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The Interreg IVB North Sea Region Programme

WP5 Measures

Basic analysis reports

Measure nr° 20. Walsoorden pilot part A (2004): relocation of dredged sediment to a shallow water area at the edge of the Walsoorden sandbar

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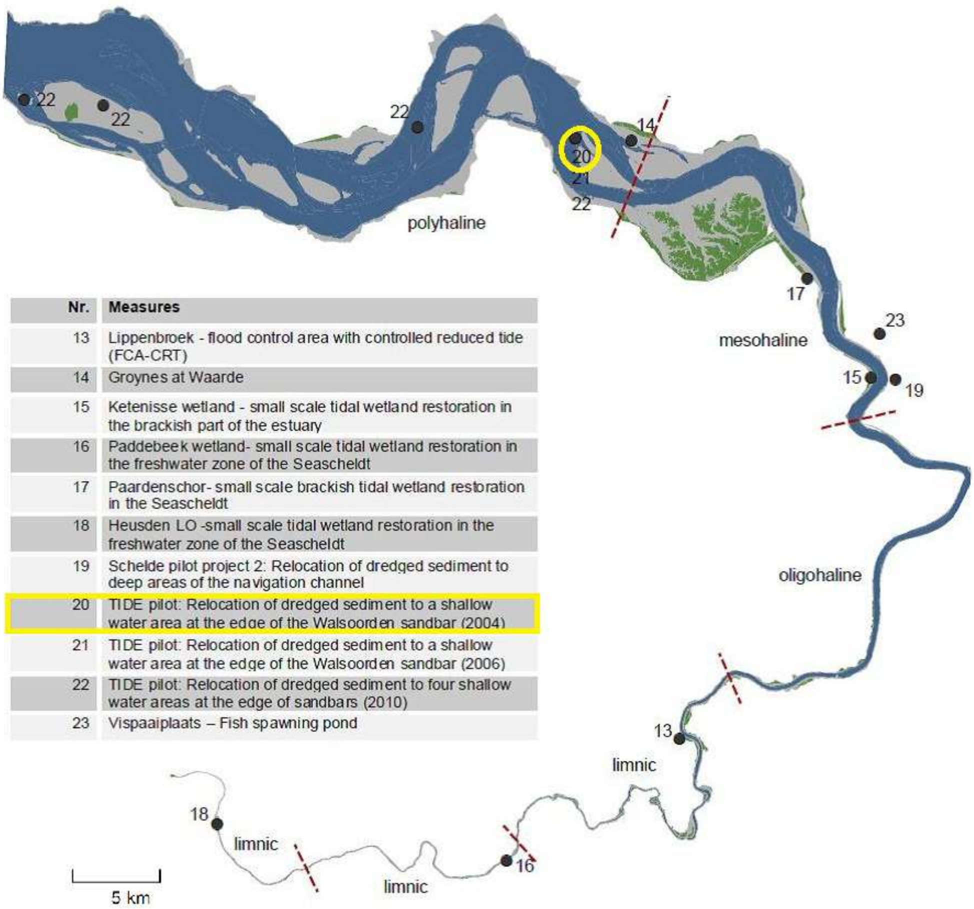
- Measure Category: Biology/Ecology
- Estuary: Scheldt
- Salinity zone: Polyhaline
- Pressure: Gross change in morphology and hydrographic regime
- Status: Implemented (in 2004)
- River km: TIDE-km 120
- Country: the Netherlands
- Specific location: Western Scheldt, seaward of the Walsoorden sandbar
- Responsible authority: Flemish government, Department of Mobility and Public Works (MOW), Maritime Access Division
- Costs: /
- Cost category: 250,000 – 1,000,000 €



Nr.	Measures
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Figure 1. Location of the Walsoorden sandbar (Western Scheldt, Westerschelde)

