



*Sand extraction in the Belgian part of the North Sea:
European context and lessons from 10 years of EMS
control and bathymetric monitoring*

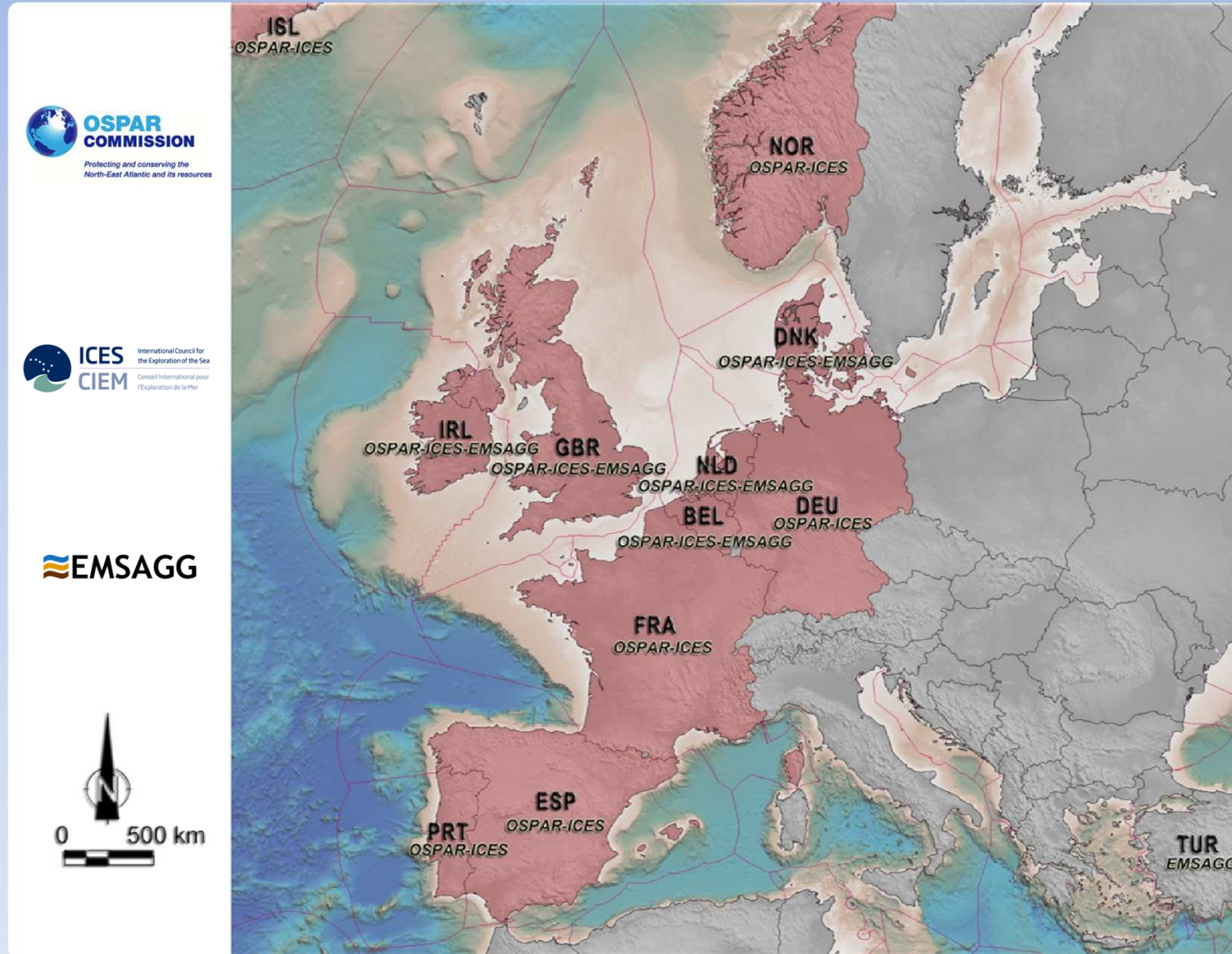
*M. Roche, K. Degrendele, L. De Mol,
P. Schotte & H. Vandenreyken*



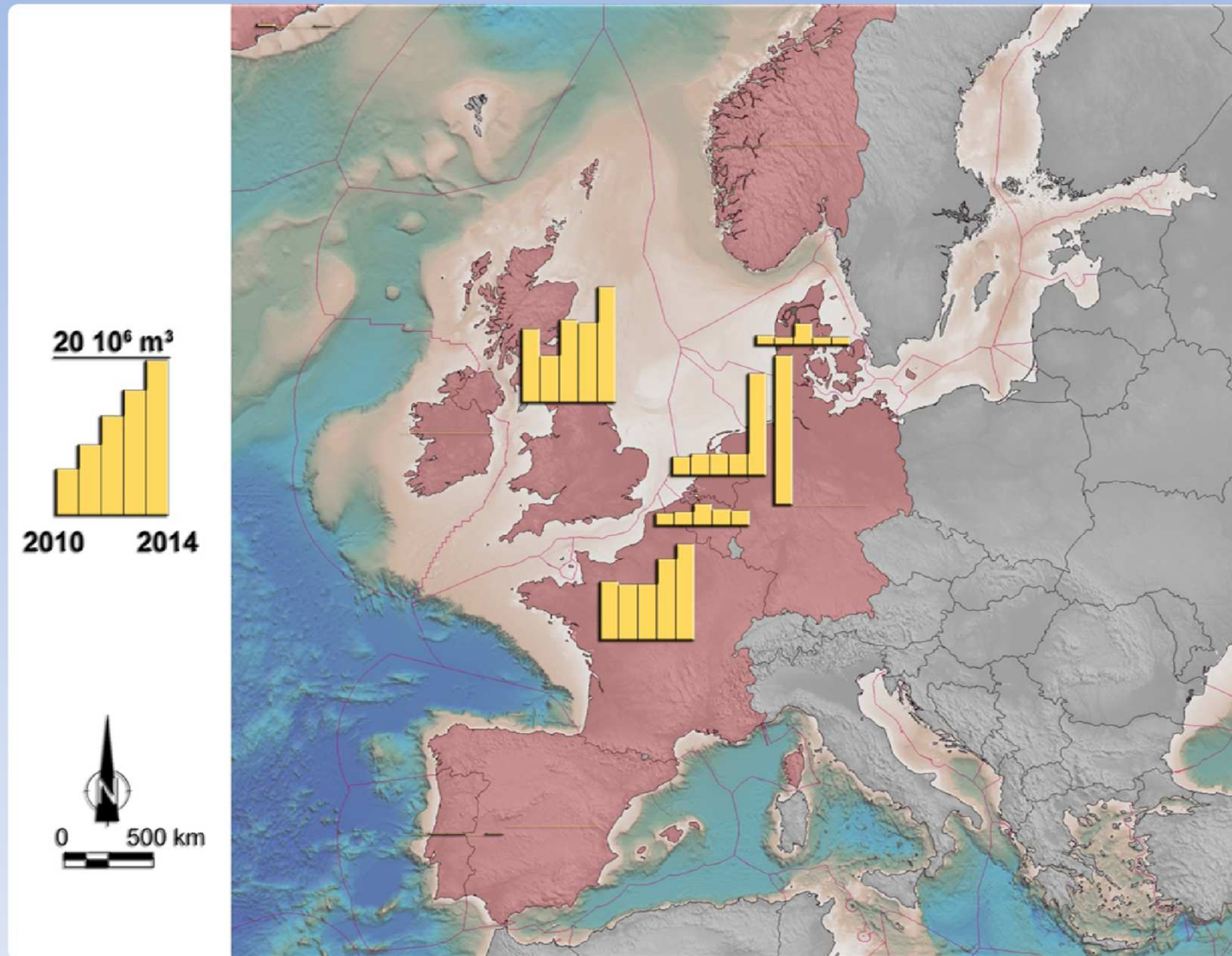
*R. Van den Branden,
G. De Schepper & L. Naudts*



