Climate change and socio-economic impact on the long term sediment balance in the Belgian Part of the North Sea

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Outline of the presentation

- Introduction
  - BPNS
  - Research projects
- Climar
  - Primary effects
  - Scenario’s
- Quest4D
  - Antropic influence : case study sediment disposal
  - Natural evolution versus antropic influence
- Climar
  - Secondary impacts on different sectors
  - Sectoral CC adaptation with holistic view on sediment budget
- Conclusions

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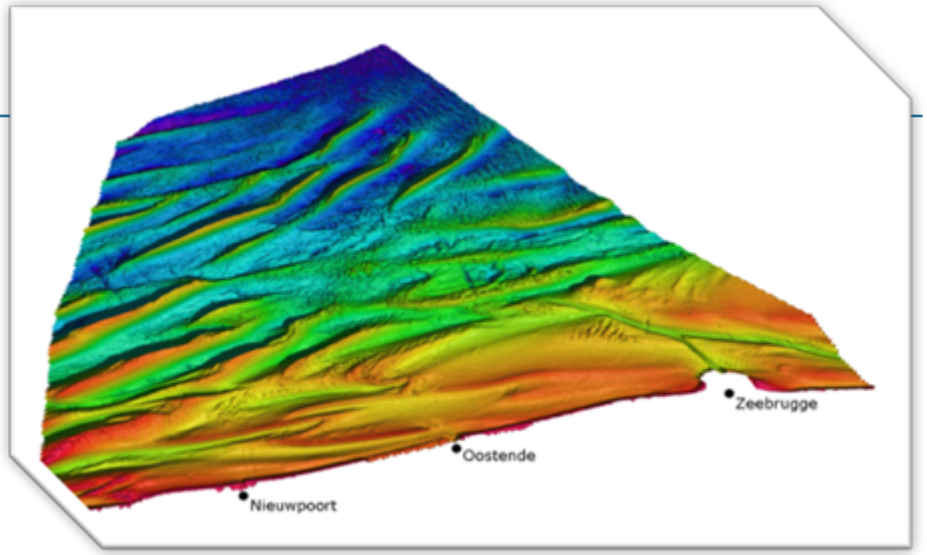
Introduction



Van Lancker et al., 2007

CLIMATE CHANGE → SEDIMENT BALANCE

SOCIO-ECONOMIC ACTIVITIES

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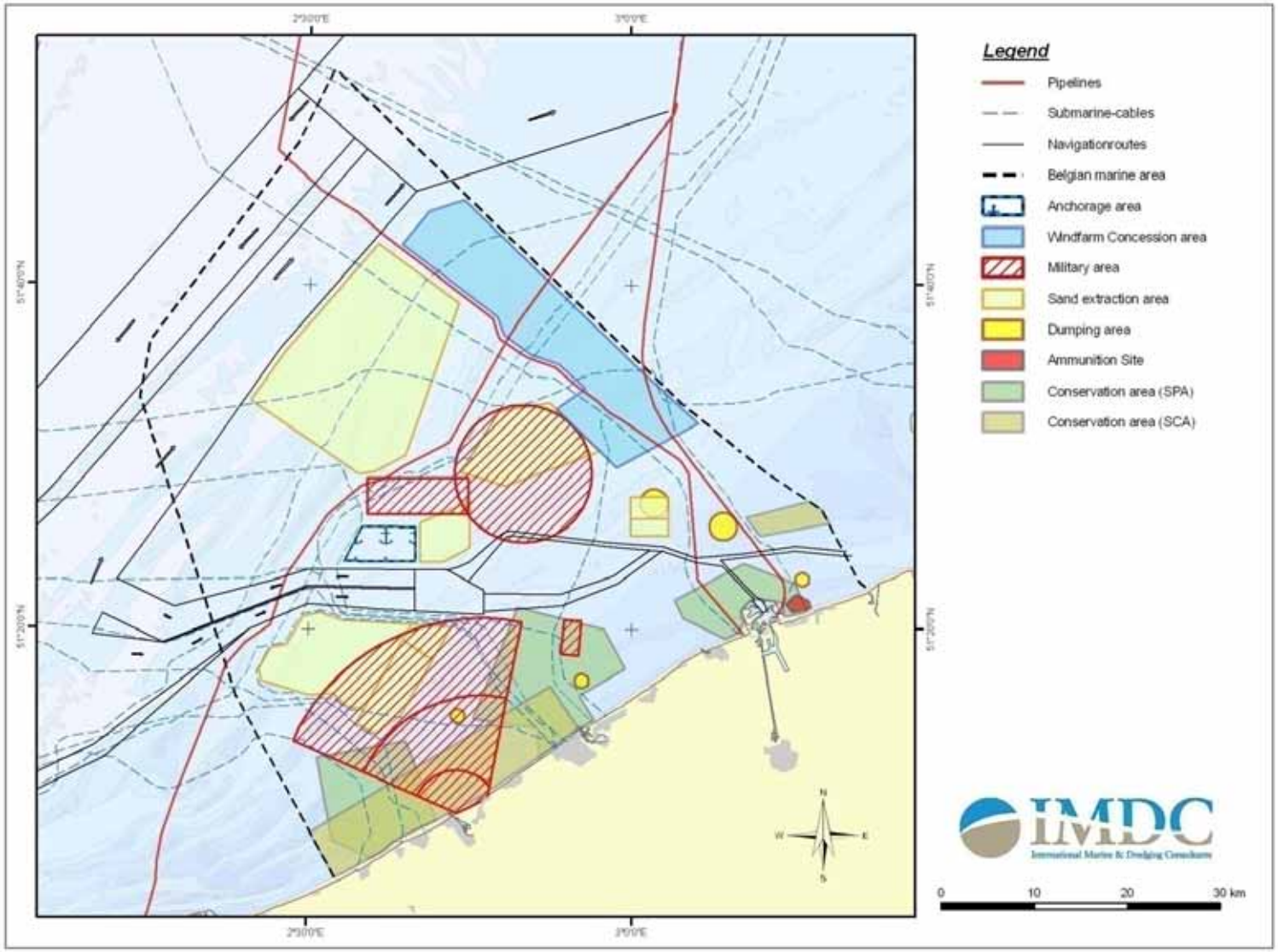
Belgian Part of the North Sea



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Climar

FEDERAAL WETENSCHAPSBELEID

WP1
Definition and modelling of climate change induced primary impacts at North Sea scale

Climate change induced primary impacts: sea level rise, increased storminess, possible increased rainfall, salinity, temperature, etc..
- *Definition and modelling*

WP2
Deduction of climate change induced secondary impacts

Case study - **Coastal flooding**
- *Modelling*

Secondary impacts on the marine ecosystem in general and related socio-economic activities
- *Identification and classifications*

Case study – **Fisheries sector**
- *Impact assessment*

WP3
Identification of adaptation scenario's/measures

Case study – **Coastal flooding**
- *Identification/modelling of adaptation scenario's/measures*

Marine ecosystem in general and related socio-economic activities.
- *extrapolation of adaptation scenario's/measures*

Case study – **Fisheries sector**
- *Identification/modelling of adaptation scenario's/measures*

WP4
Evaluation of adaptation scenario's/measures

Case study – **Coastal flooding**
- *Evaluation adaptation scenario/measures*

Marine ecosystem in general and related socio-economic activities.
- *Evaluation adaptation scenario/measures*

Case study – **Fisheries sector**
- *Evaluation adaptation scenario/measures*

Elaboration of an evaluation framework for adaptation scenario's/measures as a response to climate induced impacts (North Sea)

Integrated sustainability assessment of adaptation scenario's/measures

Evaluation of the effects of the proposed adaptive strategies (embedding in policy, practical integration, implementation)

Formulation of recommendations towards North Sea future policy and its different socio-economical activities.