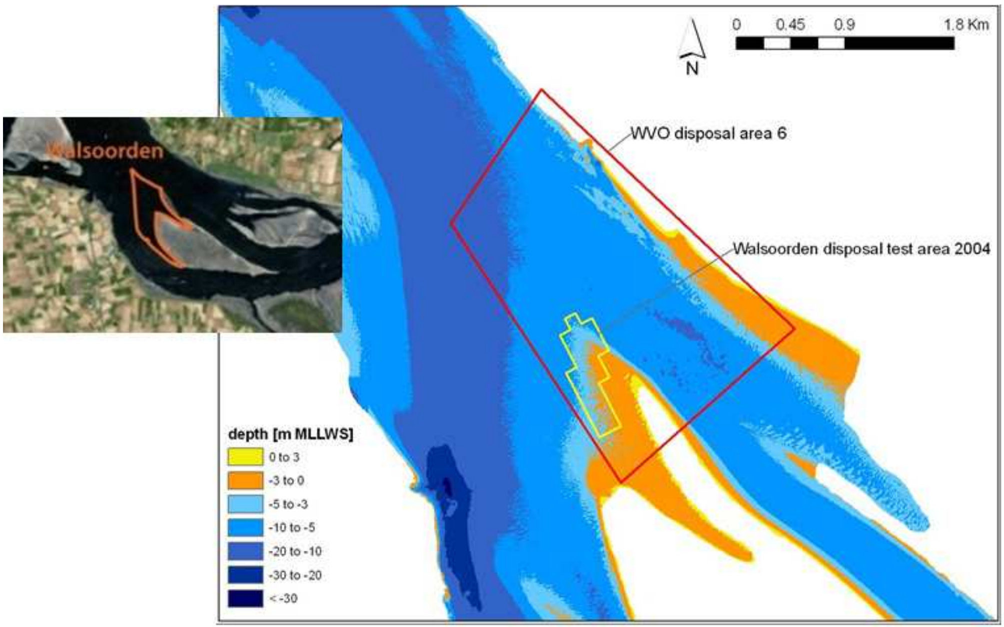


Figure 2. Relocation area at the Walsoorden sandbar, test site 2004 (Vos et al. 2009)

1.1 Measure description

This project fits in with "The Long Term Vision 2030 (LTV) for the Scheldt estuary" which presents a view on the preferred functioning of the system, accepted by both the Dutch and the Flemish government. One of the main questions considered in the LTV was where to relocate the large volumes needed for further deepening and widening of the navigation route, respecting the preservation of the estuary's physical system characteristics. An international expert team proposed that strategic relocation of dredged sediment could fit in a proactive morphological management strategy as an instrument to improve the morphology of the Western Scheldt, for instance by steering the development of channels and shoals. As a pilot project to test this strategy, the expert team proposed to relocate sediment at the eroded tip of the Walsoorden sandbar.

Since 2002, this new relocation strategy is being investigated as a pilot project on the Walsoorden sandbar in the Western Scheldt. An extended research was conducted in 2002 and 2003, combining several tools: desk studies with maps on the historical morphological changes, field measurements, physical scale model tests and numerical modeling. As a result it was concluded that none of the results contradicted the feasibility of the new relocation strategy at the Walsoorden sandbar, although final judgment would only be possible after the execution of an in situ relocation test. This project would test the stability of the relocated sediments. Indeed, it was the fear of some morphologists and ecologists that the material would not be stable, possibly inducing negative effects in the estuary.

During one month (17 November – 20 December 2004), 500.000 m³ of dredged material (sand) was almost continuously relocated with a diffuser in relatively shallow water at the seaward end of the Walsoorden sandbar (**Fout! Verwijzingsbron niet gevonden.**). The dredged material originated from regular maintenance dredging works in the navigation channel in the Western Scheldt (Westerschelde). The amount of 500.000 m³ for the in situ relocation test was chosen in order to be detectable from bathymetrical viewpoint. On the other hand this amount is small enough not to induce irreversible negative effects if negative effects would occur.

The dredging vessel (self-discharging hopper dredger) was connected to a floating pipeline through which the sand is transported to a pontoon "Bayard II" (Figure 3). On this pontoon the sand is pumped to a diffuser (Figure 3) that relocates the sediment in an accurate way on to the bottom, with minimal disturbance of the local environment. This methodology is much more accurate for relocation in shallow waters compared to the traditional method of relocation (so-called "clapping"), which involves the hopper of the dredging vessel being opened so that the material is released in the water column just under the keel of the ship, from where it will sink to the river bed (Vos et al. 2009).

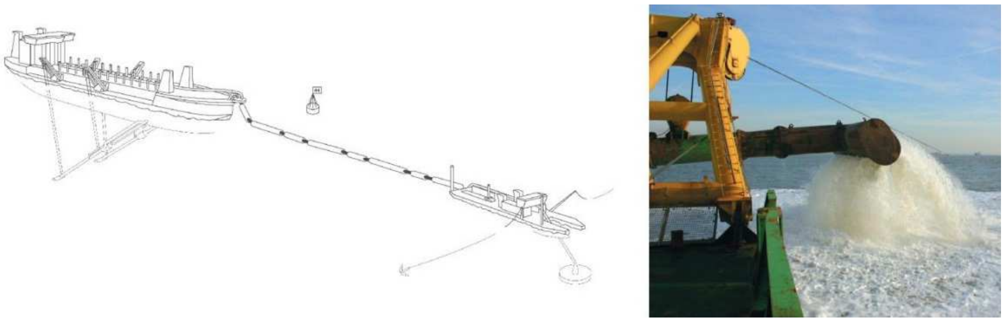


Figure 3. Principal relocation test (left) with a detail of the diffuser (right) (Plancke and Ides 2007, Ides 2010).