EU COUNTRIES and EEZ OSPAR, ICES and EMSAGG members/represented

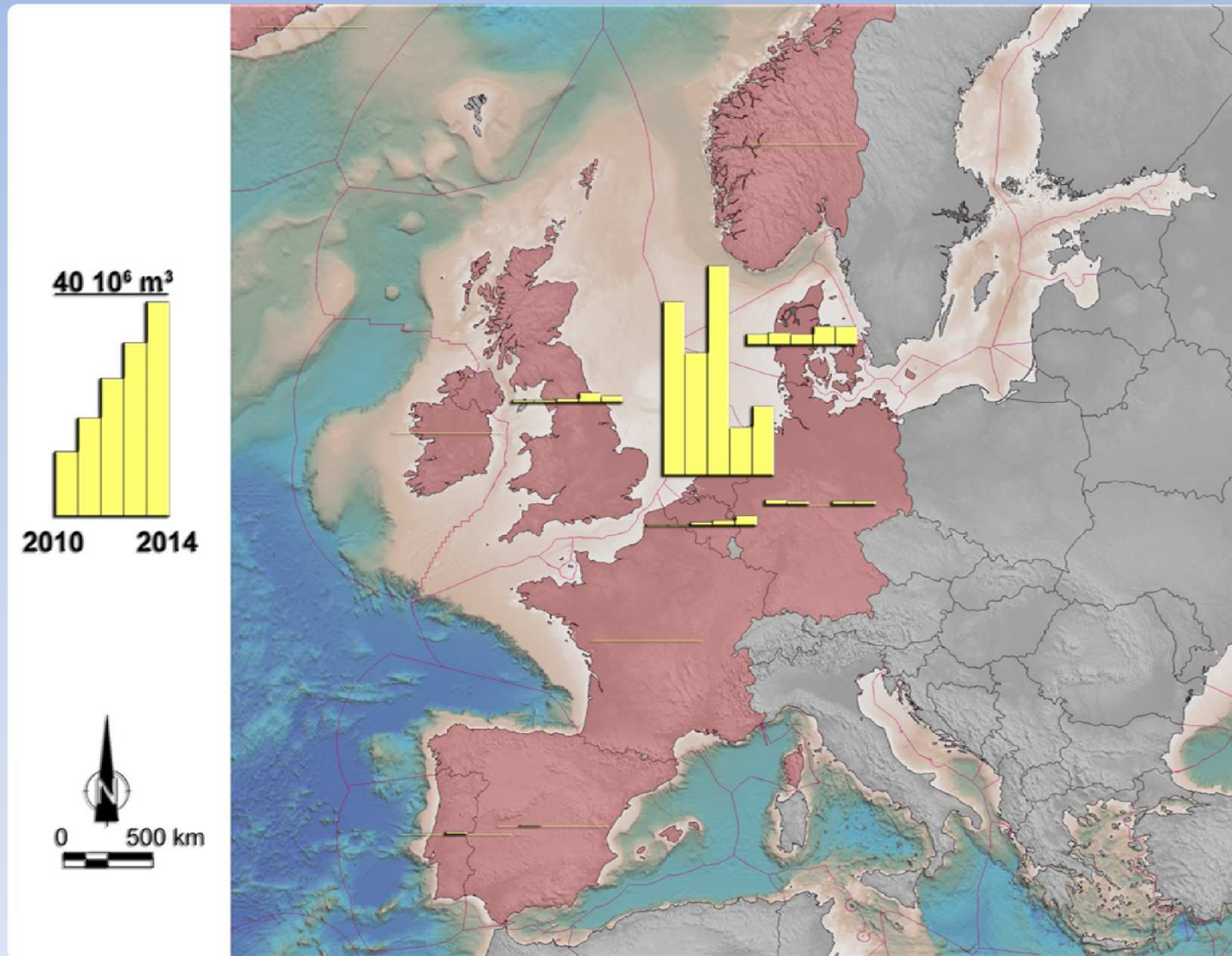


Extraction Activities from 2010 to 2014 Construction / Industrial aggregates



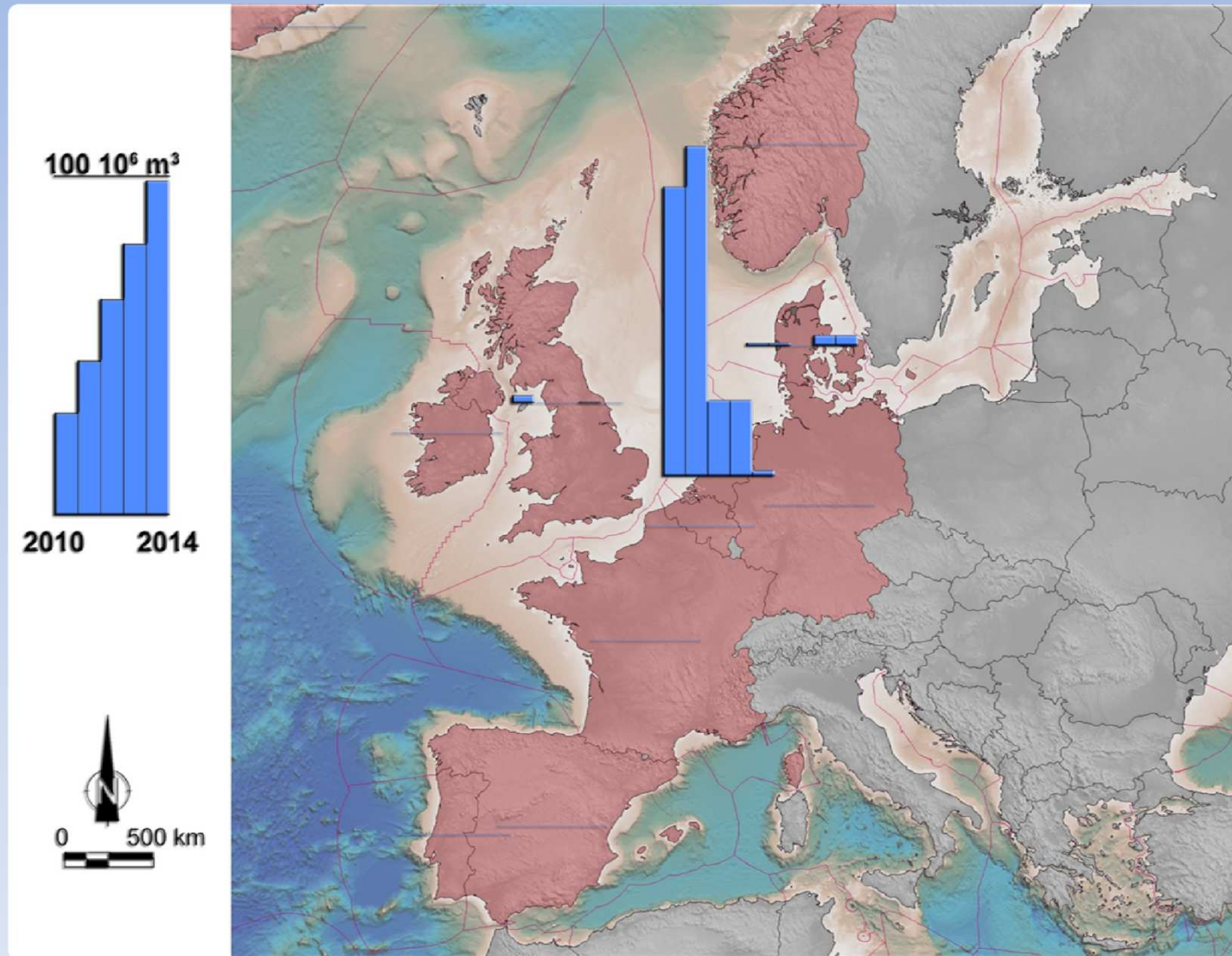
Source:
ICES WGEXT
Reports 2010 to 2014

Extraction Activities from 2010 to 2014 Beach Replenishment



Source:
ICES WGEXT
Reports 2010 to 2014

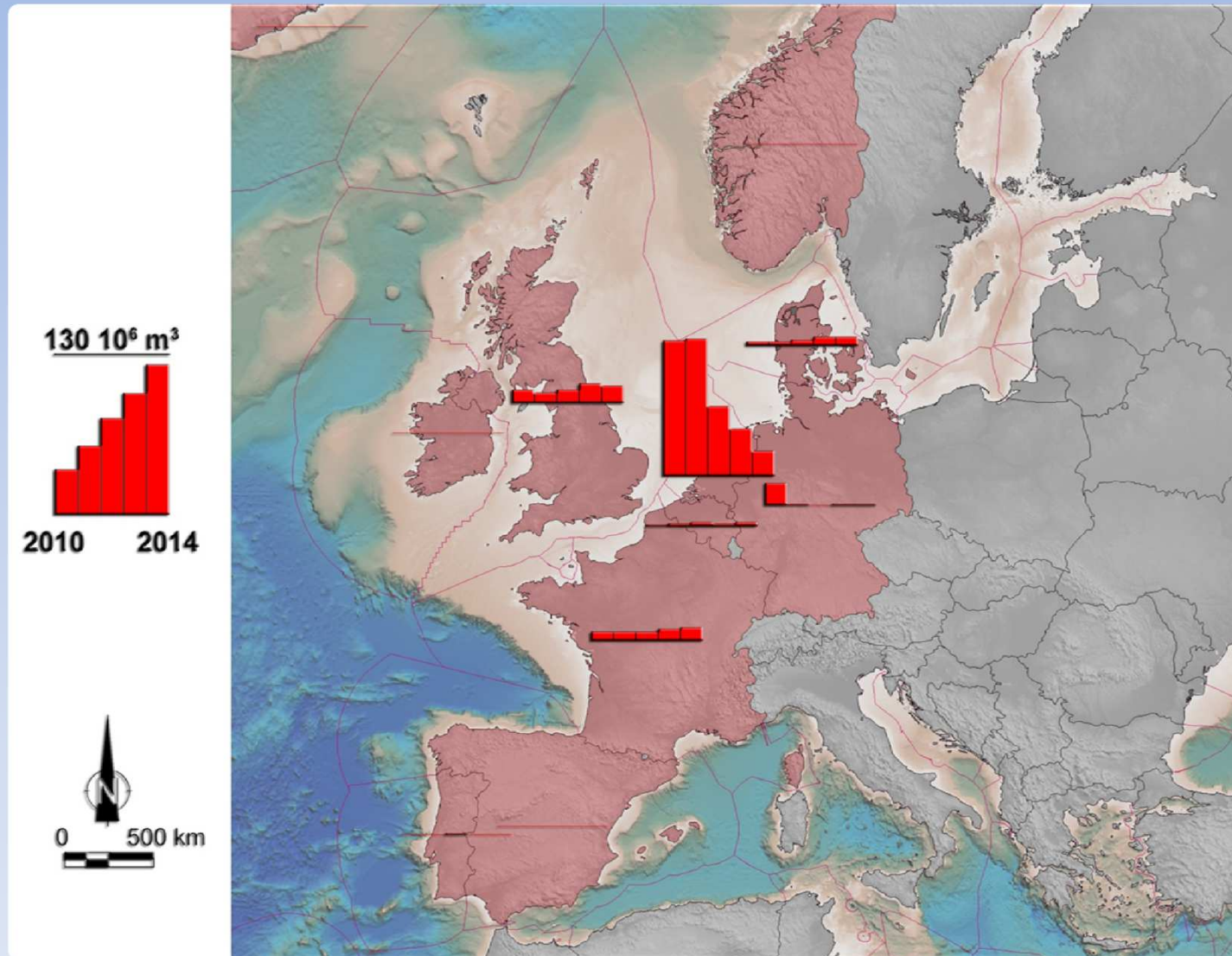
Extraction Activities from 2010 to 2014 Construction Fill / Land Reclamation



Source:
ICES WGEXT
Reports 2010 to 2014

Extraction Activities from 2010 to 2014

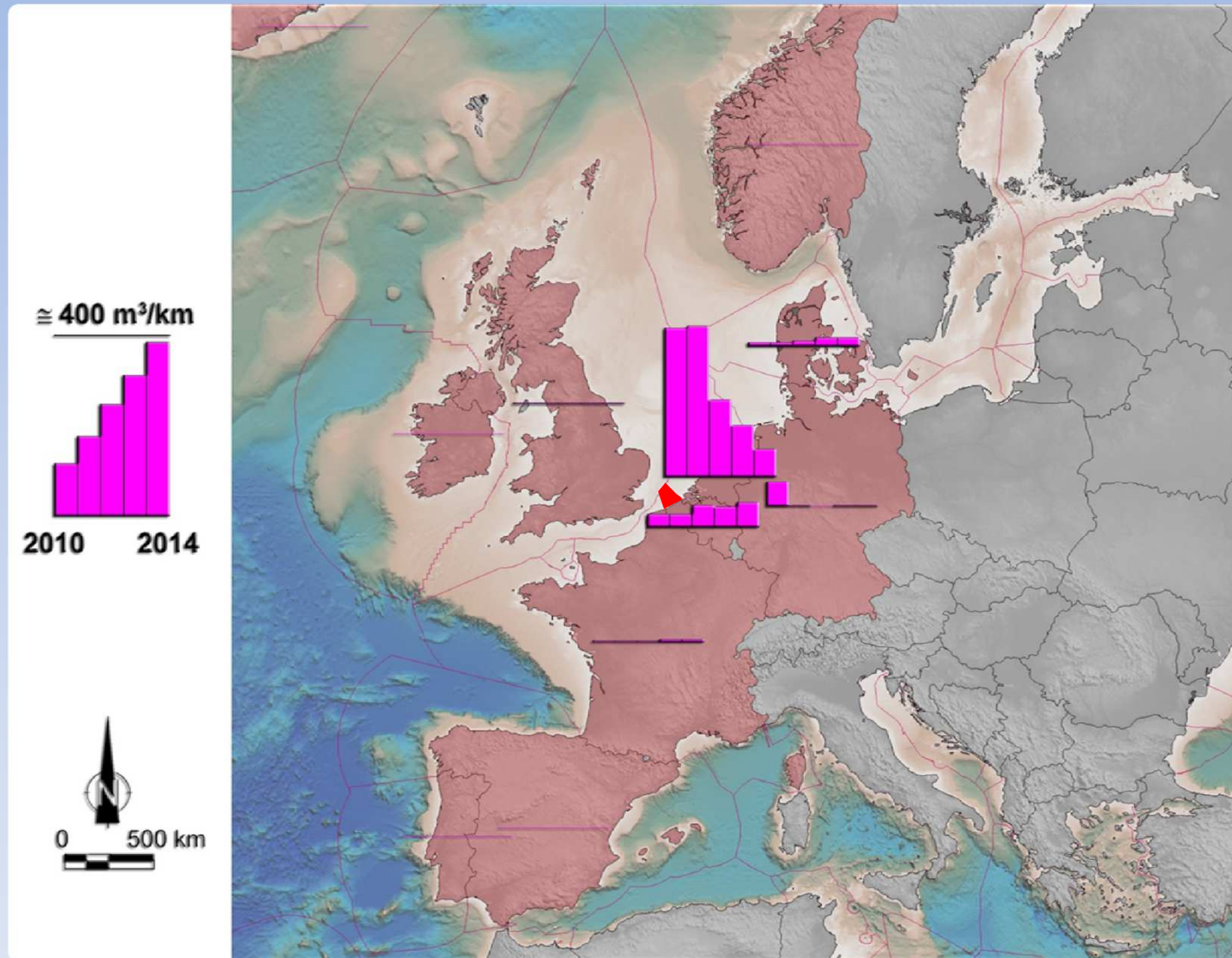
Total extracted



Source:
ICES WGEXT
Reports 2010 to 2014

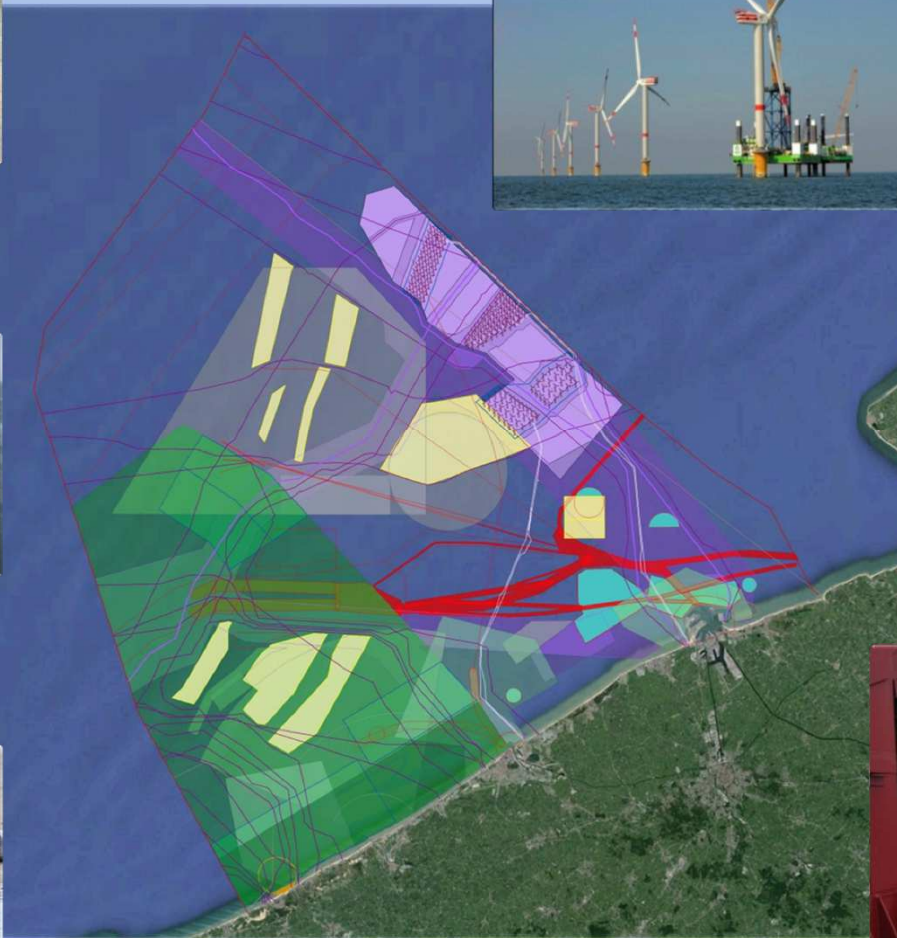
Extraction Activities from 2010 to 2014

Total extracted ÷ Coastline length



Source:
ICES WGEXT
Reports 2010 to 2014
EEA coastline

The Belgian part of the North Sea: Very restricted area (~ 3450 km²) under high pressure



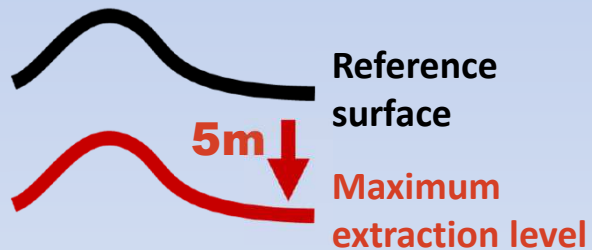
- Navigation
- Fisheries
- Wind farms
- Electric cables
- Pipes
- Telecommunication cables
- Natural reserves
- Dumping areas
- Military exercise areas
- Danger areas
- **Sand extraction**