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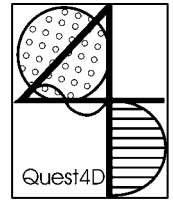
waterbouwkundig LABORATORIUM

ILVO

MARITIEM INSTITUUT

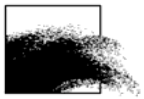
Quest4D

- New process studies and refined modelling
  - Quantification of changes and trends (depth, sediment, sediment transport, macrobenthos and their linkages);
  - Improvement of model input and integration
- Establishment of a baseline
  - Gilson dataset ~1900 (sediment and macrobenthos)
- Decifering change, both naturally and anthropogenically- steered over the past 100 yrs

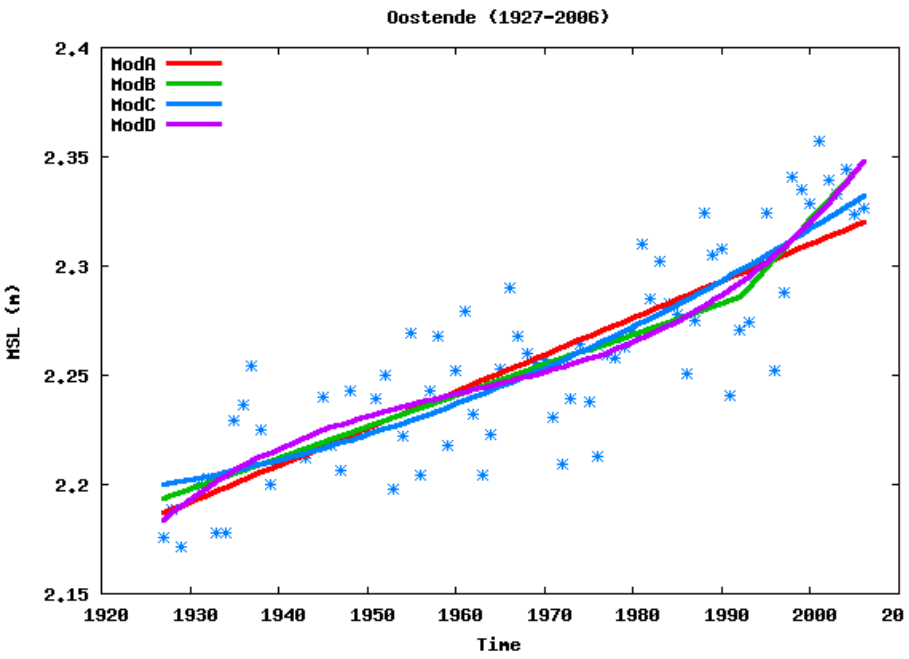


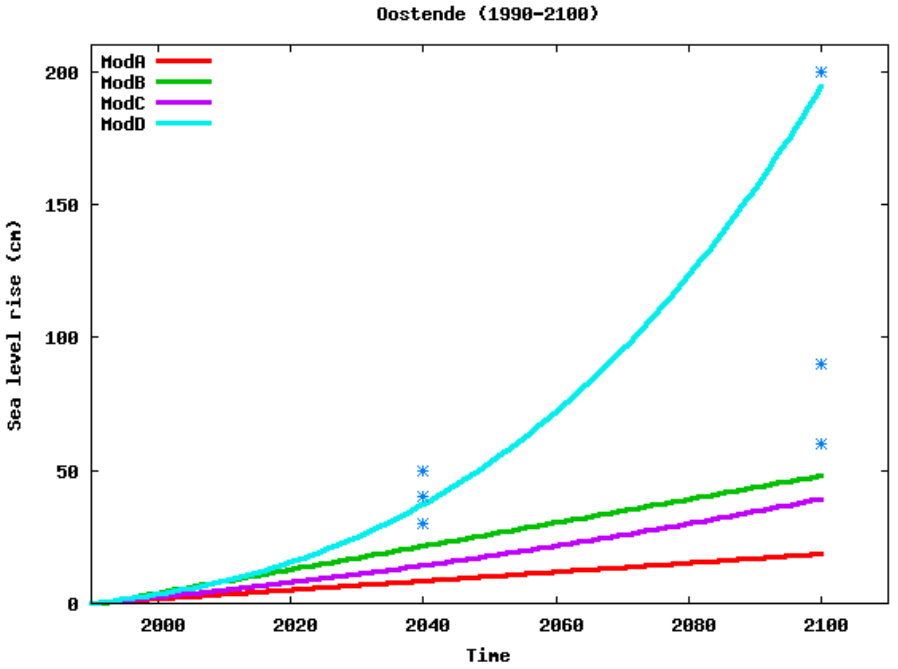
Ultimate goal:

- Better allocation of disposal grounds, sustainable marine aggregate extraction, sustainable coastal protection schemes, *in the view of climate change*
- Optimisation of monitoring practices



