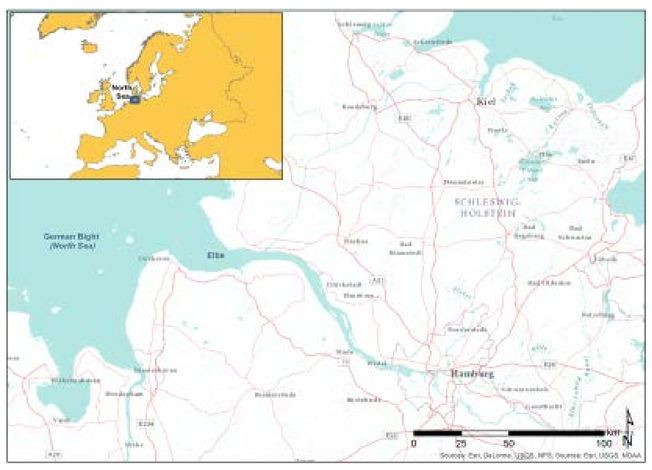
A new wave in coastal protection

Elbe estuary case study site

Kappenberg, J., Sothmann J., Helmholtz-Zentrum Geesthacht
Ohle, N., Schuster, D., Hamburg Port Authority



The Elbe Estuary is a mesotidal (max. tidal range 3.6 m), partially mixed coastal plain estuary of 120 km length. Mean freshwater discharge is approx. 700 m³/s. The estuary serves as waterway for seagoing ships to the city of Hamburg but also comprises important habitats and Natura 2000 areas. Since the 11th century the site is subject to diking and hydraulic engineering

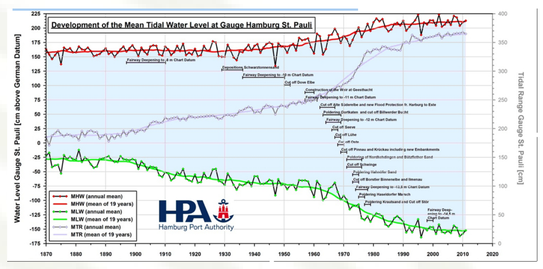
Key challenges and main activities

Enhanced flood protection in Hamburg

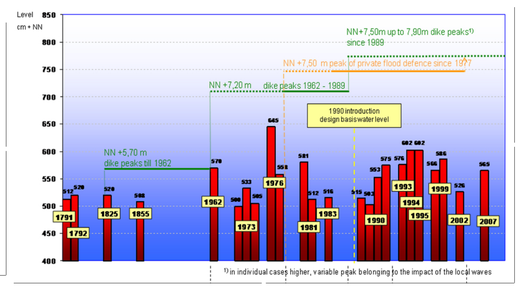
Is the HafenCity district save against climate change effects ?

- Increasing tidal range in Hamburg
  due to civil engineering works, flood protection
- Problems with space for additional flood defense in Hamburg port
- HafenCity district without conventional flood protection:
  dwelling mounds + individual building protection.
  Is this concept sustainable under future climate change ?

Method: Simulations of present and future climate change water levels and current velocities by numerical hydrodynamic models

