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Potential climate change effects in the North Sea and the Baltic Sea coastal zones

Jacobus Hofstede

Project part-financed by the European Union

Coastal flood defence

Coastal protection

= coastal risk management

German press coverage (headings) about **climate change**

31.10.05: The calm before the storm!

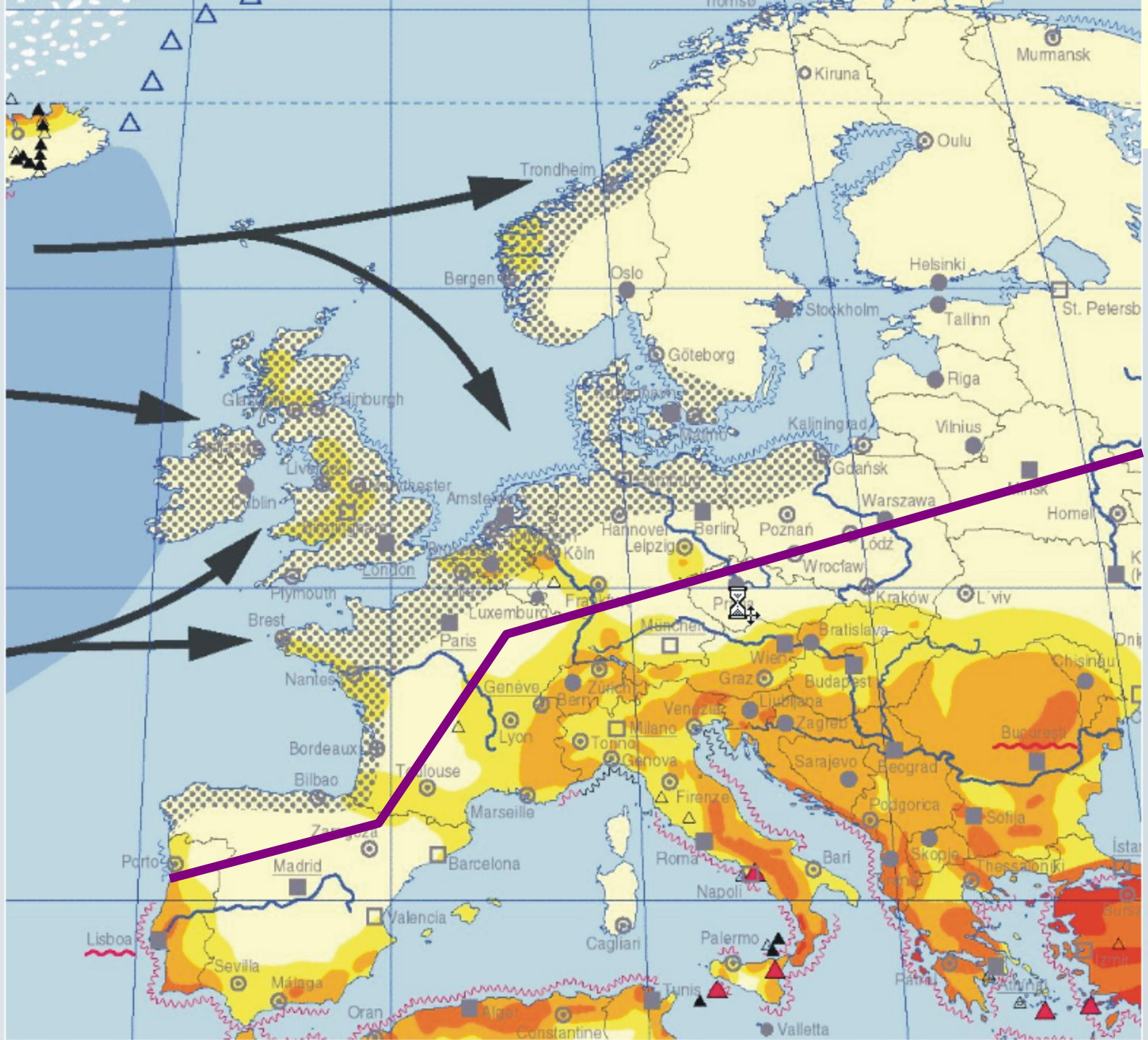
24.03.06: Coastal cities may drown in this century!

05.12.06: Germans feel threatened by climate change!

02.02.07: UNO-Experts predict horror climate!

02.04.07: climate change boosts business activity!

23.04.07: Bangladesh: in the dead zone of climate change!

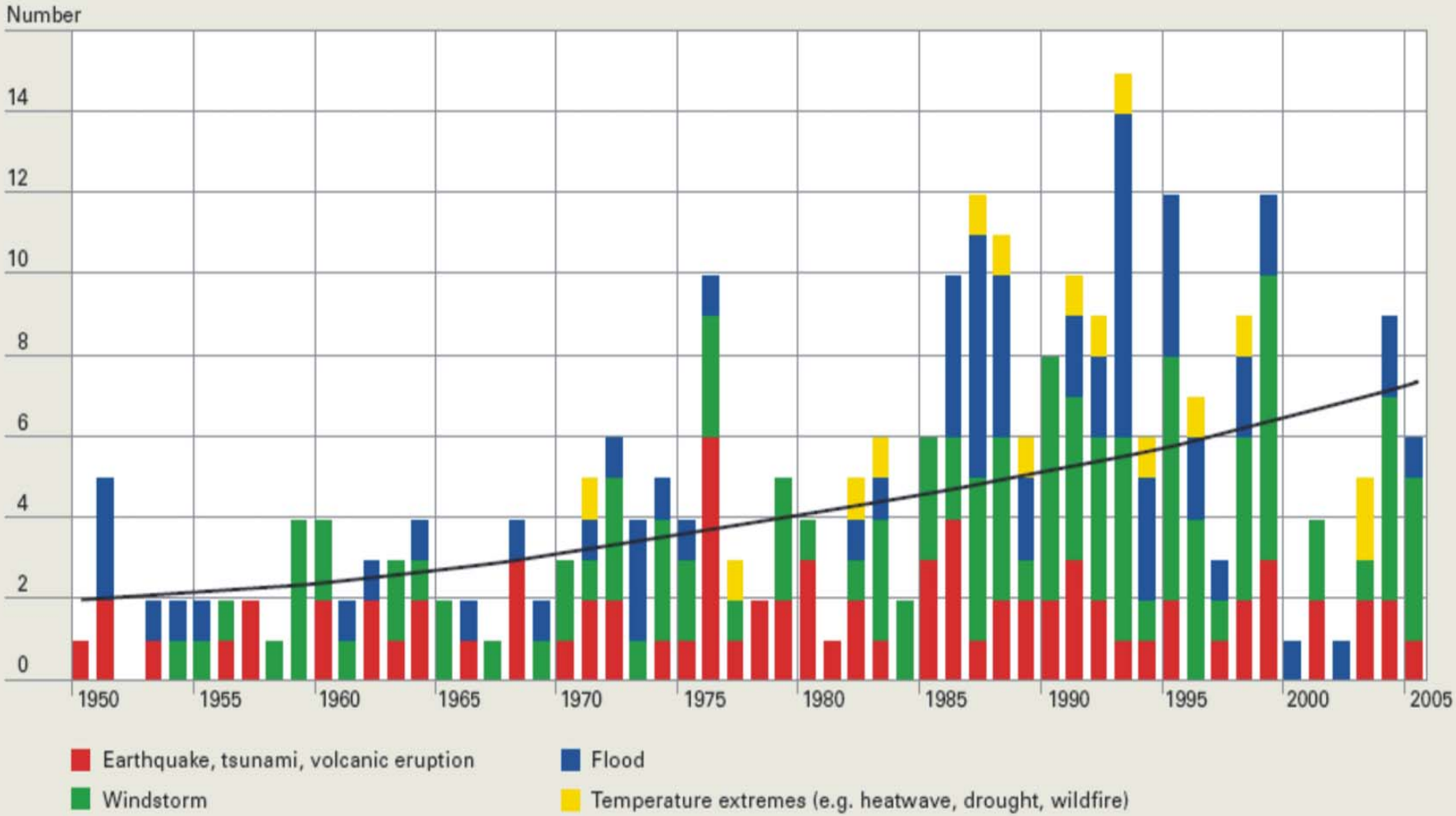


World map of
natural hazards
www.munichre.com

Legende

Number of events

The chart shows for each year the number of great natural catastrophes, divided up by type of event.