1.2 Monitoring

The experiment was thoroughly monitored between November 2004 and January 2006, morphologically as well as ecologically. Five criteria (2 for morphology and 3 for ecology) were defined on beforehand to judge the success of the test (see **Fout! Verwijzingsbron niet gevonden.**).

The morphological criteria were related to the stability of the relocated material and to the sedimentation in the "Schaar van Valkenisse", the flood channel next to the Walsoorden sandbar. In order to be able to follow the morphological developments (topographic and bathymetric monitoring), high resolution multibeam surveys were executed on and around the relocation area at a regular basis (in the beginning weekly, after a while monthly). Additional, the altitude of the Walsoorden sandbar was measured twice from an airplane (LIDAR technique). Sediment transport was also monitored with a measurement campaign (before, during and after the relocation test), as well as with a sediment tracing test after the relocation.

The ecological criteria were related to the elevation of the Walsoorden sandbar, change in percentage intertidal mud and change in intertidal macrobenthos. The ecological monitoring consisted of an intertidal (Walsoorden sandbar) and subtidal part (shallow water around the Walsoorden sandbar, i.e. impact area Figure 4: I1). To analyse significant changes, a number of control areas were defined (Figure 4: C1-4). First the consistency of the soil (grain size and mud-percentage) was determined for the different areas in different seasons. Samples were also taken to analyse macrobenthos (biomass, diversity and density). At three locations, the elevation was observed in detail. To observe the developments of the Walsoorden sandbar as a whole, a flight was executed while using remote sensing and hyperspectral analysis. The goal of this extensive ecological monitoring program was to see whether the in situ relocation test caused a significant effect on all measured parameters, thus affecting the local ecology.

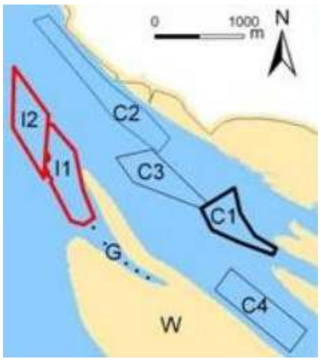


Figure 4. Study area: impact areas (I1 for relocation 2004; I2 for relocation 2006), control areas (C1-4), Walsoorden sandbar (W) and washout channel (G).

1.3 Monitoring results

Table 1. Overview of predefined morphological and ecological criteria and observed effects from the relocation test Walsoorden 2004 (WL 2006, Plancke and Ides 2007, Vos et al. 2009, Ides 2010, Vos 2010)

Predefined criteria	**Observed effects**
Morphology	
1. Stability of the relocated material: Two weeks after relocating the dredged material, maximum 20% of the total relocated material may have left the relocation area. The test has failed if more than 40% of the total relocated material is lost.	The relocated material was very stable. • Two weeks after ending the relocation test there was even a small increase of sediment (+2.7%), instead of a loss. • One year after the completion of the relocation test, 83% of the relocated material was still present within the control polygon.
2. Sedimentation of "Schaar van Valkenisse": Two weeks after relocating the dredged material, maximum 15% of the cross section of the Schaar van Valkenisse may be filled with sand.	No sedimentation took place at the "Schaar van Valkenisse". • Two weeks after ending the relocation test there was a limited increase (respectively +1.9% and +0.1%) of the cross section at two selected cross sections. This increase continued during the first three months after ending the relocation test. Analysis of two longitudinal sections in the Schaar van Valkenisse also shows no trend of sedimentation.
Ecology	
1. Elevation of sandbar Walsoorden: elevation with more than 40 cm at 25% of the sandbar, elevation with more than 2 cm at 50% of the sandbar, or elevation with more than 1 cm at 100% of the sandbar is seen as a problem.	The height of the sandbar showed no deviation as a result of the relocation test compared to long-term trends, a mean elevation of 2.2 up to 2.9 cm per year was measured. This is the trend as determined from the MOVE measurements.
2. Change in percentage intertidal sludge: change in mud-concentration of more than 40% at 50% of the sandbar, or a change of more than 20% at 100% of the sandbar is seen as a problem.	The granulometry of the sandbar showed no deviation as a result of the relocation test. Seasonal fluctuations were slightly observed: larger grain size in winter, smaller grain size in summer and autumn. A sub-tidal effect was established as a result of the relocation test: the sediment composition in the impact zone was slightly altered (decrease in mud- and semi-coarse sand-percentage, increase of sand and fine sand fraction). This was a result of a difference in granular size between the relocated material and the sediment that was initially present at the relocation site.
3. Change in intertidal macrobenthos: the	Both intertidal and subtidal macrobenthos in the study area showed no

