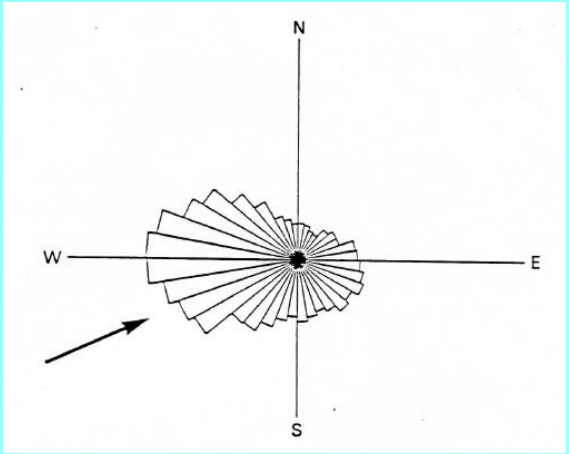
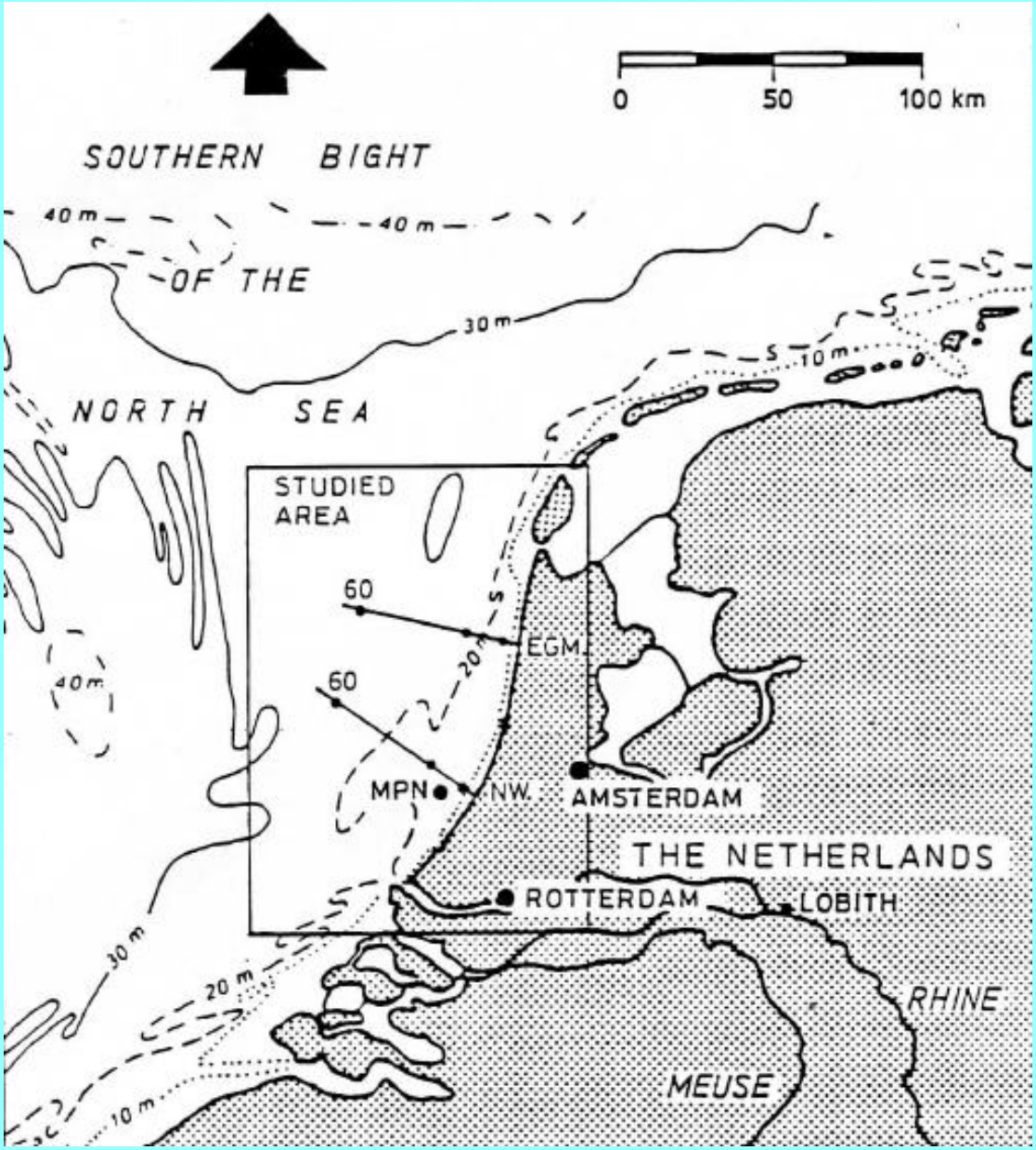
Coastal dynamics

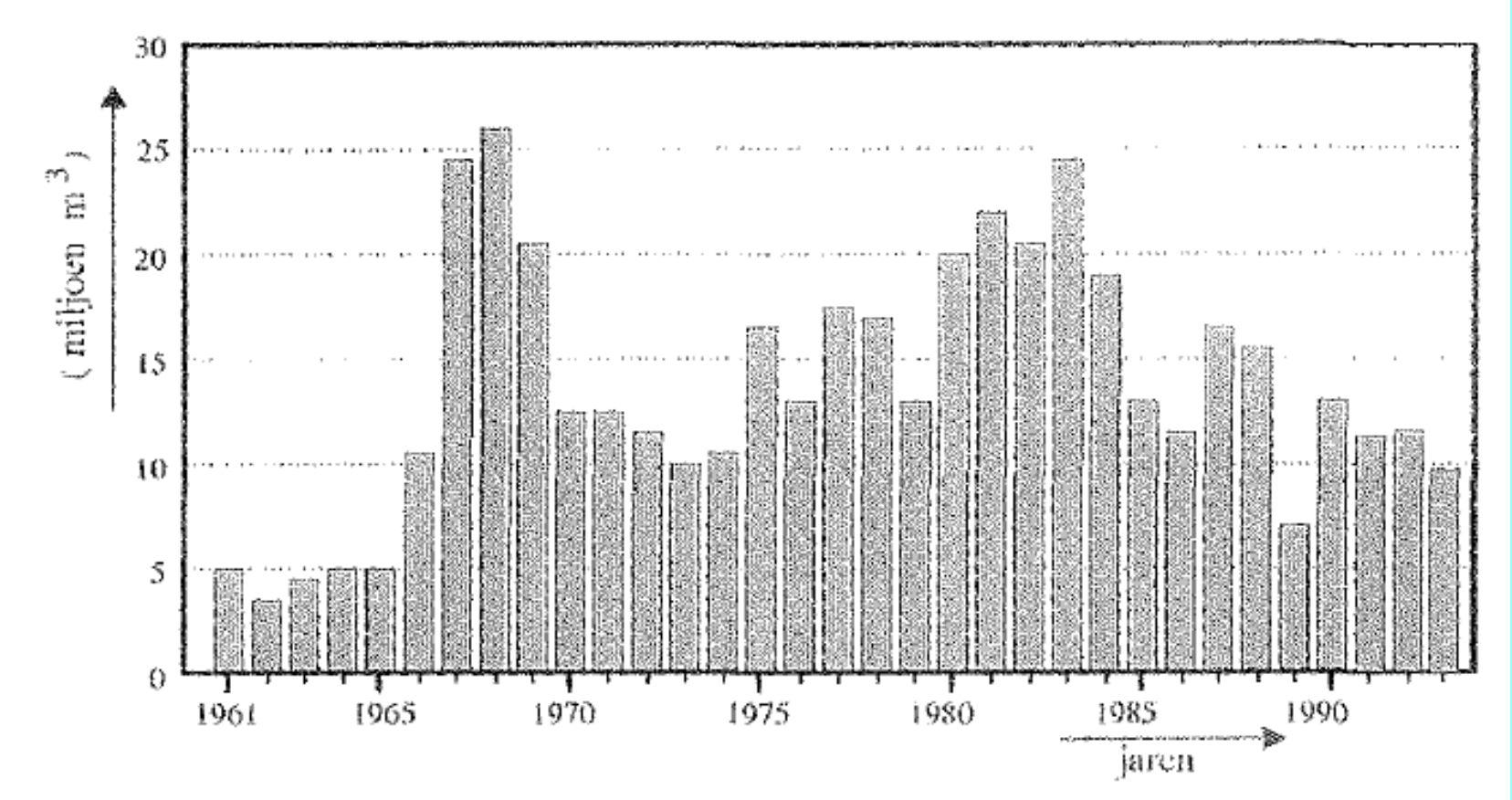
Experiments and observations 1962-1982





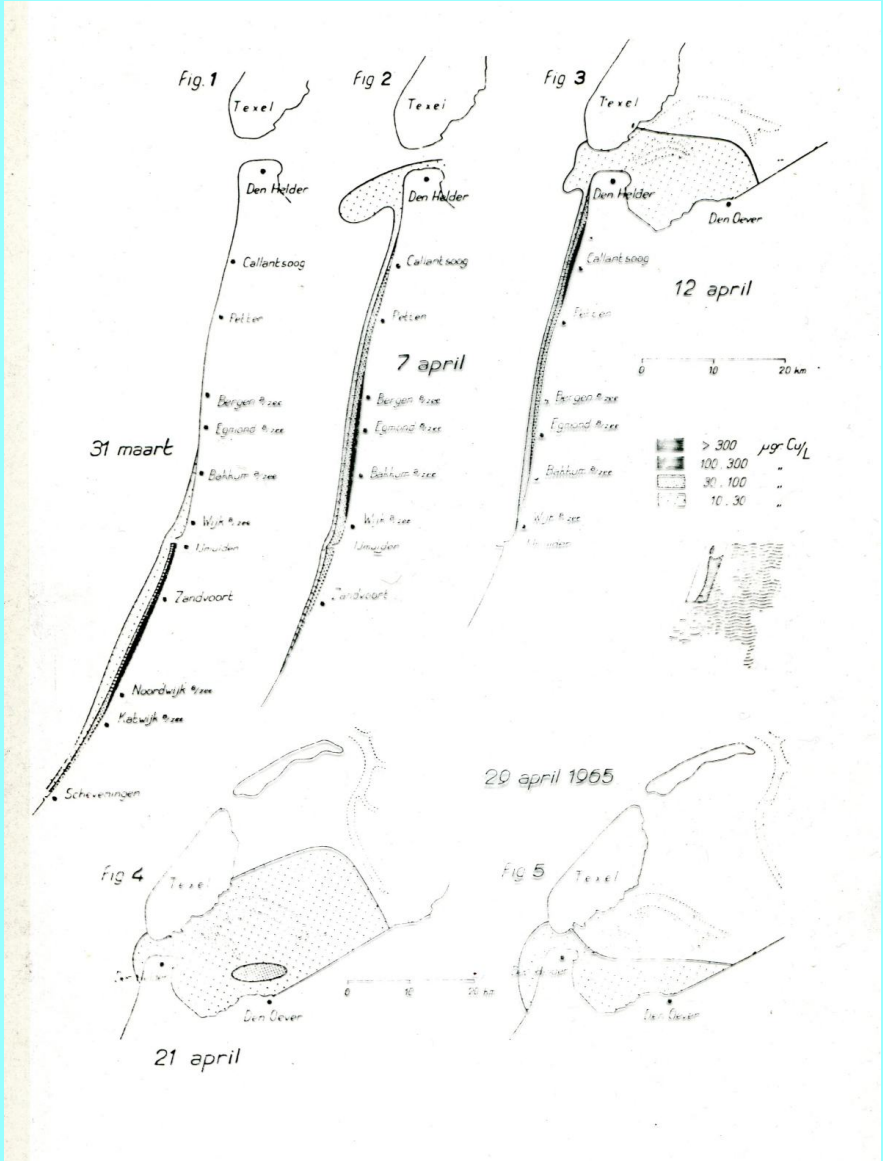

LOSWAL NOORD-WEST
LOSWAL NOORD OOST
16 VERDIEPTE LOSWALLEN
(5 mln kubieke meter inhoud)
Referentie-Alternatief
LOSWAL NOORD
Hoek van Holland

