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The Interreg IVB North Sea Region Programme

WP5 Measures

Basic analysis reports

Measure nr° 18. Heusden LO wetland - small scale tidal wetland restoration in the freshwater zone of the Sea Scheldt

Annelies Boerema,
Antwerp Port Authority (APA)

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Annelies Boerema
Antwerp Port Authority

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- Measure Category: Biology/Ecology
- Estuary: Scheldt
- Salinity zone: Limnic
- Pressure: Habitat loss and degradation
- Status: Implemented (in 2004-2006)
- River km: 0 TIDE-km
- Country: Belgium
- Specific location: Sea Scheldt, Flanders, near Heusden (Gent), left bank Scheldt, downstream Heusdenbrug
- Responsible authority: Waterwegen en Zeekanaal NV
- Costs: /
- Cost category: 1,000,000 – 5,000,000 €

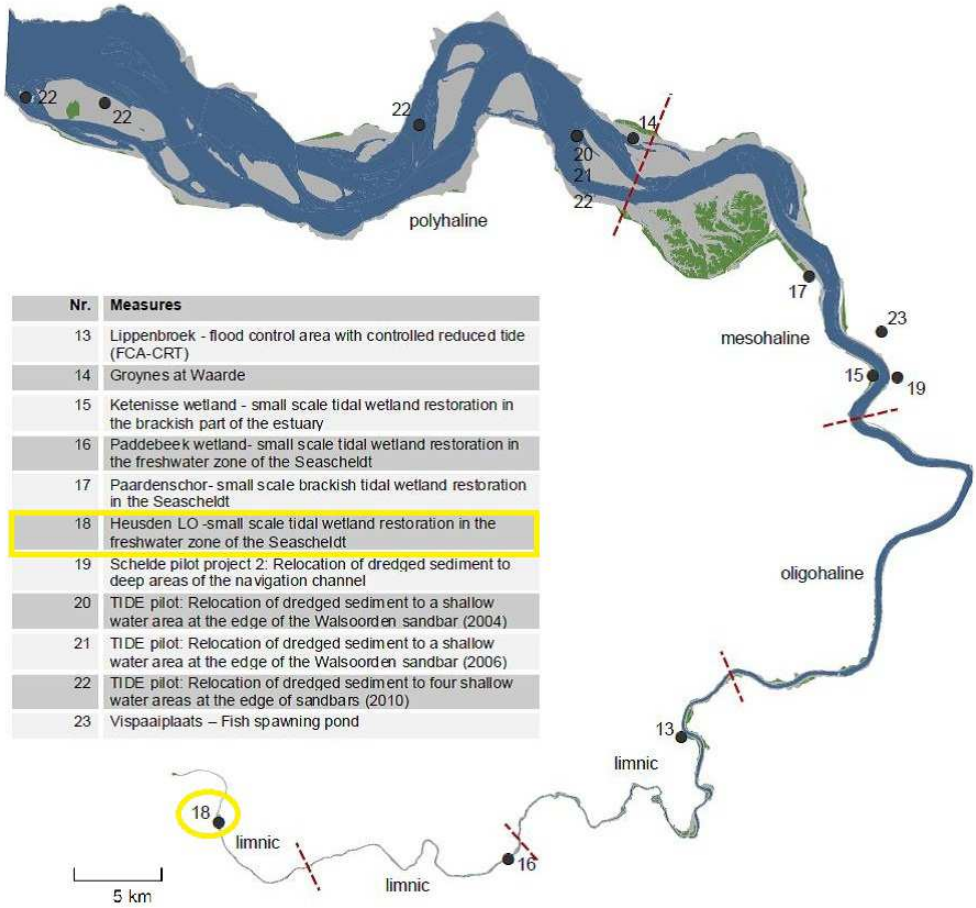

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Figure 1. Location Heusden LO wetland

1.1 Measure description

The Heusden LO wetland is an area of 10 hectare in the freshwater zone at the left bank of the Sea Scheldt (near Heusden (Gent), downstream Heusdenbrug).

