



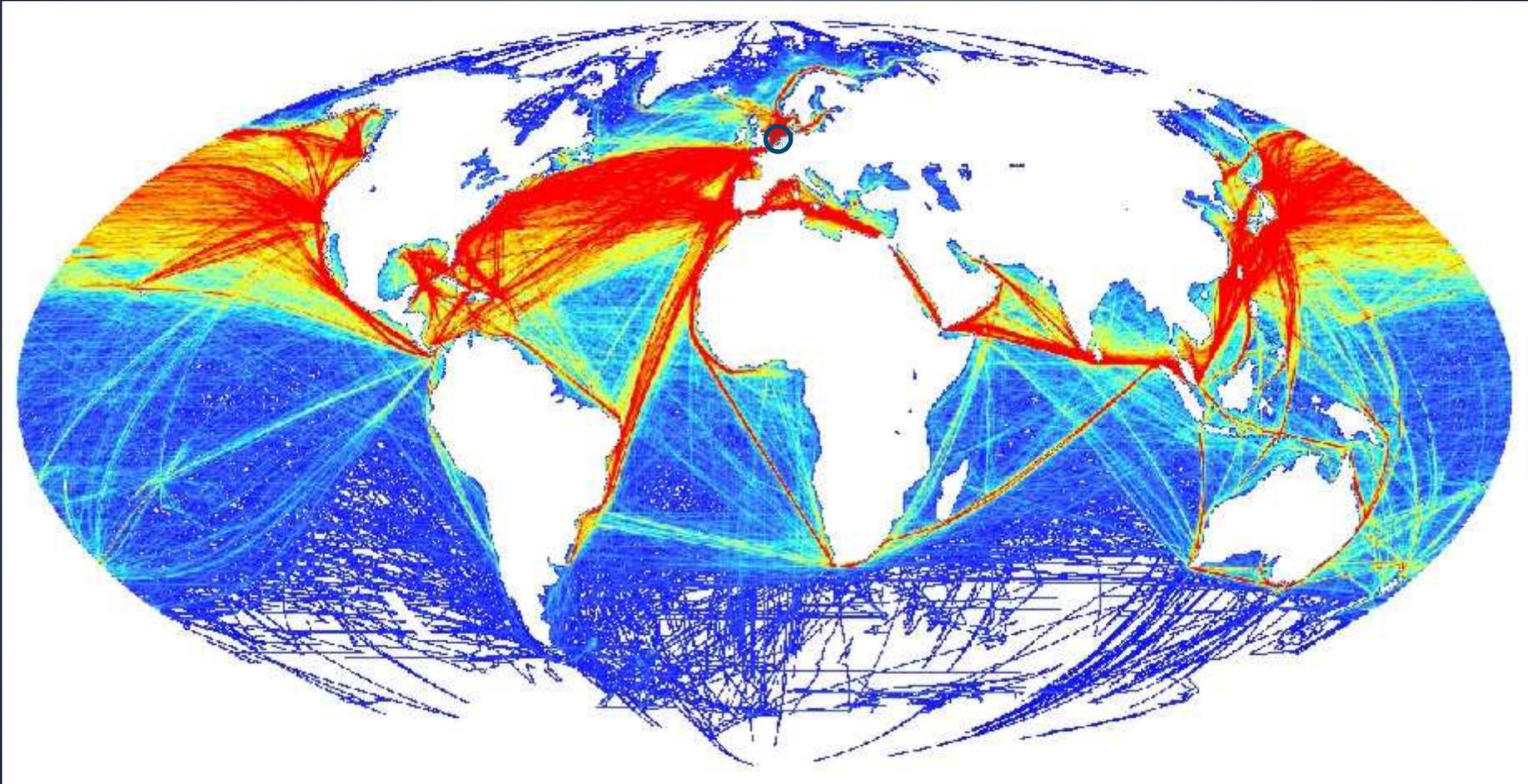
**Scientific Forum Speaker/Panellist Information Form
Vienna, 15-16 September 2015**

HYDROSEDIMENTOLOGY FOR SUSTAINABLE DREDGING IN MARINE & COASTAL WATERS: BETTER INSIGHTS THANKS TO RADIO-ACTIVE TRACERS

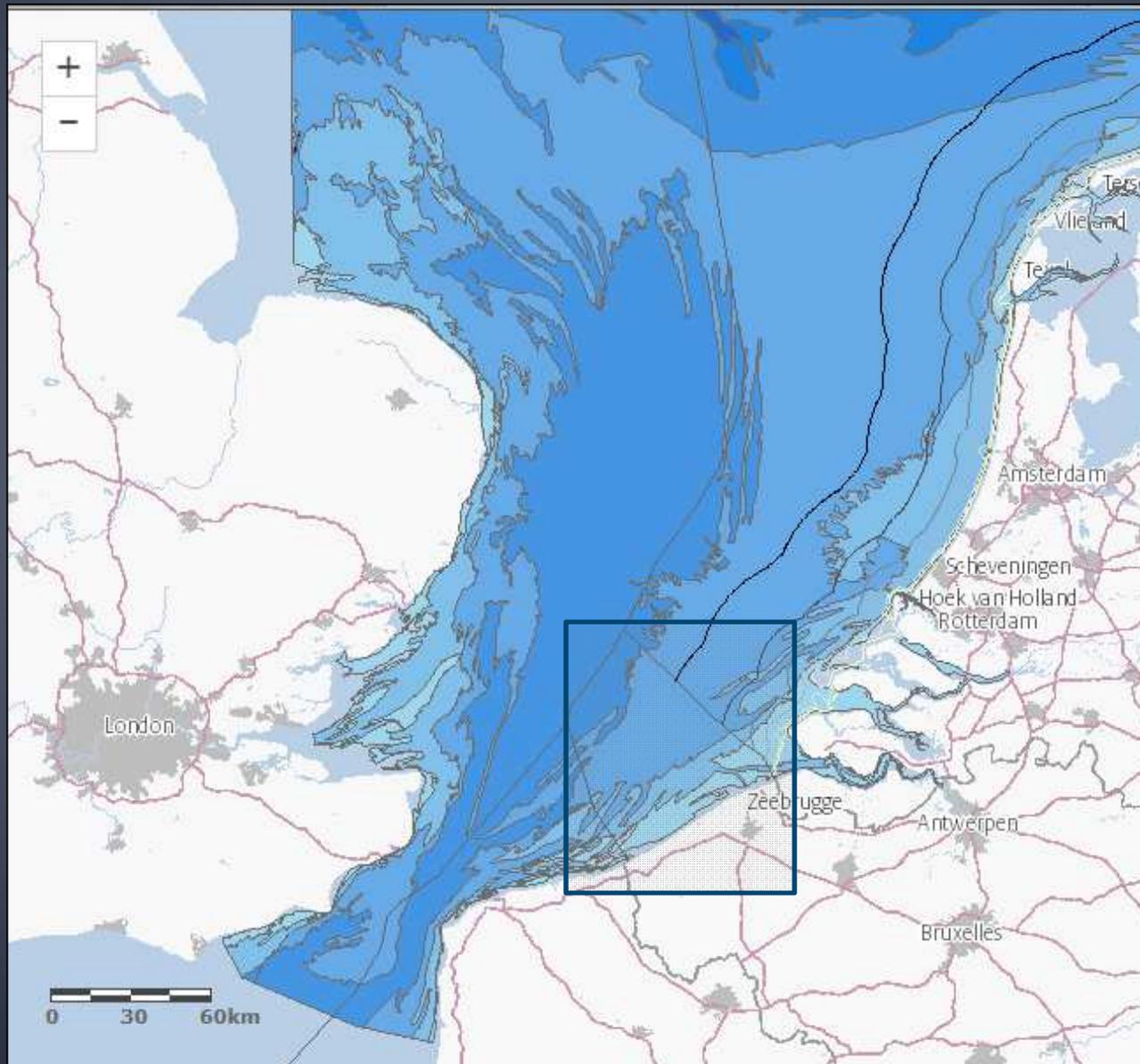
**Ir. Bernard Malherbe
Director Project Development
Jan De Nul Group**



