Ad Hoc Expert Meeting on

Climate Change Impacts and Adaptation: A Challenge for Global Ports

29 – 30 September 2011

Climate Change Impacts on Port Development – A Case Study of the Port of Hamburg

Presentation by

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Hamburg Port Authority

Climate change impacts on port development – A case study on the Port of Hamburg

30 September 2011

Nicole von Lieberman

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Outline

- Background and motivation
- Local climate change scenarios
- Sensitivity of planning, construction and maintenance to impacts of climate change
- Conclusions

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Background and motivation

- Changes in climate conditions already recognizable today
- Depending on greenhouse gas emissions further increase expected
- Great uncertainties in the prediction of regional and local changes

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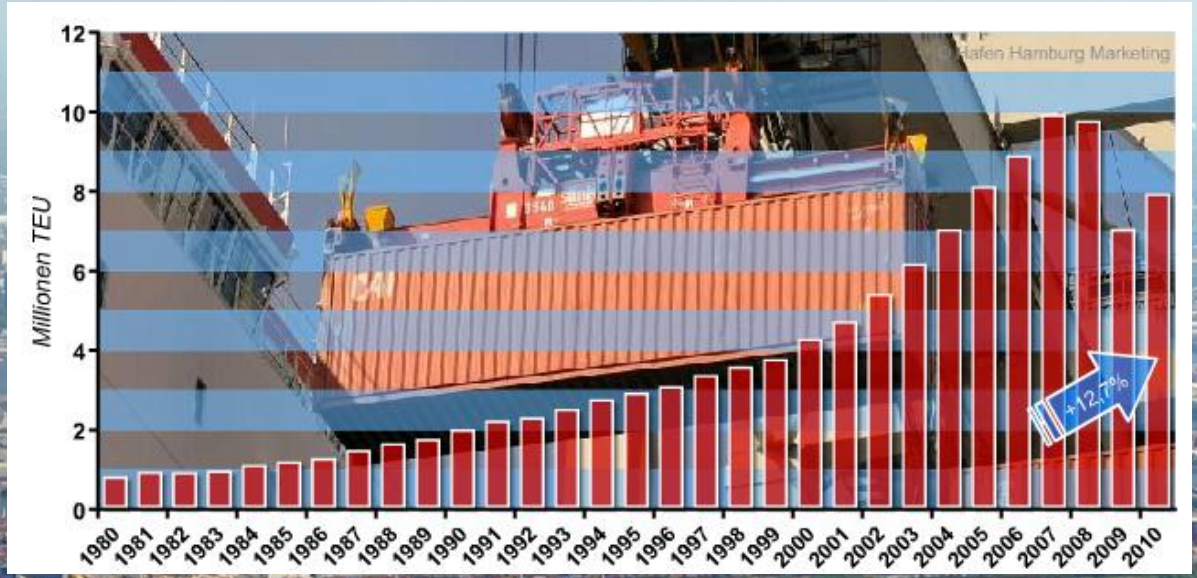
Background and motivation

- Port of Hamburg

Background and motivation

- **Port of Hamburg**
- 3rd in Europe
- 72 km²
- 275,000 Jobs in Germany
- 7.9 Mio. TEU in 2010
- Fairway 12.80 / 13.80 m
- further deepening on its way