density, biomass, and diversity of intertidal macrobenthos may not deviate from the long term trends.	deviation as a result of the relocation area (not in diversity, biomass and density). Seasonal trends were observed: autumn > spring. Only an increase in intertidal biomass was significant (van der Wal 2010). Also a change in the composition of macrobenthos species was observed: less B. pilosa and more H. filiformis, N. diversicolor and P. elegans (van der Wal 2010).

1. Morphological monitoring

One year after the execution of the in situ relocation test, it was concluded that from morphological viewpoint the test **was a success**. Despite a small loss of sediment directly after execution of the relocation test, which is probably caused by the transport of the finer sands by the currents (i.e. natural segregation), the amount of material within the control area equalled the relocated quantities. Only after 2 months a decrease of volume was measured, a loss of circa 10% after 6 months and circa 17% after one year (Figure 5), which is much lower than the predefined criterium. The main part of the eroded sand is transported during flood towards the Walsoorden sandbar (

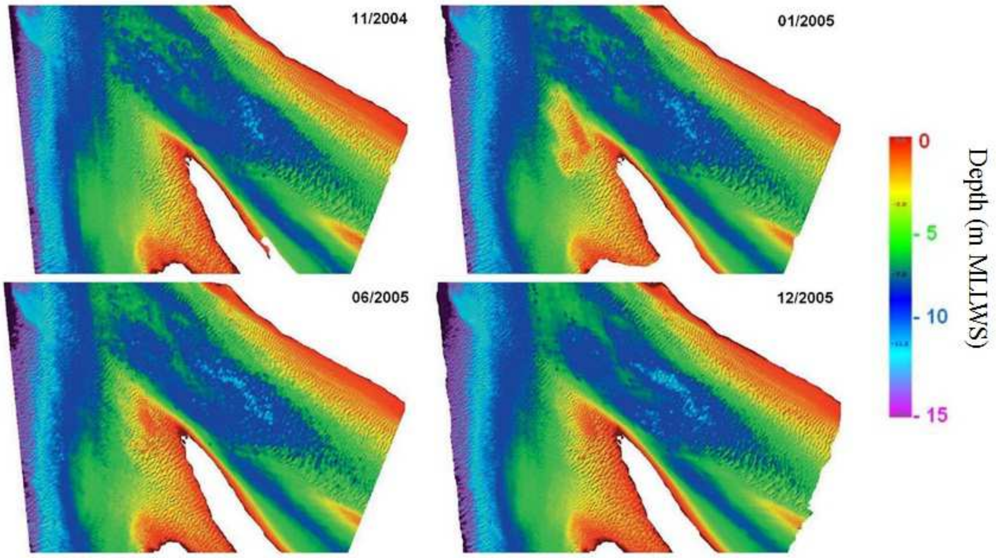


Figure 6). This evolution is in agreement with the predictions of the feasibility study. Hence, a small shallow water area is created as a consequence of the relocation test. This shift towards the sandbar is desirable in terms of the objective of reconstructing the seaward tip of the Walsoorden sandbar.

