Some remarks about sediment budgets in the Danish Wadden Sea.

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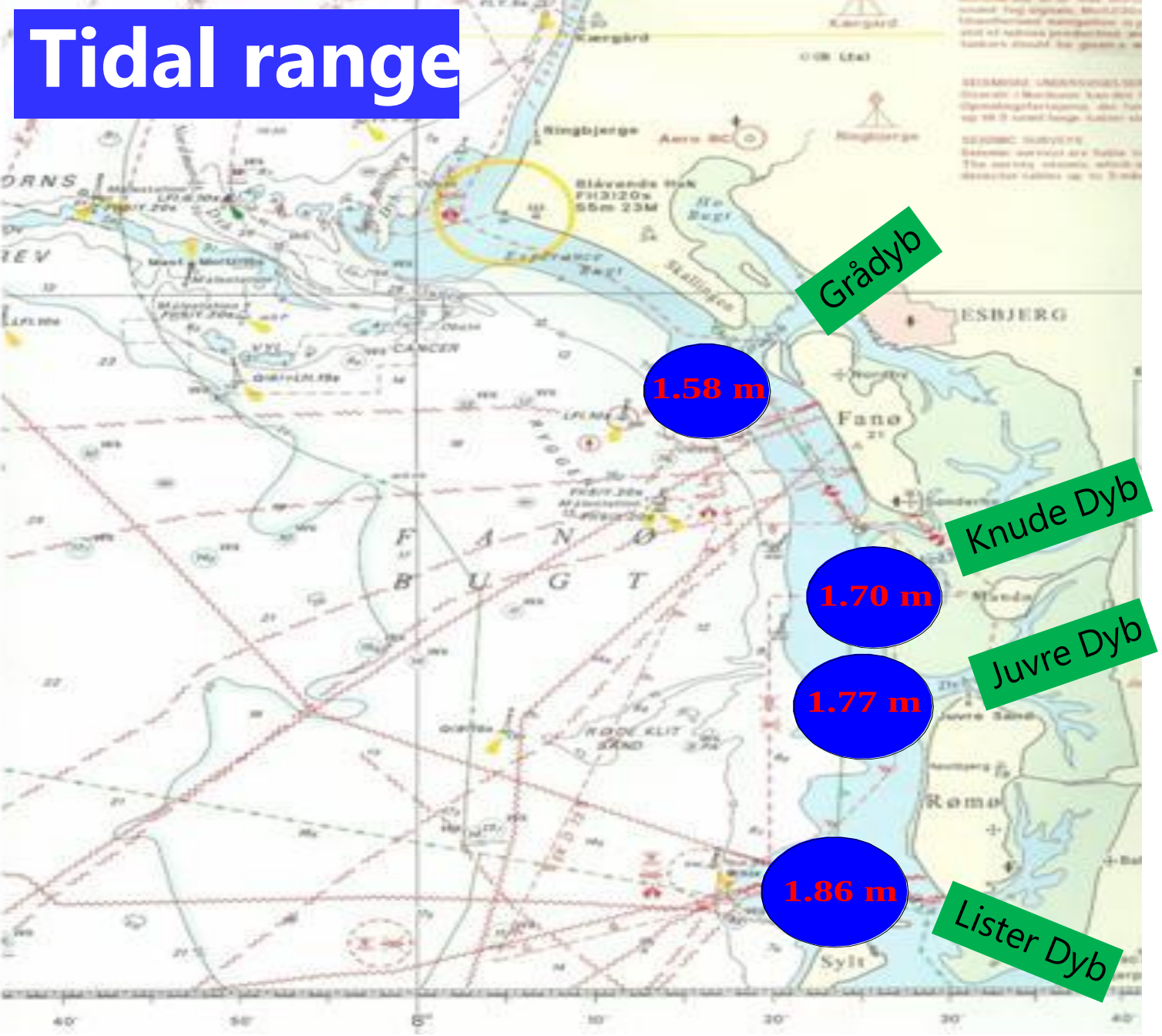
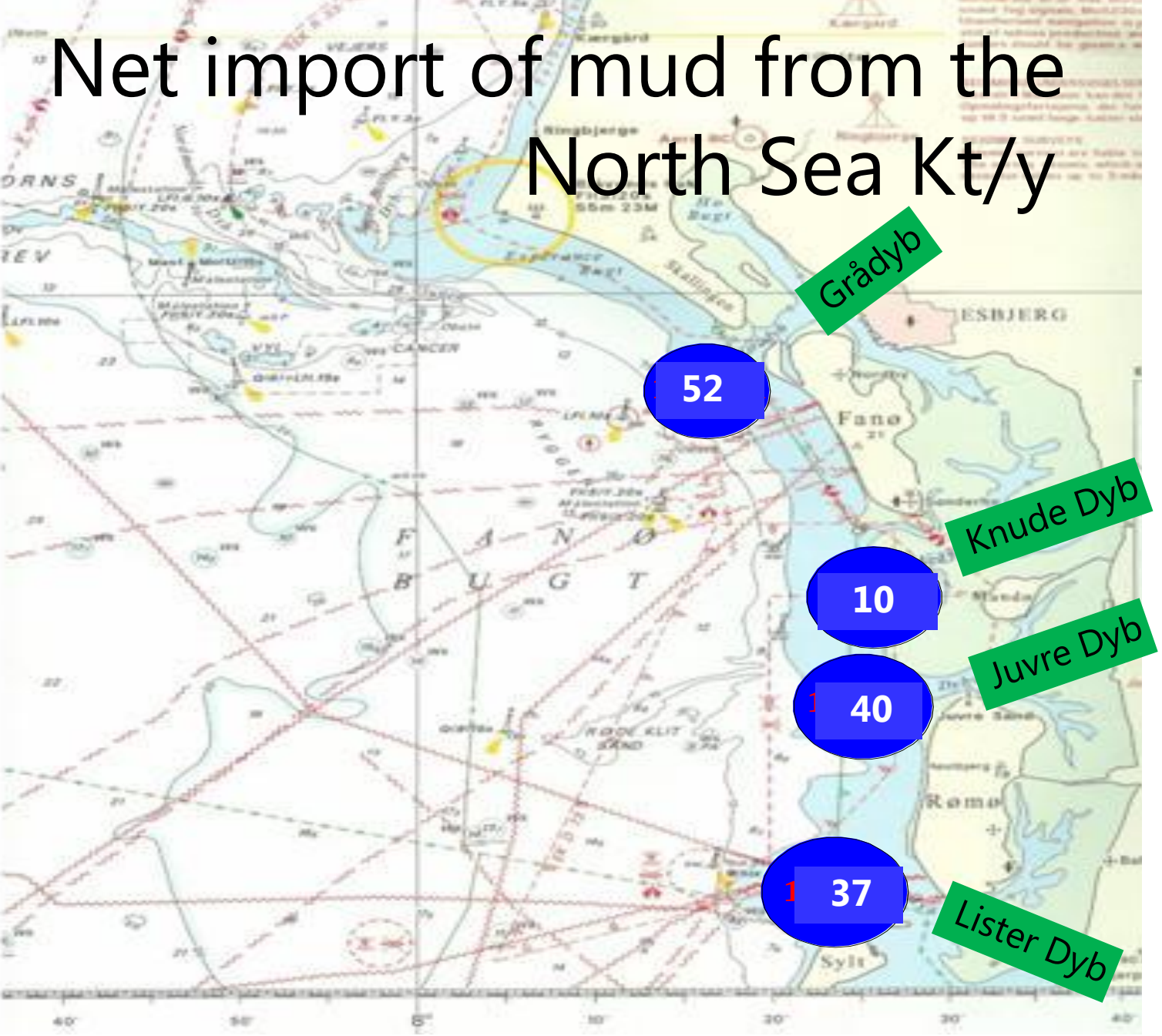
Tidal range