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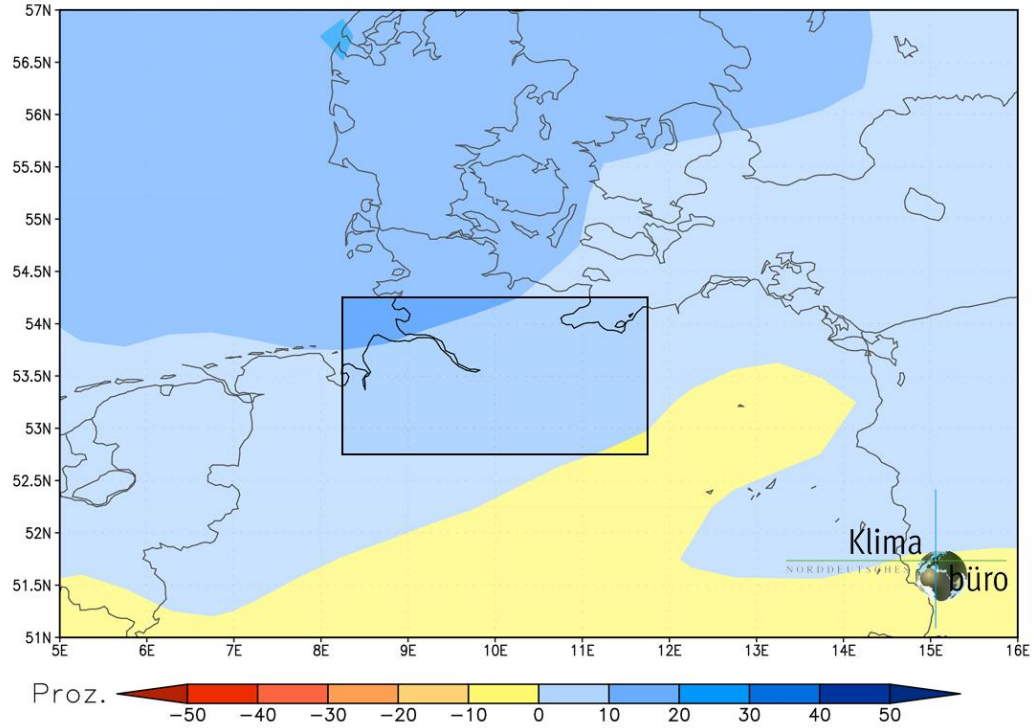
Local climate changes (here precipitation)

Metropolitan region of Hamburg: possible mean changes of the annual precipitation until the end of the 21. century (2071-2100) in comparison to today (1961-1990)



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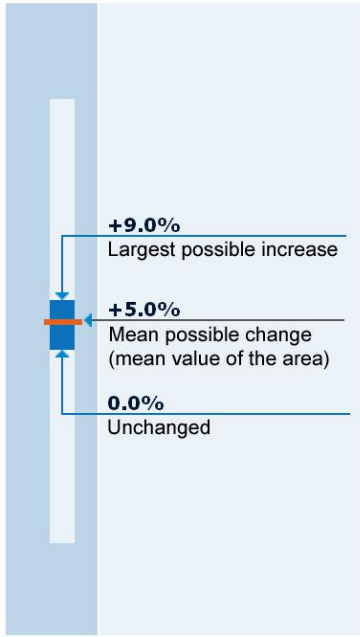

