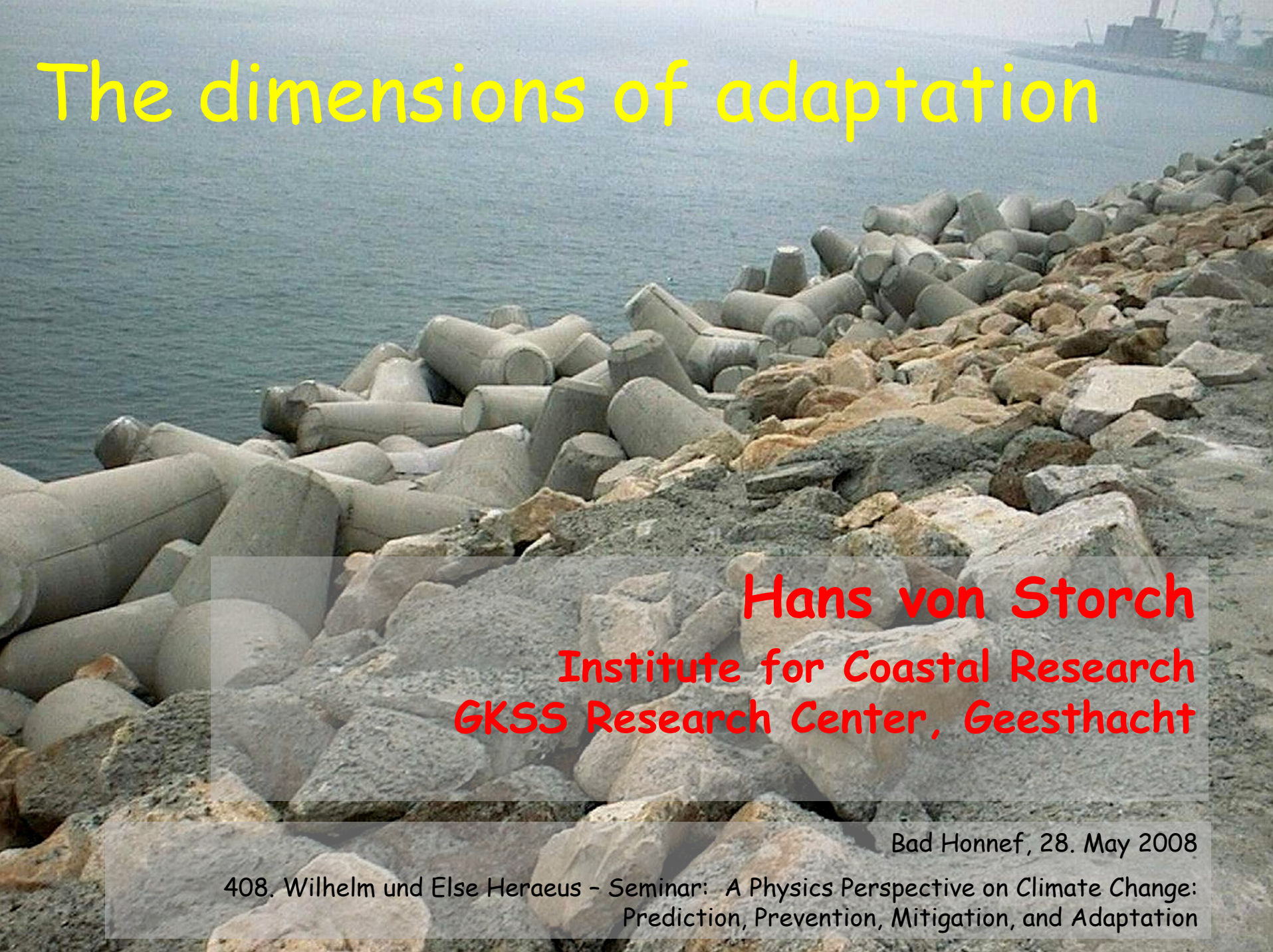
The dimensions of adaptation



Hans von Storch

Institute for Coastal Research
GKSS Research Center, Geesthacht

Bad Honnef, 28. May 2008

408. Wilhelm und Else Heraeus – Seminar: A Physics Perspective on Climate Change: Prediction, Prevention, Mitigation, and Adaptation

Who is this?

Hans von Storch
(born 1949)

Diploma in mathematics, PhD in meteorology

Director of Institute for Coastal Research, GKSS Research Center, near Hamburg,

Professor at the Meteorological Institute of Hamburg University

Works with social and cultural scientists.

Overview

1. The "Zeppelin Manifest on Climate Policy" (Stehr and von Storch)
2. Example: Storm surges – global phenomenon, with regional manifestation.
3. The case of the German Bight
4. The case of Hamburg – assessment and options
5. Advising stakeholders

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1. Anthropogenic climate change (ACC) is not an intermittent phenomenon.

- It can not be controlled by short term (decadal) climate policies.
- Reduction of emissions leads to reduction of growth of ACC, but not to stabilization or reversal in the coming few decades.
- Reaching a new equilibrium needs several decades if not centuries (sea level).

2. Climate policy needs to pursue two goals, adaptation and mitigation.

- such efforts are in most cases independent.

- both lines require technological innovations, which needs a favourable social perception of technology and innovations.

3. Adaptation and Mitigation are useful and needed in any case. Also if …

- unexpected technological fixes "solve" the ACC problem.

- the concept of ACC is overblown.

- the reduction policy is very successful (reducing emissions by many tens of percent within a few decades).

4. The presently ongoing change can not be avoided. It can only insignificantly be curbed in the foreseeable future. Only on longer terms emissions policies have the potential of "solving the problem".

A climate policy *without* a significant adaptation policy – to deal with the unavoidable part of ACC – is irresponsible.

Example: "heat deaths" (e.g., 2003)
- was first of all a failure of adaptation (to a predictable risk)
- the concept was used as an excuse for risk management failures by faulting "higher forces"
- cf., Nargis

5. Need for adaptation - 1

- presently installed measures to reduce the emission increase will have a significant effect only in several decades.

- in the meantime ACC will further emerge.

- the time scale of political decisions and legitimization (short) and of ACC (long) are fundamentally different.

- the political and social success of mitigation will be "harvested" not by present political and social actors.

5. Need for adaptation – 2

-The present threat of climatic extremes – e.g., heat waves (Europe 2003), storm surges (02B, Katrina, Nargis) – is significant. + Was always significant (Hamburg 1962, Bhola 1970).


news.com.au

Cyclone 'a sign of things to come'

By Bruce Loudon
May 09, 2008 04:38am

Article from: (http://www.theaustralian.news.com.au/)

- Blaming ACC for such threats – such as TC Mitch in Central America during the Rio de Janeiro summit in 1992 – means: downplaying the significant fact of unpreparedness and insufficiently managed vulnerability.


The present vulnerability is further increased by the political-economic development (globalization, urbanization, migration), independent of ACC.

5. Need for adaptation – 3

The Third World demands support for reducing vulnerability, which is to large extent: development.

6. Kyoto Protocol

- a top-down approach, limited to a subset of emittors.

- almost entirely directed towards emission control.

- direct effect very small, even if implemented successfully.

- promised goals will not be reached; GHG concentrations show clear upward trend; no indication of a noteworthy reduction of increase – mostly BAU.

- why should a successor of Kyoto be more successful?

- by some in the Third World seen as hegemonial tool of the West.

7. Instituting adaptation is politically relatively easily feasible:

-Successes become visible on a time horizon comparable to the multi-year political time scale.

- Adaptation measures may be combined with other specific political goals. (Mitigation also.)

- Adaptation measures may be designed to be consistent with local or regional political conditions.

8. Climate change impact depends strongly on the regional (geographical, cultural) specifics.

- Adaptation measures may be conditioned on local needs, options and culture.

- Technological "solutions" of local and regional problems are less complex than restructuring energy industry and re-educate people in energy usage.

9. Dual strategy of mitigation and adaptation can be pursued in a division of labour.

- local and regional authorities and stakeholders pay attention to limit local vulnerability and to exploit opportunities. (This already happens, e.g. with respect to coastal defence or port management.)

- national and supra-national authorities organize overall energy policy and, more generally, regulate emissions of anthropogenic substances into the environment

10. In the public, only efforts to limit emissions are considered laudable.

- Most of these efforts on the personal level are of symbolic nature, with no measurable effect on GHG emissions.

- Such symbolic acts tell the actors that they have contributed their share to the solution of the problem, while they practically have done nothing.

- Most of the efforts in the western countries are inefficient, and often a tool of industry policy.

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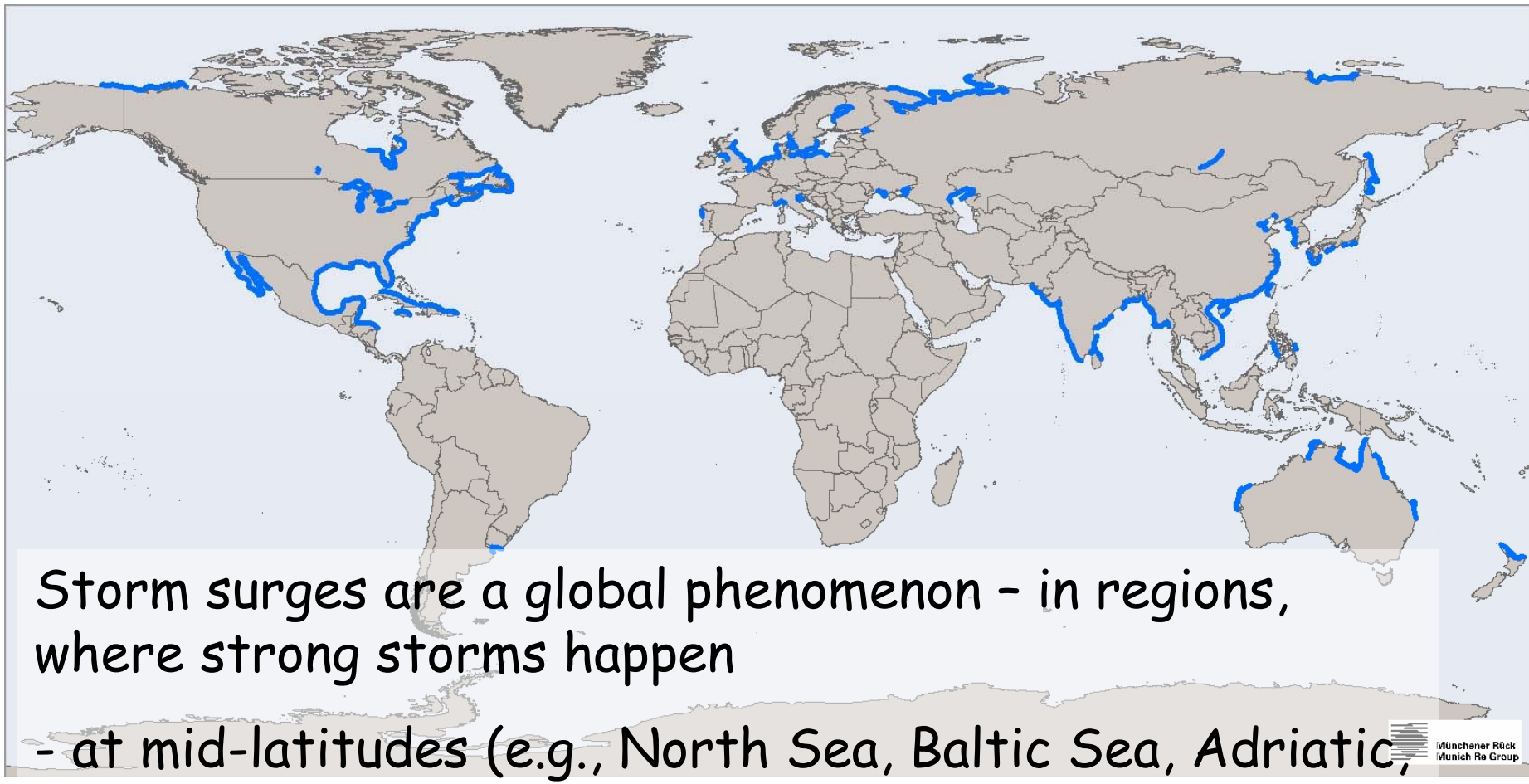
Dürchbrüch deß Dammes Zwischen Amsterdam, v. Vacrlem.


Dürchbrüch deß Dammes bey der Staff-Hoorn.



Storm surges are a global phenomenon – in regions, where strong storms happen

- at mid-latitudes (e.g., North Sea, Baltic Sea, Adriatic, Irish Sea …)

- in the tropics where typhoons emerge.