Dredging Rotterdam



1964 closure entrance to Grevelingen
1958-1972 (1968) closure Haringvliet

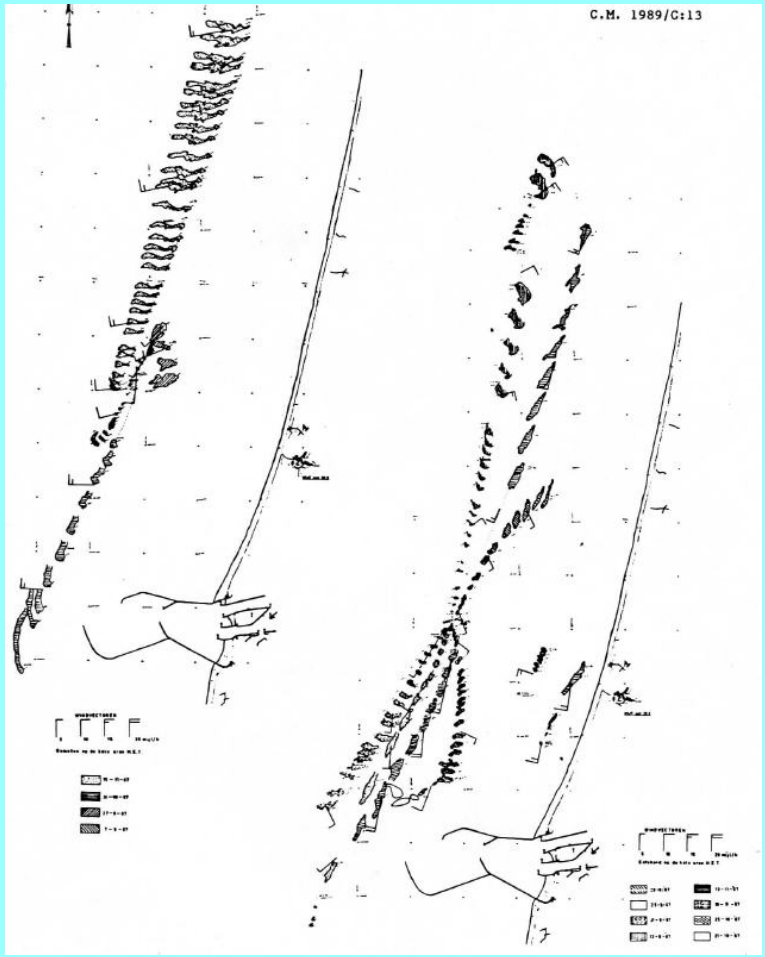
Copper on the beach in 1965



Dyes and helicopters

In the years 1962 to 1982 a rather great number of dye experiments in the North Sea was performed by researchers from the Netherlands

Modelling data



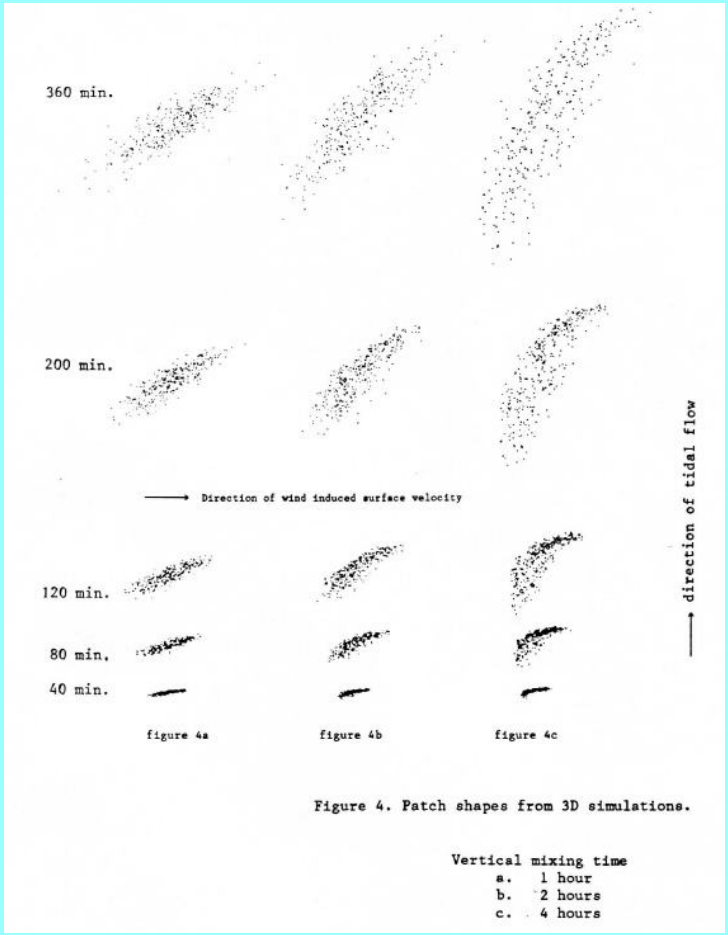
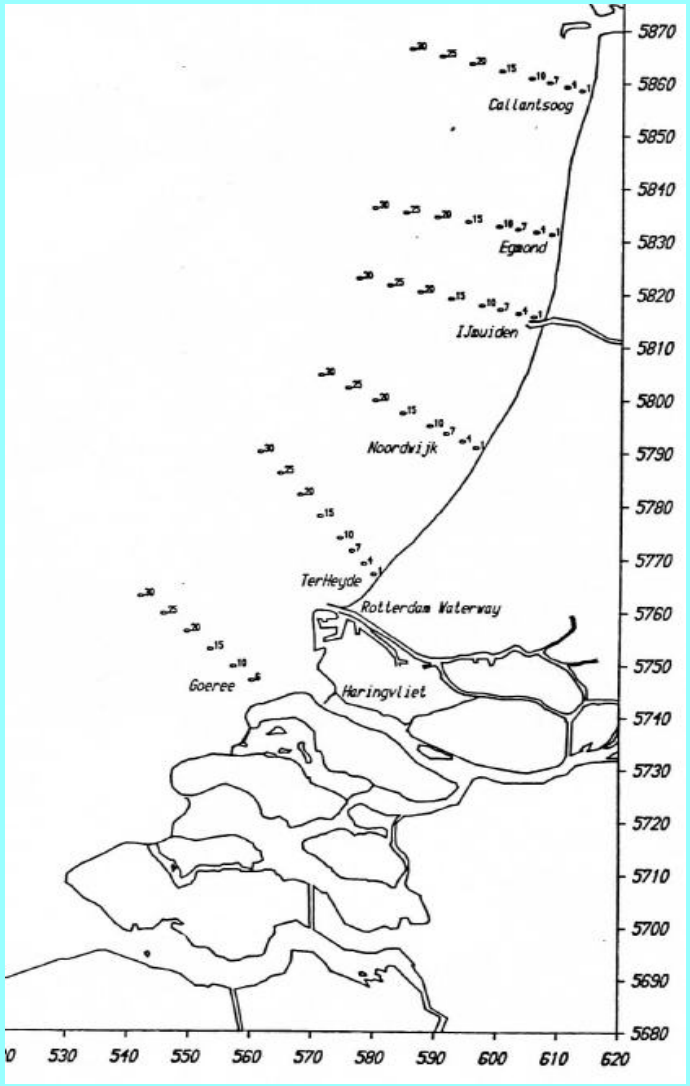
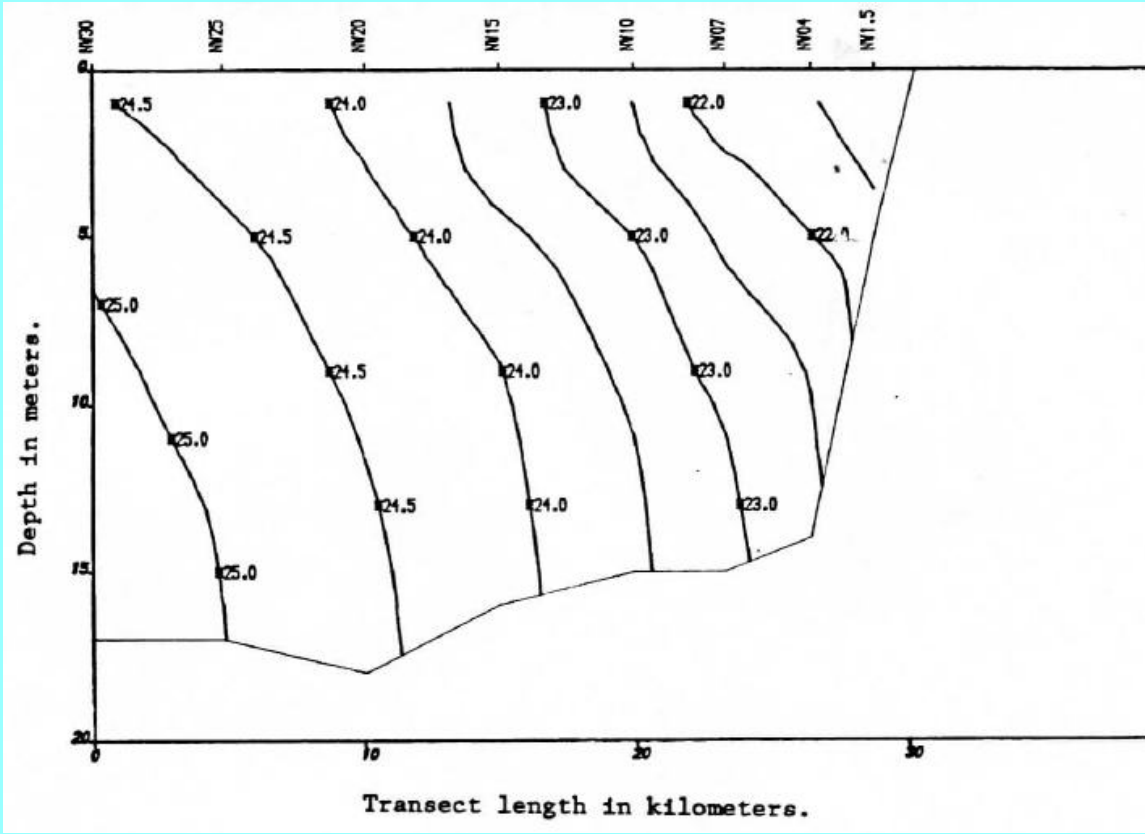