The maritime world: 87 % of world-trade is seabound



The southern North Sea: Cross Roads of one of the most dense maritime traffic areas (200.000 ship movements /year)



Bathymetry (m
wrt LLWS CD (ref
Noordzee-Atlas)



Zoom on Belgian Continental Shelf

Sand Banks

Maritime Access-Channels

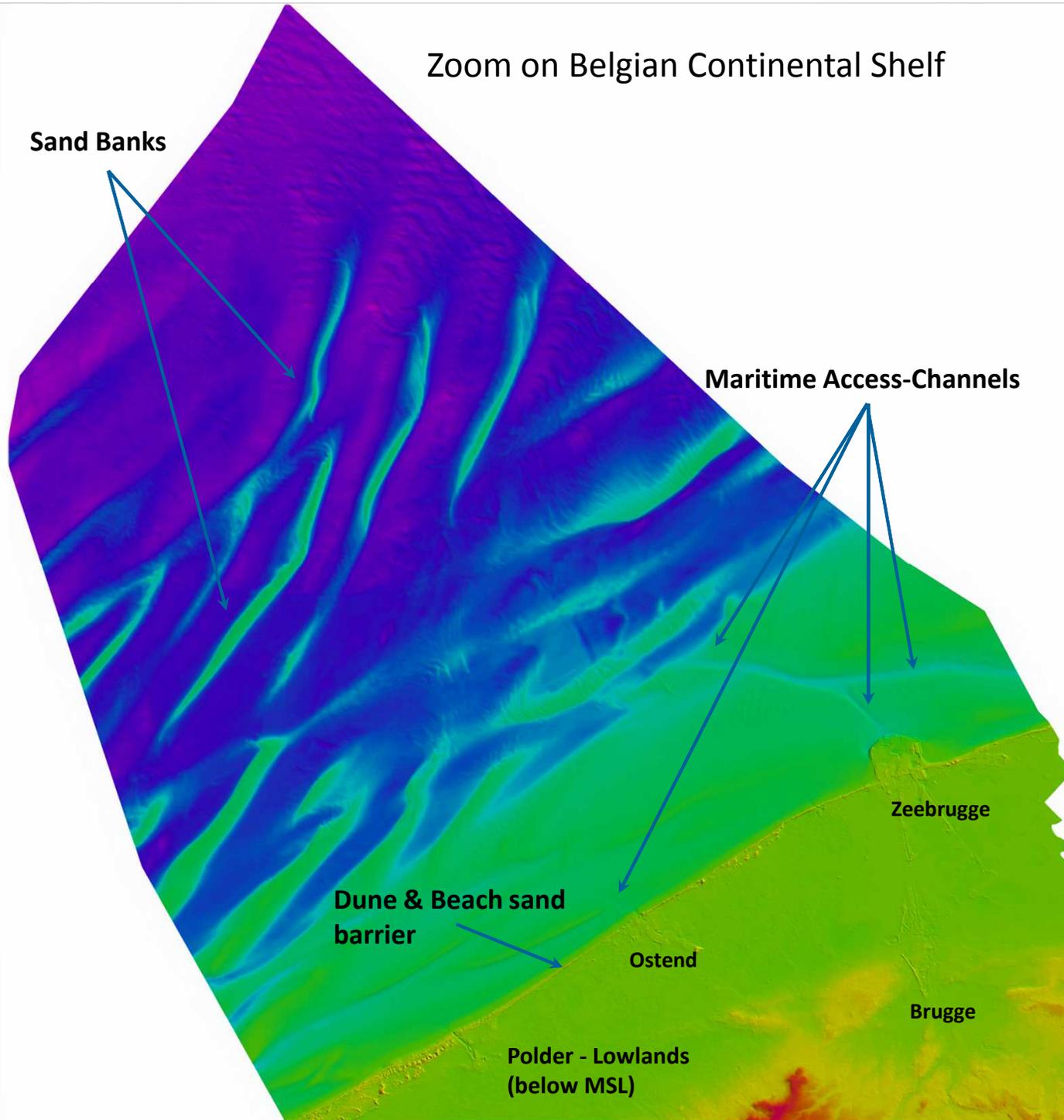
Dune & Beach sand barrier

Zeebrugge

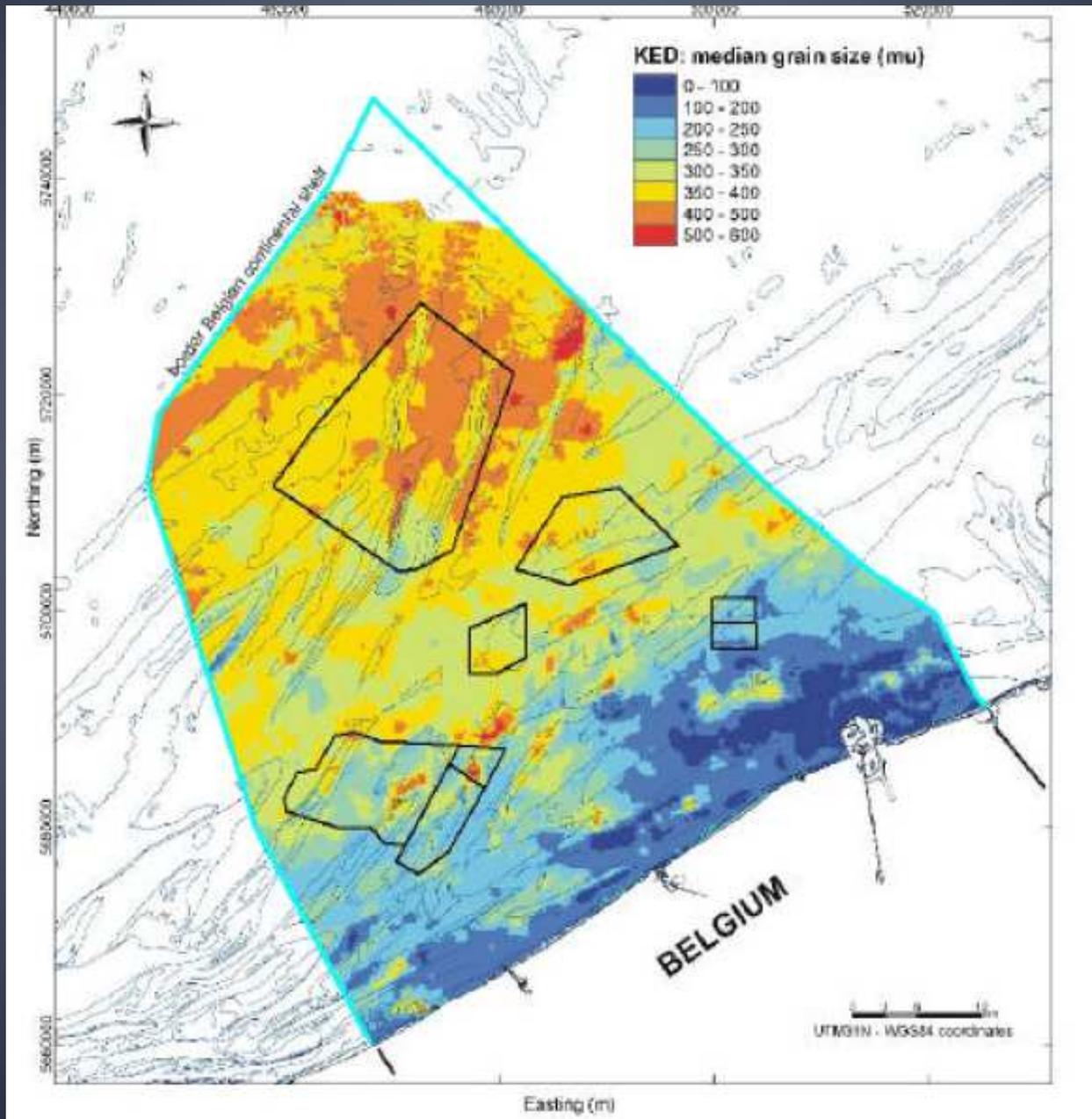
Ostend

Brugge

Polder - Lowlands
(below MSL)