www.norddeutscher-klimaatlas.de

Local climate changes until 2100

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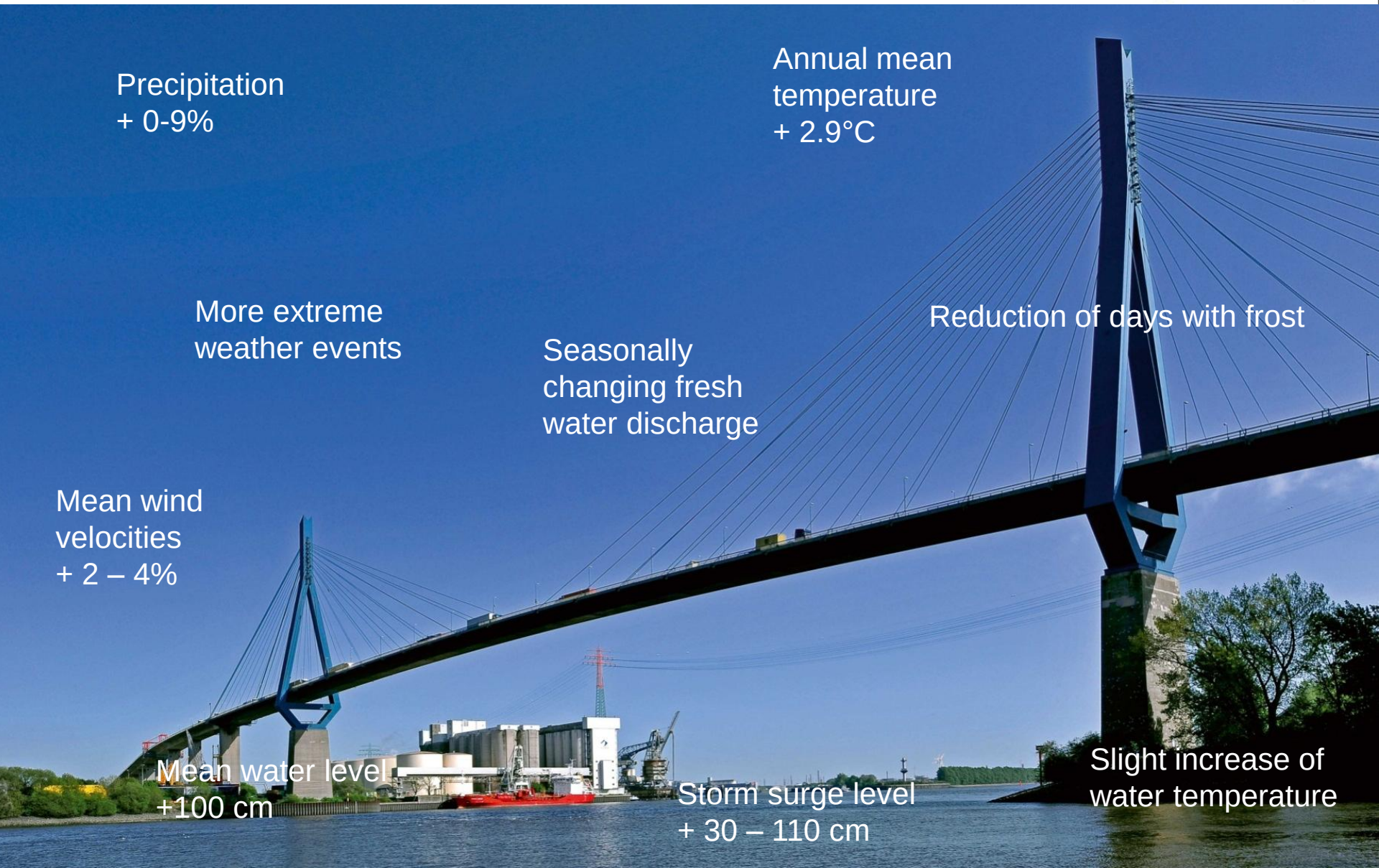

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Sensitivity of planning, construction and maintenance to impacts of climate change

- General considerations
- Maritime access channel
- Maintenance dredging
- Hinterland connection
- Flood Protection and Banks
- Movable infrastructure
- Quay walls
- Bridges

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Planning

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General considerations for planning, construction and maintenance I

PLANNING

+ temperature	=	no effect on design standards
+ extreme weather events	=	development to stricter design standards and change in static calculations (dimensioning of drainage system)
+ sea water level	=	new design water levels for the Elbe in discussion
+ ground water level	=	influencing design of foundations

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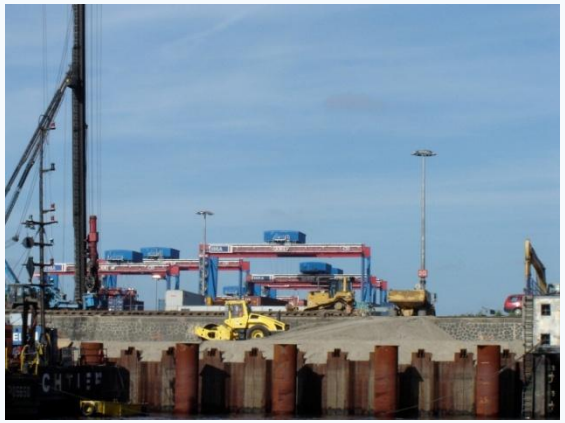
General considerations for planning, construction and maintenance II

CONSTRUCTION

- frost days = less downtime
- + extreme weather events = more downtime



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General considerations for planning, construction and maintenance III

