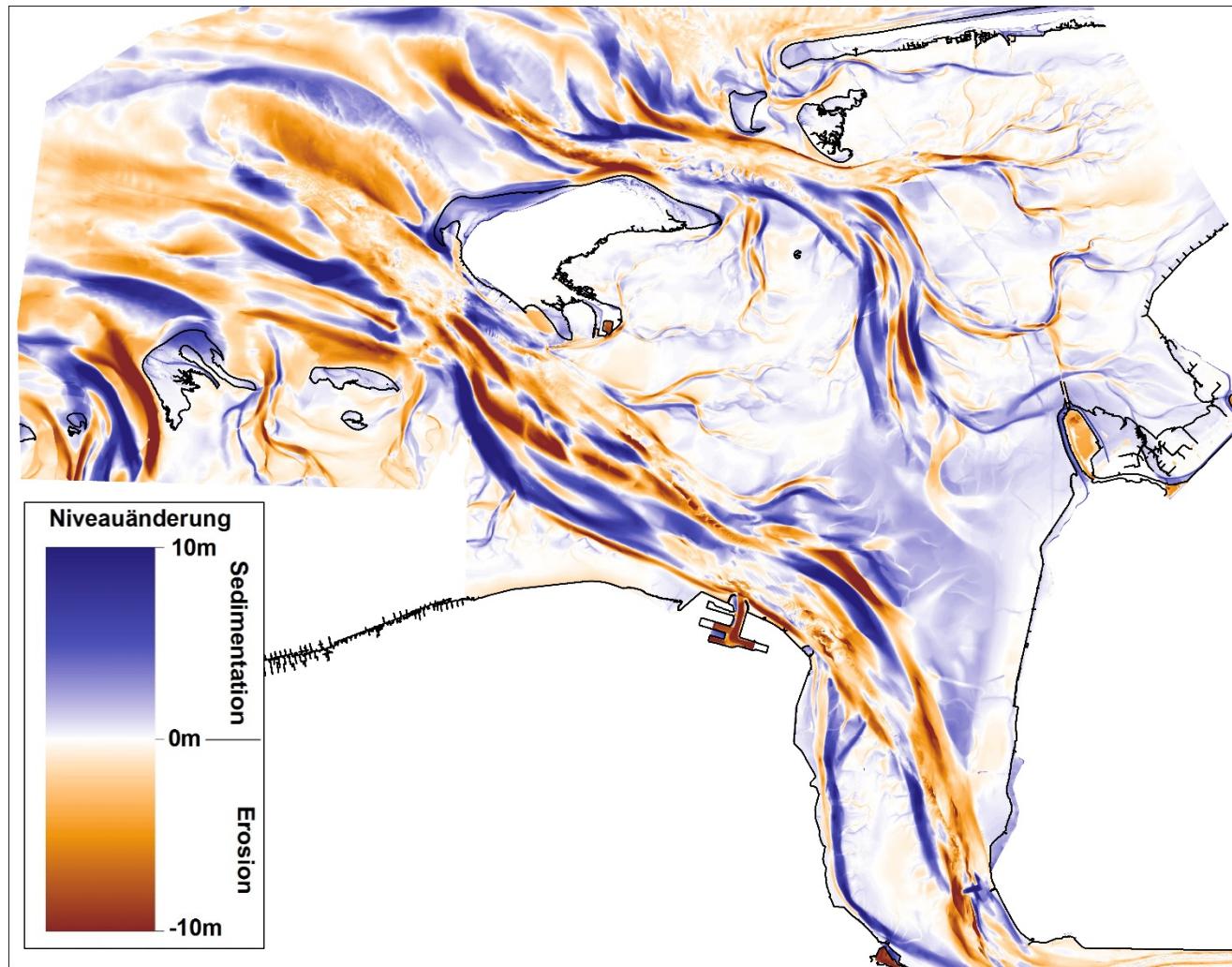
Large-scale sediment transport Morphological development

