Sustainable Management of the North Sea

*from a **Marebasse** perspective*
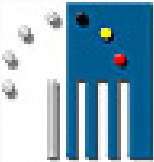
Vera Van Lancker

Renard Centre of Marine Geology (RCMG)

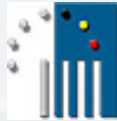**Ghent University (Belgium)**

UNIVERSITEIT GENT

RCMG

Belgian
Science Policy

Management, research and budgeting of aggregates in shelf-seas related to end-users:

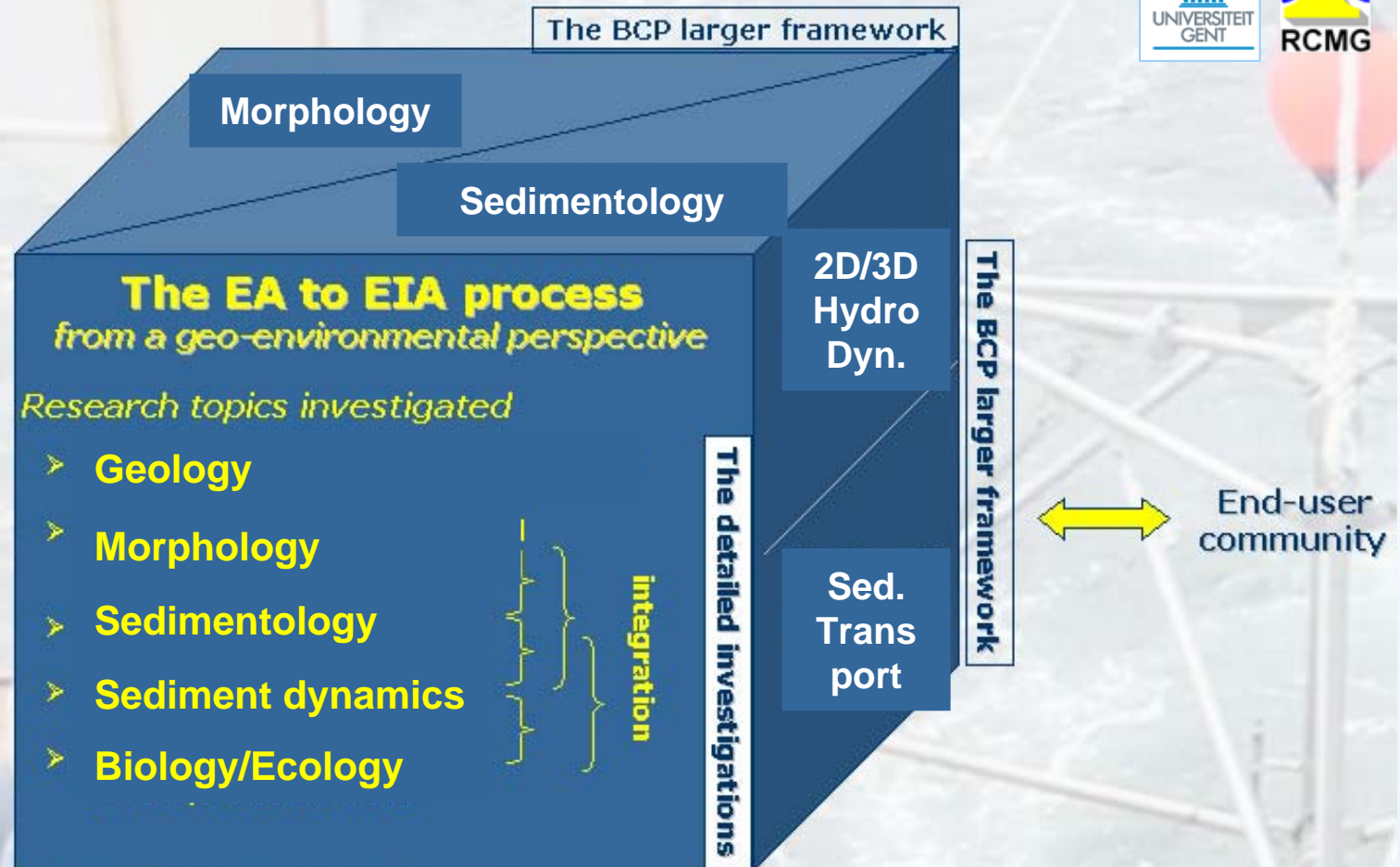**http://users.ugent.be/~vvlancke/Marebasse/**

MAREBASSE

Surficial sedimentology – D50

KED: median grain size (mu)
- 0 - 100
- 100 - 200
- 200 - 250 } Fine sand
- 250 - 300
- 300 - 350
- 350 - 400 } Medium sand
- 400 - 500
- 500 - 600 } Coarse sand

Northing (m)
Easting (m)

0 3 6 12 Km
UTM31N - WGS84 coordinates
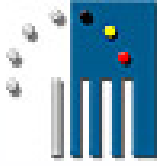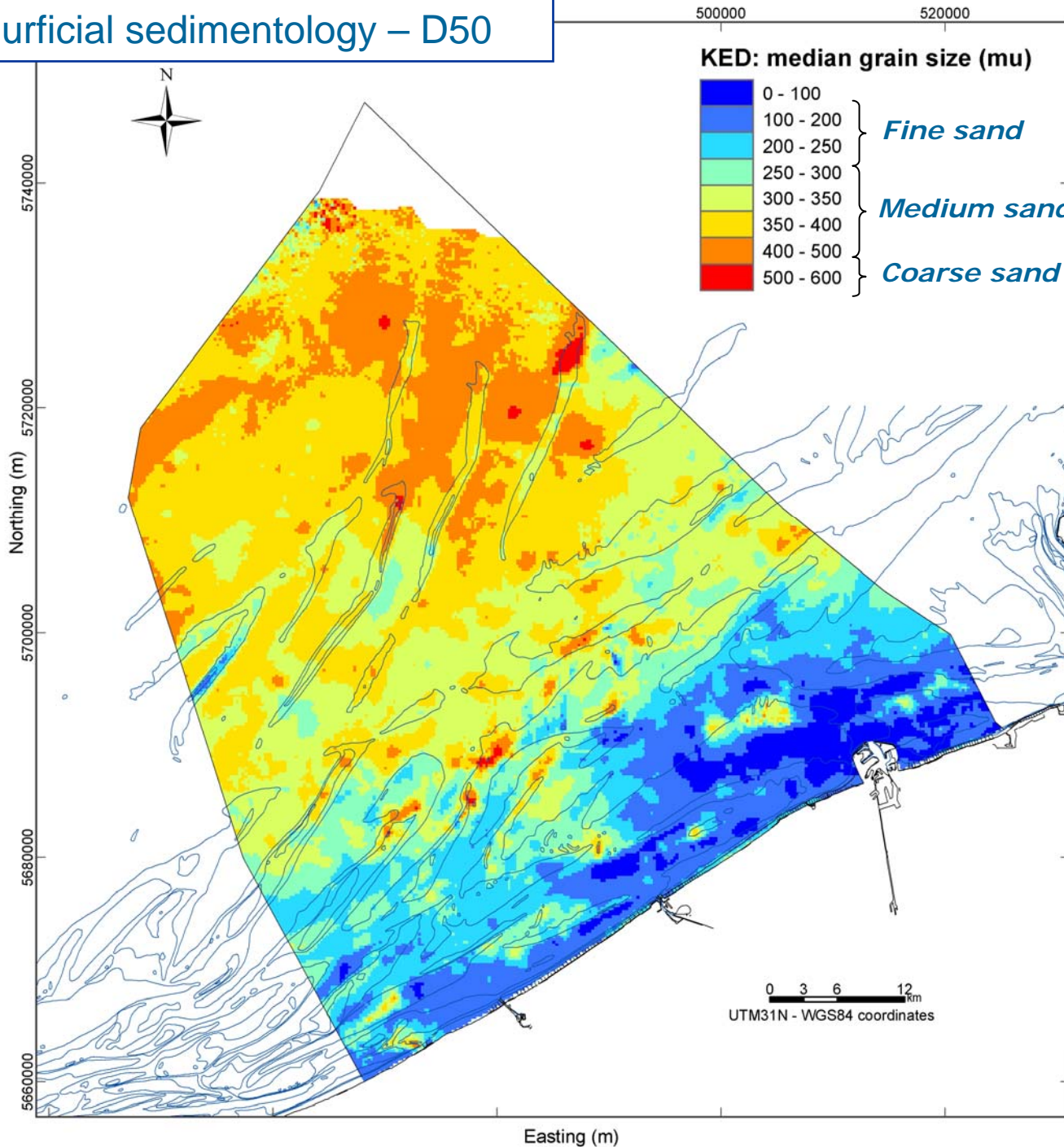
Belgian Science Policy

Large-scale
 # project contexts

GIS
Thematic maps
(250 m grid resolution)

related to:
Geology
Bathymetry
Morphology
Sedimentology
Sediment dynamics
→ hydrodynamics,
→sediment transport

**Reference framework
and used for
input to other projects**

Legend
Bathymetry (m)
- 46
- 0

Windmill parks
Sand extraction
Dredged zones
Dredge disposal

Easting (m)

Northing (m)

440000 460000 480000 500000 520000

5740000
5720000
5700000
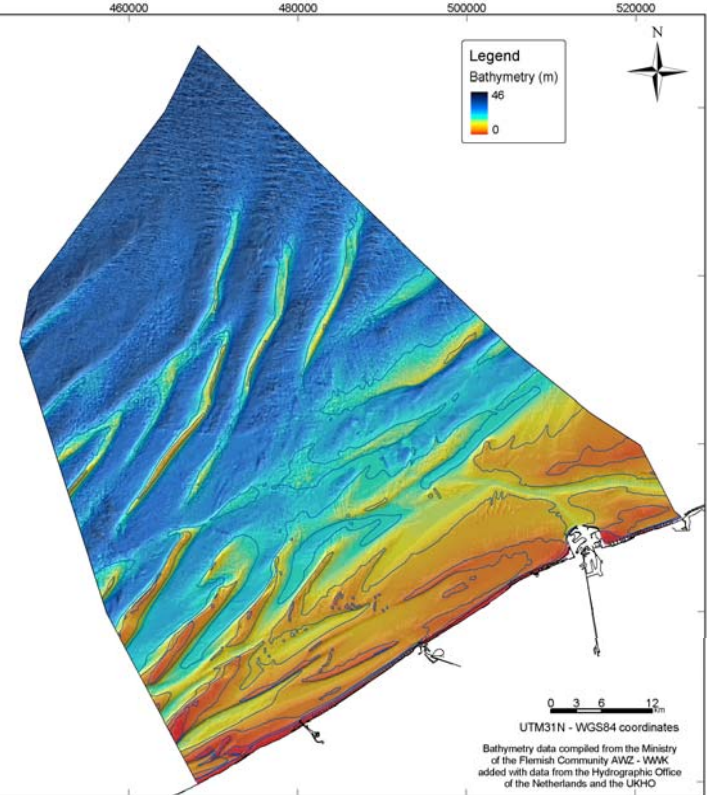5680000

1
2
3
4

km
0   5   10   20

UTM31N - WGS84 coordinates

UTM31N - WGS84 coordinates
Bathymetry data compiled from the Ministry
of the Flemish Community AWZ - WWK
added with data from the Hydrographic Office
of the Netherlands and the UKHO