MAINTENANCE

+ water temperature	=	corrosion of sheet piles increase
+ air temperature	=	more air conditioning facilities
+ precipitation, storm intensity	=	control & maintenance more often (more field service personnel)
+ extreme weather events	=	more downtime
- frost days	=	reduction of days with working restrictions

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Maritime access channel

- From the North Sea to Hamburg 100 km
- Hydrodynamics formed by the fresh water discharge, tidal wave and wind conditions
- Water depth maintained by dredging and relocation of sediments
- Next deepening planned 2012/13

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Maintenance dredging

- Total amount 4.7 Mio m³ in 2010
  - + sea level and seasonally lower discharges = more sedimentation
  - + water temperatures (oxygen deficits) = restrictions in relocation of sediments

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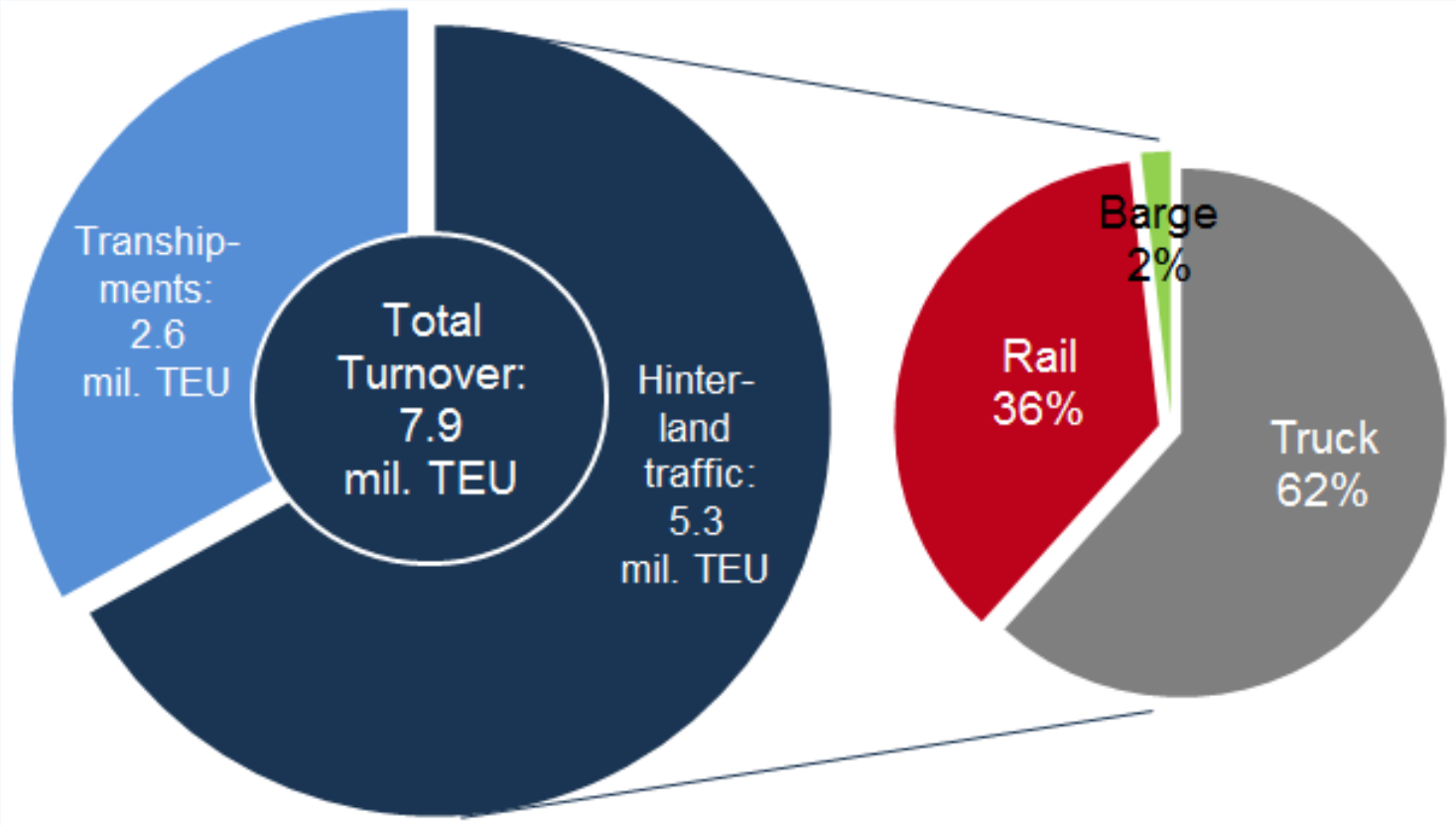
Hinterland connection 2010