Primary effects : sea level rise





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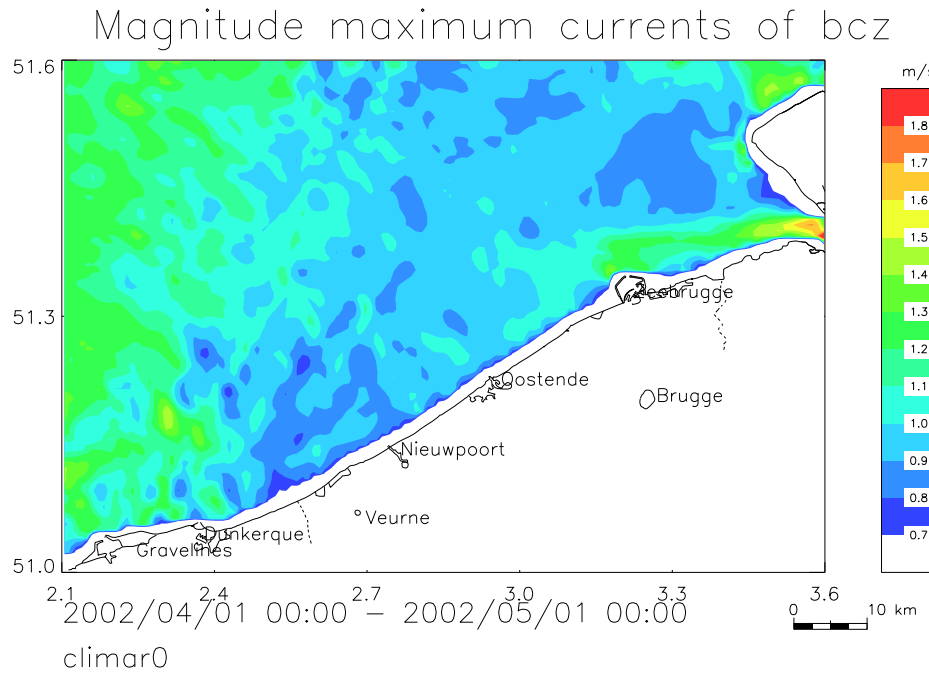
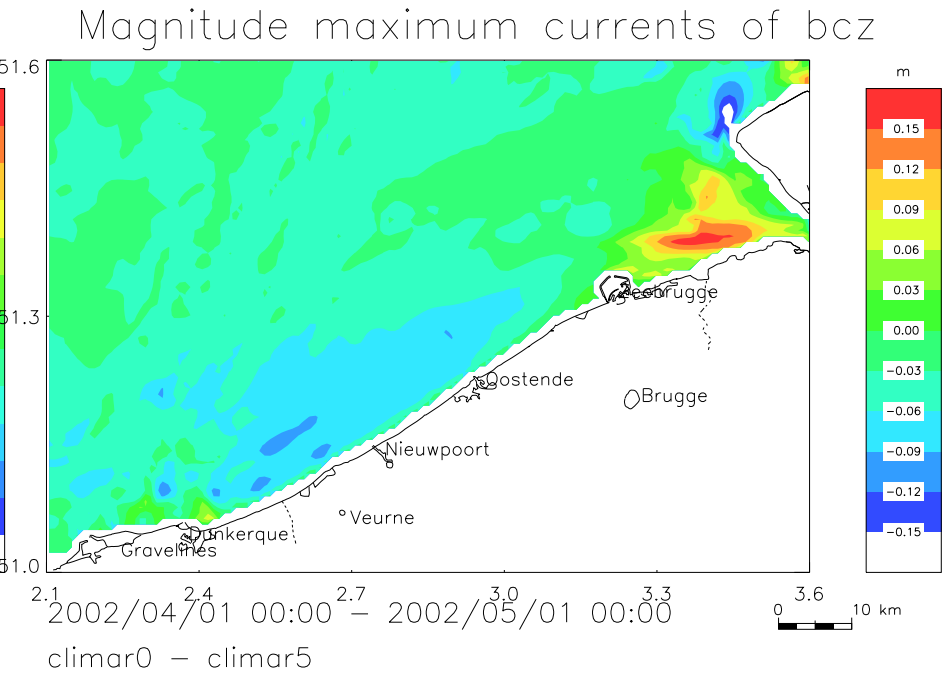
Primary effects : change in currents





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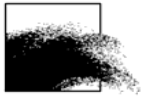
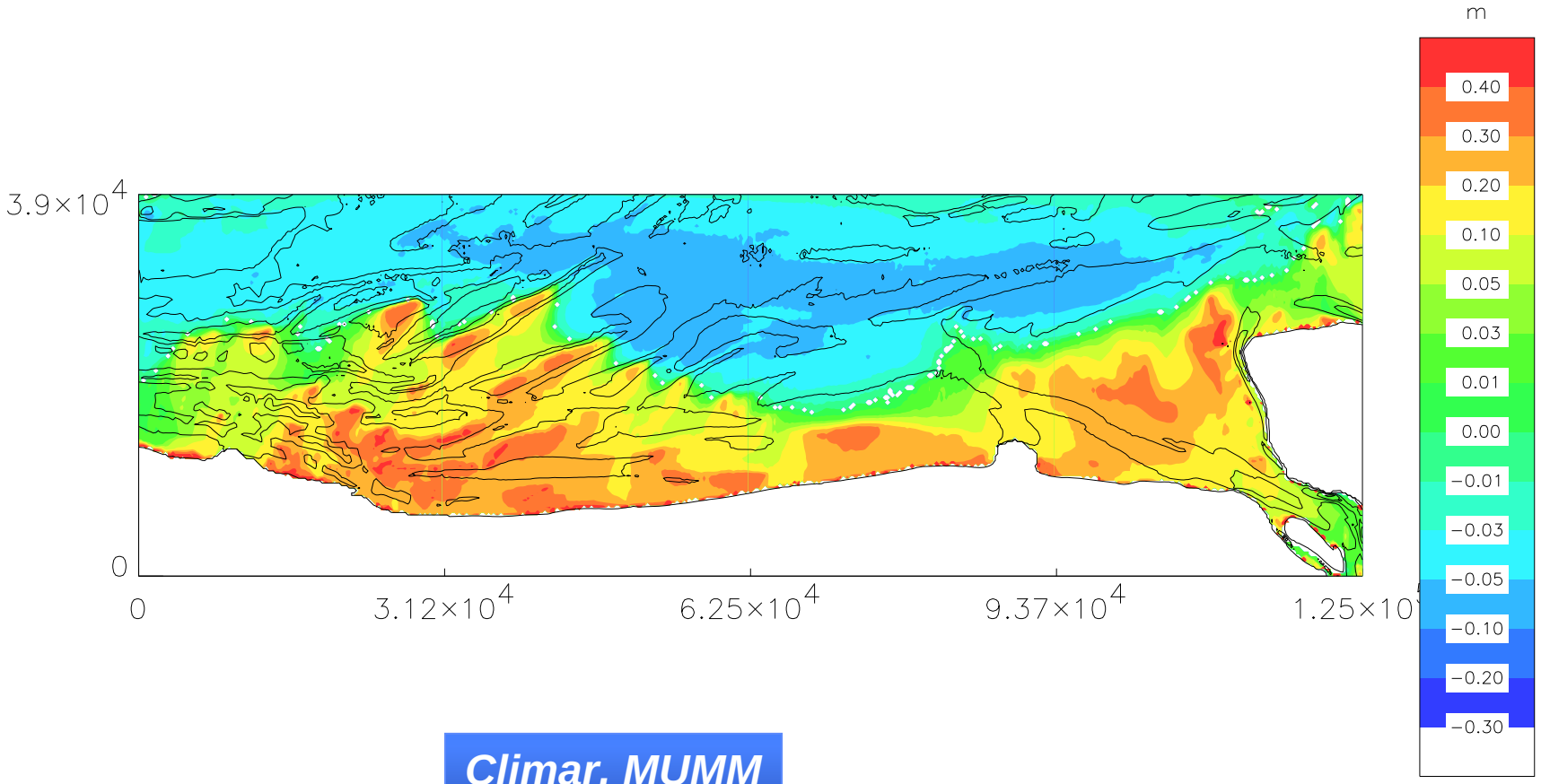


Primary effects : change in wave climate



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Working with CC scenario's

	M	M+	W	W+	Worst
Air temperature	+ 2 °C	+ 2 °C	+ 4 °C	+ 4 °C	+ 4 °C
Change air circulation	No	Yes	No	Yes	Yes
Winter precipitation	+ 8%	+ 14%	+ 16%	+ 28%	+ 28%
Wind velocity	0%	+ 4%	- 2%	+ 8%	+ 8%
Summer precipitation	+ 6%	- 20%	+ 12%	- 40%	- 40%
Sea water temp	+ 2.5%	+ 2.5%	+ 3.5%	+ 3.5%	+ 3.5%
Mean sea level	+ 60cm	+ 60 cm	+ 93 cm	+ 93 cm	+ 200 cm