Ems from Eemshaven
to the Gatjebogen

Tidal basin of the Osterems

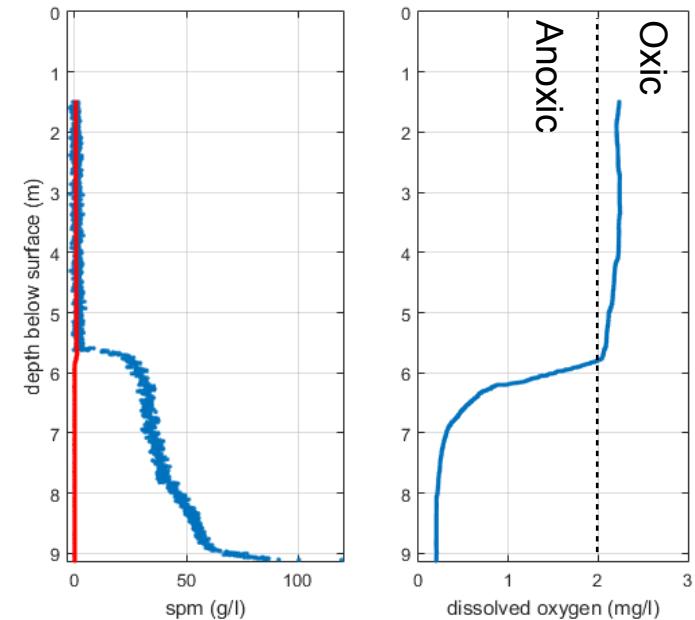


Large-scale and long-term changes in bathymetry between 1975 and 2015



„Natural dynamics“: Fluid mud

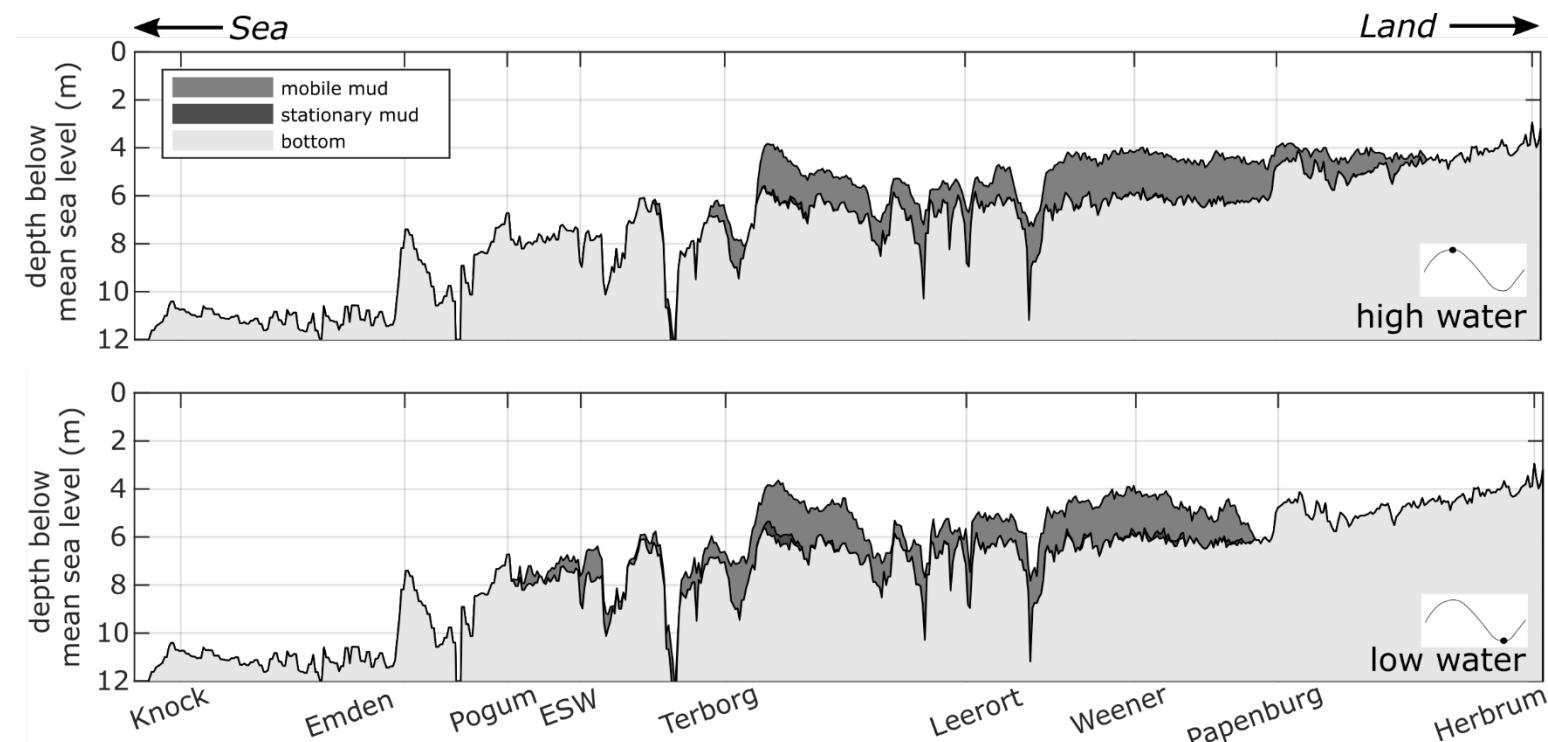
- High suspended sediment transport can change estuaries in a so called ***high-turbid estuary*** and forms **fluid mud** layers
- Fluid mud has a major impact on ***ecological state*** of an estuary
- Sediment induced stratification during high water and ebb leads to ***massive oxygen strain*** in the turbidity zone
- **Objective:** Development of a one-phase water-fluid mud mixture numerical model with transient hydrodynamics and turbulence exchange between Newtonian and non-Newtonian flow behavior



