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The Interreg IVB North Sea Region Programme

WP5 Measures

Basic analysis reports

Measure nr° 22. TIDE pilot 1: Large scale execution “plaatrandstortingen” (2010), relocation of dredged sediment to shallow water areas near sandbars

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- Measure Category: Biology/Ecology
- Estuary: Scheldt
- Salinity zone: Polyhaline
- Pressure: Habitat loss and degradation
- Status: Under construction (Implementation between 2010 and 2015)
- River km: Scheldt-km 42-47; TIDE-km 110-116
- Country: the Netherlands
- Specific location: Western Scheldt, three sandbars (four relocation locations): sandbars Hooge Platen (North and West), Rug van Baarland and Walsoorden
- Responsible authority: Department of Mobility and Public Works (MOW), Maritime Access Division
- Costs: /
- Cost category: 1,000,000 – 5,000,000 €

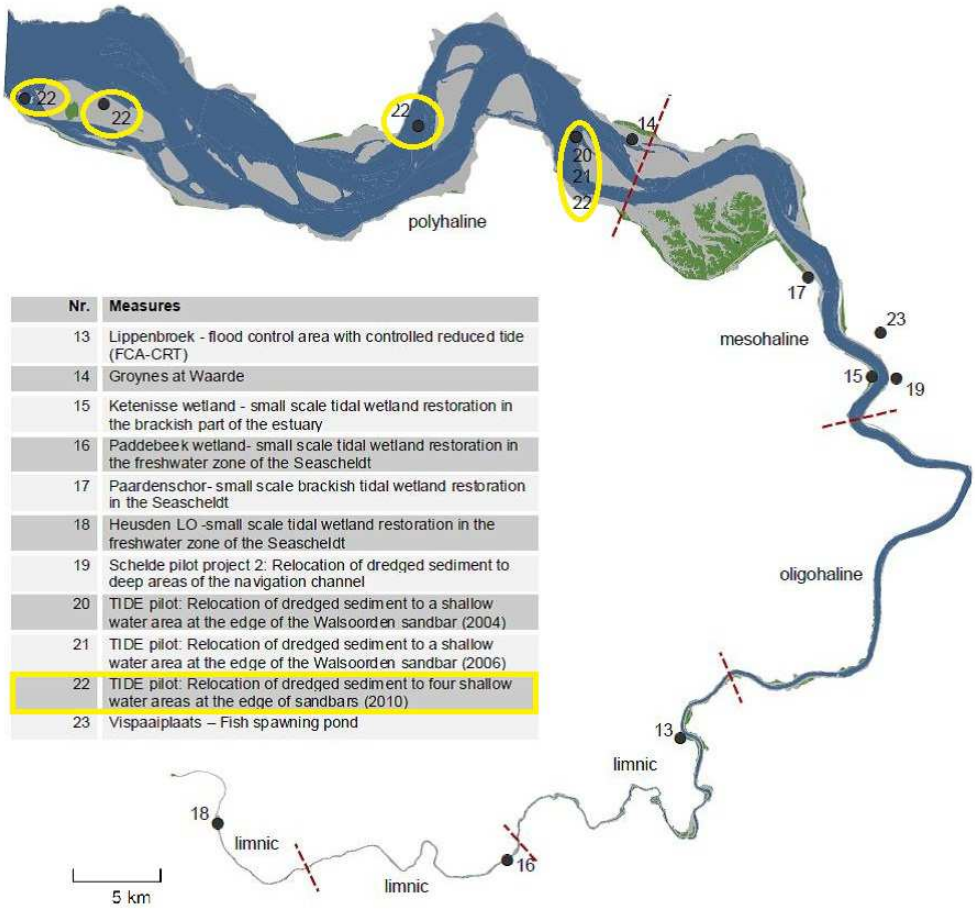

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Figure 1. Location of the different sandbars (Western Scheldt, Westerschelde)

