2nd Baltic Earth Conference

Identification of extreme storm tides with high impact potential for the German North Sea coast

The EXTREMENESS Group

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EXTREMENESS

How does climate change look like and what are the impacts?

→ *IPCC Perspective*

→ *Many publications*

→ *Percentiles, statistics, long-term changes*

What is the “best” adaptation strategy for a given place and/or time?

→ *Risk management perspective*

→ *Less publications*

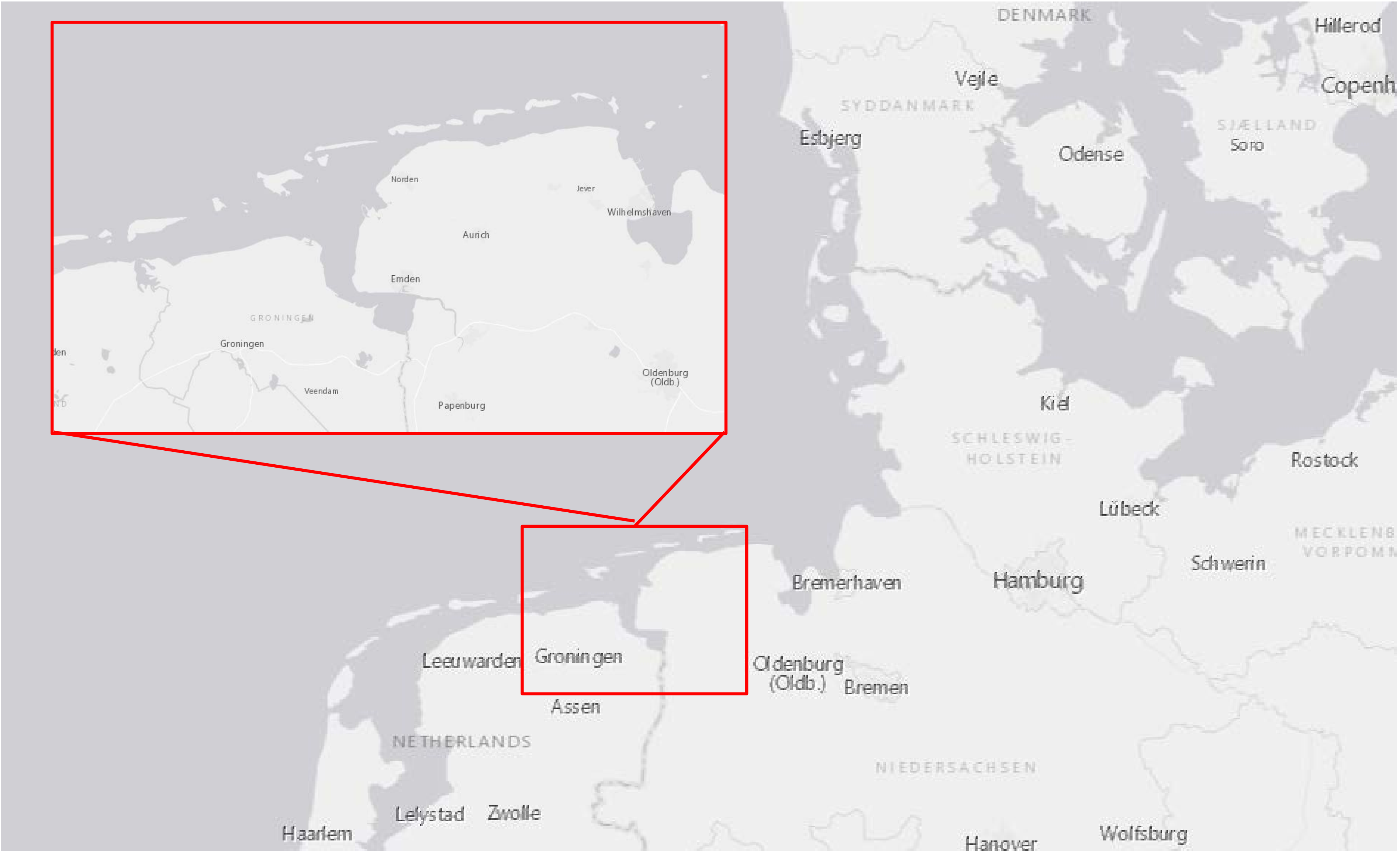
→ *Needs information on the extreme extremes*

Probabilities ./. Possibilities


(Foto: Deutscher Wetterdienst/ALR Husum)

"EXTREMENESS aims at identifying extreme events that are highly unlikely but still physically possible and plausible and which may cause extreme damages or have extreme consequences (so called „black swans").“

Project region: Emden



1. **Identification of extreme storm tides**
   Searching for the „perfect storm“ or the „needle in a haystack“

2. **Exploring options in dealing with such events**
   Contribution to the discussion about necessity and forms of future coastal protection

Science-stakeholder cooperation forum

→ *Five science partners from the project team*

→ *18 local stakeholders, risk managers, decision makers*
[Authorities: coastal protection (NLWKN, Deichachten), disaster risk management (THW, local county, Emden city), drainage management (Entwässerungsverband), industry (Volkswagen, GASSCO AS)]