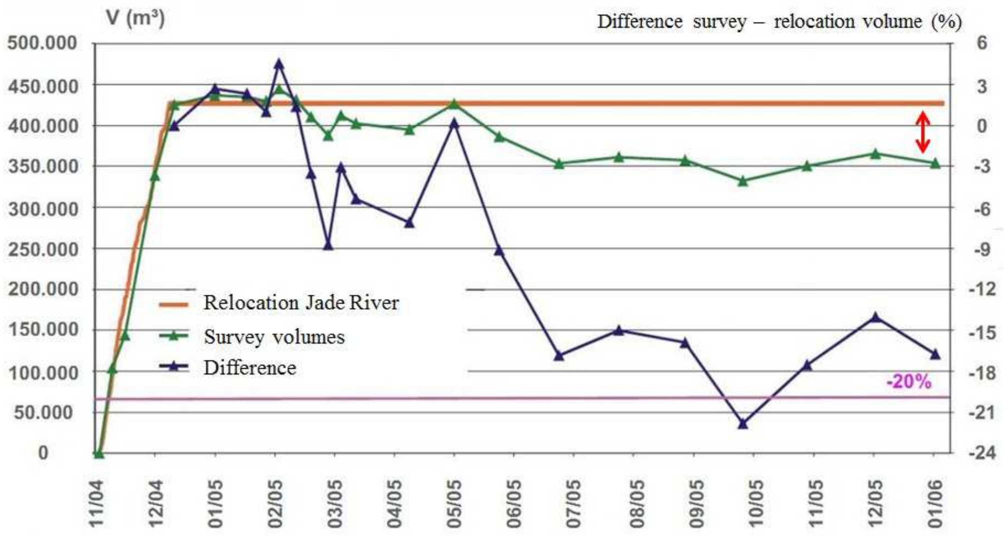


Figure 5. Evolution of the sediment volume for the relocation test 2004. (Plancke and Ides 2007, Ides 2010)

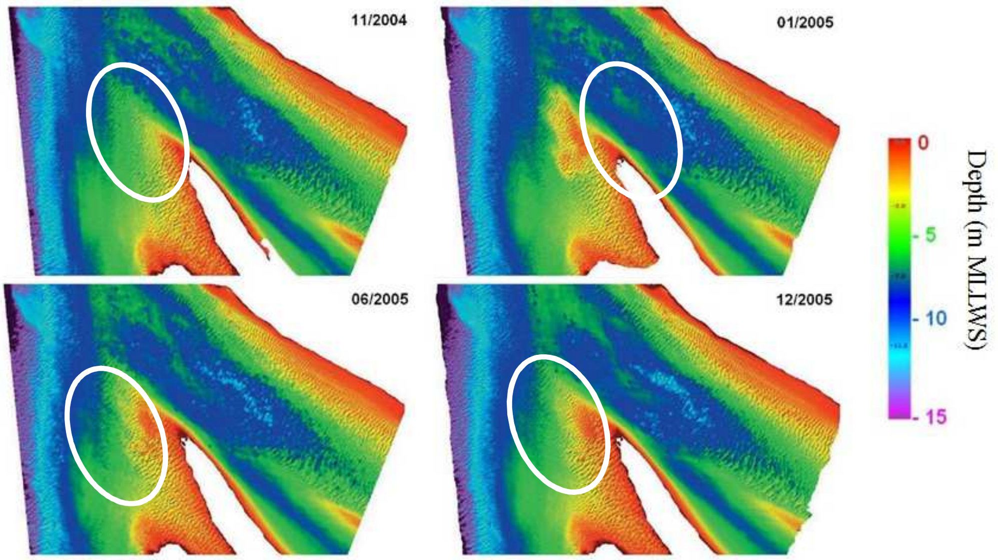


Figure 6. Morphological trend (bathymetry before relocation, 1 week after, 6 months after and 12 months after relocation); MLLWS=Mean lower low water spring (Plancke and Ides 2007)

2. Ecological monitoring

The ecological monitoring **did not reveal any significant negative impact**, neither in the intertidal areas, nor in the subtidal areas. None of the results from this monitoring indicated that the in situ relocation test was responsible for a significant change in ongoing trends. The result of this relocation test could however not be extrapolated to other areas. The effects could differ depending on local characteristics. For every relocation measure and for every area new location monitoring is needed (van der Wal 2010)!

(1) Intertidal area. No negative effects due to the relocation test were detected. All criteria were met: elevation of the sandbar was in line with the long term trend, grain size and macrobenthos on the sandbar did also not deviate after the relocation test. Figure 7 shows results from the intertidal macrobenthos analysis.

(2) Subtidal area. For the subtidal samples an initial decrease in mud-percentage was found for the impact area. This is explained by the absence of finer mud material in the dredged sediments that were relocated. The subtidal macrobenthos samples did however not show deterioration (biomass, diversity and density) for the impact area compared to the 2 other control areas (Figure 8). Assumably, this can be explained by the fact that the subtidal macrobenthos was already poor before the relocation test (

Figure 9).