At the location of Heusden LO, they decided to relocate the dike. By doing so, a small tidal wetland could develop in an area of the Sea Scheldt where tidal wetlands with mudflats and marshes are scarce. This opportunity came along when the existing dike needed to be elevated to "Sigma-height", and several alternative locations were considered. The old dike was lowered to mean high water level and two breaches to mean low water level were excavated where the old drainage sluices used to be. Because there is no shipping in this area and because dynamics are low, the new dike was not reinforced with stone rubble.

The restoration location existed mainly of grassland and cropland with also a moist willow bush surrounded by poplar plants where the Scheldt bends. In the North-western part used to be a meadow with a triangular pond. The pond is characterized by few aquatic plants and the meadow around is lower in elevation.
During the restoration works, the dike was breached through which the meadow area in the North-western part had already developed into an intertidal flat habitat before the restoration was done. During the summer, the breach was filled up again and the mud area was colonized by pioneer vegetation.
The most southern part of the area was elevated above mean water level because of the presence of a sand stock during the restoration works. Therefore, this part of the area was rarely flooded.
The most northern part of the area (northern from the pond) was flooded from the south at neap tide because the dike was not breached at this location. The drainage was also slow and inefficient because of the limited flow out possibilities.
At the end of the restoration works, the area was completely vegetated by the original vegetation. Only the area around the pond was colonized by pioneer vegetation during summer. In the beginning of the monitoring program, the area was a marsh with limited drainage during low water.

Besides the possibility to improve the connectivity in this area, developing this kind of habitat is expected to contribute in de reduction of tidal energy, increase of flood protection, improvement of oxygen condition, improvement of nutrient conditions, and improvement of self-purifying power.

The construction of the Heusden LO wetland fits in the frame of the Sigmaplan (management plan for flood defence in the Scheldt estuary), the dike needed to be broadened and elevated. Analysis of the evolution after restoration fits in with the decisions about the Development outline 2010 and Long Term Vision 2030 (Dutch and Flemish agreement on integrating accessibility, naturalness and flood safety) and the updated Sigmaplan (Flemish plan for flood protection combined with ecological objectives), of the Dutch and Flemish governments, that committed them to leap forward with the ecological rehabilitation of the Scheldt estuary. An important challenge is the creation of tidal wetlands by transformation of woods or agricultural land into tidal mudflats and marshes. In order to assess the feasibility and to identify possible problems any small scale projects already in place, such as Heusden-LO, are studied in detail to improve our apprehension of the similar larger scale future plans.

1.2 Monitoring

Monitoring is still in progress and is included in the global monitoring of the Scheldt estuary (Moneos). Also, a multidisciplinary monitoring program is installed similar to the monitoring of the other restoration projects (Paddebeek, Paardenschor, Ketenisse): changes in geomorphology (sedimentation-erosion plots (sederoplots), sederoplates, profile measures, orthophotos), sediment characteristics (granulometry, organic %, pigment, physicochemistry), benthos (oligochaeta) and vegetation (mapping and PQ's). These developments were compared as much as possible to the situation on nearby tidal wetlands.
In the Heusden LO wetland there are eleven permanent sederoplots (Figure 2: red spots) and 16 PQ vegetation sample sites situated at five different transects (Figure 2: yellow spots).