1st Emden workshop in 2017

→ *Identification of extreme or high impact events*

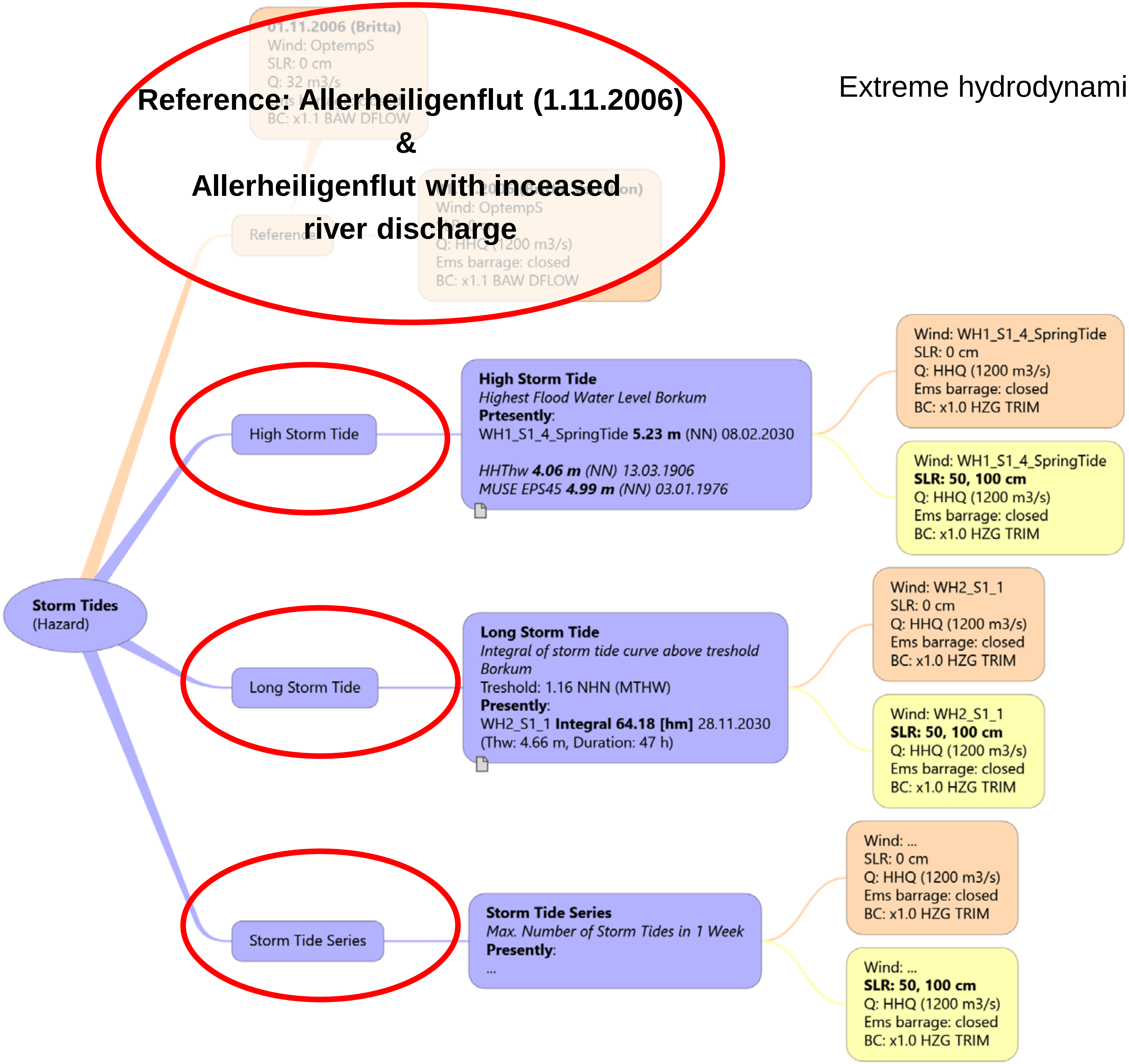
→ *Identification of hydrodynamic conditions that may trigger such events*

→ *Development of three narrative scenarios*

Potential High Impact Events (gesammelt)	# Points
3 consecutive storms (chain of storm tides)	
Ice load/pressure on dikes /structures	
Storm tide in summer	
Ship accident / Impact on dike	
Long-lasting precipitation	
Dike damages (animals, nutria)	
Increasing sea level rise	
Technical failure of barrages, sluices, floodgates	
Misguided political decisions	
Terror / Hacker attacks	
Overtopping of dikes	
Power outage / Breakdown of communication infrastructure	
Bad weather and storm surge forecasts	
Epidemics	
External surges	
Geo-tectonic changes (gas extraction)	
Waterworks in the estuary	

Potential High Impact Events (gesammelt)	# Points
3 consecutive storms (chain of storm tides)	**25**
Ice load/pressure on dikes /structures	3
Storm tide in summer	2
Ship accident / Impact on dike	**15**
Long-lasting precipitation	1
Dike damages (animals, nutria)	4
Increasing sea level rise	14
Technical failure of barrages, sluices, floodgates	**15**
Misguided political decisions	0
Terror / Hacker attacks	0
Overtopping of dikes	4
Power outage / Breakdown of communication infrastructure	3
Bad weather and storm surge forecasts	0
Epidemics	0
External surges	7
Geo-tectonic changes (gas extraction)	5
Waterworks in the estuary	0