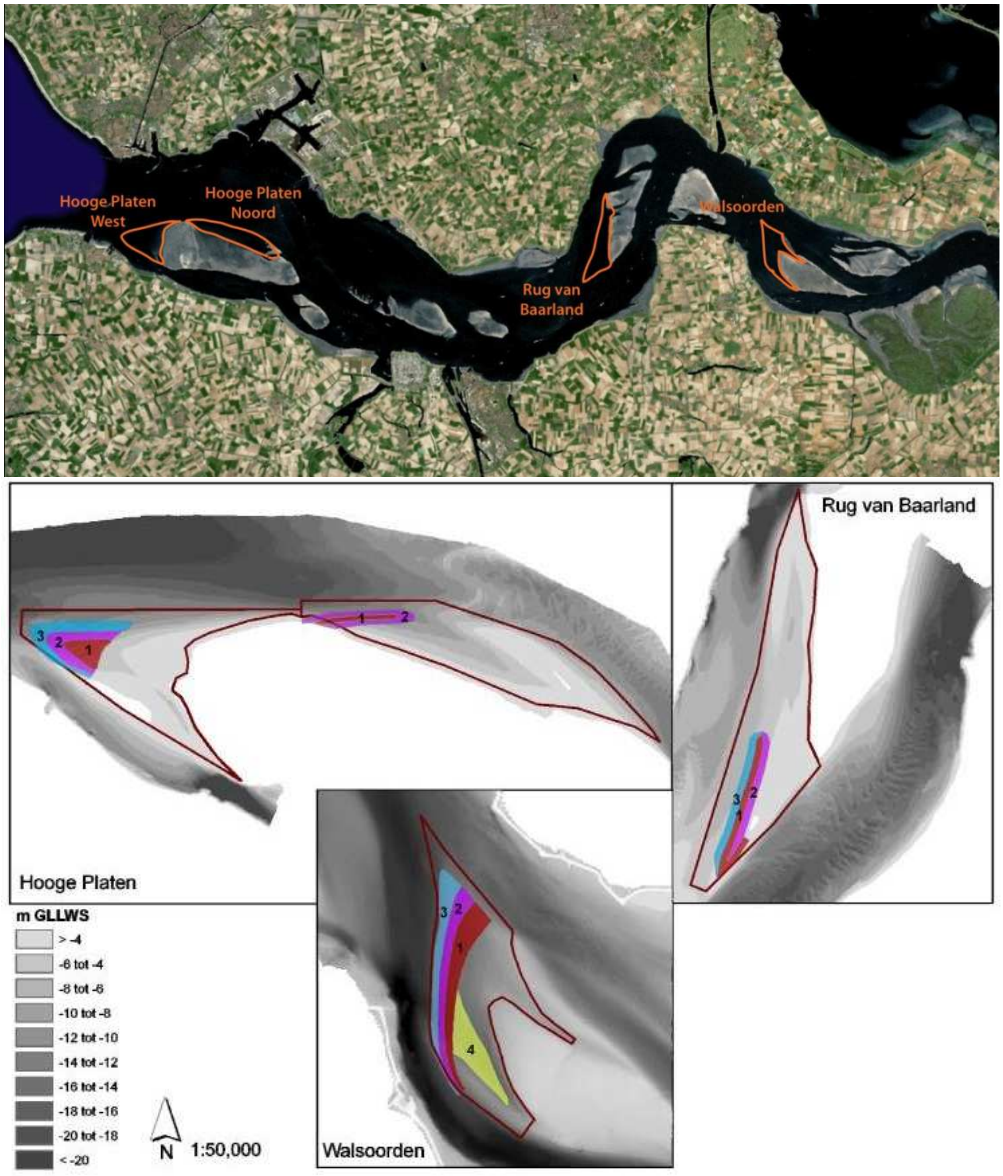


Figure 2. Site specific relocation strategies for the three sandbars: Hooge Platen (upper left), Rug van Baarland (upper right) and Walsoorden (under) (Plancke et al. 2010)

1.1 Measure description

GENERAL

This measure fits in with "The Long Term Vision 2030 for the Scheldt estuary" which presents a view on the preferred functioning of the system, accepted by both the Dutch and the Flemish government. The LTV states that further interventions should not endanger the preservation of the existing dynamic evolution of the multiple-channel estuary. One of the projects within the first action plan of the LTV is a further deepening of the navigation channel to guarantee optimal port accessibility. Based on the experiences at Walsoorden (2004-2006), one of the alternatives in the environmental impact assessment was to relocate sediment near several sandbars in the Western Scheldt. The main target of the project was to enable the deepening of the navigation channel, while conserving the multiple channel system, and creating new valuable areas (low dynamic areas, i.e. subtidal and intertidal areas

with low currents). The initial goal of this measure is to ensure that the additional volumes produced by the capital dredging works could be kept within the estuary instead of exporting it out of the estuary, into the sea (Plancke et al. 2010) or storing it on land.
The study area is located in the Western Scheldt (the Netherlands), more specifically on the sandbars Walsoorden, Rug van Baarland, Hooge Platen Noord, and Hooge platen West. The cumulated area amounts 1,513 hectares. An extensive research program was executed to determine more into detail the relocation strategy at these new locations, using field measurements (both GPS-floats and sediment transport) and hydrodynamic numerical models. An extra model validation was performed for the flow velocities on the intertidal area of the sandbars, to improve the correspondence of the patterns of ecological valuable ecotopes. Also different disposal techniques were studied: traditional disposal technique and diffuser technique. Based on this research, a site specific relocation strategy was proposed for each location (**Fout! Verwijzingsbron niet gevonden.**).