Munich reassurance

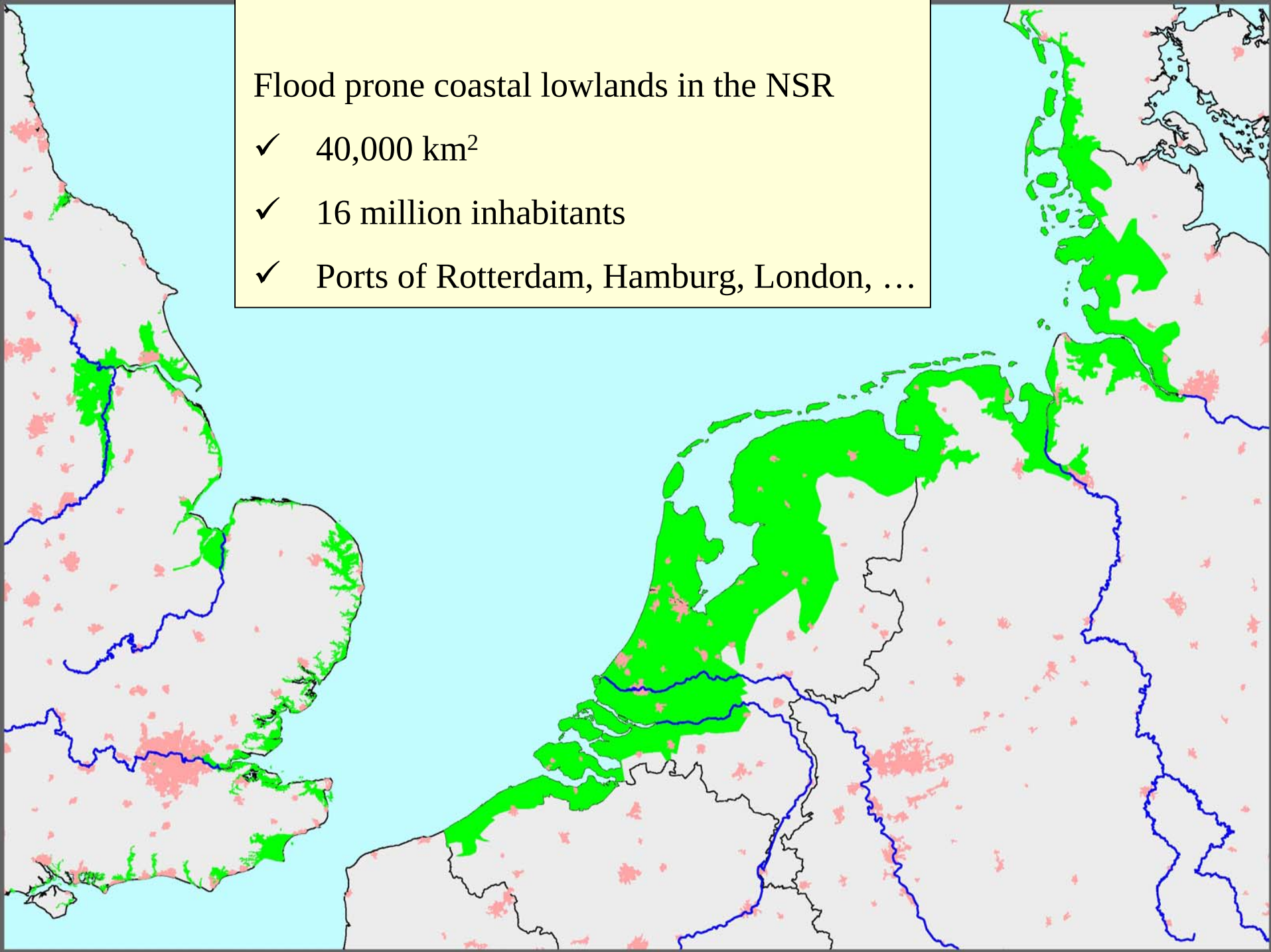
Winterstorm Gudrun (Erwin), January 2005

- ✓ 18 fatalities
- ✓ 500,000 households without power
- ✓ 5.8 billion € of damages

Faroe Islands
Sweden
Norway
Helsinki
Saint Petersburg
Estonia
Logstor
Halmstad
Ljungby
Riga
Latvia
Denmark
Kobenhavn
Lithuania
Carlisle
Ireland
United Kingdom
Netherlands
Germany
Poland
Belgium
France
Luxembourg
Czech Republic
Slovakia
Austria
Hungary
Switzerland

Legend

- Affected Cities
- Low Pressure Track
- Affected Regions


Flood prone coastal lowlands in the NSR
✓ 40,000 km²
✓ 16 million inhabitants
✓ Ports of Rotterdam, Hamburg, London, …

Storm surge barrier Rotterdam

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Sea dikes in Schleswig-Holstein and the Netherlands

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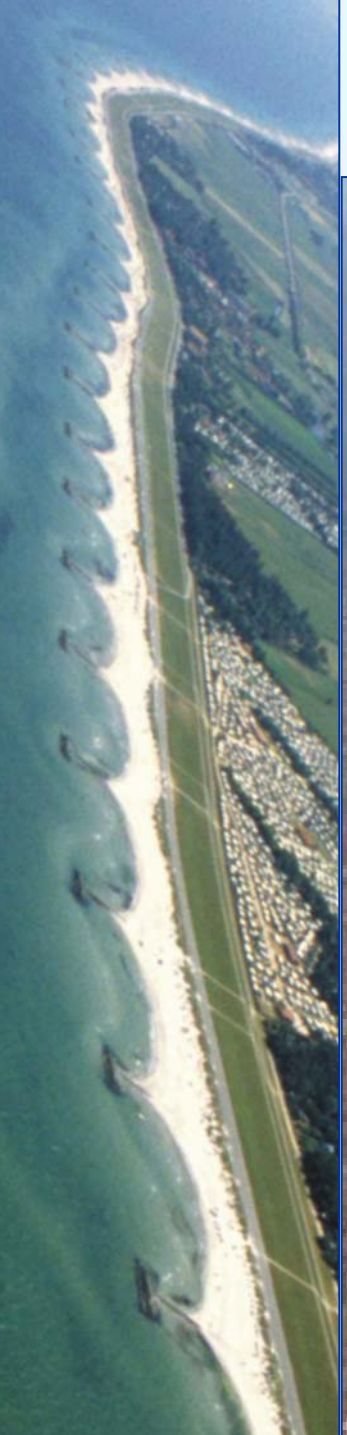
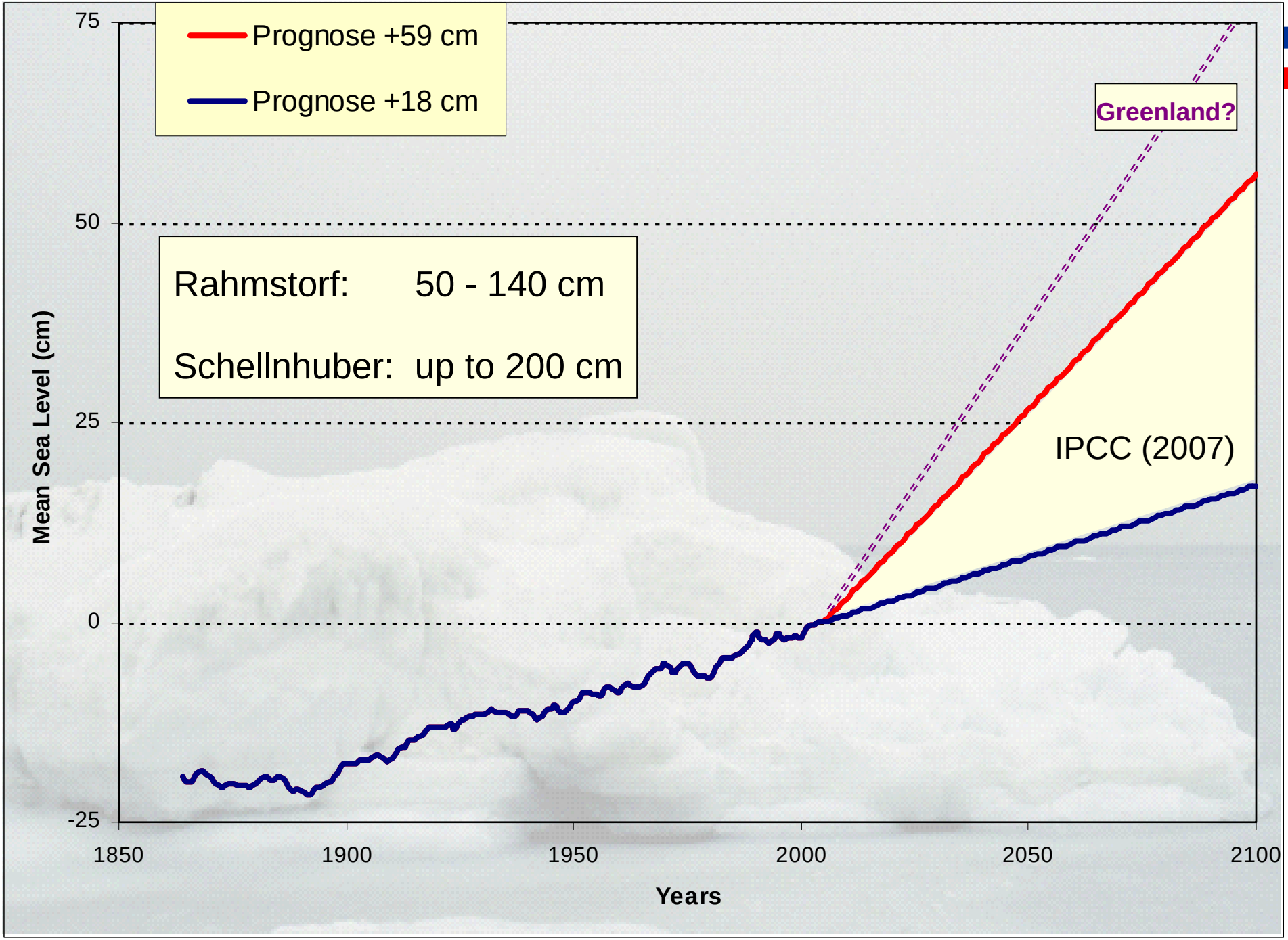


Sand replenishment (Sylt)

- ✓ 38 km of beach
- ✓ 1 meter natural retreat per year
- ✓ One million m^3/year replenished
- ✓ Costs since 1972: 130 million €
- ✓ Coast is stabilized sustainable!