Münchner Rück

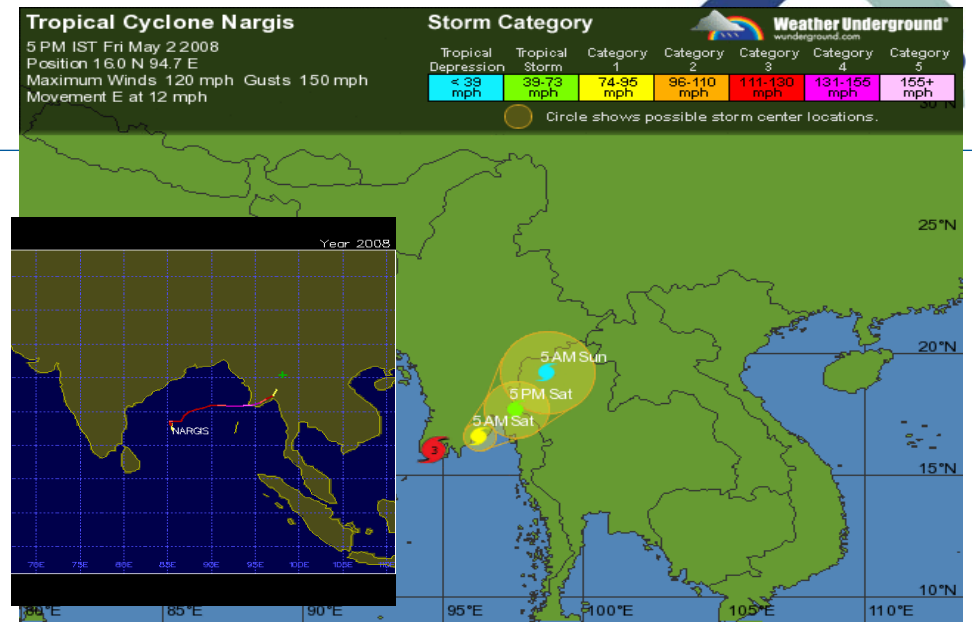
Storm Nargis

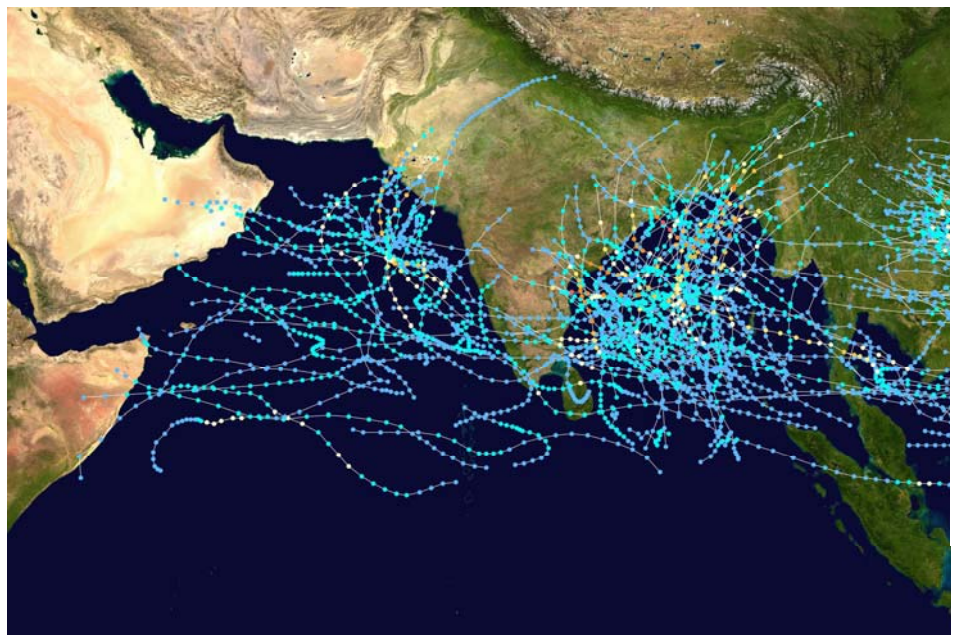
Tropical storms surges: typical spatial scale of storm 500-1000 km; amplitude up to 7-8 m; 200 km coast line affected; several hours up to half a day (Gönnert et al., 2001)

clisap

Two scientific tasks:

- operational forecasting
- determining present risk, present change of risk and possible future risk





Tracks 1980-2005

HELMHOLTZ GEMEINSCHAFT

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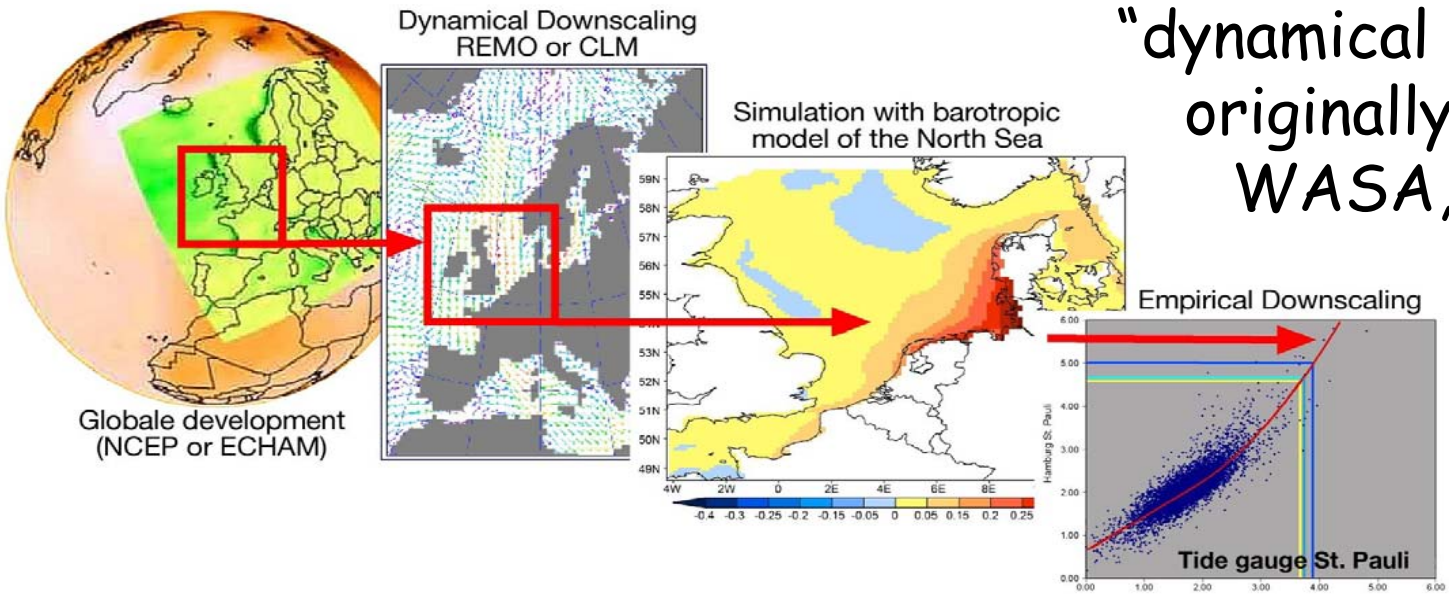
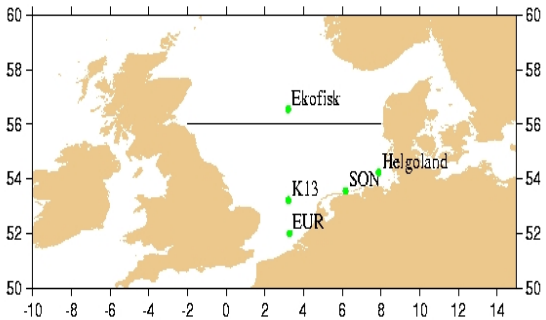
Climate community dealing with recent, present and future storm surge climatology is fragmented.

In Europe the projects WASA and STOWASUS have brought on significant progress (see below).



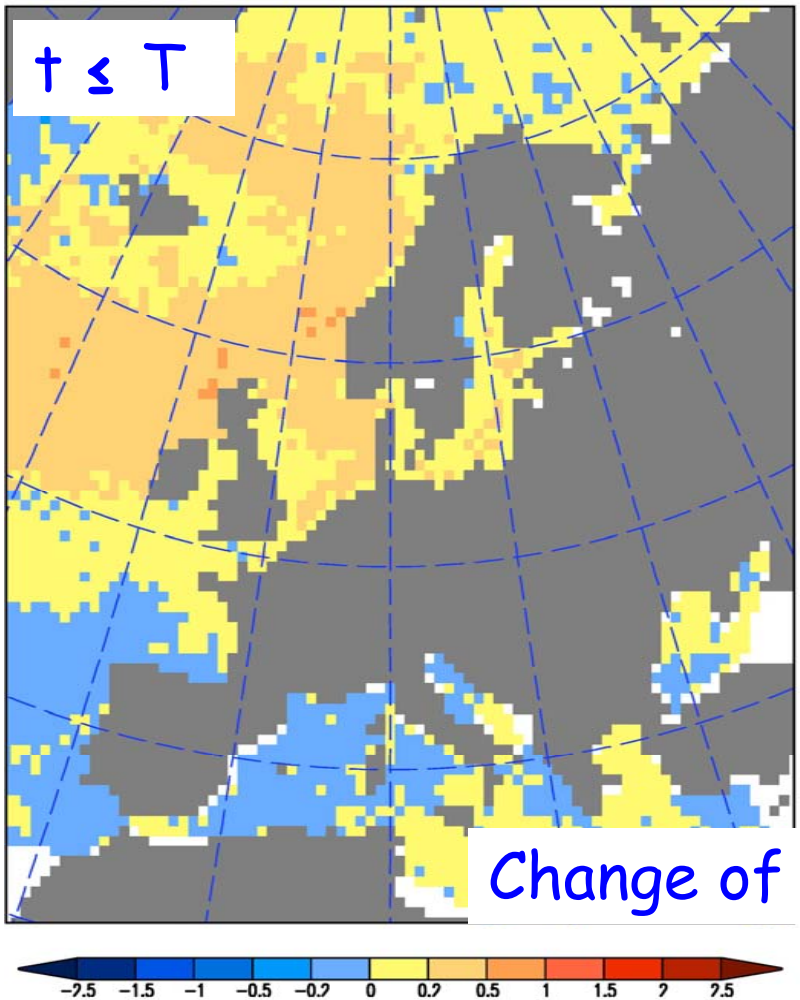
The European methodology of "dynamical downscaling", originally developed in WASA, is presently exported to other parts of the world.

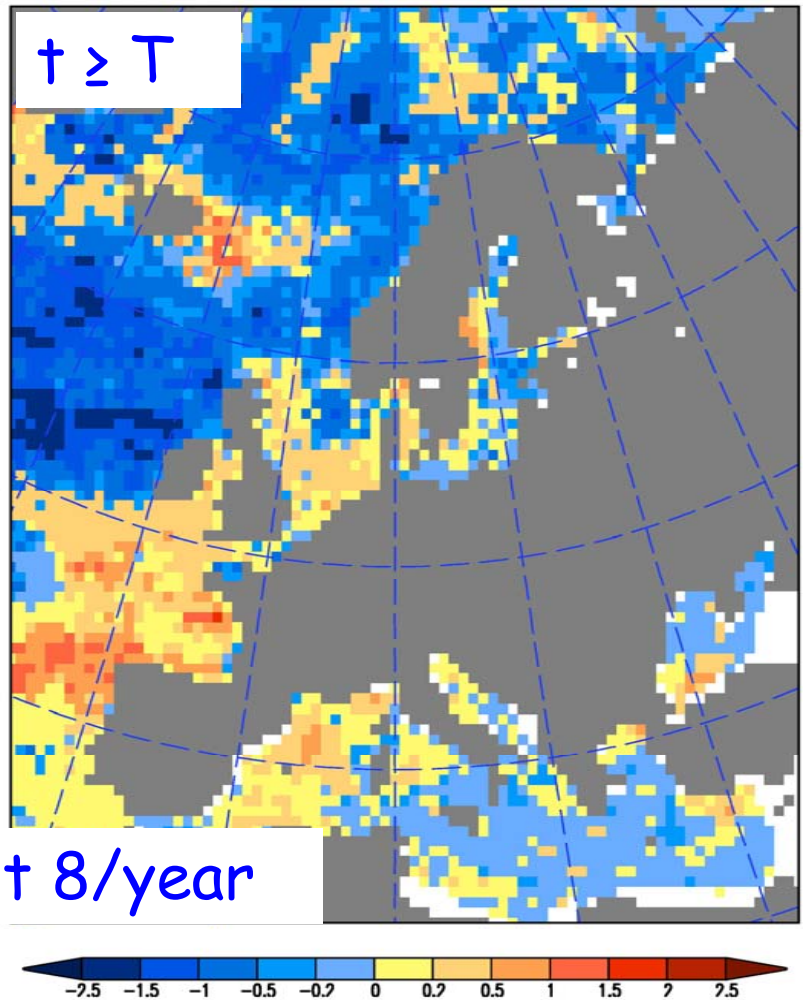
Extreme wind speeds over sea – simulated and recorded



	Years	Wind [m/s] simulated x_γ^{90}	simulated x_r	simulated x_γ^{90}	observed x_γ^{90}	observed x_r	observed x_γ^{90}
K13	2	24.38	25.17	25.96	24.05	25.21	26.37
	5	25.86	27.28	28.70	25.75	27.64	29.53
	25	28.44	31.33	34.22	28.09	32.77	37.45
EUR	2	22.50	23.16	23.82	23.16	24.03	24.90
	5	23.76	24.82	25.88	24.33	25.94	27.55
	25	25.67	28.00	30.33	26.43	29.75	33.07
SON	2	23.29	24.15	25.01	23.11	24.03	24.95
	5	24.89	26.32	27.75	24.15	25.94	27.73
	25	26.68	30.70	34.72	26.42	29.75	33.08