Beside the new relocation sites near sandbars, the current (2010) disposal license will include larger relocation zones in the secondary channels and in the deeper parts of the navigation channel (Plancke et al. 2010). This will allow the Maritime Access Division (Flemish government), responsible for executing the dredging and relocation works, to anticipate to morphological evolutions in the estuary and adapt the relocation strategy within the limitations of the disposal license.

DETAILS per sandbar
1) For the Walsoorden sandbar, the relocation strategy aims at creating a subtidal macro-dune which will migrate towards the sandbar under influence of the flood-dominated currents (Plancke et al. 2010). This macro-dune will be created using both the traditional disposal technique and the diffuser technique. A total amount of 6.5 million cubic metres of sandy sediments will be relocated at this location over a period of 5 years. This measure would increase the conservation of the multiple channel system by improving the separation between the current between ebb- (Zuidergat "2") and flood channel (Schaar van Waarde "3") (Figure 3). Additionally, the self-eroding capacity of the current upstream the "drempel van Hansweert" will increase, so that the dredging effort at this spot will decrease. The third and last effect would be the decreasing current velocity in shallow water round and above the sandbar, which will increase the ecological value of the area.

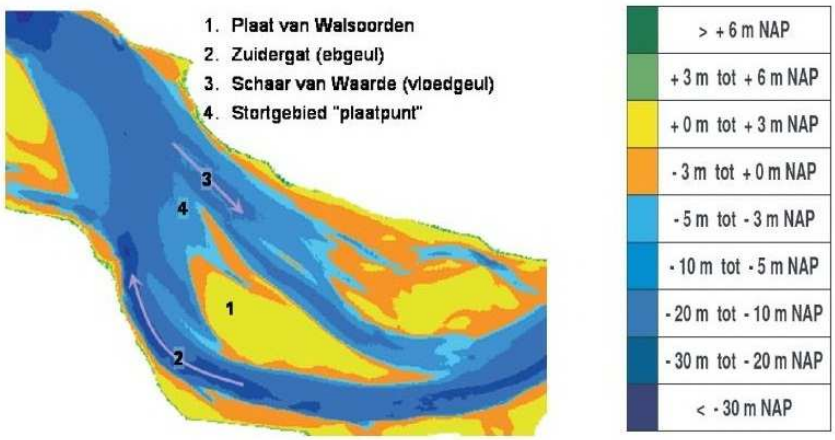


Figure 3. Walsoorden sandbar ("1"), ebb tide channel Zuidergat ("2"), high tide channel Schaar van Waarde ("3"), and relocation area (sandbar tip) ("4") (Plancke and Ides 2007)

2) Near Rug van Baarland the relocation strategy aims at constructing a sand spit near the southern tip of the sandbar. This new sand spit, in combination with the existing sand spit in the northern part, aims for the creation of an underwater barrier reducing the currents between the barrier and the sandbar, creating a low dynamic shallow water area (Plancke et al. 2010). In a second stage, the intertidal area will be expanded at the Western side of the sandbar, creating a low dynamic intertidal mudflat on the sandbar. A total amount of 5 million cubic metres of sandy sediments will be relocated here over a period of 5 years, mostly with the diffuser technique (Plancke et al. 2008).

3&4) For the Hooge Platen North the relocation strategy is similar to the Rug van Baarland and aims at constructing a sand spit. For the Hooge Platen West the relocation strategy is similar to the Walsoorden sandbar and aims at constructing a subtidal macro-dune. For both locations near the Hooge Platen, a total amount of 8,2 million cubic metres of sandy sediments will be relocated over a period of 5 years, both with the traditional disposal technique and with the diffuser technique (Plancke et al. 2010).

Starting situation (2010) of ecological valuable ecotopes at the four relocation areas (Table 1).