Seabed consist of Quaternary sand and mud sediments (ref Verfaillie et al)

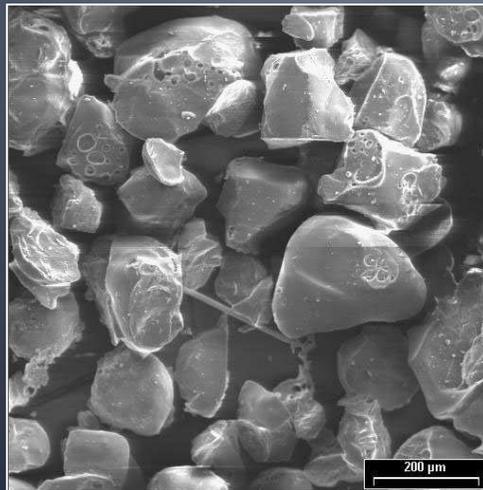


Sediments: different families, different behaviours

Sand-sediment



Mud-sediment



Electronic scanning microscope images



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Malherbe



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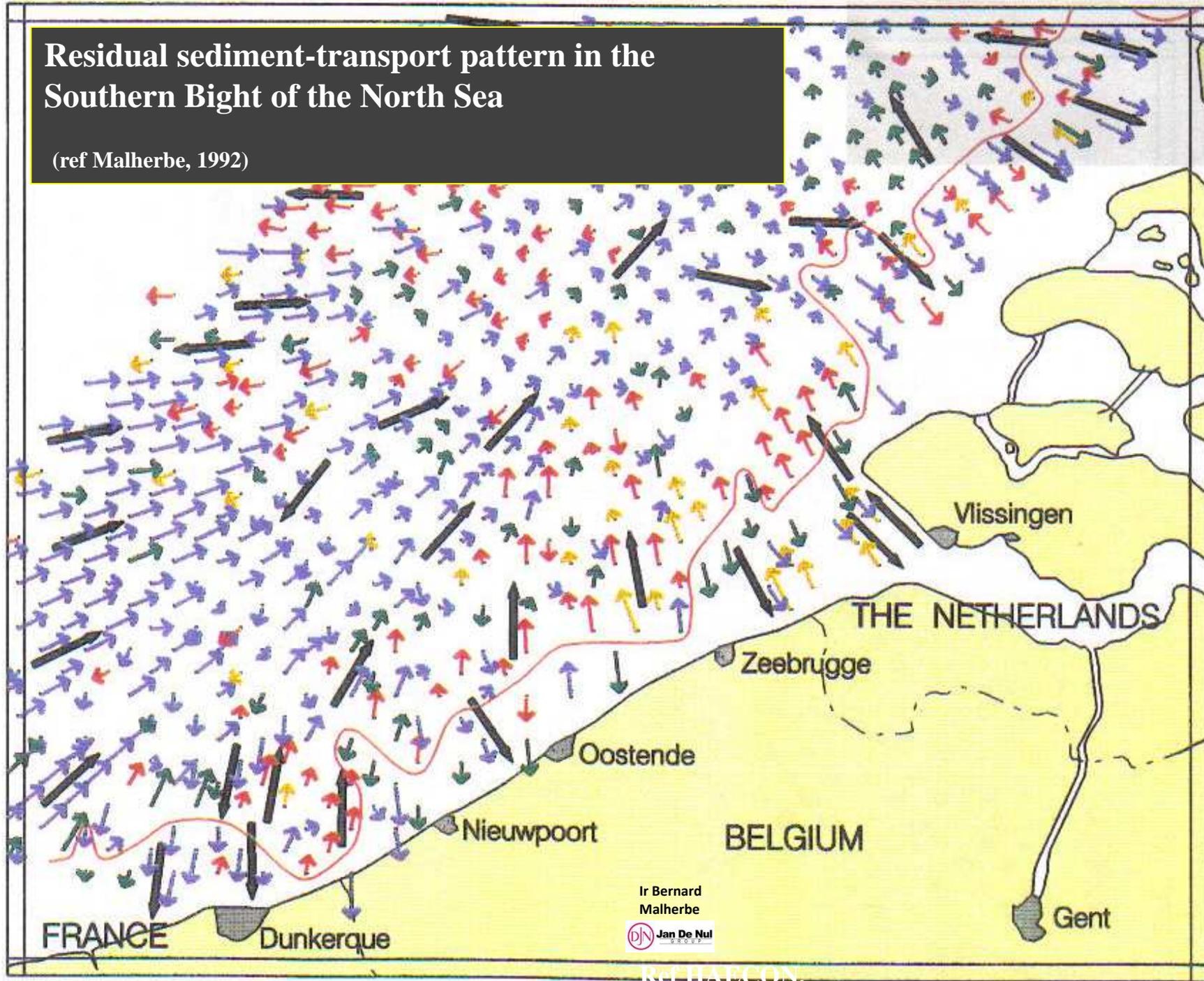
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Belgian Coast:
Primary Coastal Protection offered by a narrow beach & dune barrier of fine sand protecting 2.000 km² of coastal lowlands (below MSL)



Residual sediment-transport pattern in the Southern Bight of the North Sea

(ref Malherbe, 1992)



Ir Bernard
Malherbe



Jan De Nul
GROUP

REF HAECON

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Malherbe



**Satellite Image illustrating the existence of the
nearshore Marine Turbidity Maximum Area
(ref Belfotop, 1982)**

Dredging works open and maintain vital maritime fairways & create ports, gateways for economy and prosperity