Climar, scenario 2100

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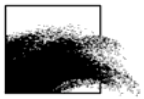
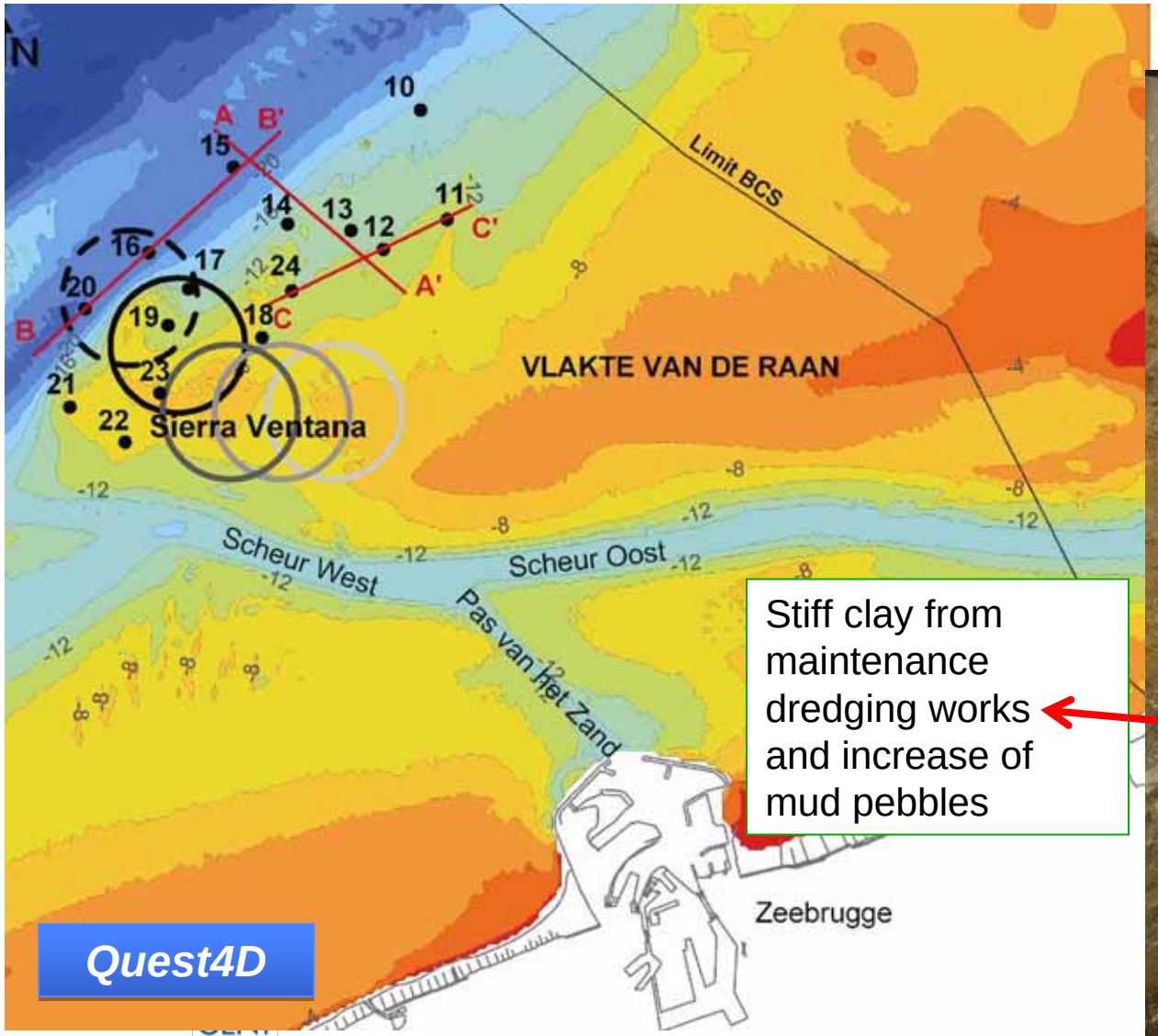
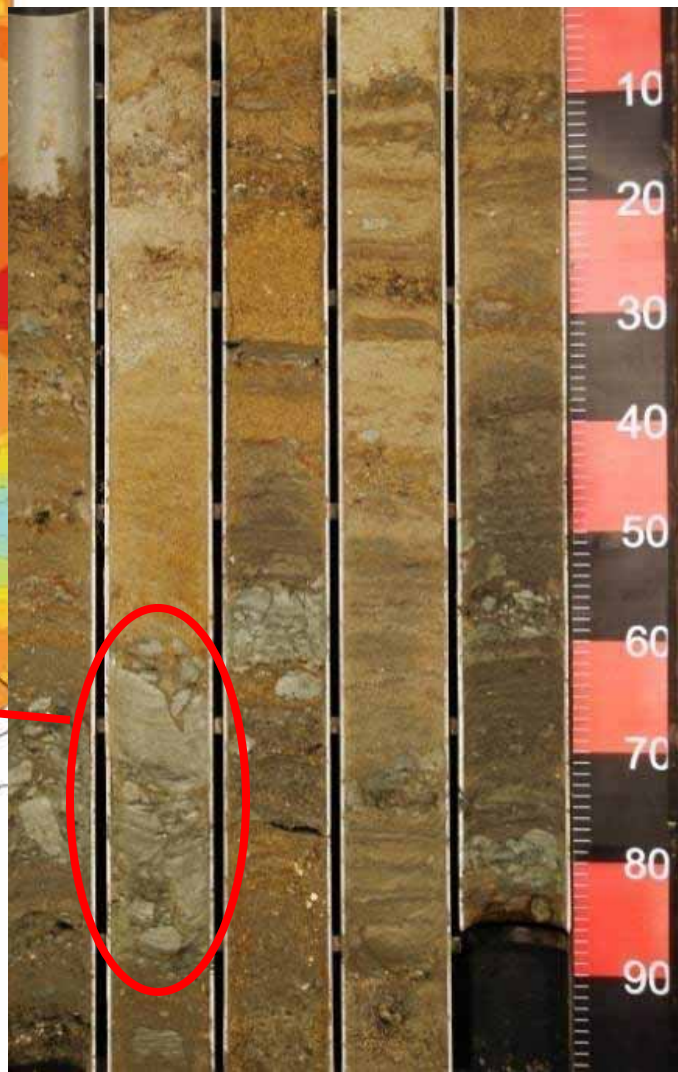