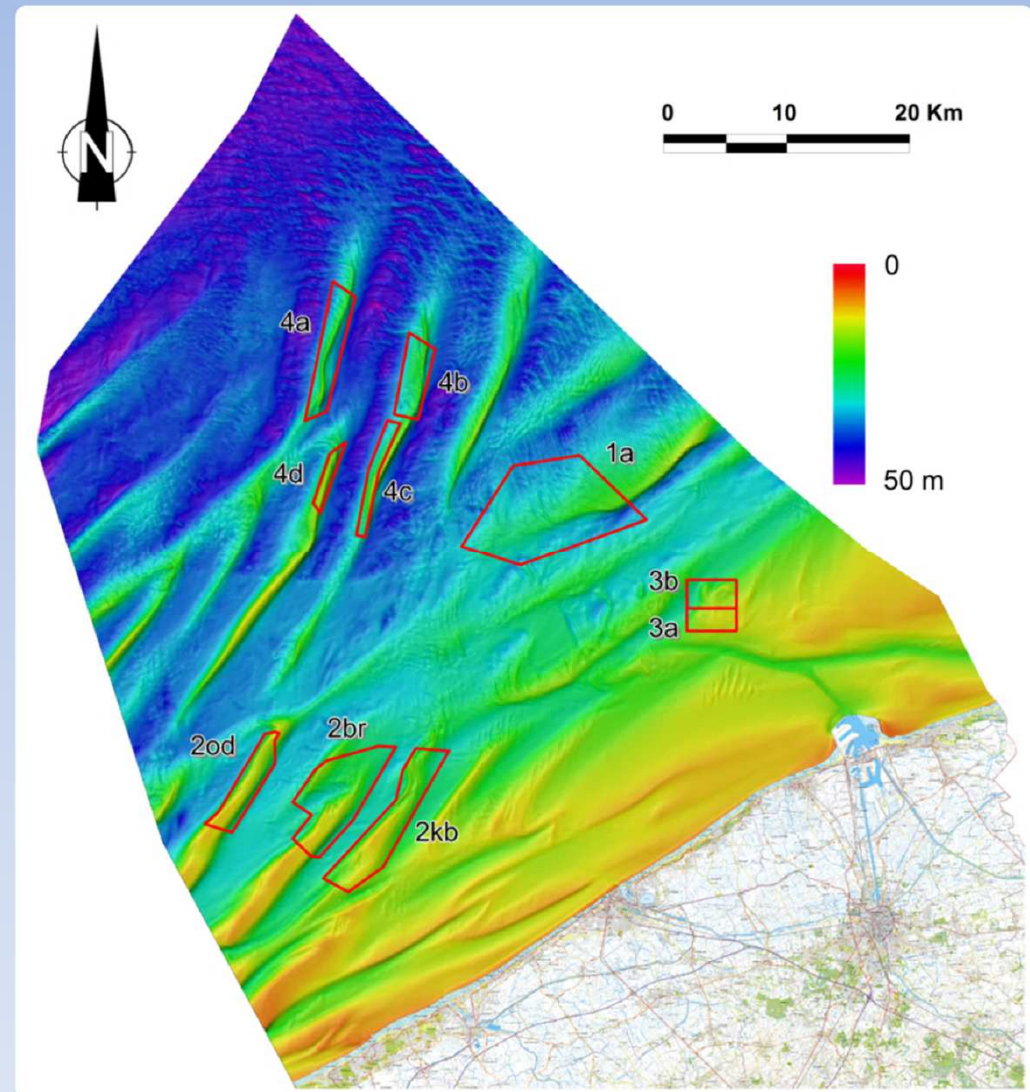
Sand extraction Belgian part of the North Sea

- Shared extraction sectors
- 10 sectors
 - $2 \cdot 10^6 \text{ m}^3 / \text{y}$ for building industry
 - $2 \cdot 10^6 \text{ m}^3 / \text{y}$ for beach replenishment

- Legislation - *Dura lex, sed lex*:

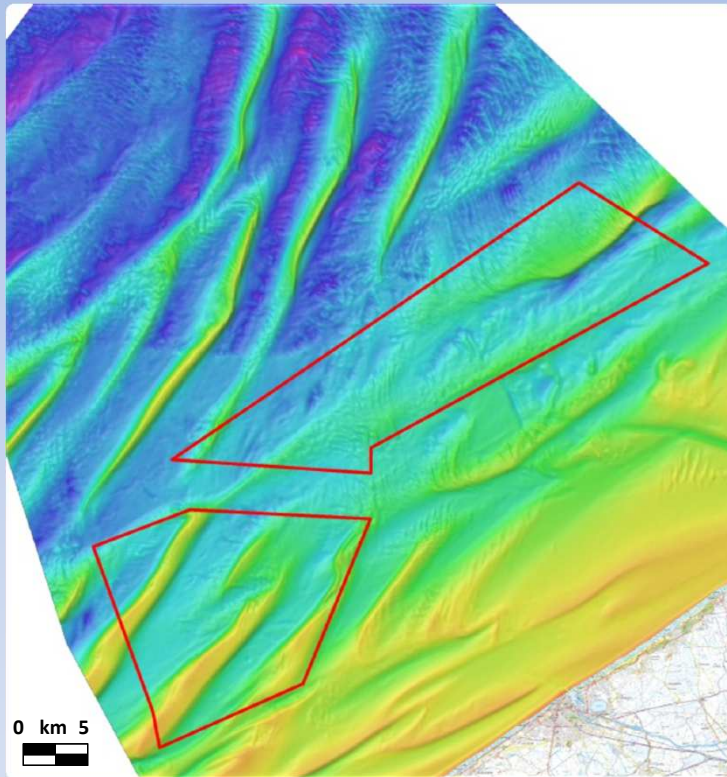


- Control:
 - Extracted volumes
 - Impact on the marine environment



Sand reserve: estimation

Extraction area
1977 to 2004



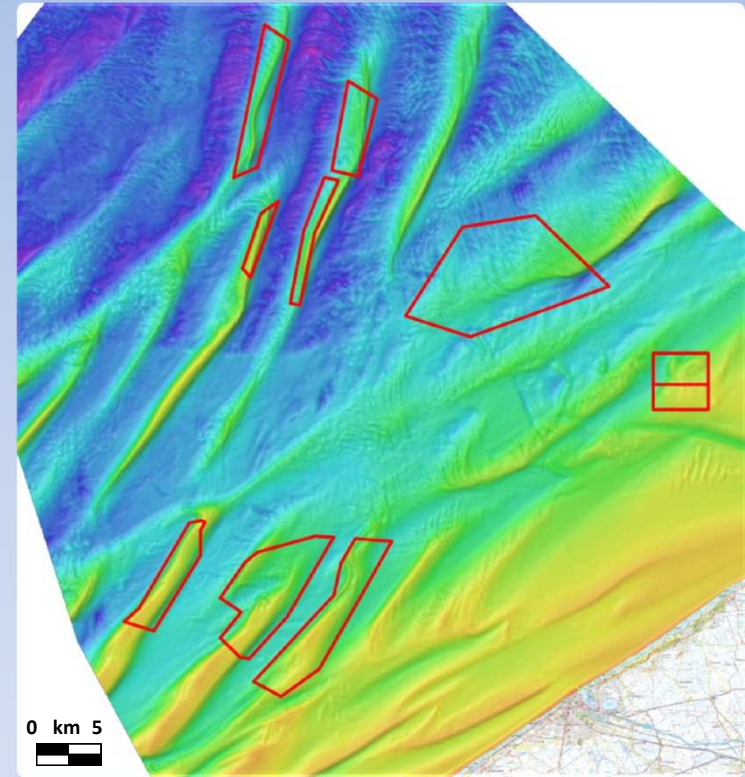
Surface inside
20 m isobath
=
Useful area

X 5m
=
Legal
vertical limit

954 10^6 m³ Useful legal reserve

655 10^6 m³

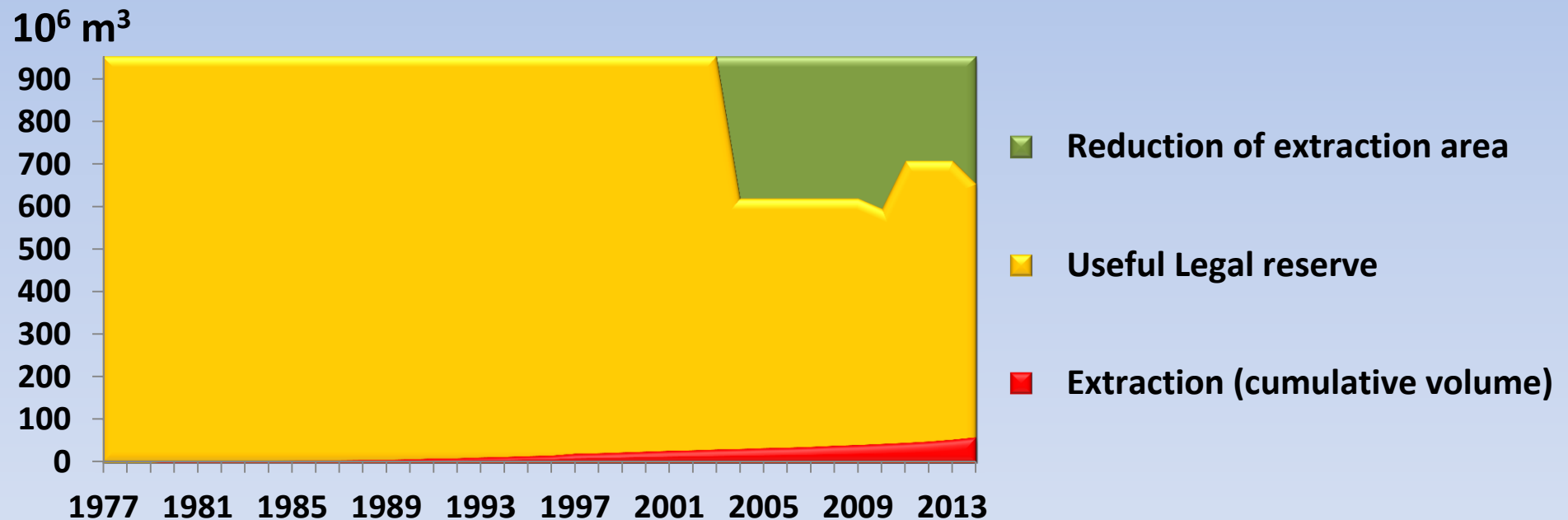
Extraction area
2014



Sand reserve: evolution

1977 to 2014 useful legal sand reserve reduction of $358 \cdot 10^6 \text{ m}^3$:

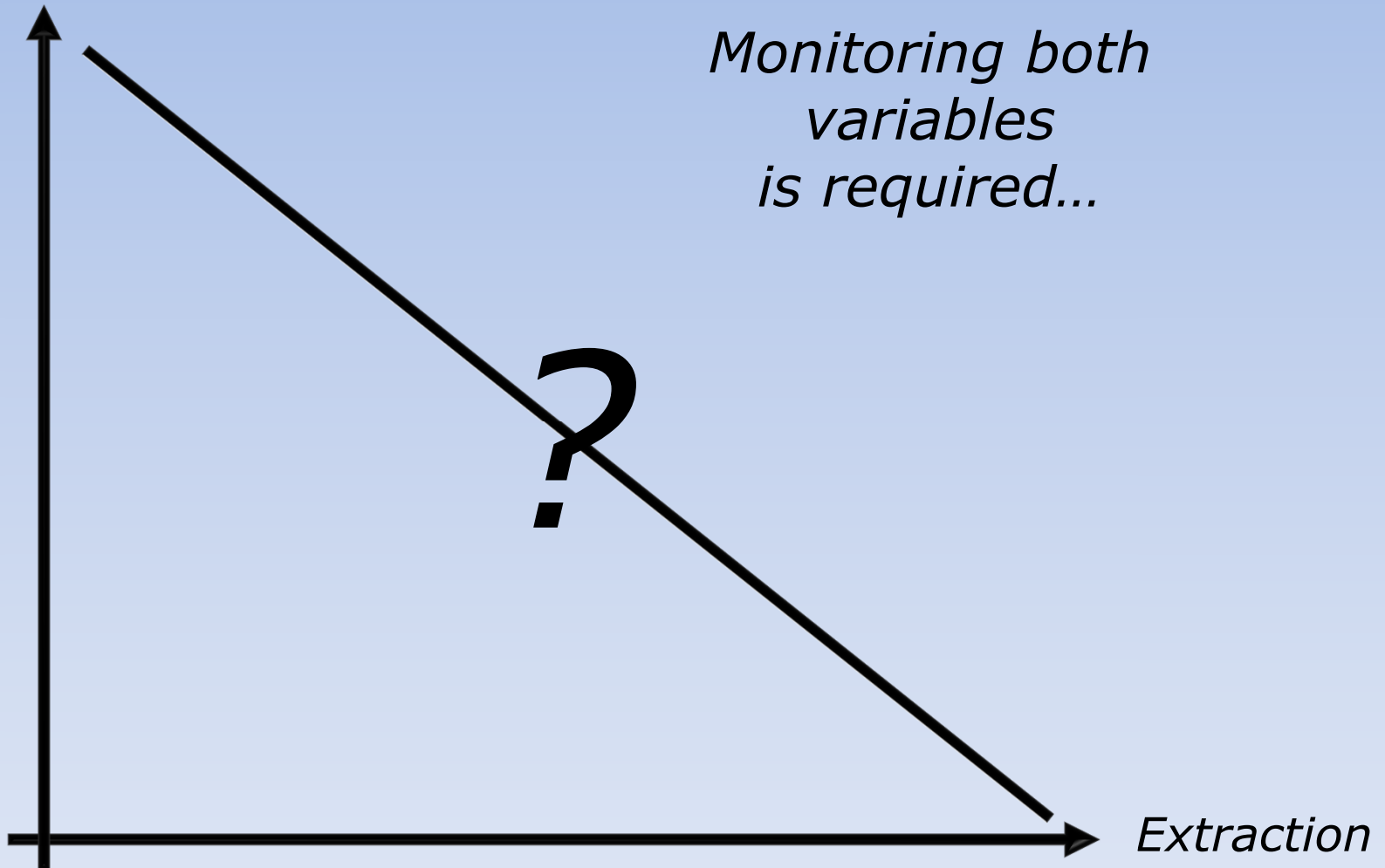
- Reduction of extraction area = $299 \cdot 10^6 \text{ m}^3 = 84 \%$
- Extraction itself = $59 \cdot 10^6 \text{ m}^3 = 16 \%$



Reserve decline is mainly due to external contingencies...