The tidal range in the North Sea adjacent to the Danish Wadden Sea decreases towards the north from 1.86 m at Listerdyb (*Danish Coastal Authority*) to 1.58 m at Grådyb (*evaluated from a 10 year period in the 1990's*).

The variation between neap and spring is small less than 25%.

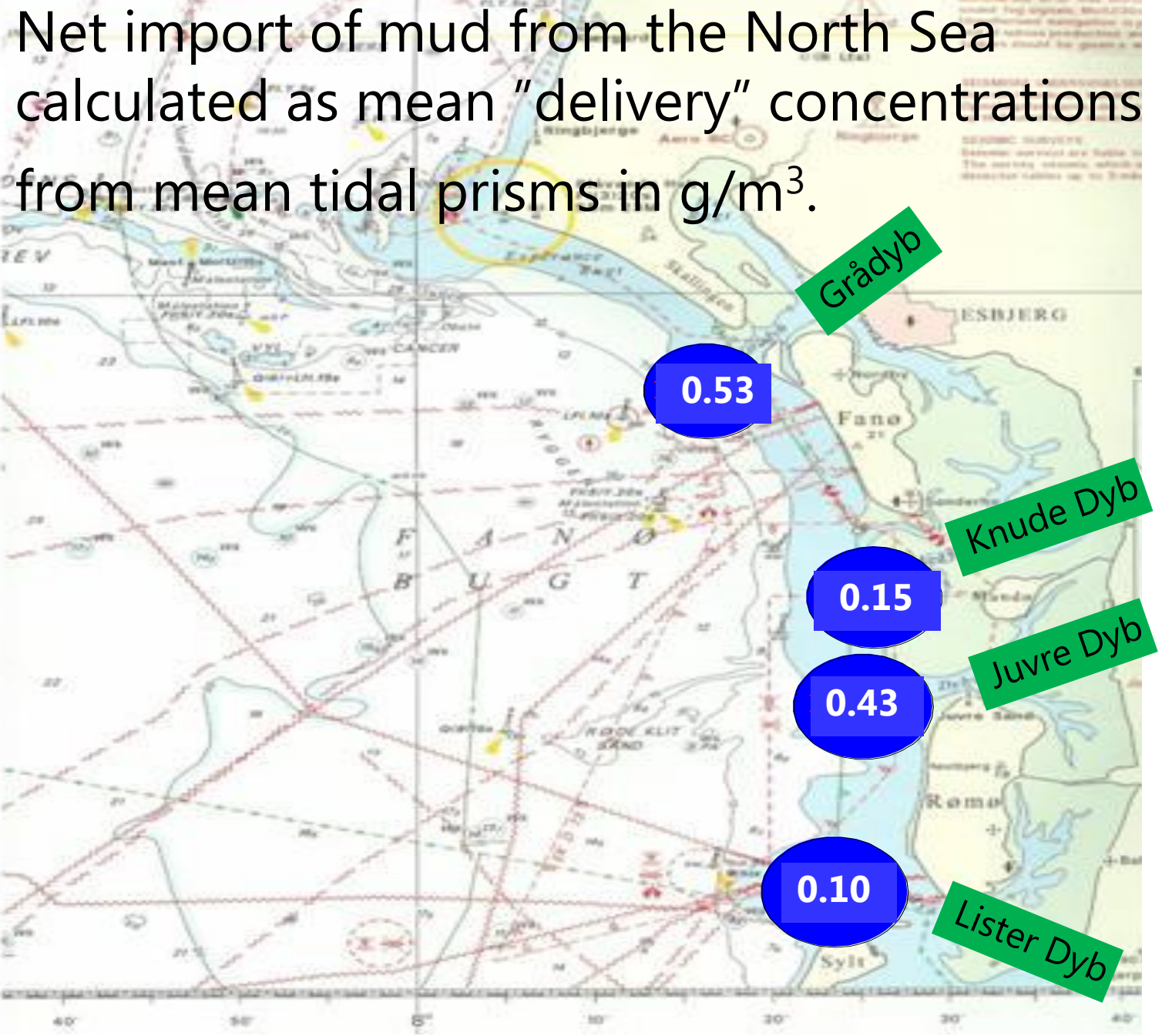
Net import of mud from the North Sea Kt/y



The net annual import of mud fromThe North Sea to the four northernmost tidal areas
In the Wadden Sea is 139 10^3 t.

Grådyb, Knude Dyb and Juvre Dyb (Pedersen & Bartholdy 2006); Lister Dyb (Pejrup et al. 1997)

Net import of mud from the North Sea calculated as mean "delivery" concentrations from mean tidal prisms in g/m^3.