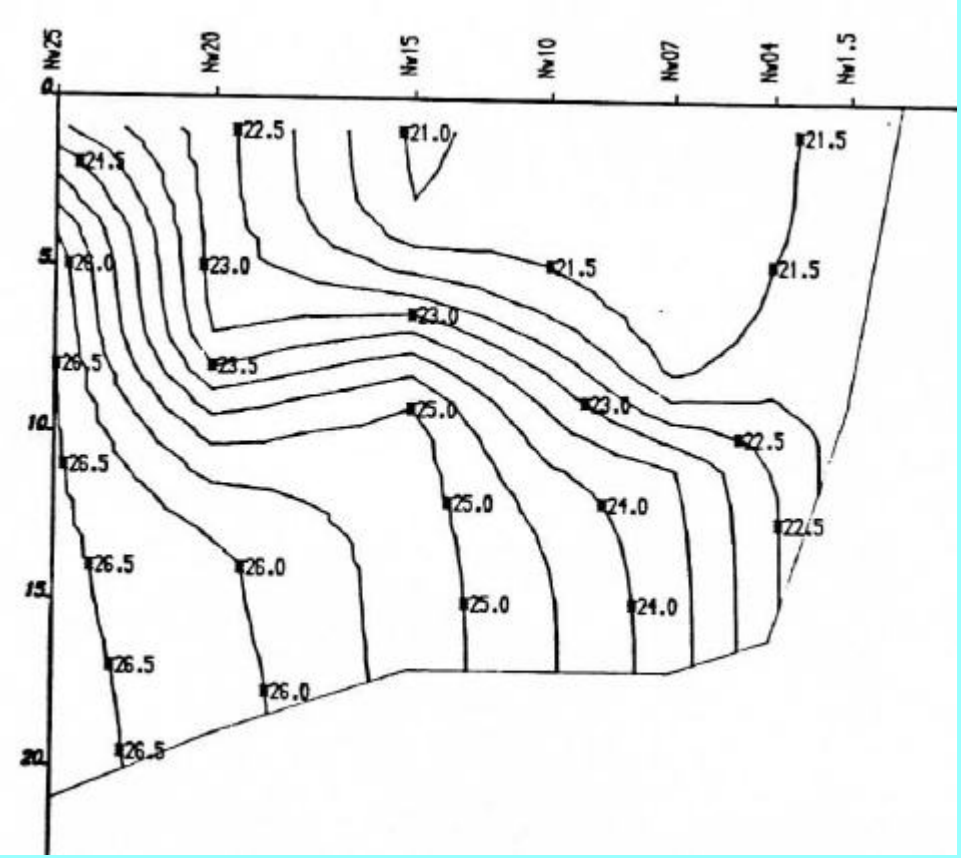
Figure 4. Patch shapes from 3D simulations.

Vertical mixing time
a. 1 hour
b. 2 hours
c. 4 hours

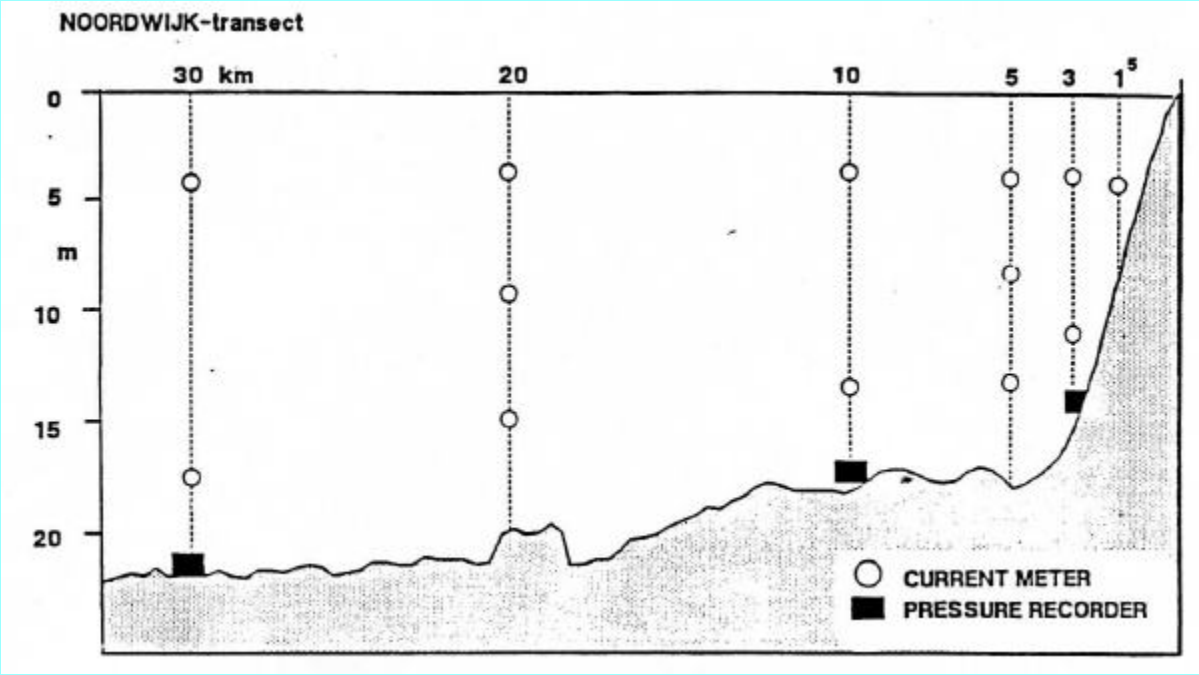

Callantsoog
Egmond
IJmuiden
Noordwijk
TerHeyde
Rotterdam Waterway
Goeree
Haringvliet
5870
5860
5850
5840
5830
5820
5810
5800
5790
5780
5770
5760
5750
5740
5730
5720
5710
5700
5690
5680
530
540
550
560
570
580
590
600
610
620


NW30
NW25
NW20
NW15
NW10
NW07
NW04
NW1.5
24.5
25.0
24.0
23.0
22.0
Depth in meters.
0
10
20
30
Transect length in kilometers.

Noordwijk, river discharge 5600 m3/s

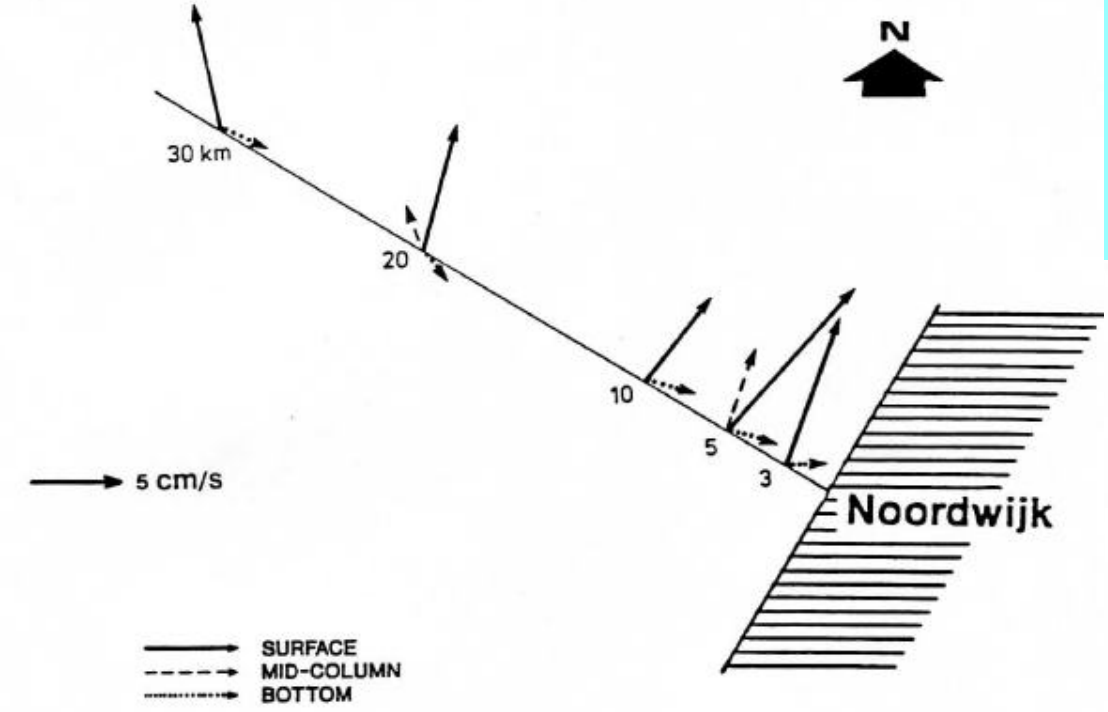


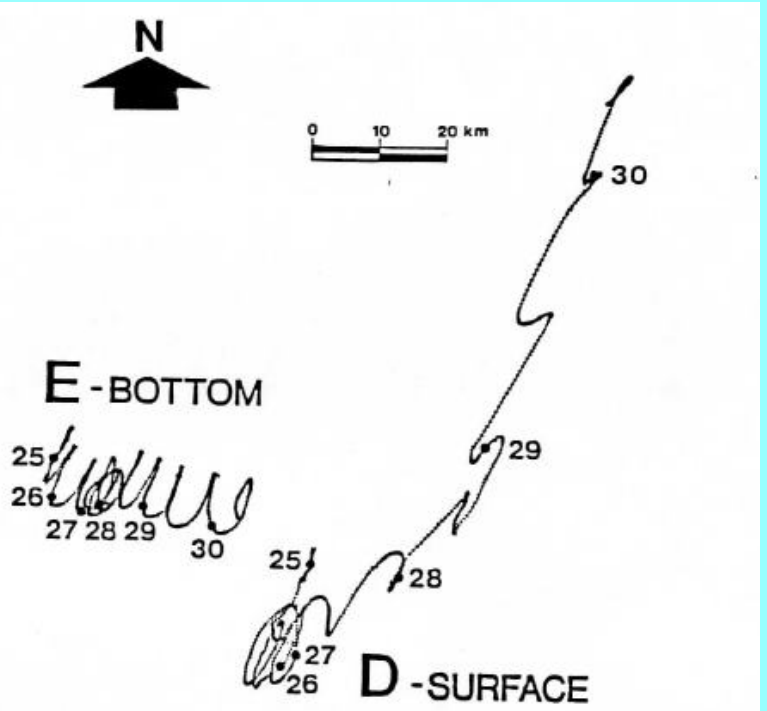
What are the consequences of salinity differences?