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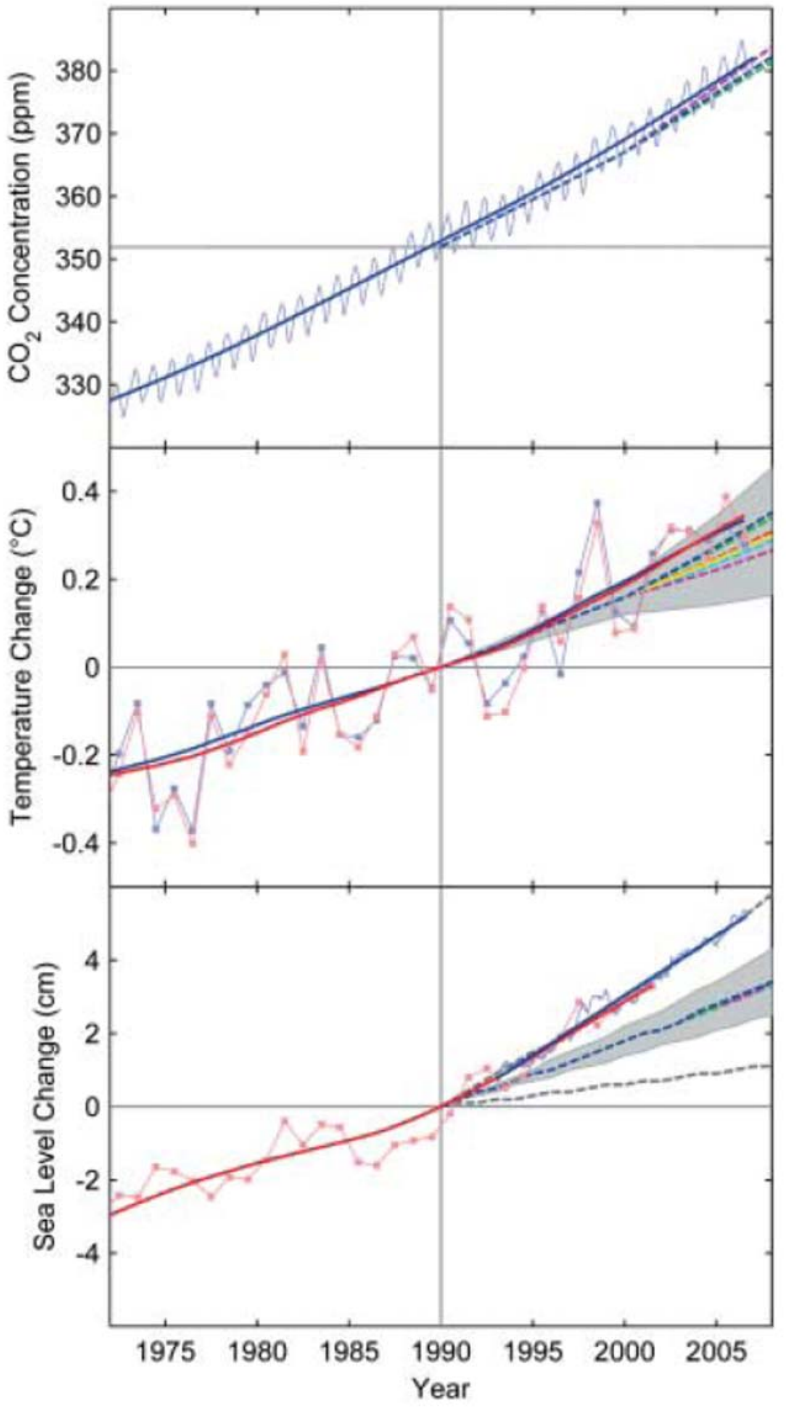

Rahmstorf *et al*., 2007 (Science): Recent climate observations compared to projections.

SLR since 1990 follows upper limit of IPCC-projections (2001), both for satellite and gauge data.

Caused by thermal expansion of the oceans and the melting from nonpolar glaciers (contribution of Greenland and Antarctica small but increasing).

Caution because of short time interval!

Regional changes in sea level rise relative to 2000 for IPCC scenario A1B

MPI for Meteorology (2006)

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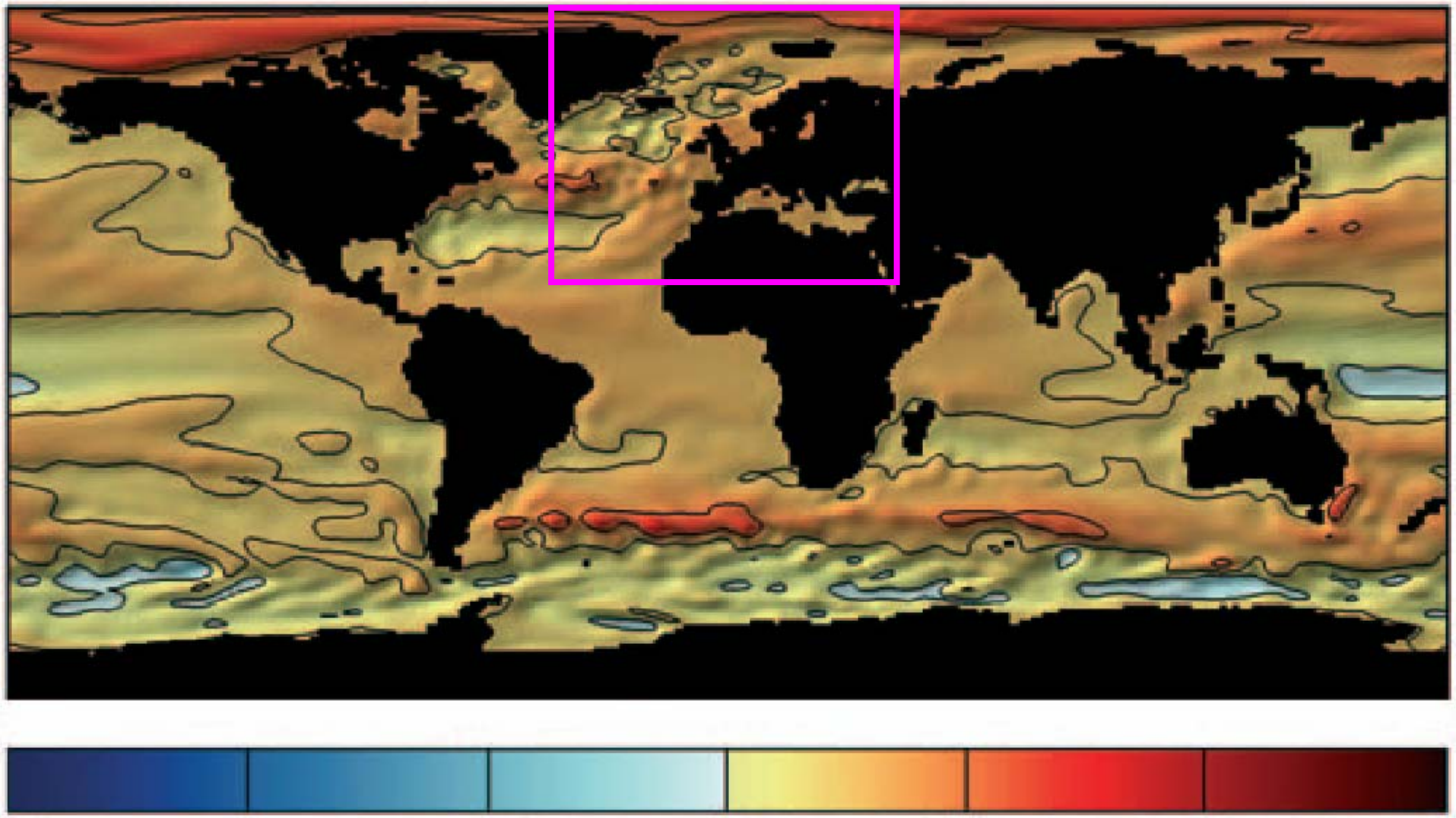