Stormcount 1958-2001

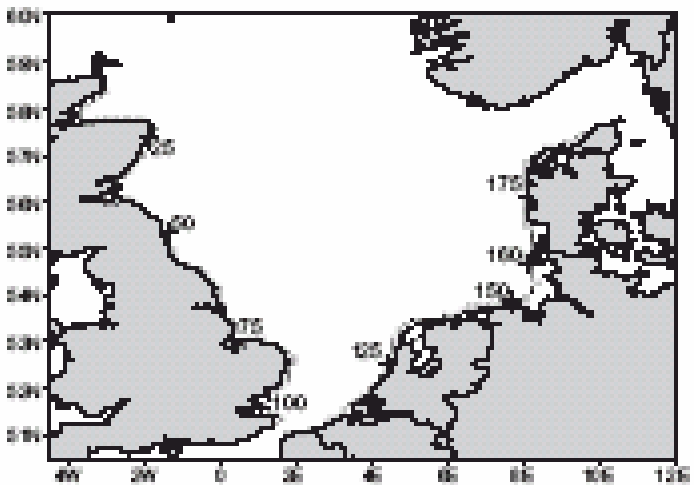


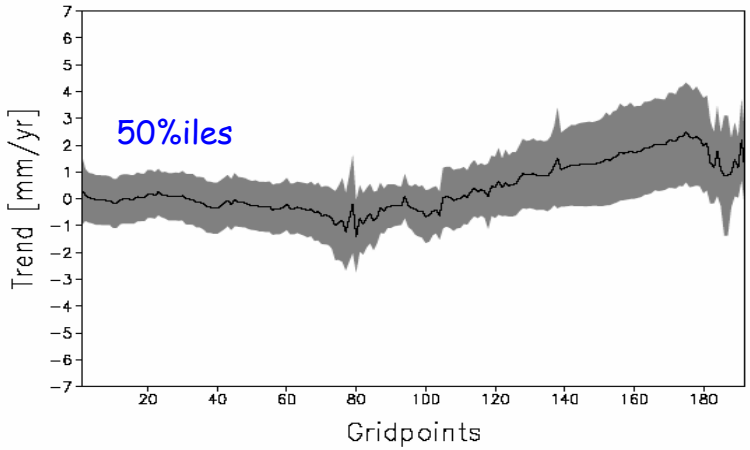


Change of # Bft 8/year

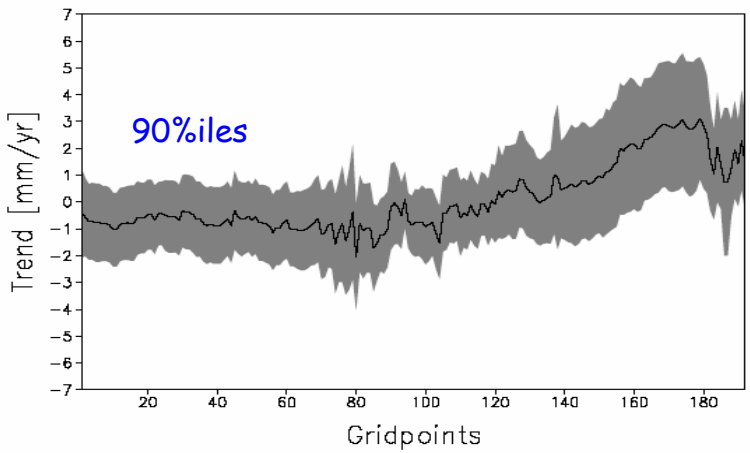
Weisse et al., J. Climate, 2005

1958-2002 Trends of annual percentiles of storm surge heights





1958-2002



Weisse & Plüß, 2005

Fig. 8. Linear trend 1958-2002 in mm year^{-1} (solid) of winter (Nov-Mar) mean (upper) and 90%-tile (lower) high water. The 95% confidence interval based on a local t-test is indicated in grey. The x-axis represents grid points along a cross section. The exact location of the cross section can be inferred from Figure 9.

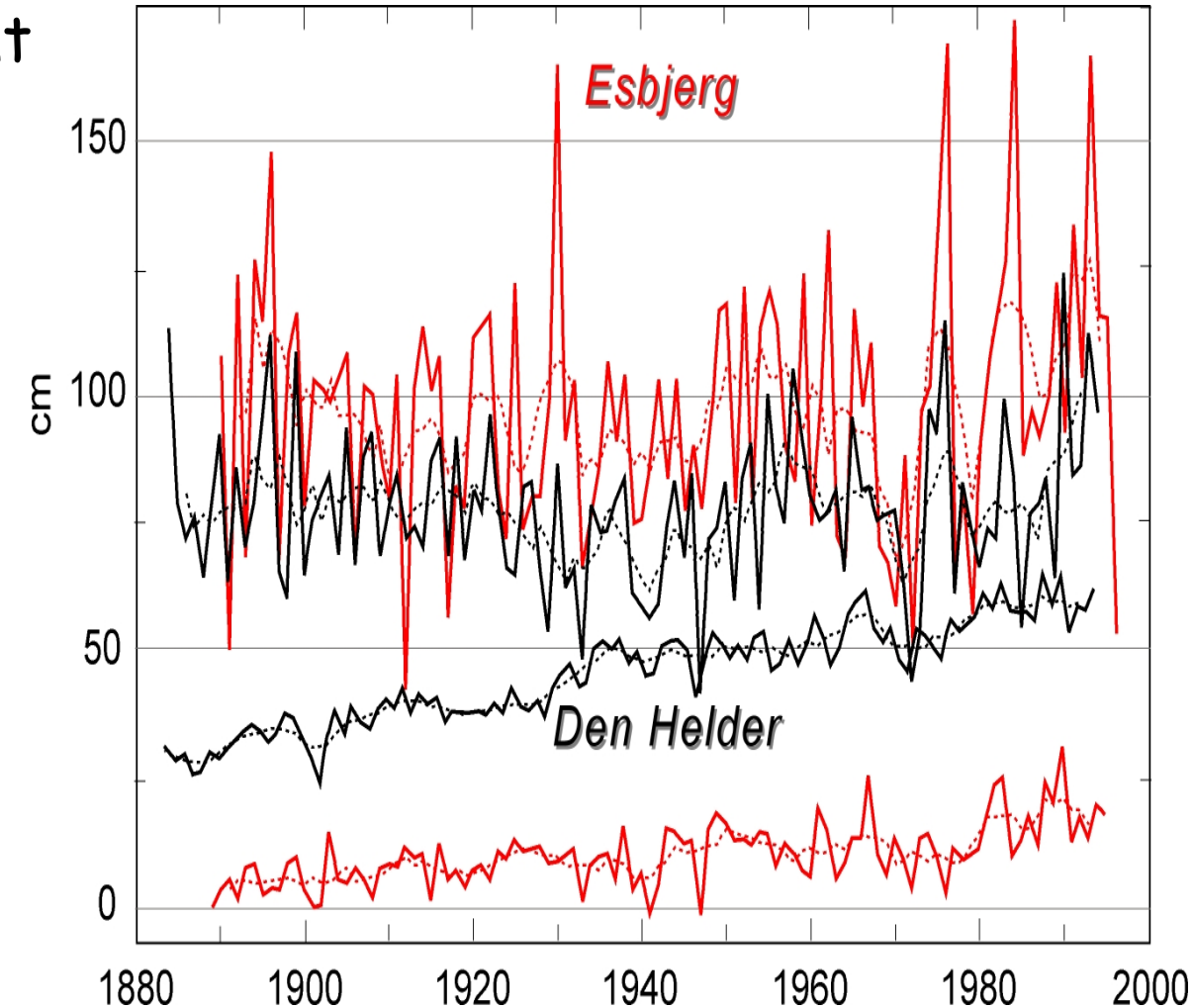
Case of German Bight

Temporal development of intra-seasonal 99%ile of high tide levels AFTER subtraction of annual mean high tide

and mean annual high tide

in Esbjerg (Denmark) and Den Helder (The Netherlands)

until 1995.



Case of German Bight

Change of regional sea level and of tidal range in the North Sea –

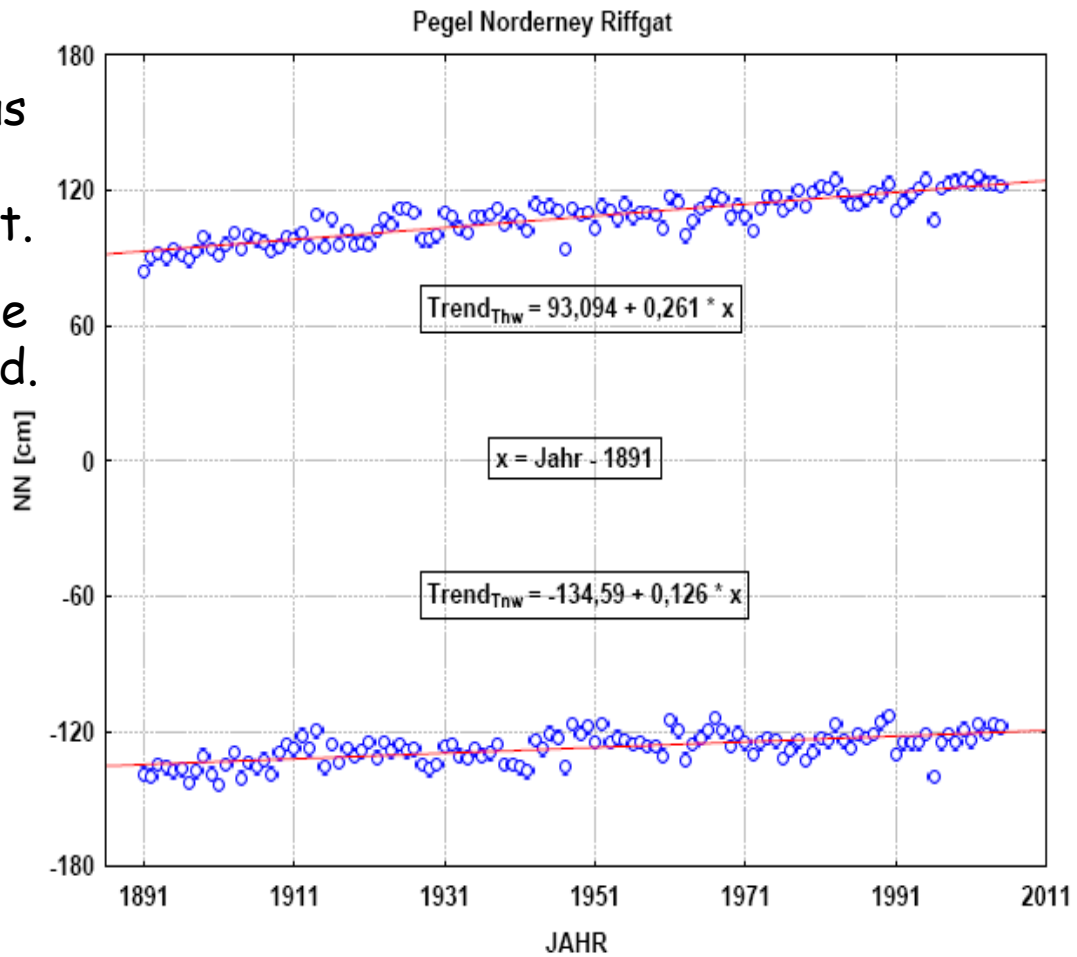
at most locations, data inhomogenous because of ubiquitous water works in harbours along the coast.

One exception is "Norderney", where the "Forschungsstelle" is situated.

It shows:

a) A monotonous increase of both mean high tide levels, low tide levelks, and of the mean tidal range.

b) Sea level rise amount to about 20 cm/100 years without acceleration.



H.-D. Niemeyer, Norderney, pers. comm

Recent, ongoing:

Natural climate variability in storminess.

Effect of water water works.

Mean sea level rise possibly about 2 mm/yr.