Extreme hydrodynamic events to consider

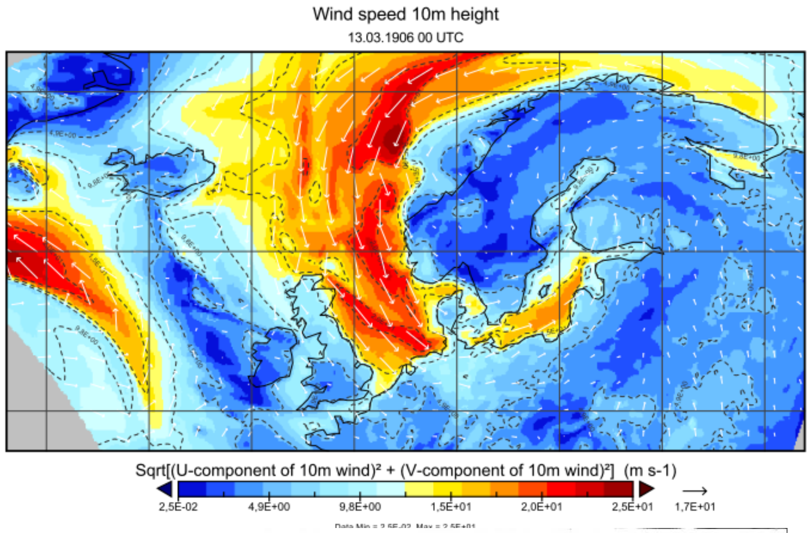


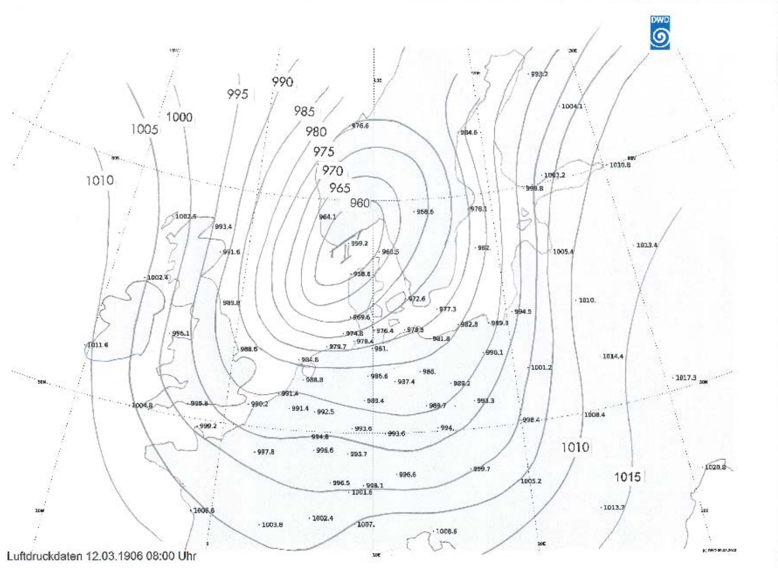
Datbase of approx. 2,500 data years

1. **Met-ocean data**
   Met-ocean hindcasts; climate change projections and control/historical simulations

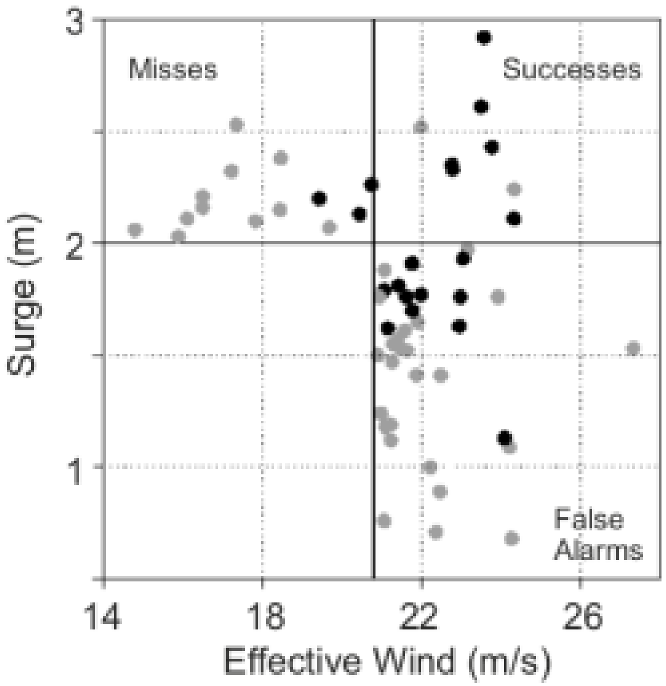
2. **Historical data**
   Historical storms that caused extremes (1906 - HHThW Borkum 4.06 m)