-1,5 m -1,0 -0,5 0 0,5 1,0 1,5

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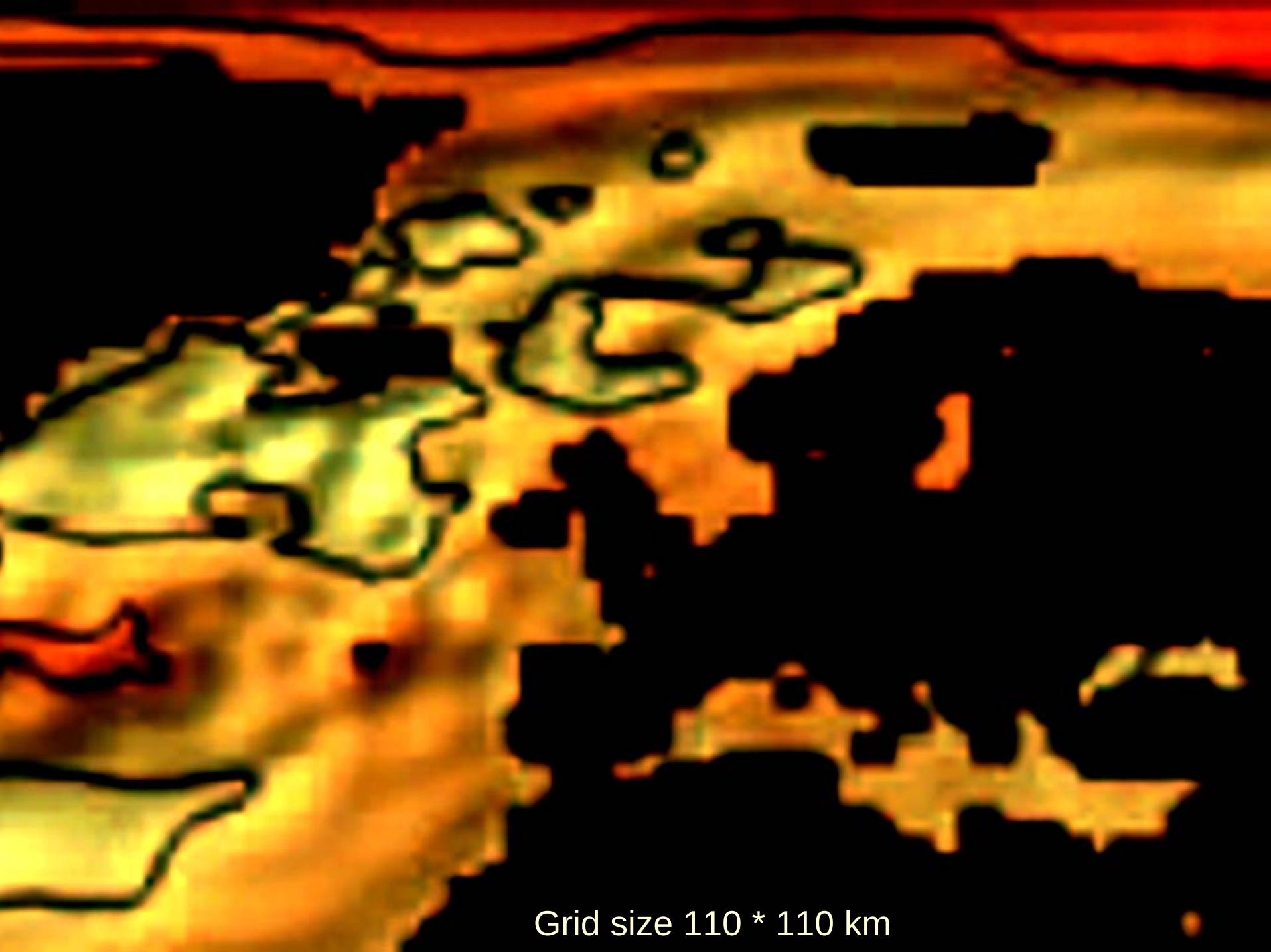
Grid size 110 * 110 km

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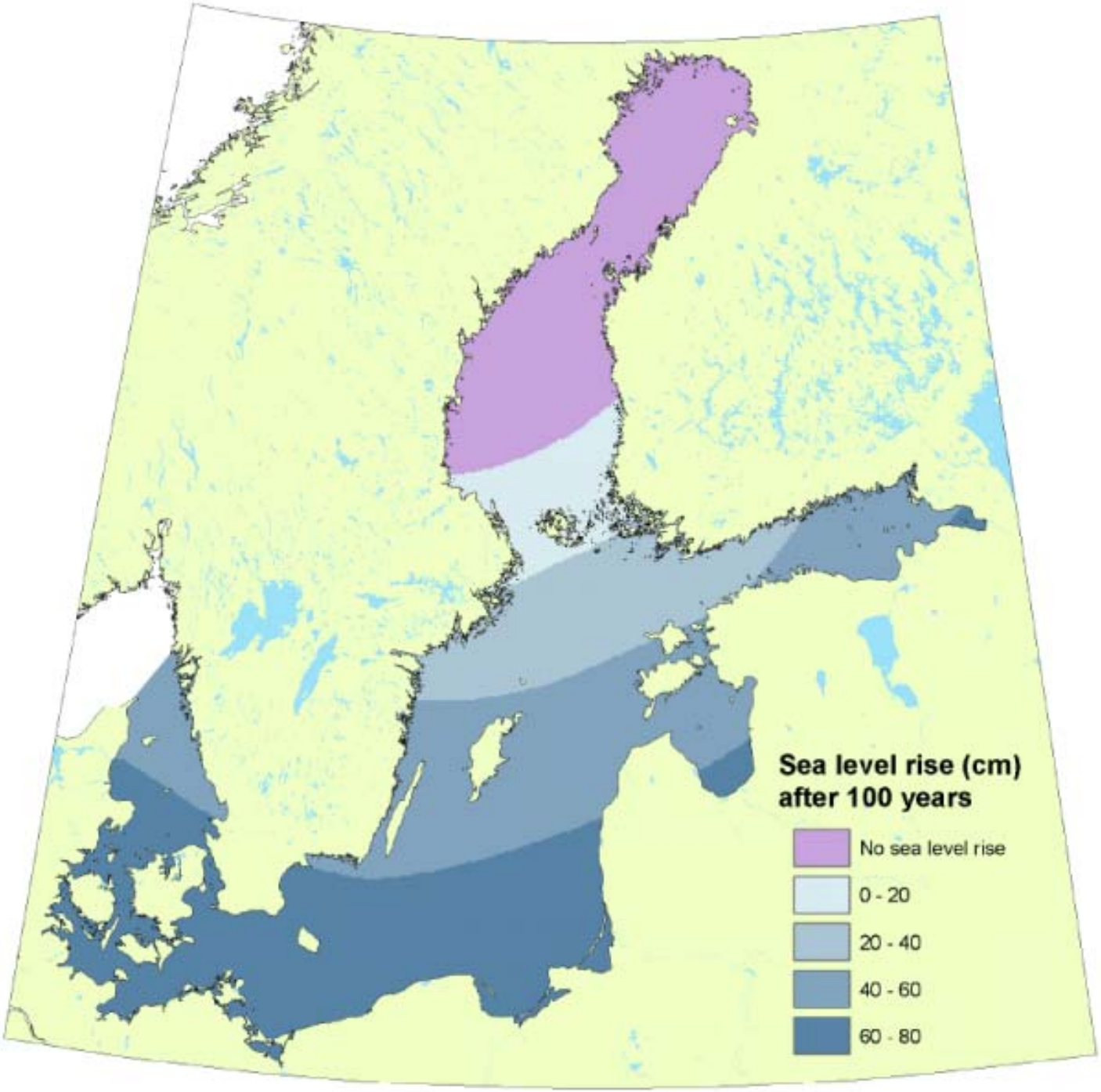
SEAREG result

