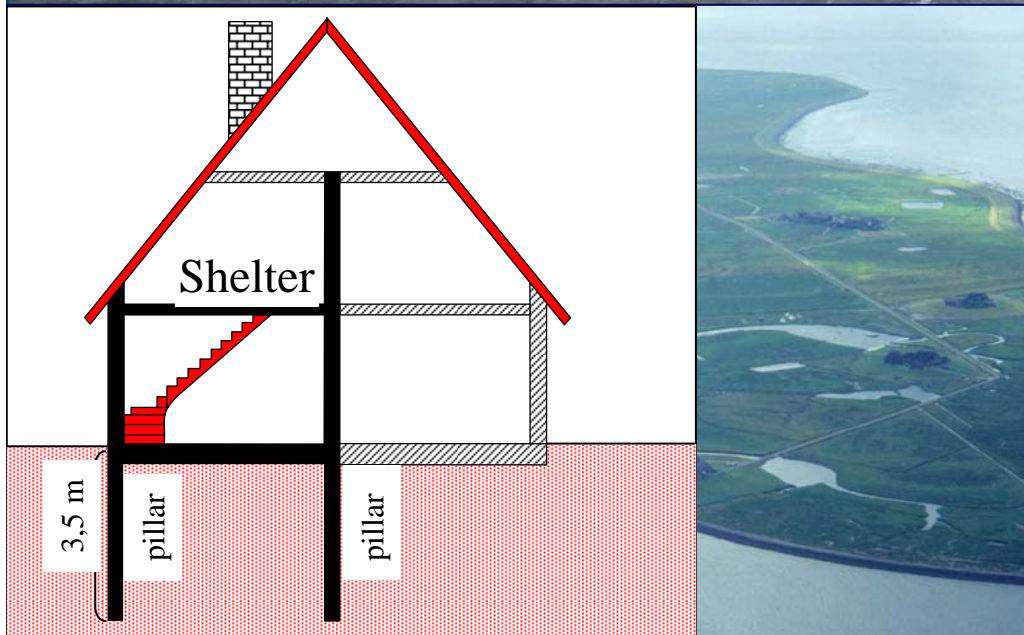




Coastal Protection Adaptation Strategies

Jacobus Hofstede, Kiel (Germany)





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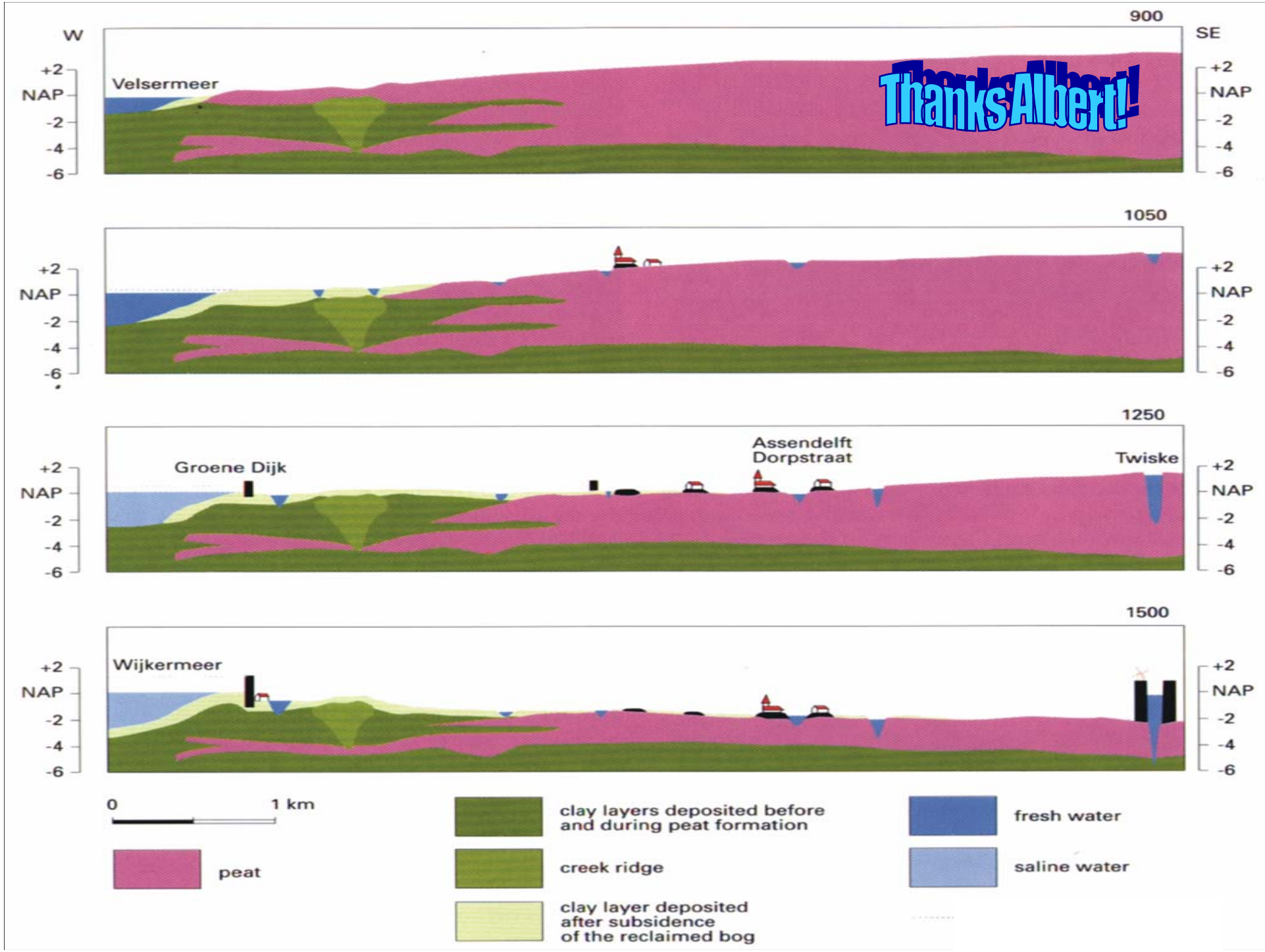
Definitions and implications

Flooding and **erosion** are natural phenomena.