Port of Zeebrugge: 2 Major Extension Programmes between 1903-2003



Anno 1976



Anno 1990



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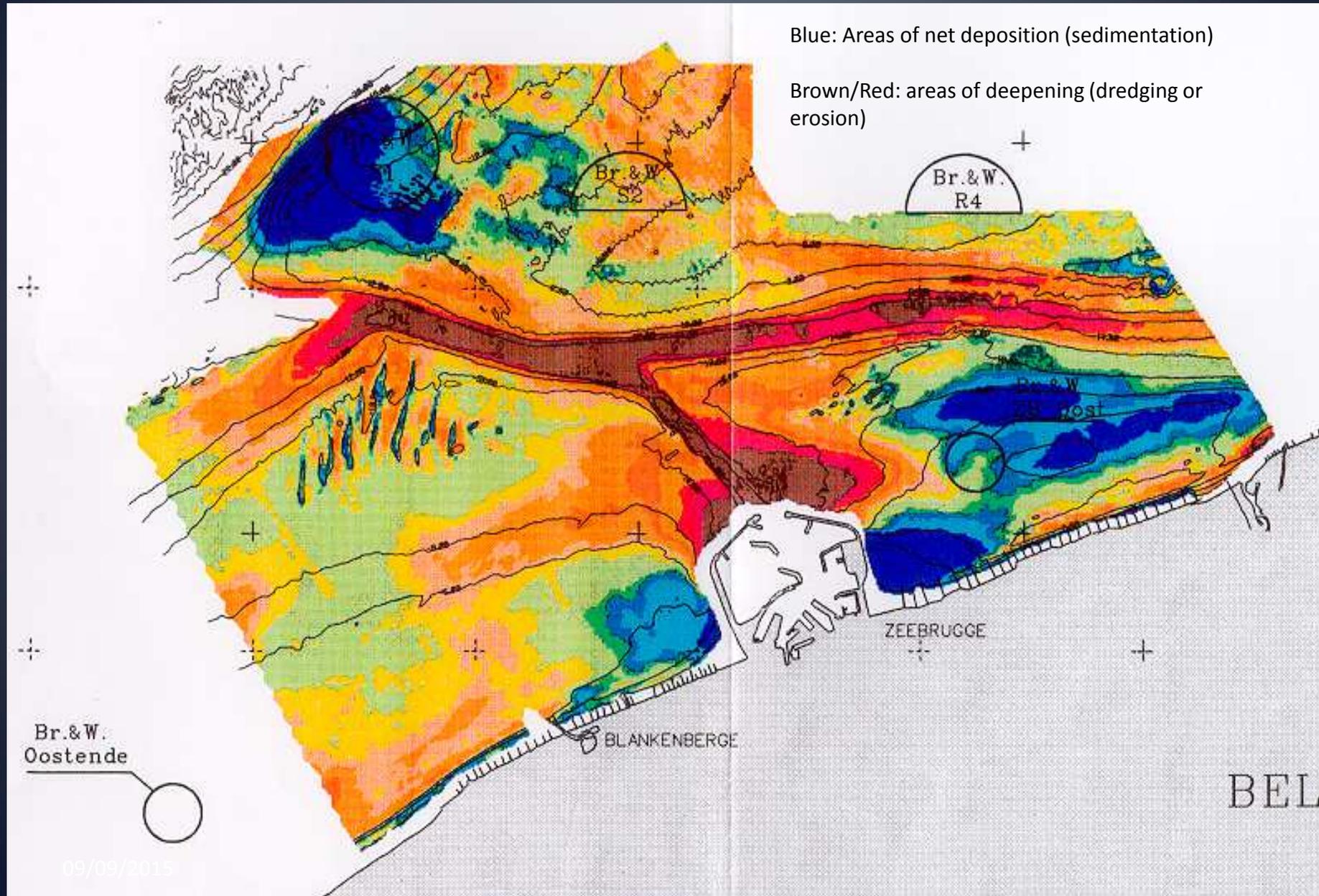


Anno 2003

“Soft” Coastal Protection by reclaiming beach & dune belts



Digital Terrain Model and Differential Mapping (1976-1994) of the Seabed illustrates the effects of port development, channel deepening & coastal protection



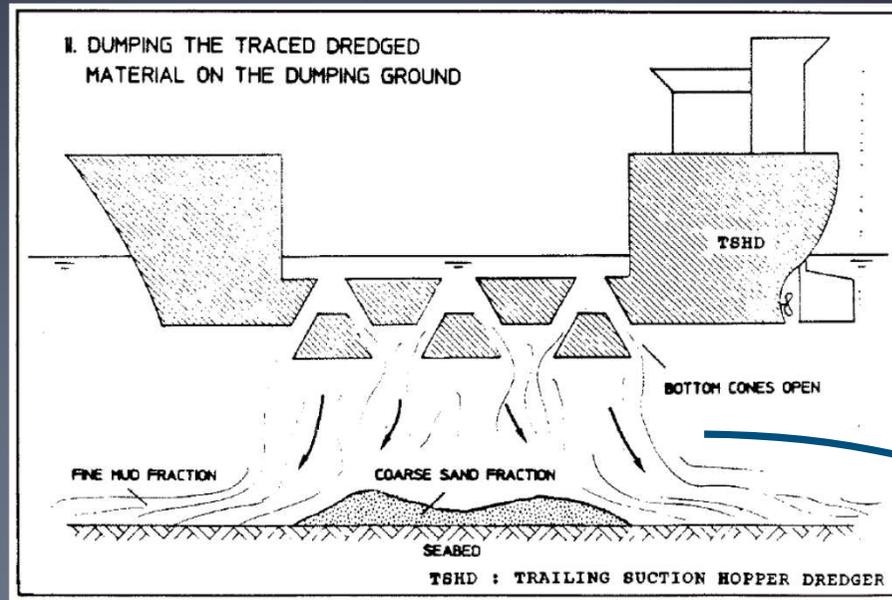
Question 1:

How does the process of open-water aquatic disposal of dredged material occur? What is the real environmental impact?

Short-living Au198 radio-active tracers (CEA, Saclay technology) co-precipitated in the alumino-silicate lattice of clay-minerals & detected in-situ with NaI scintillation detectors

Field-studies of Overflow and Dumping Processes:

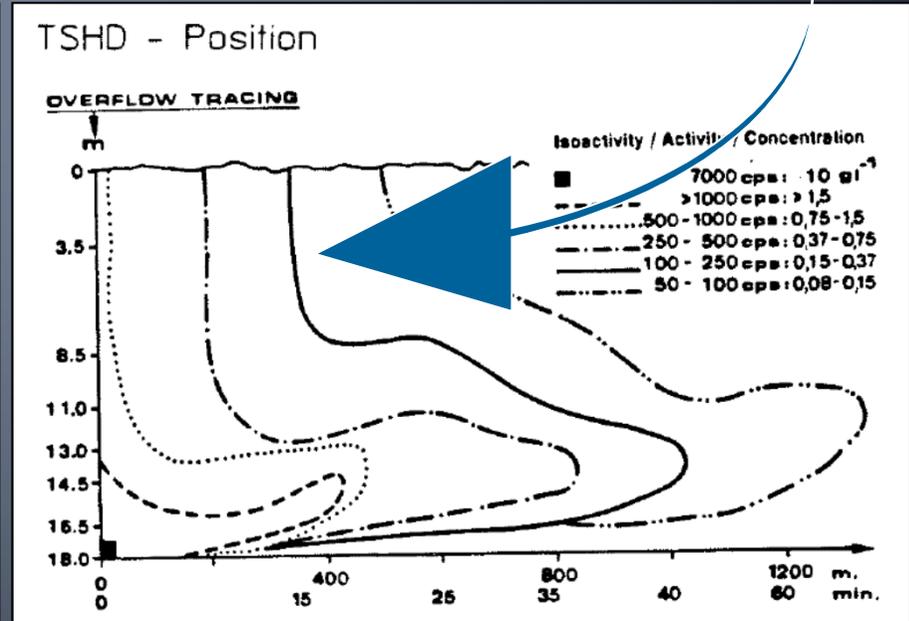
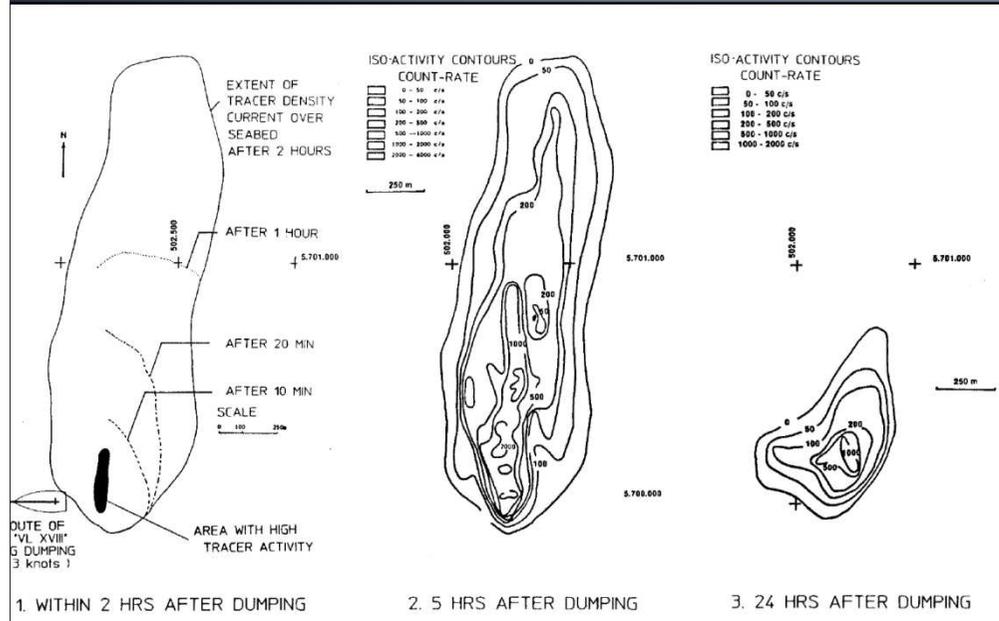
Test-results of short-living radio-active tracer experiments