0   3   6   12

Detailed scale mapping

can serve as baseline studies

Kwinte Bank central depression

Northern depression

Central depression

northing (m)

Belgian Science Policy

EU-FP5

EUMARSAND

EUROPEAN SAND AND GRAVEL RESOURCES:
EVALUATION AND ENVIRONMENTAL IMPACT OF EXTRACTION

Legend:
— Bathymetry

□ Multibeam boxes

□ Side scan sonar and multibeam box

♦ Boxcores

+ Van Veen grabs

KWINTE SWALE

central depression

NEGENVAAM SWALE

KWINTEBANK

MIDDELKERKE BANK

UTM 31
WGS84

0   500   Meters

<< **Geology**
  - Seismic investigations:

-4 phases in the sedimentary up-building of the sandbank

-dredging up to the base of the upper sedimentary deposit

<< **Morphology and its evolution**   -stabilisation of the depression after the cessation of extraction
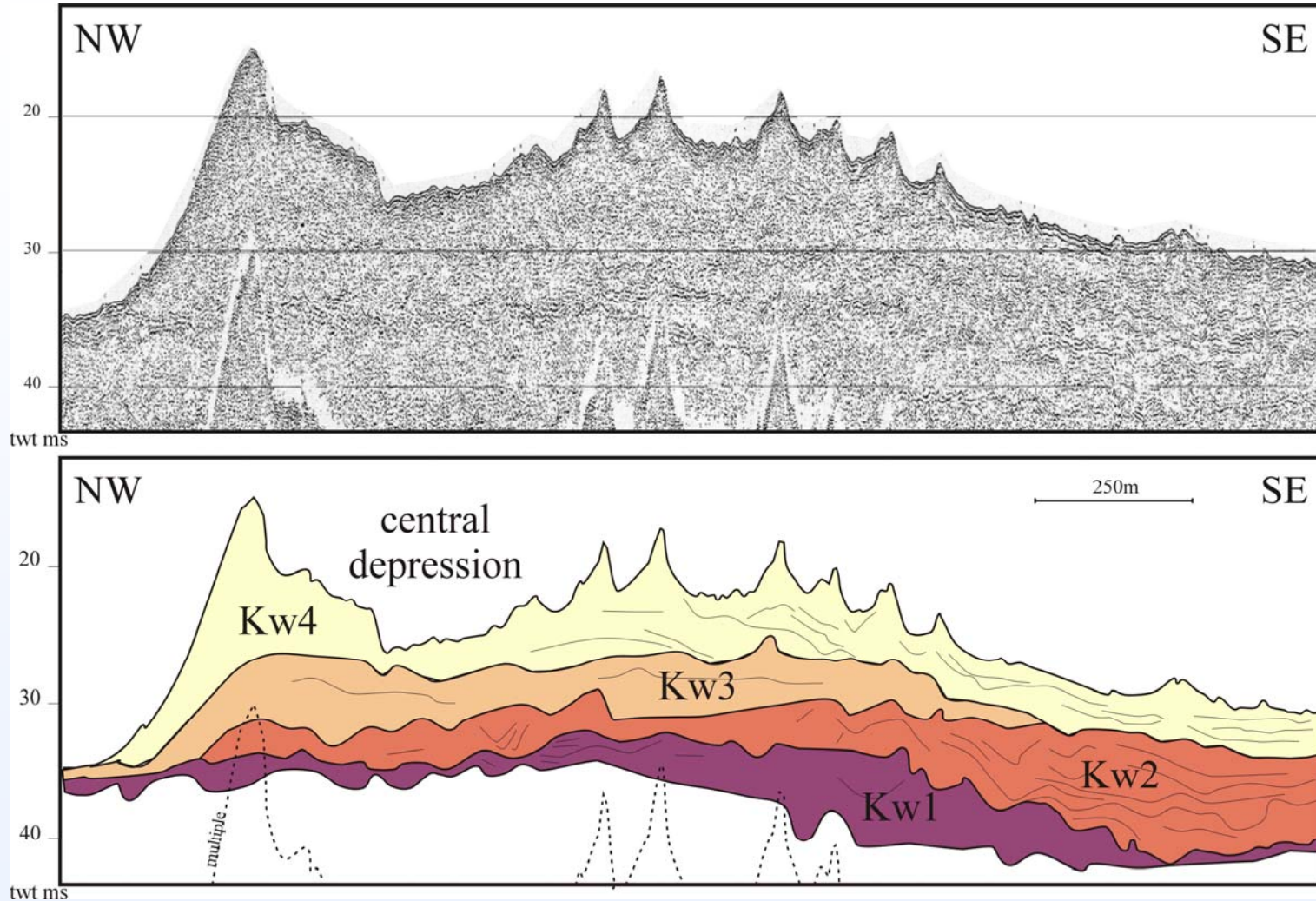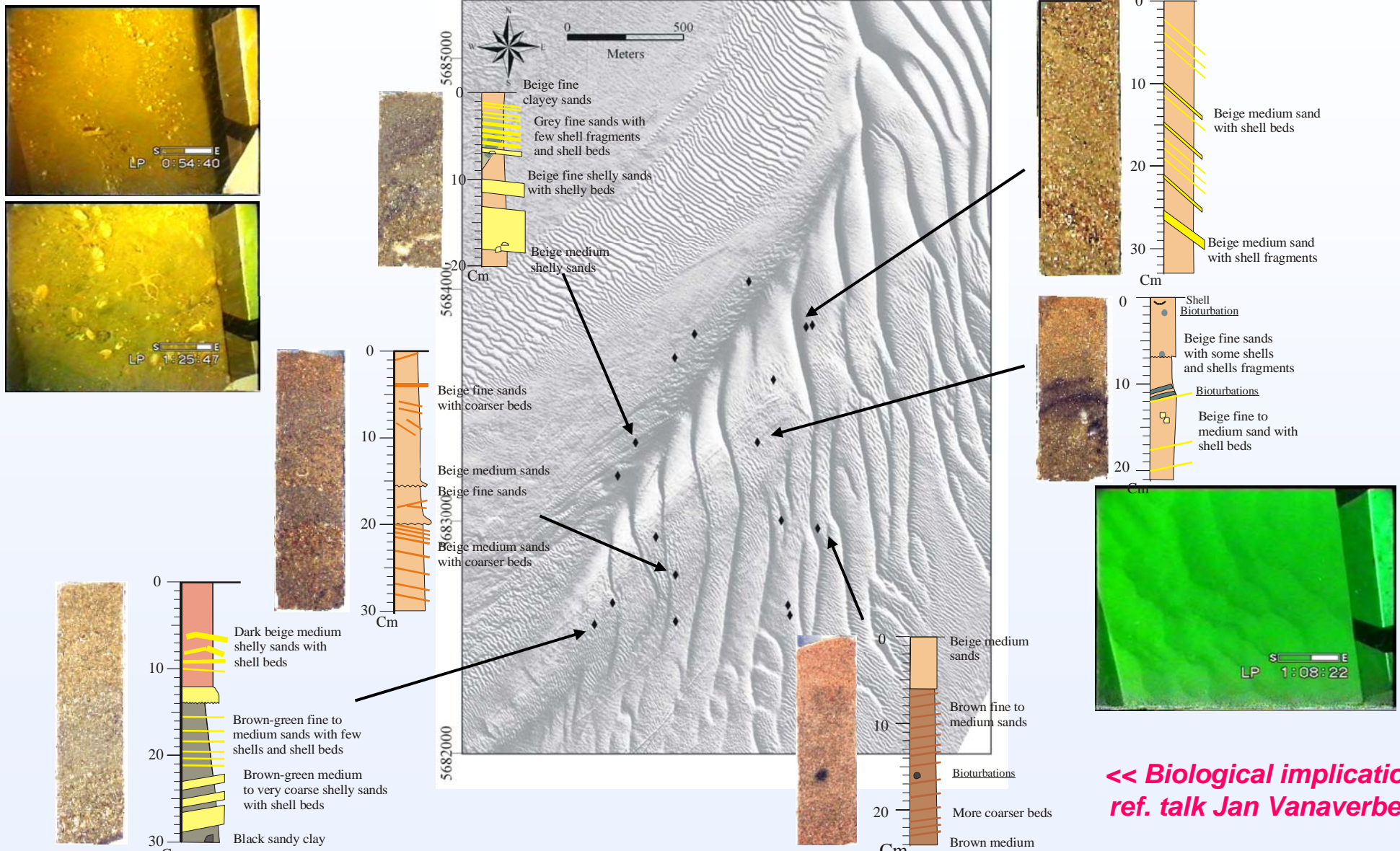
Ref. Marine Sand Fund

<< **Sedimentology** *(upper 30 cm):*

-4 distinct sedimentary environments

-Complex sediment distribution in the depression, similar evolution as the swale/channel sediments

-Transport of shells into the depression, initiation of regeneration ?