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Hinterland connection – Railway system

- Track length: 304 km
- Lifespan bridges 80 – 100 years , other infrastructure 25 years
- + extreme rainfall = new design standards for dimensioning drainage system
- + storm intensities = stronger anchorages, overhead live wires, control-safety-communication equipment
- + water levels ⇨ with a higher flood protection the railway crossing have to be adapted

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Hinterland connection – Road system

- Road length: 124 km
- Lifespan roads 15 – 20 years, bridges 80 – 100 years
- + extreme weather events = adaption of drainage system
- + water and storm surge levels = more flooding, operational downtime

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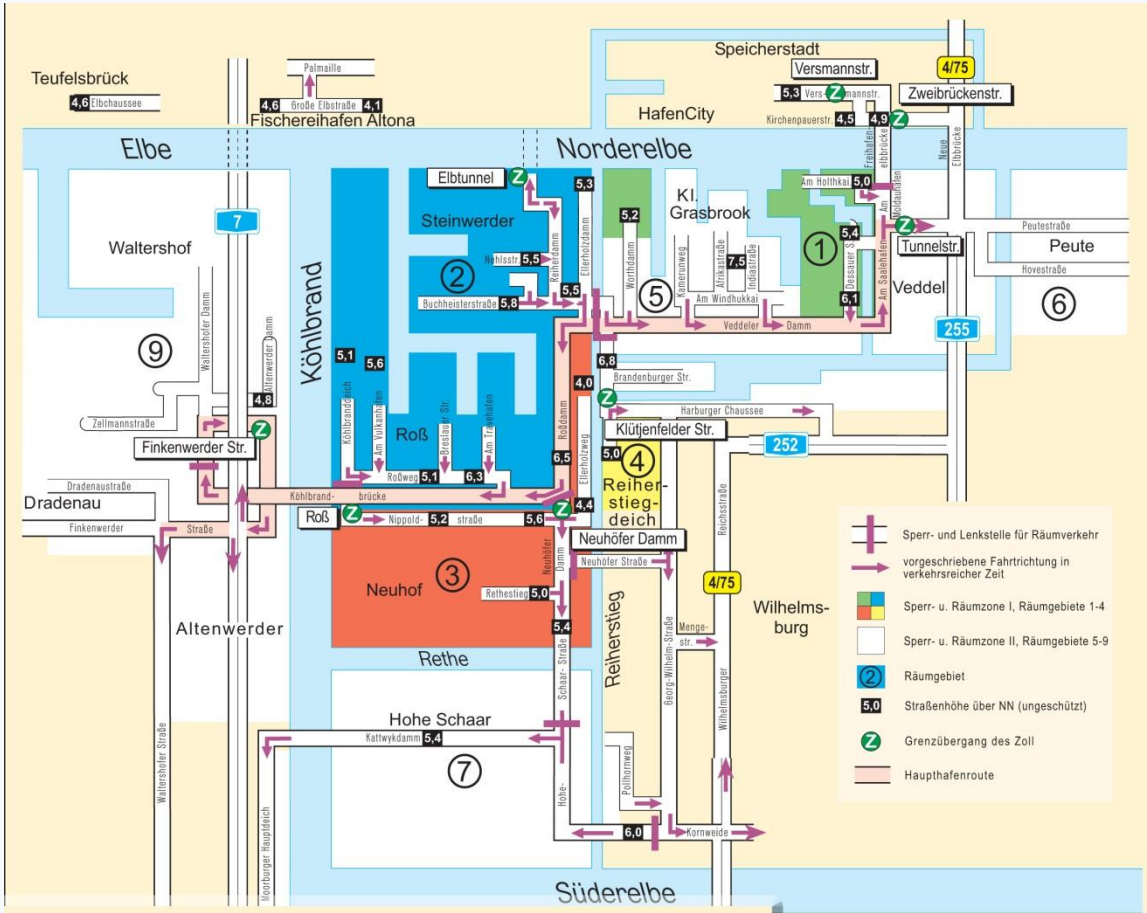
Roads - high requirement for early adaption measures because main road system serves as evacuation route