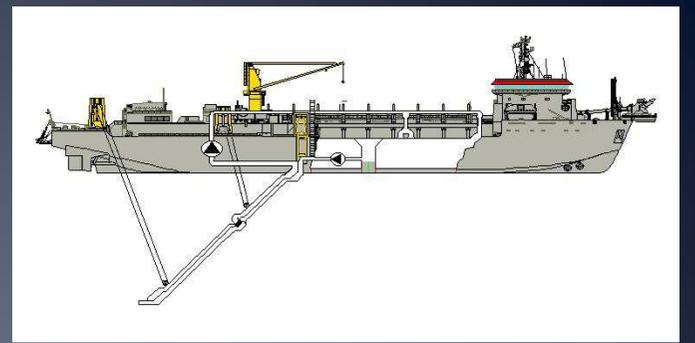
Vertical density flow: 0,5 to 1,5 m/sec

Dumping test of sand & mud

Overflow-test of mud



Comparison dredging & environmental-mitigation techniques



Standard overflow



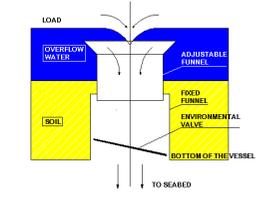
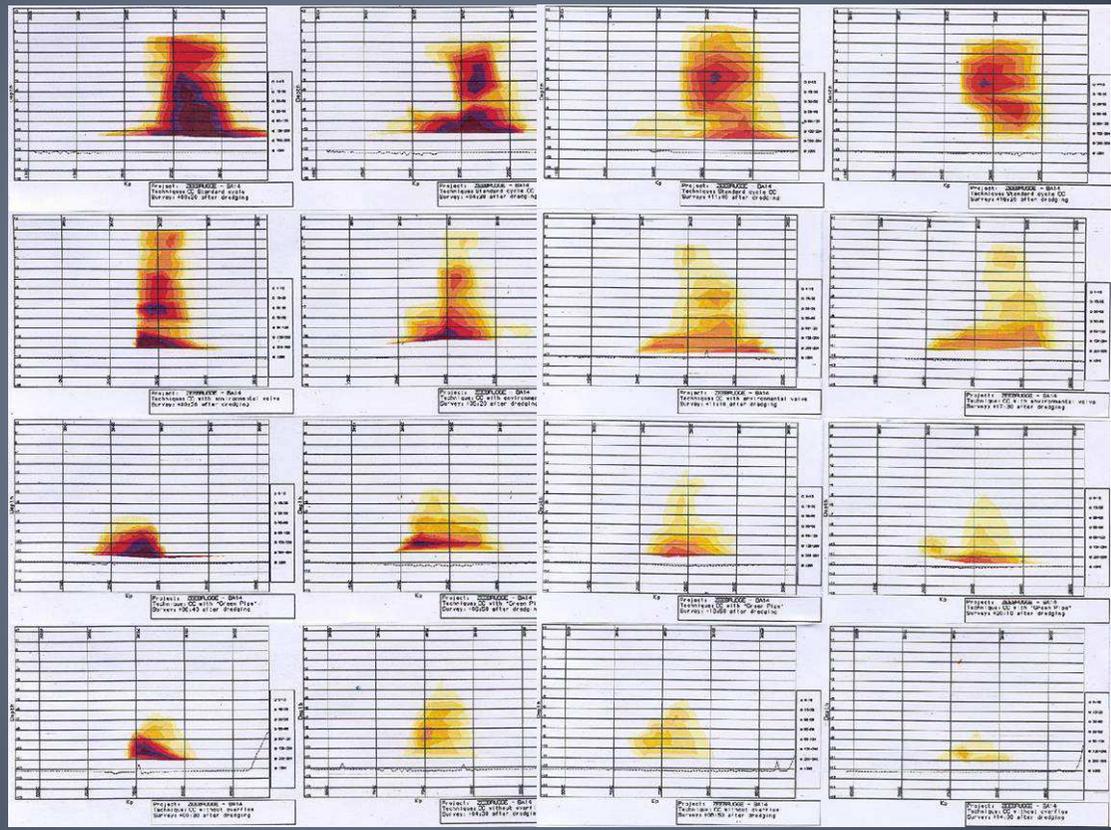
Environmental valve



'Environmental pipe'



No overflow



Time after dredging : 00:30 05:00 10:00 15:00 min

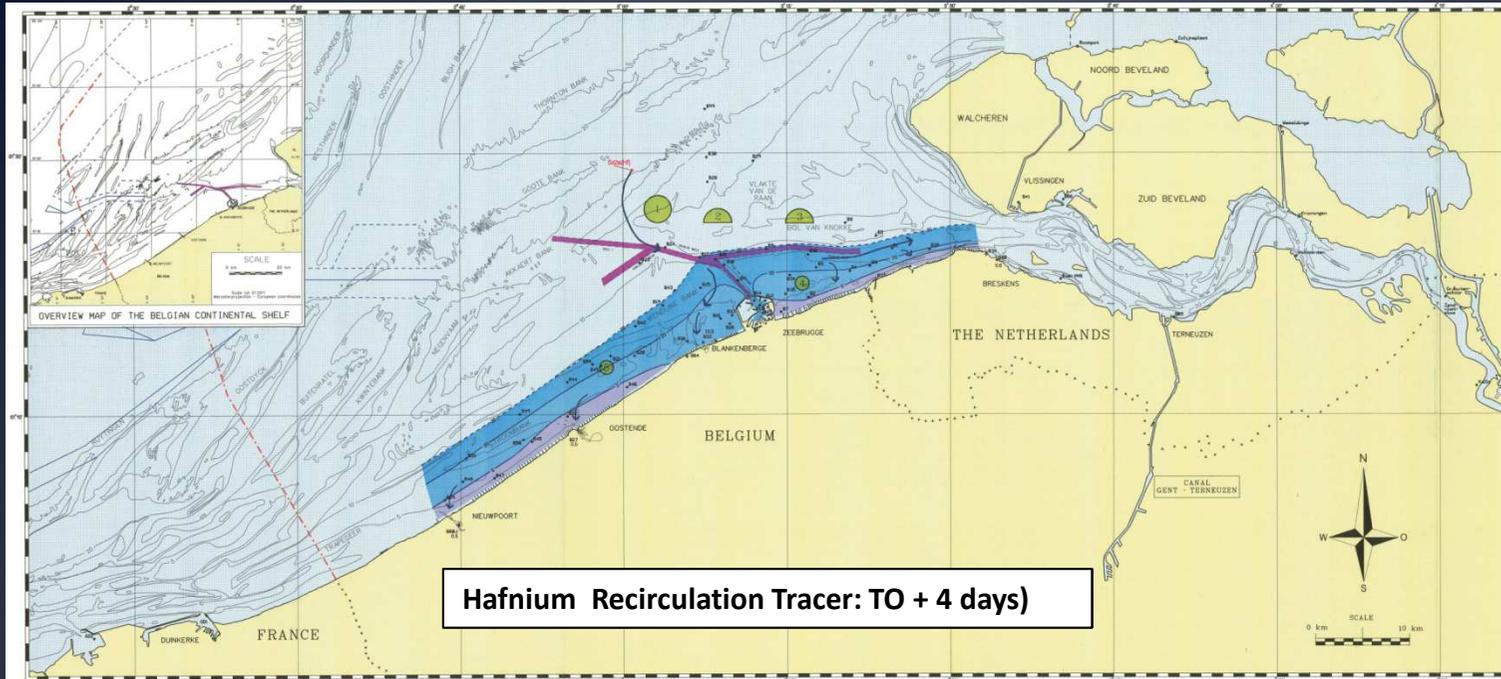
Question 2:

What is the fate of the fine-grained (mud) dredged material dredged and disposed off in open sea?