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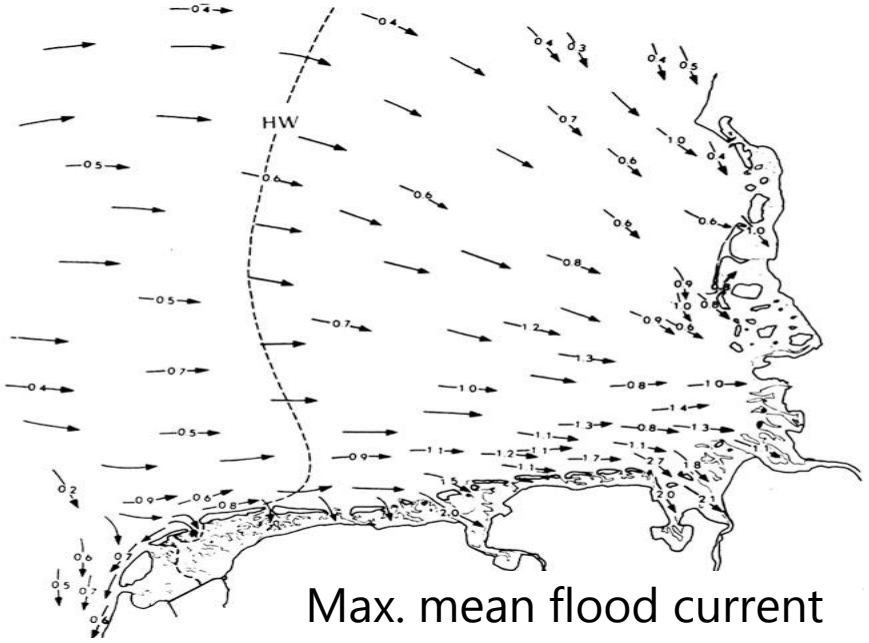
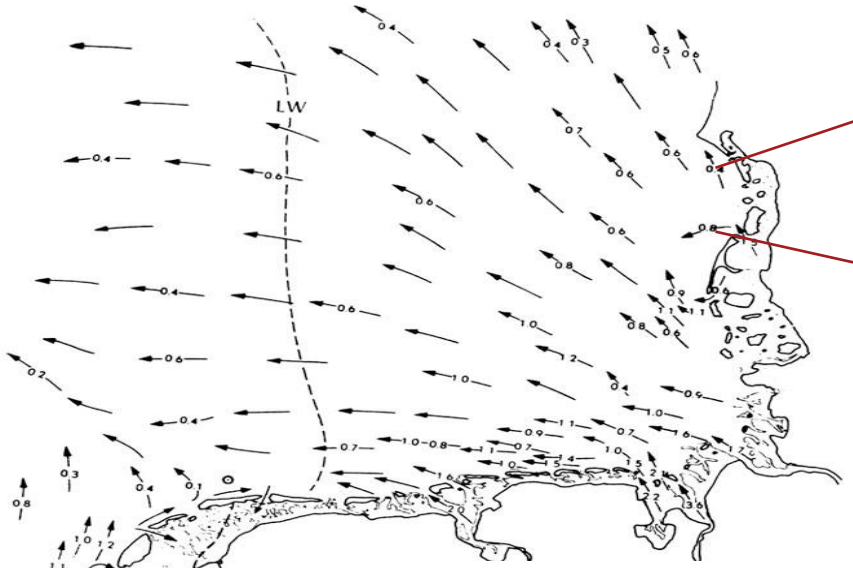
The variation is partly due to variations in the size of exposed salt marsh areas, partly due to differences in depositional conditions between closed and open tidal areas and partly (presumable primary) due to various depositional conditions outside on the coast near North Sea shelf.



Max. mean flood current

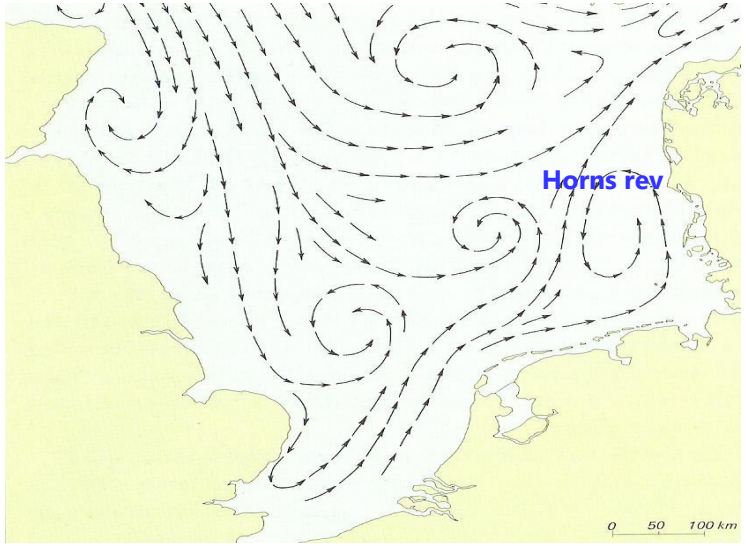
The maximum tidal current (ebb) in the North Sea decrease from c. 0.8 m s^{-1} in the shelf area off of Lister Dyb in the southern part of the Danish Wadden Sea to 0.4 m s^{-1} in the shelf area off of Grådyb in the northern part.
This is a significant decrease which from a sedimentological point of view crosses an important border of about 0.3 N/m^2 --- close to the critical bed shear stress before erosion of newly deposited mud.