Table 1. Ecological valuable ecotopes at the four relocation areas, starting situation in 2010 (IMDC 2012)

Ecotopes (2010)	Hooge Platen West	Hooge Platen Noord	Plaat van Walsoorden	Rug van Baarland
Low dynamic shallow habitat	11.8	35.4	46.5	205.3
Low dynamic low marsh	6.5	32.1	/	2.8
Low dynamic medium marsh	27.4	224.2	30.6	36.0
Low dynamic high marsh	/	21.7	32.0	0.8
Total	45.7	313.4	109.1	244.9

1.2 Monitoring

The monitoring of this measure is still in progress. To evaluate the possible effects of the deepening of the navigation channel, including the new relocation strategy, an extensive monitoring programme was set up (Plancke et al. 2010). A special protocol, composed of several morphological (stability of disposed material) and ecological (evolution of ecotopes) criteria, is appended to the relocation license to, quasi continuously, evaluate the monitoring data. An independent group of experts (“Commission Monitoring Western Scheldt”) will supervise the evaluation of the monitoring and give at least every 2 years an advise on the relocation strategy.
The monitoring program aimes to control the maintenance of the multiple channel system, to control the stability of the disposed sediment to guarantee the development of new valuable habitats, and to make sure that the relocation activities do not harm any other part of the Western Scheldt (Table 2).
During execution (started in February 2010) an intensive monitoring programme will analyse the morphological and ecological effects of the relocated sediments, allowing adjusting the strategy if necessary. Important data that was collected were dredging and relocation volumes at the different locations (continuous follow-up), multibeam surveys and difference maps,

current velocity measurements on and along the sandbars, Real Time Kinematic (RTK) elevation measurements and sediment composition on the sandbars.

Table 2. Development criteria

Criterion	Explanation of the development targets
Conservation multiple-channel system	- The water volume in the secondary channel is monitored and a maximum allowed deviation is defined.
Ecological benefits from the relocation activities	- The stability of the relocated sediment is monitored to analyse the volume changes at the sandbars. The monitored volume changes are a consequence of the executed relocations and the natural sedimentation and erosion processes. The criterion for sediment stability after two years is 70%.
Development low dynamic habitat	- The total surface of low dynamic habitat near the sandbars is determined based on the ecotopes maps (**Fout! Verwijzingsbron niet gevonden.**). The development target is a gradually increase in the surface of low dynamic habitat with 114 hectares within 5 years after starting the relocation activities. The interim target after two years is no deterioration.
Conservation of the surface ecological valuable habitat	- Elevation of flat habitat and sandbars, also at the edges of the Western Scheldt and hence not only at the sandbars. In general, a decrease in the total surface of low dynamic habitat is not allowed. In addition, an elevation change of 5 cm or more per year is undesirable. The maximum allowed sedimentation and erosion rates depend however of the elevation of the location. The allowed erosion is absolute minimal at the lowest locations and the allowed sedimentation is absolute minimal at the highest locations. Four elevation classes are defined based on the duration of flood exposure. - Current velocity at sandbar edges: as much as possible low dynamic habitat is the development target, i.e. current velocity of maximum 0.8 m/s.

1.3 Monitoring results

The implementation of the sediment relocation at the three sandbars is still in progress, but we will here describe the predicted effects and some preliminary results for the first two years (2010-2012).

1.3.1 Expectations based on prior research studies

The expected results as discussed here are based on the environmental impact assessment, appropriate assessment, in-situ pilot projects Walsoorden 2004 and 2006, and an extensive research program. The global objective of those studies was to define a relocation strategy that maximises the ecological benefit. First of all, all four of the projects are positive in the light of future dredging activities because they offer new (semi) permanent relocation sites. But even more important, the results suggest that the relocation of sediment at the sandbars could improve the presence of low dynamic intertidal mudflats and shallow areas in the Western Scheldt (Figure 4 - Figure 6).

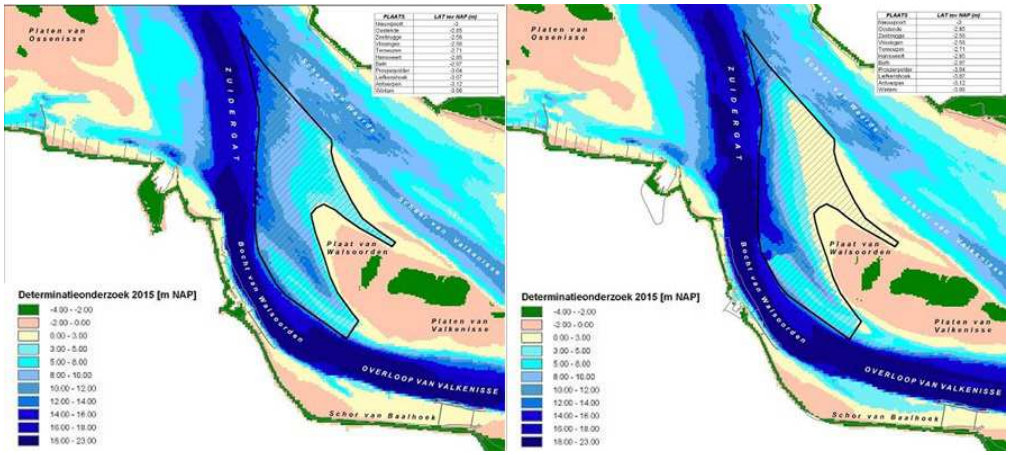


Figure 4. Location relocation area Walsoorden sandbar (left), bathymetry disposal area in 2015 (right) (Plancke et al. 2008)