Does it recirculate back to the dredging areas?

Recirculation tracers (CEA, Saclay technology)

- **Hafnium 175/Hafnium 181 (Th=70d/45d); Act = 1.45×10^{11} Bq**
- **Terbium 160 (Th = 73d) ; Act = 1.50×10^{11} Bq**
- **Physico-chemical co-precipitation of Hf or Tb-solution within the alumino-silicate lattice of clay-particles in the fine-grained sediments and detected via samples in low-background Ge-Li detectors (LNMRI, France)**



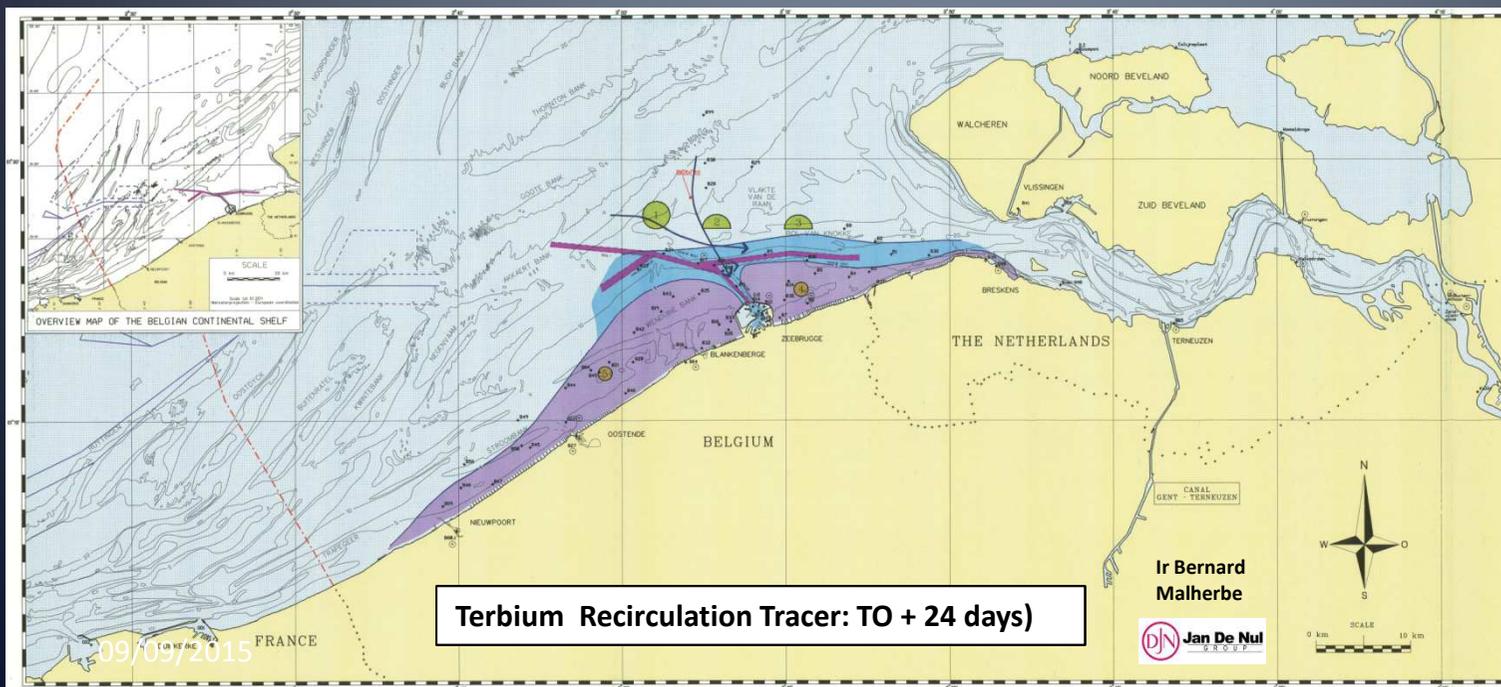
LEGEND

- Sandbank
- Navigation channel
- Depth contour in m
- Border of the Belgian Continental Shelf
- Current direction of recirculation tracer
- No-activity contour of recirculation tracer
- Injection point of recirculation tracer (Station)
- Sampling station
- No silt or old silt
- Below detection limit
- Dumping site of dredged material
- 1 - Br. & W. S1
- 2 - Br. & W. S2
- 3 - Br. & W. R4
- 4 - Br. & W. ZB Oost
- 5 - Br. & W. Oostende

0 - 1
1 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200
200 <

THE BELGIAN CONTINENTAL SHELF WITH DUMPING SITES OF DREDGED MATERIAL

INDEX	DATE	MultiFunctions	Check
DUMPING SITE RESEARCH			
MINISTRY OF THE FLEMISH COMMUNITY ENVIRONMENT AND INFRASTRUCTURE DEPARTMENT WATERWAYS, INFRASTRUCTURE AND MARINE AFFAIRS ADMINISTRATION COASTAL HARBOURS SERVICE			
DETECTED ACTIVITY Sx2 Recirculation experiment Sx2 T3 (To + 4 dagen) Hafnium			
Drawn	JRR	Checked	BME
Date	30/09/14	Scale	1:250.000
Drawing No.	MSB0721	Scale	09,70
Page	103		