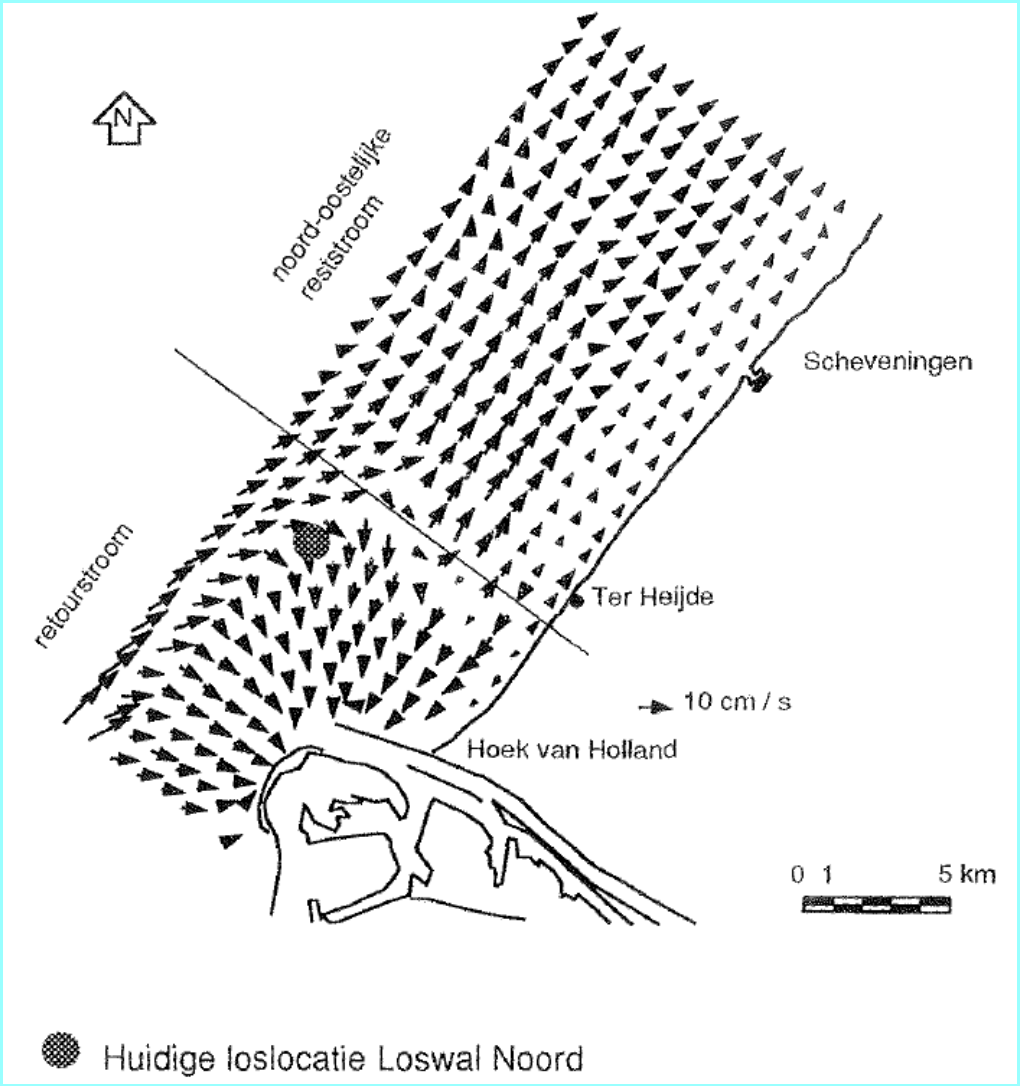
RESIDUAL CURRENT CLOSE TO THE SURFACE,
MID-COLUMN AND NEAR THE BOTTOM

(Averaged over the period aug. 1985 - sept. 1986)