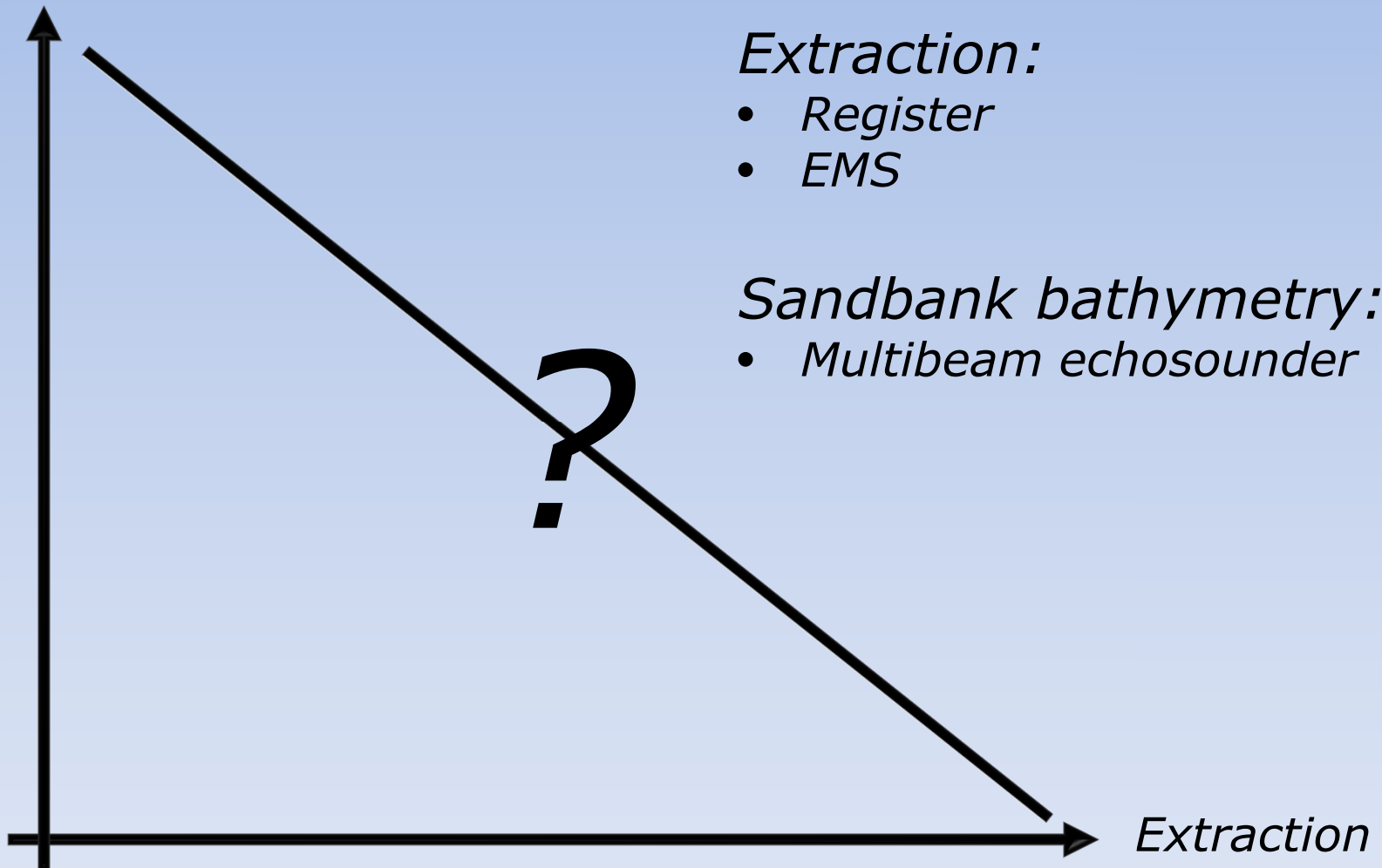
**Sand reserve evolution
Model of extraction impact**

Sandbank bathymetry



**Sand reserve evolution
Model of extraction impact ?**

Sandbank bathymetry



Seabed Monitoring = a legal obligation!

- **National regulation:**

- Law “Continental shelf” 13/06/1969



- **Supra national EU regulation:**

- EU Marine Strategy Framework Directive “MSFD” 2008/56/EEC



“... Coastal waters,
including their seabed and subsoil,
are an integral part of the marine
environment, and as such should also
be covered by this Directive...”



Monitoring the Extraction: Register

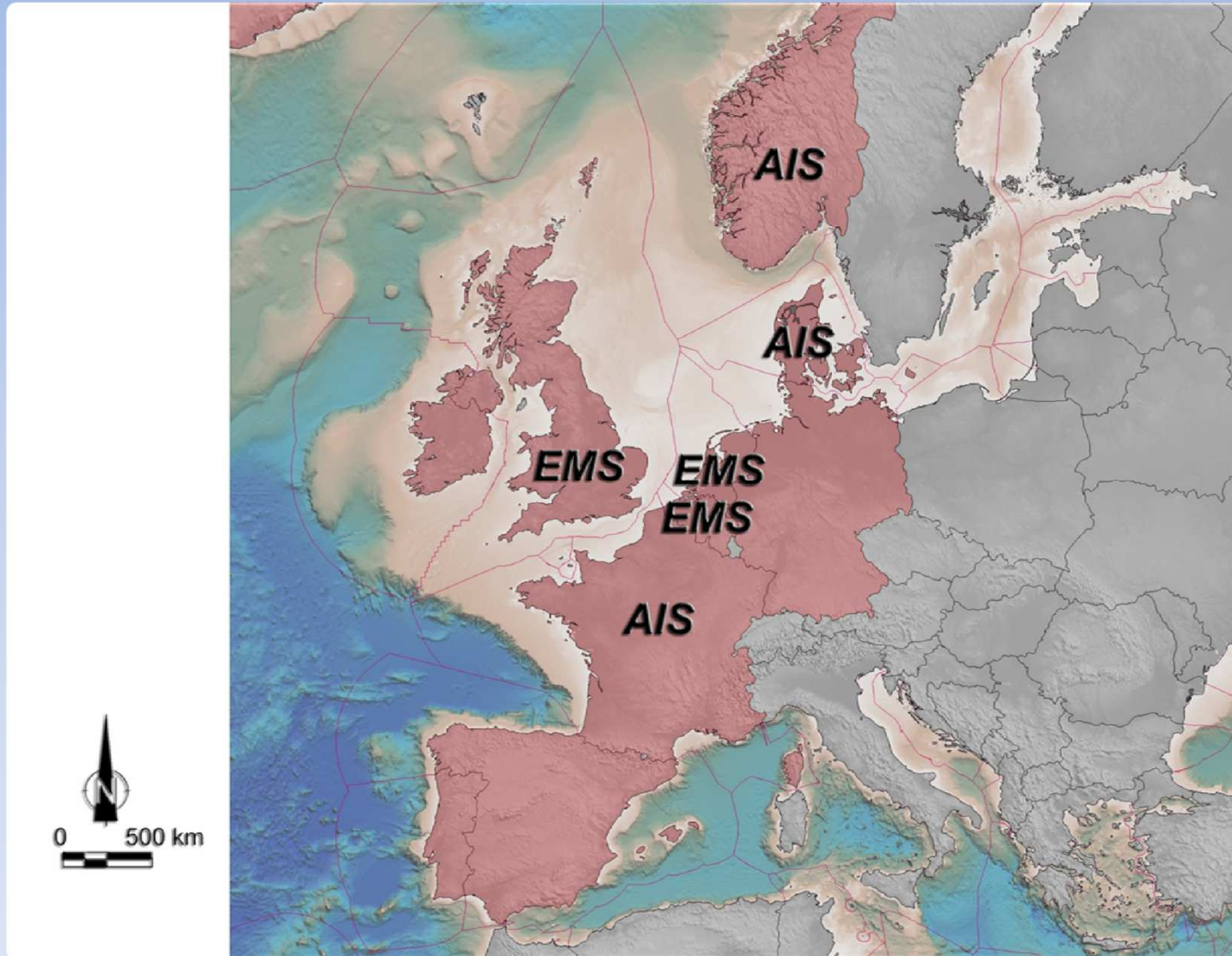
- Logbook on board
- The captain has to fill in all relevant information for each extraction

The image shows a digital form titled 'economie' (with the subtitle 'POE Economie, K.M.O., Middelenstand en Energie'). The form is divided into three main sections: 'ONTGINNINGSVAARTUIG', 'LAADGEGEVENS', and 'LOSSEGEVENS'.
1. 'ONTGINNINGSVAARTUIG' section includes a 'Volgnummer formulier:' field with a grey bar containing the text 'ONTGINNINGSVAARTUIG', followed by 'Naam vaartuig:' and 'Naam kapitein:' fields.
2. 'LAADGEGEVENS' section includes 'Datum:' (with a date picker), 'Starttijd laden:', 'Reisnummer black box:', 'Concessiecode: CP', and a 'Laadplaats:' section with seven checkboxes: Kwintebank, Oosthinder, Thorntonbank, Buiten Ratel, Westhinder, Sierra Ventana, Oostdyck, and Noordhinder.
3. 'LOSSEGEVENS' section includes 'Losplaats:', 'Geloste hoeveelheid (m³):', and 'Handtekening van de kapitein'.

- Dredging vessel
 - Vessel name
 - Master name
- Loading data
 - Date - Start time
 - EMS trip number
 - Concession code
 - Loading place - sandbank
- Unloading data
 - Location
 - Volume (m³)
- Master's signature

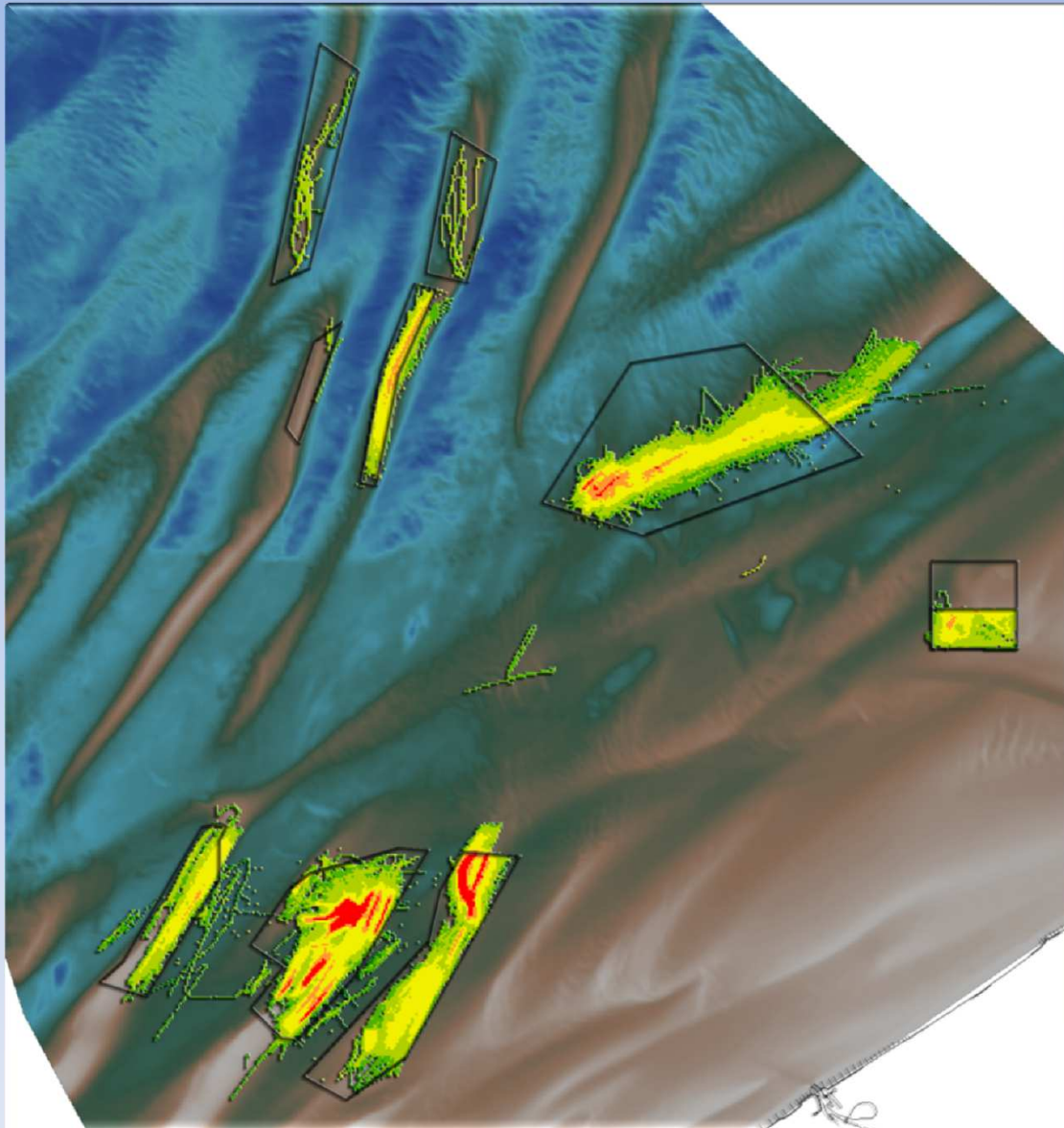
- Fees related to extracted volume are based on the register!