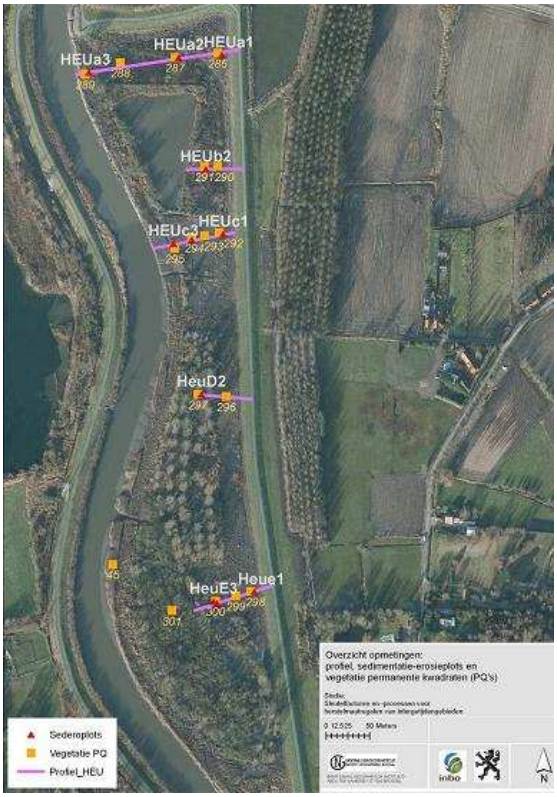

Figure 2. Overview Heusden LO wetland with measurement locations. Orthophoto January 2009. (Speybroeck et al. 2011)

1.3 Monitoring results

1.3.1 Topography and geomorphology

Sedimentation in the entire area was about 10cm during the monitoring program 2006-2009 (Speybroeck et al. 2011). The sedimentation is strongly related to elevation and therefore also with flood frequency and flood duration. Hence, sedimentation is stronger in the lower parts (transect C, sedimentation up to 30cm) and lower at the elevated parts. At transect A, even erosion occurred up to -10cm.

1.3.2 Sediment characteristics

In an initial phase after completion, the median grain size and corresponding silt content and organic matter content was highly variable. This initial phase was followed by a decrease in median grain size (refinement to type “silt”) and parallel a small increase in silt content and organic matter content.

The median grain size is rather constant in the entire area with size 30-40 µm (based on the autumn data from 2009, Figure 3). Only at locations HeuD2 and HeuE1, the median grain size is > 40 µm in one or both samples types (upper soil layer and deep soil layer). In general, the deeper layer (0-10cm) is a little more refined in 8 of 11 sample locations compared to the upper layer (0-1cm).

The silt content corresponds to the median grain size: silt content is low if median grain size is large. The silt content is rather constant at all locations and at upper and deep soil layer (Figure 4-left).

The organic matter content varies a little more and is the lowest at locations without vegetation development (HeuC2 and HeuC3, **Fout! Verwijzingsbron niet gevonden.**-right).

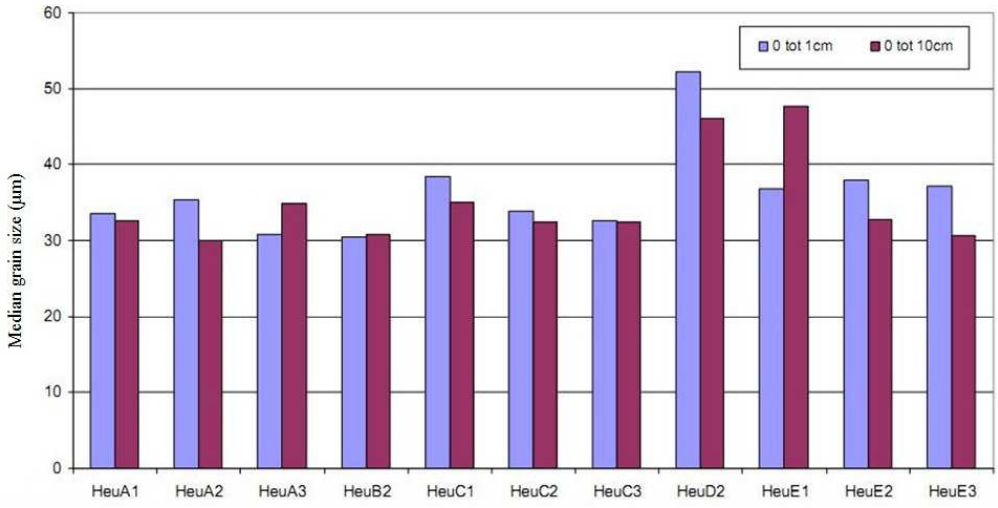

Figure 3. Sediment: Median grain size per location, autumn 2009 (Speybroeck et al. 2011).