LP 0:54:40

LP 1:25:47

476000 477000

5685000

5684000 Cm

0

Beige fine
clayey sands

Grey fine sands with
few shell fragments
and shell beds

10

Beige fine shelly sands
with shelly beds

20

Beige medium
shelly sands

5683000

0

Beige fine sands
with coarser beds

10

Beige medium sands

Beige fine sands

20

Beige medium sands
with coarser beds

30 Cm

5682000

0

Dark beige medium
shelly sands with
shell beds

10

Brown-green fine to
medium sands with few
shells and shell beds

20

Brown-green medium
to very coarse shelly sands
with shell beds

Black sandy clay

30

0

10

20

30 Cm

Beige medium sand
with shell beds

Beige medium sand
with shell fragments

Cm

0

Shell
Bioturbation

Beige fine sands
with some shells
and shells fragments

10

Bioturbations

Beige fine to
medium sand with
shell beds

20

Cm

LP 1:08:22

0

Beige medium
sands

Brown fine to
medium sands

10

Bioturbations

20

More coarser beds

Brown medium

Cm

*<< **Biological implications**
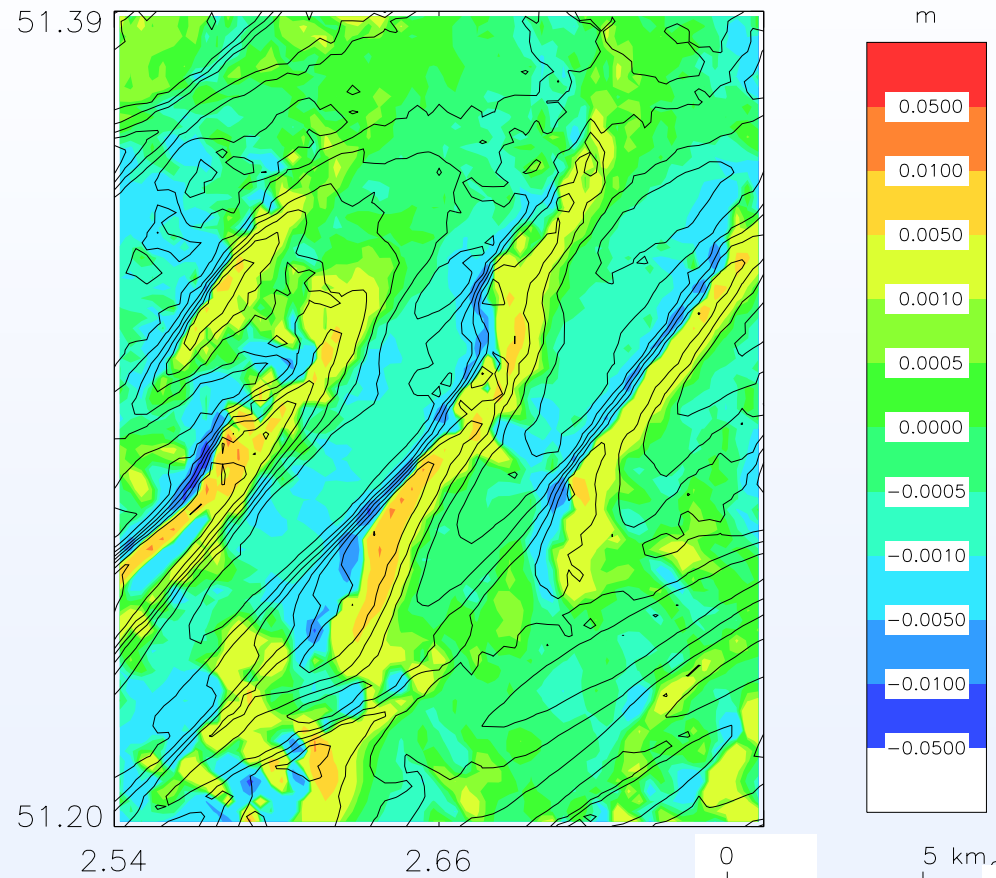**ref. talk Jan Vanaverbeke***

<< **Hydrodynamic and sediment transport modelling** *(based on 3 modelling approaches)*

-Kwinte Bank is part of system of swales and sand banks;

-distinct erosion-deposition pattern

Present-day scenario (MUMM)
based on COHERENS 3D hydrodynamic model, resolution 250 m
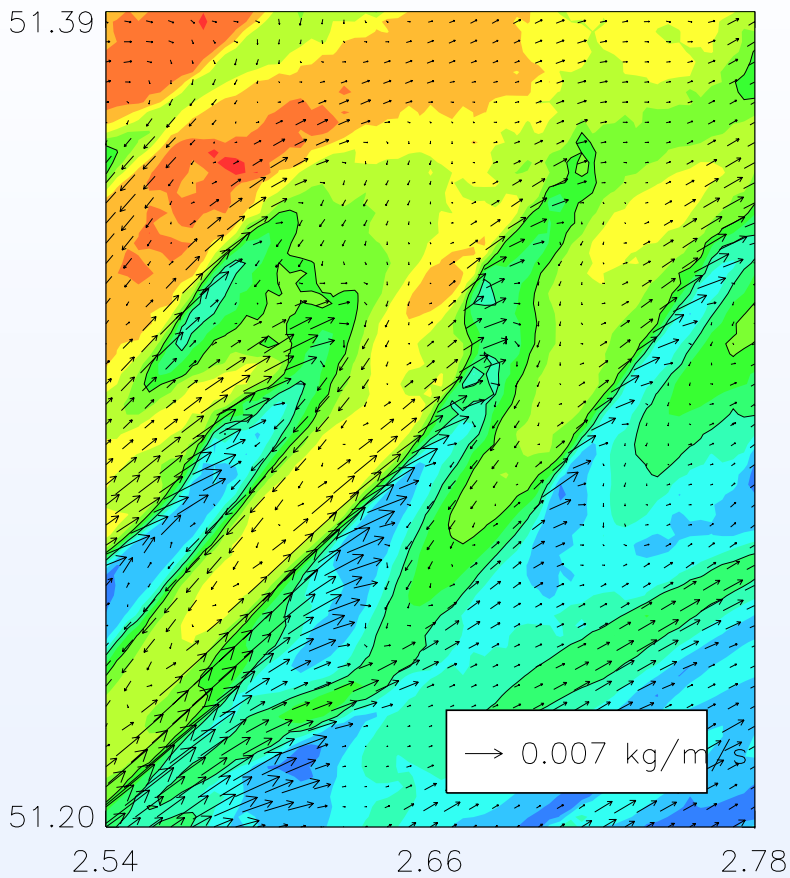
**Sediment transport
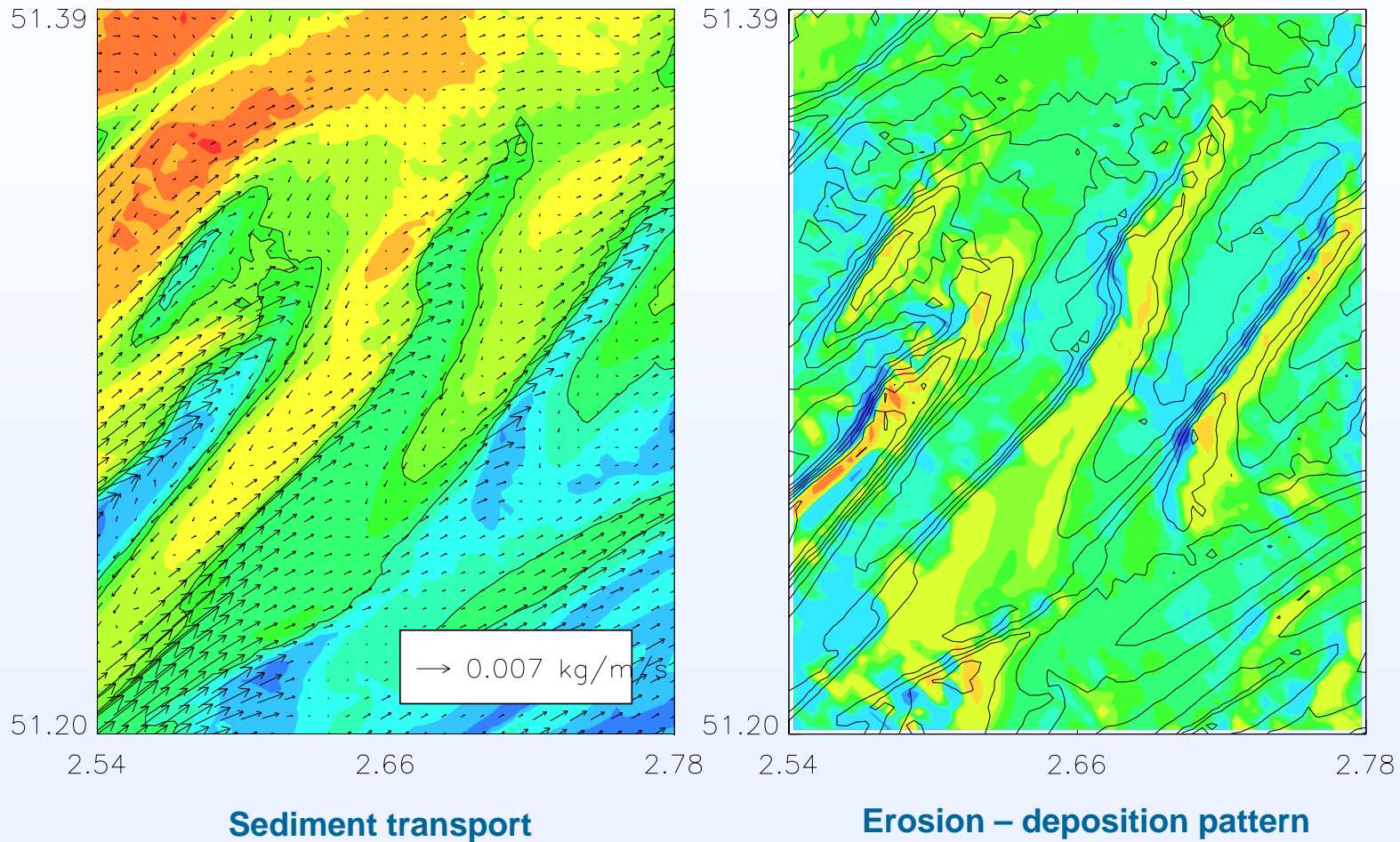(current bathymetry)**