worst case scenario

from IPCC 2001



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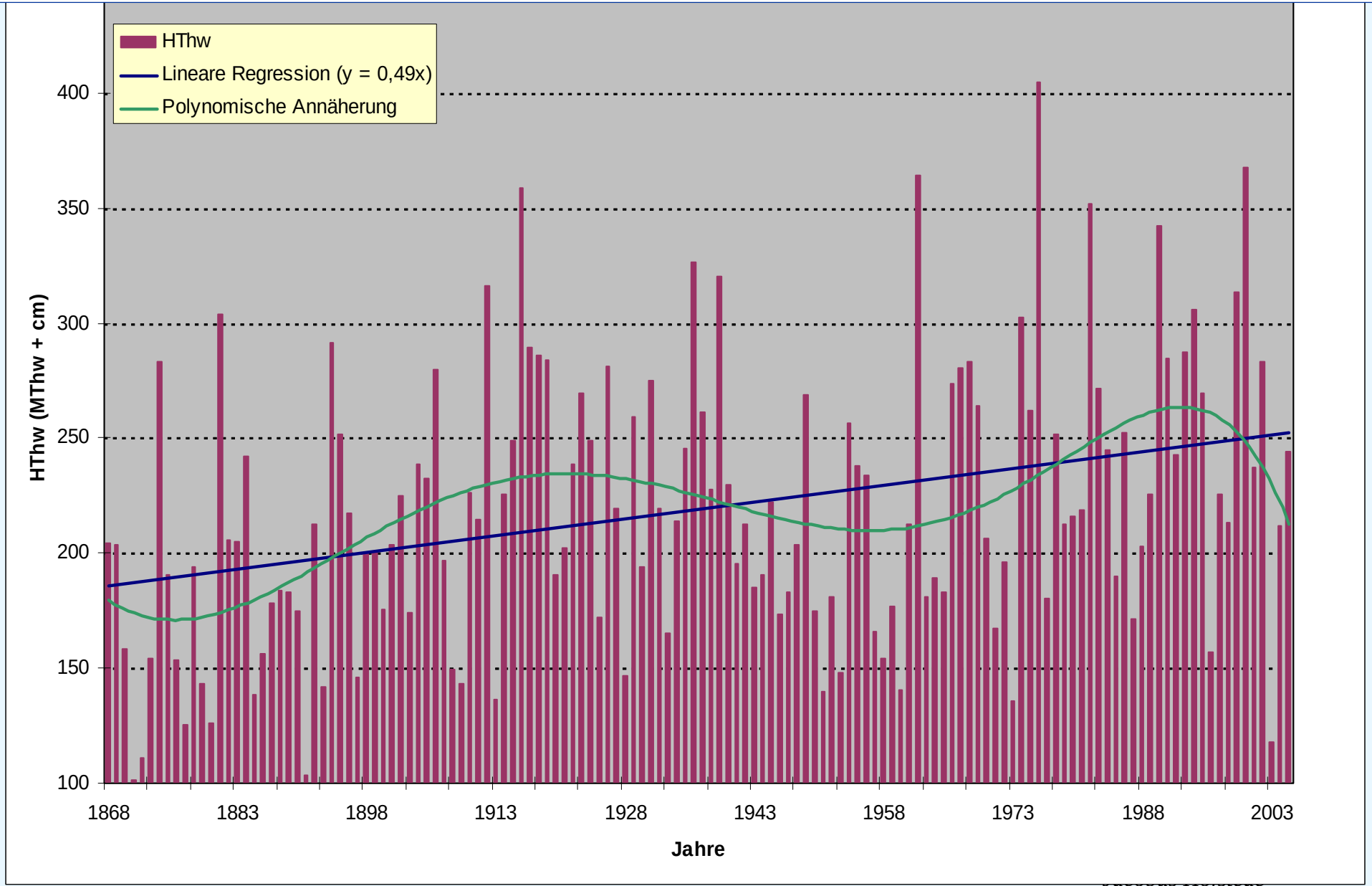
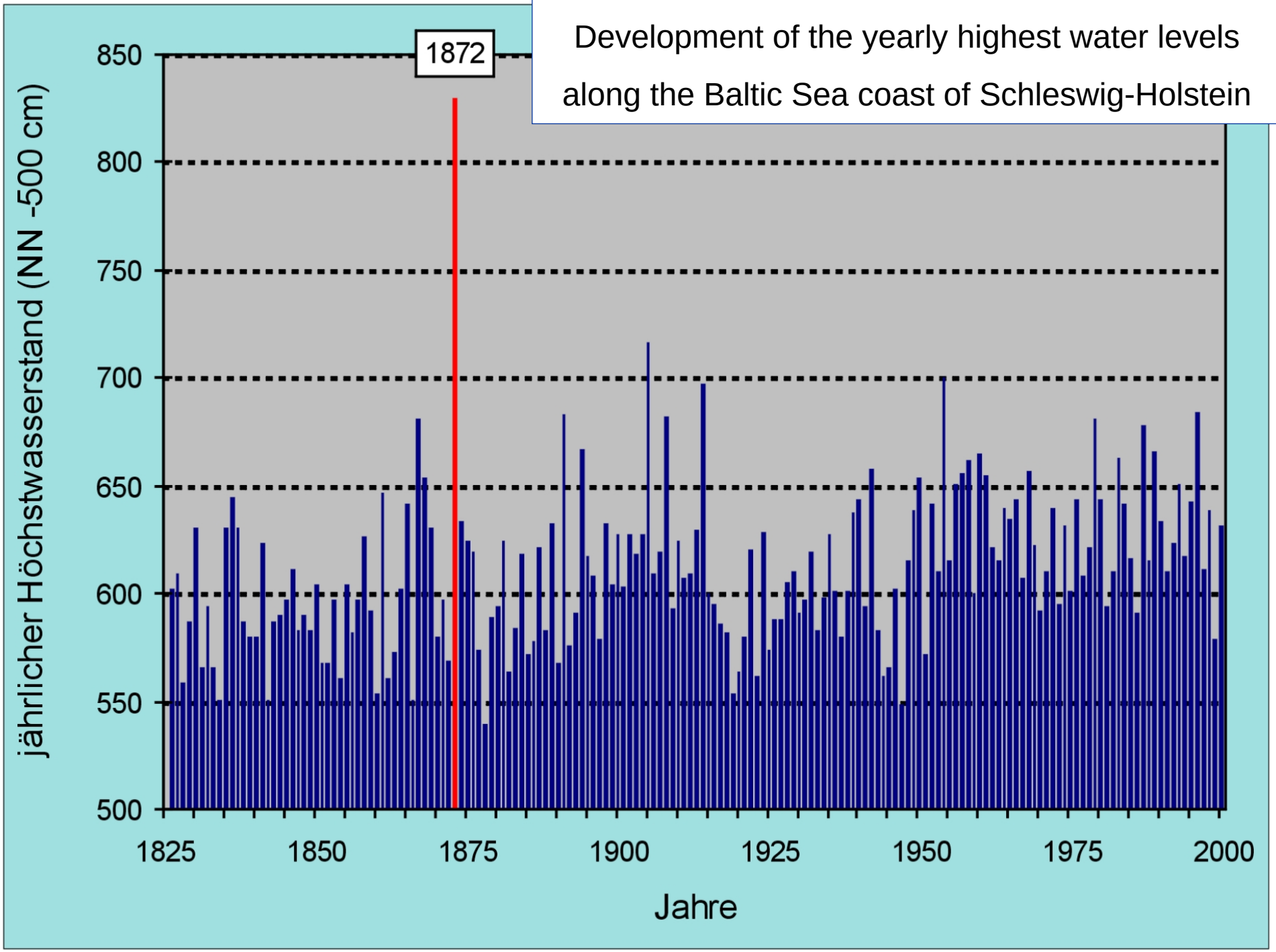
What about

Development of the yearly highest water levels

along the North Sea coast of Schleswig-Holstein



Development of the yearly highest water levels along the Baltic Sea coast of Schleswig-Holstein



Possible changes in storm water levels in the North Sea.

(Woth et al., 2006)

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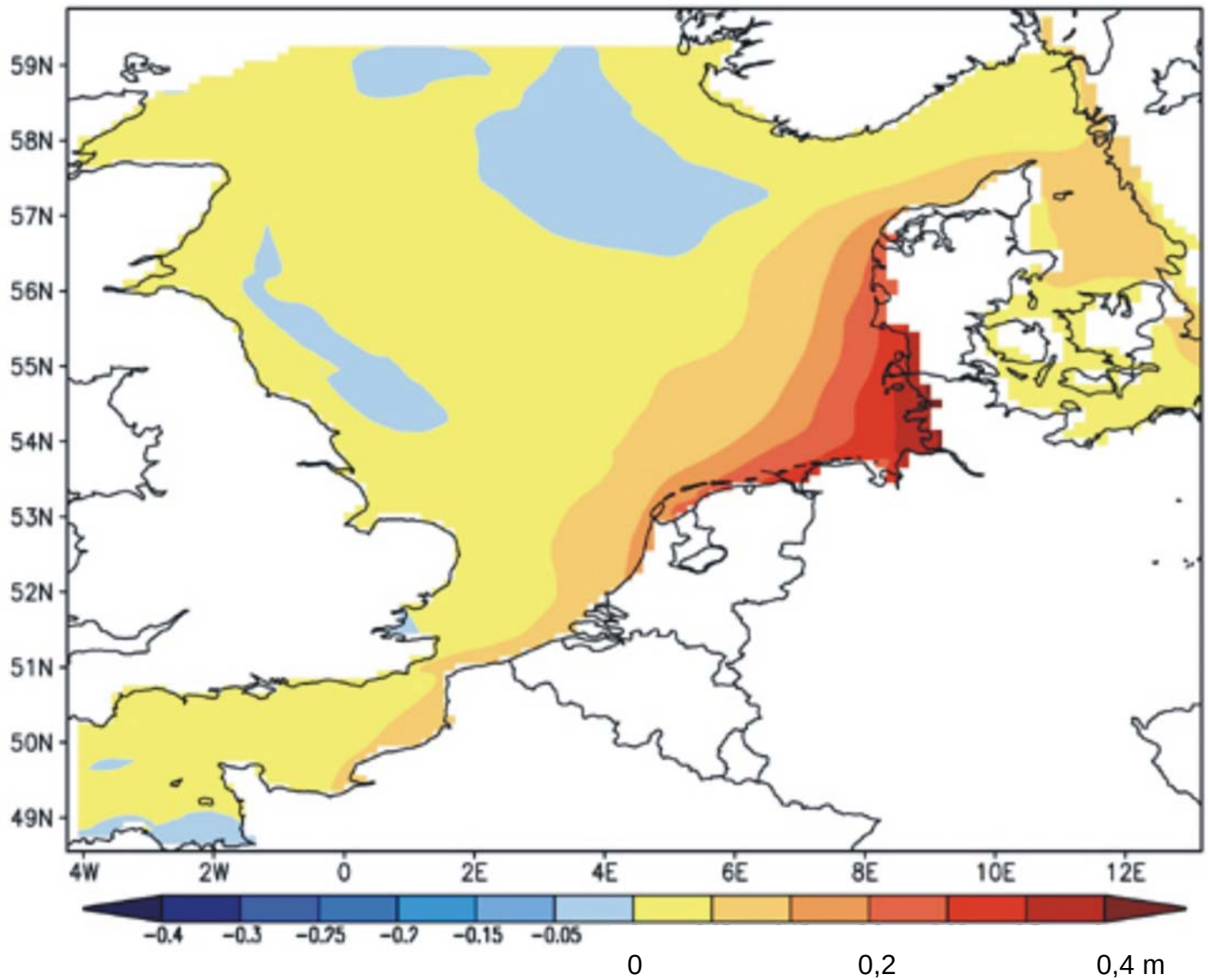