Antrophic change → case study on the disposal of dredged material



Vibrocore



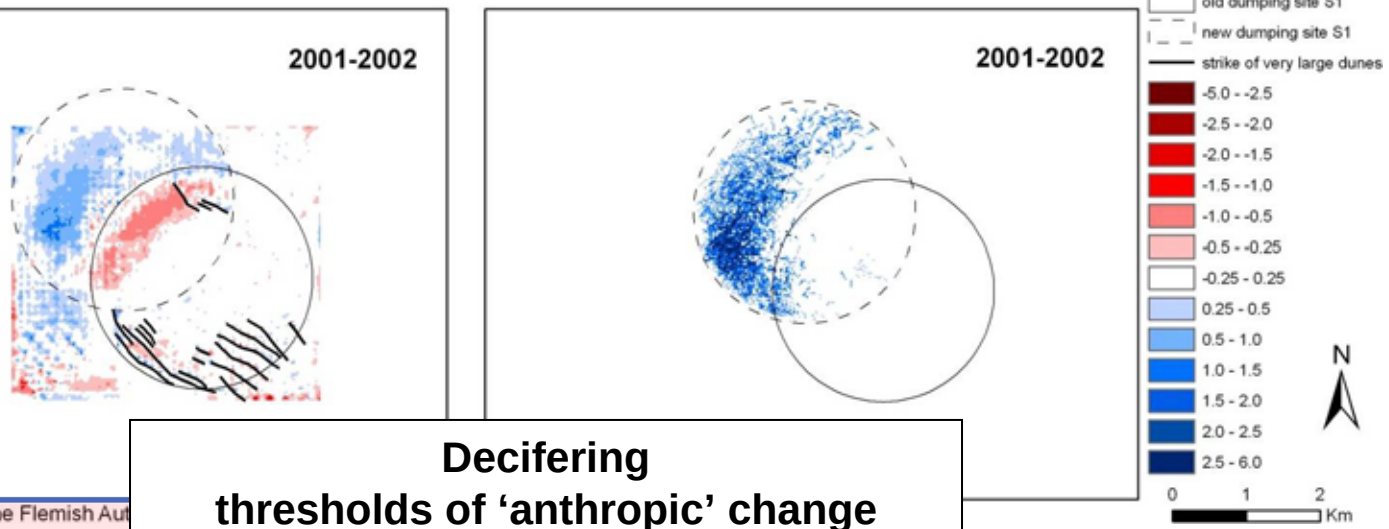
Stiff clay from maintenance dredging works and increase of mud pebbles

Antrophic change → case study on the disposal of dredged material

1 Analysis of bathymetric data

2 Analysis of corresponding data on the disposal of dredged material

Short-term impact

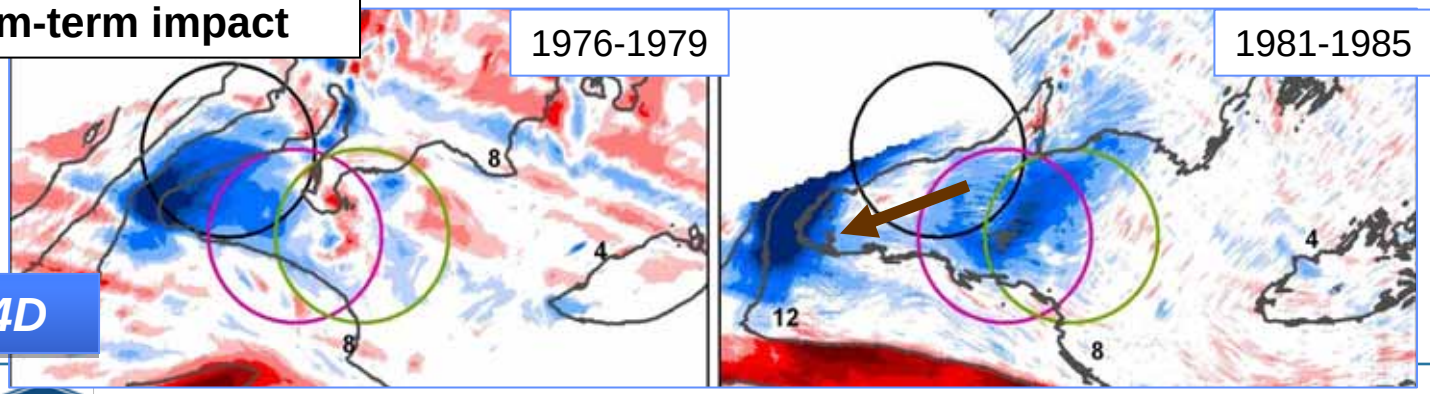


Active cooperation end-users

Data compiled from the Flemish Aut

Decifering thresholds of 'anthropic' change

Medium-term impact



3 Analysis of vibrocores:
- top 25-50 cm *highly dynamic*
- natural vs anthropic sedimentation patterns

Quest4D

Regional sedimentation beyond the disposal grounds, in the direction of navigation channels

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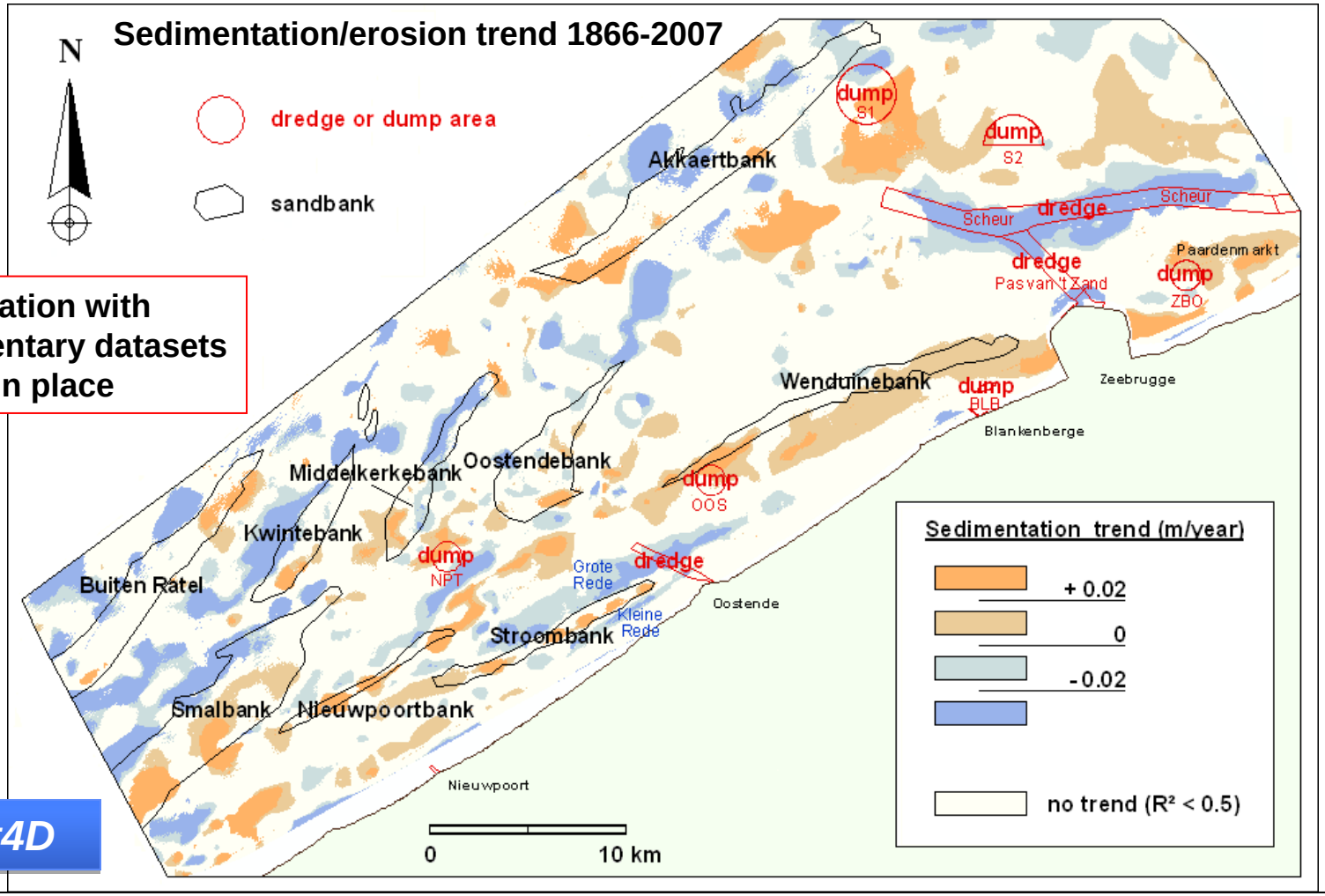
Long-term erosion/sedimentation patterns