Example: Vertical profiles of suspended sediment concentration (left) and dissolved oxygen (right)

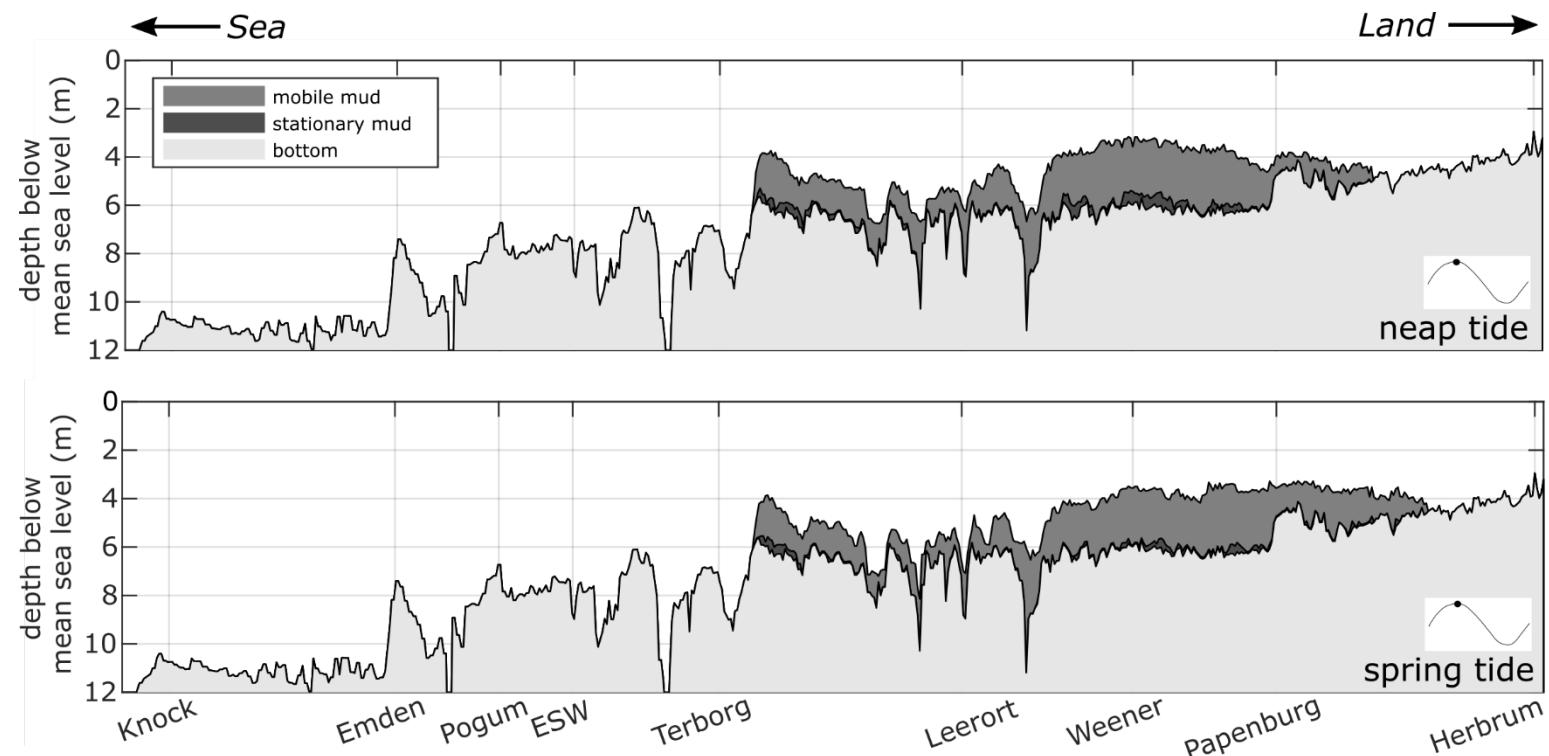
Fluid mud dynamics – tidal time scale

Model result of fluid mud distribution along the deep channel



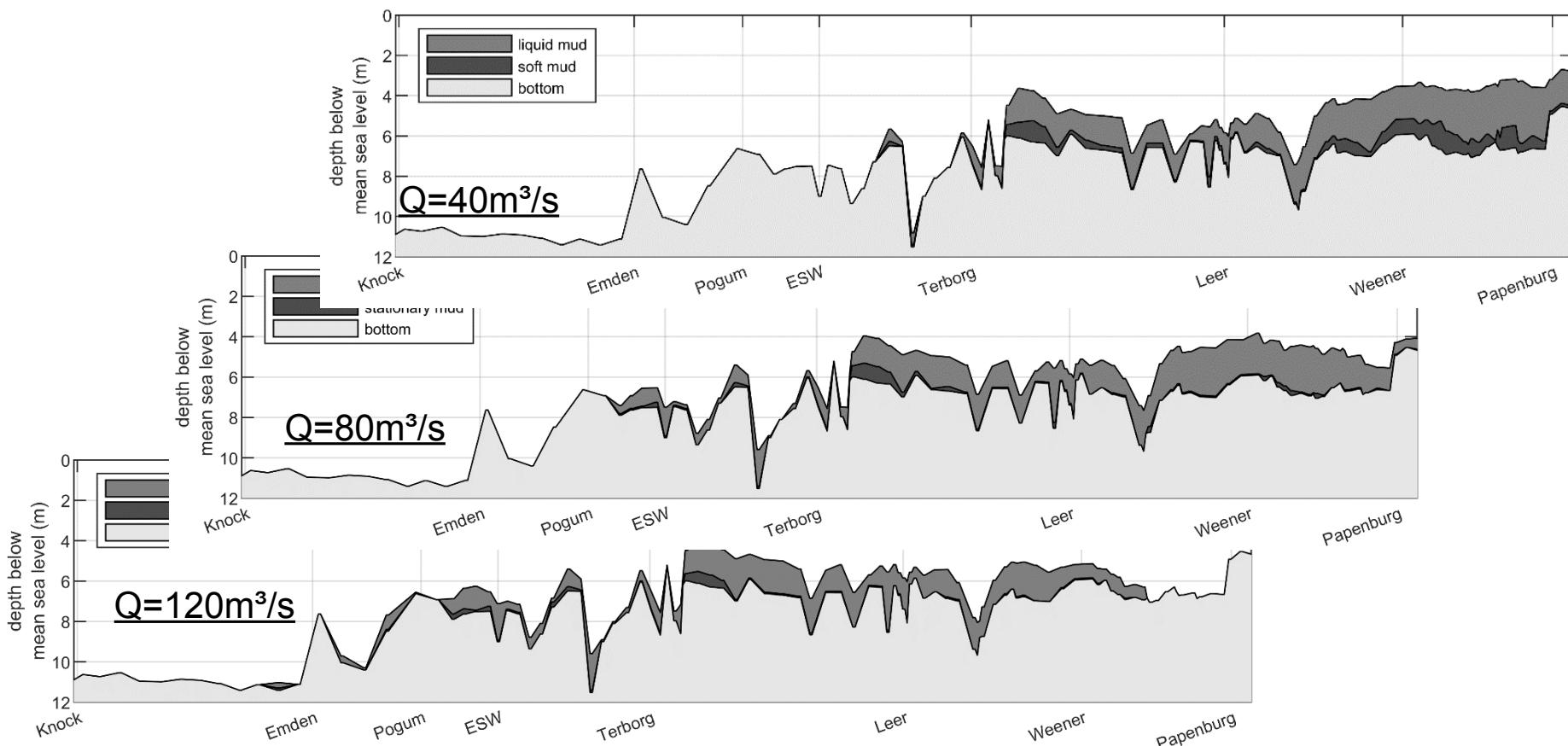
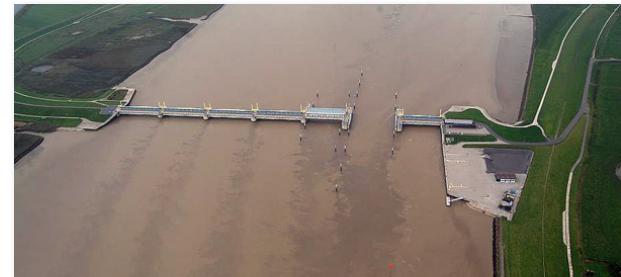
Fluid mud dynamics – neap-spring time scale

Model result of fluid mud distribution along the deep channel



Fluid mud dynamics – seasonal time scale

Model result of fluid mud distribution along the deep channel and the dynamic response to varying discharge