Monitoring the Extraction Method of control in different EU countries



Source:
ICES WGEXT
Reports 2010 to 2014
Various communications

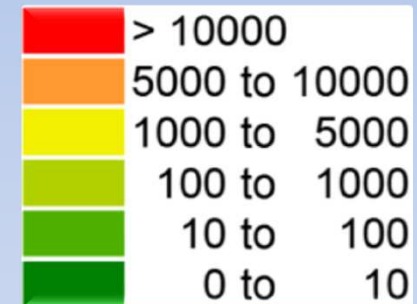
Volume calculation using EMS data



Volume calculation for any area and time interval

2003-2013

Extracted volume m³ / ha



Assumptions:

- Fixed loading capacity / ship
- Start dredging: ship empty
- End dredging: ship fully loaded

Multibeam echosounder (MBES) = Most effective tool for monitoring the sandbank bathymetry

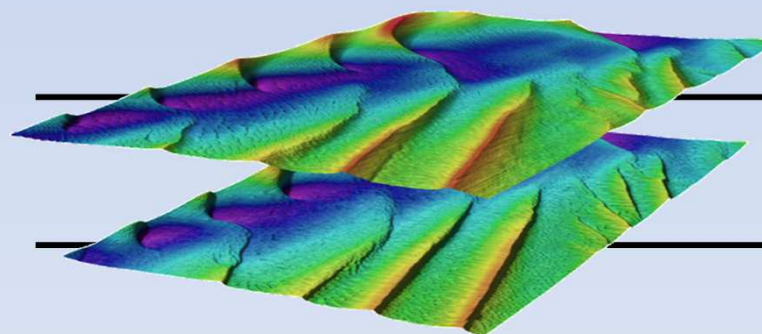
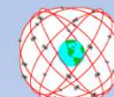
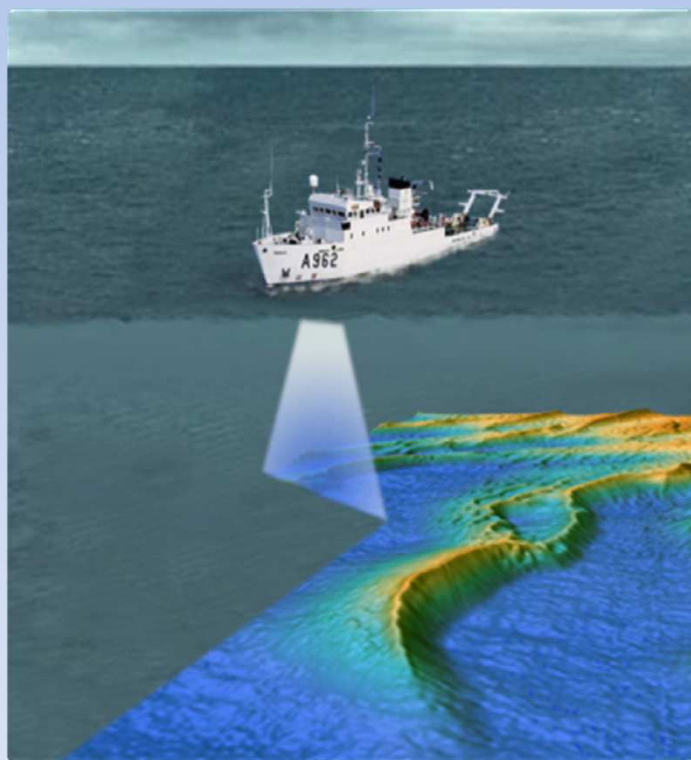
1984
RV Belgica



Singlebeam

1999
EM1002 MBES
100 kHz

2008
EM3002 dual MBES
300 kHz



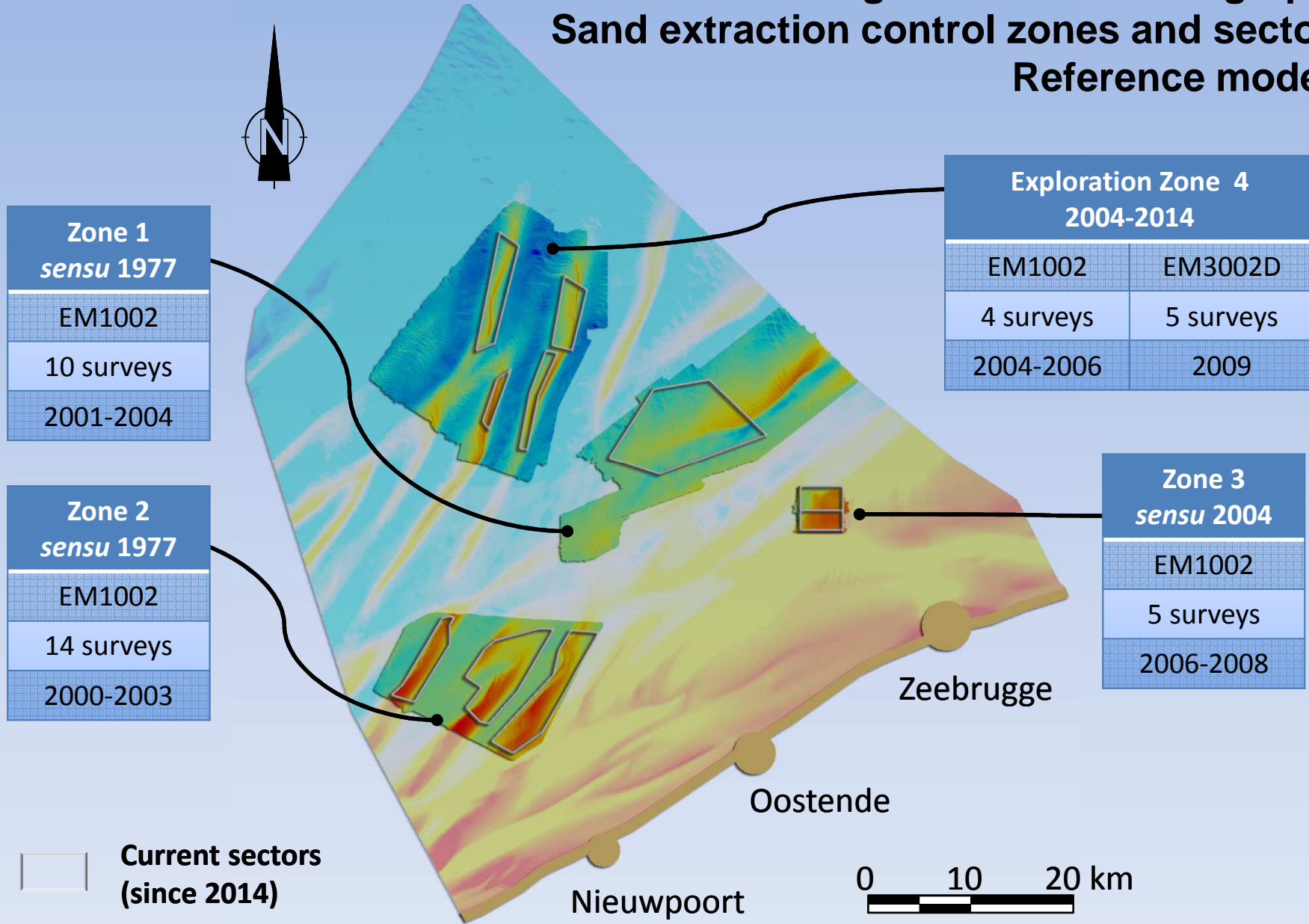
Time 2



Time 1

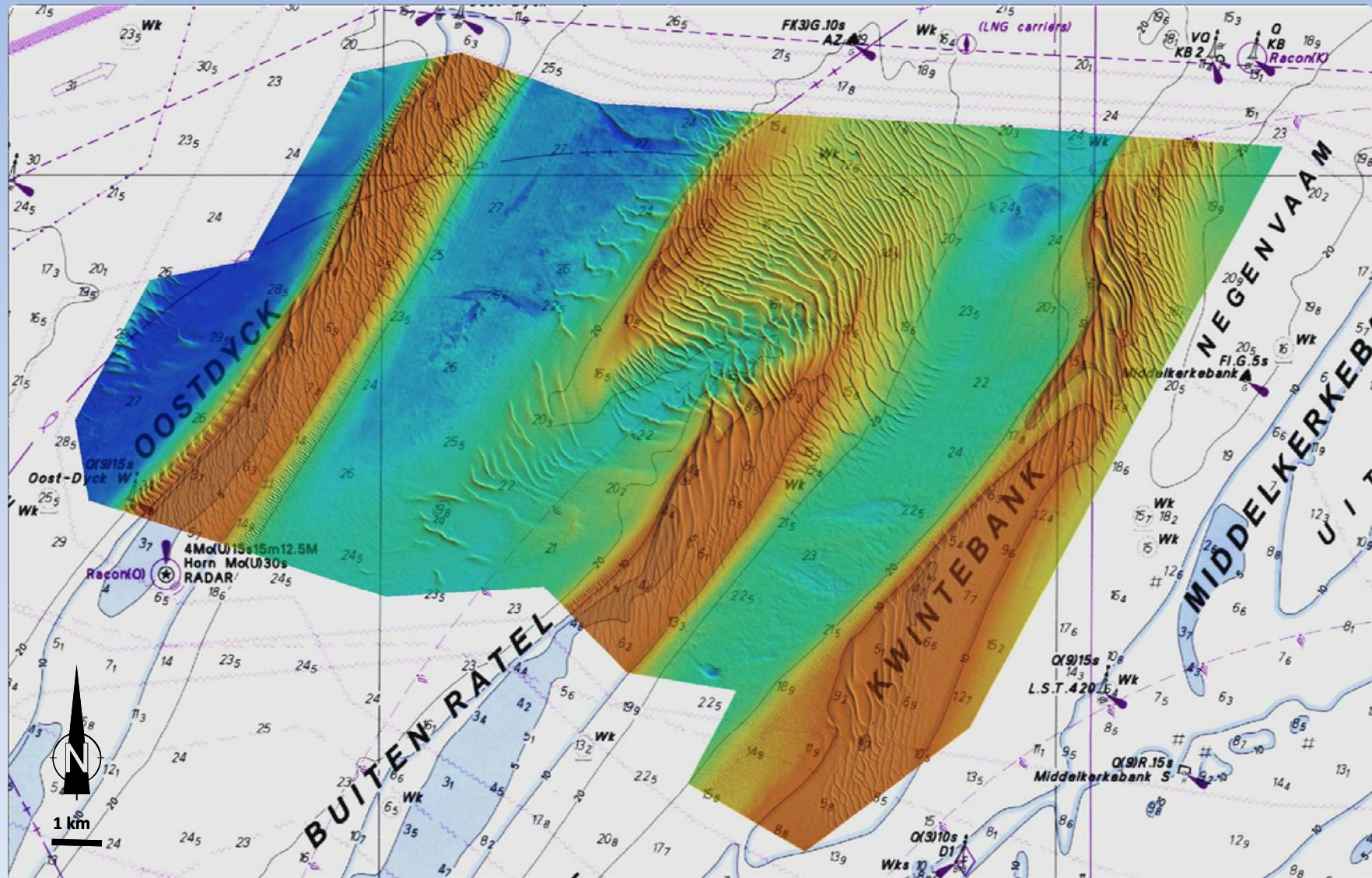
Regular Quality control → IHO S44 Special Order accuracy (= 30 cm / 20 m)

MBES High resolution cartography Sand extraction control zones and sectors Reference models



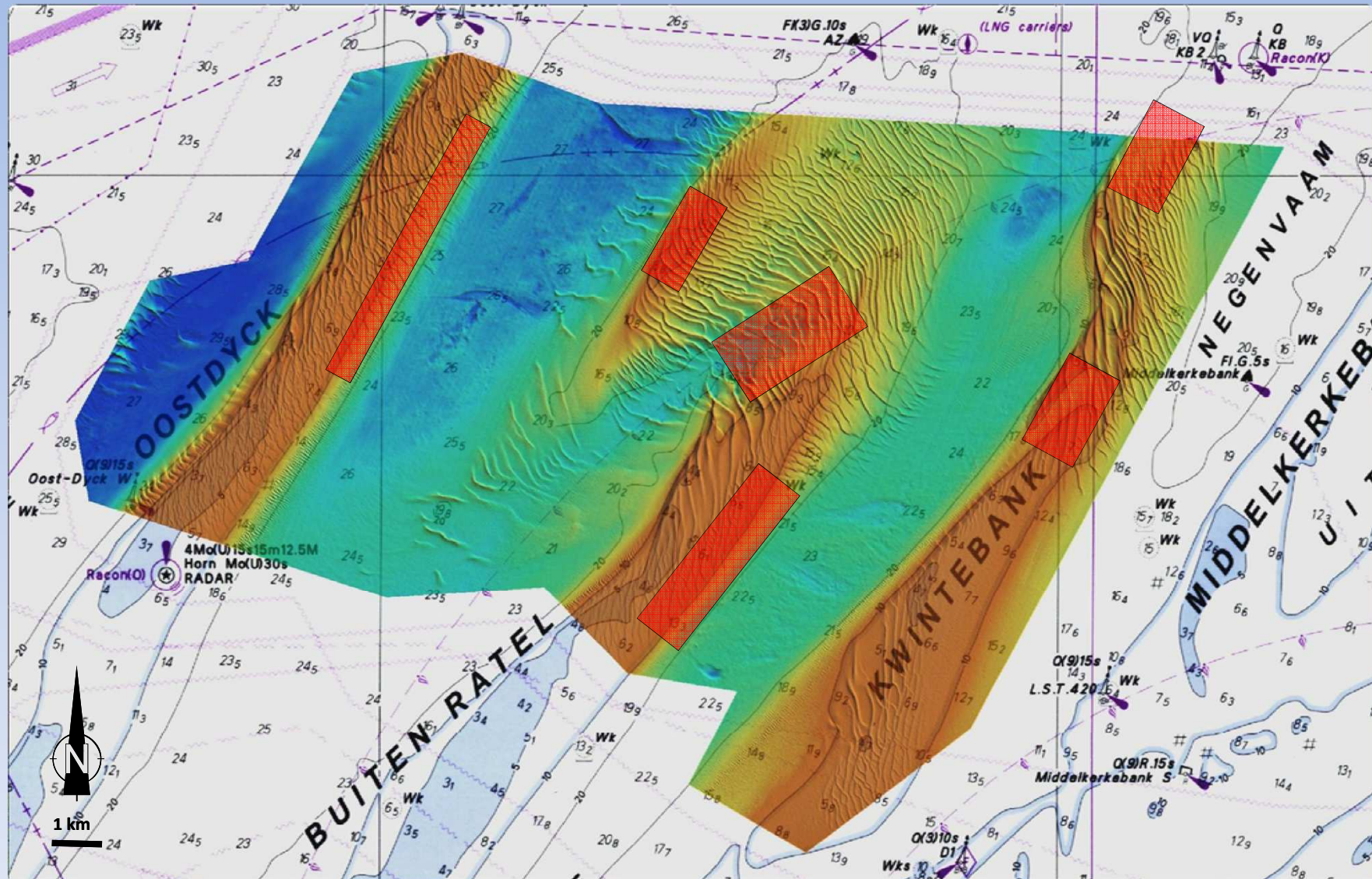
Monitoring the sandbanks with MBES Reference surface