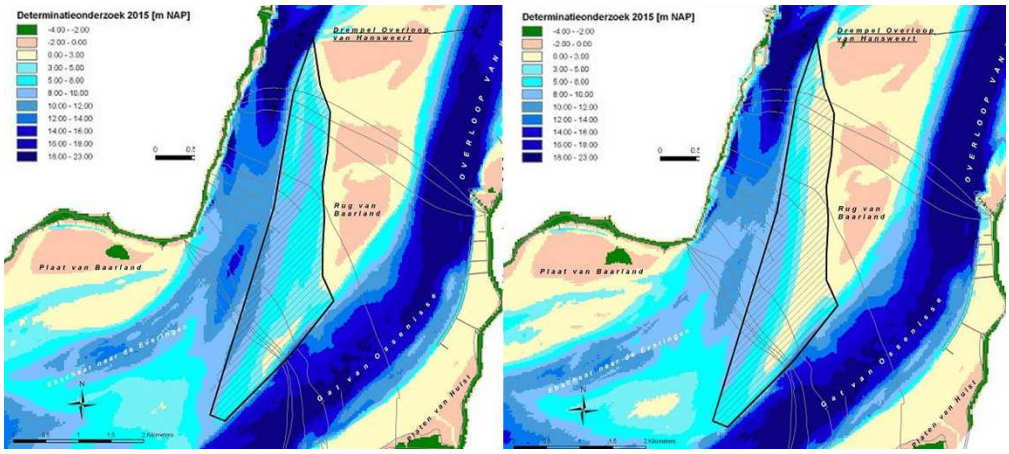


Figure 5. Location relocation area Rug van Baarland (left), bathymetry relocation area in 2015 (right) (Plancke et al. 2008)

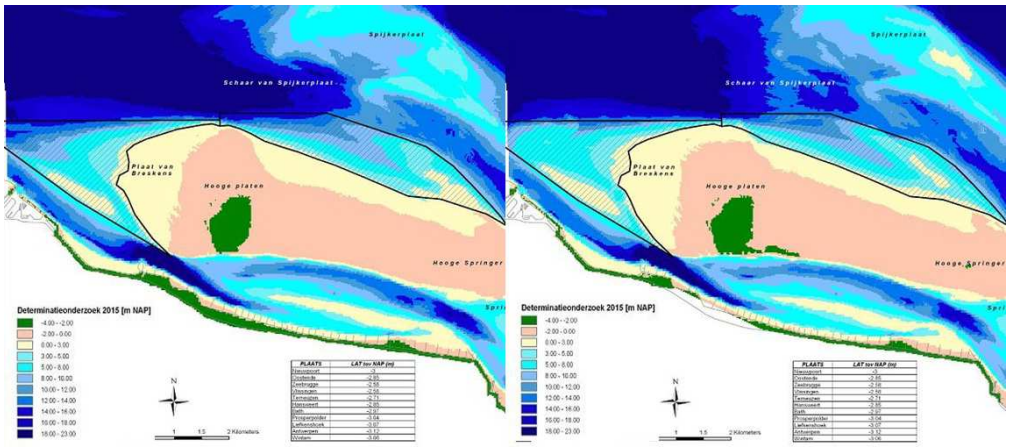


Figure 6. Location relocation area Hooge Platen North and West (left), bathymetry relocation area in 2015 (right) (Plancke et al. 2008)

Based on the specific location on the sandbar where the sediment is relocated, two types can be distinguished. On one hand both the relocation sites near the Walsoorden sandbar and the Hooge Platen West are located near the seaward tip of the sandbar, attacked by flood currents. It is expected that sediment relocated at these locations, will be gradually transported towards the sandbar. On the other hand the relocation sites near Rug van Baarland and Hooge Platen North are located along the sandbar, guiding the currents. It is expected that sediment relocated at these locations, will be rather transported along the sandbar.