**Erosion – deposition pattern
(current bathymetry)**

Scenario: cut of sand bank at -15 m (MSL) (MUMM)
based on COHERENS 3D hydrodynamic model, resolution 250 m
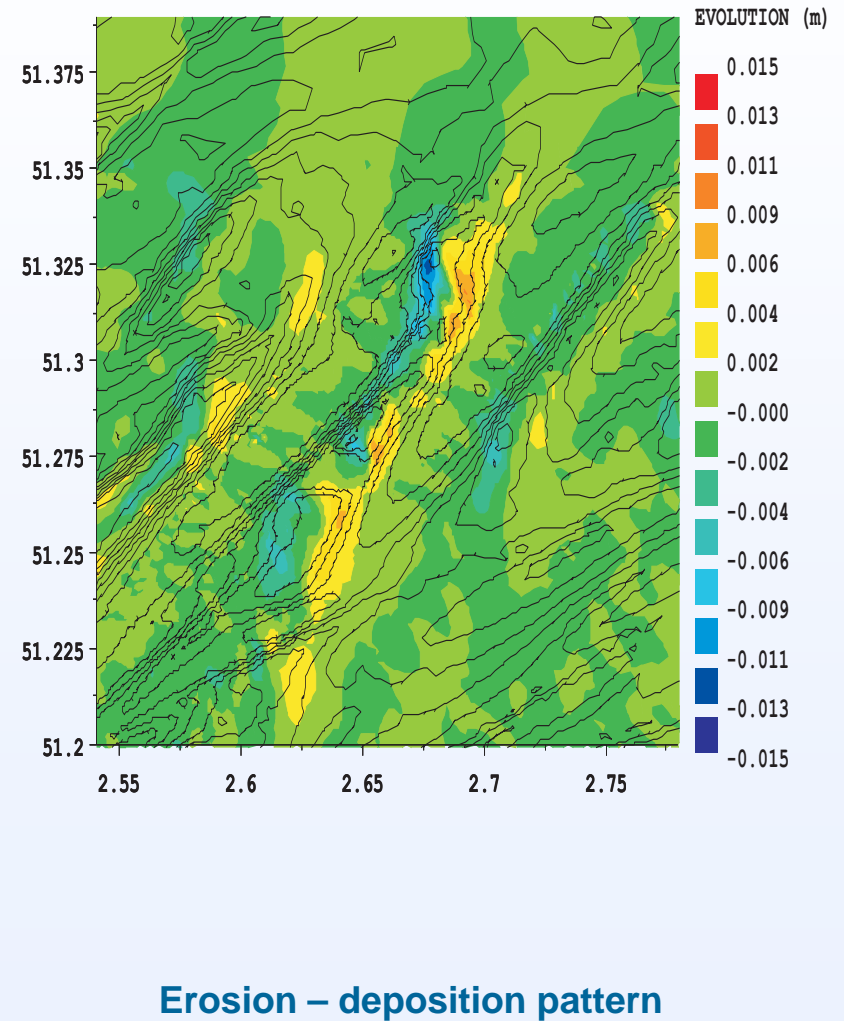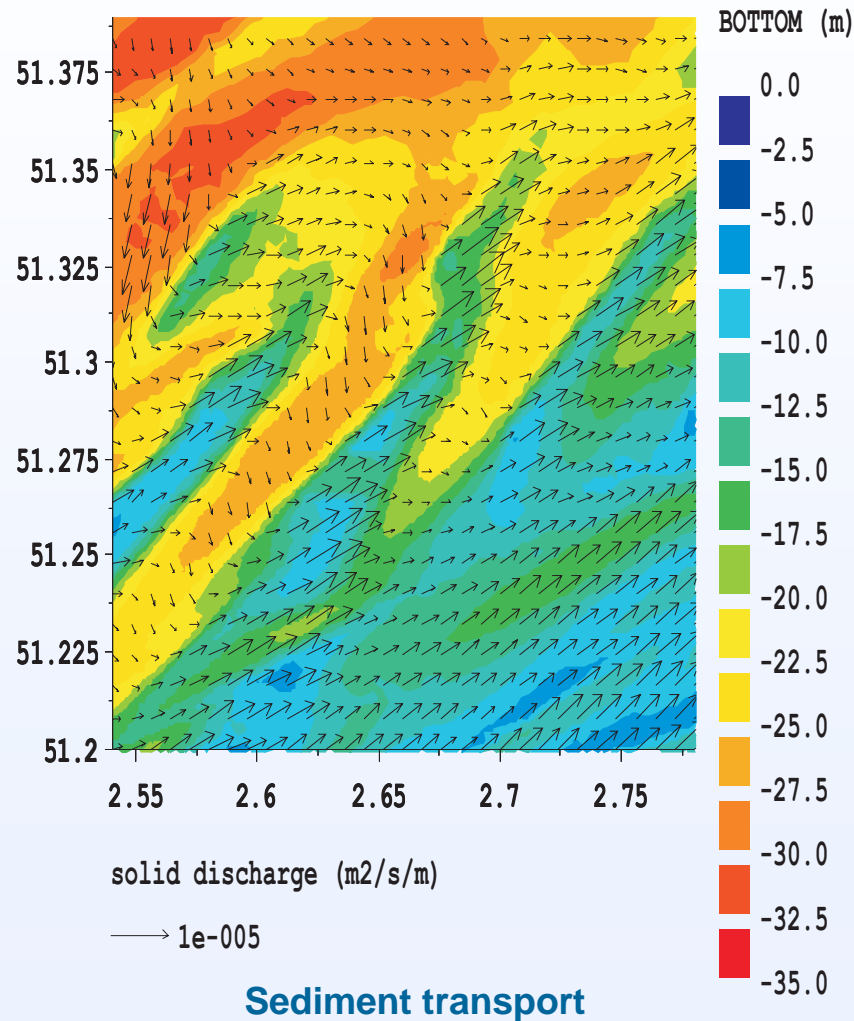levelling of the sandbank up to -15 m

WORST CASE SCENARIO

Sediment transport

Erosion – deposition pattern

Scenario: cut of trench in sand bank (KUL)
based on 2D model < Telemac, resolution 250 m
trench of 1 km x 2 km (perpendicular to the crest) up to a depth of -13 m (MSL) (- 6×10^{-6} m³)

solid discharge (m2/s/m)

$\longrightarrow$ 1e-005

Sediment transport

Erosion – deposition pattern

Impact of aggregate extraction - *preliminary conclusions in short*

The facts:	**- creation of a depression of 5 m, still extraction per time unit +/- 10 cm** **- now depression to the north of the Kwinte Bank** **- previous reporting (< 1999): limited impact and maintenance mechanism**

Geology   - almost complete dredging of upper unit

Morphology   - +/- stabilisation of the sandbank after cessation of dredging, no regeneration
    - recovery of the bedforms, though smaller in height (results Marine Sand Fund)

Sedimentology   - complex distribution; evolution similar as the swale sediments
    - depression acts as a corridor for shells during the flood
    - deposition of fines during the ebb

Sediment dynamics   - Kwinte Bank is part of system of swales and sand banks
    - distinct erosion-deposition pattern
    - impact scenario's do not seem to destabilise the sandbank, but
      indicate regeneration mechanism
    - *modelling remains however subdued to important uncertainties*
    - *impact of waves and storms on sediment transport ?*

Biology/Ecology   *ref. biology projects (Jan Vanaverbeke / Wendy Bonne)*

Very slow regeneration, mainly due to a lack of coarser sediments
The deposition of shells and their trapping of fines likely initiates the regeneration

Sustainable development ? - guidelines

ecology

same priority

economy   social justice
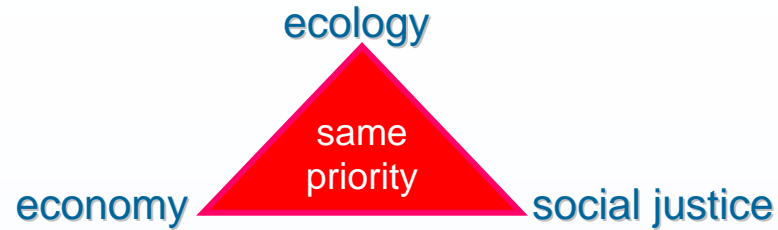
Renewable resources   **Non-renewable resources**

Use of renewable resources:
*The rate of consumption should not exceed
the rate at which they are regenerated*

Use of non-renewable resources:
*The consumption should not exceed the
amount that can be replaced by functionally
equivalent renewable resources or by
attaining a higher efficiency in the use of
renewable or non-renewable resources*

Resilience
of the system

Material and energy input into the environment should not exceed
the capacity of the environment to absorb them with minimal detrimental effects

Carying capacity of
the Earth's system

The rate of anthropogenic input and environmental interference should be measured
against the time required for natural processes to react and cope with environmental change

All of these issues are utmost difficult to address in the marine environment

**Need for detailed and careful integrated research
on the small and large spatial scale and on various time scales**

New extraction zone - Gootebank

Regions are defined where extraction is most favourable in terms of :