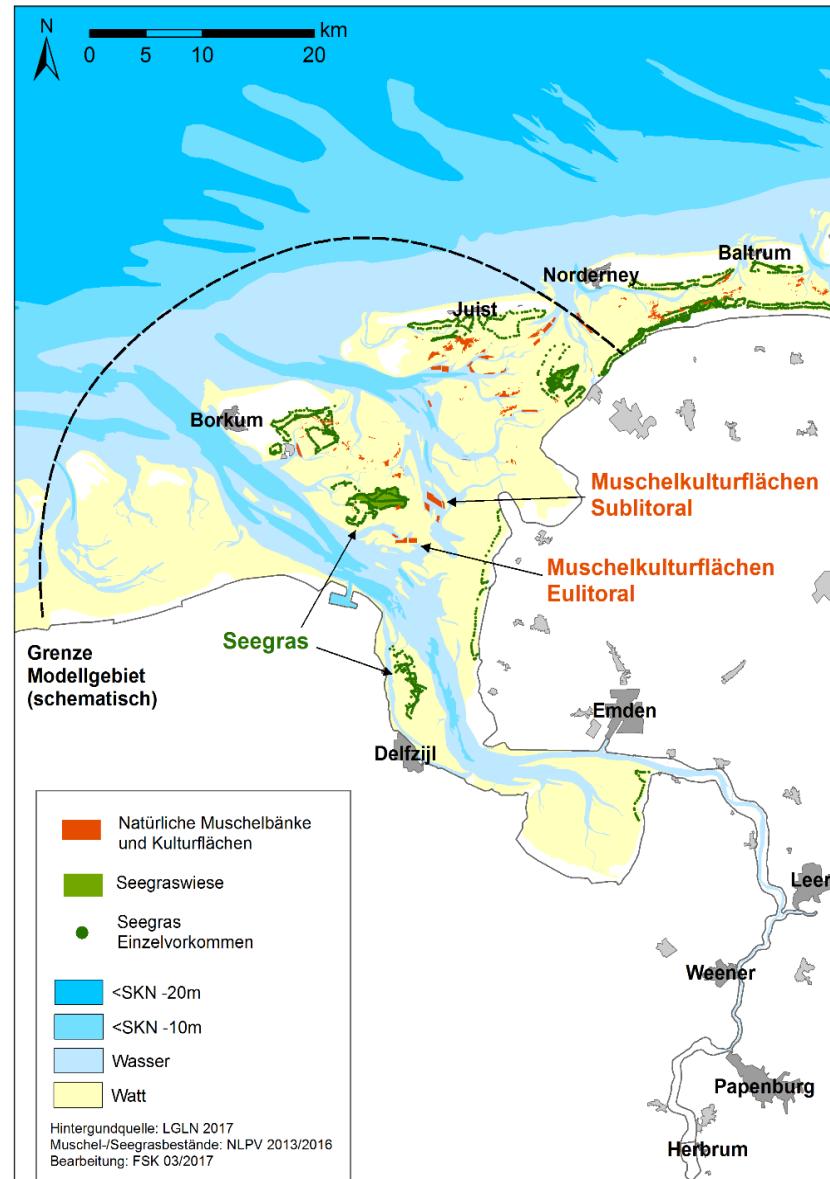
Sediment Management

Environmental goals:

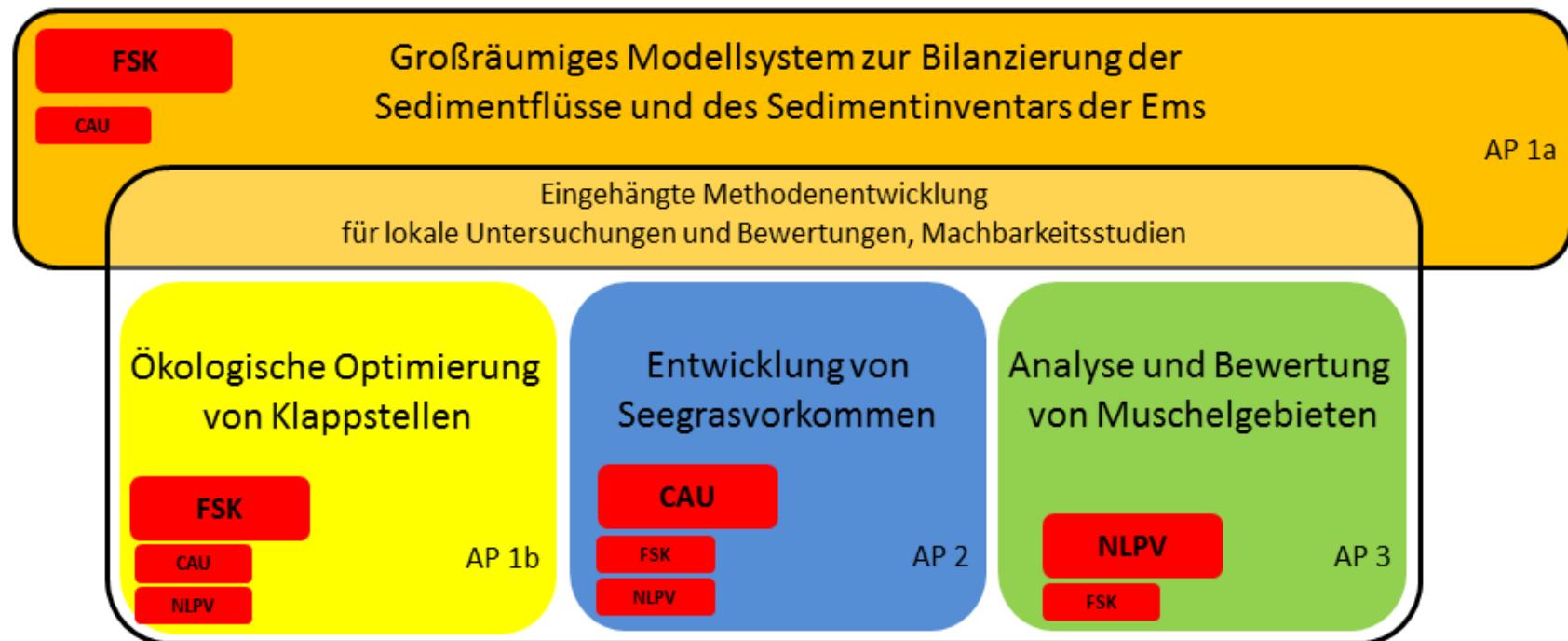
- Reproduction of the natural dynamics of the water body and the related geomorphology
- Improvement of water quality and ecology