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Katrina August 2005

Katrina August 2005


Sea level rise sets the stage for profile adjustment through storm surges
(Leatherman, 1979)
12.09.2005 (C) Mike Page

Definitions and implications

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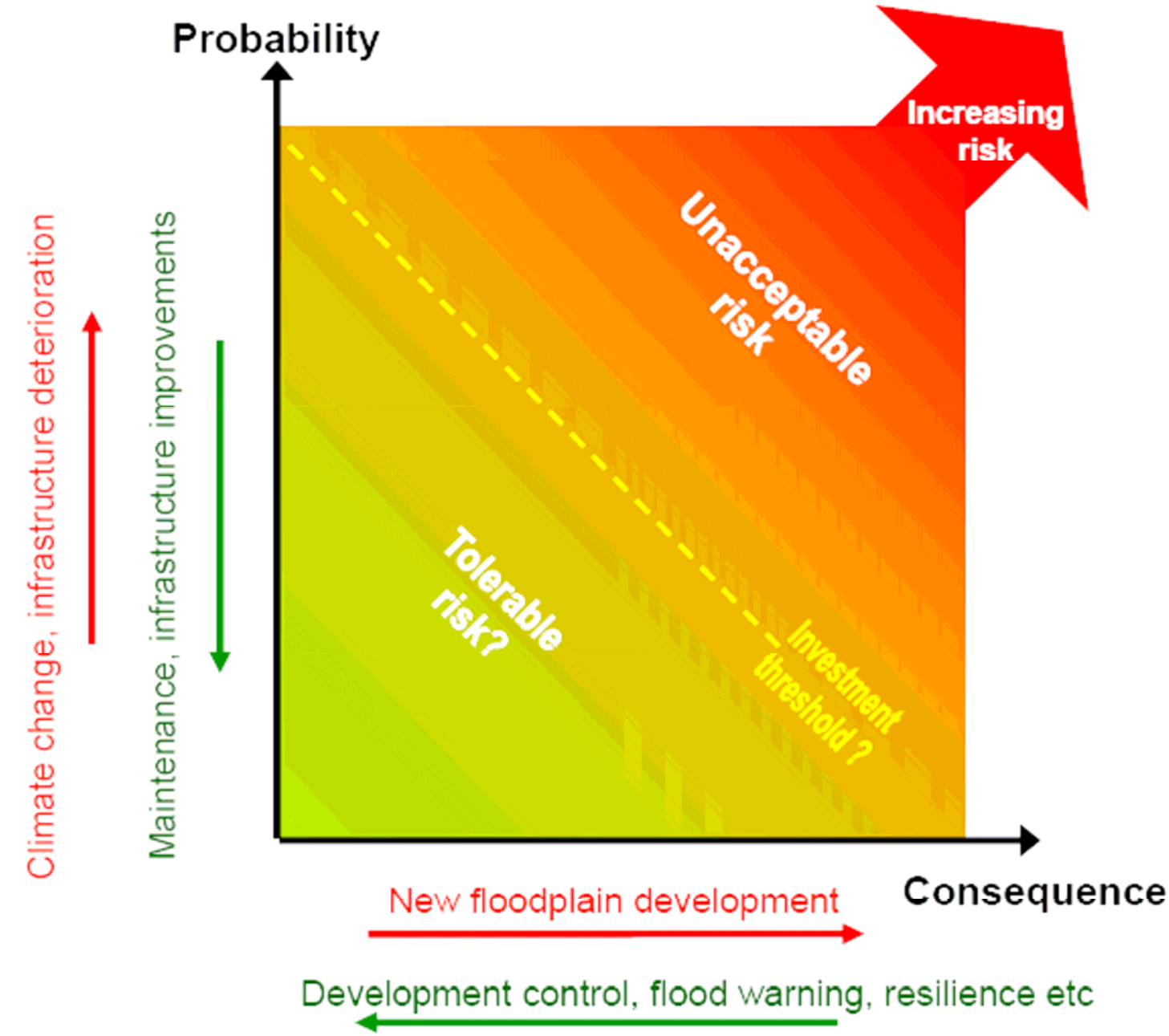
A natural hazard is an event in the physical environment that is perceived by mankind as a threat to life and property.

A disaster is the realization of a hazard.

- Nature does not know hazards, only events!
- People induce hazards that need consideration or, rather, risk management!

Risk management involves all measures to avoid and reduce vulnerabilities against hazards. Risk combines the occurrence probability of a hazard with its harmfulness.

Components of flood and coastal erosion risk



The Netherlands:
three planning horizons in coastal risk management

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Time scale	*Period (years)*	*Measures (example)*	*Climate scenario for Dimensioning / Planning*
Short term	5 – 10	Sand replenishment	20 cm/ct.
Middle term	50 – 100	Dike reinforcement	50 cm/ct.
Long term	> 100	Spatial planning	85 cm/ct. + 15% Storm

- More **Flexibility** in planning
- More **cost effectiveness** in the implementation

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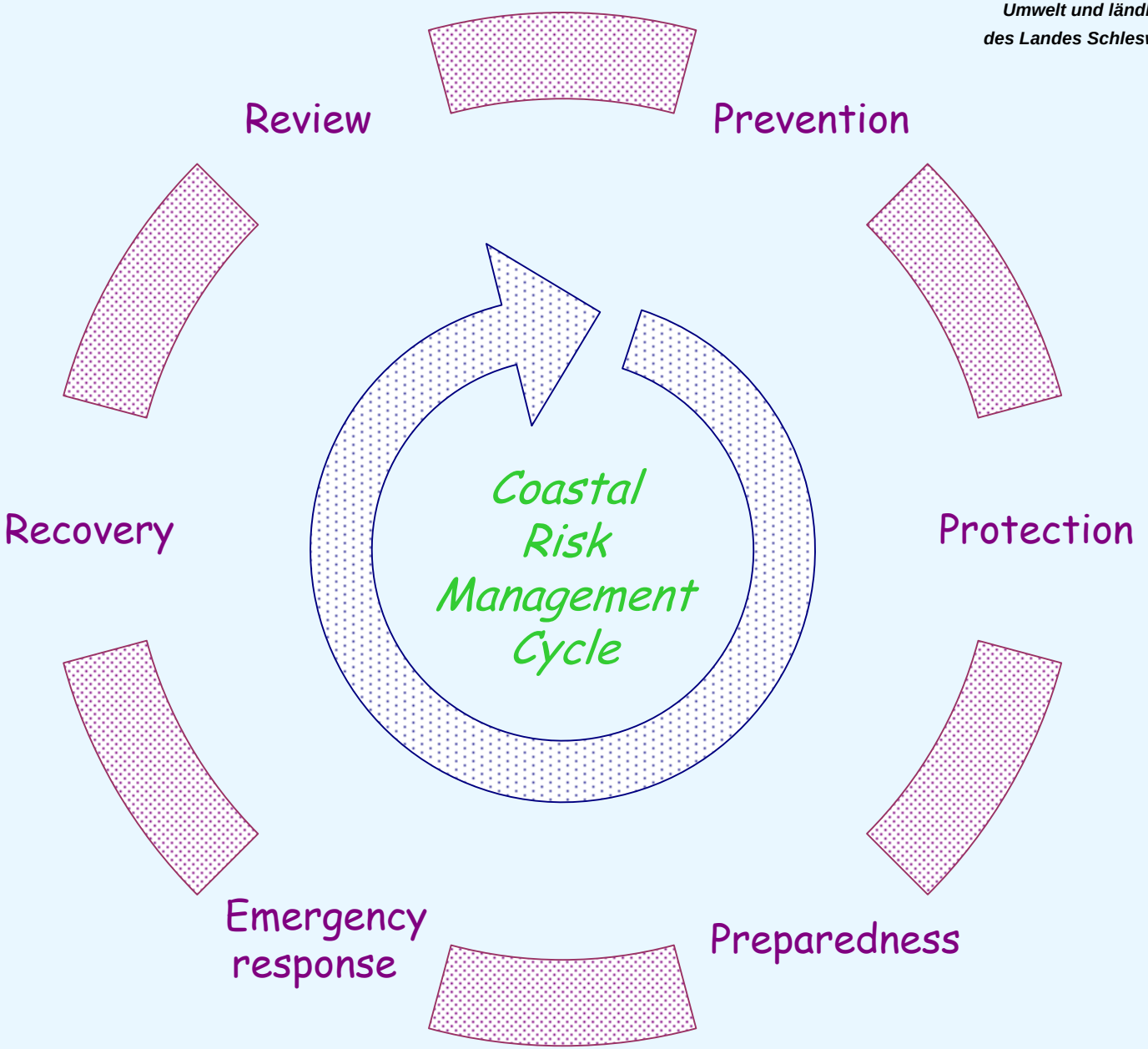