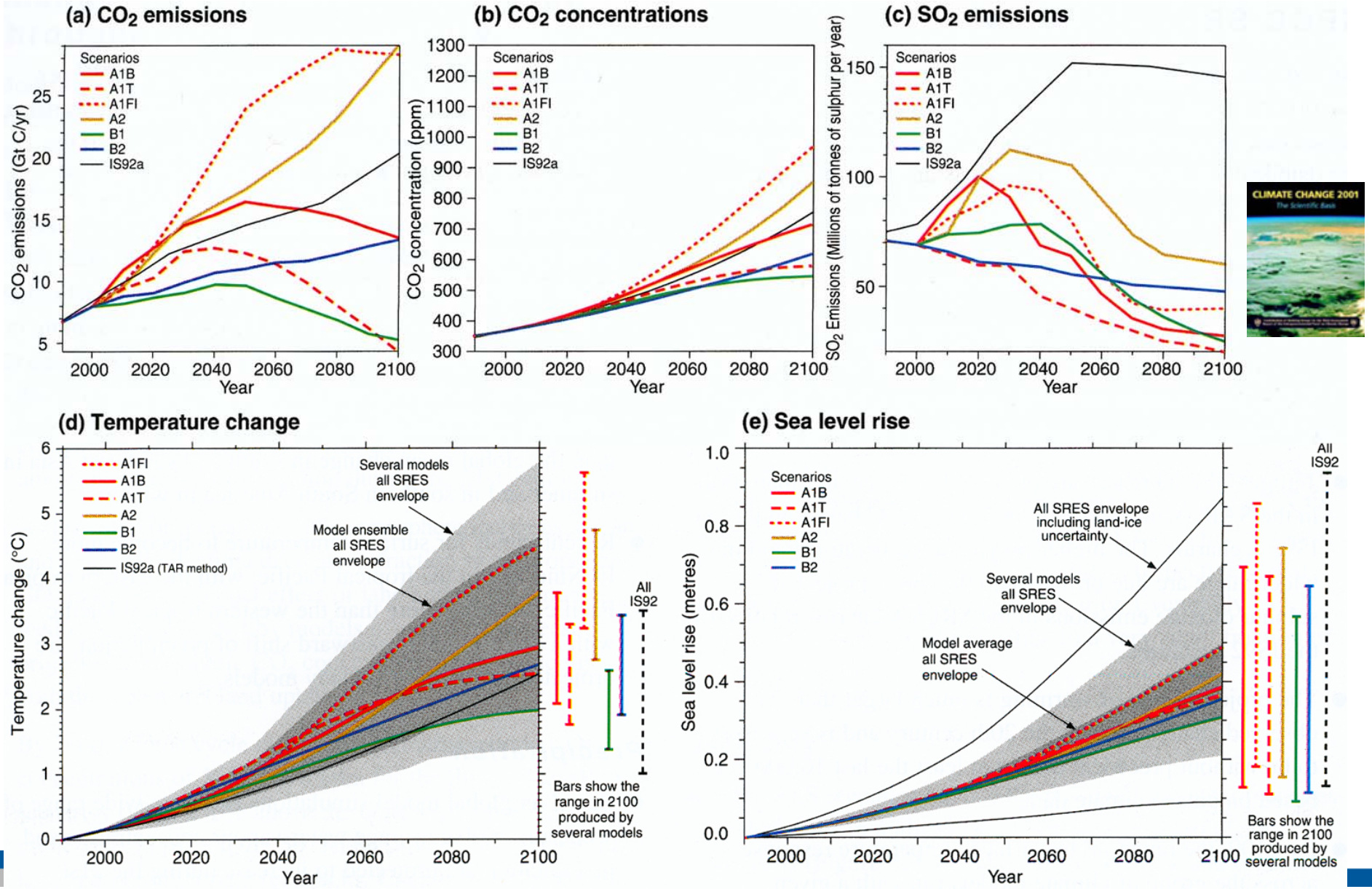
Scenarios of possible future conditions:

To the end of 21st century strongest westerly winds enhanced by about 10%. Wind/Air pressure induced increase of storm surges: 20-25 cm.

Mean sea level rise – unclear, likely larger than global mean sea level.

Increase in coastal storm surge heights in 2030 about 20 cm, in 2085 about 70 cm. Uncertain numbers!

"SRES" Scenarios
SRES = IPCC Special Report on Emissions Scenarios



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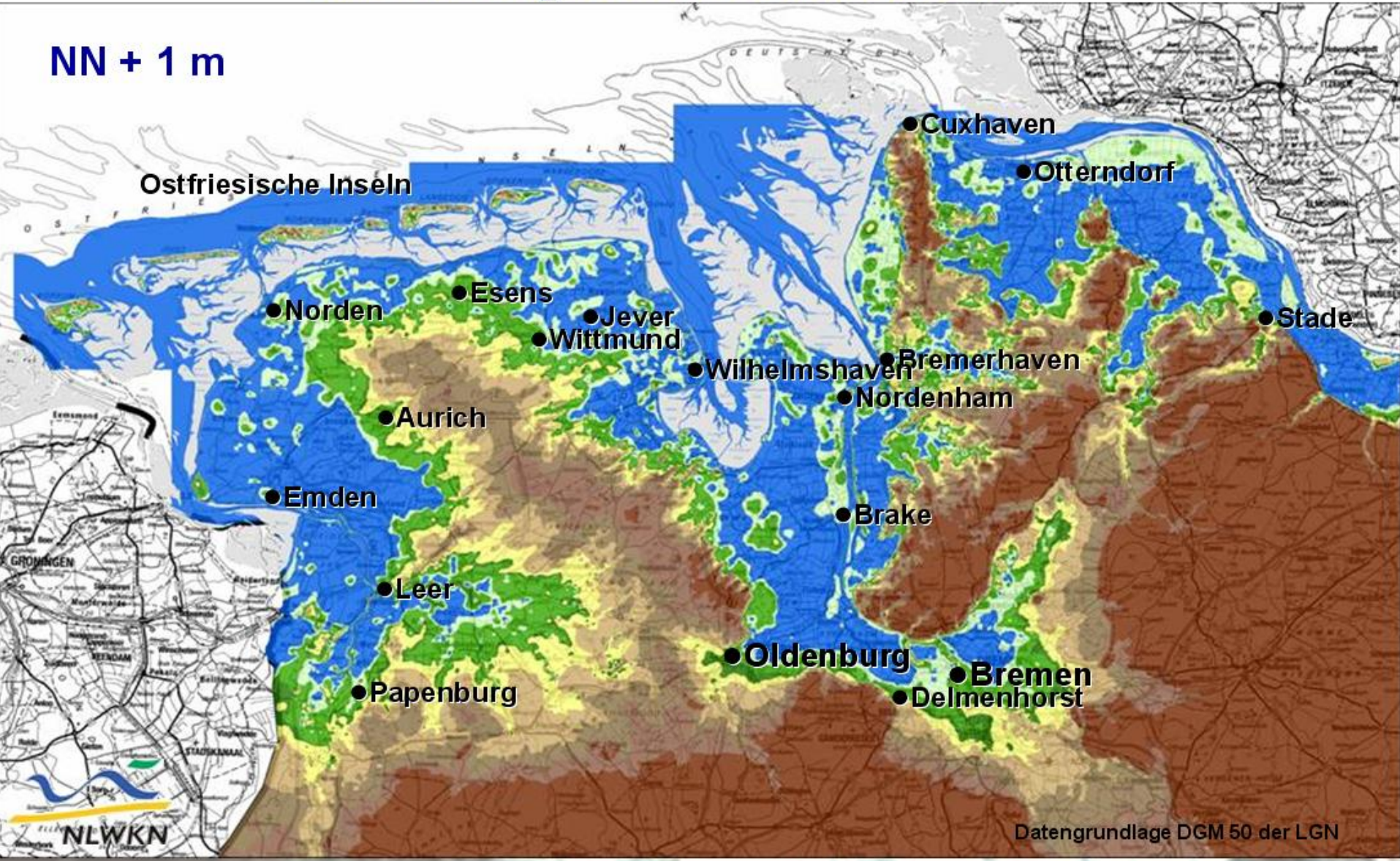
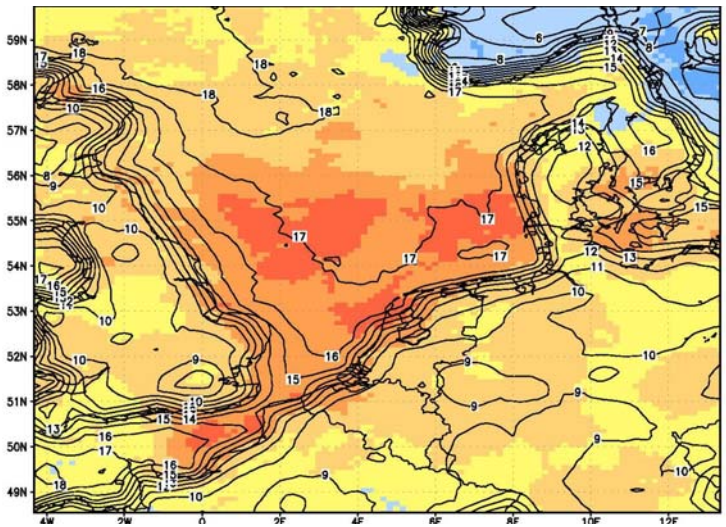
GKSS FORSCHUNGSZENTRUM

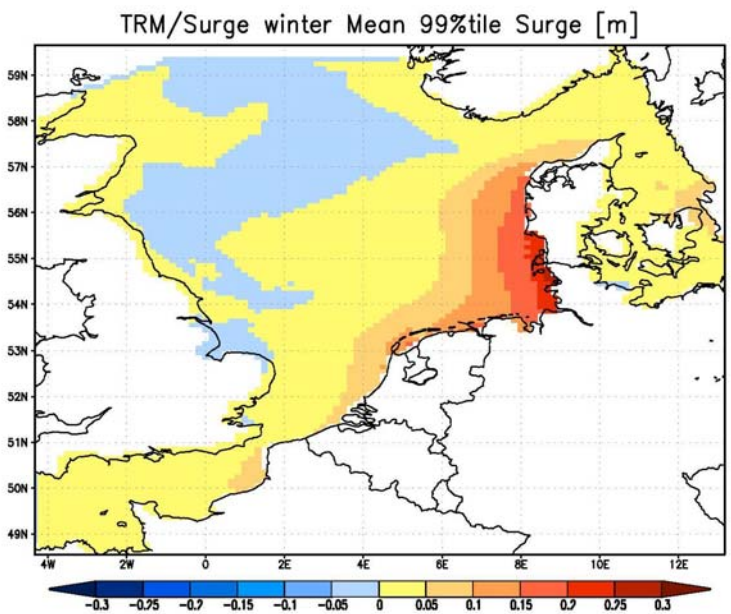
Das Küstengebiet in Niedersachsen



A2 - CTL: changes in 99 % - iles of wind speed (6 hourly, DJF): west wind sector selected (247.5 to 292.5 deg)