Validation with complementary datasets is in place

Quest4D

Sandbanks within +/- 20 km zone: **no apparant movement during last 150 years**

→ accretion of banks + erosion of troughs between the banks (few cm/year) ➔ steeper slopes of the banks

Major change Zeebrugge area: maintenance and deepening works + disposal of dredged material:

Natural vs anthropic

Natural evolution
Sediment volumes vs hydro-meteo from measuring piles *(Flemish Authorities)*

→Wind
→High- and low frequency waves
→Currents
→Water levels

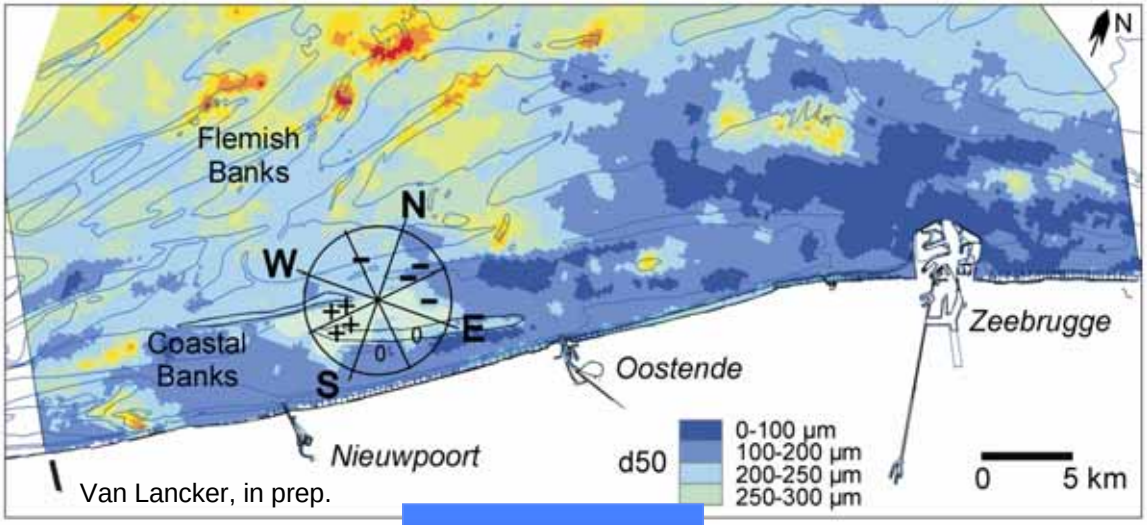
Varying sediment volumes over sandbank areas

Surveys	9609	9611	9612	9702	9709	9711	9802	9803	*maximum change*
9609		0.05	0.03	0.09	0.01	0.05	0.05	0.04	*0.09*
9611			-0.02	0.03	-0.04	0.00	0.00	-0.01	-0.04
9612									0.05
9702									-0.08
9709									0.04
9711							0.00	-0.01	-0.01
9802								-0.01	-0.01
9803									0.00
maximum change	0.00	0.05	0.03	*0.09*	-0.08	0.05	0.05	0.04	

Decifering thresholds of 'natural' change

Baland Bank bathymetric surveys.
Matrix of all the intersurvey volume differences per surface unit (m^3/m^2). The maximum differences are indicated in italic. Surveys are indicated as YYMM.

Event–driven *vs.* yearly-averaged changes



Van Lancker, in prep.

Findings along 'undisturbed' near coastal small sandbank:

(1) Enhanced SW conditions bring in sediment
(2) Persistent NW and NE conditions evoque erosion
(3) Overall shallowing of the area

Scenario's will be used to predict sediment transport changes, due to climate change

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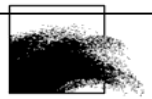
Quest4D

Secondary effects and indicators of climate change

Ecological	Economical	Social
Primary production	Shipping: accident risk, Sediment processes in navigation routes, oil pollution, …	Health: heat/cold, allergies, stress, water quality, blooms of spp.
Geographical shift	Fisheries/ Mariculture: fish loss, risk,…	Food quality (fish, seafood)
Decoupling phenological relationships (recruitment, food availability)	Industrial activities (Wind energy, sand & gravel): sediment processes, risk,…	Accommodations
Non-indigenous species & harmful blooms	Tourism: beach (pollution, loss), sea quality, accommodations	Safety
Loss of habitat	Employment	
Biodiversity		



Secondary effects on tourism - TCI index as a measure of climate attractiveness of a coast

The TCI index is weighted and computed as follows (Amelung et al., 2007):

$$TCI = 2 * (4CID + CIA + 2R + 2S + W)$$

Subindex	*Variable(s)*
Daytime comfort Index (CID)	Maximum daily temperature (°C)
	Minimum daily relative humidity (%)
Daily comfort Index (CIA)	Mean daily temperature (°C)
	Mean daily relative humidity (%)
Precipitation (R)	Precipitation (mm)
Sunshine (S)	Daily duration of sunshine (hours)
Wind speed (W)	Wind speed (m/s or km/hr)

Belgian coast → more attractive

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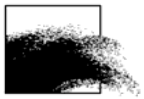
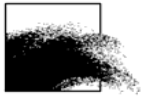
Coastal tourism

- Impacts and adaptation strategies ~ stakeholders
- Climate change opportunities !
- Certainly needs beach nourishment ← coastal defence