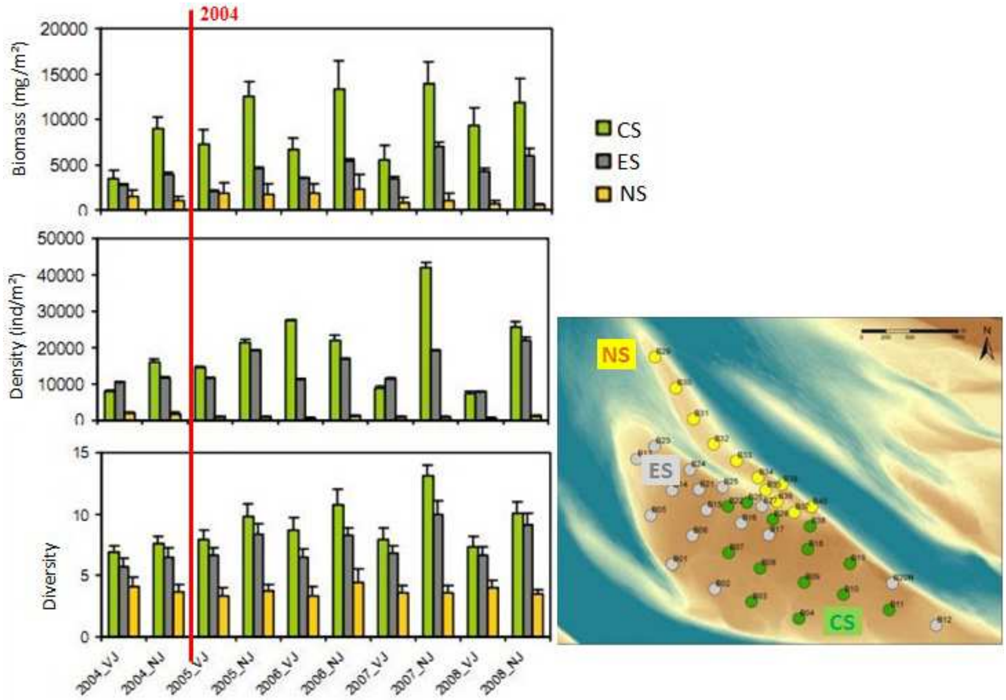


Figure 7. Spatial variation of intertidal macrobenthos. The coloured bars give the average value for biomass, density and diversity. The small black lines on top of the coloured bars represent the standard error. The vertical red line indicates the relocation test. 'VJ'=spring, 'NJ'=autumn, NS=northern spit, ES=edge of the sandbar, CS=central sandbar (van der Wal 2010)

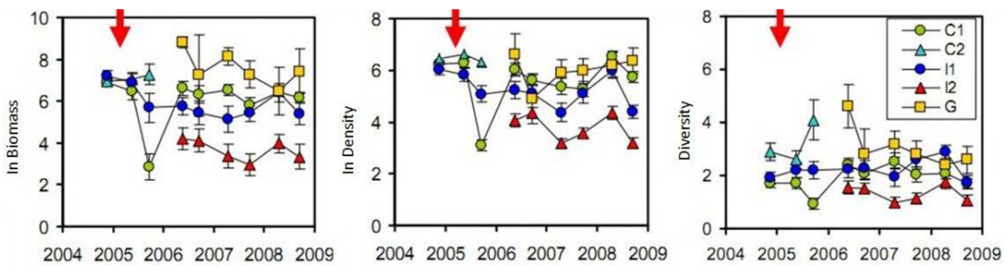


Figure 8. Trend in biomass, density and species richness of subtidal macrobenthos in the study area. The red arrows indicate the relocation test. (van der Wal 2010)

Figure 9. Poor macrobenthos community in the subtidal area around the sandbar (van der Wal 2010)

2 Execution of main effectiveness criteria

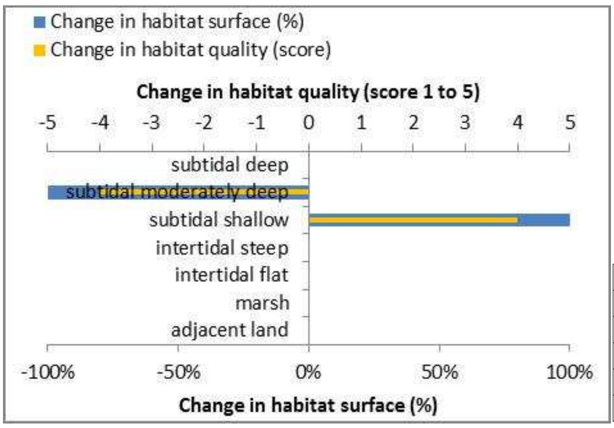
2.1 Effectiveness according to development targets of measure

Overall, this pilot test could be regarded as both a morphological and ecological success. The morphological evolutions were in agreement with the predictions of the feasibility study. Hence, a small shallow water area is created as a consequence of the relocation test. None of the results from the ecological monitoring indicated that the in situ relocation test was responsible for a significant change in ongoing trends. The ecological evolutions of this in situ test also confirmed the feasibility of the proposed relocation strategy.