Another difference was found in the flow dynamics: the 2 locations near Hooge Platen (North and West) are characterized by far more dynamic conditions, both hydrodynamic (factor 1.5 for flow velocities) as morphodynamic (factor 2.5 for sediment transport) in comparison with the location Rug van Baarland and Walsoorden sandbar (Plancke et al. 2010).

The main objective of the extensive research program was to adapt the proposed relocation sites to maximise the creation of low dynamic shallow and intertidal areas. In total, the aim is to create 114 ha of new low dynamic areas of which 85% littoral and 15% sublittoral (Plancke et al. 2008). Different strategies were used in the four measures to realise these ecologically valuable areas. The relocation at Walsoorden and Hooge Platen West is similar: a subtidal macro-dune is constructed to slow down the current velocity. At the Hooge Platen North, the material was disposed in the shape of two ‘arms’ enclosing a low dynamic area. Finally, at the Rug van Baarland, a shallow area was built to slow down the current and create an ecological valuable low dynamic area.

From the numerical calculations was concluded that the realisation of low dynamic areas at the Walsoorden sandbar will be limited because of strong current velocity gradient along the sandbar. However, also a reduction in current velocity is predicted by which the opportunity that low dynamic areas will develop increases.
Because the current velocity gradient over the Rug van Baarland is already small, a limited current velocity decrease caused by the construction of extra shallow area can provide a strong increase in low dynamic area.
Although the area around the Hooge Platen is highly dynamic, a positive effect on the development of low dynamic areas is expected for the Northern part. On the Western part, however, only a very limited effect is expected. The reconstruction of the sandbar tip is indeed very difficult because of the high dynamics.

1.3.2 Preliminary results (2010-2012) regarding “Ecological benefits from the relocation activities” (IMDC 2012)

In 2012, two years after the start of the relocation activities, the stability of the sediment is positive at three of the four locations (

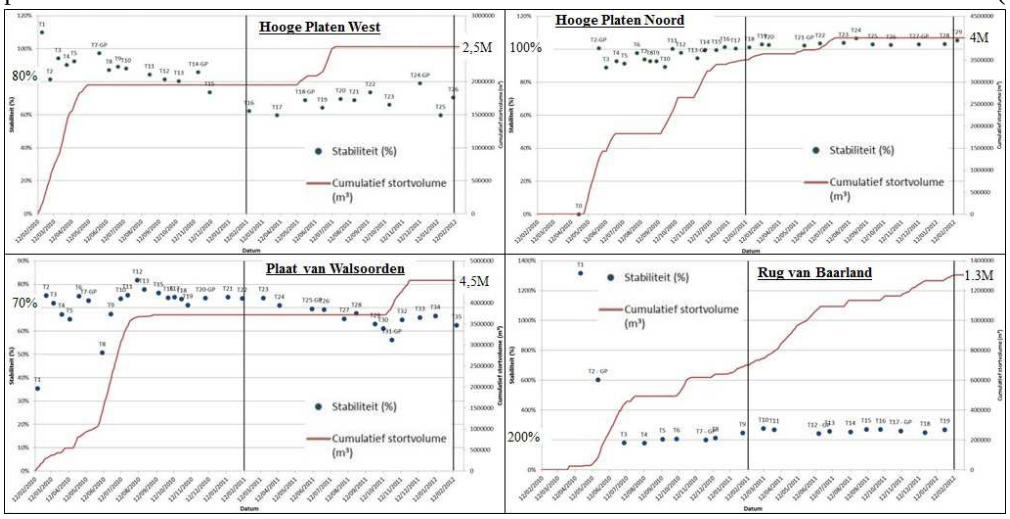


Figure 7). Hooge Platen Noord and Rug van Baarland show stability rates of >100%, this means that the relocation goes along with natural sedimentation. At Hooge Platen West the stability after two years is 70%, however the stability varies between 60% and 80%. Only at the Walsoorden sandbar the stability was too low (62%). The main problem at the Walsoorden sandbar was the sediment instability during the relocation activities. After the relocation, the sediment was mainly stable.