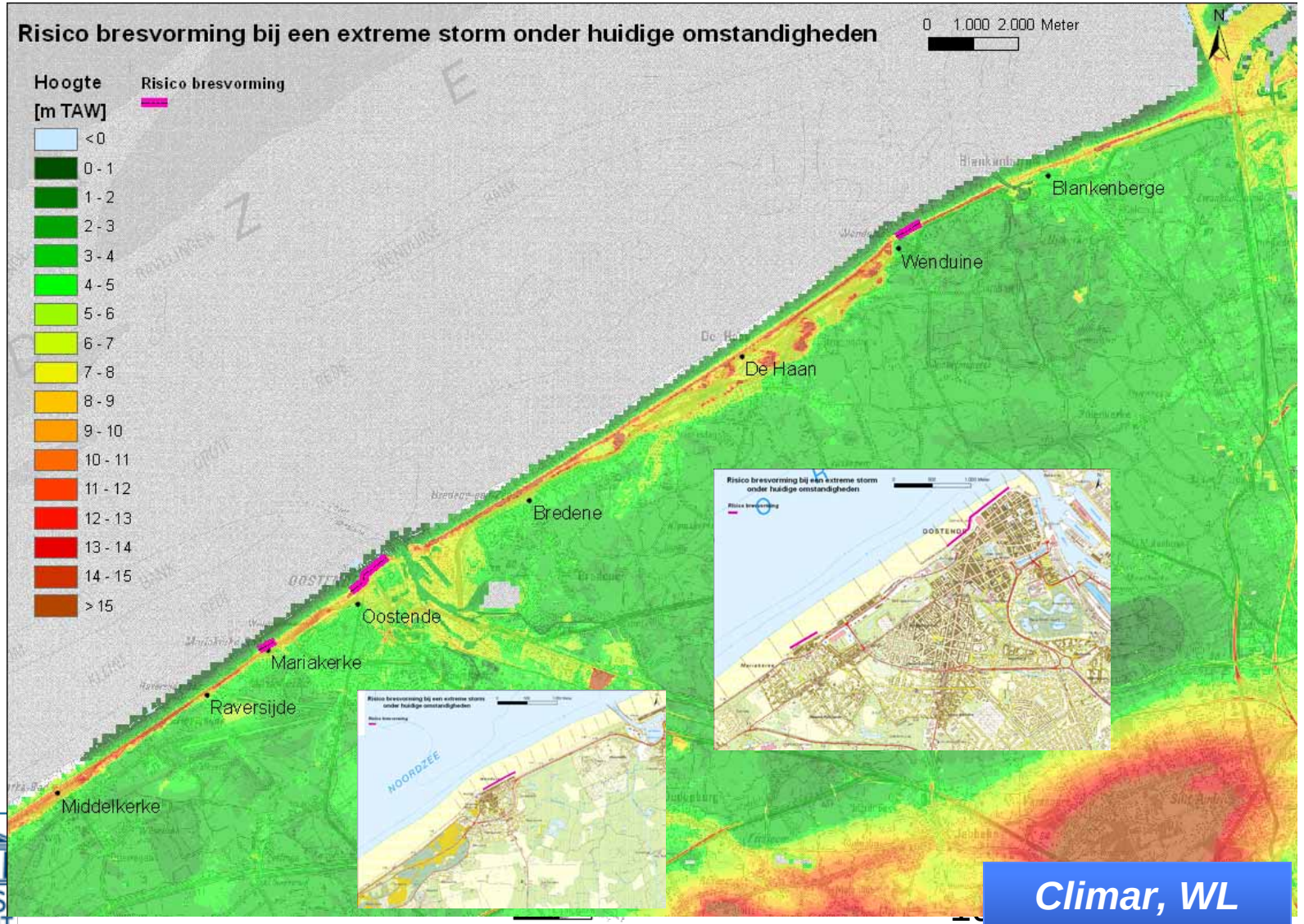
Coastal defence

- Risk estimate : current versus future
- Link with ongoing Coastal Safety Plan
- Link with need for sand extraction → clear influence on “natural sediment balance”



Risk on coastal flooding

1. Current situation – 13 (385) profiles fail



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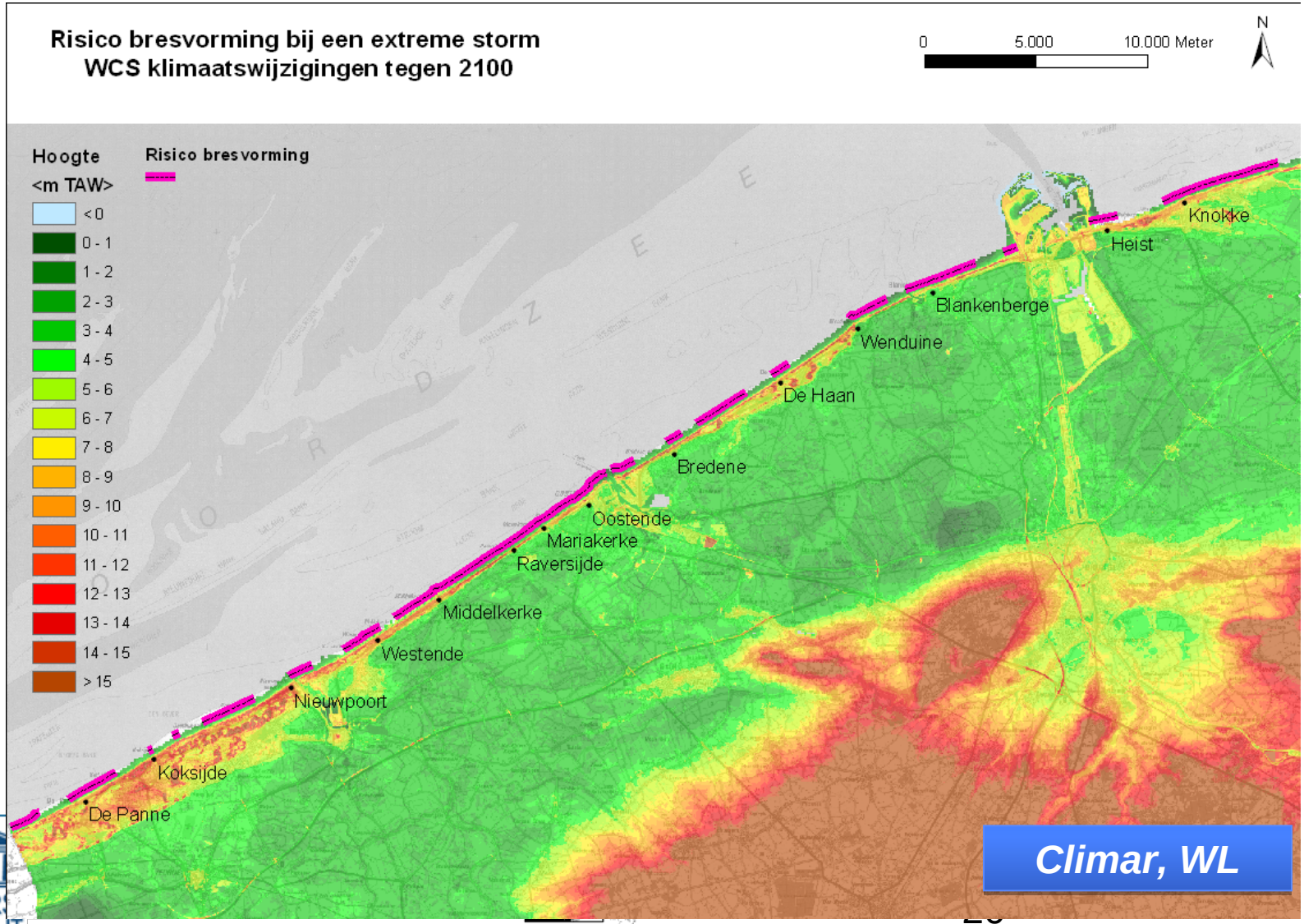
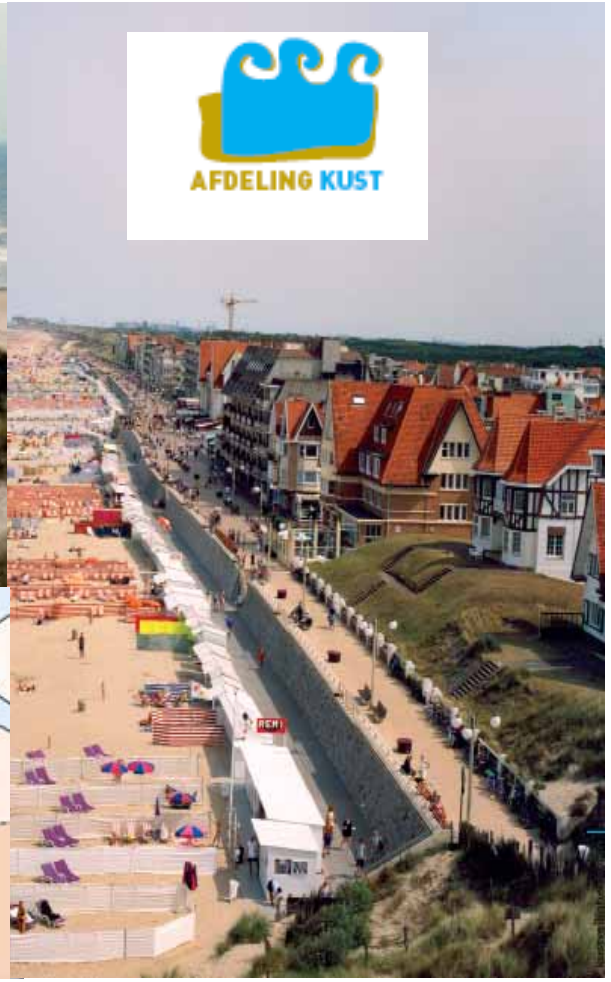
Risk on coastal flooding