2.2 Impact on ecosystem services

<u>Step 1</u>: Involved habitats
According to expert judgment, we do not have the possibility to indicate the relative involvement of different habitats in percentages and even less to indicate the quality. The reason for this is the fact that the in situ relocation test is just a small scale test to study the feasibility of the large scale relocation along a sandbar, and as such not a goal in itself.

Based on Figure 6, we can however qualitatively conclude that a small area of subtidal shallow habitat was created in front of the sandbar tip. Before the relocation this area was subtidal moderately deep habitat. This is also in line with the objective (creating low dynamic habitat).



Score habitat quality
1 = very low quality
2 = low quality
3 = medium quality
4 = high quality
5 = very high quality

Figure 10. Ecosystem services analysis for TIDE pilot: Relocation of dredged sediment to a shallow water area at the edge of the Walsoorden sandbar (2004): Indication of habitat surface and quality change, i.e. situation before versus after measure implementation. The change in habitat quality, i.e. situation after the measure is implemented corrected for the situation before the measure, is '1' in case of a very low quality shift, and '5' in case of a very high quality shift.

Step 2: Expected impact on ecosystem services, compared with targeted ecosystem services, and expected impact on beneficiaries

More information about the methodology and the correct interpretation of the results could be found in the overall measures report (Saathoff et al. 2013).

(1) Overall expected impact on ES:
From the ES assessment it is concluded that this measure generates both positive and negative expected impacts. A positive expected impact is indicated for the ES water quantity regulation (dissipation of tidal and river energy). A slightly positive expected impact is indicated for "biodiversity", and some regulating services (Water quality regulation: reduction of excess loads coming from the catchment; Erosion and sedimentation regulation by biological mediation; Water quantity regulation: landscape maintenance; Climate regulation: carbon sequestration and burial; Regulation of extreme events: water current regulation). A slightly negative expected impact is indicated for the ES Water quality regulation: transport of pollutants and excess nutrients, and Water quantity regulation: transportation.

(2) Expected impact on targeted ES
As this measure was only a test case, the target was limited to studying the stability of the relocated material (ES 'Information for cognitive development' and 'Erosion and sedimentation regulation by water bodies'). The expected impact on both development targets is nihil (neutral).

(3) Expected impact on beneficiaries
The expected impact for the different beneficiary groups is slightly positive for future use and local use.

Table 2. Ecosystem services analysis for TIDE pilot: Relocation of dredged sediment to a shallow water area at the edge of the Walsoorden sandbar (2004): (1) expected impact on ES supply in the measure site and (2) expected impact on different beneficiaries as a consequence of the measure.

TIDE pilot: Relocation of dredged sediment to a shallow water area at the edge of the Walsoorden sandbar (2004)

Cat.	Ecosystem Service	Score
S	"Biodiversity"	1
R1	Erosion and sedimentation regulation by water bodies	0
R2	Water quality regulation: reduction of excess loads coming from the catchment	1
R3	Water quality regulation: transport of polutants and excess nutriënts	-1
R4	Water quantity regulation: drainage of river water	0
R5	Erosion and sedimentation regulation by biological mediation	1
R6	Water quantity regulation: transportation	-1
R7	Water quantity regulation: landscape maintenance	1
R8	Climate regulation: Carbon sequestration and burial	1
R9	Water quantity regulation: dissipation of tidal and river energy	2
R10	Regulation extreme events or disturbance: Wave reduction	0
R11	Regulation extreme events or disturbance: Water current reduction	1
R12	Regulation extreme events or disturbance: Flood water storage	0
P1	Water for industrial use	0
P2	Water for navigation	0
P3	Food: Animals	0
C1	Aesthetic information	0
C2	Inspiration for culture, art and design	0
C3	Information for cognitive development	0
C4	Opportunities for recreation & tourism	0

Beneficiaries:	
Direct users	0
Indirect users	0
Future users	1
Local users	1
Regional users	0
Global users	0

X Targeted ES

Legend: expected impact*	
3	very positive
2	positive
1	slightly positive
0	neutral
-1	slightly negative
-2	negative
-3	very negative

*: Indicative screening based on ES-supply surveys and estimated impact of measures on habitat quality and quantity. Quantitative socio-economic conclusions require local supply and demand data to complement this assessment.