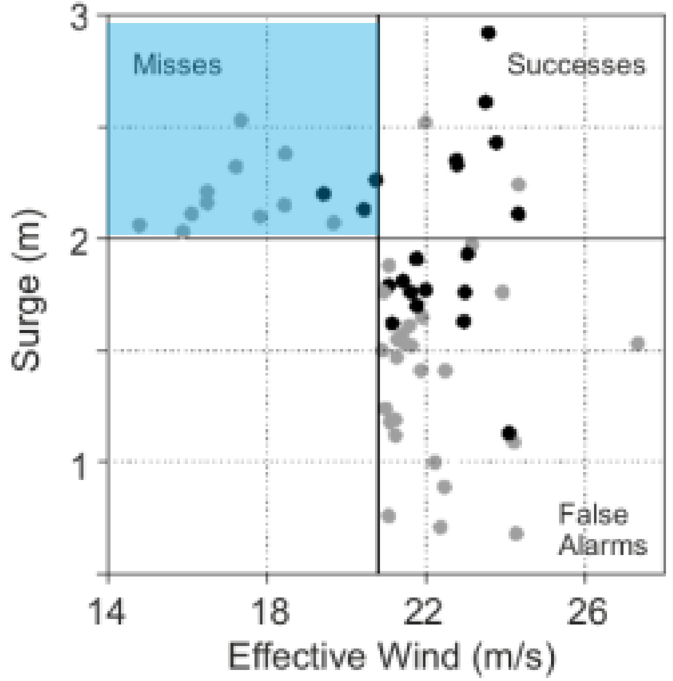
3. **Atmosphere only data**
   Atmospheric reanalysis (e.g. 20th century, NCEP/NCAR; ERA); climate change simulations (e.g. CMIP5, 6);