0.4 m/s

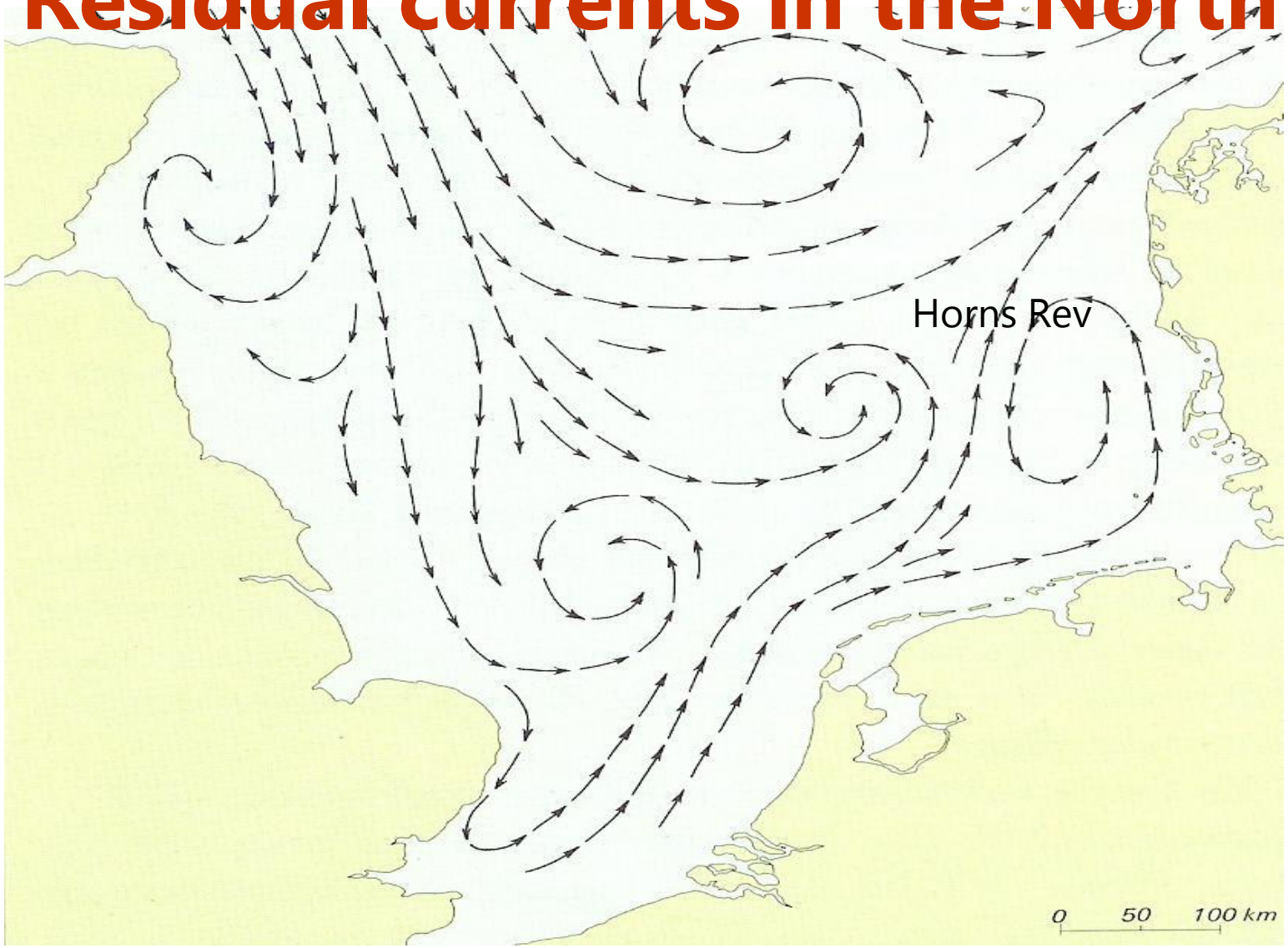
0.8 m/s

Max. mean ebb current



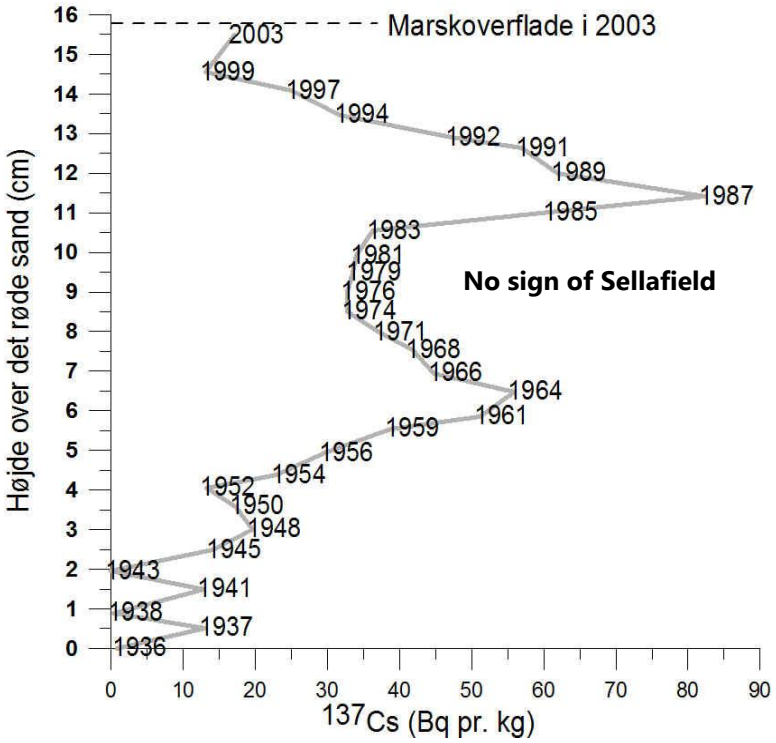
Added to this is, that the residual current pattern in The North Sea, during "normal" conditions form a large vortex is south of Horns Rev, enhancing the possibility of mud deposition between storms in the northern part of this shelf area.