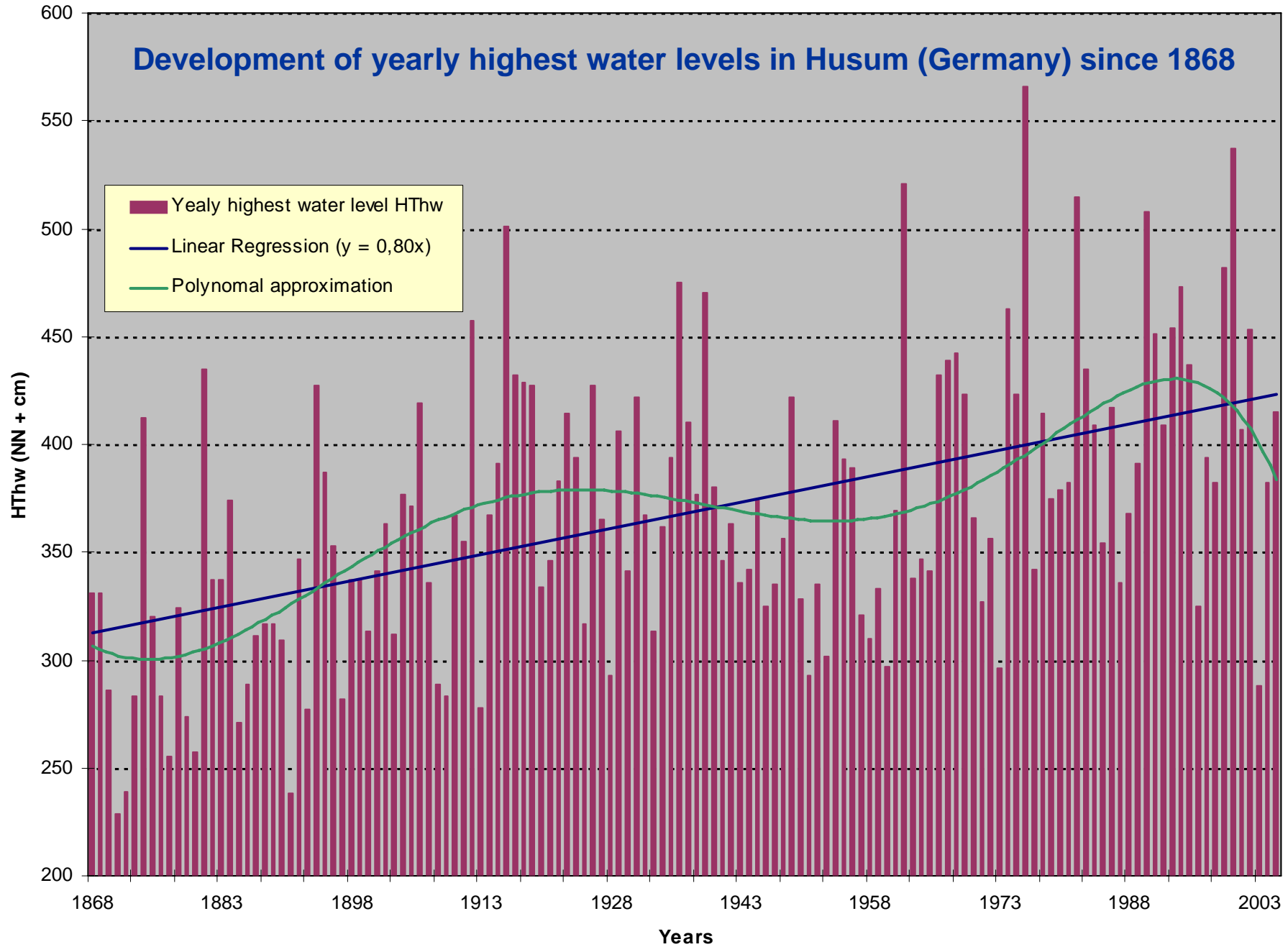
A **natural hazard** is an event in the physical environment that is perceived by mankind as a threat to life and property.

- **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 consequences (damage expectations).