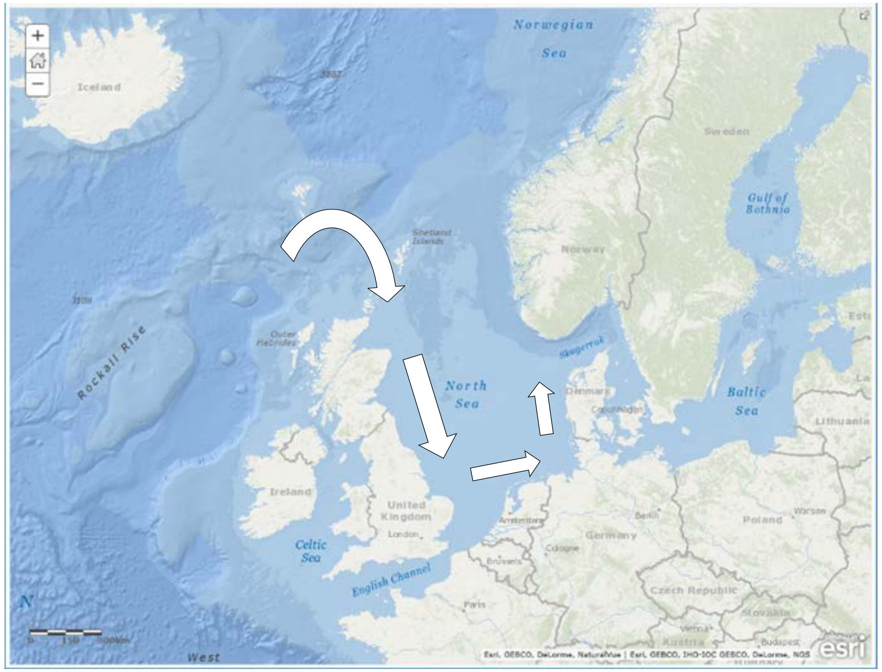


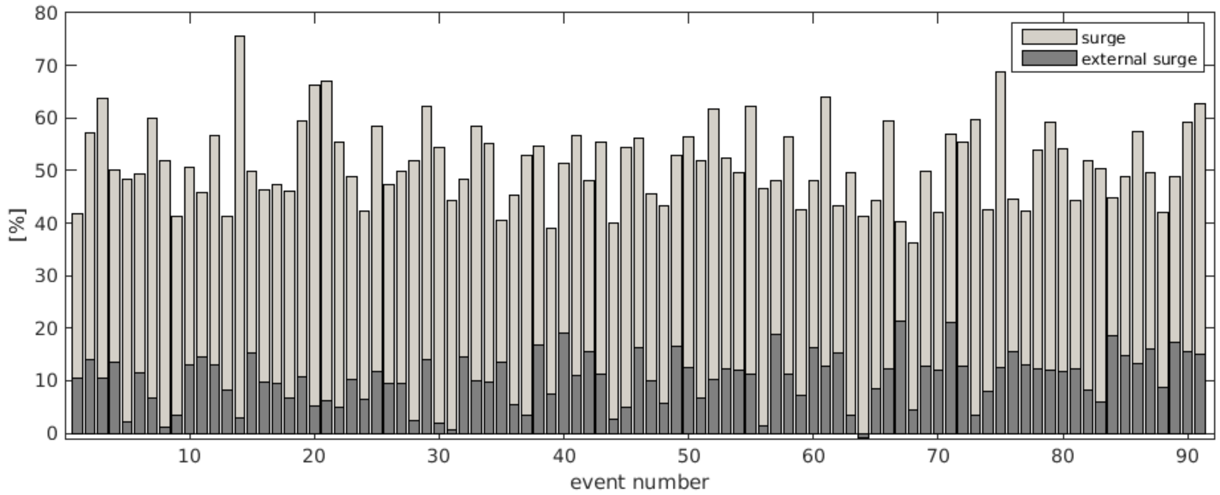


Statistical approach for atmosphere only data



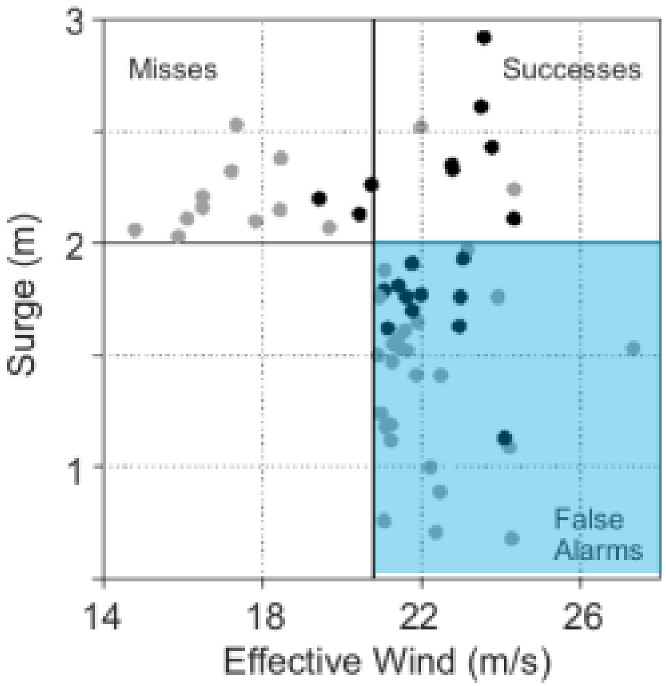




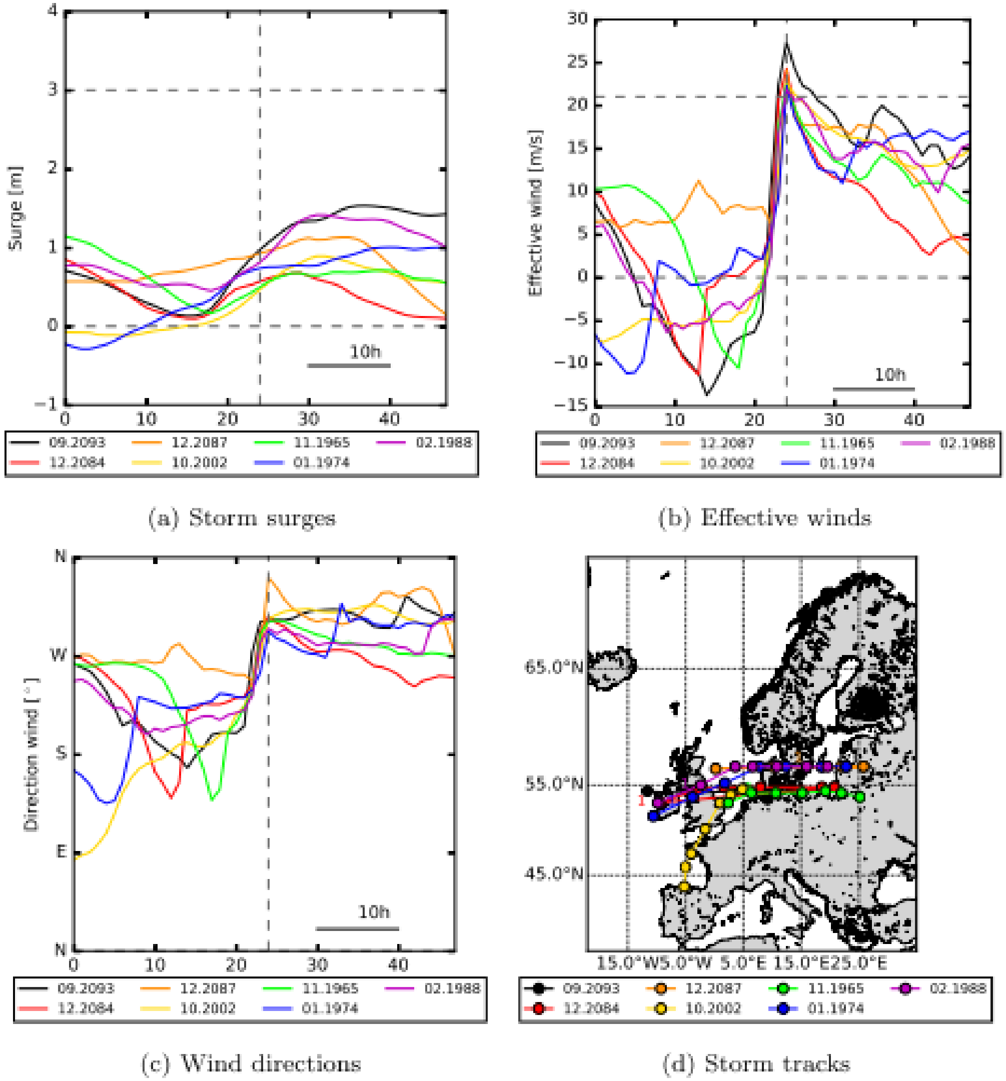


→ External surges can contribute up to 20% to storm tides.

→ Average contribution is about 10%.