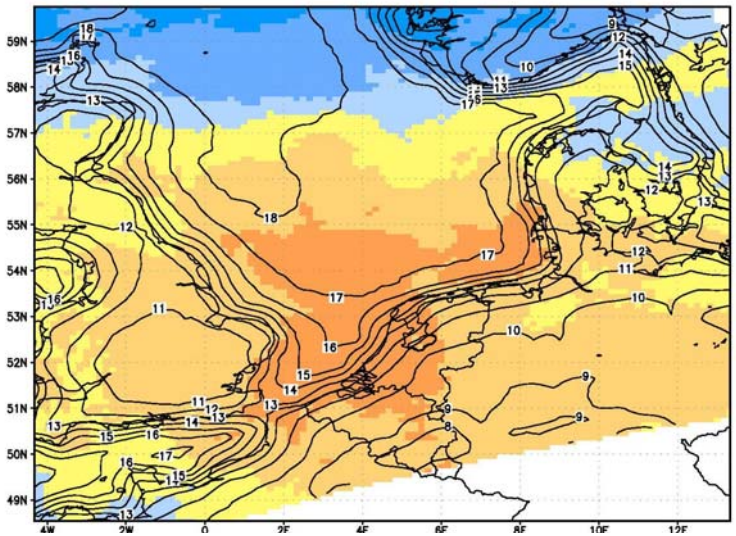
HIRHAM

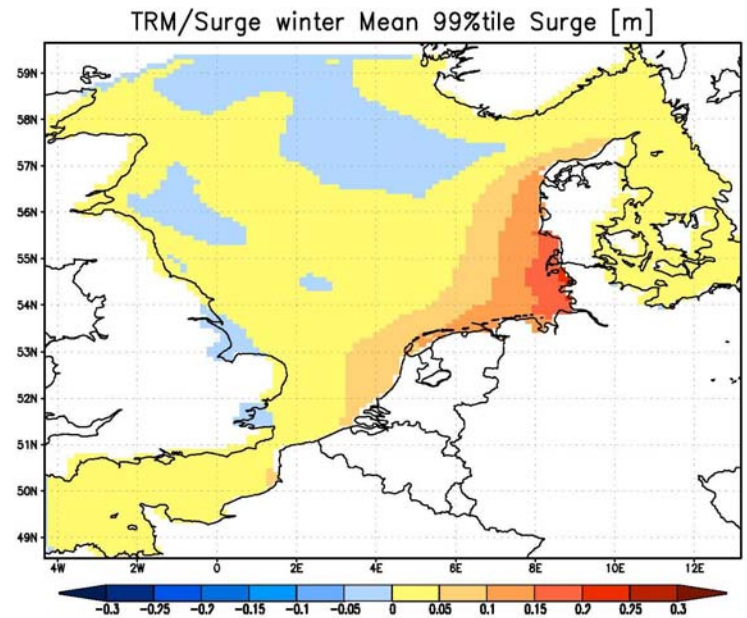




Scenarios for 2085

RCAO



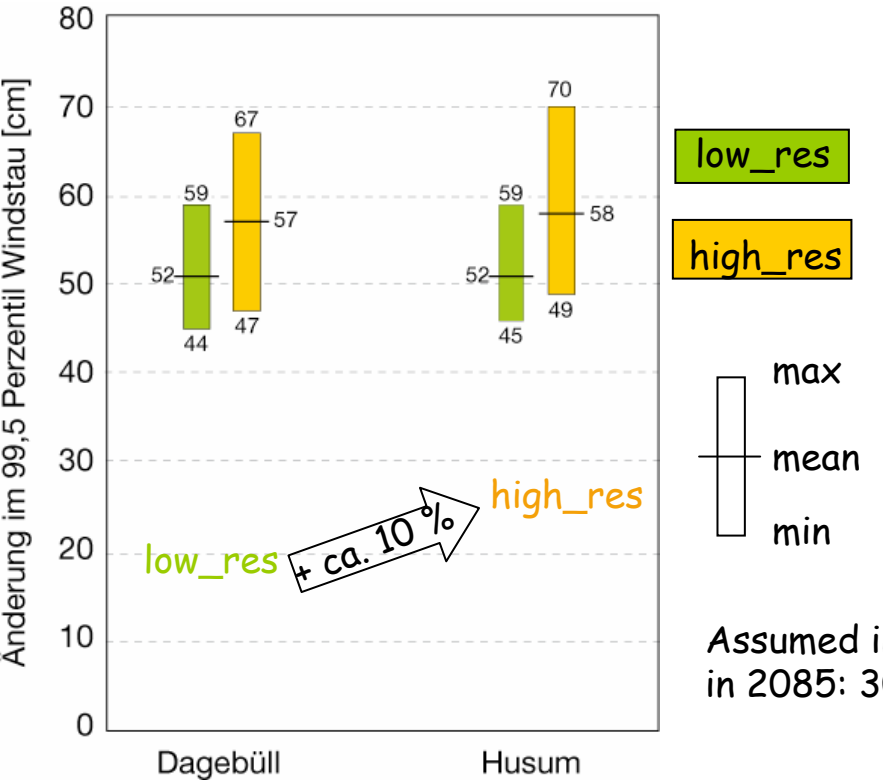


clisap

"Localisation": From the 10 m depth line to the shore line.

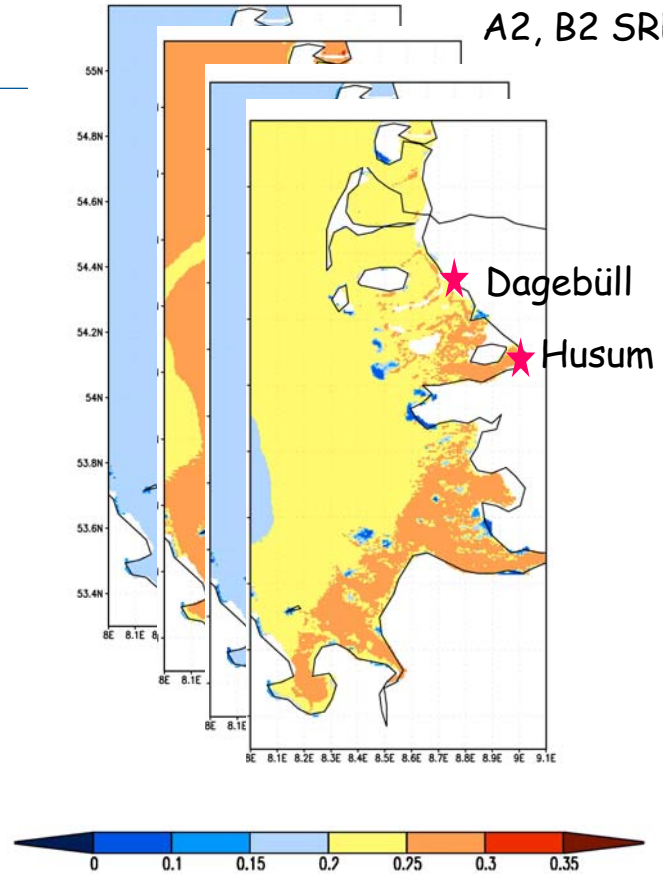
Change of winter 99.5%ile of wind and air pressure related water levels (6 hourly data) in 2085

Δ wind effect, 99.5%-ile [cm] +increase MSL



Assumed increase in MSL in 2085: 30 cm

Δ wind effect, 99.5%-ile [m], Ensemble A2, B2 SRES



Estimated with a regression model, trained with high resolution hindcast.

Woth, pers. comm.

HELMHOLTZ GEMEINSCHAFT

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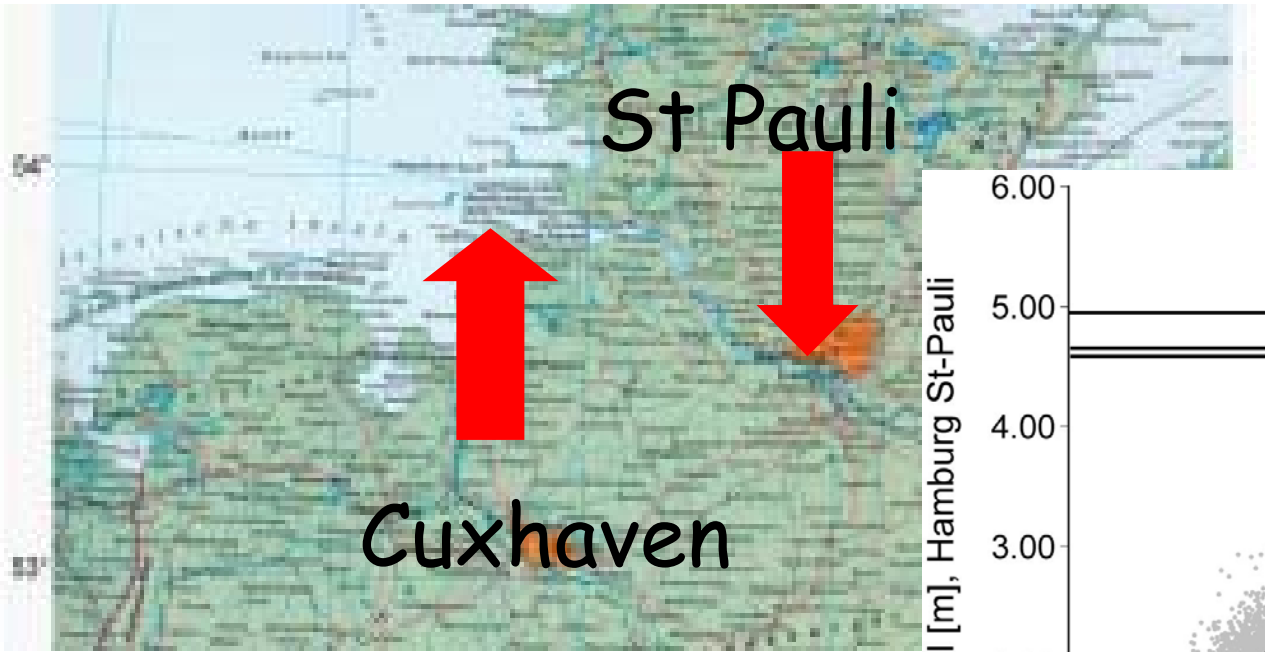
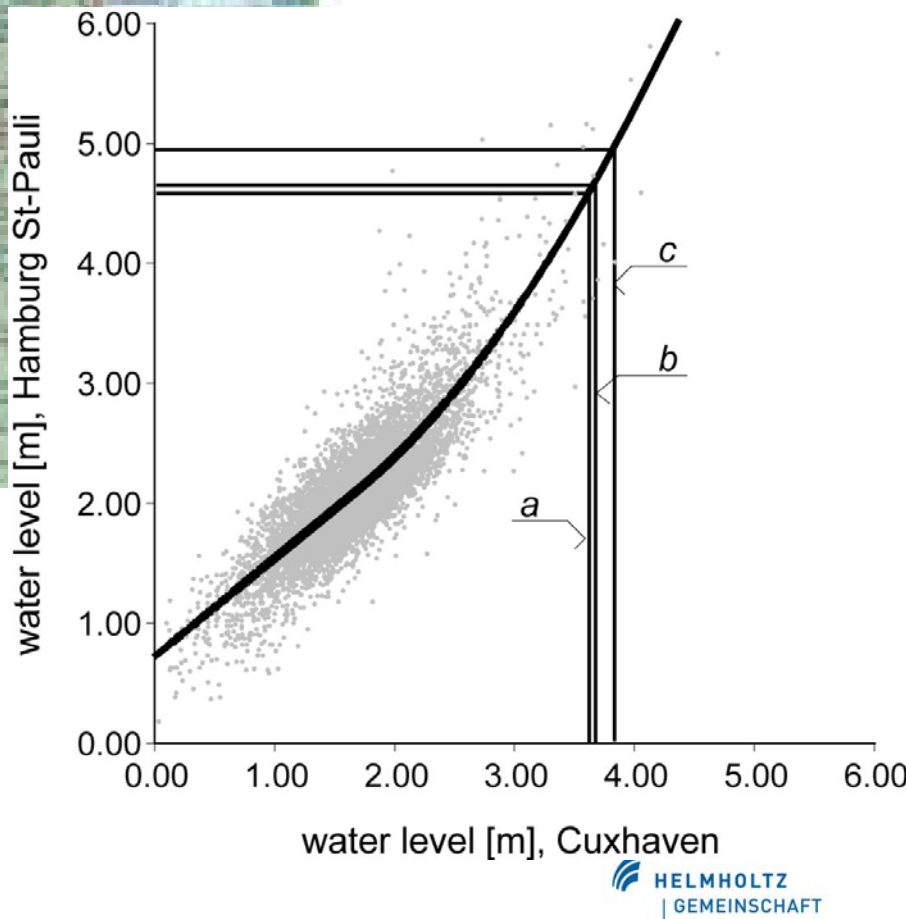
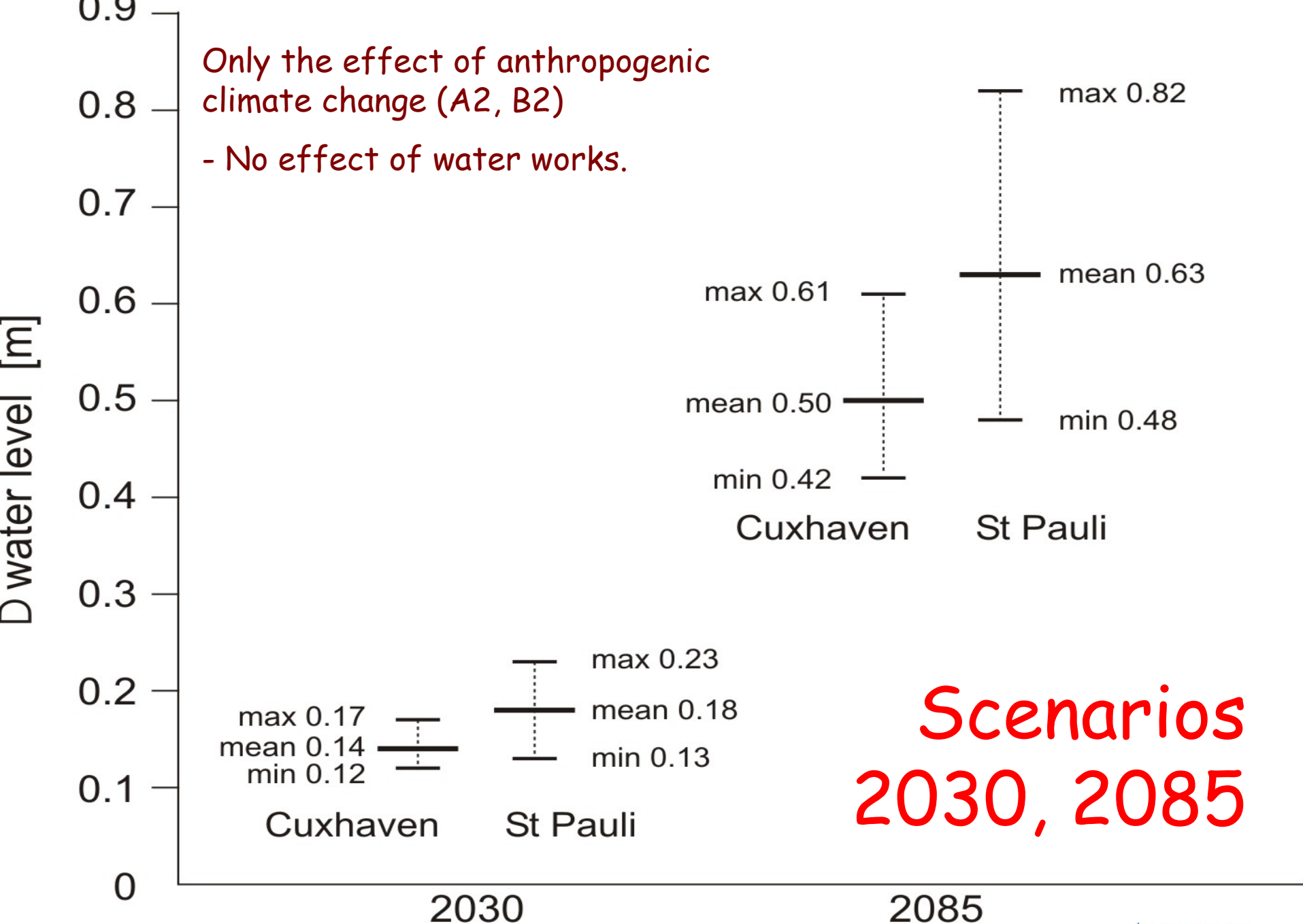
"Localisation": From the coast into the estuary