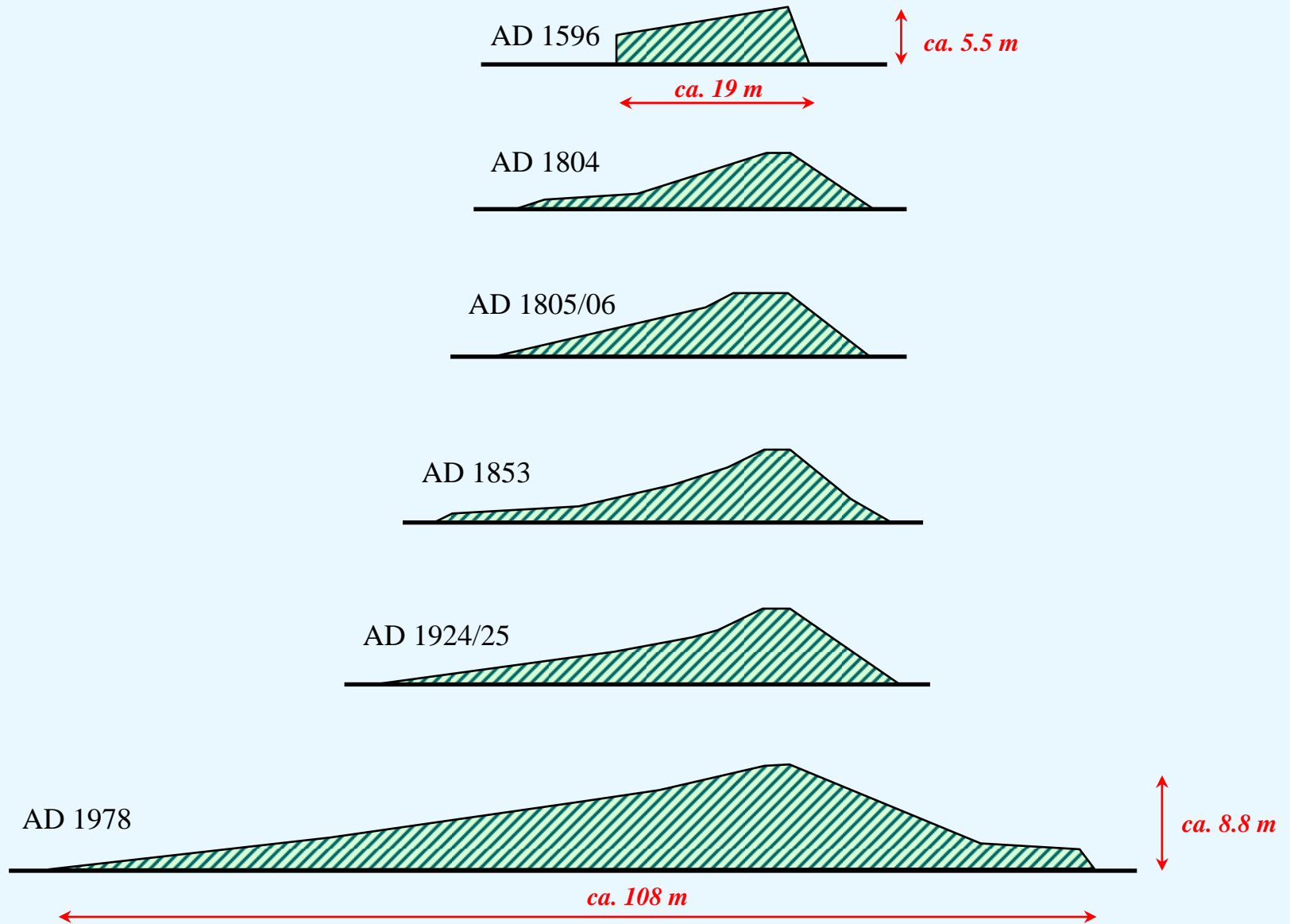


Development of yearly highest water levels in Husum (Germany) since 1868



Development of sea walls in Schleswig-Holstein

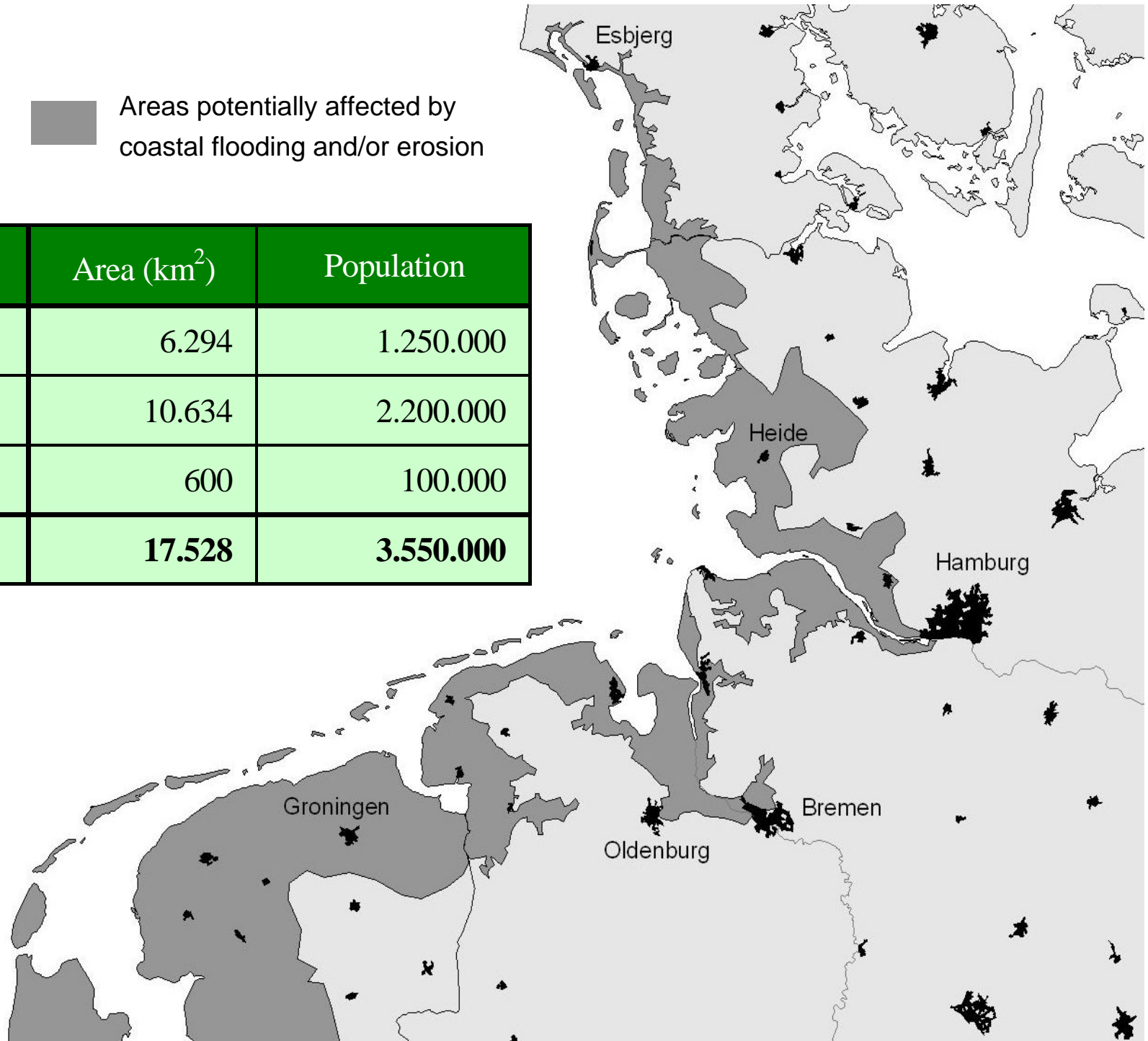
Schleswig-Holstein State Ministry
for Agriculture, Environment
and Rural Areas