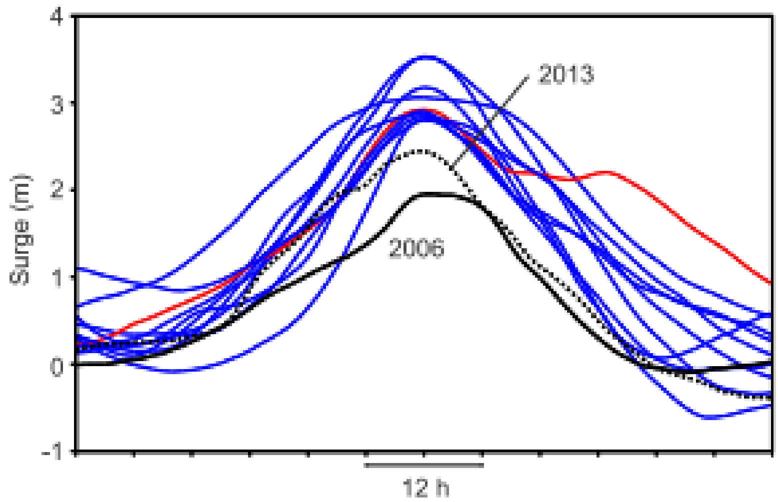
→ Fast moving cyclones with a southerly track that do not last long enough for local surge production



(a) Storm surges (b) Effective winds

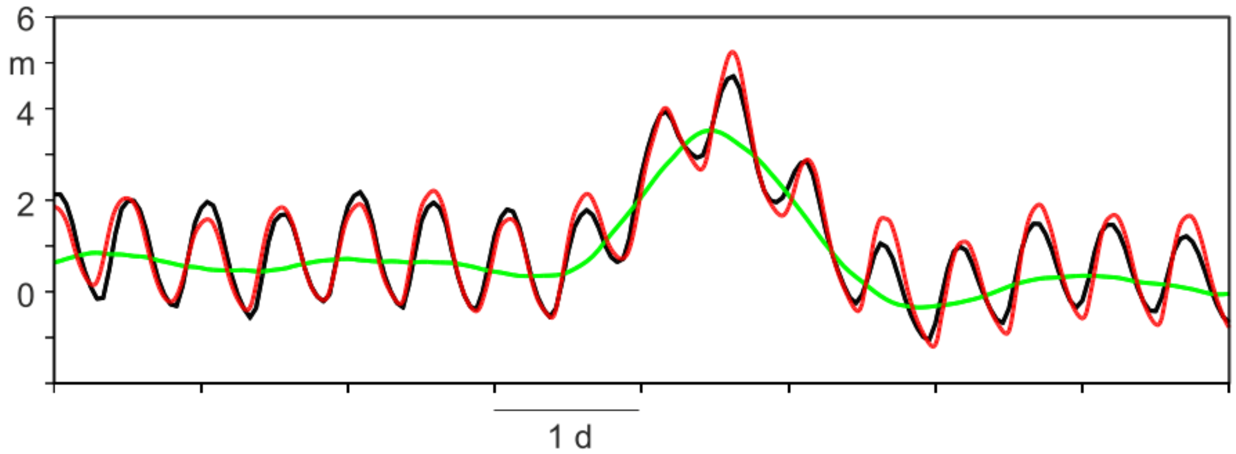
(c) Wind directions (d) Storm tracks

1. **Surge height at Borkum**
   A number of events higher than the 2006 reference