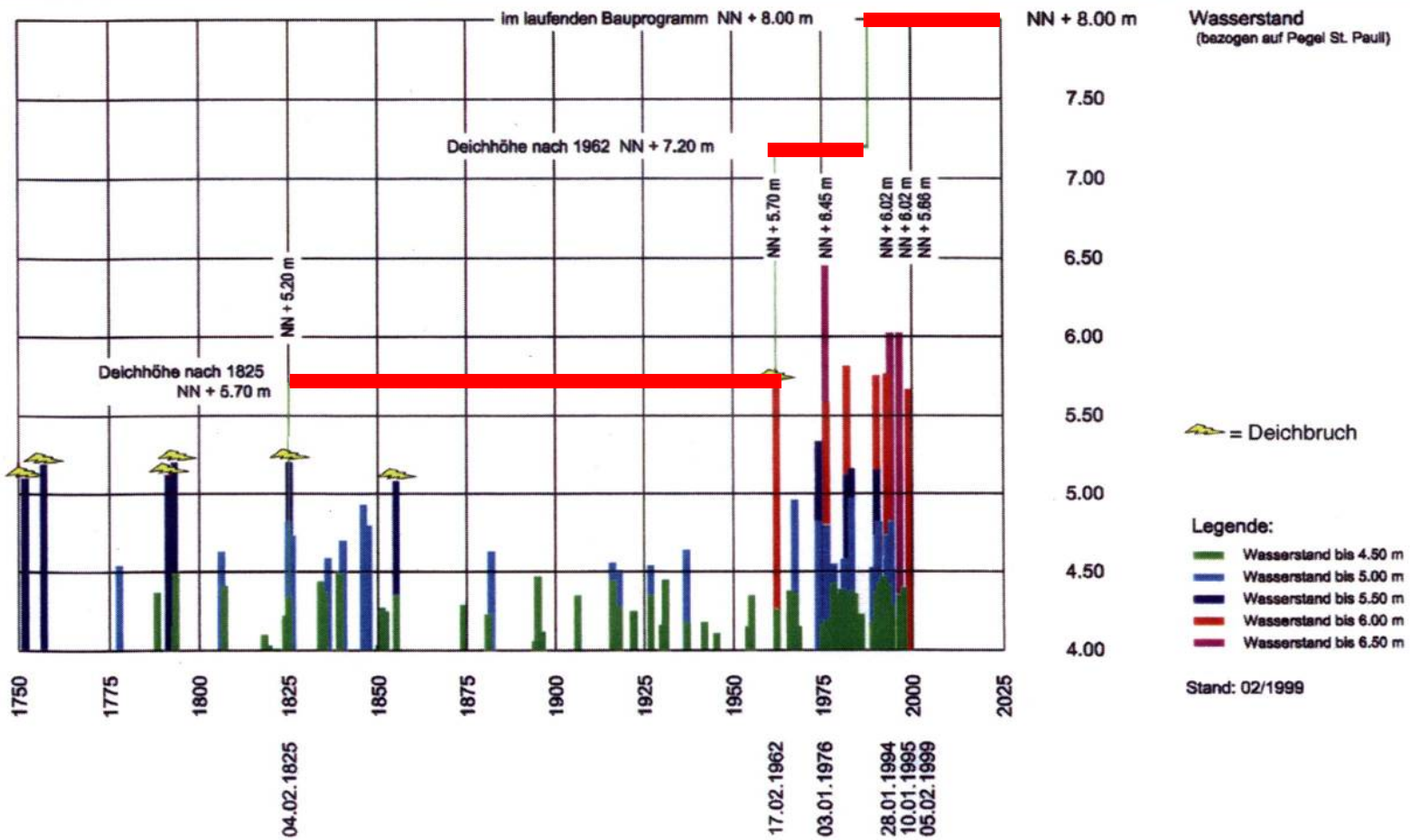

Only the effect of anthropogenic climate change (A2, B2)
- No effect of water works.
D water level [m]
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2030
2085
max 0.82
mean 0.63
min 0.48
max 0.61
mean 0.50
min 0.42
Cuxhaven
St Pauli
max 0.23
mean 0.18
min 0.13
max 0.17
mean 0.14
min 0.12
Cuxhaven
St Pauli
Scenarios
2030, 2085

Hamburg – storm surges

Freie und Hansestadt Hamburg
Baubehörde - Amt für Wasserwirtschaft

Hochwasserschutz in Hamburg

Sturmfluten in Hamburg seit 1750

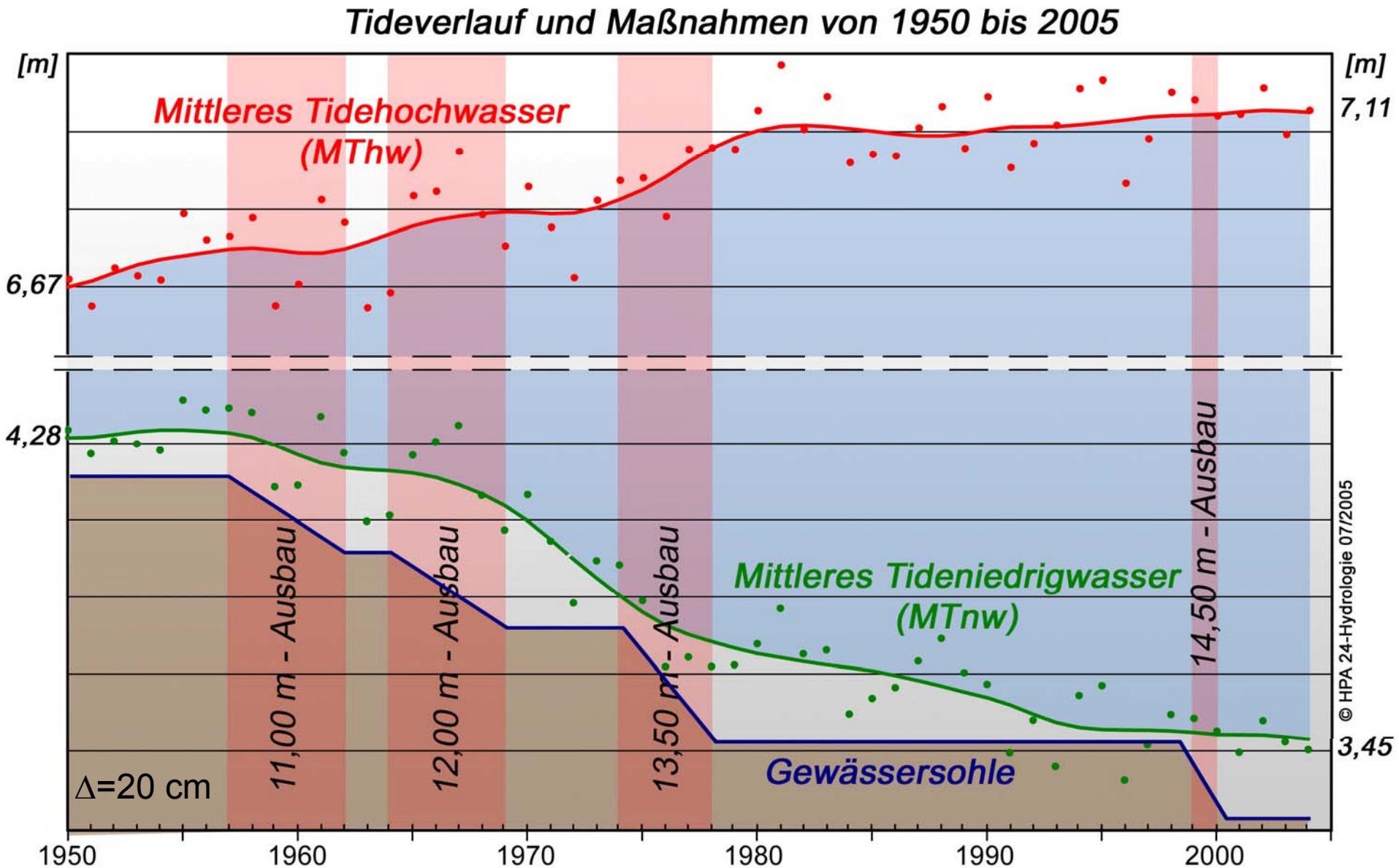


Where do the enhanced storm surge levels Hamburg come from?

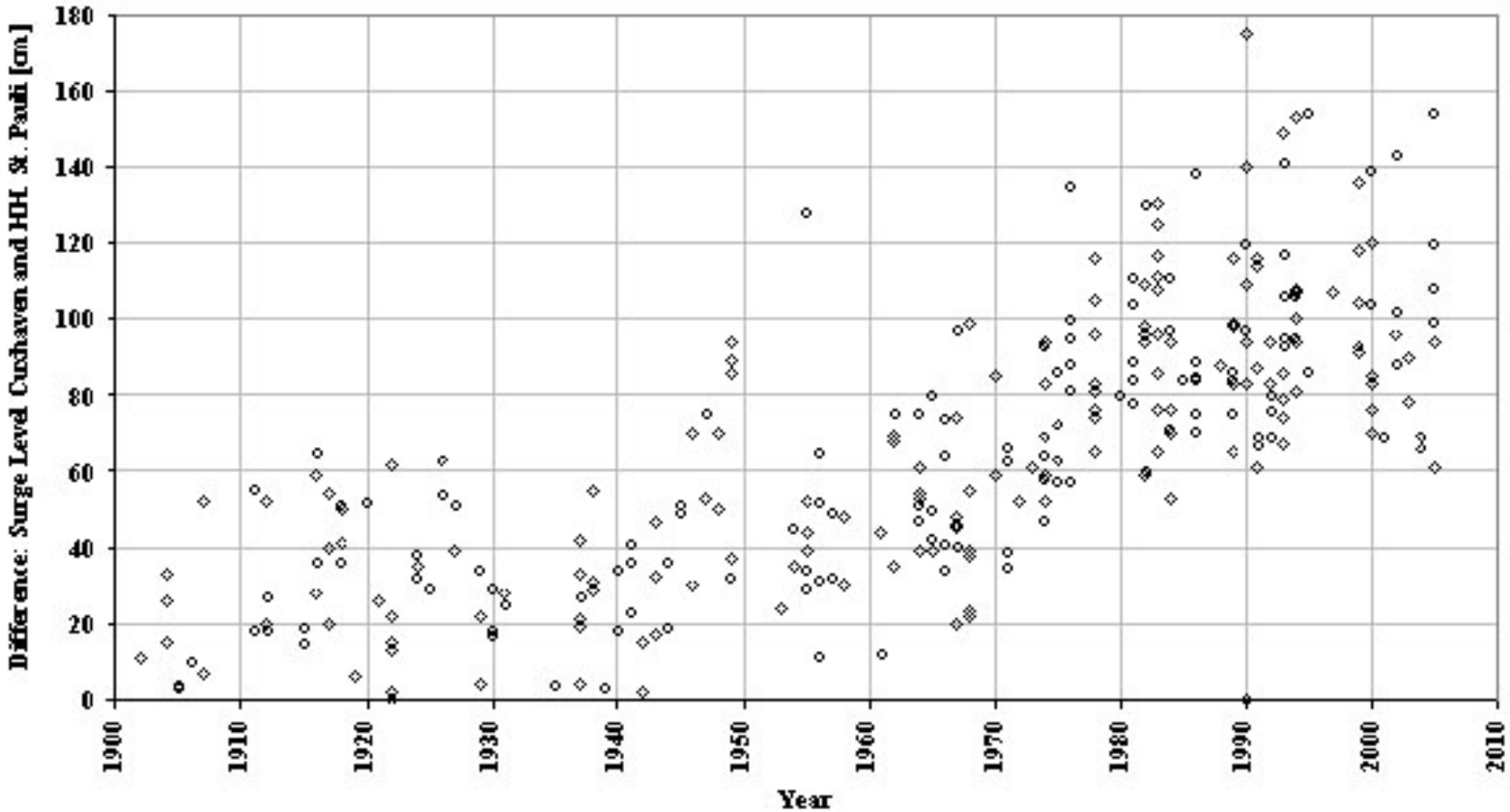
- Sea level rise – a couple of decimeters
- Intensification of storm activity 1960-1995

- What else has happened in the coastal/estuarine environment?

Hamburg – storm surges



Difference in storm surge heights – mouth of Elbe estuary and Hamburg, 1900- 2005



The tidal change is due to coastal protection measures and modifications of the tributaries, and to the deepening of the shipping channel. These measure also had an effect on the heights of severe storm surges – estimates are 45 cm caused by measures of coastal defense and 15 cm by deepening the shipping channel (Haake, 2004: 27).