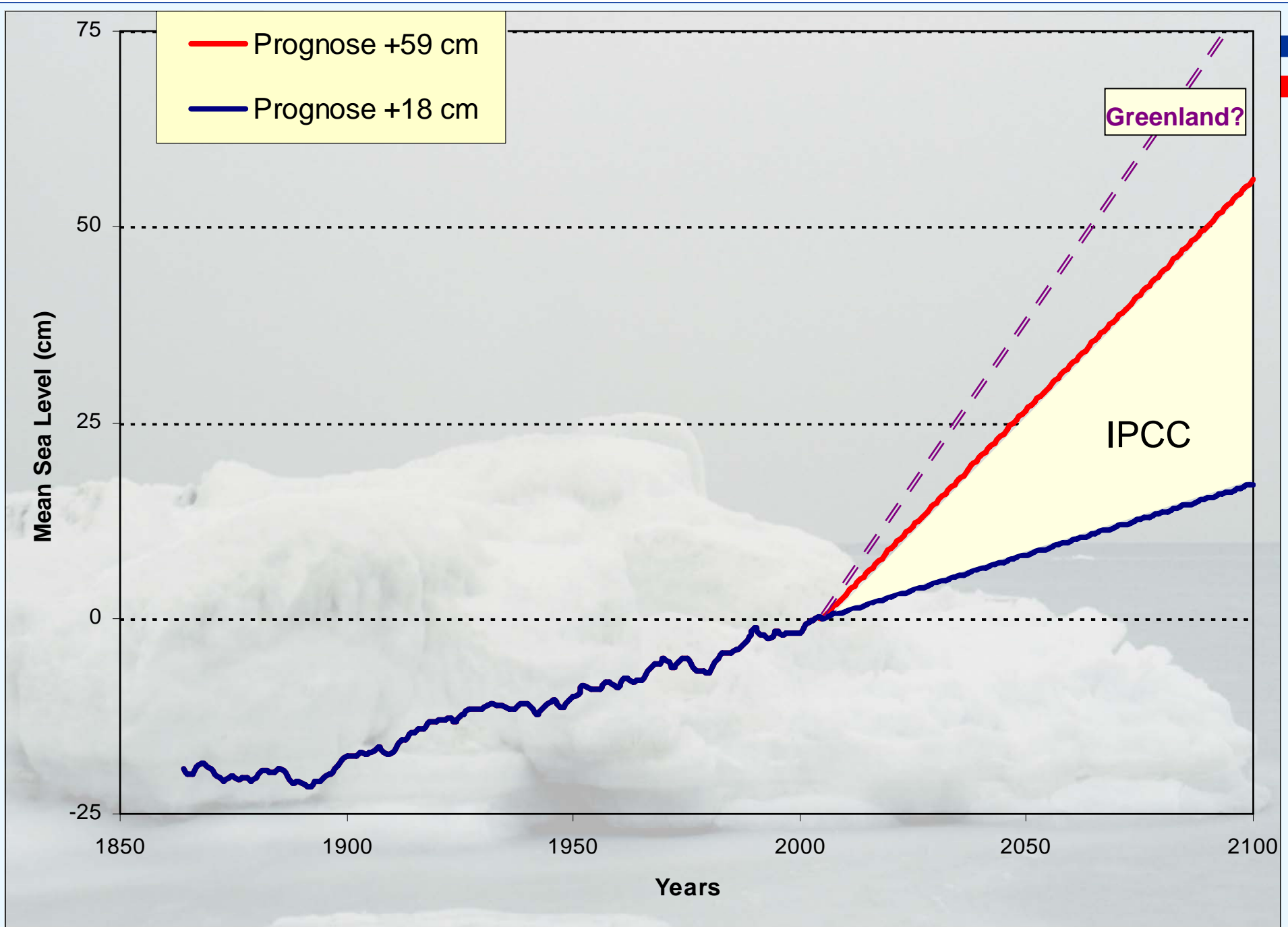


Jacobus Hofstede

■ Areas potentially affected by coastal flooding and/or erosion

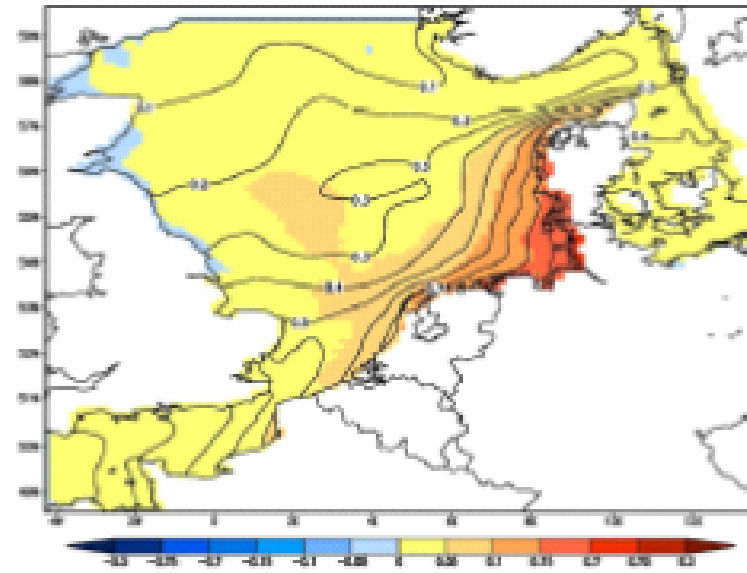
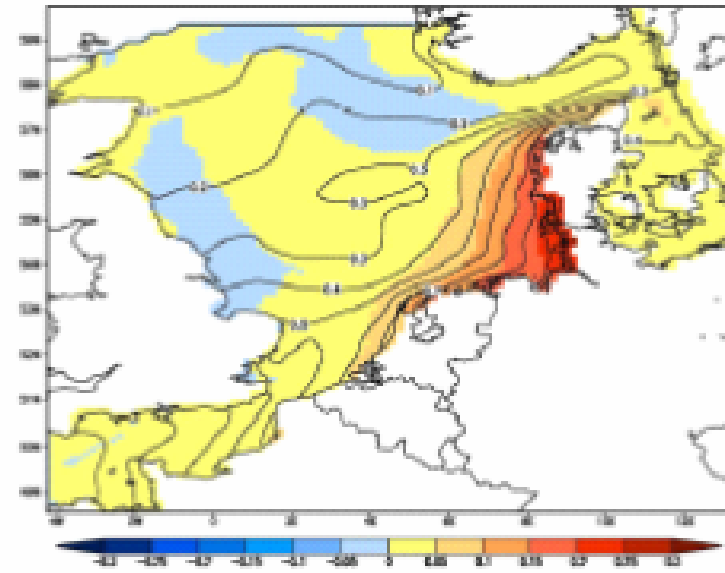
Country	Area (km ²)	Population
NL	6.294	1.250.000
GER	10.634	2.200.000
DK	600	100.000
Sum	17.528	3.550.000



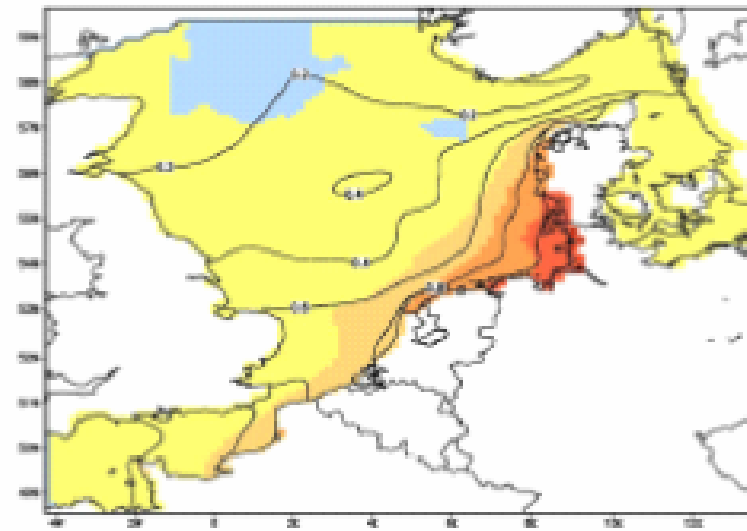
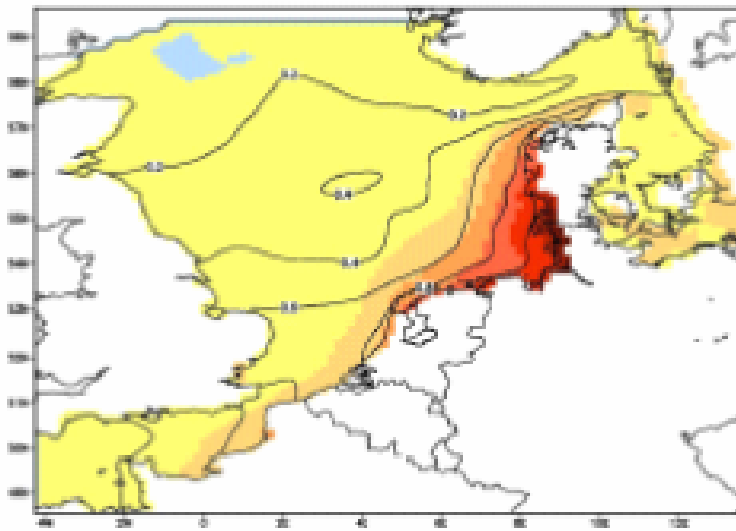


A2

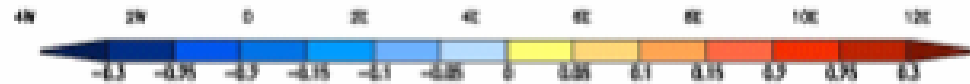
B2



Modell 1



Modell 2



0

0.3 m

Scenarios for 2100



Sea level may rise among 18 and 59 cm (IPCC, 2007)

Uncertainties in SLR:

- ✓ Greenland; up to 20 cm extra
- ✓ Antarctica; reduction (quantity unknown)
- ✓ Regional disparities (quantities unknown)
- ✓ Acceleration non-linear (increasing with time)
- ✓ Increase in tidal range by up to 30% (?)