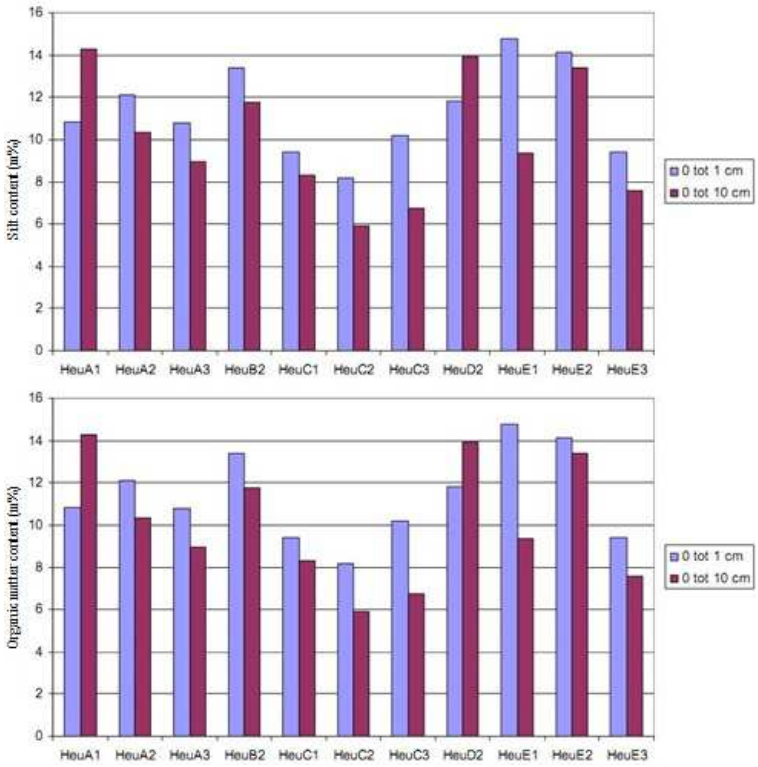

Figure 4. Sediment: silt content (< 63 µm) per location (up) and content organic material (m%) per location (down), autumn 2009 (Speybroeck et al. 2011).

1.3.3 Sediment quality

The global sediment quality is constant in the area with Triad score 3 "medium contaminated compared to the reference." With the restoration work, the concentration of some heavy metals decreased (chrome and lead) while the concentration of some organic contaminants increased (PAHs, PCBs, nonpolar hydrocarbon) (Speybroeck et al. 2011). An explanation for this effect is that the recently deposited sediment showed significantly higher concentrations of organic contaminants (cadmium, nonpolar hydrocarbon, OCP, PCBs and PAHs) whilst the original soil was more contaminated with heavy metals (chrome, copper and nickel) (Van den Neucker et al. 2007).
The quality of the recently disposed material was comparable with that of adjacent areas outside the dike.

1.3.4 Macrobenthos

The benthic fauna at the Heusden LO wetland is strongly dominated by Oligochaeta of which 60% Tubificides without hair and 16% Tubificides with hair. Other taxa of Oligochaeta are mainly dominated by the opportunistic species of the Limnodrilus genus (Table 1). Both the *Limnodrilus hoffmeisteri* and the *Tubifex tubifex* are known for (heavily) eutrophic substrates. Further, the diversity in Oligochaeta fauna gives an indication of some local evolutions. At HeuB2, for example, the community of pioneer marsh-taxa changed to fauna with only taxa typical for more developed marshes.
Benthic density and biomass show a continual increase from year to year at most locations except for locations HeuC1 and HeuC3 (Figure 5). At both locations, the values were of the highest in 2006 but decreased in the following years. This is probably the consequence of a

quick initial colonisation (both located near the in- and outlet), followed by a decrease as mud became vegetated.

Table 1. Relative proportion of taxa of Oligochaeta Heusden without the not determined Tubificides with or without hair (Speybroeck et al. 2011).