Evacuation of the Port
in case of a severe storm surge

Herausgeber und ©:
Hamburg Port Authority • Neuer Wandrahm 4 • 20457 Hamburg.
Redaktion: Gefahrenabwehr H214 • Tel.: 040 / 428 47 -2887.
Produktion: Kartographie H135 • Tel.: -3997 • August 2011.

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Hinterland connection - Inland waterways

- 8,000 inland vessels in 2010
- - ice cover = less downtime
- + water levels = reduced clearance height
- + dryer summer/ wetter winter = difficulties in unregulated parts of the middle Elbe

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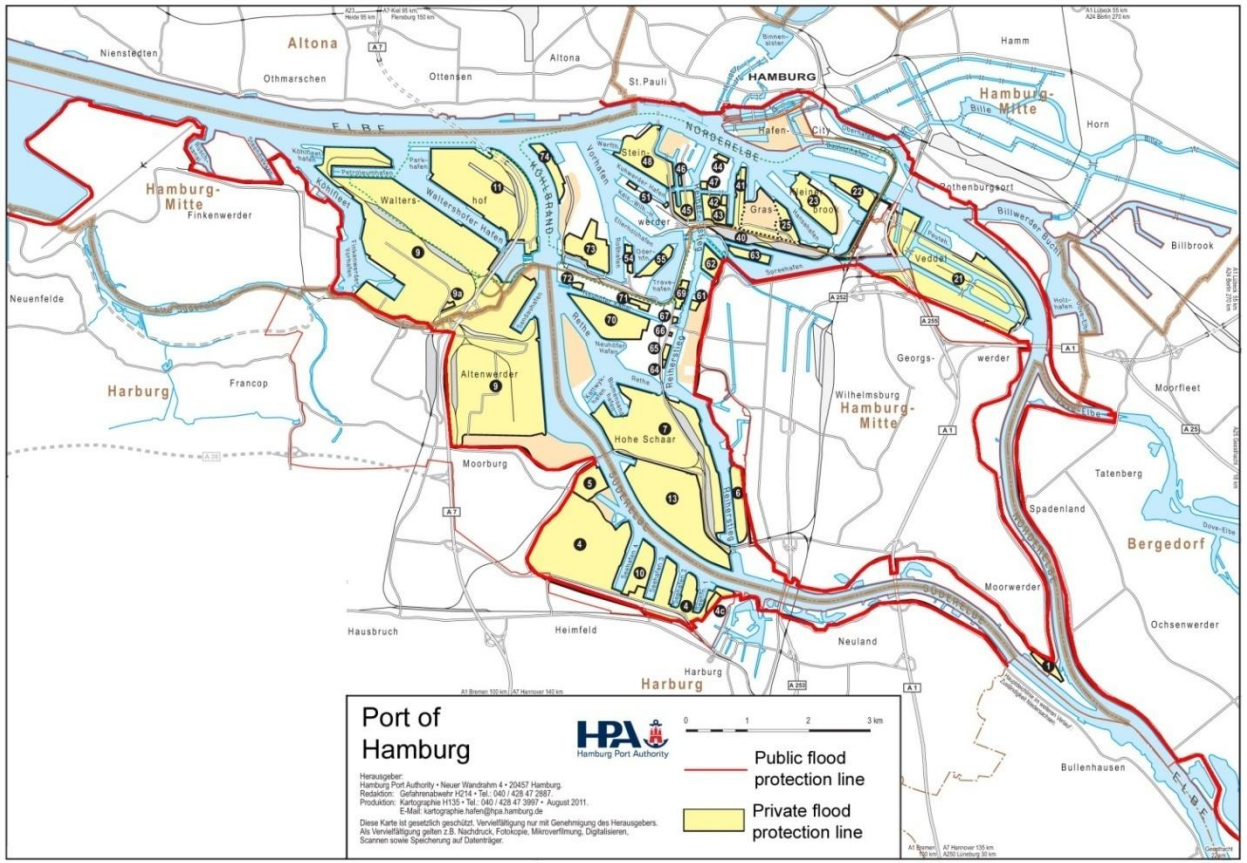
Flood protection and banks