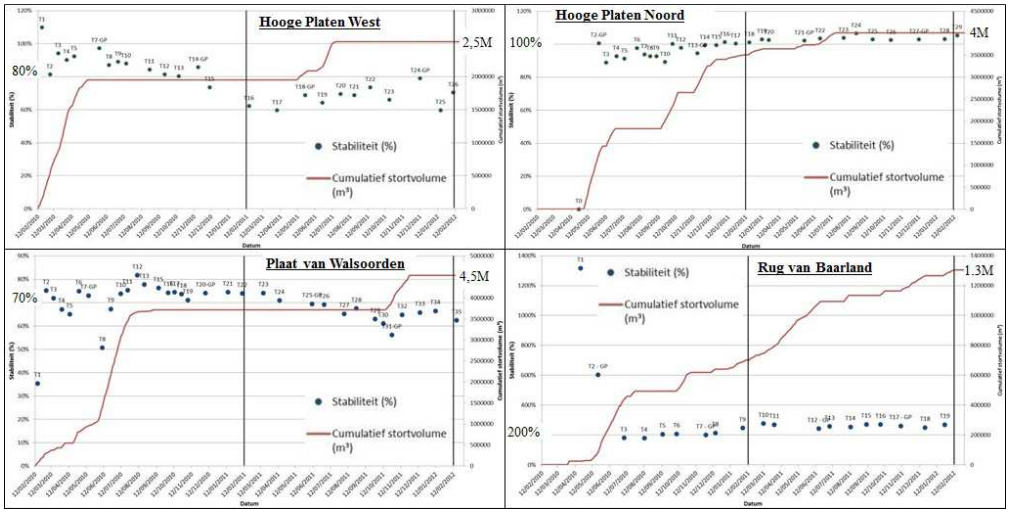


Figure 7. Evolution stability (%) of the relocated volume and the cumulative relocated volume (m³) for the complete relocation zone of the four areas, between 2010 and 2012. Left axis (dots): stability (%), right axis (red line): cumulative relocated volume (m³). (IMDC 2012)

2 Execution of main effectiveness criteria

2.1 Effectiveness according to development targets of measure

Step 1: Definition of development targets
This new relocation strategy is a mitigation measure for the deepening of the fairway in the Western Scheldt with both economic and ecological benefits. The economic benefits are related to the deepening and maintenance of the fairway. The ecological benefits are related to keeping the sediment in the estuary and creating new valuable areas without endangering the multiple channel system. The relocation of the dredged sediment is well-considered to limit the current velocity around the sandbar and hence create low dynamic habitats.

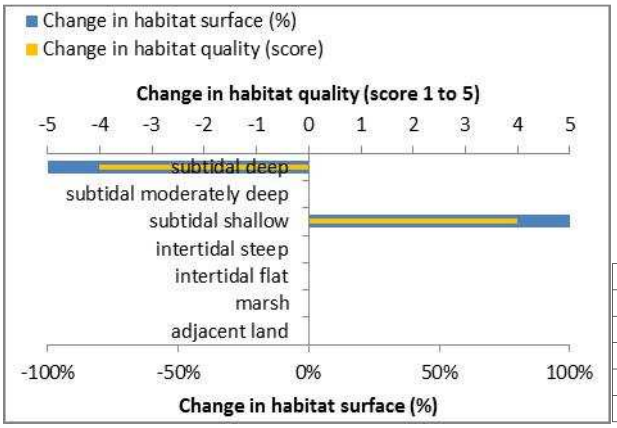
Step 2: Degree of target achievement
The degree of target achievement is not clear yet as the measure is still in progress. Up till now the implementation is partially on track with the expected targets.
During the implementation since 2010 the relocation strategy is already adapted based on new insights from the monitoring, which emphasizes the usefulness of the flexible strategy applied here. The sediment volume relocated into the shallow water areas is maintained during a period of 5 years following the deepening. At the Rug van Baarland, some spots are not used anymore to dispose material because of a rich local benthos population. At the Hooge Platen the use of the diffuser technique is stopped during the summer months because of the breeding season of the Common Tern (*Sterna hirundo*).

2.2 Impact on ecosystem services

Step 1: Involved habitats

The measure TIDE pilot project 1 Sandbars (2010) in the polyhaline and mesohaline zone of the Scheldt estuary was about the relocation of dredged sediment to four shallow water areas at the edge of sandbars by transforming mainly subtidal deep habitat into subtidal shallow habitat without changing the habitat quality.

Before the measure, the relocation area consisted mainly of subtidal deep habitat and a small part of subtidal moderately deep habitat and subtidal shallow habitat.
After the implementation of the measures (2015, Figure 4 - Figure 6), the creation of more low dynamic subtidal shallow habitat is expected.



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

Figure 8. Ecosystem services analysis for TIDE pilot project 1 (Scheldt): Relocation of dredged sediment to four shallow water areas at the edge of sandbars (2010): 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 impact on ES. A positive to very positive expected impact is indicated for Water quantity regulation (dissipation of tidal and river energy); and Water quantity regulation (landscape maintenance). A slightly positive expected impact is indicated for "biodiversity"; food (animals); and some regulating services. A negative to very negative expected impact is indicated for Water quality regulation (transport of pollutants and excess nutrients); Water quantity regulation (transportation); Water for industrial use; and Water for navigation.