Taxon	Totaal	%
Limnodrilus hoffmeisteri	430852	29%
Limnodrilus sp.	199858,3	14%
Quistadrilus multisetosus	152517,5	10%
Limnodrilus claparedeianus	129016	9%
Tubifex tubifex	113500,7	8%
Paranais spp.	100874,7	7%
Enchytraeidae	80721,96	5%
Nais spp.	74216,99	5%
Amphichaeta sannio	59642,31	4%
Tubifex blanchardi	61728,27	4%
Limnodrilus udekemianus	45468,76	3%
rest	26493,77	2%

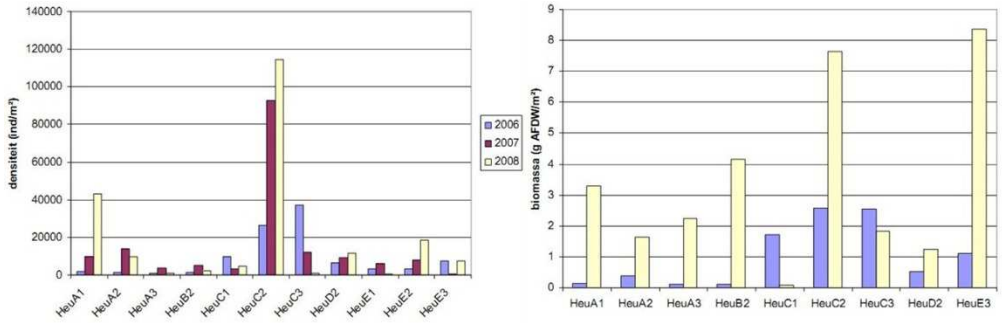

Figure 5. Density (left) and biomass (right) per location – autumn surveys from 2006, 2007 and 2008. Biomass data for 2007 is not available (Speybroeck et al. 2011).

1.3.5 Vegetation

The vegetation development in the area is mainly determined by the prior land use types. The higher elevated parts were used as grassland and cropland, while lower elevated parts were forested.

The background of the area was responsible for a divergent succession (

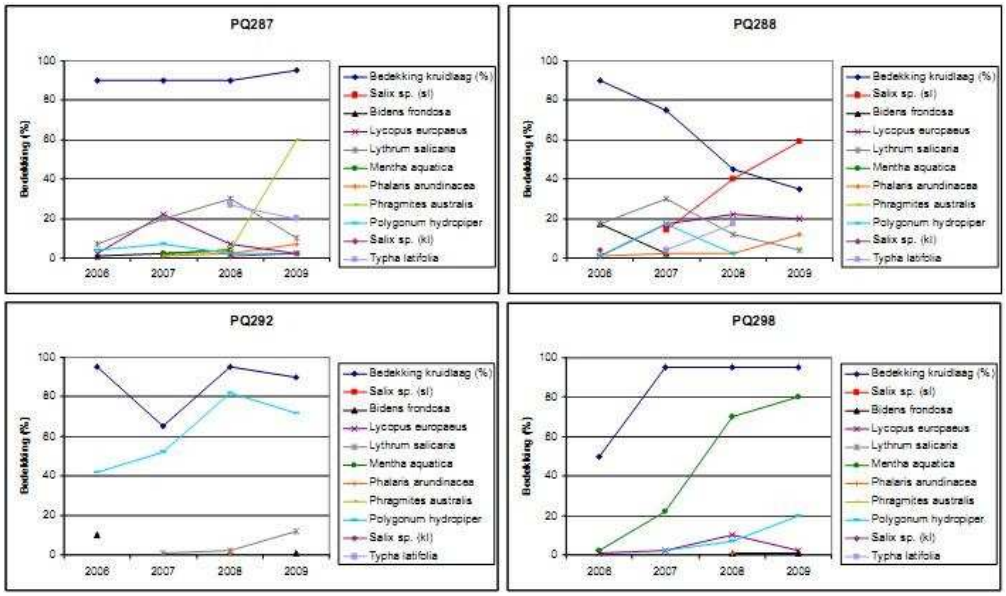

Figure 6 & Figure 7). Areas with willows developed further to willow bush with limited ground layer (eg. PQ288). Areas where no willows were settled developed depending on the elevation and corresponding hydrological regime. The lower elevated zones (eg. PQ292) developed with pioneer vegetation such as Water-pepper (*Polygonum hydropiper*). Also in PQ286 a similar pioneer vegetation of Water-pepper and Beggar Ticks (*Bidens frondosa*) developed but evolved rapidly to Reed vegetation (*Phragmites australis*).
The higher elevated zones (eg. PQ299 and PQ298 with less frequent floods but nevertheless wet) developed with a diverse helophyte community, dominated by Watermint (*Mentha aquatica*) with also pioneer species like Water-pepper (*Polygonum hydropiper*), Beggar Ticks (*Bidens frondosa*) and Gipsywort (*Lycopus europaeus*).