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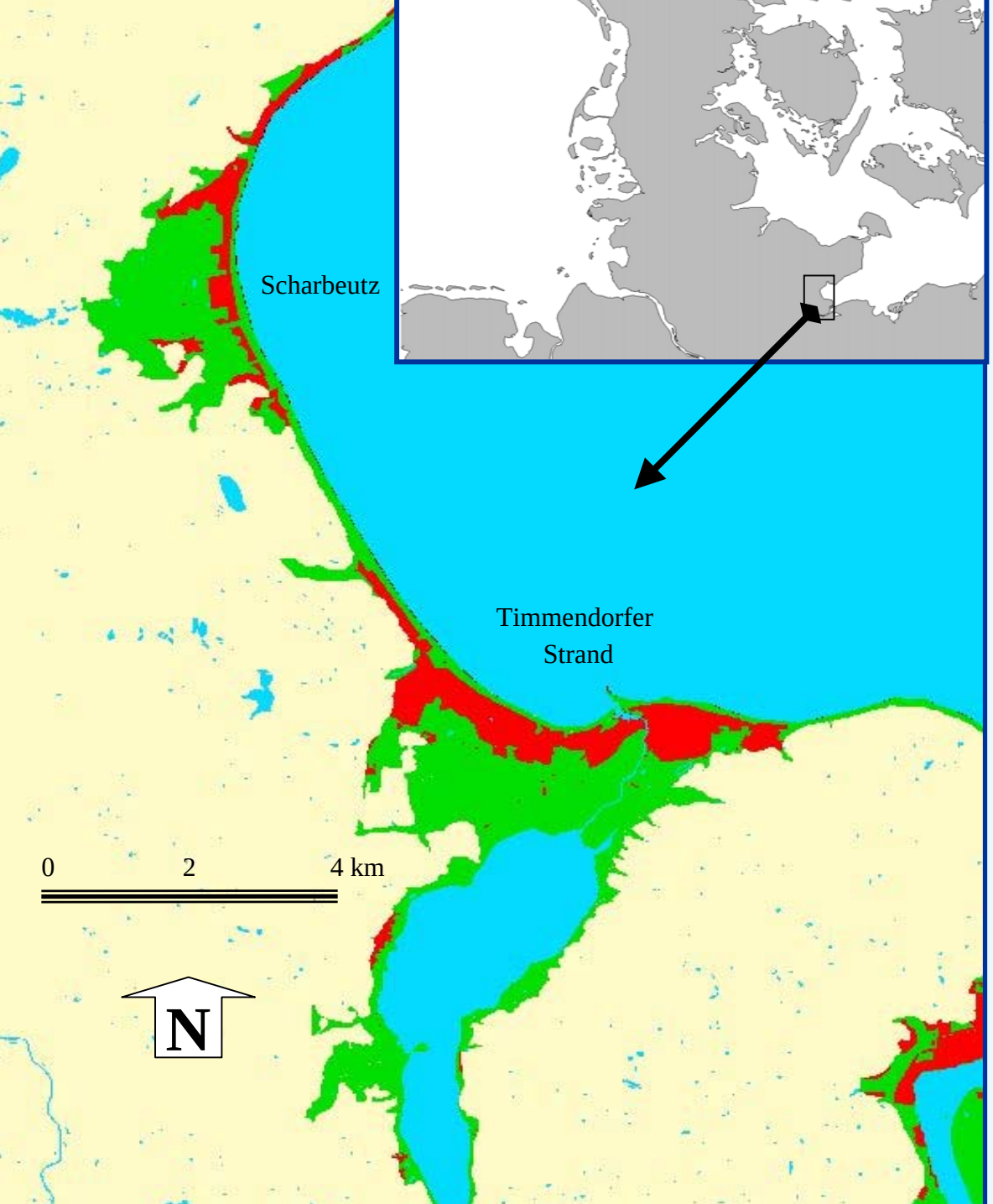
Increased hazard of flooding (even in areas not affected so far) calls for integrated flood risk management

- Establishment of present and future hazard areas (EU-flood directive)
- Development of sustainable defence strategies (technical and non-technical)
- Development of disaster management strategies

Increased hazard of coastal erosion (even in areas not affected so far) calls for sustainable protective measures

- Establishment of present and future hazard areas
- Establishment of sustainable strategies (work with nature)



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Coastal lowland (< GOL +3 m)

Area	1,265 ha
Inhabitants	5,667
Economic values	1.760 billion Euro
Gross value added	70 million Euro/a
Working places	1,896
Bed capacity	5,927

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Line of departure (summer 1999)

- Coastal flood defence (beach wall ca. MSL +2.2 m) is deficient
- Local population is very sceptic towards coastal flood defence (negative impact on tourism)
- Some local demands for protection against coastal erosion (suppletion, groins), to be financed by the State
- Prerequisite for State funding is an integrated (coastal protection and flood defence) concept for the entire lowland
- Local demand for active participation in the establishment of such a concept

Frequency distribution of yearly HHW in Neustadt (1921 - 1996)

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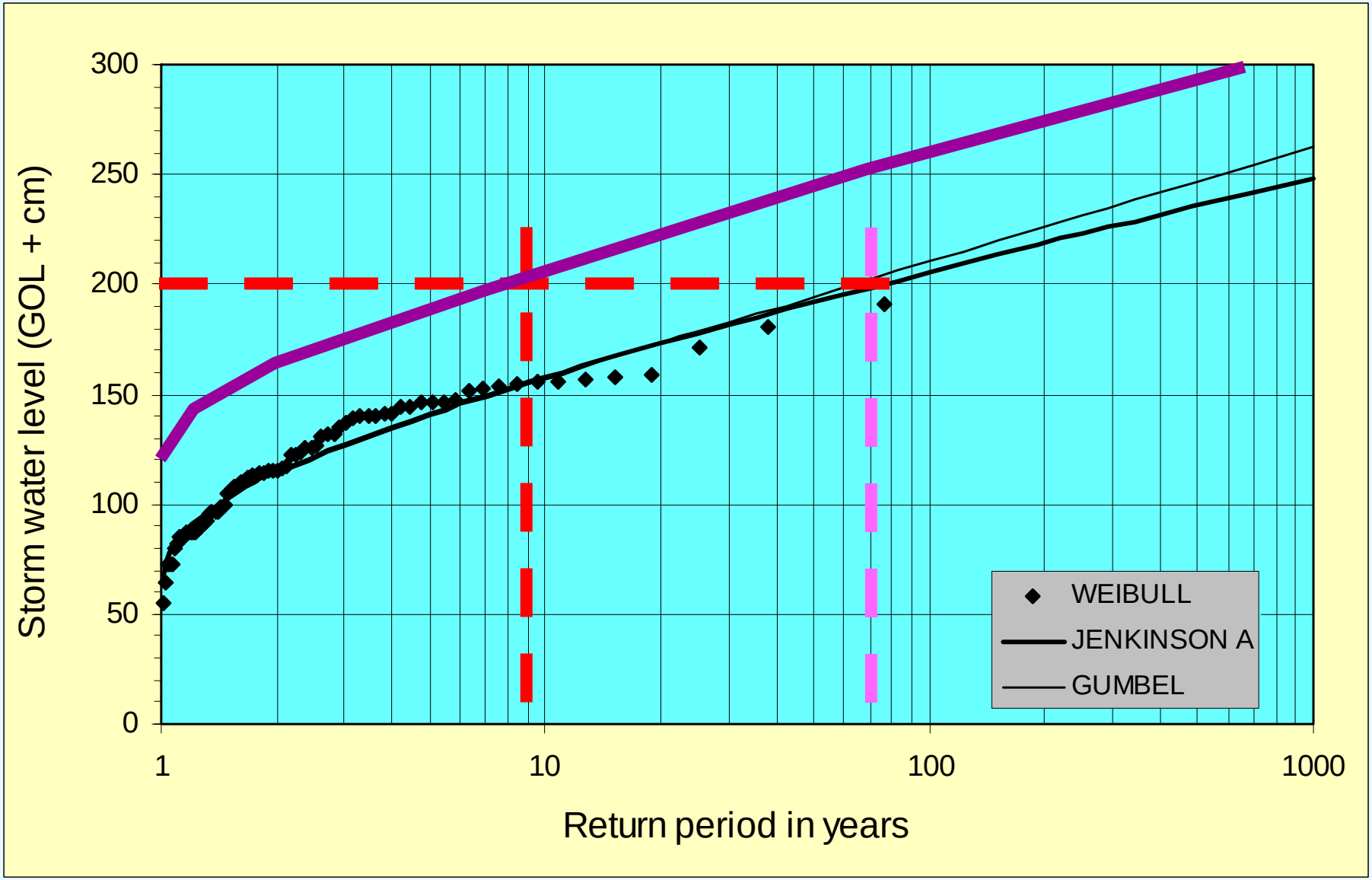

Sensitivity analysis Timmendorfer Strand/Scharbeutz

Moderated by external experts, representatives of the local population conducted the following steps:

1. characterisation of the region with variables (e.g. security against natural hazards, economic power, quality of life),
2. definition of the effects (strength and direction) of the variables on each other, i.e. establishment of a model,
3. definition of a sub-model coastal defence (e.g. risk of flooding) and of five coastal defence scenarios (e.g. zero-scenario),
4. simulation of future development with the sub-model for each scenario,
5. discussion of the results, and
6. establishment of common recommendations.