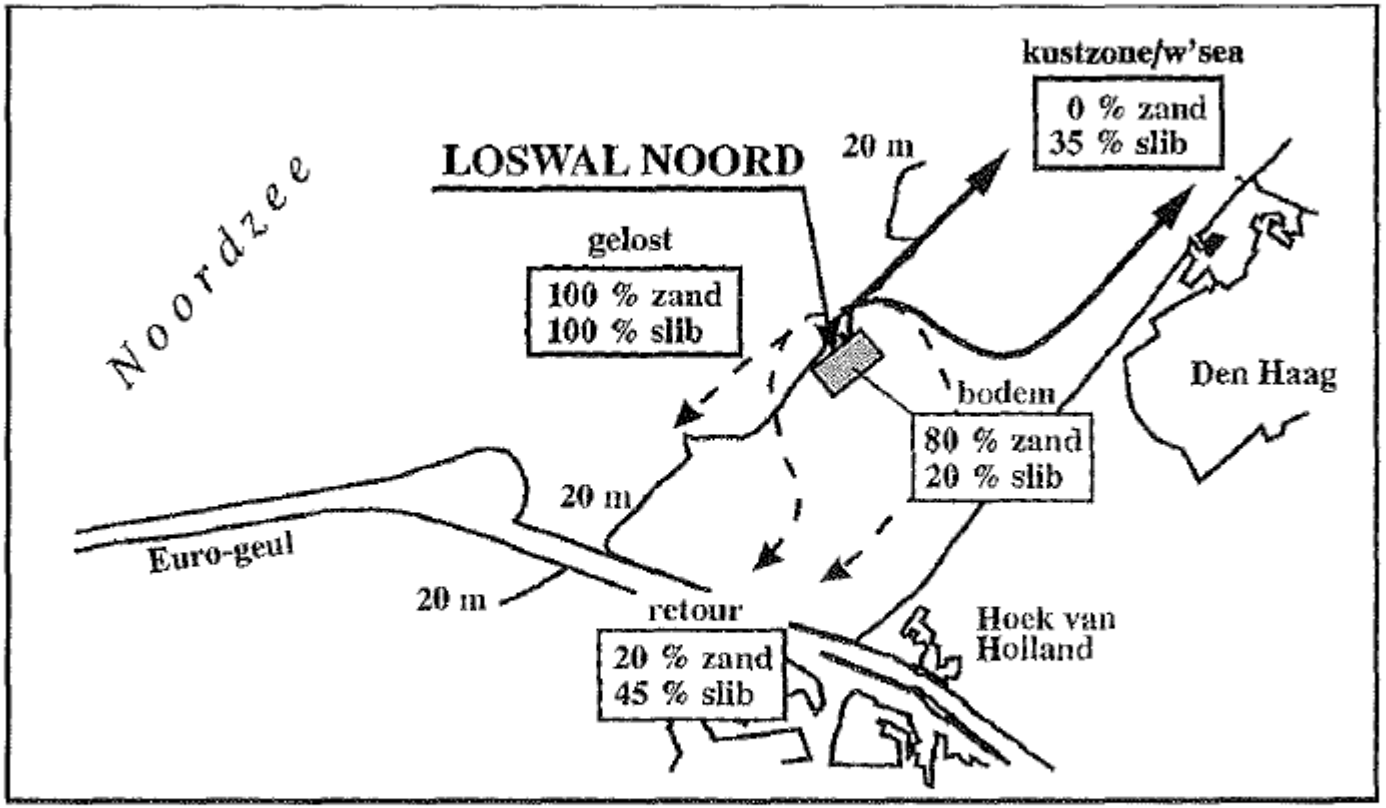


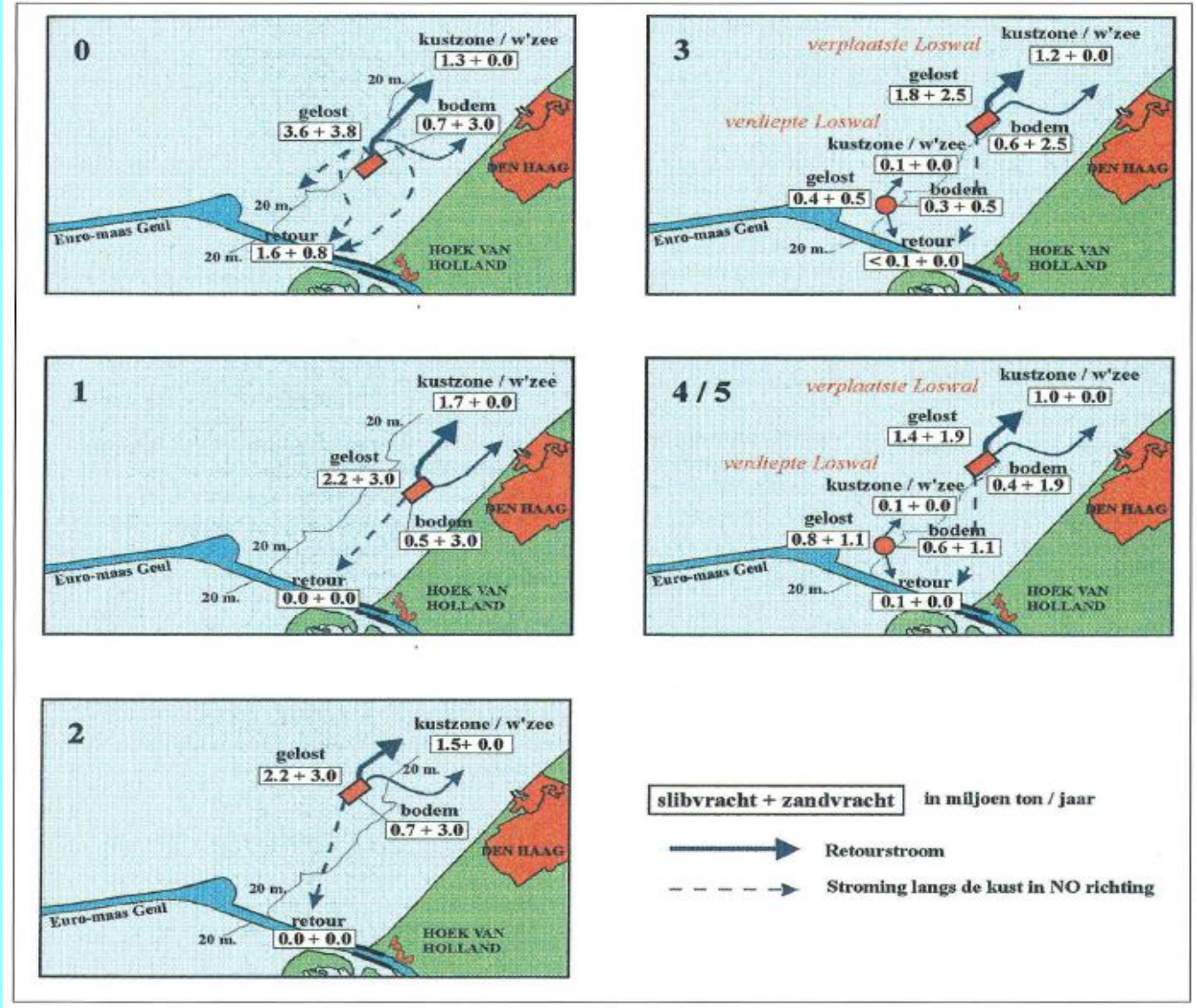


Residual current at 7 meters above sea floor

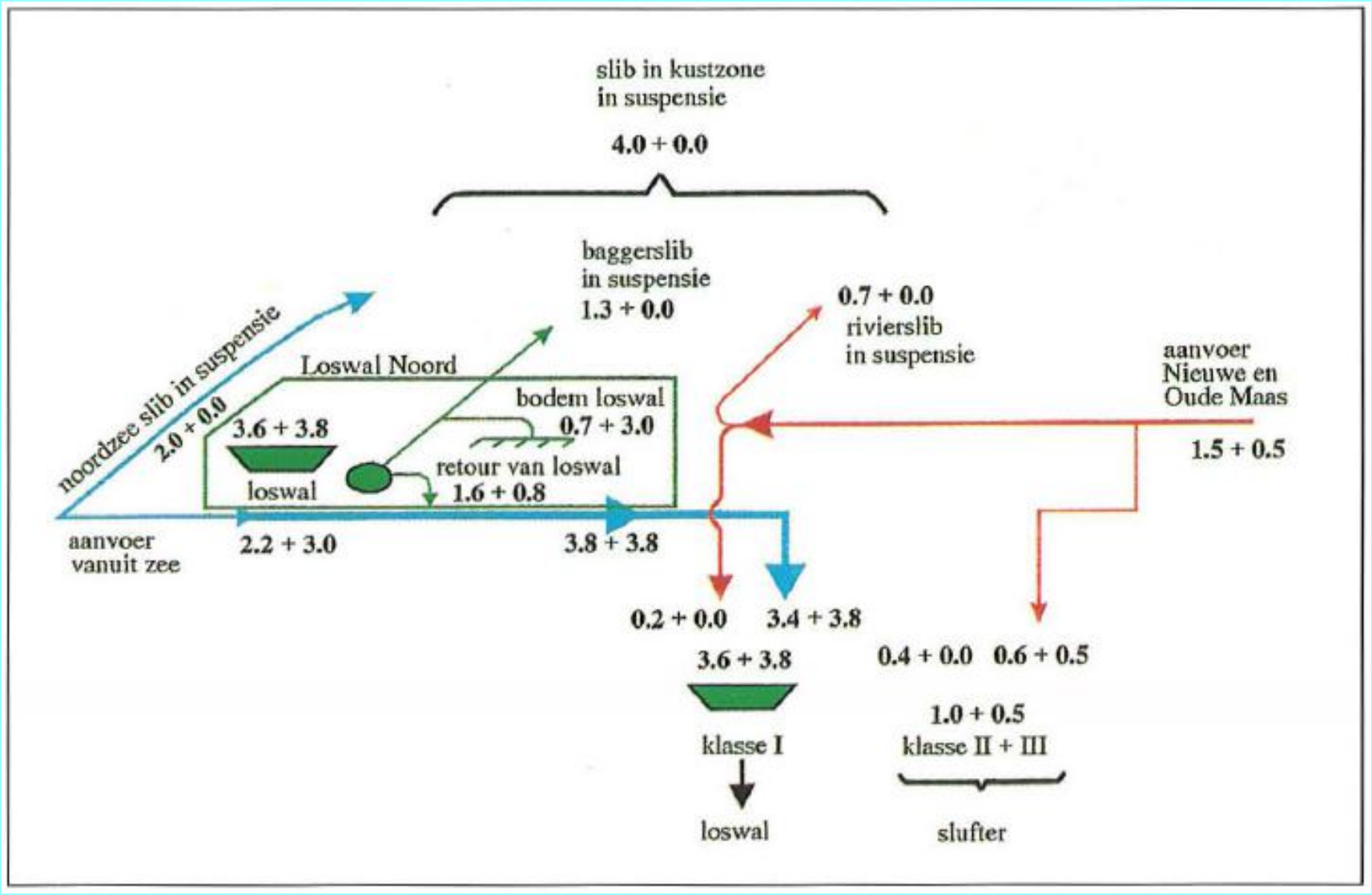


Zand- en slibstromen vanaf Loswal Noord




0
kustzone / w'zee
1.3 + 0.0
20 m.
gelost
3.6 + 3.8
bodem
0.7 + 3.0
DEN HAAG
20 m.
Euro-maas Geul
retour
20 m.
1.6 + 0.8
HOEK VAN HOLLAND
3
verplaatste Loswal
kustzone / w'zee
1.2 + 0.0
gelost
1.8 + 2.5
verdiepte Loswal
bodem
0.6 + 2.5
kustzone / w'zee
0.1 + 0.0
DEN HAAG
gelost
0.4 + 0.5
bodem
0.3 + 0.5
Euro-maas Geul
20 m.
retour
< 0.1 + 0.0
HOEK VAN HOLLAND
1
kustzone / w'zee
1.7 + 0.0
20 m.
gelost
2.2 + 3.0
DEN HAAG
bodem
0.5 + 3.0
20 m.
Euro-maas Geul
retour
20 m.
0.0 + 0.0
HOEK VAN HOLLAND
4 / 5
verplaatste Loswal
kustzone / w'zee
1.0 + 0.0
gelost
1.4 + 1.9
verdiepte Loswal
bodem
0.4 + 1.9
kustzone / w'zee
0.1 + 0.0
DEN HAAG
gelost
0.8 + 1.1
bodem
0.6 + 1.1
Euro-maas Geul
20 m.
retour
0.1 + 0.0
HOEK VAN HOLLAND
2
kustzone / w'zee
1.5+ 0.0
gelost
2.2 + 3.0
20 m.
bodem
0.7 + 3.0
DEN HAAG
20 m.
Euro-maas Geul
retour
20 m.
0.0 + 0.0
HOEK VAN HOLLAND
slibvracht + zandvracht
in miljoen ton / jaar
Retourstroom
Stroming langs de kust in NO richting

Present situation in million tonnes per year



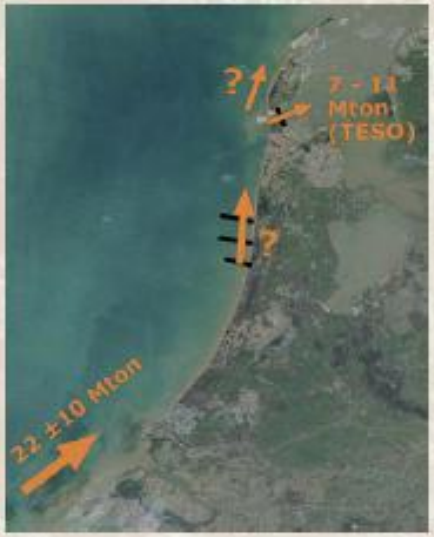
A turbidity maximum zone in the Dutch coastal area

Carola van der Hout, FYS

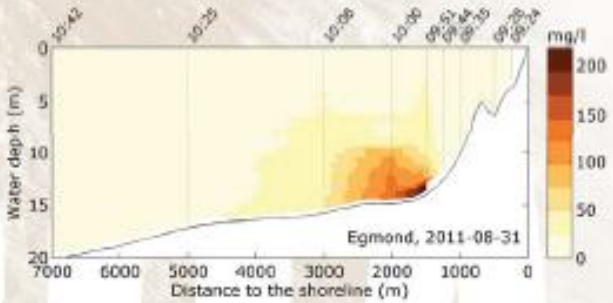
Satellites reveal high concentrations of suspended matter close to the surface in the coastal zone, with even higher concentrations found near the seabed. New measurements have shed more light on the main transport route of suspended matter along the Dutch coast.

The North Sea is quite a turbid sea. Along the Dutch coast large volumes of suspended matter are transported, like a river of silt. This can clearly be seen from satellite images. Most of the material enters the North Sea through Dover Strait. Previous estimates of the amount of sediment that passes along the coast are very broad and do not indicate where the suspended matter may be found, and how it varies with time. This information is crucial to understand whether sand nourishments, harbor extensions or other changes to the coast affect the natural transport to ecologically important areas, such as the Wadden Sea. Within the Building with Nature program we have now found that a persistent turbidity maximum exists near the seabed at just 1.5 km from the coastline. This zone may well be the location where most of the suspended matter is transported. We performed several surveys during spring, summer and autumn at three transects perpendicular to the coast to identify the location of the turbidity maximum zone along the coast.

Water samples are filtered to determine concentrations of suspended matter. Differences in colour show concentration variations and variations in material type.



Satellite image of the Dutch coastal zone showing high suspended matter at the surface close to the coast in brown. The sediment transport direction and estimated volumes are indicated. Three black lines indicate the locations of the measurements.



The distribution of suspended matter from the coastline (right) to 7 km offshore (left) during one survey. Most concentrations are up to 25 mg/l, but there is a distinct patch (turbidity maximum zone) where concentrations >200 mg/l are found.

Implications

What other density driven under currents do we know?

What is the consequence for fish migration?

Winter and summer migration?

Algae and nutrients?

What about dredging the channel connecting Holwerd with Nes??

Conclusions 1

Natural estuaries: sediment importing systems

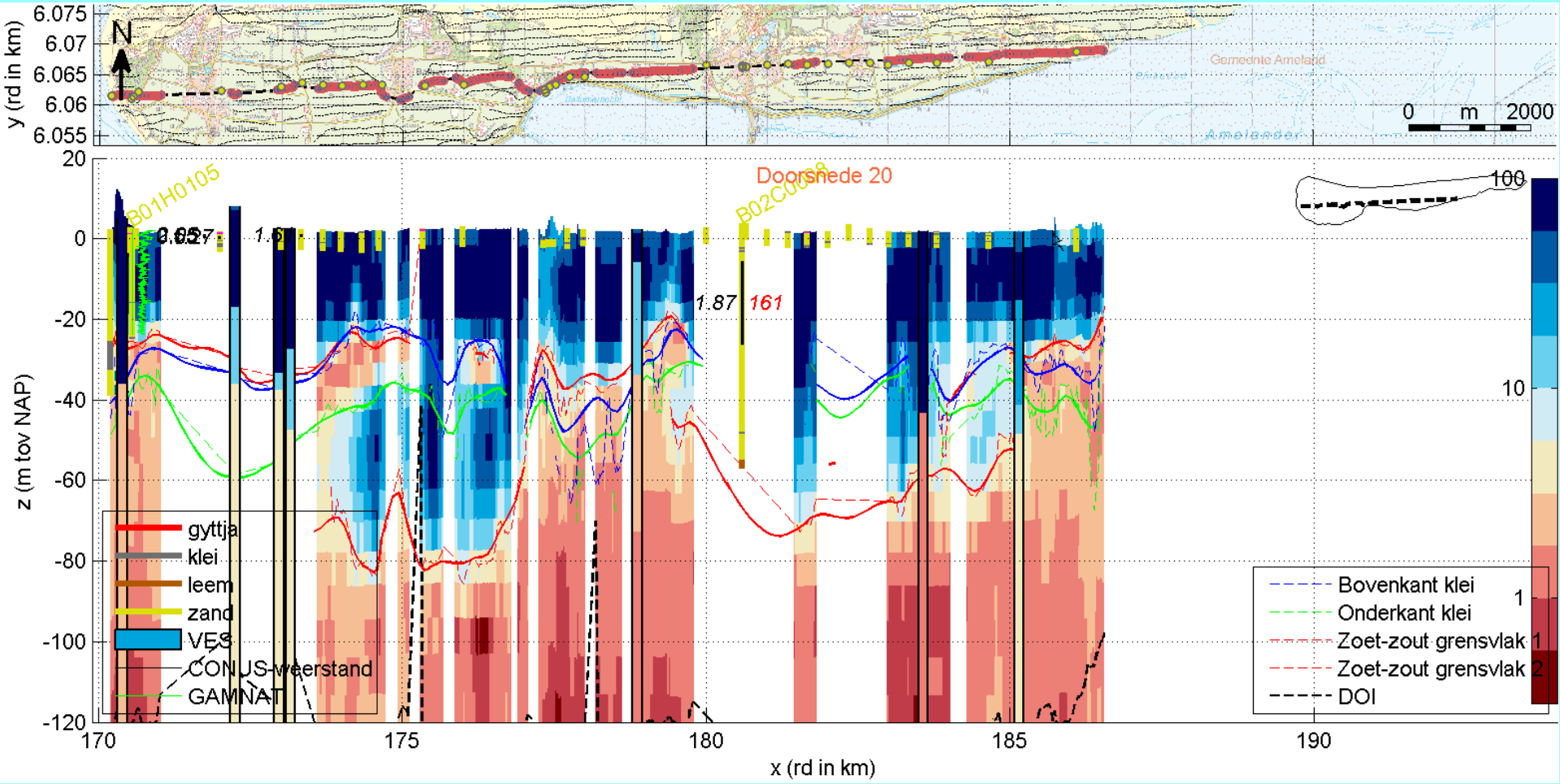
Driving processes: flocculation and density under currents