Approach: Development of a numerical model, which

- describes the present state with sufficient accuracy
- allows a qualitative and quantitative description of sediment transport in the area of investigation
- a qualitative and quantitative assessment of interventions in the sediment budget and
- Based on results, methods for ecological improvement can be developed and applied.



Applied research project: Model set-up for sediment management purposes

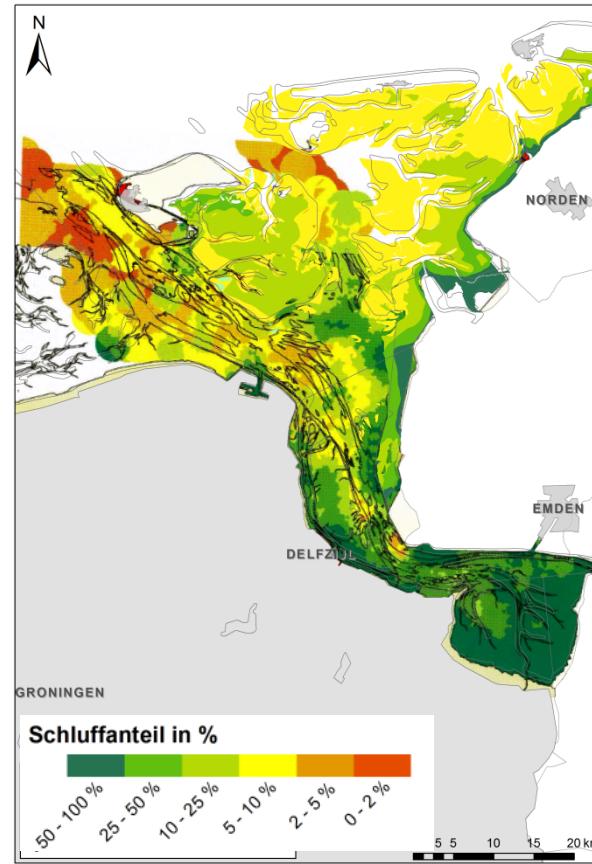
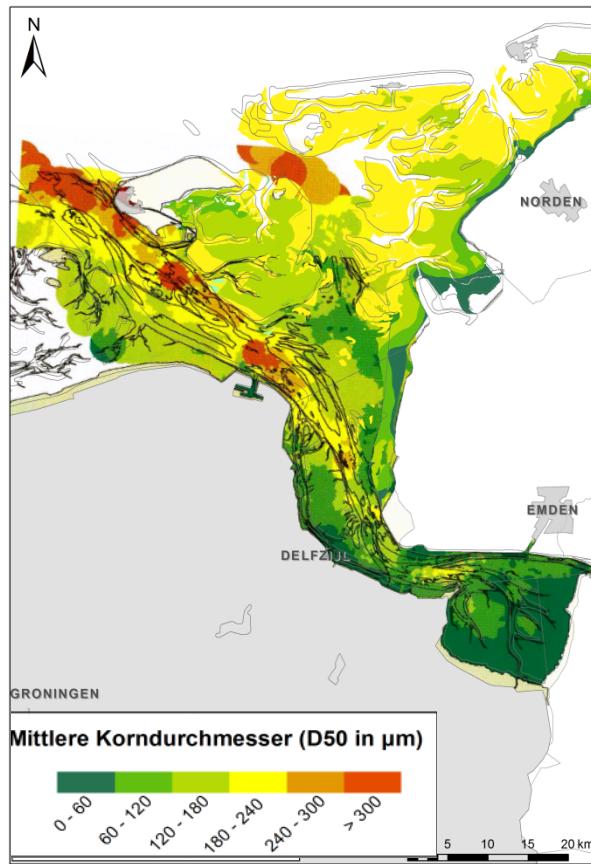