2. Worst Case Scenario 2100 – 194 profiles fail



Coastal safety plan



www.afdelingkust.be

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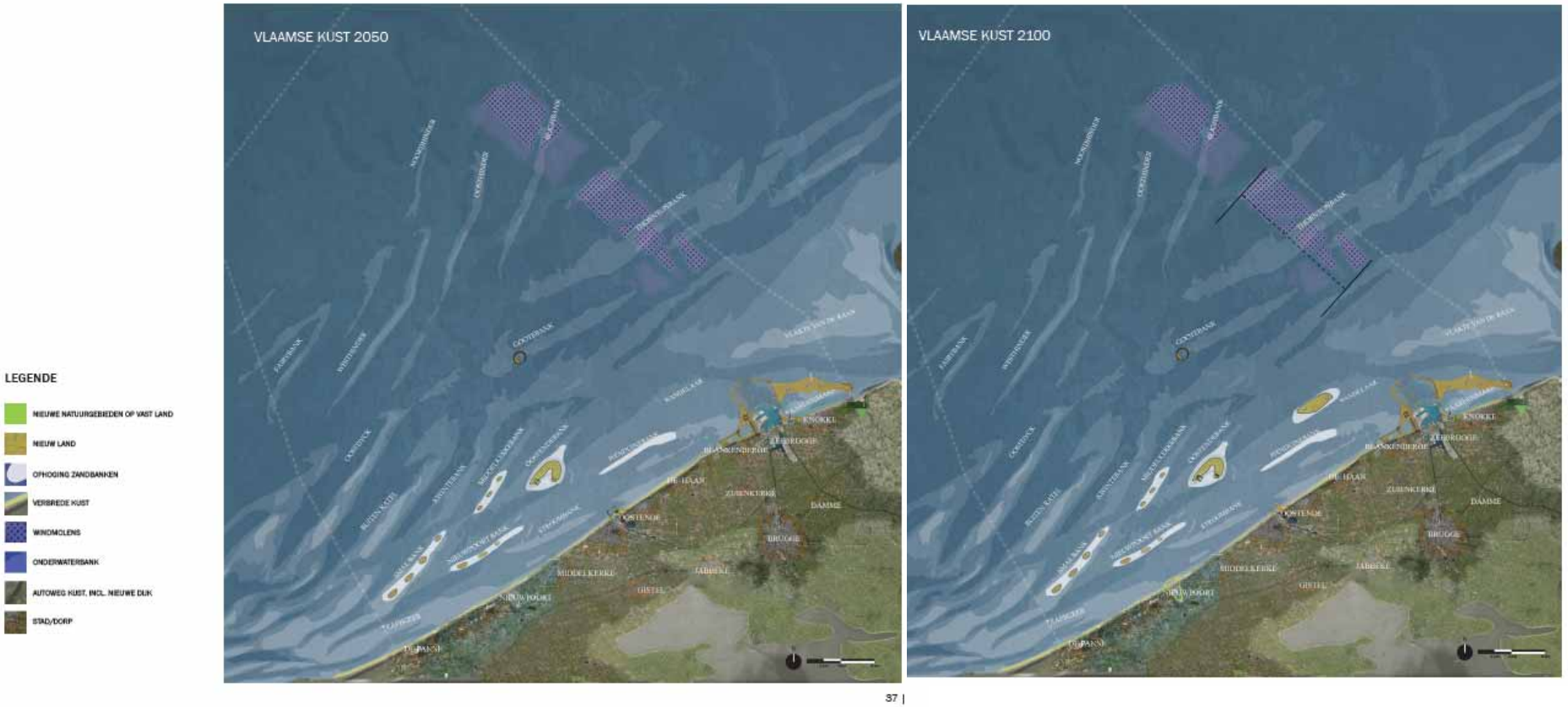
IMDC
International Marine & Dredging Consultants

CC adaptation – future ideas
Vlaamse Baaien 2100



www.deme.be* & *www.jandenul.be

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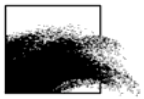
Future work

- Climar
  - Form adaptation strategies for different sectors
  - Development of evaluation tool
  - Evalutation of adaptation scenario’s
- Quest4D
  - Evaluate impact of climate change on sediment budgets
  - Recommendations for a more sustainable exploitation of the seabed
  - Recommendations for beach nourishment schemes



Conclusions

- Sediment budget of the North Sea is complex and poorly understood →
  - Need for more research (e.g. extreme events, input-output, carrying capacity)
  - Need for policy instruments (e.g. sediment management plan)
- Climate change
  - Working with scenario's is inevitable
  - In balance with socio-economic evolution
  - Policy relevant assessment tools
- CC as a "driver"for sustainable sediment budget ?