Options for dealing with future elevated storm surge levels

- at the coast:
  - ▶ fortifying, extending presently installed coastal defence
  - ▶ flexible response strategies;
  - ▶ design dykes such that the amount of water which may safely spill over for a few hours is considerably larger than allowed today.
- in the estuary: partial undoing of previous man-made increases

Strategies (IPCC Definition)

From: H-D. Niemeyer, Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency – Coastal Research Station

Dyke overtopping tolerance

- **Currently overtopping tolerances:**
  - 3% of all - Lower Saxony
  - 2 l/(m·s) - Masterplan Schleswig-Holstein
  - 0,1-1,0 l/(m·s) - The Netherlands

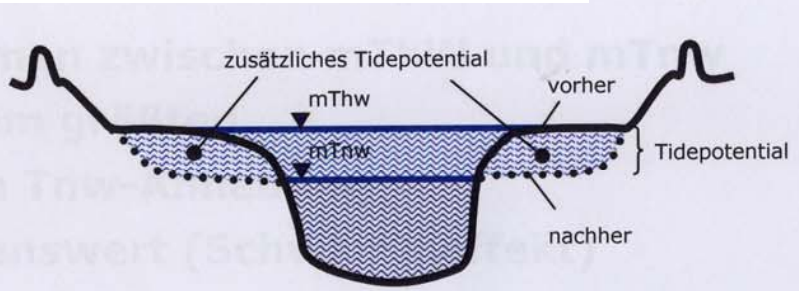
- **Results of overtopping test in Delfzijl/NL**
  - No damage up to **50 l / (m · s)**
  - No severe damage at 50 l (m · s)
  - after artificial damage still functioning

Niemeyer & Kaiser 2008, NLWKN

NLWKN

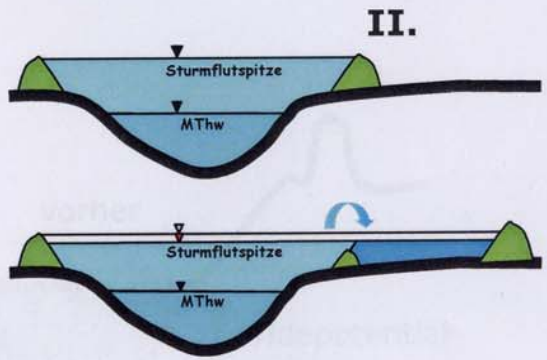
Dealing with rising sea level and elevated storm surge heights in Hamburg

1. Additional flooding areas



The Tidal Elbe concept of Hamburg Port Authority

2. Availability of additional polders to be flooded during severe storm surges to cap the peaks of such surges.



3. Additional dissipation of tidal (and surge) energy by narrowing the mouth segment of the estuary

Heinz Glindemann, HPA, pers. comm.

Hamburg Port Authority

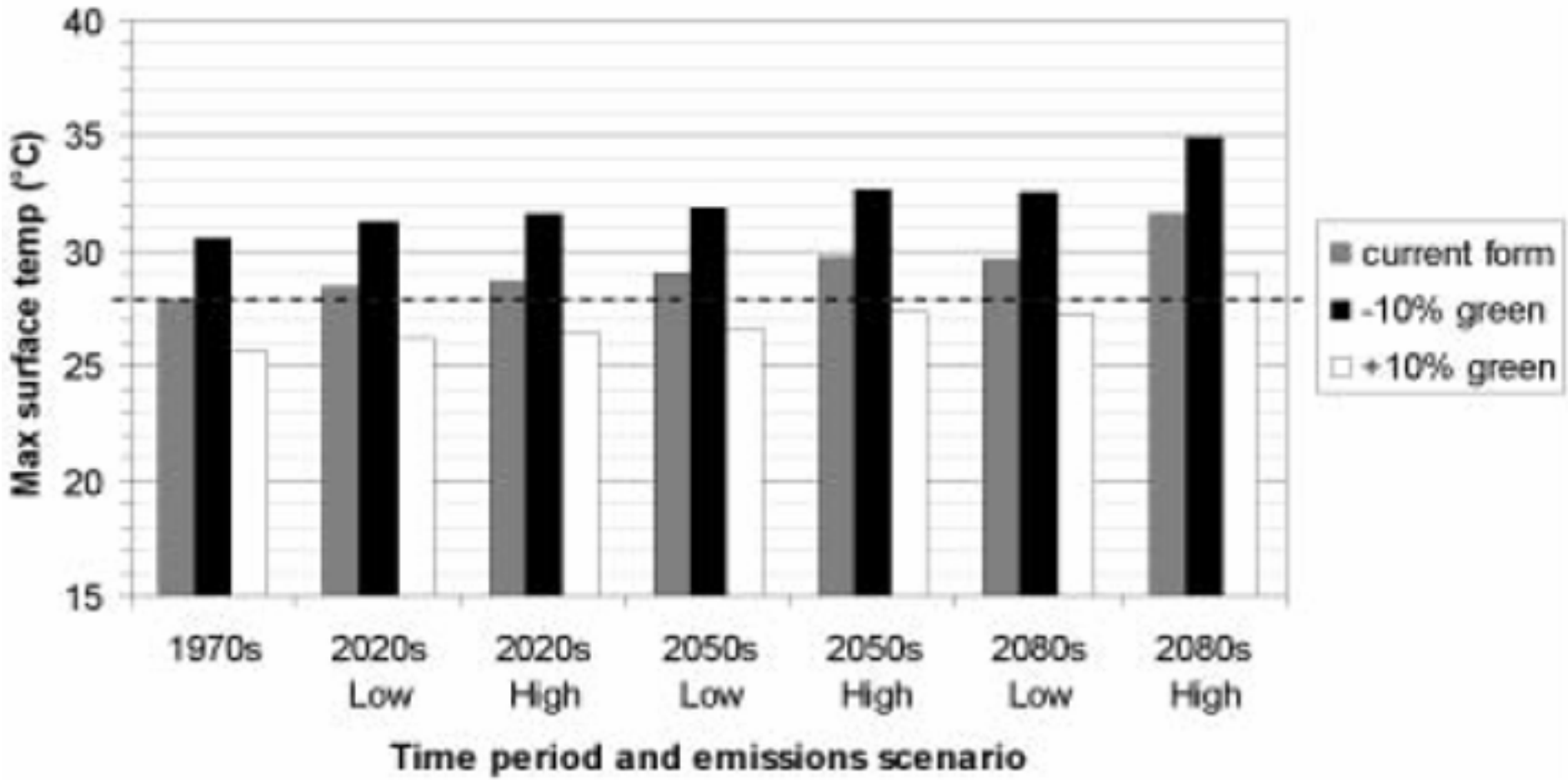
Storm surges

- Storm surges are a serious issue
- We have developed a methodology to characterize recent, ongoing and possible future storm surge conditions
  - by analyzing air-pressure proxies available for the 20th century and longer, and
  - by running a cascade of global/regional/impact models
- The North Sea is the best studied area, with no indications for present man-made change but perspectives for increases of 20 cm and 70 cm in 2030 and 2085 in its SE storm surges. These numbers are uncertain and represent scenarios.

... German Bight & Hamburg

- Most of the increase will take place even if the ambitious climate control measures will be successful. Thus the preparation of adaptive measures is needed.
- Novel adaptive measures need to be developed and examined, e.g.,
  - damping of incoming tidal energy in estuaries
  - improving dyke design to allow for stronger overtopping.
- The same type of studies need to be implemented in tropical regions.

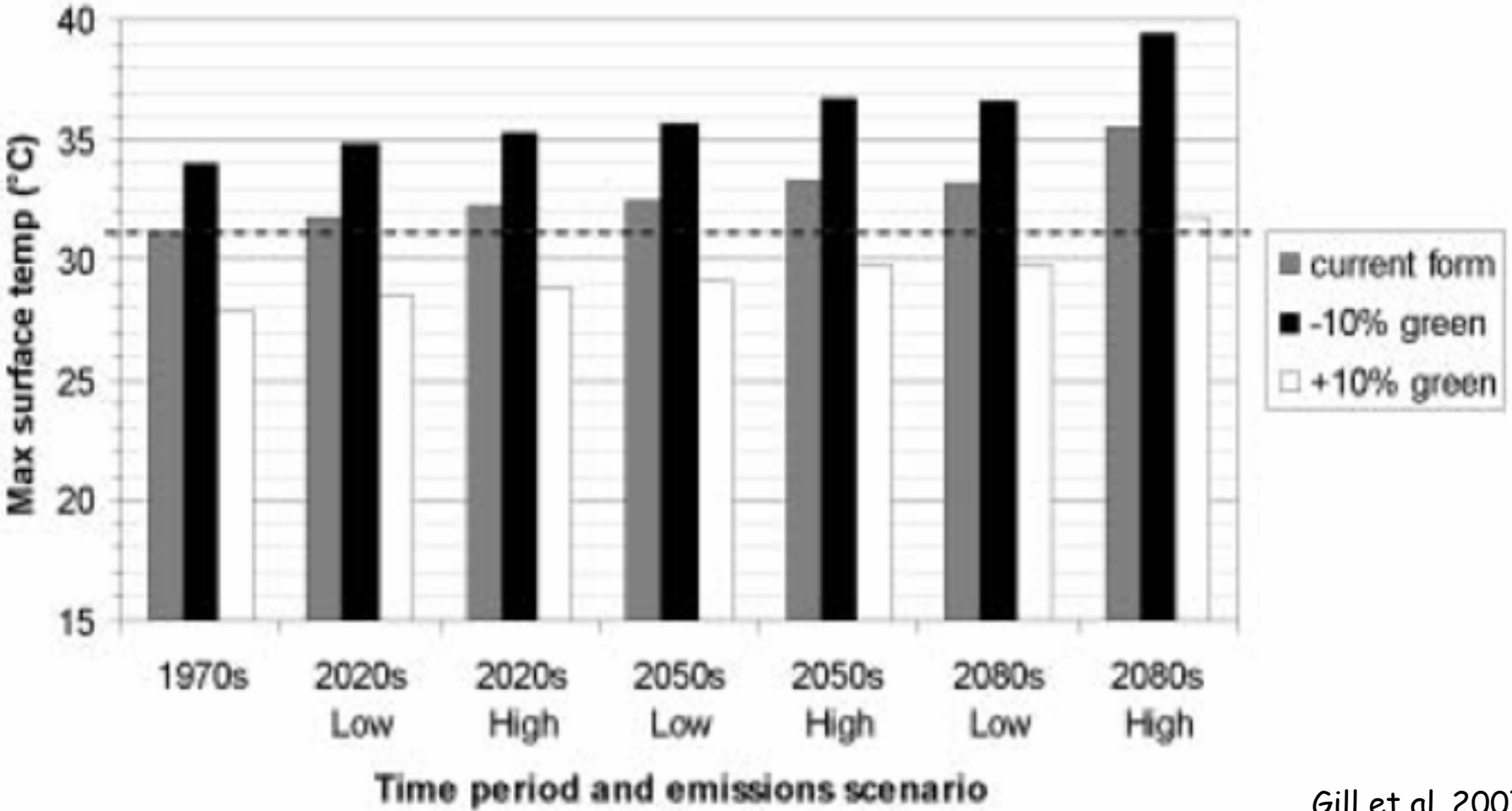
Urban adaptation by un-doing urbanization



Gill et al.,2007

Figure 5. Maximum surface temperature for the 98th percentile summer day in high-density residential areas, with current form and when 10 per cent green cover is added or removed. Dashed line shows the temperature for the 1961–1990 current form case.

Urban adaptation by un-doing urbanization



Gill et al.,2007

Figure 6. Maximum surface temperature for the 98th percentile summer day in town centres, with current form and when 10 per cent green cover is added or removed. Dashed line shows the temperature for the 1961–1990 current form case.

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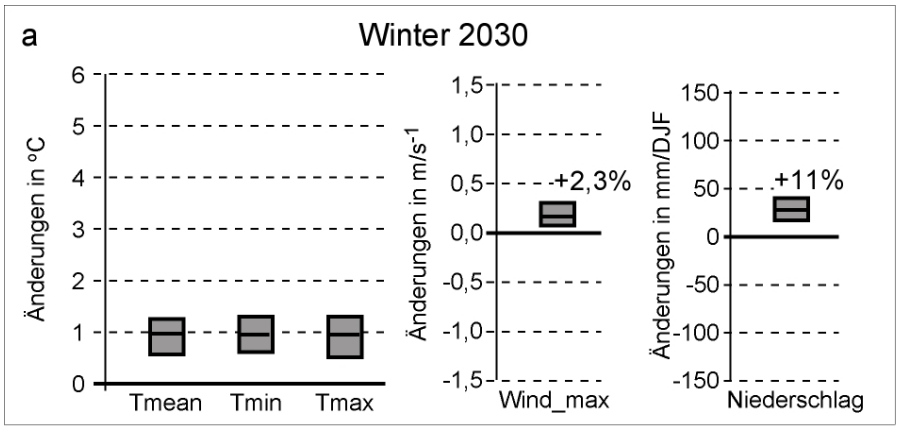
An institution set up to enable communication between science and stakeholders

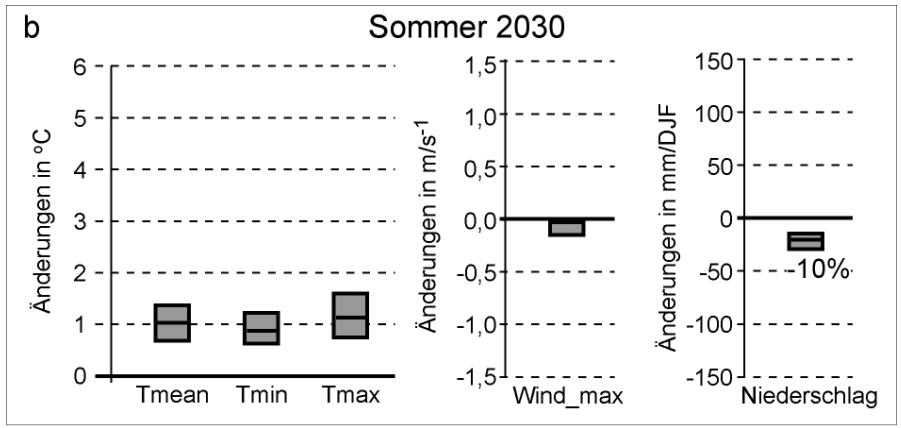
- that is: making sure that science understands the questions and concerns of a variety of stakeholders
- that is: making sure that the stakeholders understand the scientific assessments and their limits.