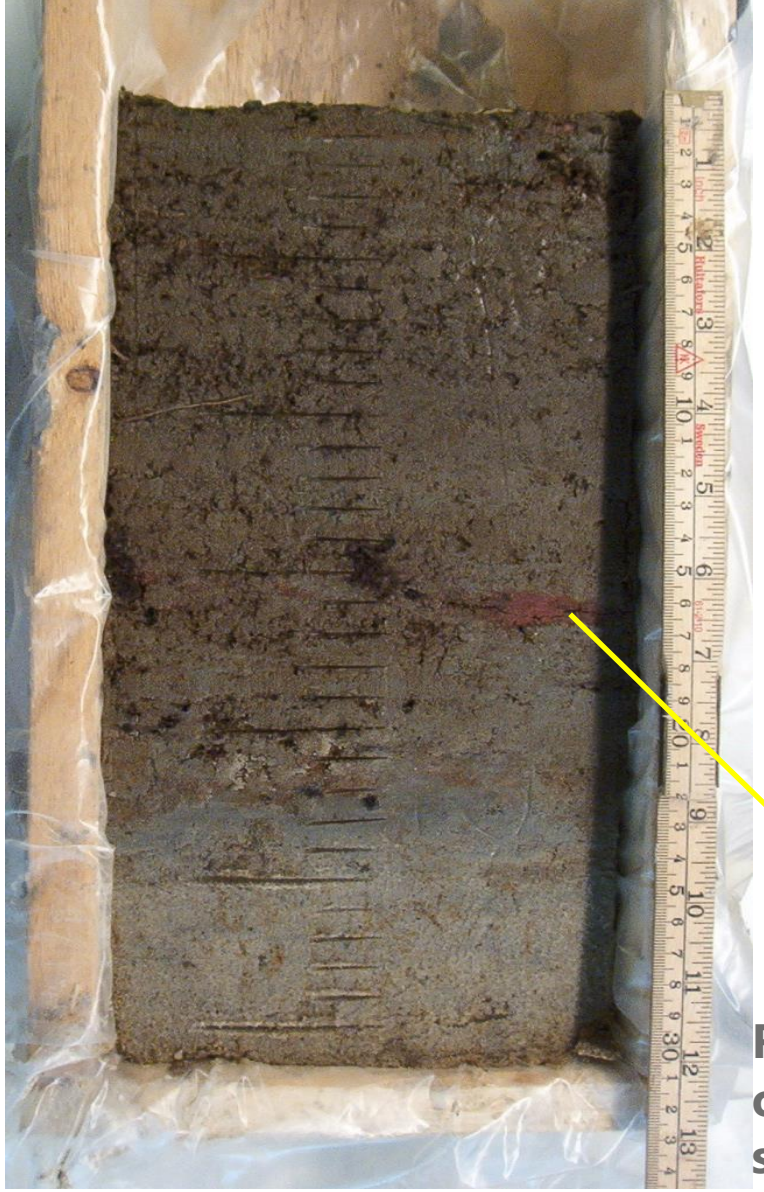
Residual currents in the North Sea

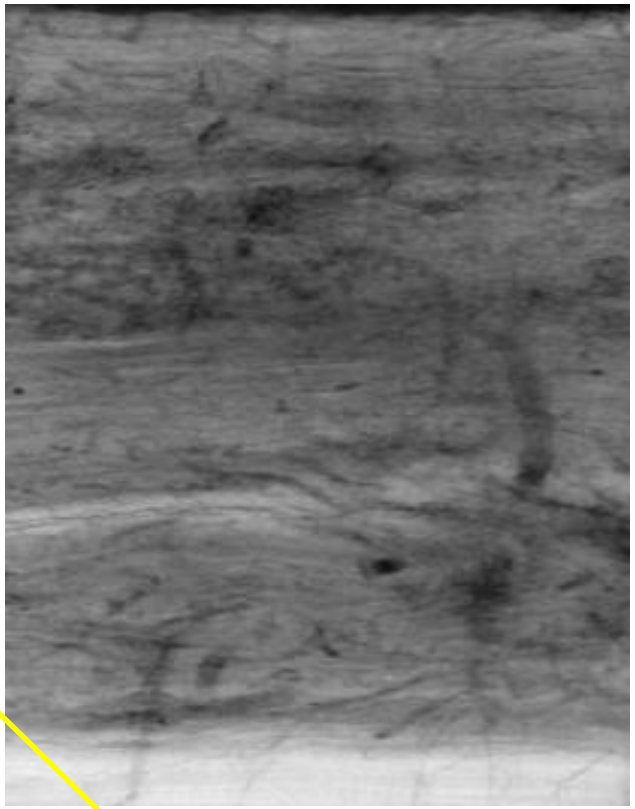


The pattern of the residual current in the North Sea, also suggests that the East Anglia Plume never will reach the Wadden Sea, even in the most northern part.