In the lower elevated parts (eg. PQ288), the restoration of the area was responsible for a reverse succession. This happened because the willow bush, traditional climax vegetation at freshwater marshes and therefore present at the higher elevated parts of the marsh, is in Heusden LO present at the lower elevated parts (C transect, eg. location 292). Typical for this area are the high sedimentation rate and the limited drainage, responsible for limited presence of ground layer. Willow bush survived, but poplars (*Populus x canadensis*) died systematically and the ground layer evolved from Brambles (*Rubus sp.*) to reed land.
Because of a dike breach during the construction (spring 2006), this area was flooded during a short time resulting in extinction of existing vegetation and sedimentation with a fine mud layer. During the summer of 2006, highly diverse pioneer vegetation developed on this fine mud layer with different species from the Goosefoot- and Dock family (*Chenopodiaceae* and *Polygonaceae*). Also different willows developed on this dry bare mud. Since the autumn of 2006, this area was definitely under tidal influence.

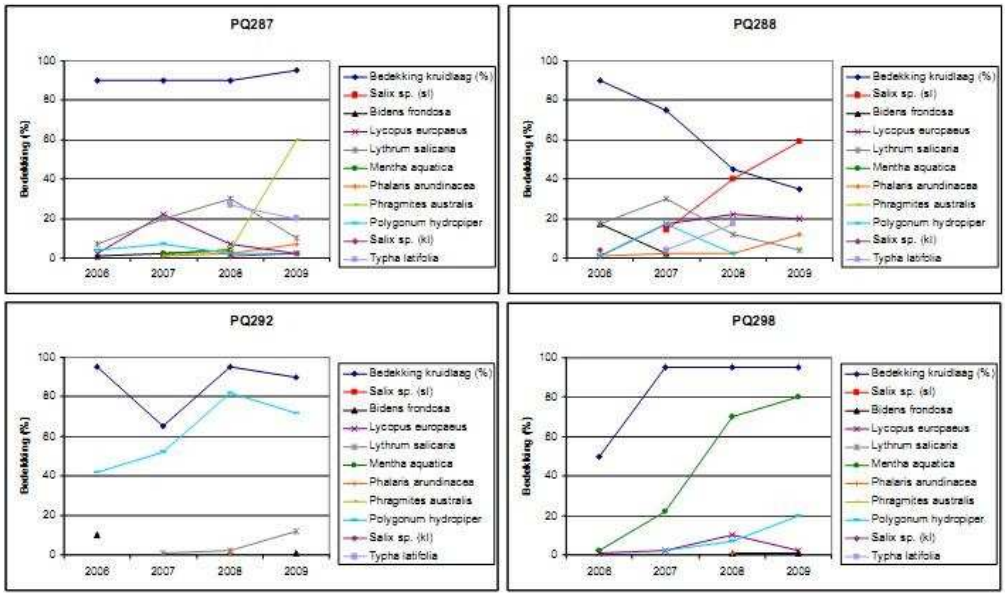

Figure 6. Changes in vegetation coverage by the most important plant species in some permanent quadrants (PQ) at Heusden LO from 2006 to 2009 (Speybroeck et al. 2011).