Zone 2 Reference surface (time 0 = 2000-2003)



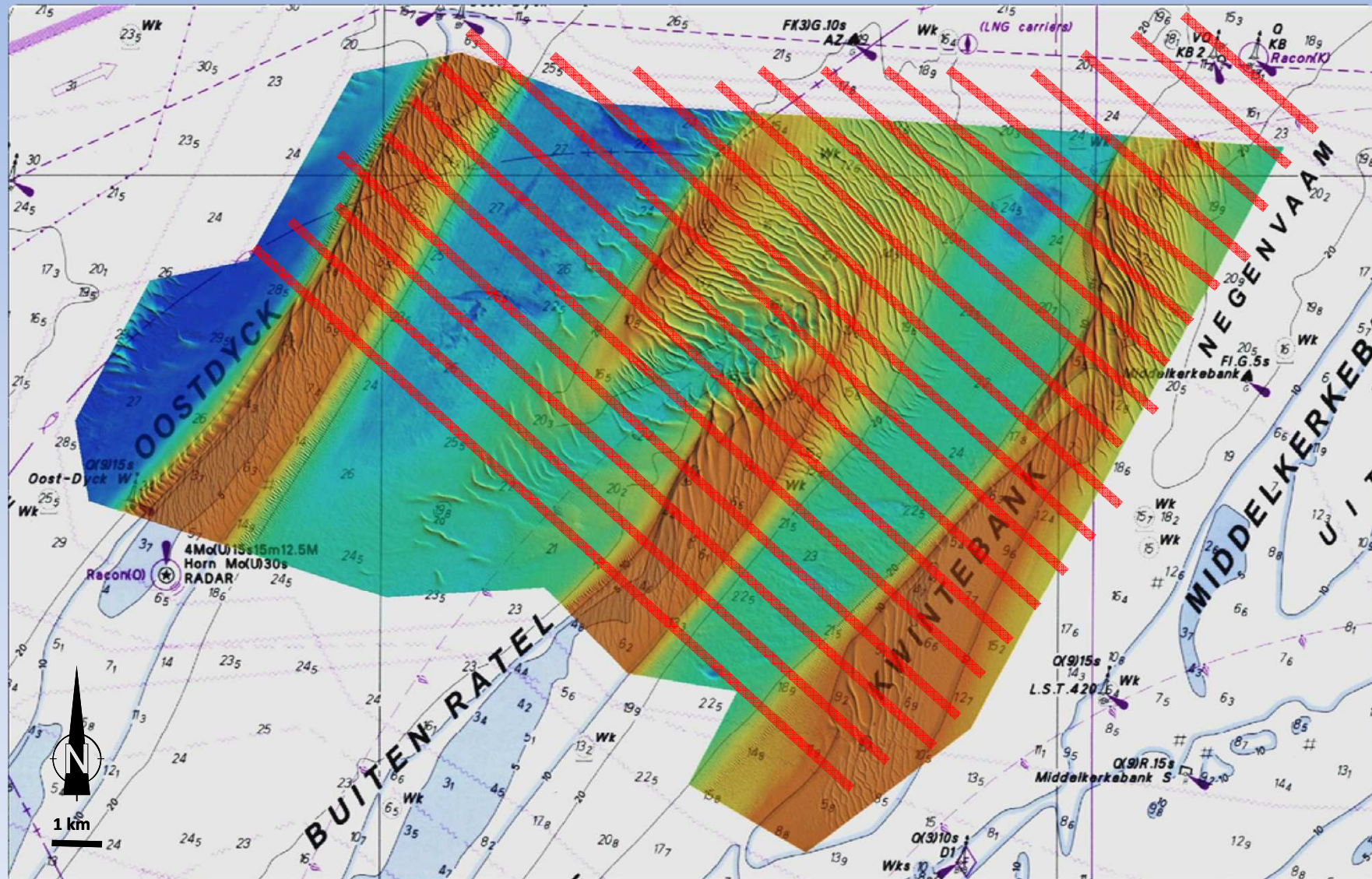
Monitoring areas

- On highly dredged areas:
- High resolution and full coverage
 - Local and time consuming



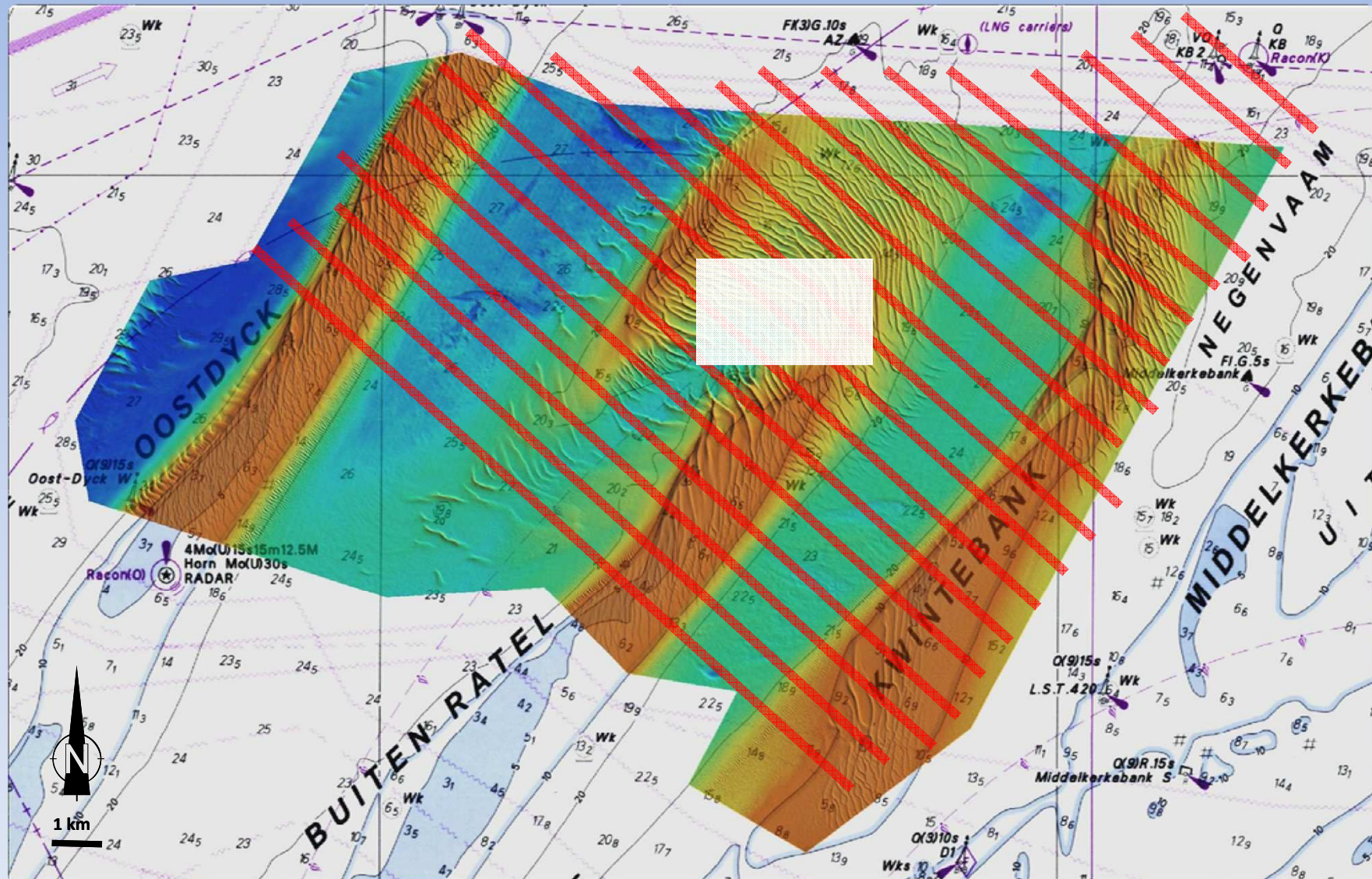
Monitoring along “DECCA” lines:

- *Fast*
- *Global but fragmented*



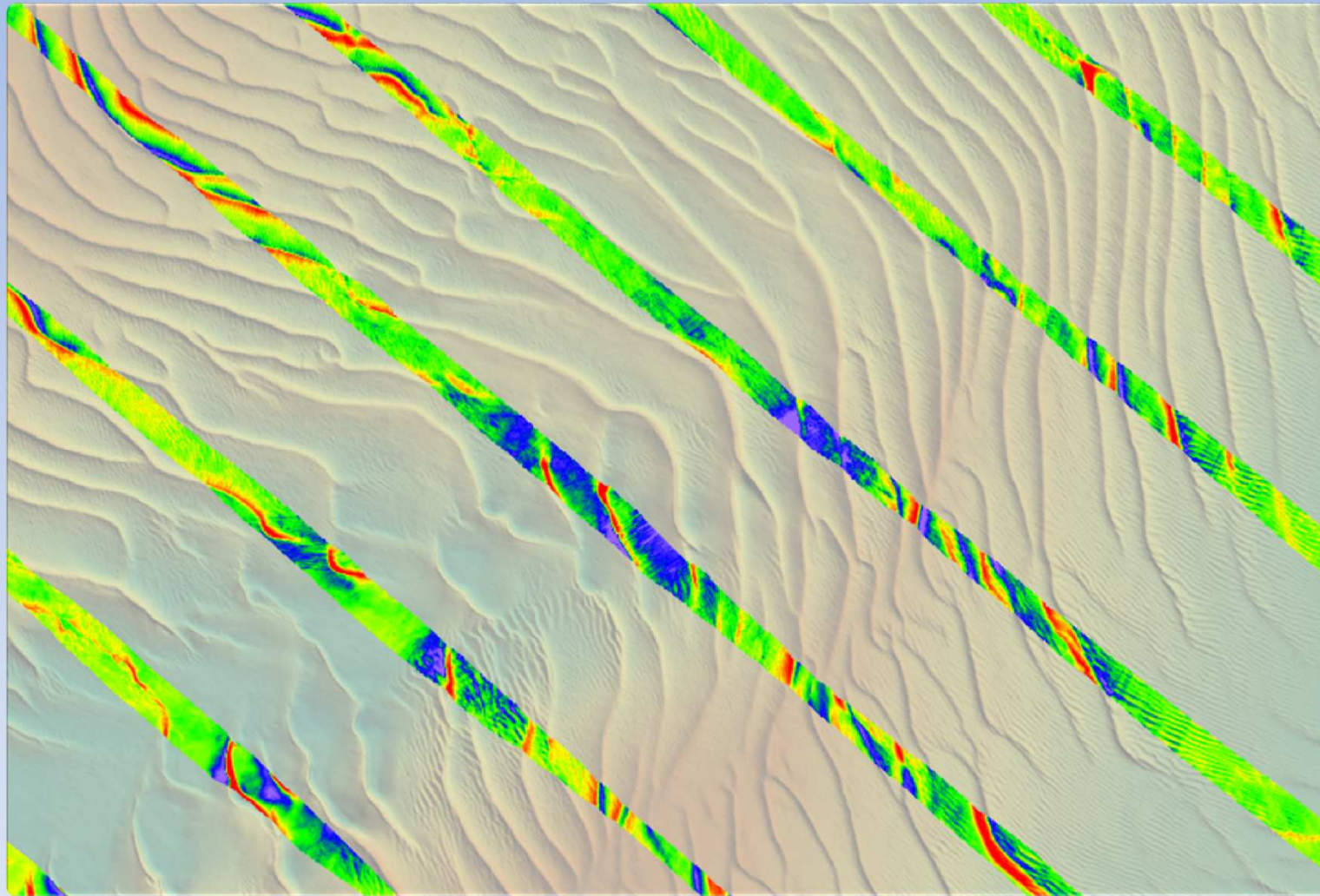
Monitoring along “DECCA” lines:

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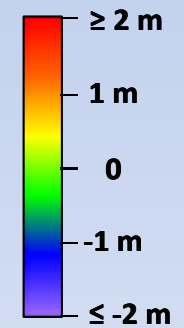


Monitoring along “DECCA” lines:

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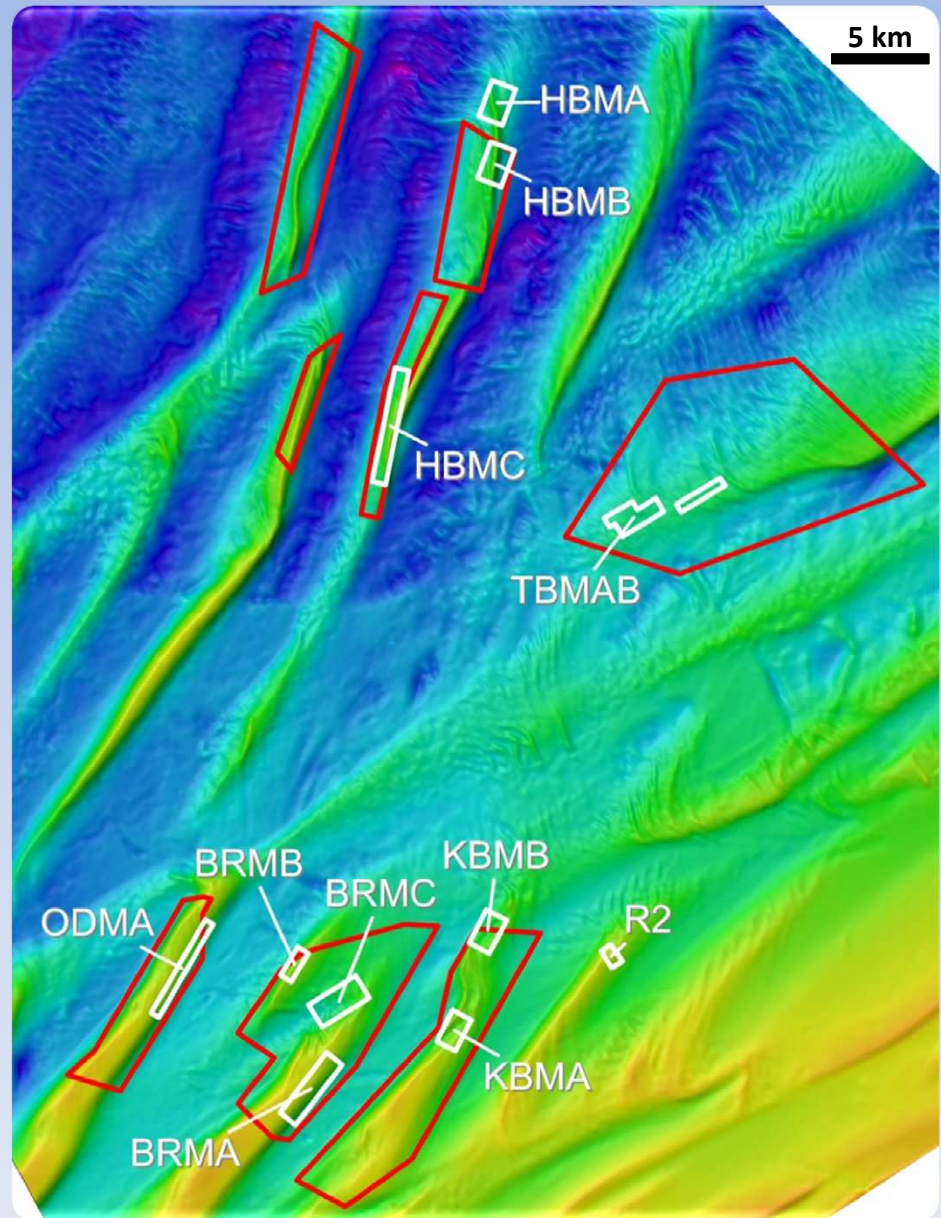
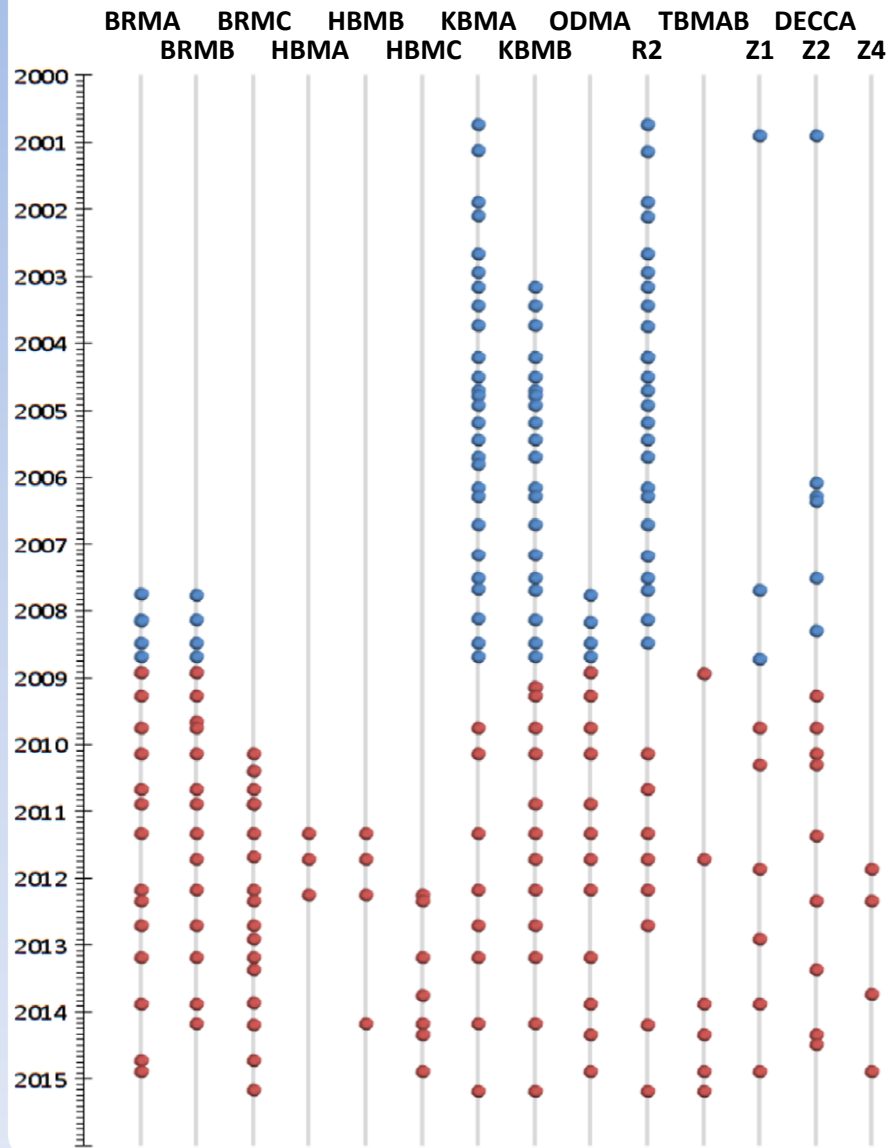


Δ
Bathymetry
“DECCA” lines –
reference model



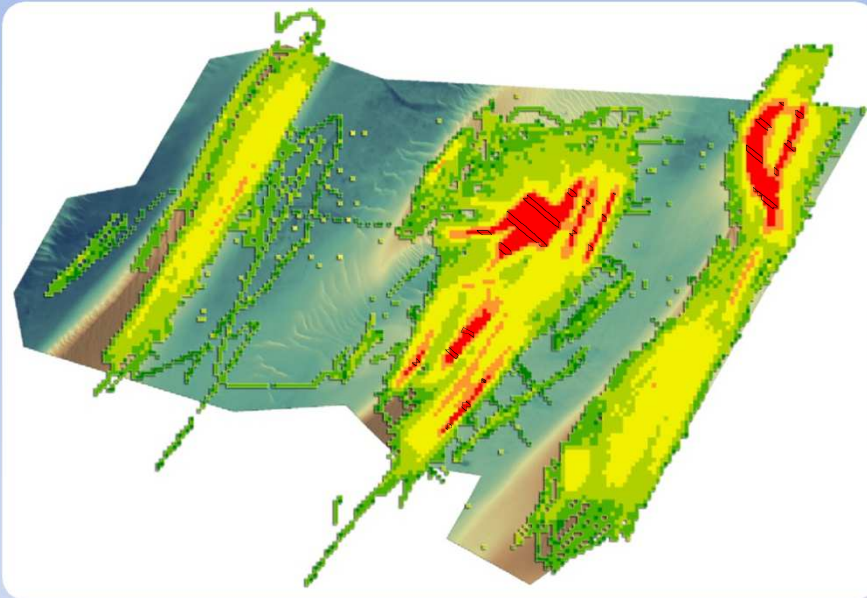
Monitoring areas and DECCA MBES Time Series

● EM1002 ● EM3002D

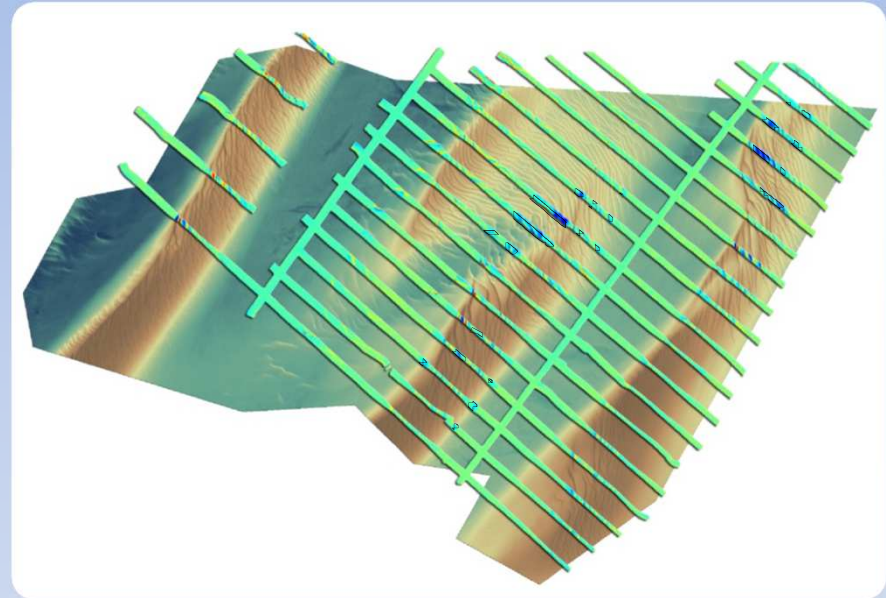


Correlation EMS volumes *versus* MBES data

Extracted volume (m^3/ha)
from the EMS data



MBES data Δ Bathymetry (m)
DECCA - reference model 2003

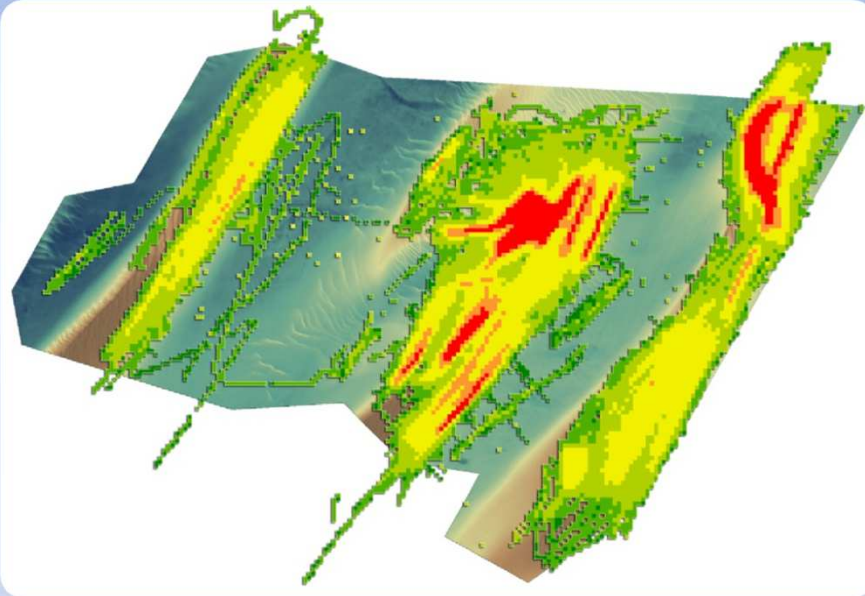


Crossing data from same time interval and area:

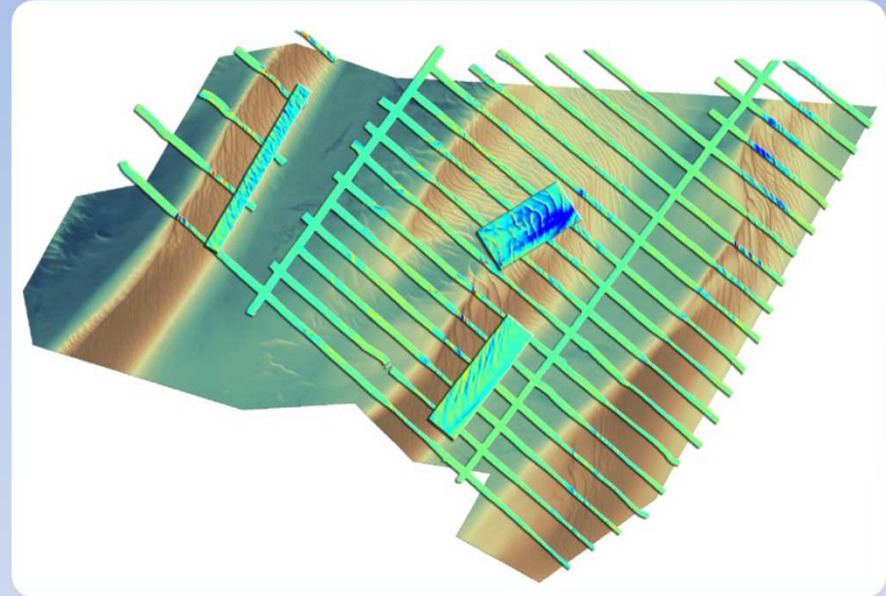
FOR DECCA DATA: EMS VOLUME INTERVALS ($10^3 \text{ m}^3/\text{ha}$)	MEAN BATHYMETRIC DIFFERENCE DEDUCED FROM EMS	MEAN BATHYMETRIC DIFFERENCE BASED ON MBES MEASUREMENTS
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Correlation EMS volumes *versus* MBES data

Extracted volume (m^3/ha)
from the EMS data



MBES data Δ Bathymetry (m)
DECCA - ref model 2003
MONITORING area - ref model 2003