Geology → resource availability
<< previous seismic investigations
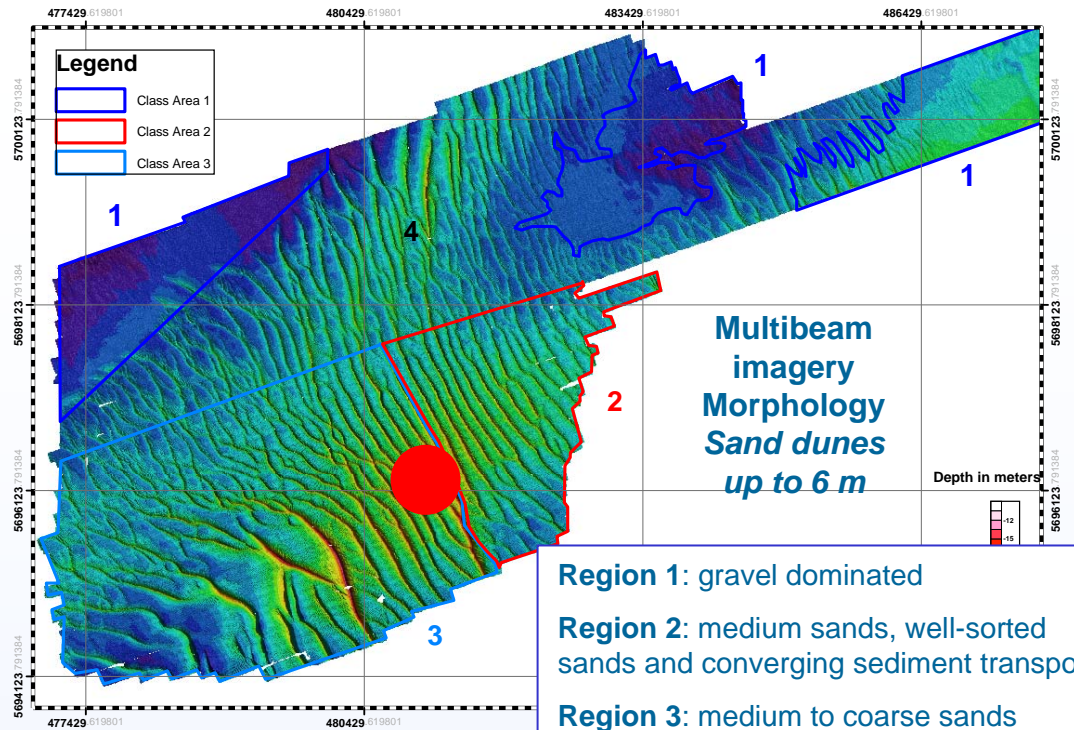**Morphology** → bedform heights
<< acoustics
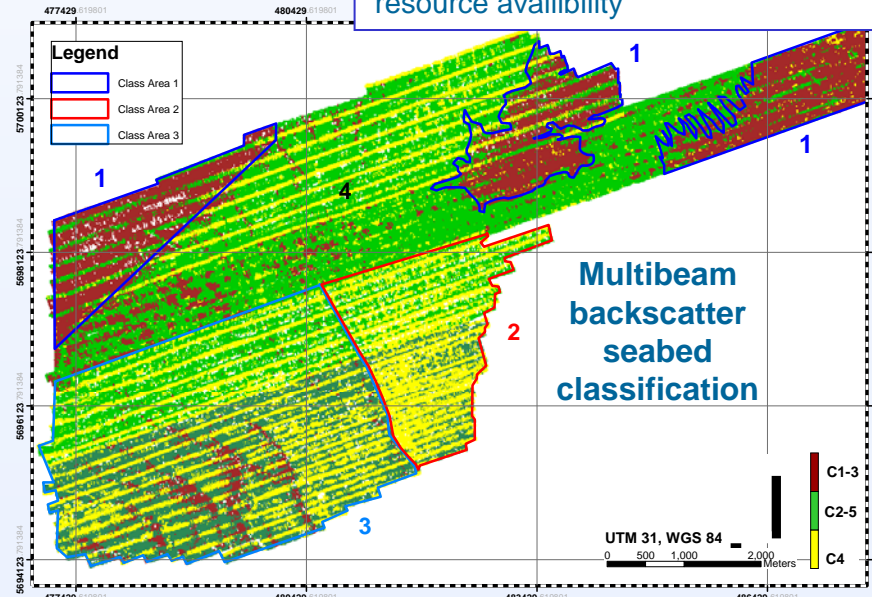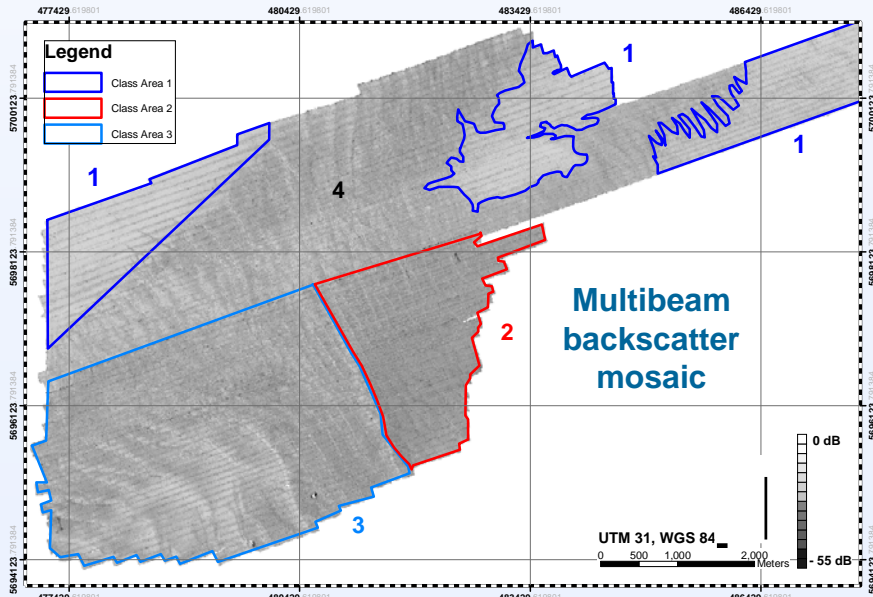**Sedimentology** → grain-sizes
<< acoustics + sampling
Sediment dynamics → sediment supply / recovery
potential << sediment transport models + acoustics
Biology/Ecology in terms of minimal environmental
impact << acoustics + sampling

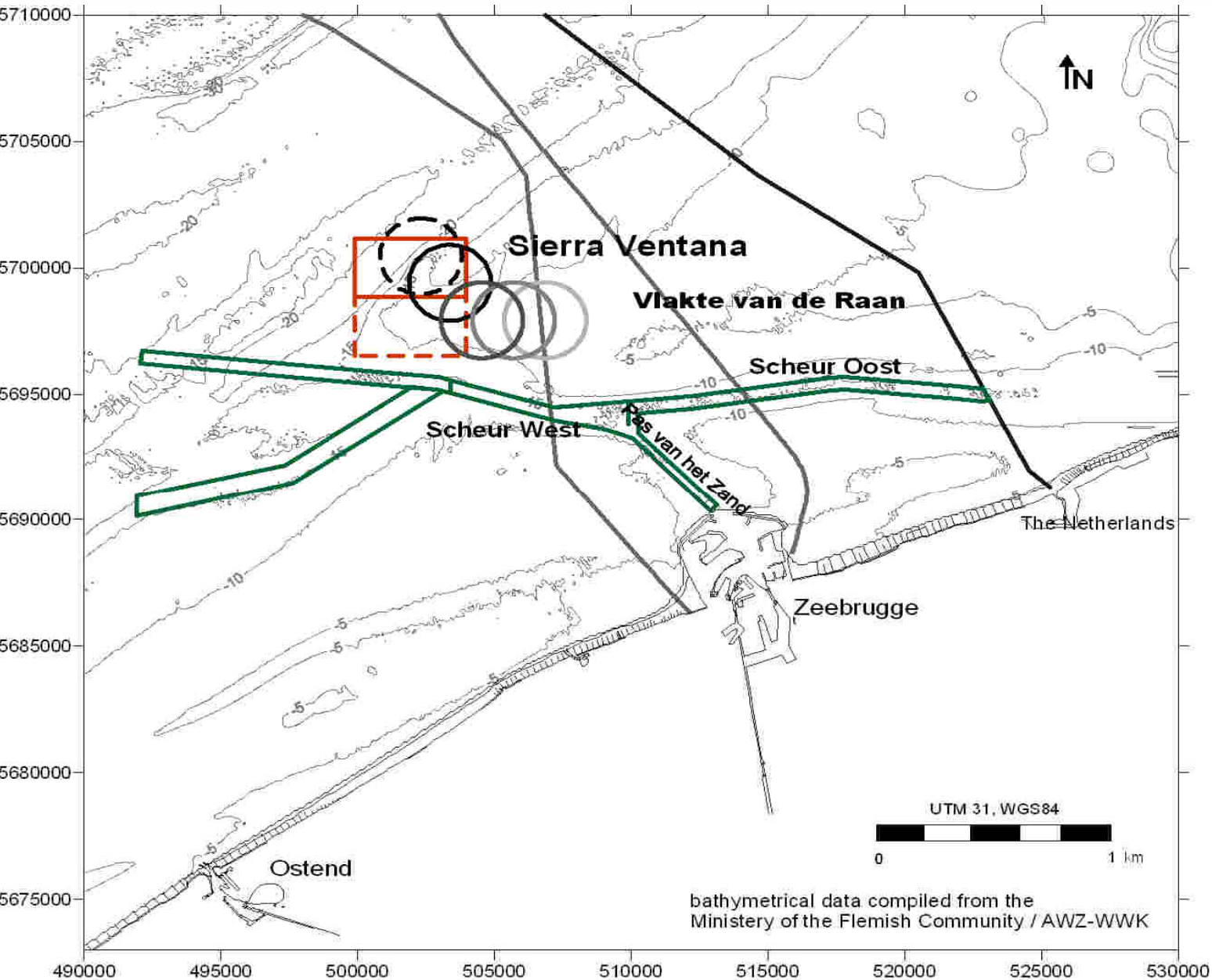**Multibeam imagery Morphology** *Sand dunes up to 6 m*

Depth in meters

Region 1: gravel dominated

Region 2: medium sands, well-sorted sands and converging sediment transport

Region 3: medium to coarse sands

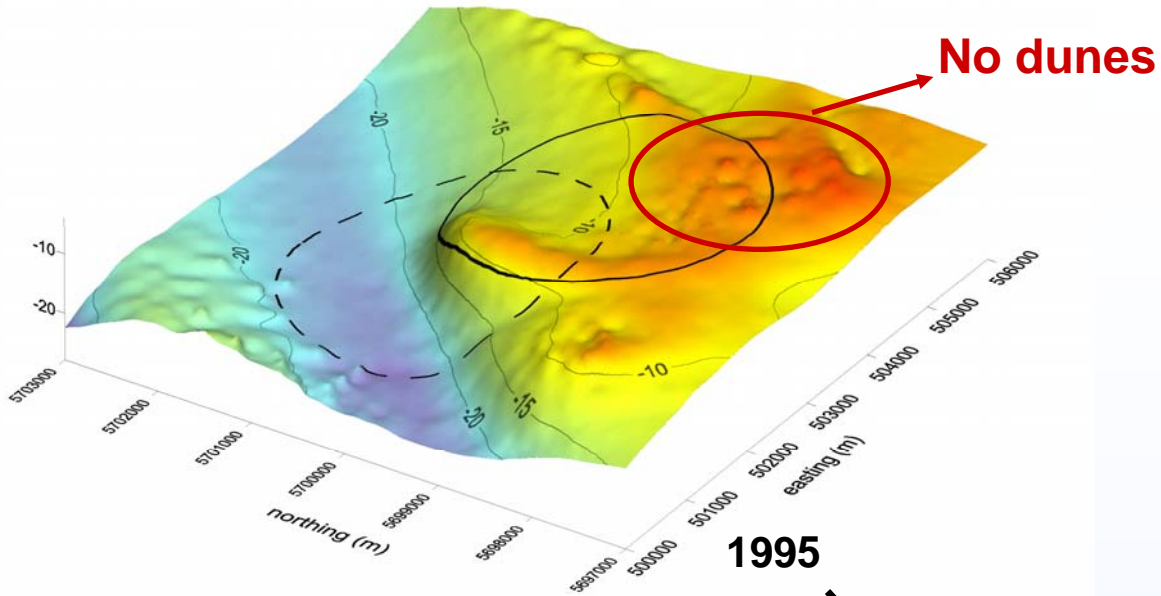**Region 4**: medium sands, but limited resource availibility

Multibeam backscatter mosaic

UTM 31, WGS 84

Multibeam backscatter seabed classification

UTM 31, WGS 84

New extraction zones 3a/3b Sierra Ventana region

Map legend:
- dumping site S1: 66-70
- dumping site S1: 70-80
- dumping site S1: 81-84
- dumping site S1: 84-99
- dumping site S1: 99-
- extraction zone 3b
- extractie zone 3a
- dredged zones
- pijpleiding

UTM 31, WGS84

0   1 km

bathymetrical data compiled from the
Ministery of the Flemish Community / AWZ-WWK