- Public:
  length 26.2 km
  height between
  NN + 7.50 m – + 9.25 m
  lifetime 100 years

- Private:
  length 100 km,
  height NN + 7.50 m
  changes more frequent

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Flood protection and banks

+ storm surge levels	=	new design water levels adaption of drainage system including larger pipes, pumping stations and retention basins
- days with sub-zero temperatures	=	less ice load related damages
+ static water pressure	=	increasing loads

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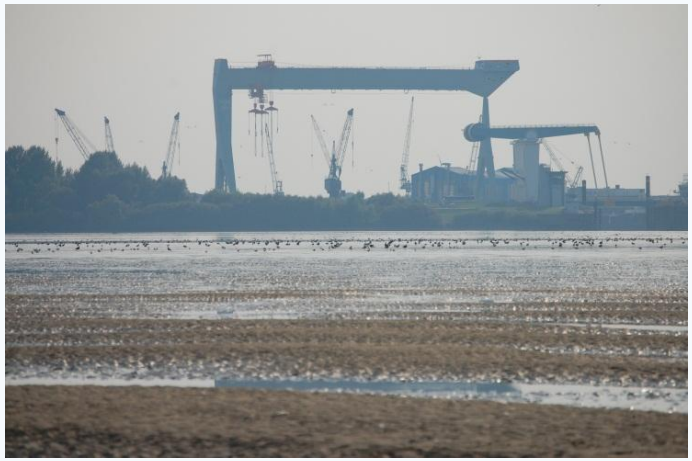
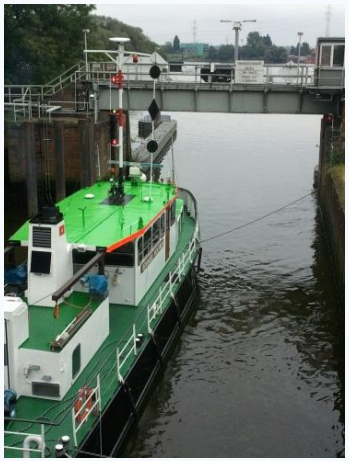
Movable infrastructure

- 4 flood barriers in public flood protection line, 3 in private
- 2 pumping stations and 4 sluices; 3 locks and 3 barrage locks





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Movable infrastructure

- constructions of 80 – 100 years, mechanical 30 years, electronical 15 years
- + water and storm surge levels = reserve capacities in foundations for adaption

In operation:

- + water and storm surge levels = closing of barriers more frequent
  (more personnel)
  faster wear
  restrain navigation and port economy
- + sedimentation rates = problems in closing gates

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Quay walls

- Length of 37.5 km, berths for 320 vessels
- Design life 50 – 60 years

+ water temperature (higher microbiological activity)	=	increase of corrosion rate
+ water temperature (oxygen deficits)	=	restrictions in dredging
+ water and storm surge levels	=	adaption (flood protection)

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Bridges

- 140 bridges (including road, railway, pedestrian pathes)
- Design life of 80-100 years
- + water levels = clearance heights
  duration of possible passage

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Bridges – new construction is costly and land consuming

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Conclusions

- Impacts on construction and operation of the Port of Hamburg due to climate change
- Extreme rainfalls to be taken into account in the planning of drainage systems
- Main impacts expected in conjunction with rising water levels and sedimentation

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Conclusions

- Climate change impacts not that important in the planning of short-living investments with lifetimes up to 30 years

- But, these impacts to be considered in the planning of long-living structures

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