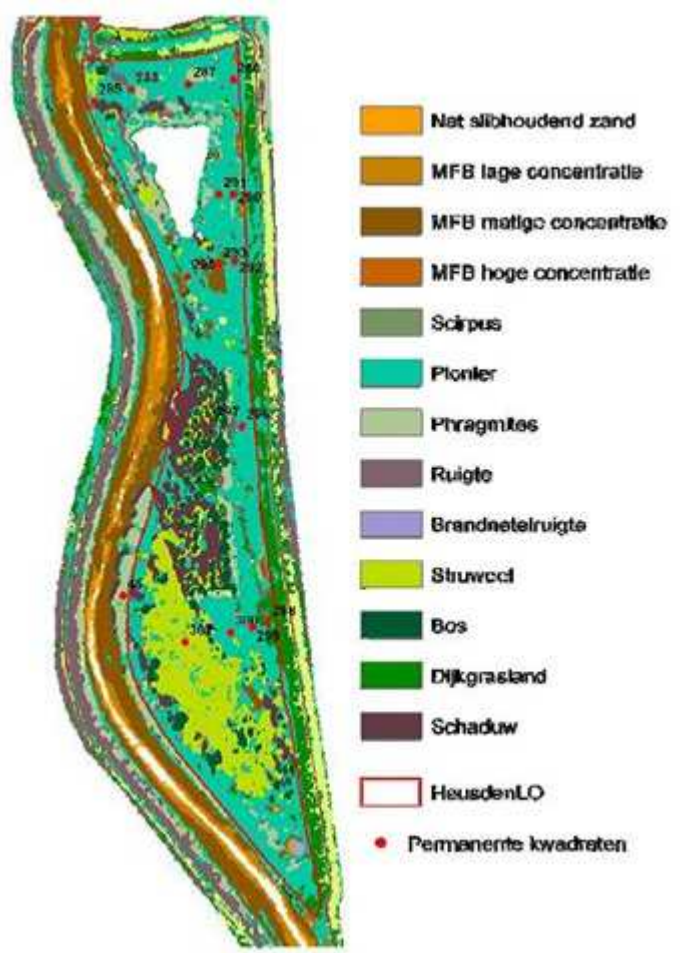

Figure 7. Vegetation map of Heusden LO, 2007. (MFB: microphytobenthos) (Speybroeck et al. 2011)

1.3.6 Macrozoobenthos

No monitoring results available.

1.3.7 Avifauna

No monitoring results available.

1.3.8 Fish

No monitoring results available.

2 Execution of main effectiveness criteria

2.1 Effectiveness according to development targets of measure

Step 1: Definition of development target
The creation of new ecologically valuable intertidal wetlands can contribute to estuarine restoration as it enables habitat development and biodiversity. Success factors are related to the improvement of estuarine processes (such as sedimentation-erosion, creek formation and soil development).

Step 2: Degree of target achievement
Overall, the restoration of the Heusden LO wetland succeeded in the aim to create an ecological valuable intertidal freshwater wetland. Initially the site only inundated at spring tides and it was not drained at low tide. Later two breaches to MLW were added where the old sluices used to be, connecting to ditches. It then had every aspect of a breached site with a strongly accentuated spring tide/neap tide differentiation in the inundation regime. Nevertheless, some areas remained inundated at low tide and the southern part where the sand stock for the dike construction works was not completely removed remained supratidal. As a result of this design a site with a great variety of habitat types was created, with permanent pools, mudflats and all stages of typical tidal marsh vegetation. The vegetation gradient from low marsh to supratidal was uninterrupted because of the absence of fortifications.
Unfortunately the area was recently colonised by Floating marsh pennywort (*Hydrocotyle ranunculoides*), an invasive species. Chances are that this species will soon invade the complete tidal area.

2.2 Impact on ecosystem services

Step 1: Involved habitats

The measure Heusden LO in the freshwater zone of the Scheldt estuary was about the creation of intertidal habitat by transforming adjacent land (grassland, cropland, willow bush, poplars and meadow) into mainly marshland with a high change in the habitat quality.