Labels on map: Sierra Ventana, Vlakte van de Raan, Scheur Oost, Scheur West, Pas van het Zand, Zeebrugge, The Netherlands, Ostend
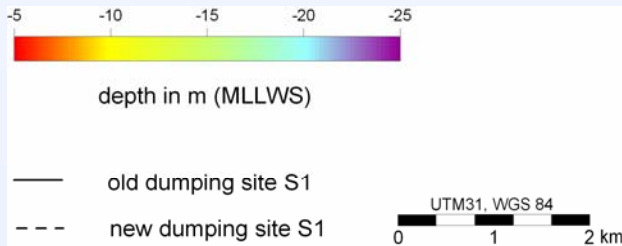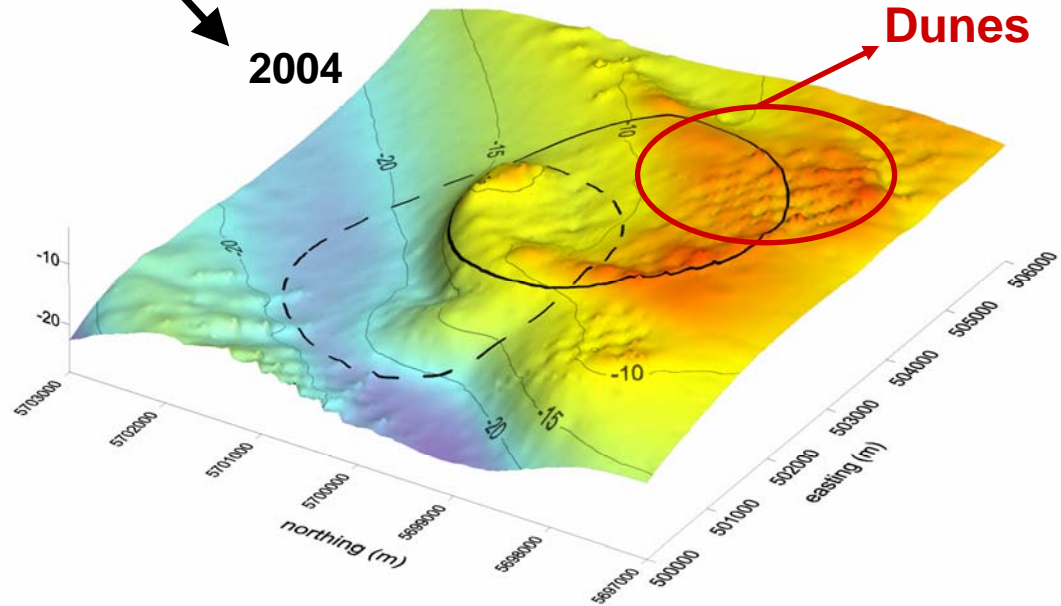
No dunes

Physical recovery of the old dumping site of dredged material S1

□ grain-size again in equilibrium
□ dune structures up to 2 m

1995

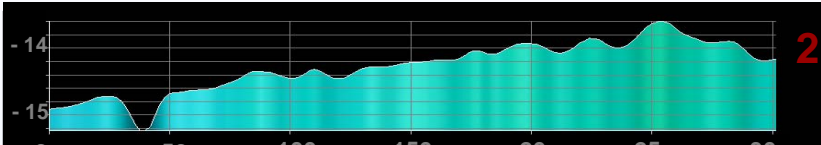**1999: Closure old dumping site**

2004

Dunes

depth in m (MLLWS)

—— old dumping site S1

- - - new dumping site S1

UTM31, WGS 84
0   1   2 km

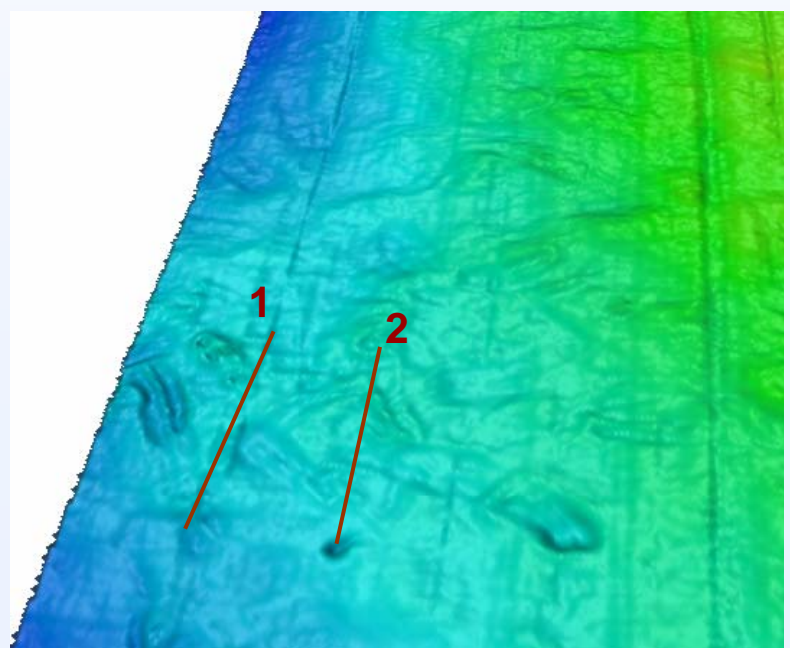bathymetrical data compiled from the Ministry of the Flemish Community / AWZ-WWK

Data acquisition consisted of:
- multibeam measurements (bathy+backscatter)
- boxcoring
- grab sampling
- chemical analyses (<NHM NV/Zeegra)

New S1

Old S1

N

1

2
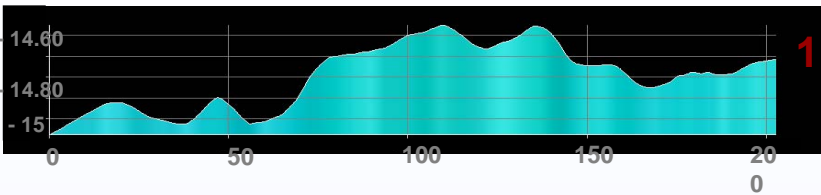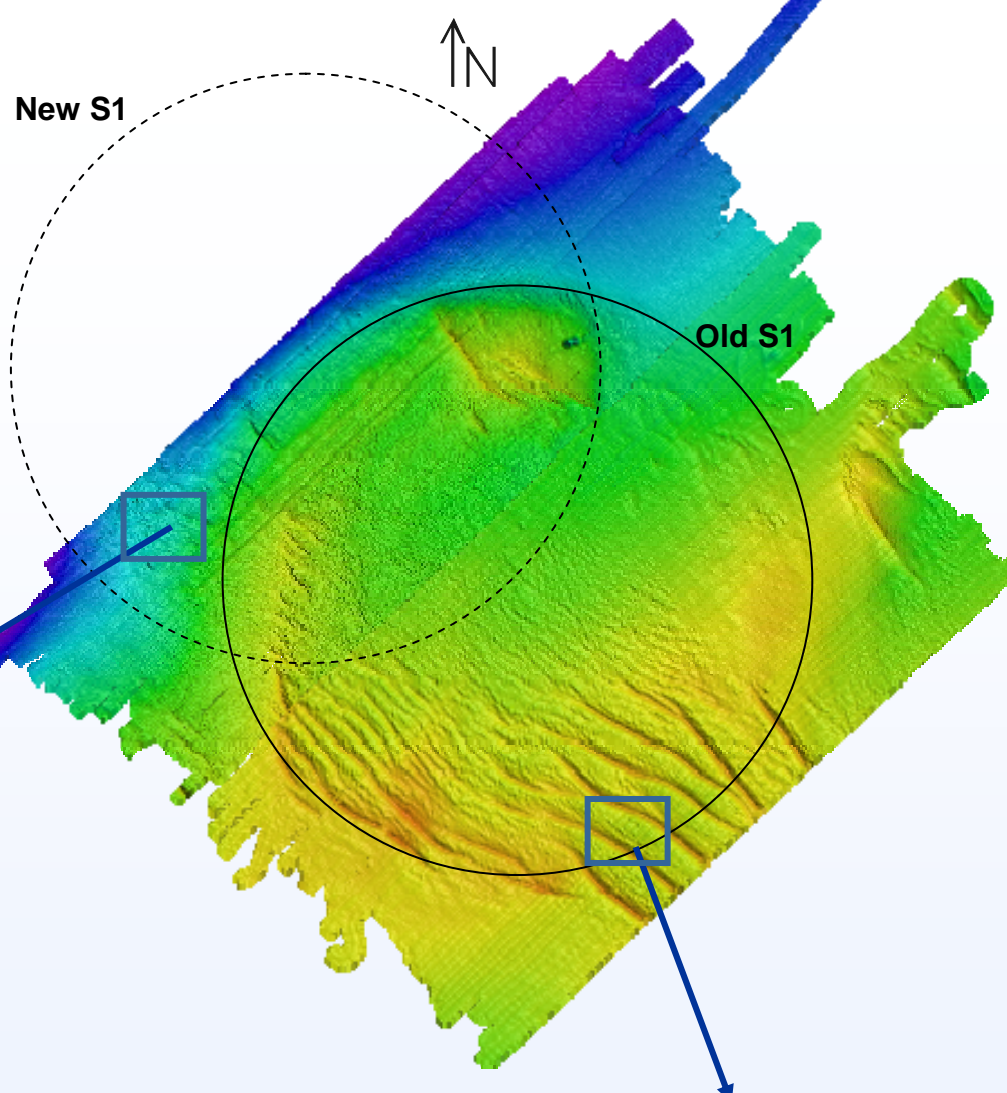
Dredge spoils (max 1 m height; irregular shape; small negative features of 40 cm deep**)**

1

2

Large dunes (H: 0.75-2m, L: 1500-2000m)