Storm surges may increase by 10 to 40 cm (large uncertainties)

Land subsidence among 0 and 10 cm per century

⇒ **The situation is serious, but not “out of control”**

Dutch quote: we have the technical abilities to maintain present safety standards for a SLR of up to one meter per century for five centuries

Evaluation of possible measures

Trilateral expert group Coastal Protection and Sea Level Rise

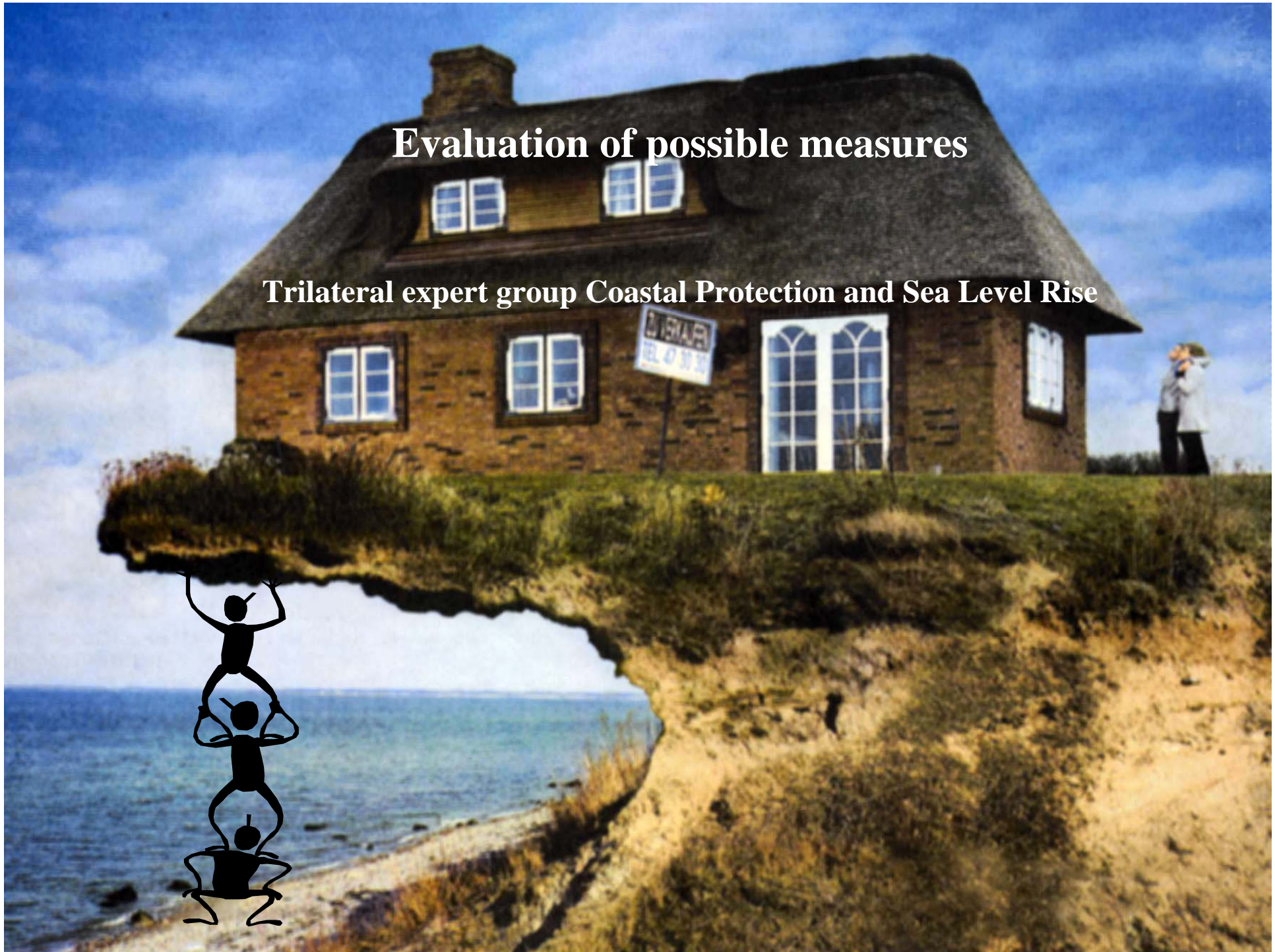


Table 6.1:

Relative scoring of coastal defense practices for feasibility and Best Environmental Practice (BEP) criteria.