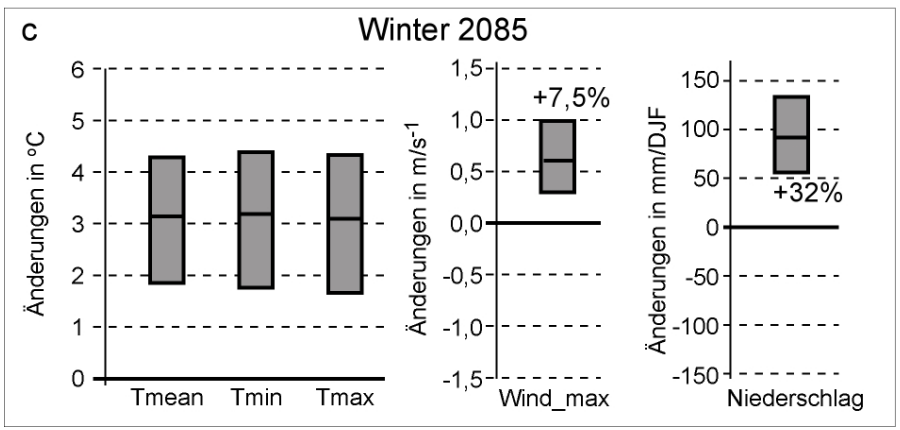
Klima Norddeutsches büro

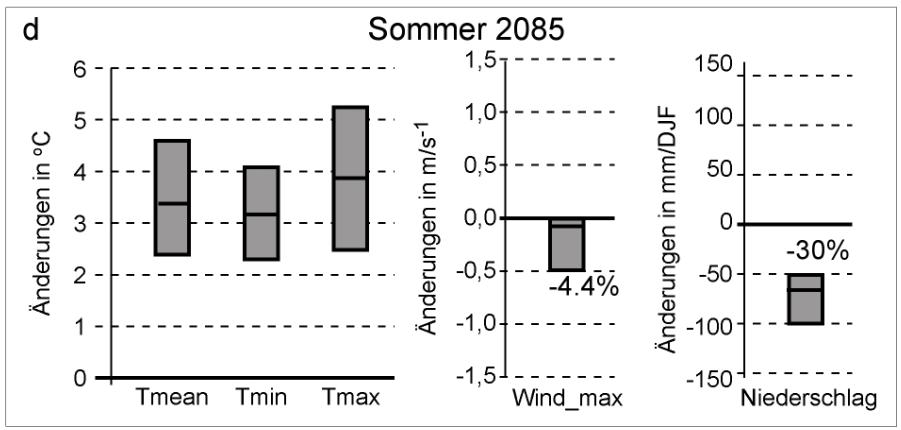
Typical stakeholders:
Coastal defense, agriculture, off-shore activities (energy), tourism, water management, fisheries, urban planning

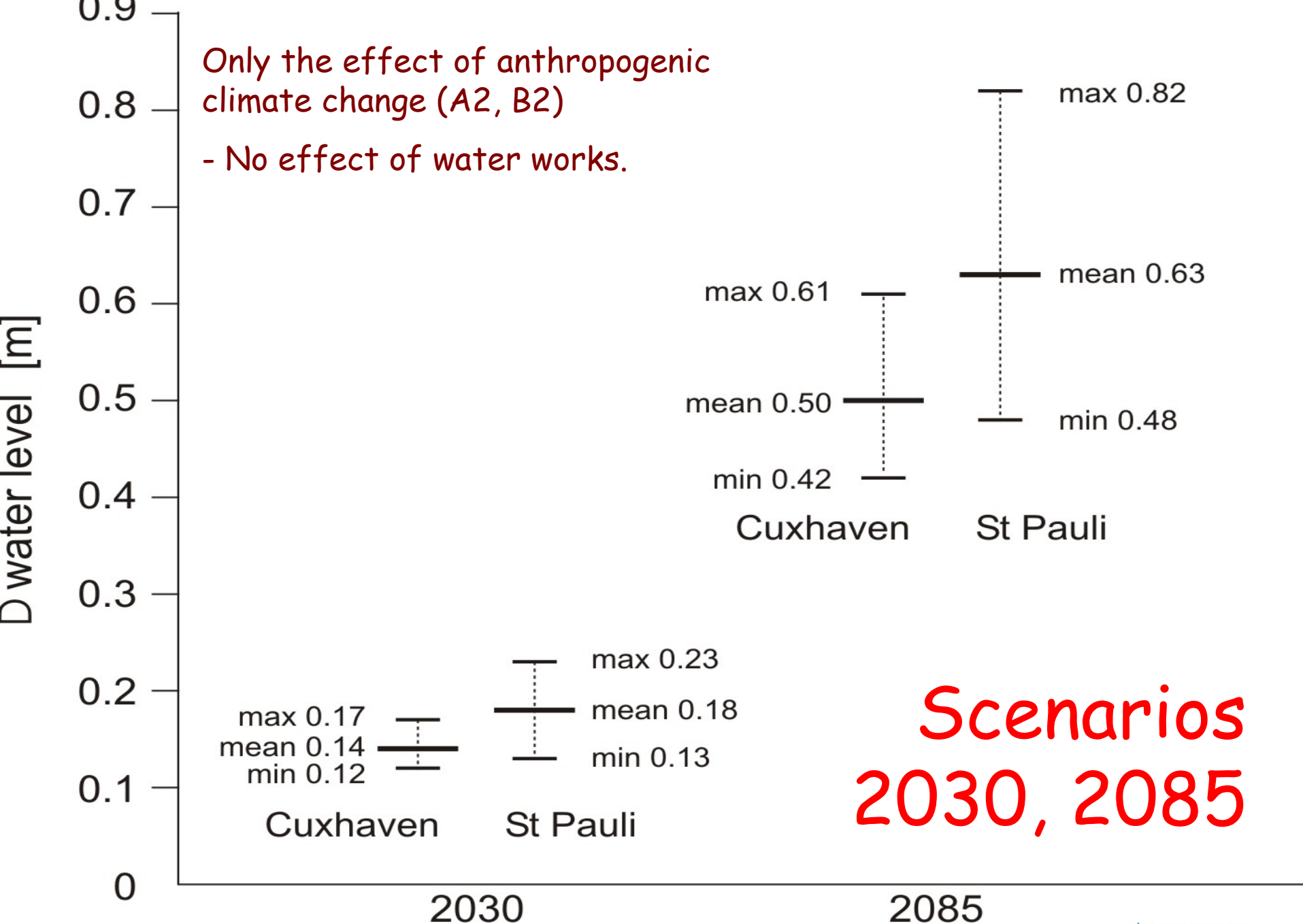
Scenarios for Northern Germany










Only the effect of anthropogenic climate change (A2, B2)
- No effect of water works.
D water level [m]
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2030
2085
max 0.82
mean 0.63
min 0.48
max 0.61
mean 0.50
min 0.42
Cuxhaven
St Pauli
max 0.23
mean 0.18
min 0.13
max 0.17
mean 0.14
min 0.12
Cuxhaven
St Pauli
Scenarios
2030, 2085

The Baltic Sea Catchment Climate Change Assessment: BACC

An effort to establish which knowledge about anthropogenic climate change is available for the Baltic Sea catchment.

Working group BACC of GEWEX program BALTEX.

Approximately 80 scientist from 10 countries have documented and assessed the published knowledge.

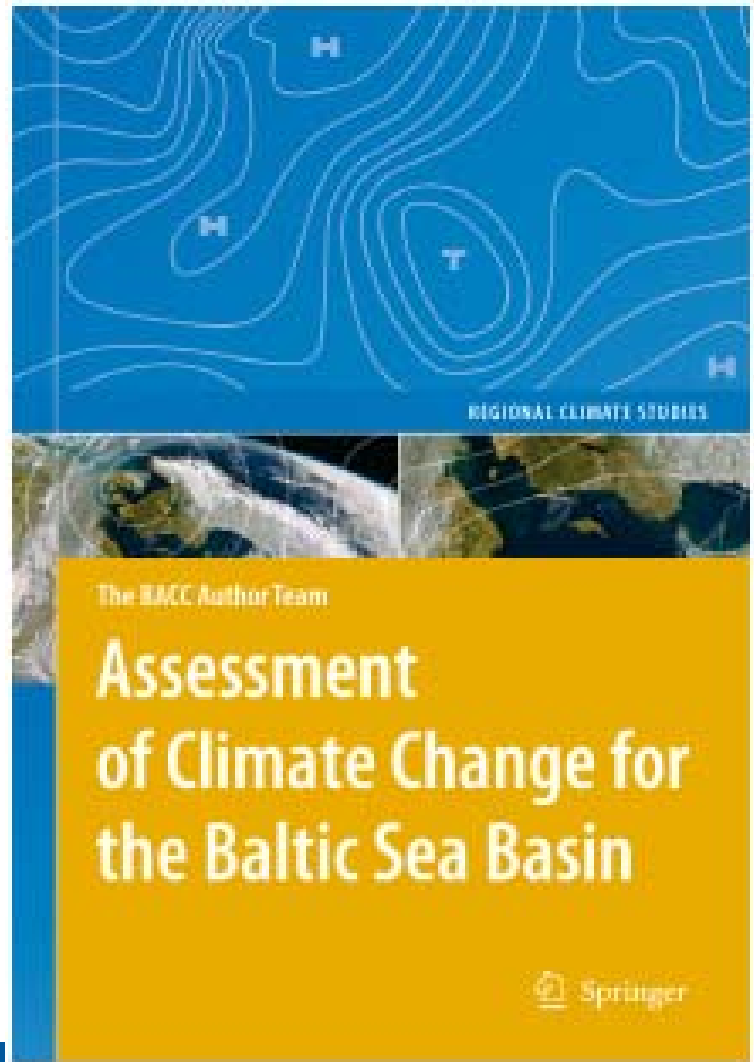
Assessment has been accepted by intergovernmental HELCOM Commission as a basis for its future deliberations.

BACC: The **purpose** …

… of the BACC assessment was to provide the scientific community and the public with an assessment of ongoing and future climate change in the Baltic Sea region. This was done by reviewing published scientific knowledge about climate change in the Baltic Sea region.

An important element was the comparison with the historical past (until about 1800) to provide a framework for the severity and unusualness of the change.

Also changes in environmental systems, due to climate change, were assessed – such as hydrological regimes and ecosystems.



BACC results: In short …

- Presently a warming is going on in the Baltic Sea region.
- BACC considers it plausible that this warming is at least partly related to anthropogenic factors.
- So far, and in the next few decades, the signal is limited to temperature and directly related variables, such as ice conditions.
- Later, changes in the water cycle are expected to become obvious.
- This regional warming will have a variety of effects on terrestrial and marine ecosystems – some predictable such as the changes in the phenology others so far hardly predictable.

Role of climate science after IPCC AR4

The basic questions – *Is there anthropogenic climate change (ACC)? how does it depend on emissions? How quickly will it emerge? Which impact is plausible?* – have been answered with sufficient confidence for society to take the issue of anthropogenic climate change seriously.

- Climate science can hardly contribute to the design of mitigation policy.
- Climate science must provide knowledge for the institution of adaptation policies.
- Climate science must continue to monitor the development of climate, in order to try to falsify the ACC-theory, and to provide more robust assessments of ongoing change and needed adaptation.

Furthermore, climate science is a legitimate curiosity driven intellectual effort, which should – beyond the social and political needs – be pursued just for its own interest.

Outlook: The service of science

The debate about global warming has rightly become a political debate, with unfortunately spills over to science – where scientists act as "stealth advocates" for value-based agendas.

In the course of this process, the authority of science is eroded, as it becomes difficult to distinguish between scientific analysis and advice from science and from NGOs or other value-driven social actors.

In this model, science gets the role of auxiliary troops for broader social movements.

To maintain the service provided by science to society – namely to provide "cold" knowledge which may help to sort out some aspects in an otherwise passionate and value-driven decision process – scientists should limit themselves to factual and not normative statements. (They may do that if they act as citizens, of course.)