1

New dumping site

Old dumping site

Extraction zone 3b

Extraction zone 3a

N

UTM31, WGS 84

0   3 km
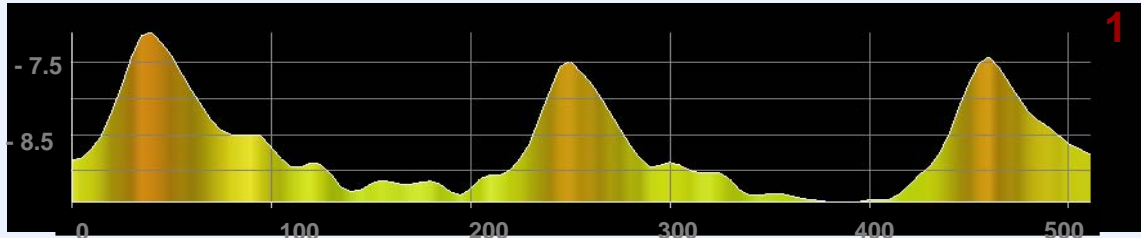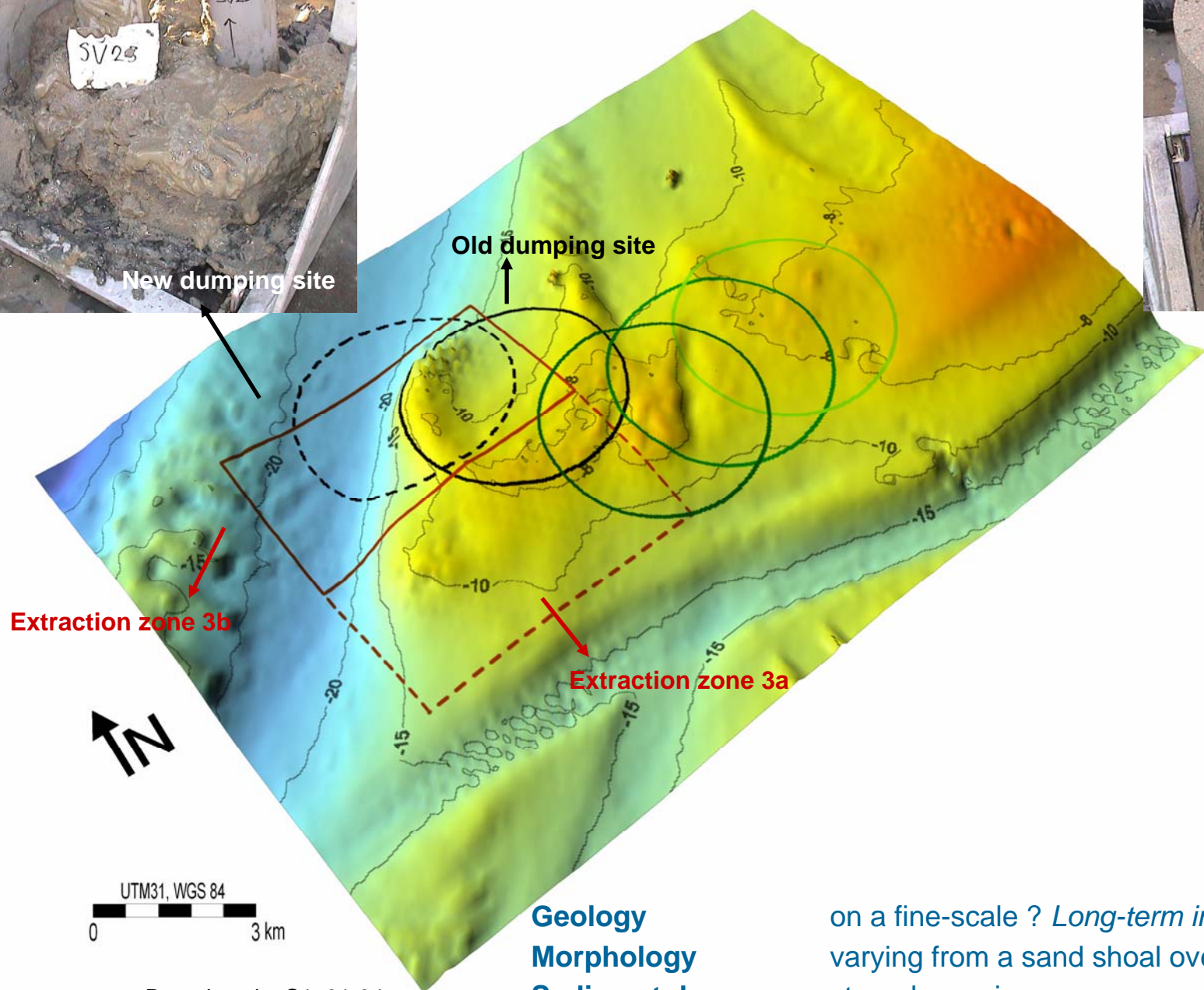
—— Dumping site S1: 81-84

—— Dumping site S1: 70-80

—— Dumping site S1: 66-70

Geology	on a fine-scale ? *Long-term impact of dredging ?*
Morphology	varying from a sand shoal over a slope towards a swale
Sedimentology	strongly varying
Sediment dynamics	*studied elsewhere*
Biology/Ecology	on the old dump site, often **no fauna** is found

New exploration zone Hinder Banken
Evaluation of gravel resources
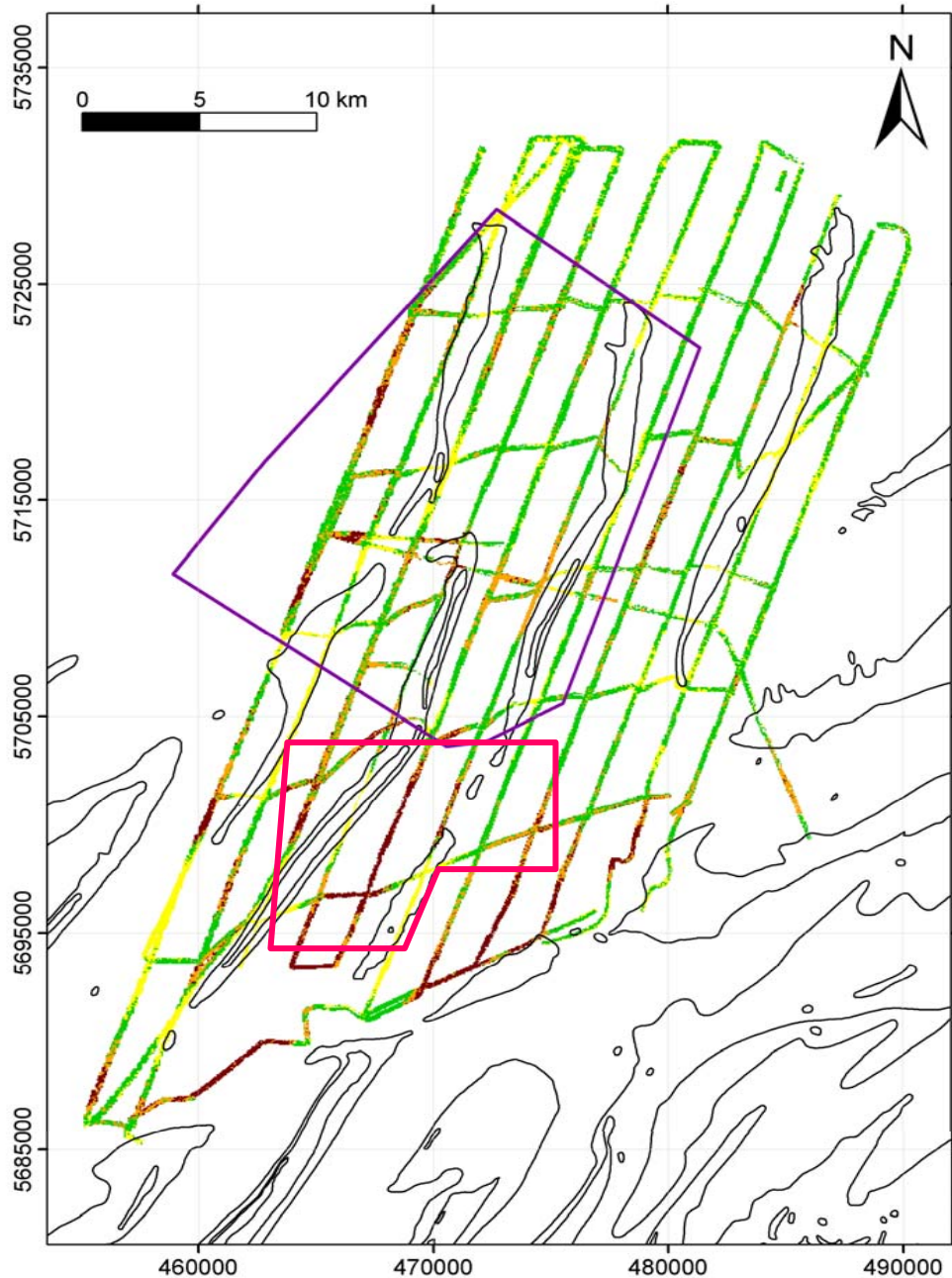
>> based on acoustic seabed classification

-Higher gravel amount in swales than on banks

-Higher gravel amounts near southern parts of the Westhinder and Oosthinder

-Exploration zone and northern part of Hinder Banks region is characterized by lower gravel amounts and more dunes

exploration zone Hinder Banks

fine sand

medium sand

medium/coarse sand
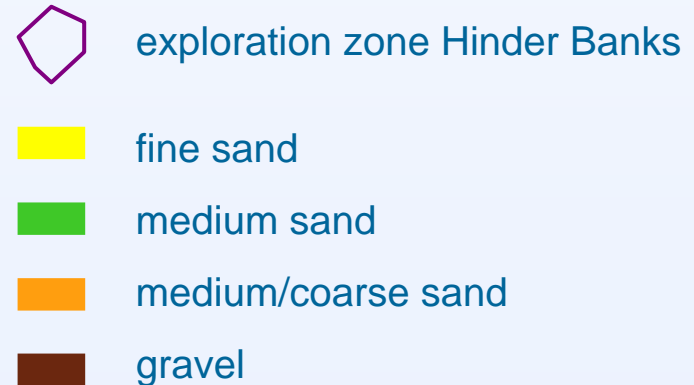
gravel

>> acoustic seabed classification of an area covering the Oosthinder and Westhinder and their swales

See posters

Oosthinder

Westhinder

Blue: fine to medium sand
Brown: coarse sand to gravel

→ Highest gravel amounts in the swale between the Westhinder and Oosthinder *(confirmed with video and Hamon grabs)*