Sensitivity analysis Timmendorfer Strand/Scharbeutz

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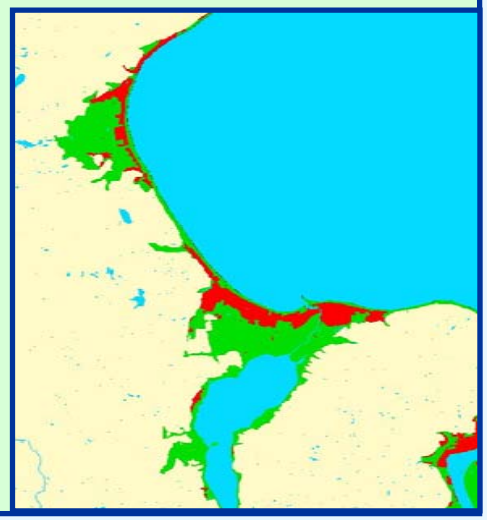
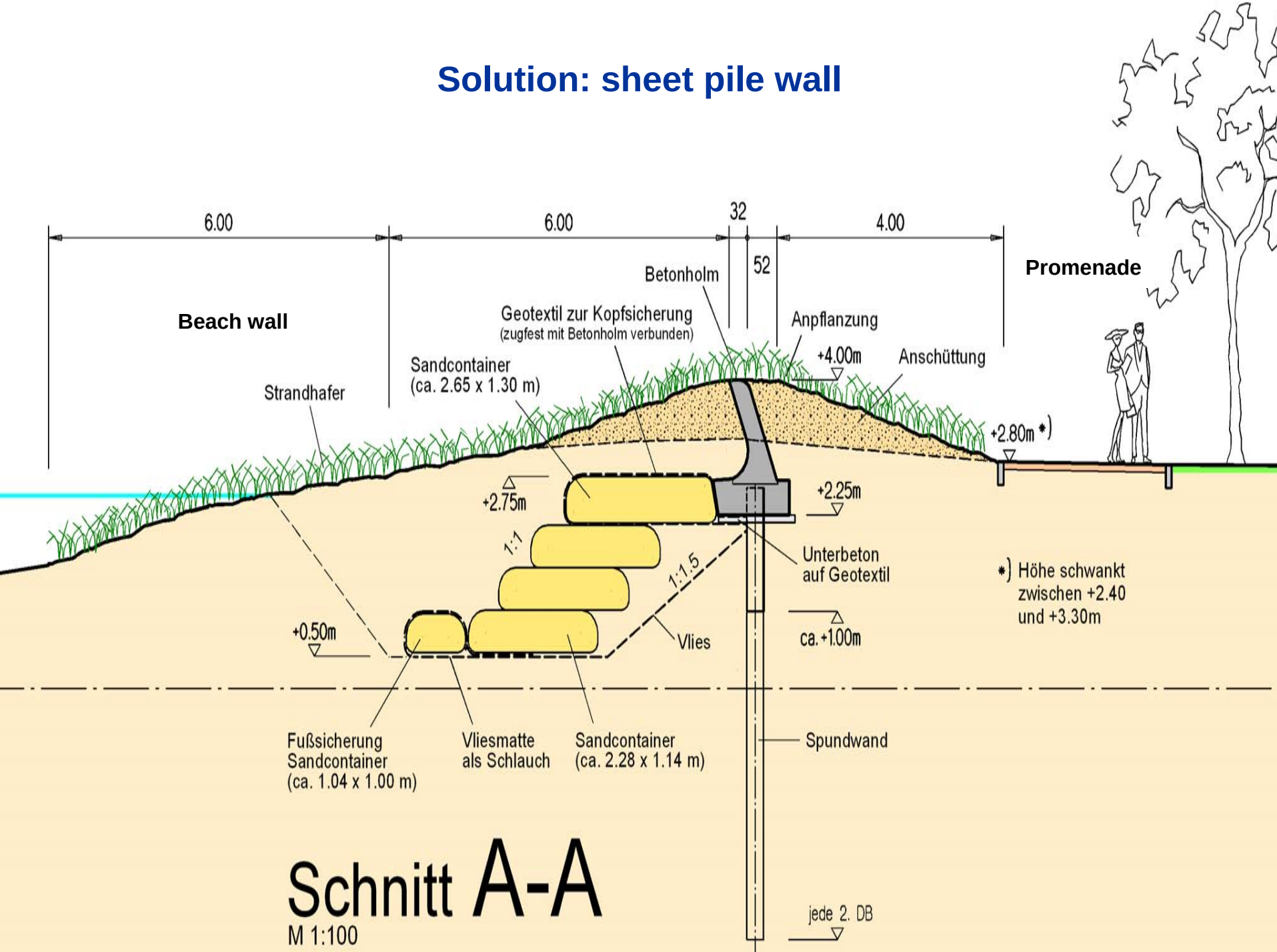
The early involvement of the public/stakeholders in the planning of a coastal defence solution turned out positive:

- the participants have recognised the long-term risk for their lowland,
- the participants (as representatives of the local population) have accepted their responsibility,
- the participants have evolved from sceptics to advocates of an integrated coastal defence concept!

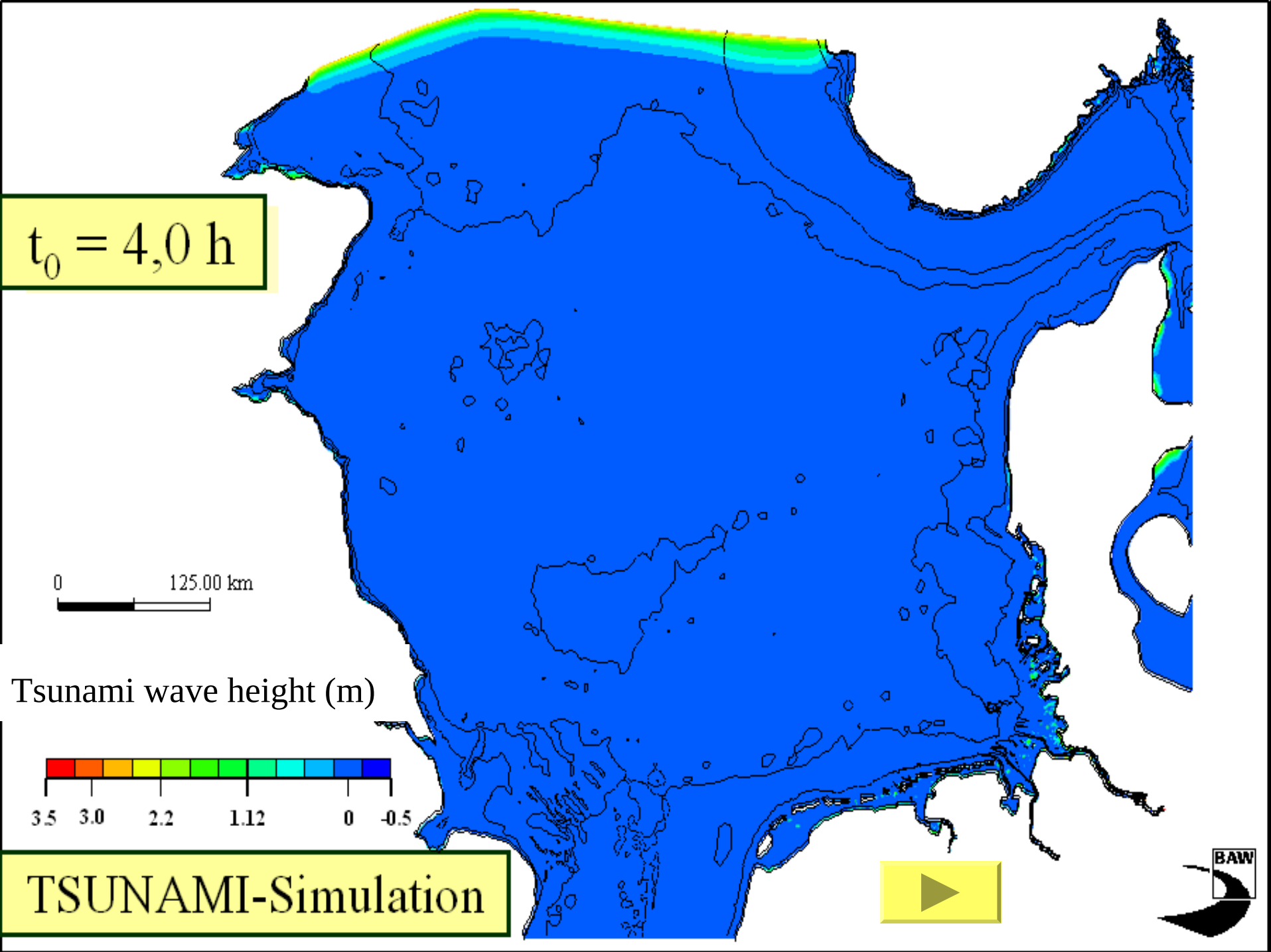
=> **a combined solution that fits in the landscape was demanded and is now implemented**



Solution: sheet pile wall



Photos: *WTM ENGINEERS GMBH - Beratende Ingenieure im Bauwesen*


t_0 = 4,0 h
0
125.00 km
Tsunami wave height (m)
3.5
3.0
2.2
1.12
0
-0.5
TSUNAMI-Simulation
BAW