- NLWKN-Coastal Research Station (FSK)
- Christian-Albrechts-University of Kiel, Prof. Winter, Coastal Geology and sedimentology (CAU)
- National Park Authority of the Lower Saxony Wadden Sea (NLPV)

Further expertise and data from the NLWKN (Bst. Aurich und Oldenburg) and continuous exchange with colleagues from the Netherlands

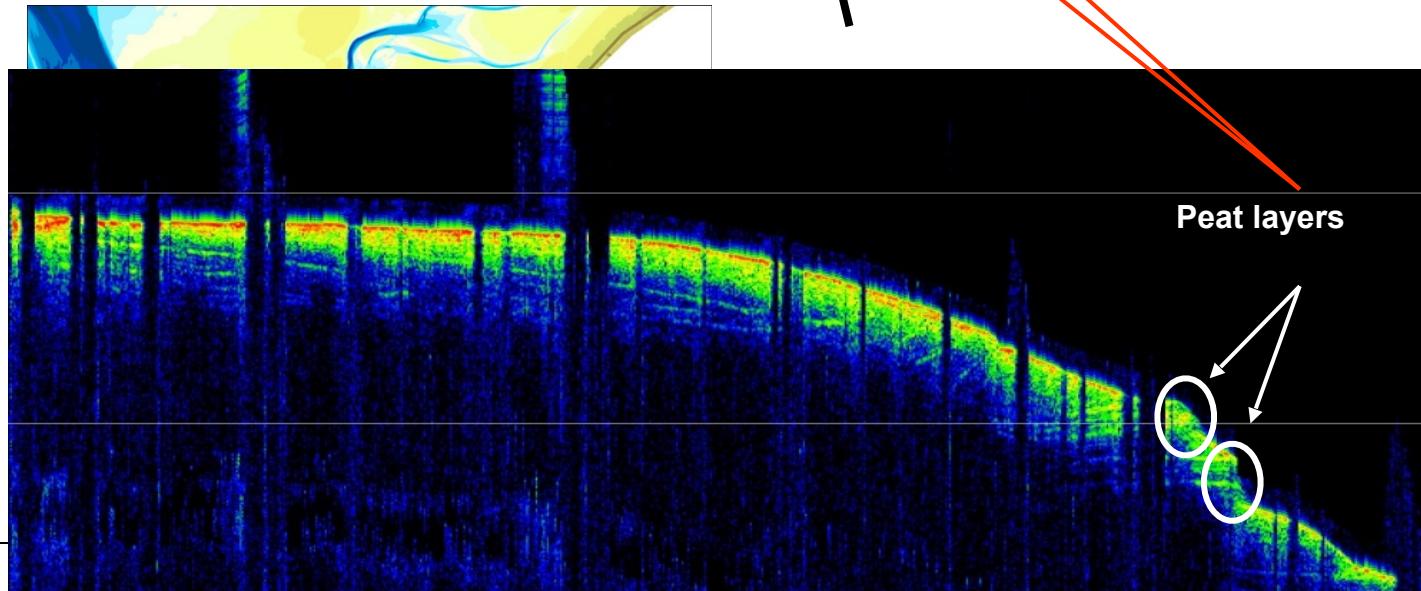
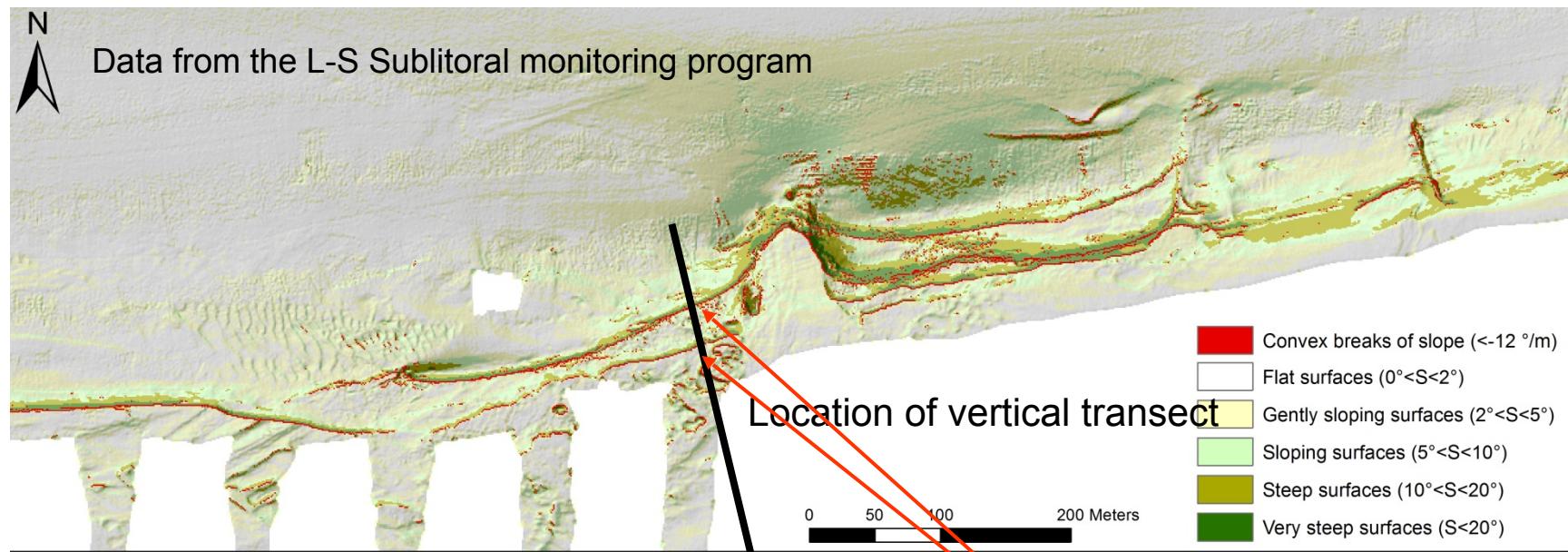
Sediment bed content