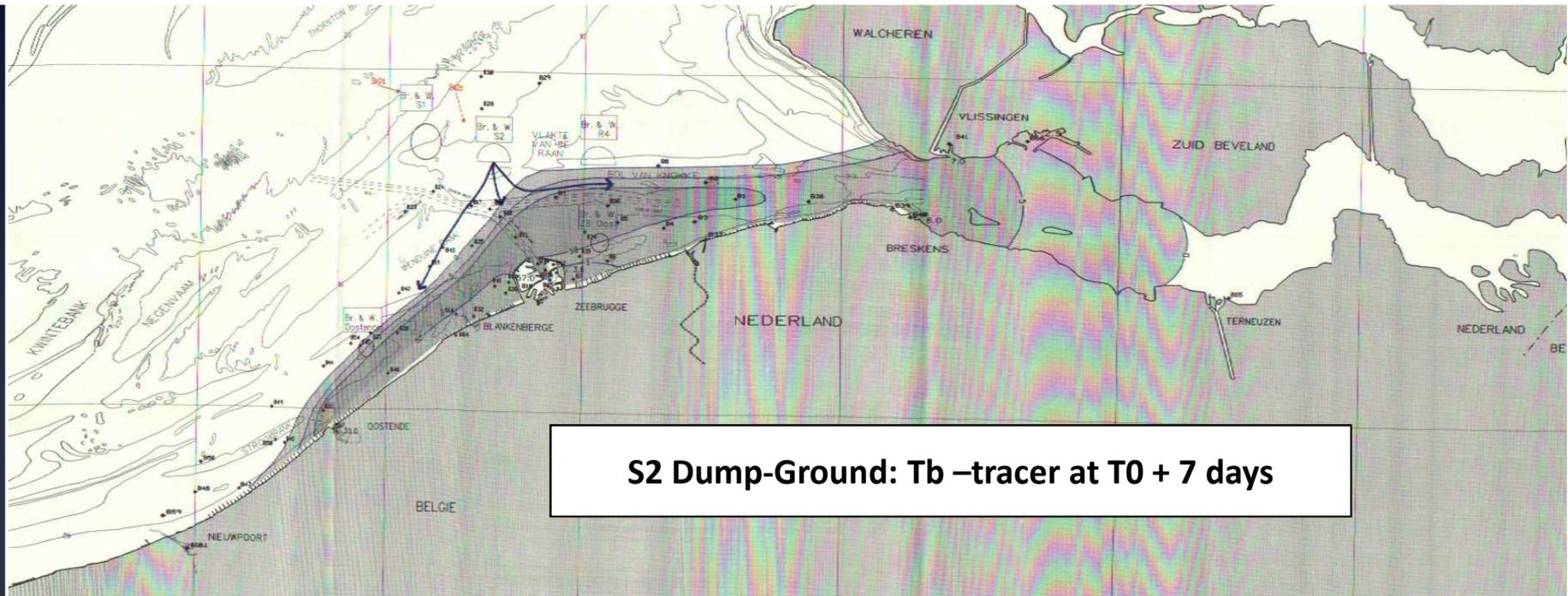
LEGEND

- Sandbank
- Navigation channel
- Depth contour in m
- Border of the Belgian Continental Shelf
- Current direction of recirculation tracer
- No-activity contour of recirculation tracer
- Injection point of recirculation tracer (Terblum)
- Sampling station
- No silt or old silt
- Below detection limit
- Dumping site of dredged material
- 1 - Br. & W. S1
- 2 - Br. & W. S2
- 3 - Br. & W. R4
- 4 - Br. & W. ZB Oost
- 5 - Br. & W. Oostende

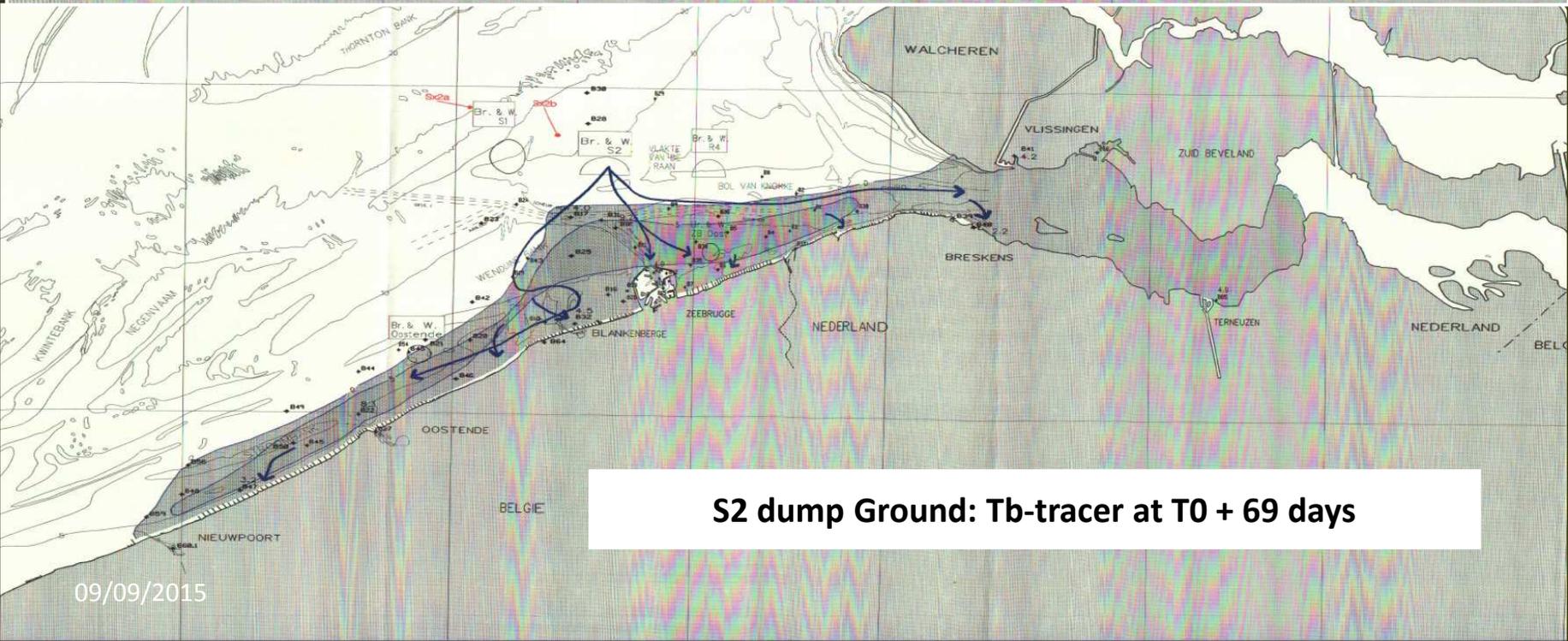
0 - 1
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THE BELGIAN CONTINENTAL SHELF WITH DUMPING SITES OF DREDGED MATERIAL

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DETECTED ACTIVITY Sx2 Recirculation experiment Sx2 T8 (To + 24 dagen) Terbium			
Drawn	JRR	Checked	BME
Date	30/09/14	Scale	1:250.000
Drawing No.	MSB0721	Scale	09,70
Page	114		



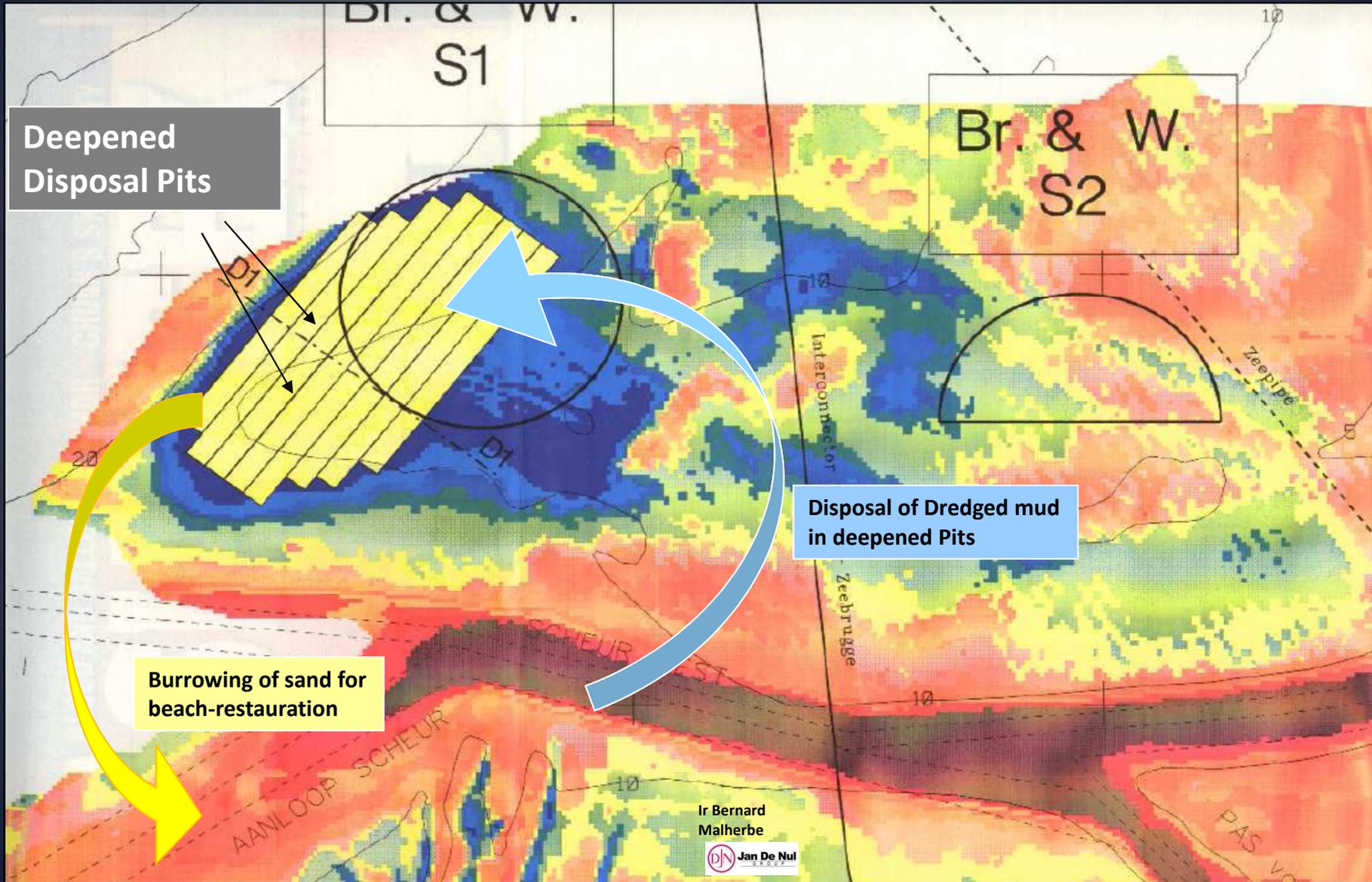
S2 Dump-Ground: Tb-tracer at T0 + 7 days