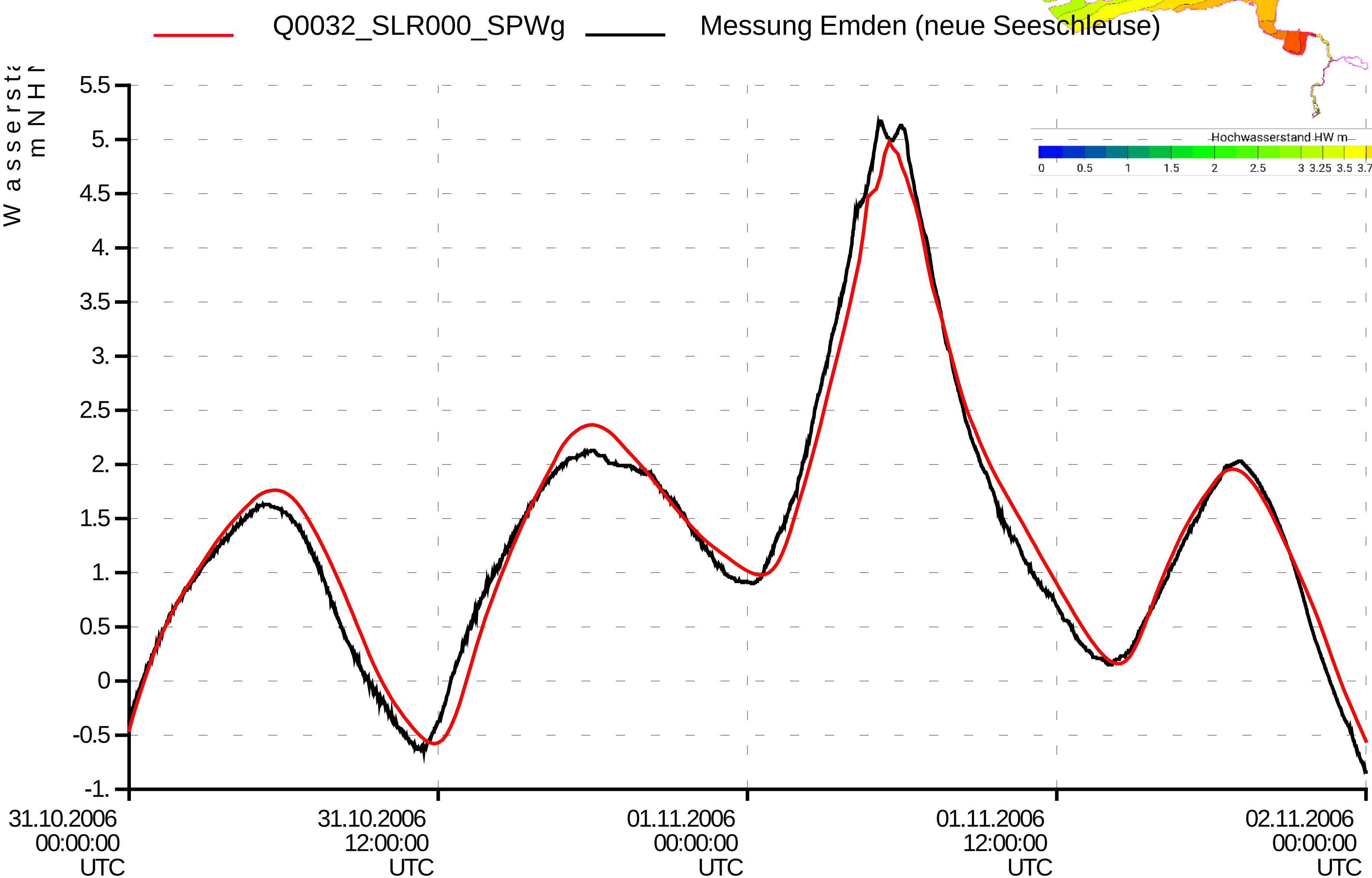


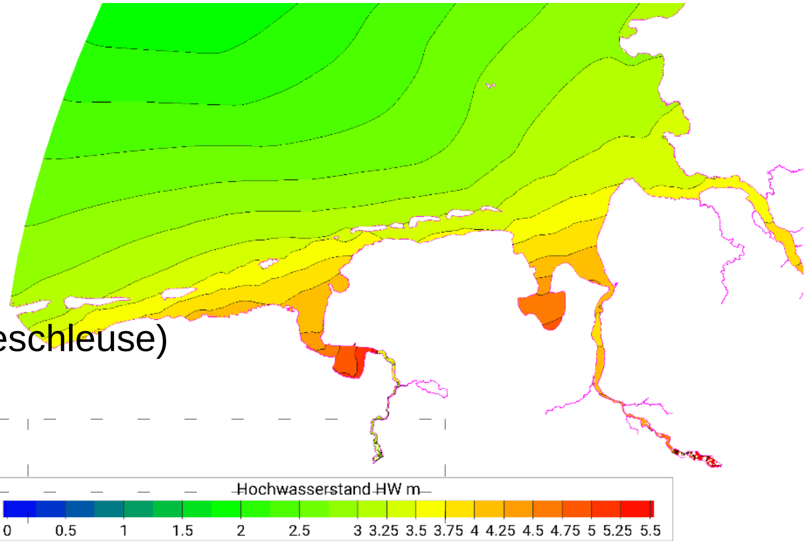
2. **Potential for amplification**
   Present day: Tidal phase
   Future: Sea level rise

HHThW	4.06 m NN
MUSE EPS45	4.99 m NN
WH1_S1_4	4.71 m NN
	(3.52 m surge)
WH1_S1_4	5.23 m NN
(Spring Tide+2h)	(+52 cm)