From Prandle et al. 1994

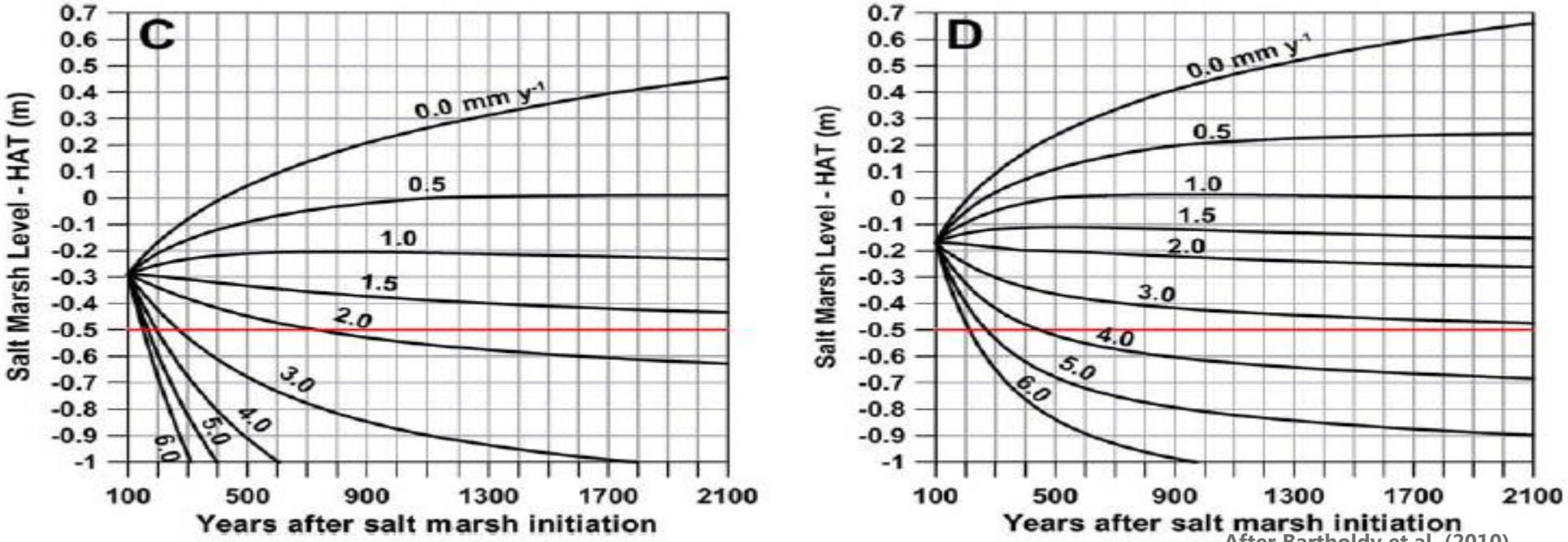






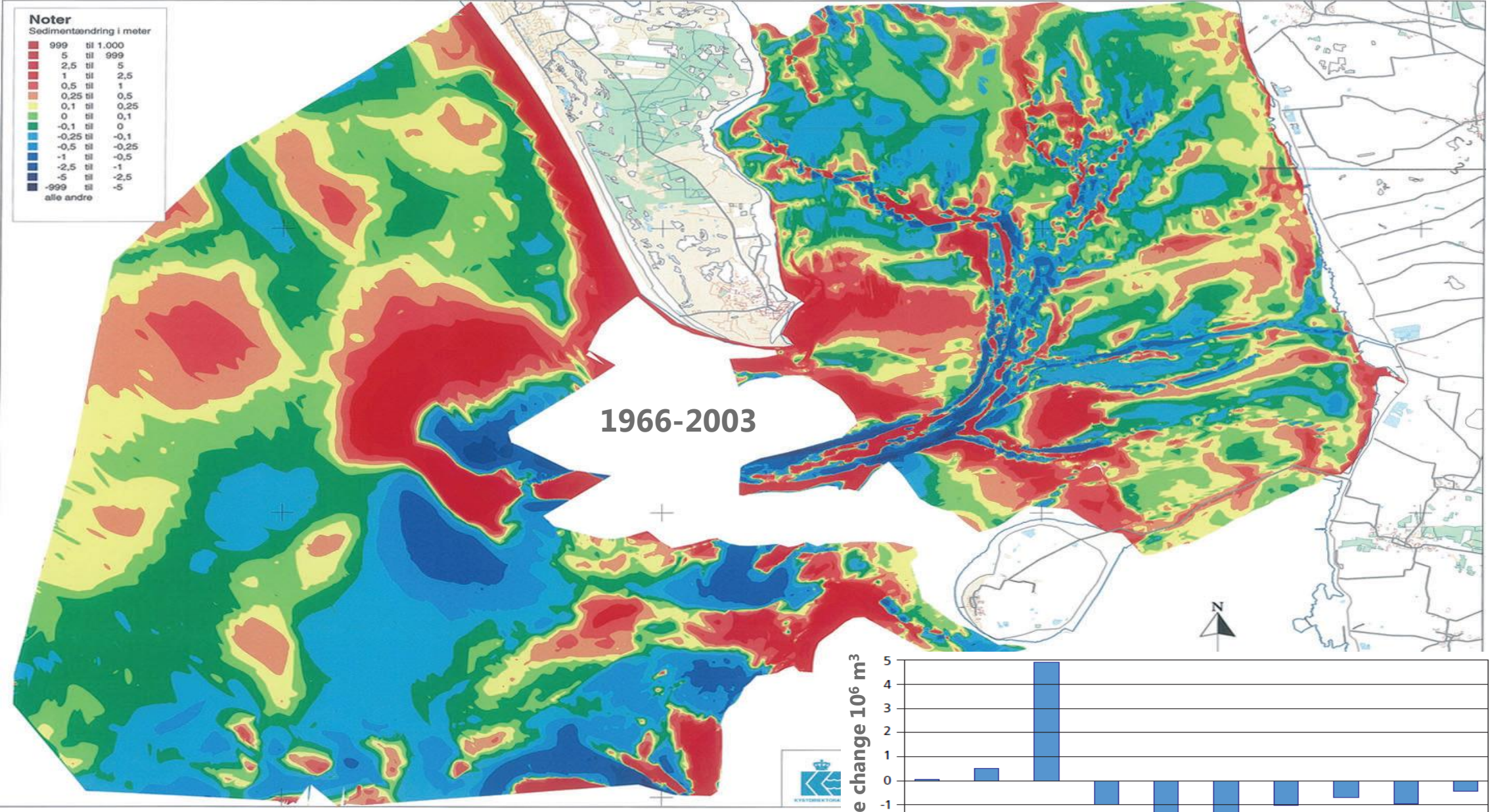
Red sand spread out on the salt marsh surface in 1936.