Environment	Measure	Feasibility				BEP Aspects						
		Technical	Financial	Legal	Public opinion	Spatial	Impact on Habitat	Impact on natural dynamics	Safety			
Sandy barrier coasts												
1	Artificial reefs	4	3	3	3	1	2		2	3		
2	Beach drainage	4	1	3	3	1	2		3	3		
3	Dunes creation	4	4	3	4	2	3	Replace one habitat by another	2	4		
4	Dunes relocation	4	4	3	2	2	3		3	4	Relocation=retreat	
5	Allowing wind driven sand transport	4	5	3	2	2	4		5	2	Possibly positive on a long time scale and strongly dependent on locality	
6	Overwash creation	4	4	2	2	2	4	Loss of fresh water species	4	2	On a very long run	
7	Revetment building	4	3	2	3	3	2		2	4		
8	Groynes	4	3	3	3	3	3		2	3		
9	Sand nourishments	4	4	4	3	4	3		2	4	Extraction from outside the sandsharing system	
10	Spatial planning (create buffer zones)	4	3	3	2	4	3		4	4		
Tidal basins												
11	Dam building	4	2	2	2	3	2		2	4		
12	Dredging reduction	4	4	1	1	1	4		4	3	In estuaries	
13	Gullies damming	3	3	2	3	1	3		3	3	One positive example from SH	
14	Reinstallation and protection of mussel beds	4	3	3	3	3	4		2	Reinstall 4 Protect	2	In the long run
15	Sea-grass beds reinstallation	3	2	3	3	2	4		3	2	In the long run	

Environment	Measure	Feasibility				BEP Aspects				
		Technical	Financial	Legal	Public opinion	Spatial	Impact on Habitat	Impact on natural dynamics	Safety	
Salt marshes										
16	Revetments	4	3	2	3	2	3	2	4	
17	Creation from dredged materials	3	3	3	3	2	3	2	4	
18	Outbanking of summer polders (Brushwood)	4	2	3	2	2	5	4	1	Site specific in estuaries
19	groyves	4	3	4	4	4	3	2	3	
20	Artificial drainage	4	3	3	3	4	3	2	3	
21	Grazing	4	4	3	3	4	3	2	3	Reducing flotsam
Dikes										
22	Revetments	4	3	4	4	4	2	2	4	
23	Enforcement	4	2	4	4	4	3	3	5	
24	Second dike line	4	2	3	3	4	4	3	5	
25	Relocation of first dike line	4	1	1	1	2	4	4	2	
26	Spatial planning	4	4	3	2	4	3	4	4	In the long run
Mainland										
27	Pumping stations	4	2	3	4	3	3	3	4	
28	Sluices	4	2	3	4	3	3	3	4	
29	Storage basins	4	3	3	3	2	3	3	4	

Legend

Technical:	1 (almost impossible)	5 (very practical)
Financial:	1 (very expensive)	5 (very cheap)
Legal:	1 (very problematic)	5 (unproblematic)
Public opinion:	1 (very negative)	5 (very positive)
Spatial:	1 (site specific)	5 (everywhere)
Impact on habitat:	1 (large scale destruction of typical Wadden Sea habitats)	5 (large scale creation of typical Wadden Sea habitats)
Impact on natural dynamics:	1 (large scale reduction of natural dynamics)	5 (large scale increase of natural dynamics)
Safety:	1 (low contribution)	5 (substantial contribution)

Passive vertical drainage (PEM)



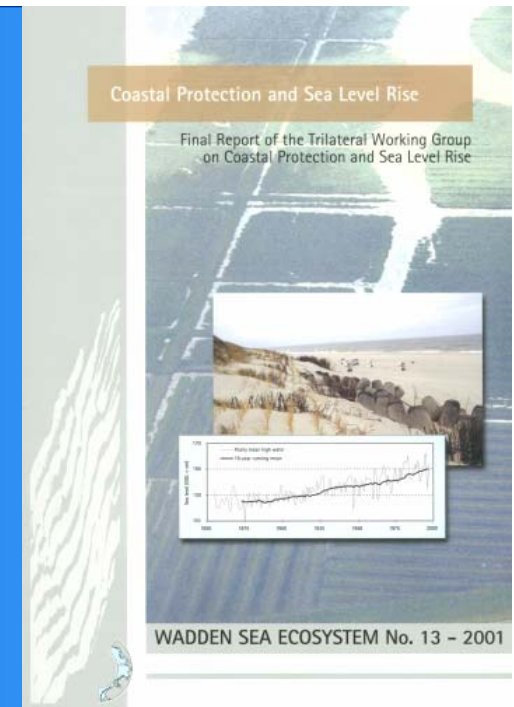
CPSL II

Evaluation of seven selected measures

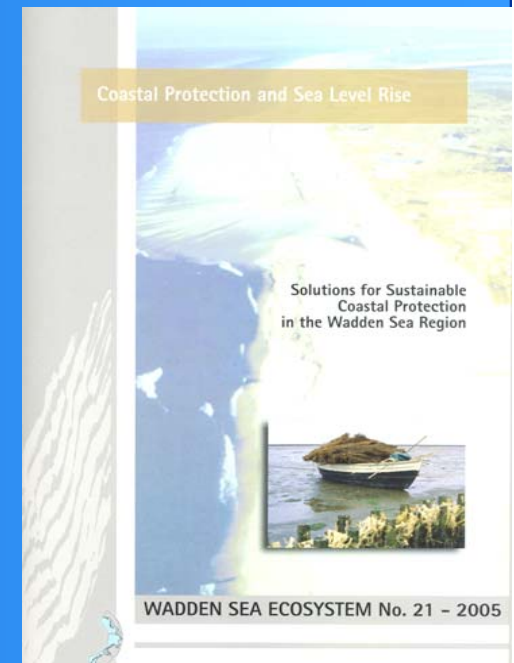
Measures:

- ✓ Spatial planning (plans with buffer zones and risk zones)
- ✓ Sand replenishment
- ✓ Dune management
- ✓ Salt marsh management
- ✓ Mussel beds and eelgrass meadows
- ✓ Outbanking of summer polders
- ✓ Dike measures (incl. relocation and second dike line)