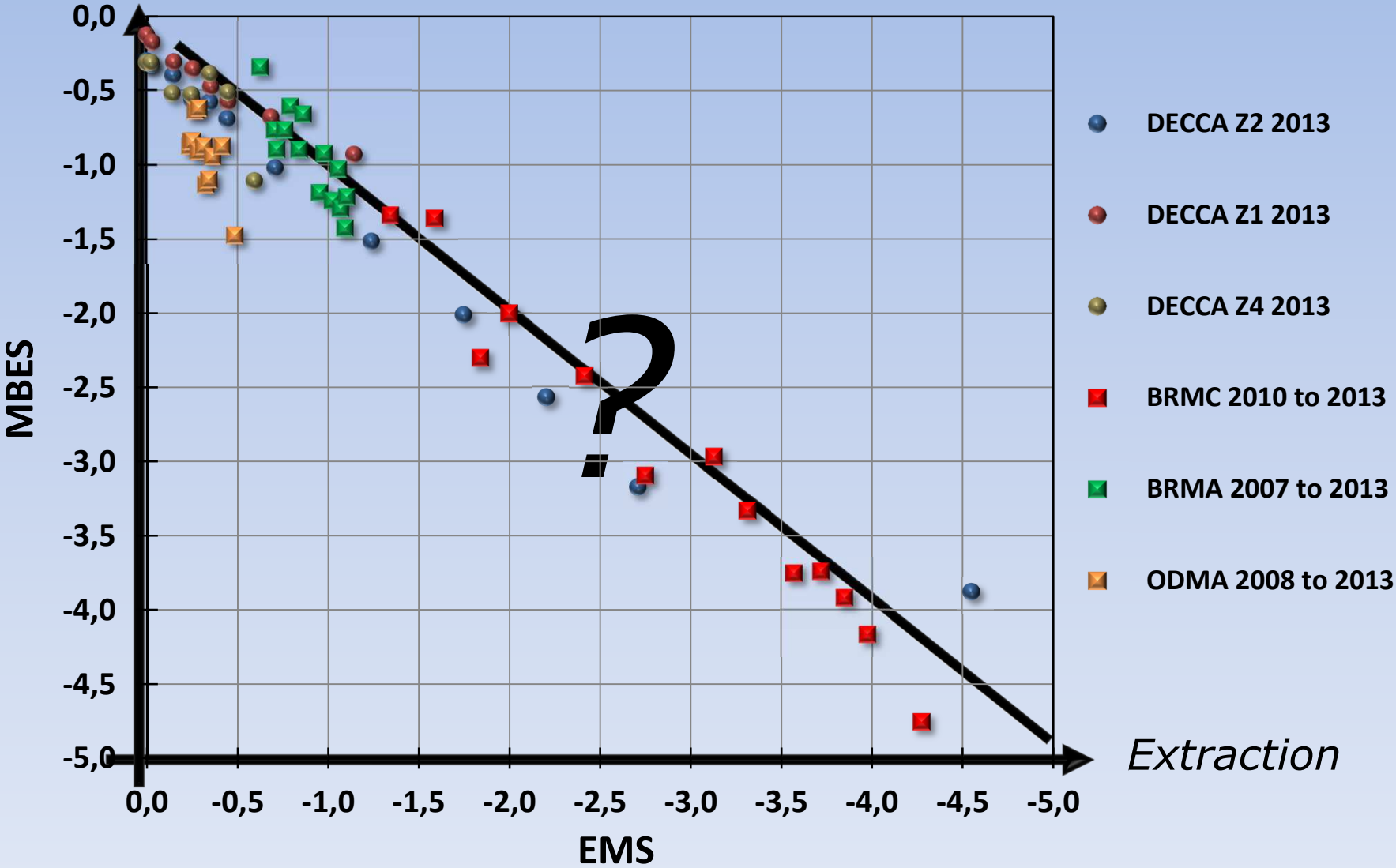


Crossing data from same time interval and area:

FOR DECCA DATA: EMS VOLUME INTERVALS ($10^3 \text{ m}^3/\text{ha}$)	MEAN BATHYMETRIC DIFFERENCE DEDUCED FROM EMS	MEAN BATHYMETRIC DIFFERENCE BASED ON MBES MEASUREMENTS
FOR MONITORING AREA DATA: ALL SURVEY AREA	MEAN BATHYMETRIC DIFFERENCE DEDUCED FROM EMS	MEAN BATHYMETRIC DIFFERENCE BASED ON MBES MEASUREMENTS

Sand reserve evolution Model of extraction impact ?

Sandbank bathymetry



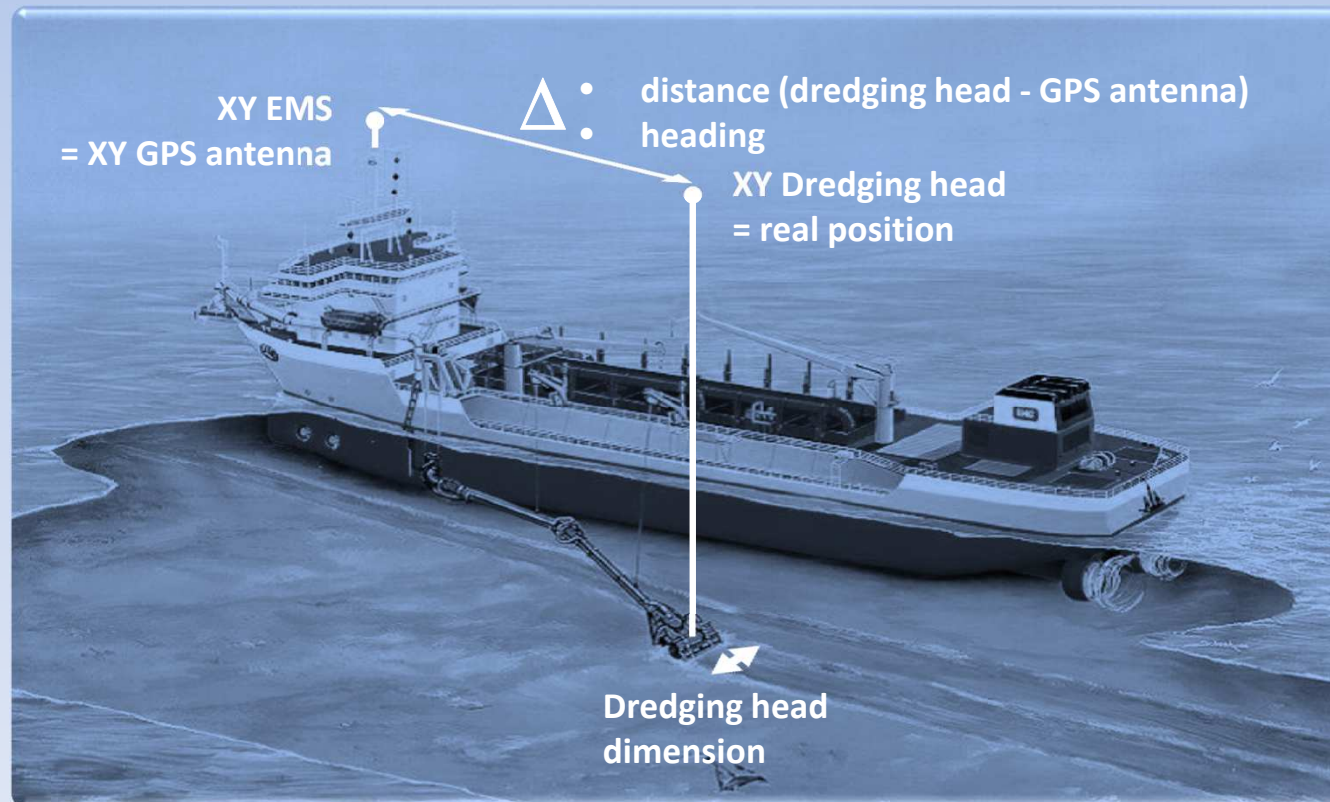
Sand reserve evolution
Final model of extraction impact



Sand reserve evolution and impact of extraction Model validation

By mean approach certainly valid and significant! But mandatory to:

1. Analyze the spatial variability
2. Investigate seabed evolution around the exploited areas
3. Quantify errors on EMS data and improve EMS positioning

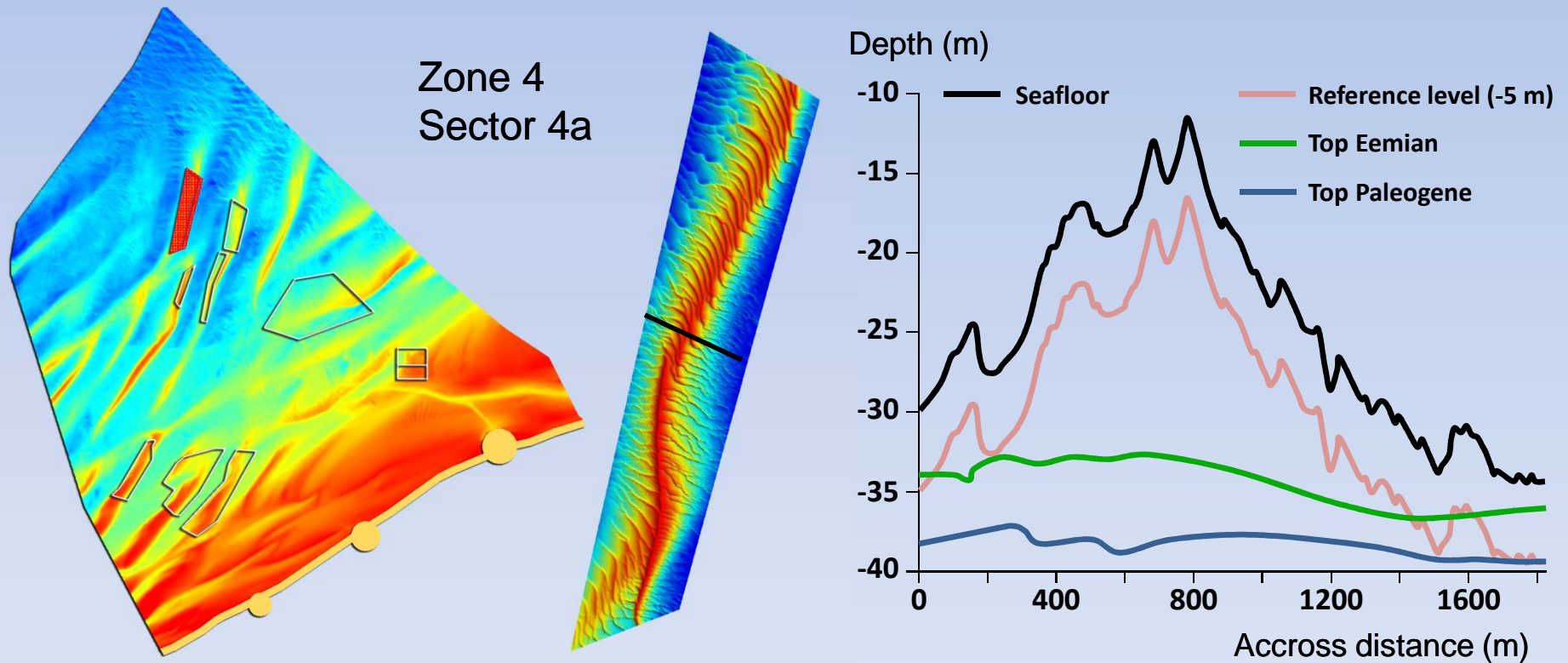


Sand reserve evolution and impact of extraction

Optimal reference surface for sand extraction in the BPNS

Ongoing Project (start in 2013, final phase expected in 2016):

- Reference surface based on geological-seismic surfaces + samples
- Combine optimal exploitation and preservation of the sandbanks



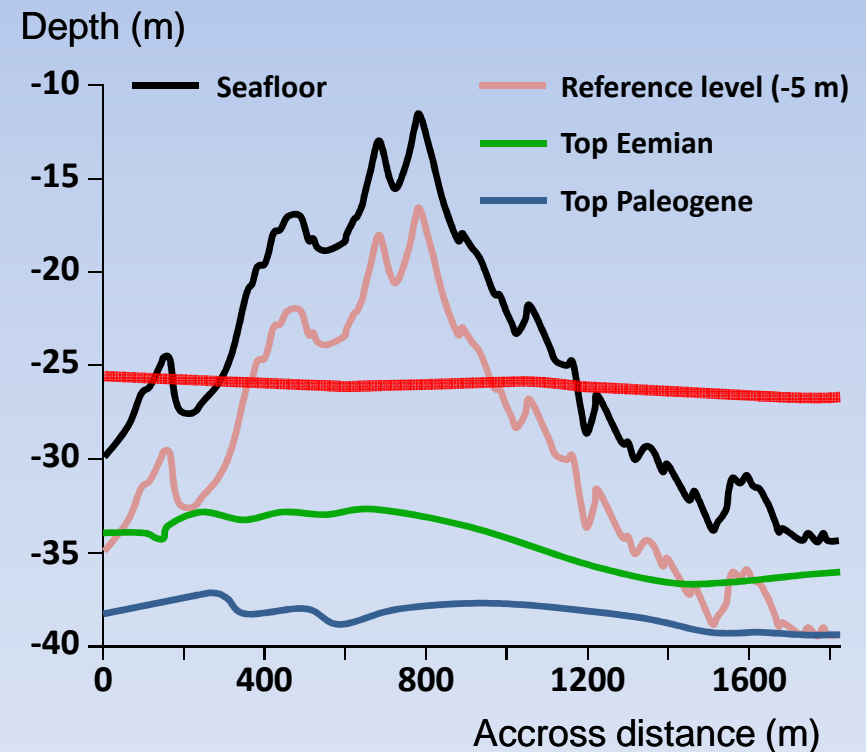
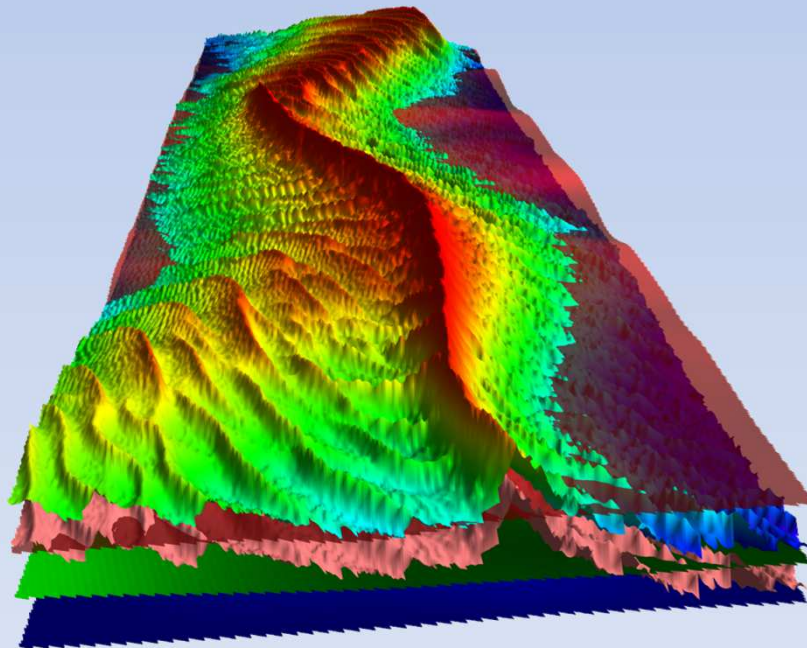
Sand reserve evolution and impact of extraction

Optimal reference surface for sand extraction in the BPNS

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- Combine optimal exploitation and preservation of the sandbanks

New reference surface 



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for your attention!*



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