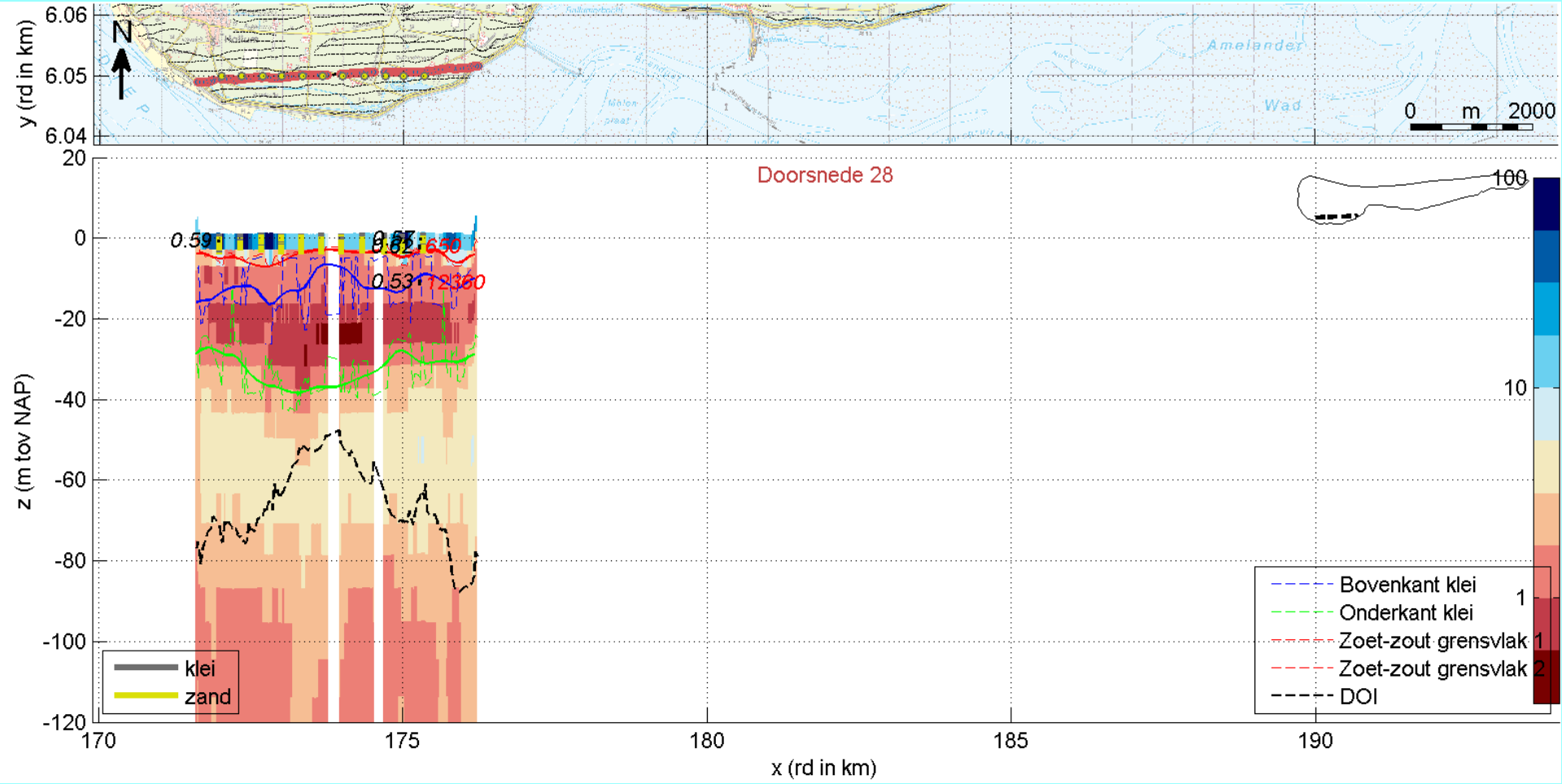
Rotterdam is exception due to:

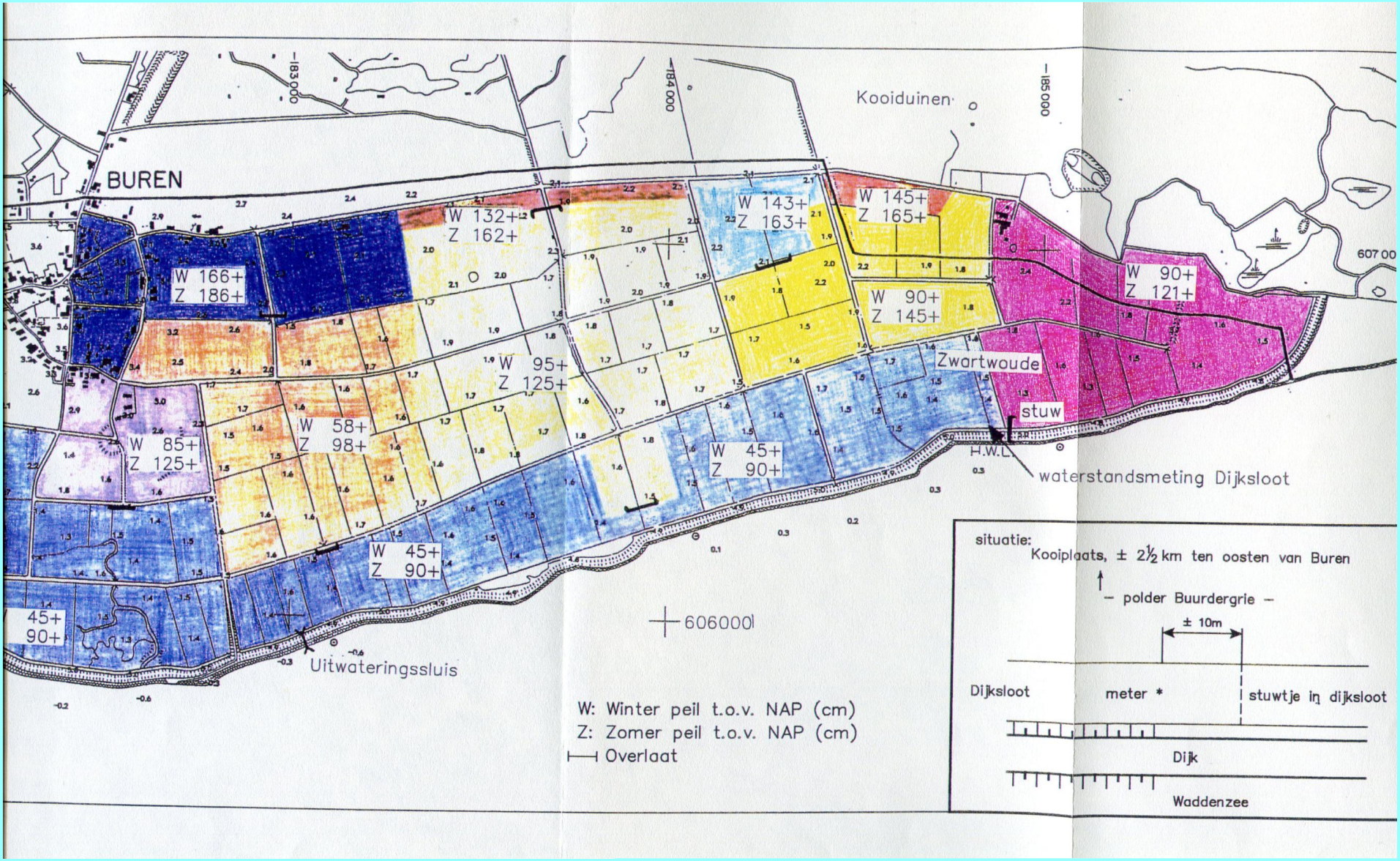
- closure Grevelingen and Haringvliet
- dredging and disposal at sea