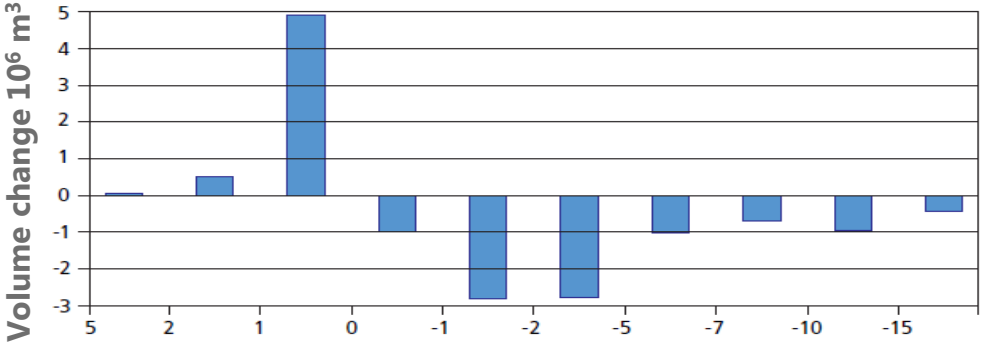
GM4-1936

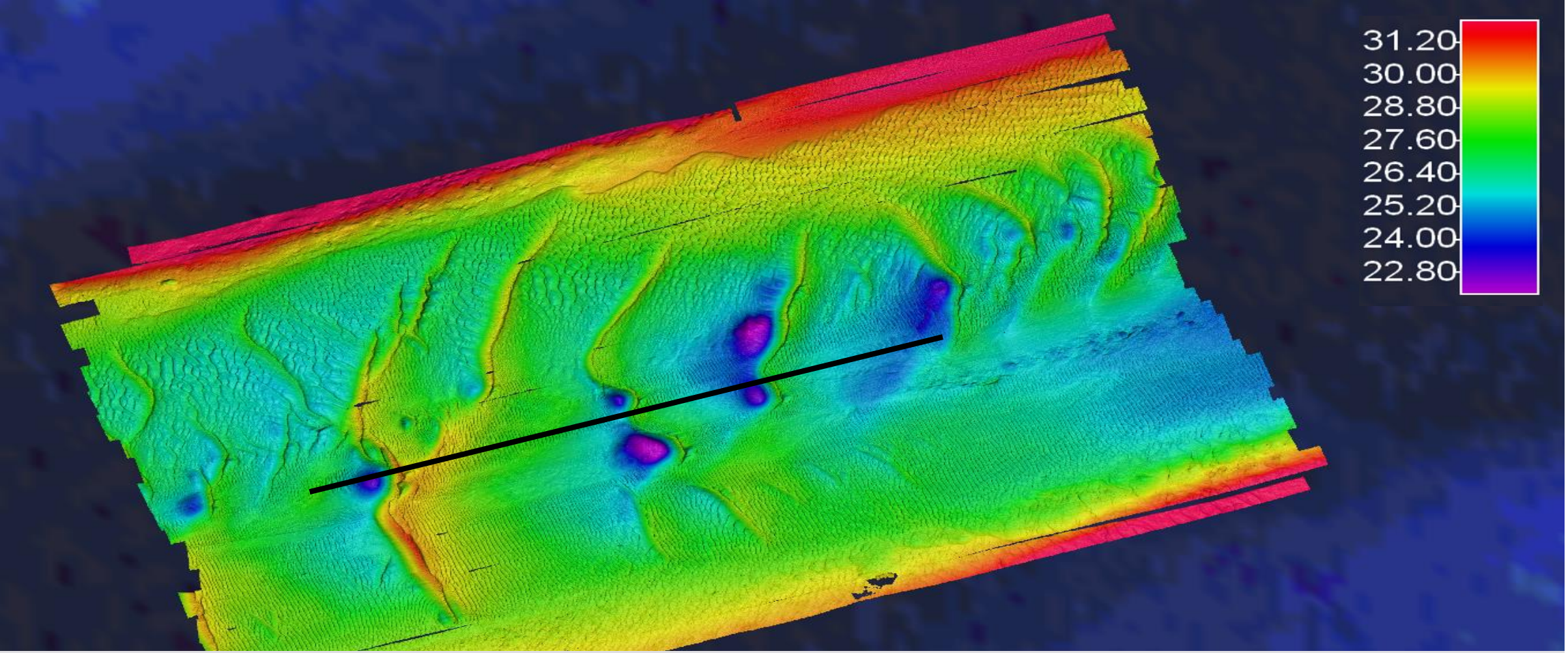


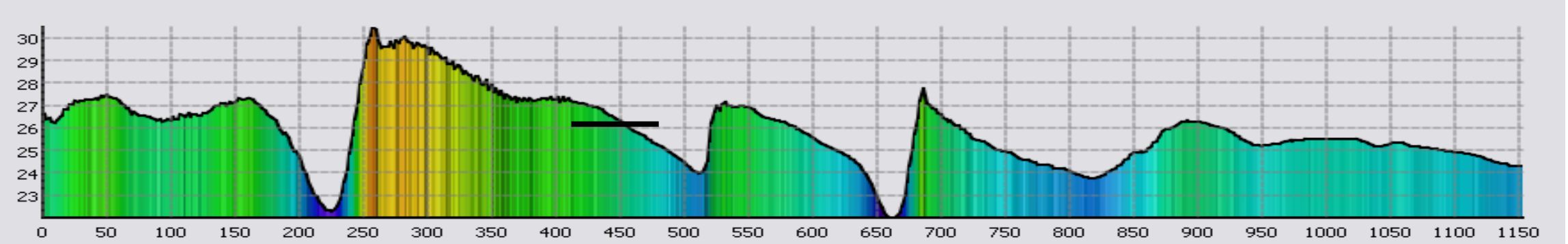
After Bartholdy et al. (2010)

Simulated saltmarsh level relative to the highest astronimical tide (HAT)
For the inner part (C) and outer part (D) of the Skallingen Saltmarsh. The salt marsh disintegrate when the level gets bleow half a meter under HAT.

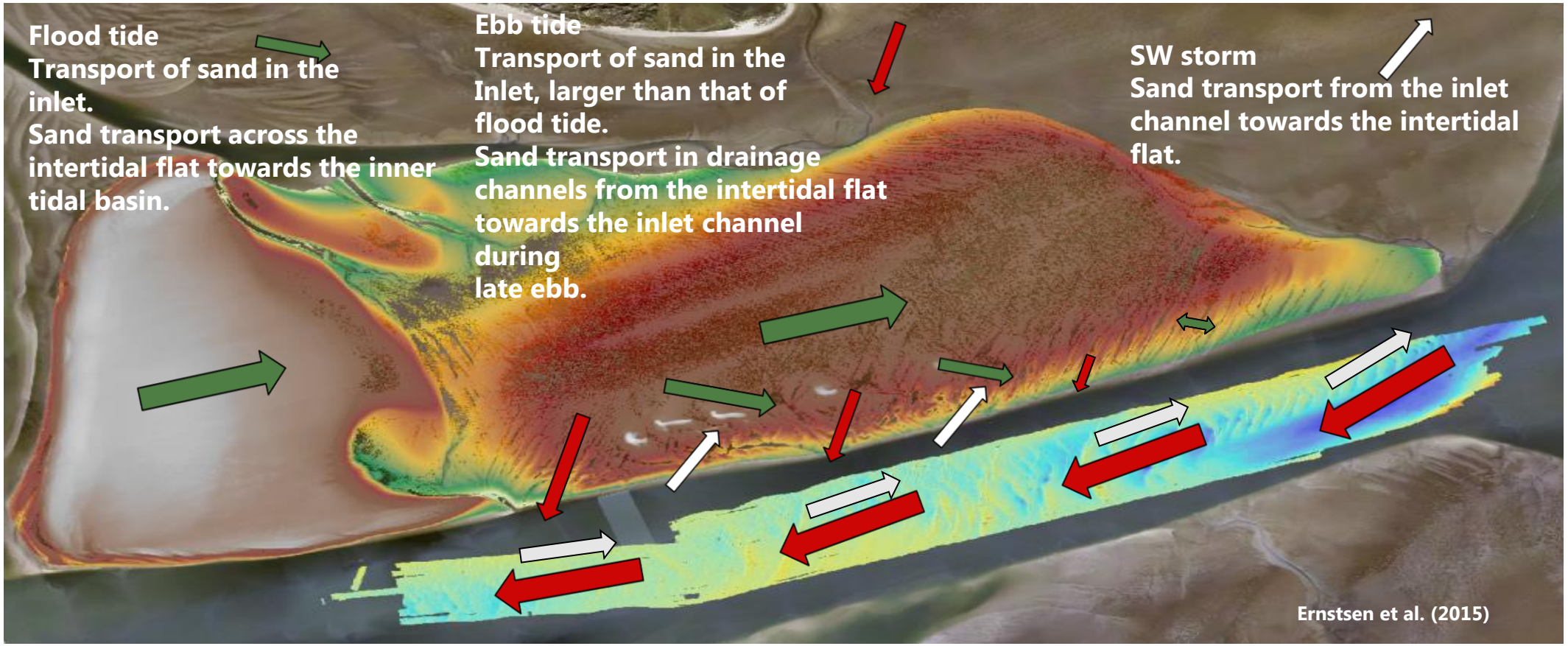

Noter
Sedimentændring i meter
999 til 1.000
5 til 999
2,5 til 5
1 til 2,5
0,5 til 1
0,25 til 0,5
0,1 til 0,25
0 til 0,1
-0,1 til 0
-0,25 til -0,1
-0,5 til -0,25
-1 til -0,5
-2,5 til -1
-5 til -2,5
-999 til -5
alle andre
1966-2003
N
Level (m, DVR90)