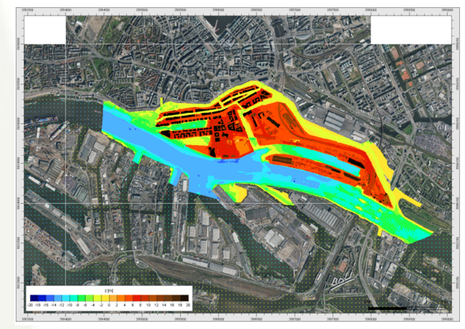


Increase of tidal in Hamburg
And human interventions



Historical storm surges
and dyke heights in Hamburg

Inundation of a part of the HafenCity during a storm surge in 2007



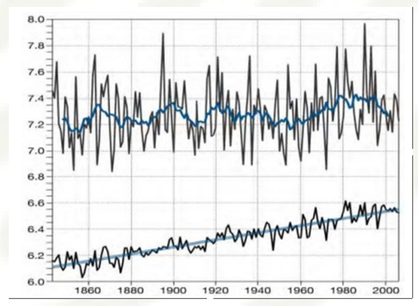
Topographic map of the HafenCity

Key outcomes

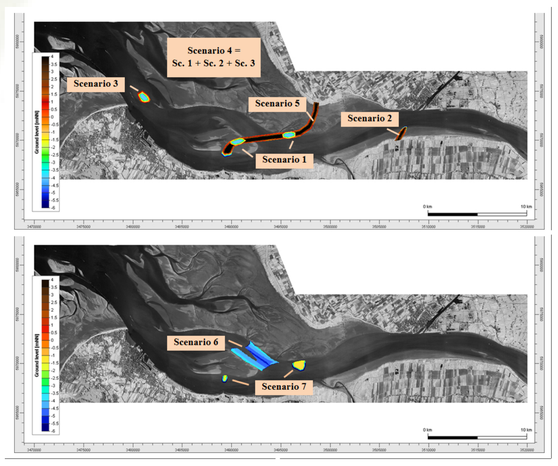
Reduction of flood levels in Hamburg by introducing artificial sandbanks in the mouth of the Elbe

Future safety of the HafenCity

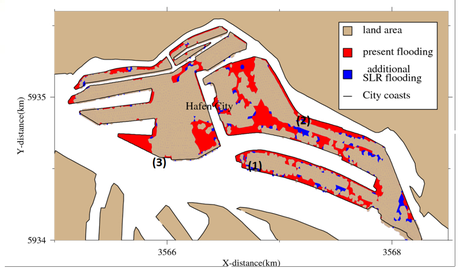
- Long-term trends at the mouth of the Elbe show:
  - increase of some 2 mm/year in mean sea level
  - no clear trend in storminess
- Reduction of tidal wave energy at the mouth by sandbanks:
  1 – 3 cm reduction of flood height in Hamburg, only the dam scenario 5 results in 13 cm flood height decrease
- Efficiency of the sandbanks under future climate change:
  The efficiency of the sandbanks remains the same under climate change conditions (scenario 4 in 2020s, 2050s, 2080s)
- Under the investigated sea level rise of up to 90 cm (2085) stormsurge levels in the HafenCity will not exceed the height of the dwelling mounds in HafenCity



Long-term trends in storm activity (upper curve) and mean sea level (lower curve) at the mouth of the Elbe



Location of the investigated emerged (upper panel) and submerged (lower panel) sandbanks in the mouth of the Elbe



	2025 (+30cm)	2055 (+50cm)	2085 (+90cm)
Flooding height (m)	6.209	6.409	6.795
Flooding area (m^2)	314,015	355,774	409,804

Flood level and flooded areas (upper panel: 2025 situation) in the Hafencity under present and climate change conditions

Scenario No.: year	decrease in HW level in receptor area Hamburg (annual mean)	decrease in HW level in receptor area Hamburg (std. dev.)	decrease in max. current velocity in receptor area Hamburg (annual mean)	decrease in max. current velocity in receptor area Hamburg (std. dev.)
1: 2006	0	2 cm	0	1 cm/s
2: 2006	0	2 cm	0	1 cm/s
3: 2006	1 cm	3 cm	0	1 cm/s
4: 2006	3 cm	3 cm	1 cm/s	1 cm/s
5: 2006	13 cm	4 cm	< 1 cm/s	1 cm/s
6: 2006	1 cm	2 cm	0	1 cm/s
7: 2006	2 cm	3 cm	1 cm/s	1 cm/s
4: 2020s	2 cm	2 cm	- 11 cm/s	1 cm/s
4: 2050s	2 cm	2 cm	- 10 cm/s	1 cm/s
4: 2080s	2 cm	1 cm	- 9 cm/s	1 cm/s

Effects of the sandbank scenarios on high water (HW) level and max. current velocity in Hamburg (2006 conditions and future)

Innovative technologies for safer European coasts in a changing climate (THESEUS)

FP7 ENV2009-1 Large Integrated project - Contract n. 244104
December 2009 – November 2013

COOPERATION

www. theseusproject.eu