And the winner is

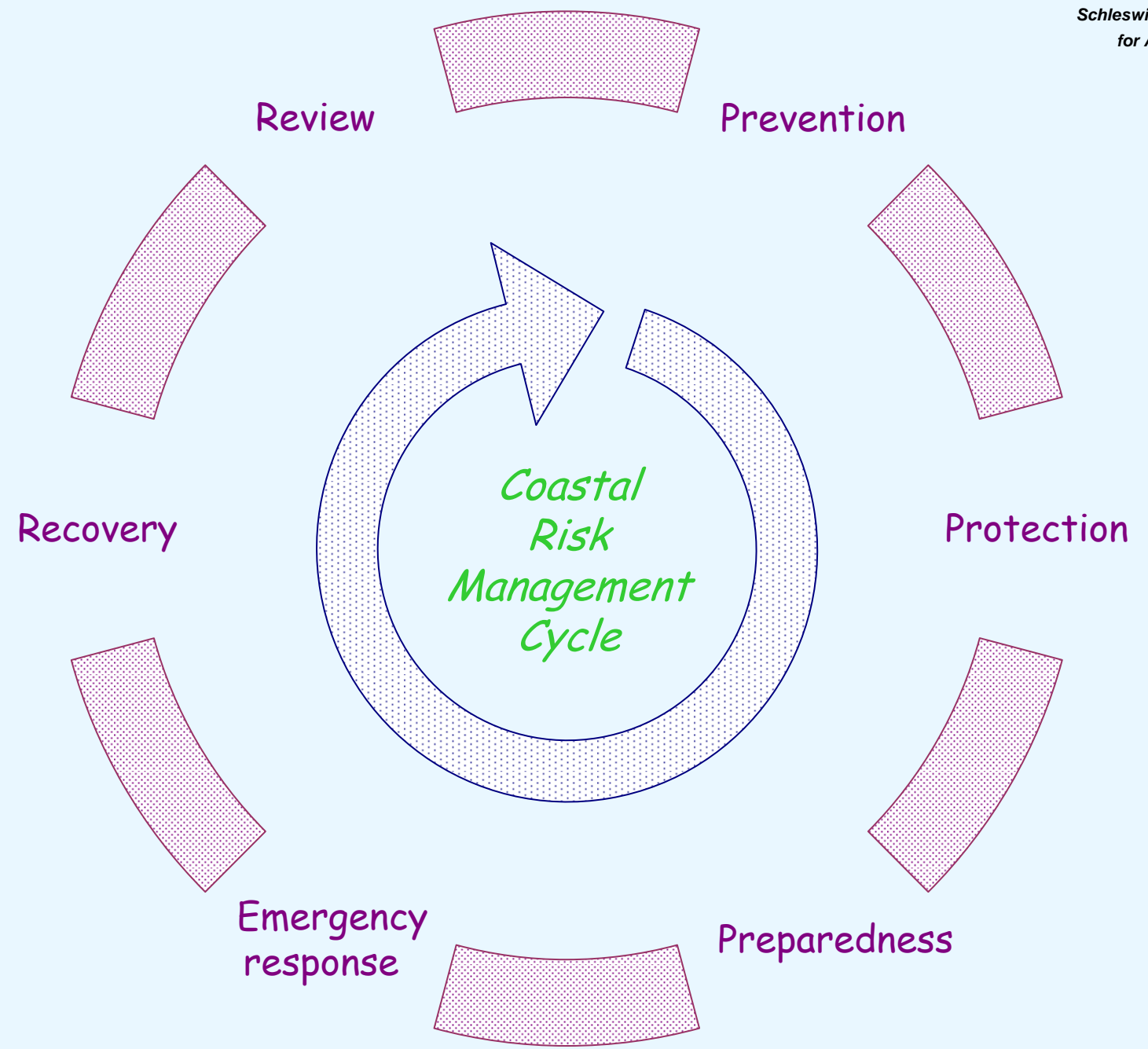


www.waddensea-secretariat.org



Recommendations

- 1) Coastal spatial plans that include buffer and coastal flood hazard zones should be established based on the principles of integrated coastal zone management. Coastal protection and climate change should be duly considered.
- 2) Sand nourishment should be applied, wherever feasible, to combat erosion along sandy coastlines. A study should be carried out on the feasibility and effects of sand nourishment to balance the sediment deficit of the Wadden Sea tidal basins under increased sea level rise.



Katrina August 2005



Key lessons Coastal Risk Management from INTERREG projects (COMRISK, COMCOAST, SAFECOAST, FLOWS, etc.)



- ✓ A robust CRM policy considers a **wide range of management options!**
- ✓ Sustainable CRM **considers nature** (coastal resilience, the river of sand)
- ✓ CRM is an **interdisciplinary challenge!**
- ✓ **Risk communication** improves the awareness and preparedness of the affected!
- ✓ **Early education** improves the sustainability of risk communication!
- ✓ CRM is about **managing human behavior**, before, during, and after the event!
- ✓ CRM is an **international challenge!**

Focal points and research challenges

- ✓ **Climate change!**
- ✓ **Holistic approaches** (coastal risk management cycle)!
- ✓ **Innovative solutions** (multi-functional coastal zones, flood-proof housing)
- ✓ **Risk communication** (science translation, school material)!
- ✓ **Coastal resilience / Securing the sediment budget (the river of sand)**
 - How much sediment is needed to maintain present structure and functions?
 - Where may it come from (natural and/or artificial sources)?
 - If artificial deposition is appropriate, how much is needed for different SLR-scenarios?
 - If artificial deposition is appropriate, what are strategic locations to replenish?
 - What are the ecological effects of replenishment (on varying locations)?