2.3 Degree of synergistic effects and conflicts according to uses

No conflicts were observed. The relocation location was situated in an area that was already licenced for relocation activities. However, this pilot project could not have been executed without the permission of the licensing authority who granted the use of a pontoon for relocation of dredged material. This project was integrated in the annual maintenance dredging activities. At a larger scale, this measure could give the possibility to combine dredging and port development with habitat creation and nature conservation.

3 Additional evaluation criteria in view of EU environmental law

3.1 Degree of synergistic effects and conflicts according to WFD aims

The relocated sediment was stable and moved slowly towards the sandbar, expanding the shallow area around the sandbar and also changing the bathymetry at a local scale. The sediment is placed into an area that has been eroding for several decades. The quantity of dredged material (0.5 million m³) is low regarding the capacity of the eroded area and will therefore not significantly change the erosive hydrodynamic conditions. Also, this measure tackles the effect (eroded area), not the cause!

Indicator Group	Code	Main pressures **polyhaline** zone Scheldt	Effect?					Description
			--	-	0	+	++	
S.I.	1.1	Habitat loss and degradation during the last about 100 years: Intertidal				X		Enlargement of the sandbar and local change of bathymetry (small scale test)

S.I.	3.1/3.2	Decrease of water and sediment chemical quality			X			
S.I.	3.3	Increased chemical loads on organisms			X			
D.I.	1.7	Relative Sea Level Rise			X			
D.I.	2.6	Capital dredging			X			
D.I.	2.12	Port developments			X			

S.I. = state indicator; D.I. = driver indicator

3.2 Degree of synergistic effects and conflicts according to Natura 2000 aims

This measure is located in the Natura-2000 area **Western Scheldt (Westerschelde) & Saeftinghe (code 122)**. The relocation of dredged material at a sandbar had the ambition of creating new, and more divers habitat in the estuary. However, the measure as described here is only a small scale test with the aim of studying the stability of the relocated material. This has no impact on the Natura-2000 aims.

CO	**Specification**	**Effect?**					**Short explanation**
		- -	-	**0**	+	++	
Estuarine habitat: Western Scheldt (Westerschelde) & Saeftinghe	Improvement of the quality of the estuary (H113 0) Western Scheldt (Westerschelde)				X		More habitat diversity: shallow water area was created (small scale test)
	Preserve and increase the quality of marshes, mud flats and salt grasslands.			X			
	Preserve and develop the quality of inner dike brackish areas for breeding birds, marshes, etc.			X			
	Preserve undisturbed resting places and optimal breeding habitat.			X			Small scale test: no effects
Bird directive				X			Small scale test: no effects

4 Crux of the matter

This first relocation test proved that the new relocation strategy is feasible. When relocating sediment near the Walsoorden sandbar, the sediment is stable. The planning phase was not an issue because it was integrated in the regular maintenance dredging activities. Also the implementation was not an issue because it was executed in an area that was already licenced for relocation of dredged material. Only for the use of the diffuser pontoon an extra licence had to be requested.

The relocation test as executed at the Walsoorden sandbar in 2004 showed the feasibility of morphological relocation at sandbars. This strategy could become part of a global approach of morphological management. Morphological relocation at sandbars is a creative solution to use dredged material to create positive effects (instead of the actual "get rid of the

sediments"-principle). In addition, the sediment is relocated at a permanent location so it will less circulate throughout the system and possibly reduce the need for maintenance dredging.
An important critique on the relocation strategy is that it only tackles the effect of erosion, not the cause. However, this is crucial for a proper morphological management. The cause of the erosion (orientation of the flood currents towards the tip of the sandbar) should be investigated and solved within the philosophy of morphological management of the estuary (which would also have to include morphological dredging and modifying the hard bordering at some locations).
Other commonly known knowledge gaps are on the understanding of sediment transport pathways and resulting sedimentation and erosion patterns and on the inhabitation of benthic macrofauna of new shallow areas.
The successful results of the in situ test of 2004 formed a base for a new in situ test in 2006. With this test another relocation methodology was analysed: traditional "clapping" technique (Plancke and Ides 2007). This test will be discussed as a separate measure: Walsoorden pilot test part B 2006.

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