From Borkum to Emden

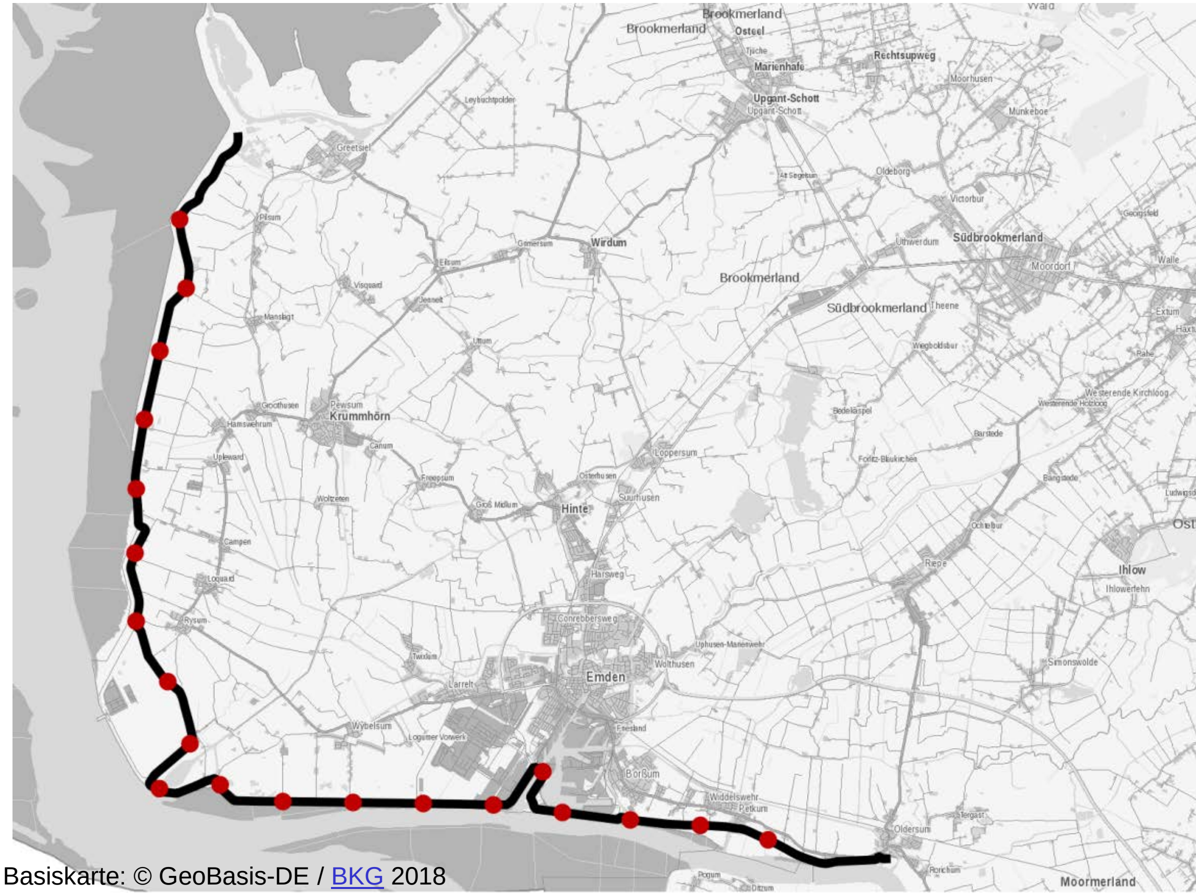




1. **Hydrodynamic flooding model**

2. **Exploring scenarios according to discussion in the collaboration forum**

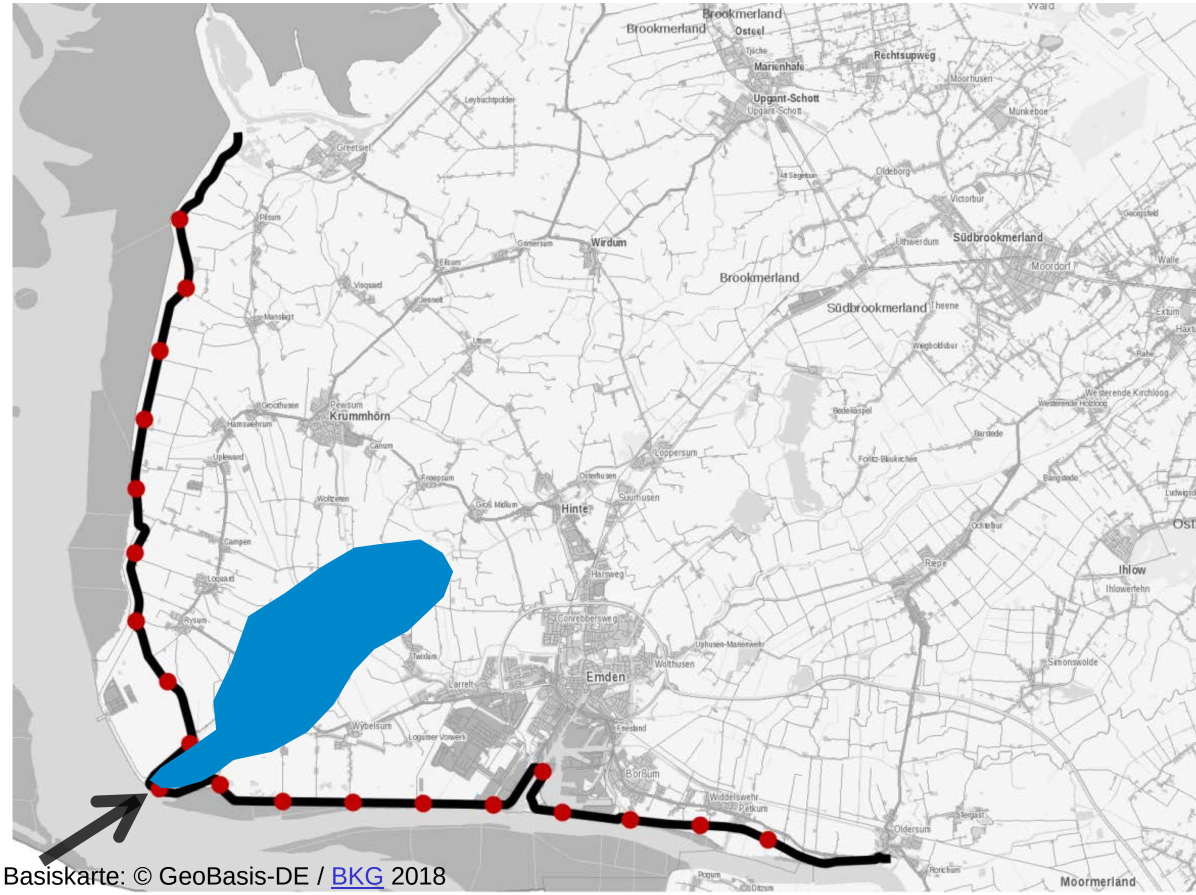
Here a number of “standard breaches” every 2 km



Basiskarte: © GeoBasis-DE / BKG 2018

1. **Damage potential relative to 2006 for each breach and scenario**

2. **Which area is protected by dike section “XY”?**



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Total damage potential

What is at risk in total?

What contribution from section “XY”?

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Summary

→ EXTREMENESS aims at identifying extreme events that are highly unlikely but still physically possible and plausible and which may cause extreme damages or have extreme consequences.

→ What makes an "extreme event" from a risk managers perspective was discussed and decided in science-stakeholder workshop.

→ First results indicate that so far unprecedented storm tides are possible.

→ Damage potentials will be analysed in a transdisciplinary and participative approach.