The transformation from subtidal deep to subtidal shallow water is in general indeed negative for transportation. But in the local context of the relocation of dredged material at the edges

of the Walsoorden sandbar it was proven that it contributes to the maintenance of the multiple channel system, which is positive for transportation.

(2) Expected impact on targeted ES
The expected impact on the development target creation of low dynamic areas (ES habitat services "biodiversity") is slightly positive.

(3) Expected impact on beneficiaries
The expected impact for the different beneficiary groups is slightly positive for future users, but slightly negative for indirect use and regional use.

Table 3. Ecosystem services analysis for TIDE pilot project 1 (Scheldt): Relocation of dredged sediment to four shallow water areas at the edge of sandbars (2010): (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 four shallow water areas at the edge of sandbars (2010)

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	-2
R4	Water quantity regulation: drainage of river water	0
R5	Erosion and sedimentation regulation by biological mediation	1
R6	Water quantity regulation: transportation	-3
R7	Water quantity regulation: landscape maintenance	2
R8	Climate regulation: Carbon sequestration and burial	1
R9	Water quantity regulation: dissipation of tidal and river energy	3
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	-2
P2	Water for navigation	-3
P3	Food: Animals	1
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	-1
Future users	1
Local users	0
Regional users	-1
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

The public acceptance during the planning process was rather low and during the implementation (up to date) medium. Both conflicts and synergies are expected between the fields of 'shipping and ports' and 'nature conservation'. In one way this type of measure gives the opportunity to combine navigation channel deepening with the creation of new intertidal wetlands. However, the relocation of sediment at the sandbars may also affect the habitat at the sandbar. Uncertainties about the effectiveness of the relocation strategy in creating valuable habitat were used in court by nature organisations to dispute the licence for deepening and relocation.

3 Additional evaluation criteria in view of EU environmental law

3.1 Degree of synergistic effects and conflicts according to WFD aims

Important benefits of those measures in the polyhaline zone of the Scheldt estuary are the contribution to the creation of new intertidal wetlands and local change in bathymetry. Finally, it offers a permanent and controlled relocation strategy.

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, creation of low dynamic intertidal and shallow area
S.I.	3.1/3.2	Decrease of water and sediment chemical quality				X		Local change of bathymetry
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		Alternative relocation strategy after dredging

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

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

The sandbars are located within bird and habitat directive areas (**zone "Western Scheldt (Westerschelde) and Saeftinghe", HD code NL9803061 and BD code NL9802026**). For this measure, a small positive effect on the quality of the estuary (habitat type 1130) is expected (Plancke et al. 2008). Also a small positive effect is expected for some foraging birds.

CO	**Specification**	**Effect?**					**Short explanation**
		- -	**-**	**0**	**+**	**++**	
HD: estuary habitat (1130)					X		More habitat diversity, especially more low dynamic habitat
BD: non-breeding birds (with conservation objective)	Common Shelduck (*Tadorna tadorna*)				X		Positive effect from the relocation strategy
	Great Ringed Plover (*Charadrius hiaticula*)			X			Small positive effect, not significant
	Dunlin (*Calidris alpine*)			X			Small positive effect, not significant
	Common Greenshank (*Tringa nebularia*)			X			Small positive effect, not significant
	Red Knot (*Calidris canutus*)				X		Positive effect from the relocation strategy
	Bar-tailed Godwit (*Limosa lapponica*)				X		Positive effect from the relocation strategy
	Common Redshank (*Tringa tetanus*)			X			Small positive effect, not significant
	European Curlew (*Numenius*				X		Positive effect from the relocation

	arquata)						strategy
	Grey Plover (*Pluvialis squatarola*)				X		Positive effect from the relocation strategy
	Spotted Redshank (*Tringa erythropus*)			X			Small positive effect, not significant

4 Crux of the matter

The learning phase is still in progress and the end date is foreseen in 2015. A protocol for flexible relocation is developed based on the previous research studies to determine how the monitoring results should be used to prevent for unwanted effects. Until now it already led to adjustments and the expectation is that this method will lead to positive contribution to the ecological value of the Western Scheldt by the enlargement of low dynamic shallow water and intertidal habitat (Plancke et al. 2008). In this way, this measure is meant to be a pro-active way to contribute to the long term vision of the Scheldt estuary. However, to create a well-balanced morphological management of the Scheldt estuary, in addition to alternative relocation strategies, attention should also be addressed to morphologic dredging and the management of solid constructions (dikes, solid layers) in the estuary (Vos et al. 2009).

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