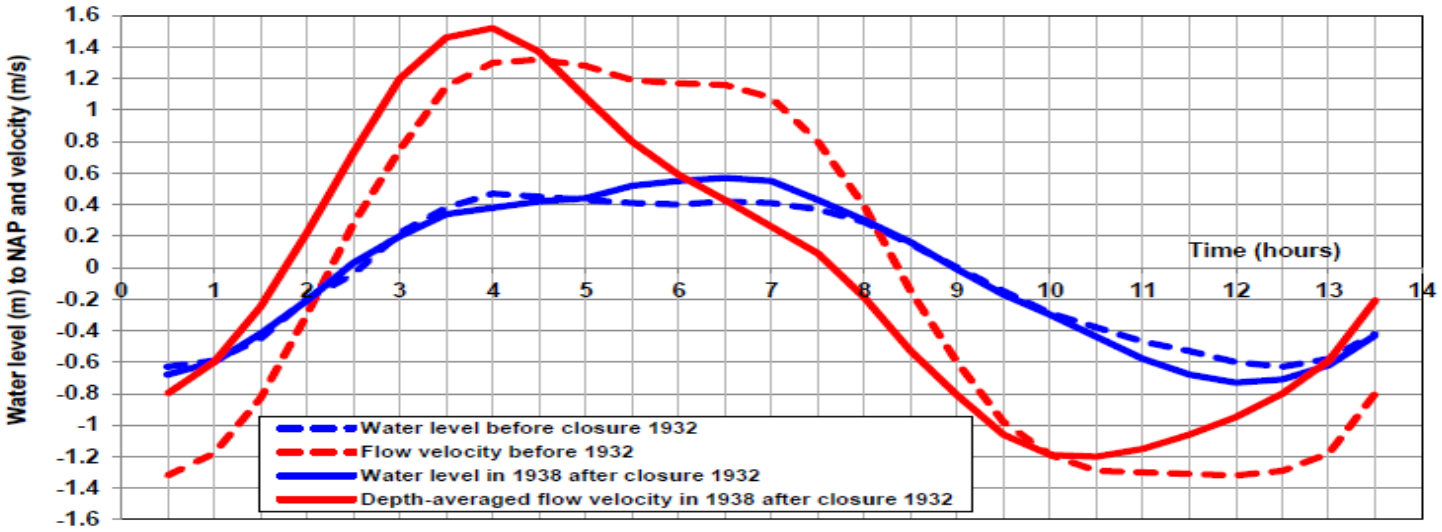

Volume change 10^6 m^3
5
4
3
2
1
0
-1
-2
-3
5
2
1
0
-1
-2
-5
-7
-10
-15

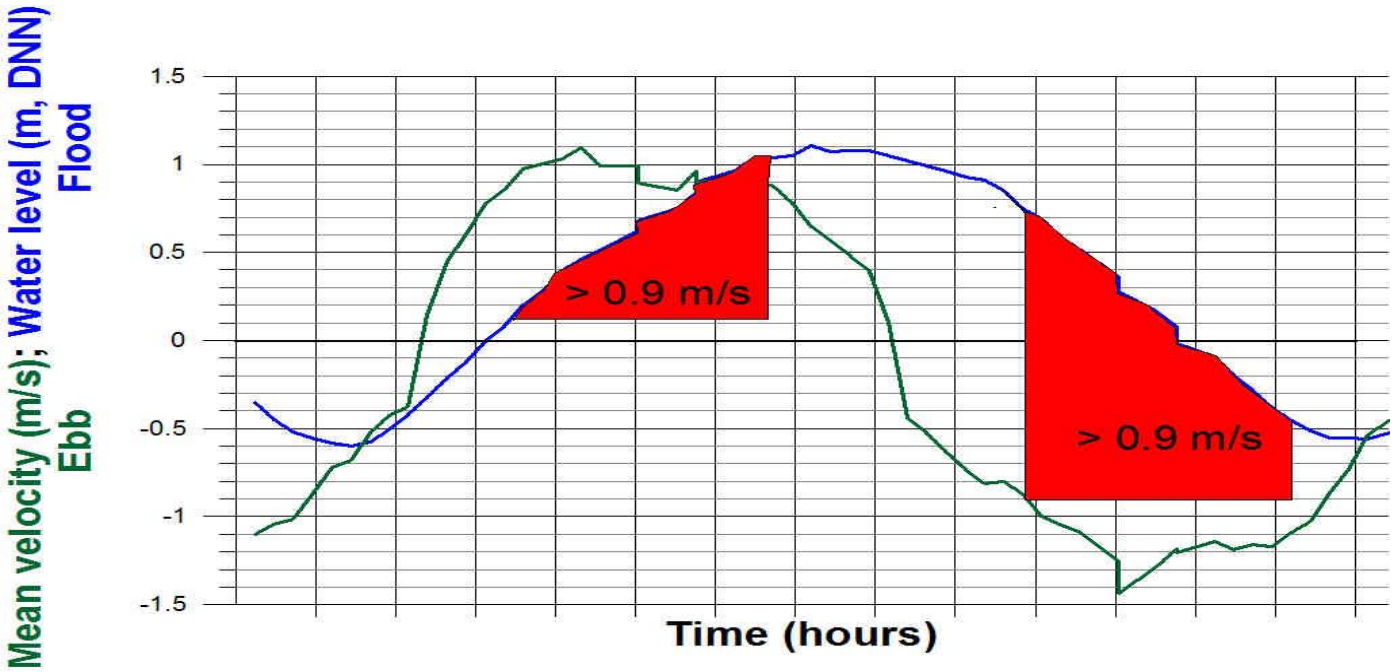

31.20
30.00
28.80
27.60
26.40
25.20
24.00
22.80


30
29
28
27
26
25
24
23
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
1150

Studies based on repeated surveys (multibeam and LIDAR) in the Knude Dyb tidal inlet Ernstsen et al. (2009) suggested a conceptual model of recirculating sand transport in the inlet. Net flood directed transport over the tidal flat adjacent to the inlet, net ebb directed transport in the channel, supply of sand from the tidal flat to the channel during late ebb, and supply of sand from the channel to the tidal flat during storms.







There are differences in the tidal conditions between the suddern part of the Wadden Sea (The Netherlands) and the northern part (Denmark). Even if the Tidal range is similar (a bit smaller in the south) tidal pumping is functioning In the Netherlands, whereas all tidal inlets in the Northern part are ebb dominated.

This means that The Netherlands have more use of the sand from the ebb tidal deltas, as nourishment of its tidal areas, than Denmark.

Conclusions:

1. **The annual import of mud to the Danish Wadden Sea is about 139 000 t.**

2. **Because of dynamic differences on the coast-near shelf (in casu a vortex in the residual current) there is a larger import in the north and a smaller import in the southern part of the Danish Wadden Sea.**

3. **Mud in the East Anglia Plume is not part of the import to the Danish Wadden Sea.**

4. **There are no reasons for fearing an immediate drowning of the Wadden Sea Landscape.**

5. **Differences in the tidal dynamics between The Netherlands and Denmark provide better conditions for tidal pumping in the Dutch Wadden Sea whereas tidal inlets in the Danish Wadden Sea are ebb-dominated.**