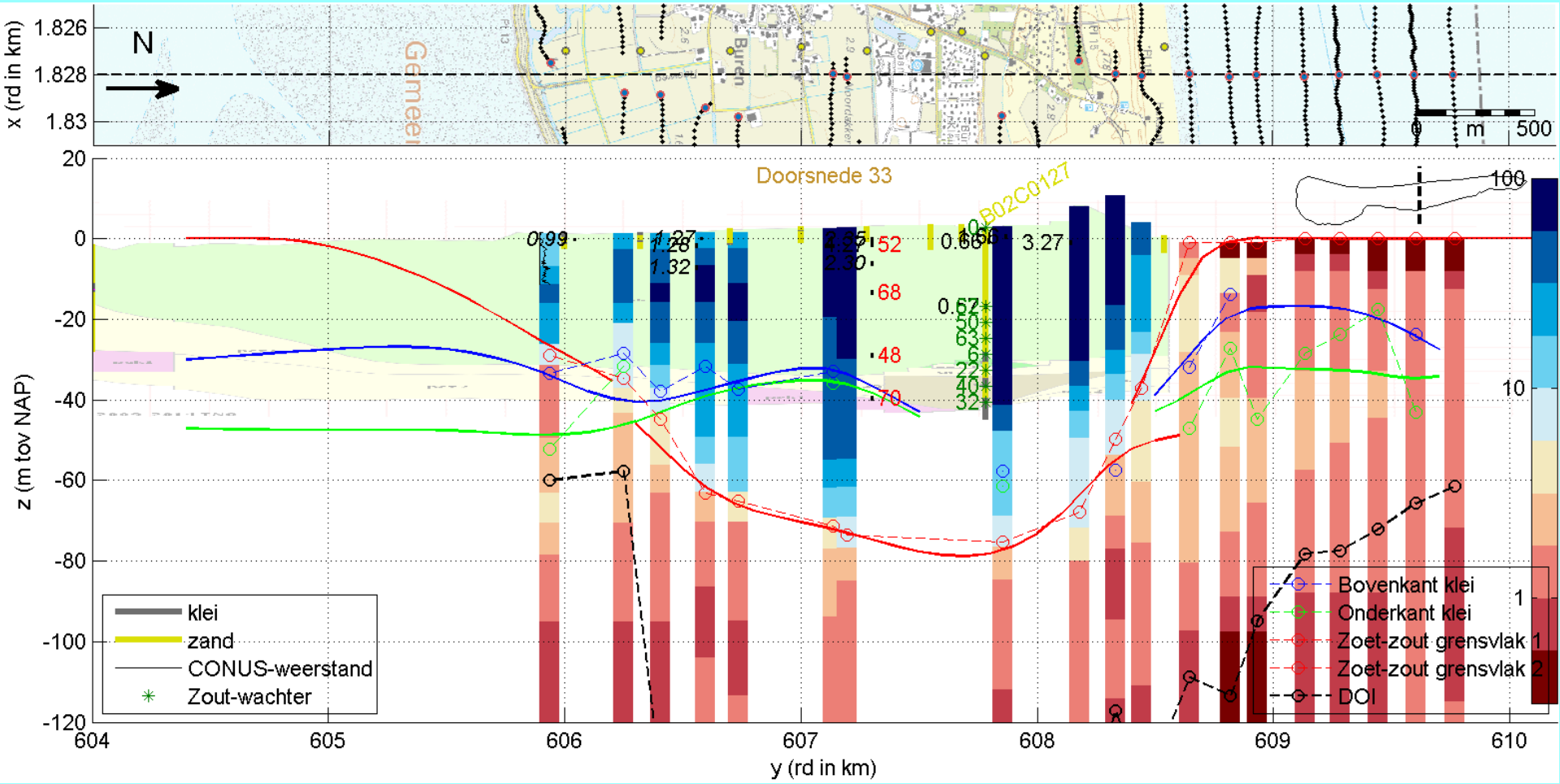
Conclusions 2

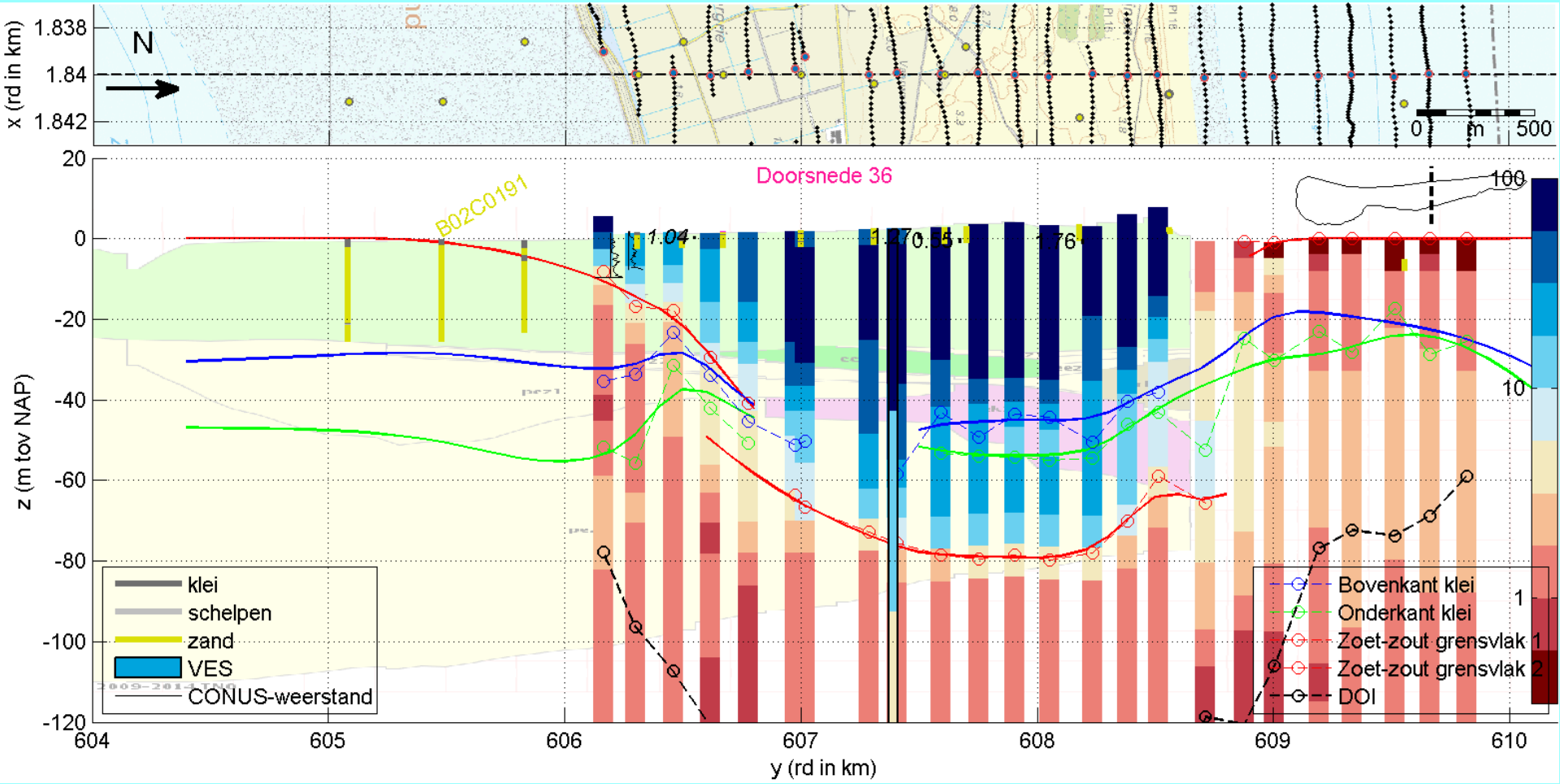
- Western winds keep the freshwater to the coast: the coastal river
- Freshwater creates a coastal directed under currrent
- River output is directed into the Wadden Sea
- Freshwater discharges directly in the Wadden Sea keep the sediment (silt) in

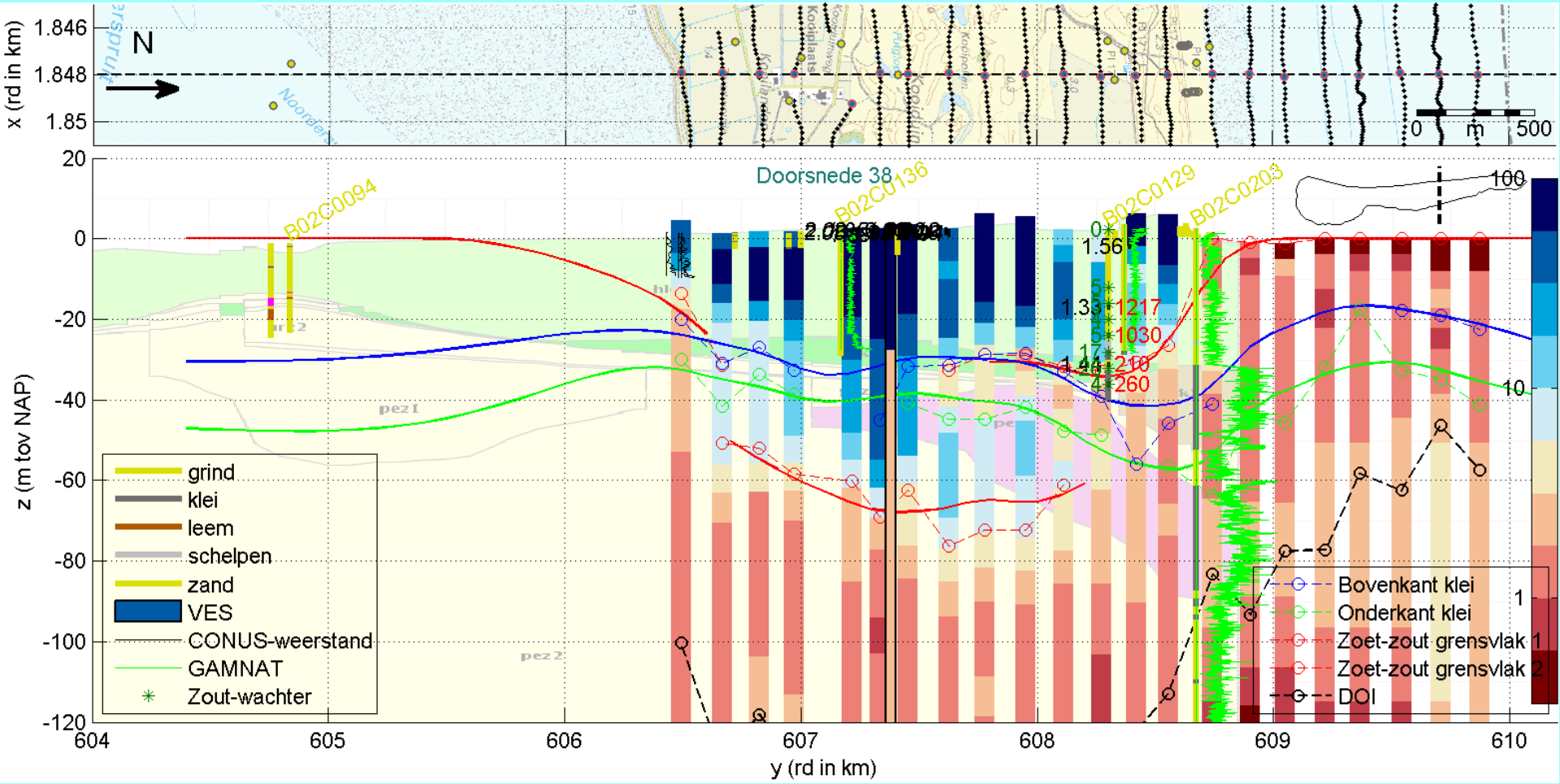

Doorsnede 20
B01H0105
B02C0058
1.87
161
N
0 m 2000
y (rd in km)
z (m tov NAP)
x (rd in km)
gyttja
klei
leem
zand
VES
CONUS-weerstand
GAMNAT
Bovenkant klei
Onderkant klei
Zoet-zout grensvlak 1
Zoet-zout grensvlak 2
DOI

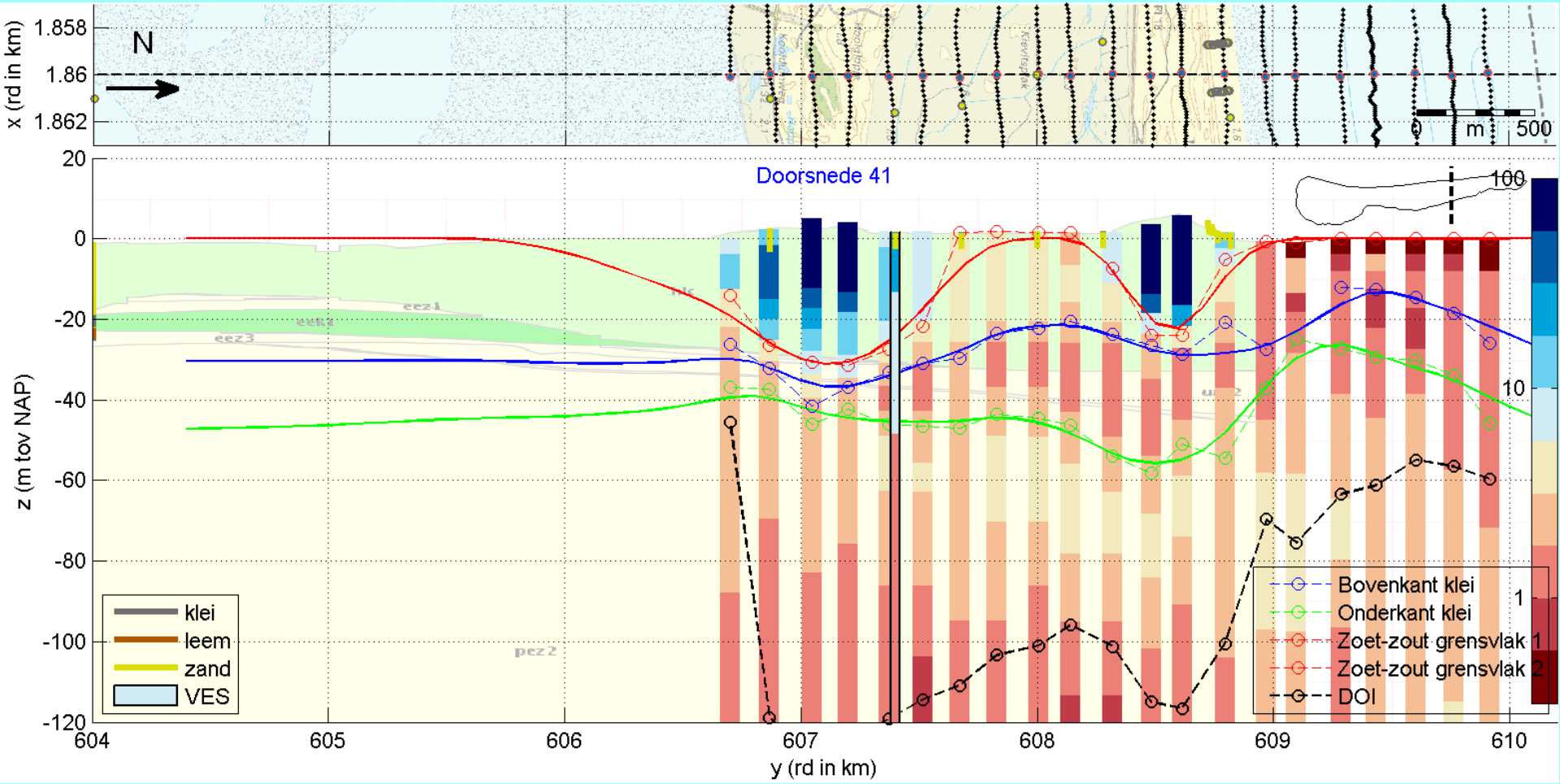

Doorsnede 28
N
Amelander
Wad
0
m
2000
y (rd in km)
6.06
6.05
6.04
z (m tov NAP)
20
0
-20
-40
-60
-80
-100
-120
170
175
180
185
190
x (rd in km)
0.59
0.53
650
2160
100
10
1
1
2
klei
zand
Bovenkant klei
Onderkant klei
Zoet-zout grensvlak
Zoet-zout grensvlak
DOI