Essential input data for morphodynamic modeling
(Calibration and Validation)



Reference:
McLaren et al. (1998)
Meyer & Ragutski (1999)
NDS Sublitoralkartierung

Bed structure (as an example, based on outer curve at Bantsbalje)



Scientific requirement

Objectives:

- How we can reduce the ecological load (e.g. siltation)
- Strengthening the natural dynamics of growing wadden sea level, foreland etc.

Instruments/Tools:

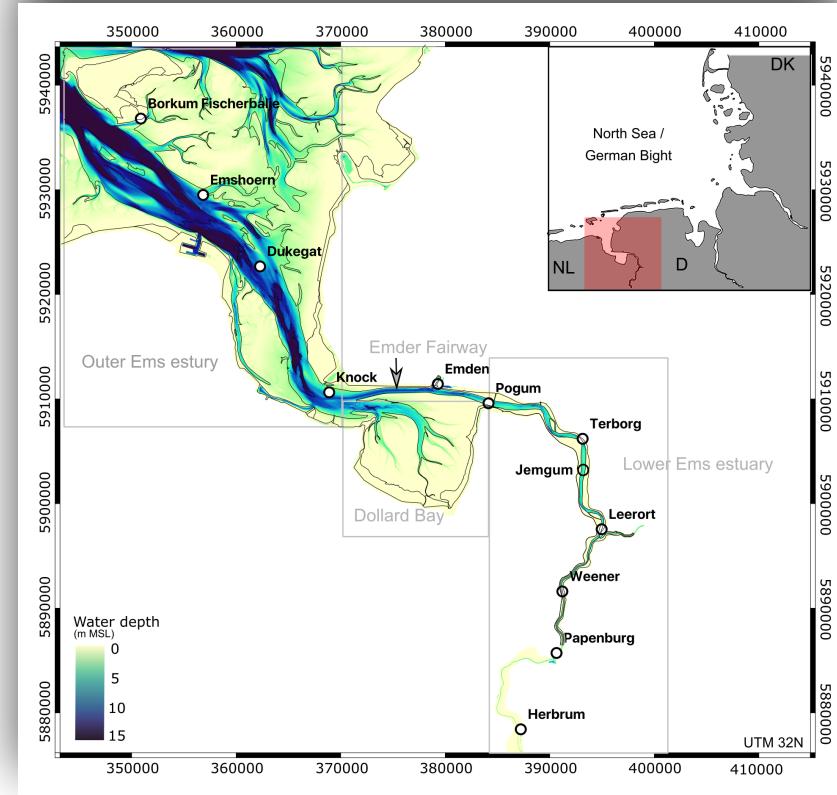
- Development of measures for permanent fluid mud reduction
- Search for fluid mud/silty sediment deployment/usage
- Utilization of natural sediment transport processes to strengthen natural dynamics

Area of investigation:

- Ems estuary, adjacent Wadden Sea und East Frisian Islands
- Binnendeichs (landward the dike line)

Close connection with further, interdisciplinary and partly cross-border activities

- D-NL water quality modeling of the Ems estuary
- In preparation: D-NL-Interreg-A-project phytoplankton in the Outer Ems estuary
- Investigations in the Masterplan Ems 2050 project



Further outlook:

- Balanced solution for environmental/ecological and economical sediment management
- Improved climate change adaptation