→ Direct discrimination of fine versus coarser sand
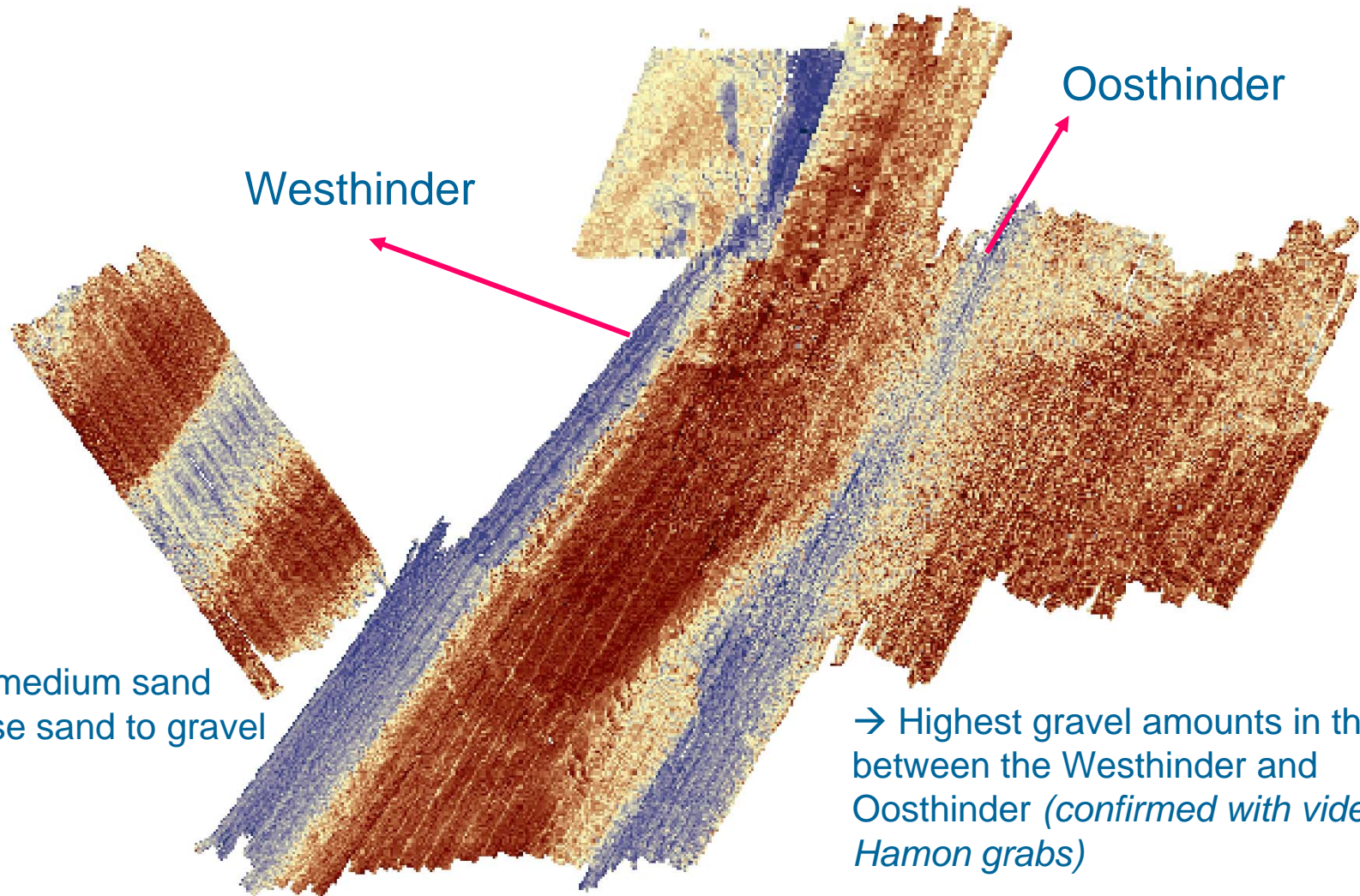
Multibeam backscatter map

GRAVEL: very irregular in shape, in quantity, in size and in type: quartz, limestone, sandstone, silex, igneous rocks, ... In many cases covered with a **top layer of sand.**

Photo by M. Fettweis (RBINS/MUMM)

Detailed side-scan sonar
image of large objects
(2-3 m) on the seafloor.
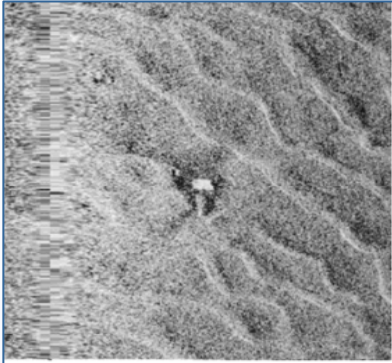
Oosthinder sandbank

Hamon grab

Video

Detailed multibeam bathymetry image
of the irregular morphology of the typical
gravel patches, often covered with a layer of sand.

Sustainable exploitation of sand resources *(from a maintenance perspective <-> creation sandpits)*

-sufficiently thick quaternary cover with a more or less constant quality   **Geology**

-areas with bedforms, but no excessive interdune areas *(different sedimentary environment)* **Morphology**

-extraction of the grain-size that is in transport   **Sedimentology**
     (importance of coarser relict sediments in the regeneration process)
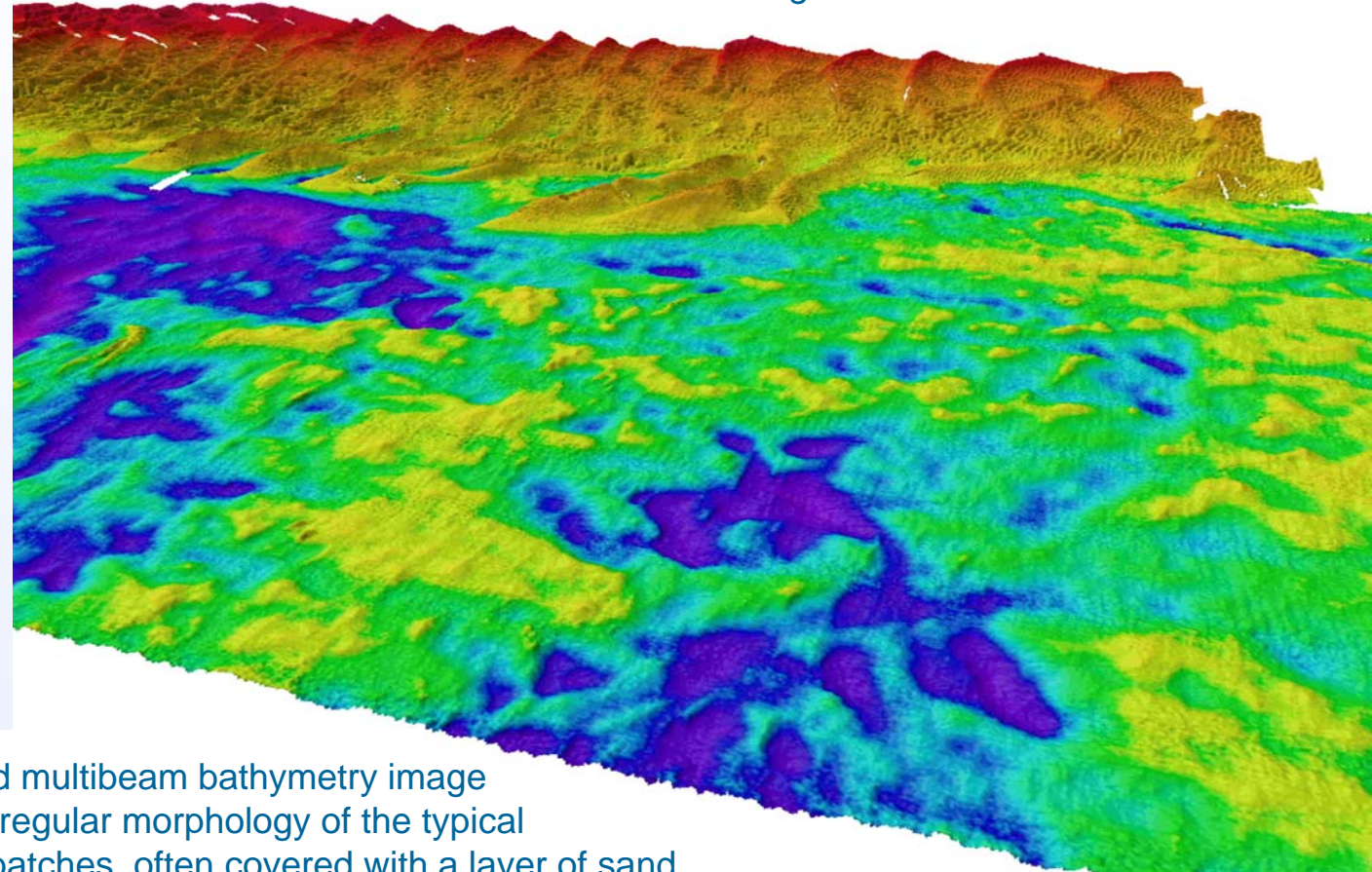-in areas of deposition and high sediment transport rates *(regeneration process)*   **Sediment dynamics**

-avoid areas that are less stable in nature *(i.e. kink areas)*   *Geology/Sediment dynamics*

~~Sustainable exploitation of gravel resources~~ *– restrictions*

-thickness of the gravel layers (origin) ?   **Geology**

-heterogeneity and patchy nature of the gravel beds   **Morphology**

-often sandy cover   **Sedimentology**

-importance of the gravel in protecting the seabed from further erosion ?   **Sediment dynamics**

-protecting habitats - biologically sensitive *(ref. JS Houziaux)*   *Biology/Ecology*

Approach recommendations *to support a sustainable exploitation*

	Geology	Morphology	Sedimentology	Sediment dynamics	Biology/Ecology
Knowledge/data need	Resource availibility (sufficient Q cover) Good characterisation of subsoil strata (homogeneity of the subsurface layers) Resource origin	Volume calculations Fine-scale Morphometric analysis Bedforms	Spatial distribution Quality mapping << industry needs	Fine-scale hydrodynamics 2D/3D (currents + waves) Sediment transport (bedload/suspended) Sediment balance (erosion/deposition) +grain-size	Identification of ecologically sensitive areas Habitat characterisation *Ref. Biology projects*
Tools/innovation need	VHR Seismics + Coring+Geotechnics	High frequency Acoustics + Video/Still	High frequency Acoustics + Sampling+Geotechnics	High frequency Acoustics/Optics/EM + Sampling	High frequency Acoustics + Video/Sampling

← *Sensor improvement* →

Monitoring – adequate time series – good reference framework

Predictive modelling – long-term !

Most challenging: dealing with uncertainty !!

TIME AND SPACE SCALE

Relevance of short-medium-long-time series

Discontinuous time series

Need for adequate time series ⟶

Time scale of local versus regional impacts

Short versus long-term impact

High spatial variability

Mixture of old and new surface sediments

Need for good spatial references

NATURAL VERSUS ANTHROPOGENIC INDUCED SEDIMENT DYNAMICS ?

How to define natural evolution in an anthropogenically steered environment ?

Need for long-time series and their evaluation, both from a global change perspective and the overall increasing anthropogenic pressure
? Natural cyclicity in erosion/sedimentation ?

Best option: continuous measurements ! *at representative sites*

**Sustainable management should be considered over the whole period
from the very beginning of allowing and defining zones for anthropogenic activities
to the period of execution of the activities and
the period of decommissioning**

Baseline studies   ⟷   Monitoring   ⟷   Recovery/
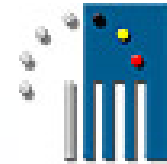Rehabilitation

You can't monitor what you don't know

Marebasse provides valuable information on all levels,
still only limited or no use of this information on a policy or management level
Why ?

Acknowledgements

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Vakgroep Biologie

Steven Degraer

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EUMARSAND
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**EU-RTN FP5
Eumarsand**

This project has received European Regional Development Funding through the INTERREG III B Community Initiative

NWE ENO
INTERREG IIIB
NORTH WEST EUROPE

Interreg IIIB MESH