BUREN
183 000
184 000
185 000
Kooiduinen
607 00
W 166+
Z 186+
W 132+
Z 162+
W 143+
Z 163+
W 145+
Z 165+
W 90+
Z 121+
W 90+
Z 145+
W 95+
Z 125+
W 58+
Z 98+
W 85+
Z 125+
W 45+
Z 90+
W 45+
Z 90+
45+
90+
Zwartwoude
stuw
H.W.L.
waterstandsmeting Dijksloot
606000
Uitwateringssluis
W: Winter peil t.o.v. NAP (cm)
Z: Zomer peil t.o.v. NAP (cm)
Overlaat
situatie:
Kooiplaats, ± 2½ km ten oosten van Buren
polder Buurdergrie
± 10m
Dijksloot
meter *
stuwtje in dijksloot
Dijk
Waddenzee

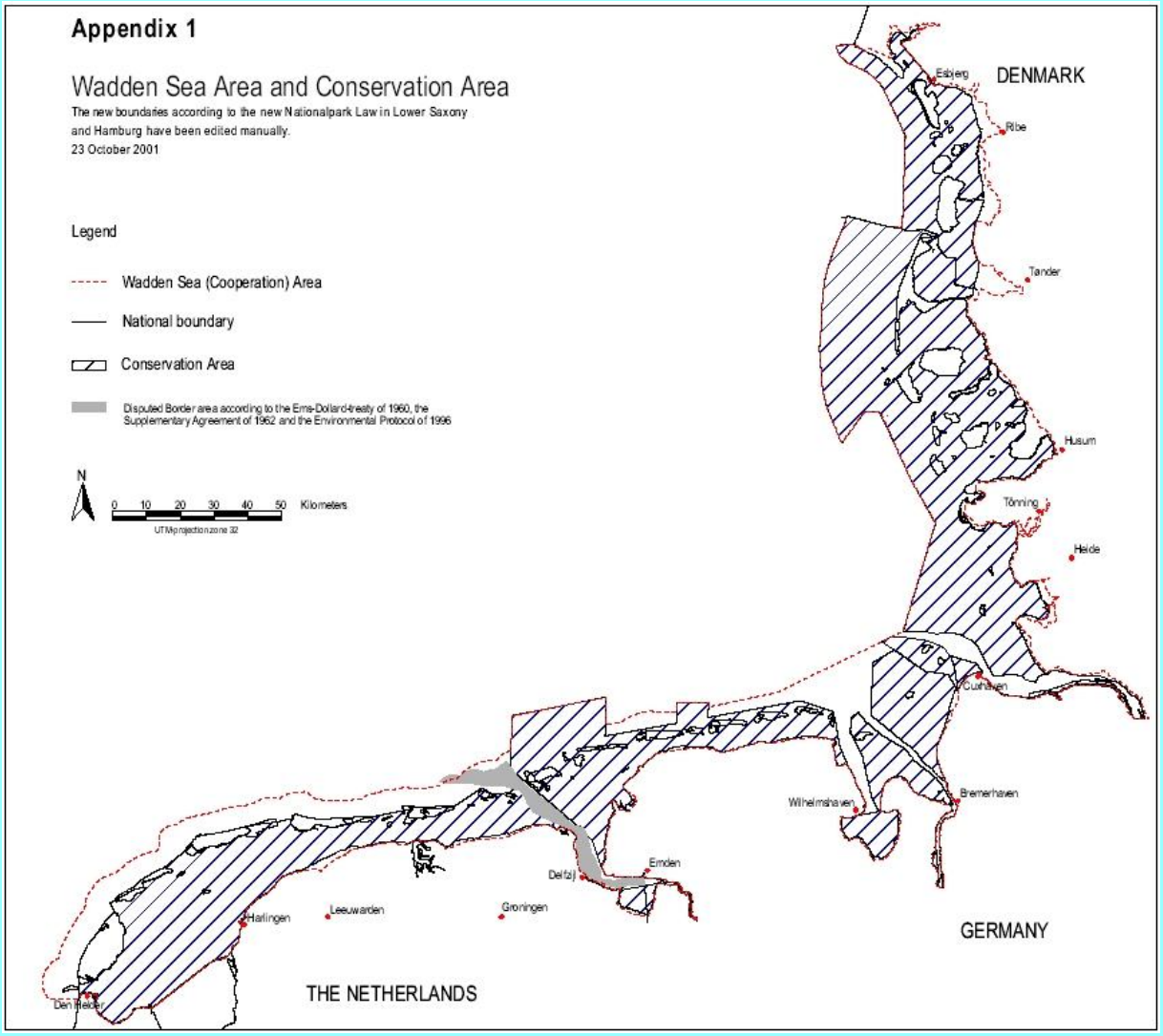

x (rd in km)
1.826
1.828
1.83
N
Gemeente
Buren
0
m
500
Doorsnede 33
B02C0127
100
10
1
z (m tov NAP)
20
0
-20
-40
-60
-80
-100
-120
604
605
606
607
608
609
610
y (rd in km)
klei
zand
CONUS-weerstand
Zout-wachter
Bovenkant klei
Onderkant klei
Zoet-zout grensvlak 1
Zoet-zout grensvlak 2
DOI


Doorsnede 36
B02C0191
1.04
1.27
0.15
1.76
N
x (rd in km)
1.838
1.84
1.842
0
m
500
z (m tov NAP)
20
0
-20
-40
-60
-80
-100
-120
100
10
1
klei
schelpen
zand
VES
CONUS-weerstand
Bovenkant klei
Onderkant klei
Zoet-zout grensvlak 1
Zoet-zout grensvlak 2
DOI
604
605
606
607
608
609
610
y (rd in km)

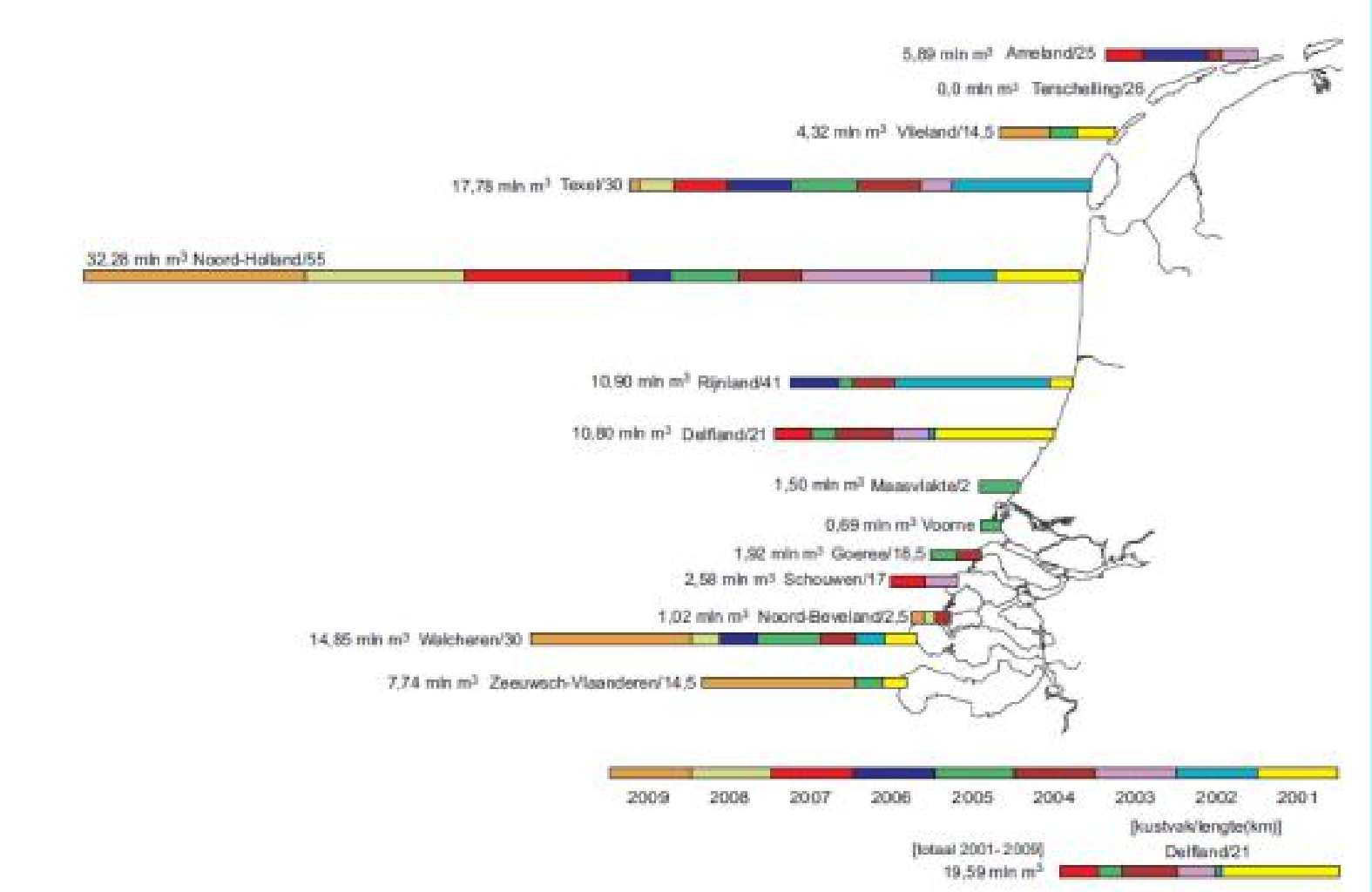

Doorsnede 38
B02C0094
B02C0136
B02C0129
B02C0203
N
x (rd in km)
1.846
1.848
1.85
0
m
500
z (m tov NAP)
20
0
-20
-40
-60
-80
-100
-120
604
605
606
607
608
609
610
y (rd in km)
100
10
1
1.56
1.33
1217
1030
210
260
grind
klei
leem
schelpen
zand
VES
CONUS-weerstand
GAMNAT
Zout-wachter
Bovenkant klei
Onderkant klei
Zoet-zout grensvlak 1
Zoet-zout grensvlak 2
DOI


x (rd in km)
1.858
1.86
1.862
N
0
m
500
Doorsnede 41
z (m tov NAP)
20
0
-20
-40
-60
-80
-100
-120
100
10
1
eez1
eez2
eez3
pez2
klei
leem
zand
VES
Bovenkant klei
Onderkant klei
Zoet-zout grensvlak 1
Zoet-zout grensvlak 2
DOI
604
605
606
607
608
609
610
y (rd in km)

Wadden Sea


Appendix 1
Wadden Sea Area and Conservation Area
The new boundaries according to the new Nationalpark Law in Lower Saxony and Hamburg have been edited manually.
23 October 2001
Legend
Wadden Sea (Cooperation) Area
National boundary
Conservation Area
Disputed Border area according to the Ems-Dollard-treaty of 1960, the Supplementary Agreement of 1962 and the Environmental Protocol of 1996
N
0 10 20 30 40 50 Kilometers
UTM projection zone 32
DENMARK
Esbjerg
Ribe
Tønder
Husum
Tönning
Heide
Cuxhaven
Wilhelmshaven
Bremerhaven
Emden
Delfzijl
Groningen
Leeuwarden
Harlingen
Den Helder
THE NETHERLANDS
GERMANY

Sand nourishment 10 billion m3/y 2001-2009



Sand sharing system

Sand nourishment

Sea level at Cuxhaven: MHW, MSL and MLW