S2 dump Ground: Tb-tracer at T0 + 69 days

09/09/2015

Sustainable Management Plan of Disposal Ground



Ir Bernard
Malherbe
DjN Jan De Nul
B.K.O.P.

Question 3:

How to achieve sustainable and cost-effective coastal protection by reclaiming sand?

By replicating natural processes and morphology: restauring nature-like beach & dunes

Execution of Morphological Beach - Nourishments:

Shoreface nourishment of subtidal beach & Profile nourishment of intertidal, supratidal beach and foredune



Twin –discharge pipes on intertidal beach



09/09/2015

Nourishment Scheme:

- coastal length: 10.315m'
- volume of profile nourishment: 6,27 Mm³ (av 610 m³/m')
- volume of feeder-berm: 3,74 Mm³ (av 360 m³/m')

Bredene, Vosseslag,
De Haan, Vlissegem,
Nieuwmunster

22/24

Monitoring a geo-engineered beach-nourishment over 20 years

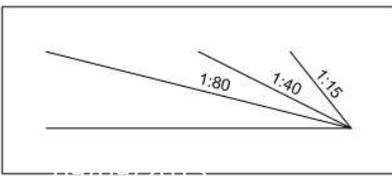
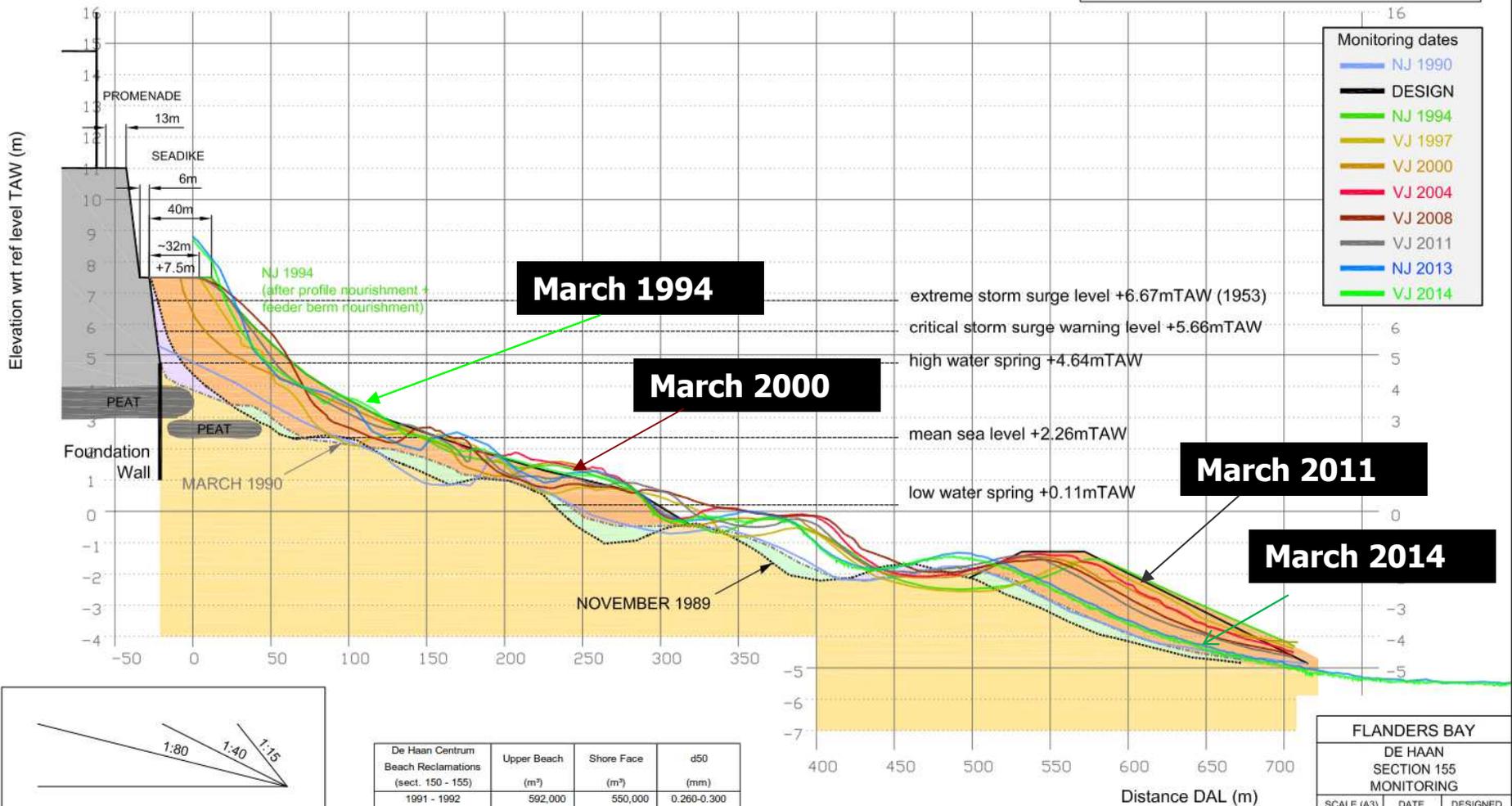


More than 70 % of the once reclaimed sand "stays" in the primary beach barrier system and is redistributed in the ridge& runnel pattern

DE HAAN CENTRUM - SECTION 155

MONITORING OF SECTION 155

- EROSION AFTER FEB'90 STORM
- SEDIMENTATION AFTER FEB'90 STORM
- ORIGINAL BEACH



De Haan Centrum Beach Reclamations (sect. 150 - 155)	Upper Beach (m ²)	Shore Face (m ²)	d50 (mm)
1991 - 1992	592,000	550,000	0.260-0.300
2000	260,493		0.270

Ir Bernard Malherbe

FLANDERS BAY		
DE HAAN SECTION 155 MONITORING		
SCALE (A3)	DATE	DESIGNED
1/8 = 1/2500 1/8 = 1/125	2/05/14	BVD
DRAWING NUMBER:		
DEHN-2-CS-001		REV.1

Perspectives: activation tracers

- To avoid lengthy safety and permit procedures
- To integrate very long monitoring periods

THANK YOU !