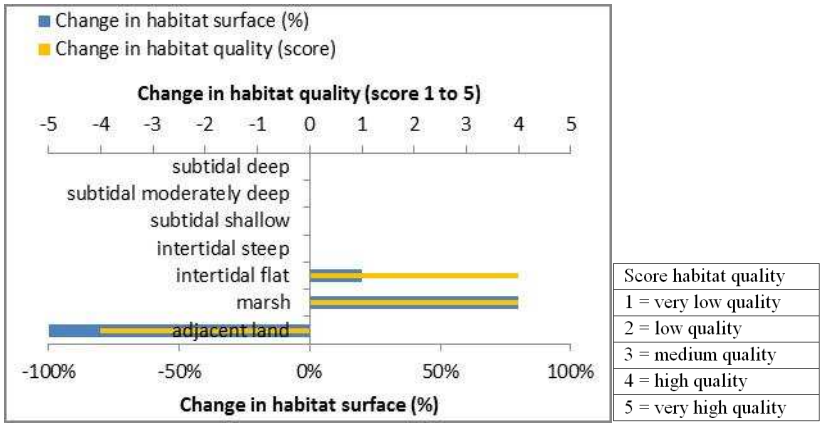

Figure 8. Ecosystem services analysis for Heusden LO wetland: Indication of habitat surface and quality change, i.e. situation before versus after measure implementation. The change in habitat quality, i.e. situation after the measure is implemented corrected for the situation before the measure, is '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 overall a positive expected impact for many ES, mainly for "biodiversity"; cultural service: Aesthetic information; and some regulating services: Erosion and sedimentation regulation (by water bodies); Water quality regulation: reduction of excess loads coming from the catchment; Climate regulation: Carbon sequestration and burial; Regulation extreme events or disturbance: Flood water storage

(2) Expected impact on targeted ES

The key objective of this measure is the creation of a new intertidal wetland to improve the general functioning of the Scheldt estuary (habitat services "biodiversity"). The expected impact for the development target "biodiversity" is very positive.

(3) Expected impact on beneficiaries

The expected impact for the different beneficiary groups is overall positive, with a very positive expected impact for future use and for local use.

Table 2. Ecosystem services analysis for Heusden LO wetland: (1) expected impact on ES supply in the measure site and (2) expected impact on different beneficiaries as a consequence of the measure

Heusden LO -small scale tidal wetland restoration in the freshwater zone of the Seascheldt

Cat.	Ecosystem Service	Score
S	"Biodiversity"	3
R1	Erosion and sedimentation regulation by water bodies	3
R2	Water quality regulation: reduction of excess loads coming from the catchment	3
R3	Water quality regulation: transport of polutants and excess nutriënts	0
R4	Water quantity regulation: drainage of river water	0
R5	Erosion and sedimentation regulation by biological mediation	2
R6	Water quantity regulation: transportation	0
R7	Water quantity regulation: landscape maintenance	2
R8	Climate regulation: Carbon sequestration and burial	3
R9	Water quantity regulation: dissipation of tidal and river energy	0
R10	Regulation extreme events or disturbance: Wave reduction	1
R11	Regulation extreme events or disturbance: Water current reduction	1
R12	Regulation extreme events or disturbance: Flood water storage	3
P1	Water for industrial use	0
P2	Water for navigation	0
P3	Food: Animals	0
C1	Aesthetic information	3
C2	Inspiration for culture, art and design	2
C3	Information for cognitive development	2
C4	Opportunities for recreation & tourism	2

Beneficiaries:	
Direct users	0
Indirect users	2
Future users	3
Local users	3
Regional users	2
Global users	1

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

Heusden LO is a small scale pilot project which on its own has no substantial influence on the Scheldt estuary. However, wetlands like Heusden LO have the opportunity to combine nature conservation with flood protection when developed on a larger scale.

3 Additional evaluation criteria in view of EU environmental law

3.1 Degree of synergistic effects and conflicts according to WFD aims

The creation of tidal wetlands in the freshwater part of the Sea Scheldt is in the first place important because this type of habitat is scarce. Besides, it offers the opportunity to give some land back to the river and to enlarge the dynamic possibilities of the river. This has an impact on the hydrographic regime of the river and can increase flood protection. Finally, wetlands proved to improve the water and sediment quality and sedimentation on the wetland can reduce the need for maintenance dredging in the main river.

Indicator	code	Main pressures **freshwater** zone Scheldt	Effect?					Description
			- -	-	0	+	++	
S.I.	1.1	Habitat loss and degradation during the last about 100 years: Intertidal				X		Development of scarce tidal wetlands in the freshwater part of the Sea Scheldt (Zeeschelde)
S.I.	1.5	Gross change of the hydrographic regime during the last about 100 years				X		Opportunity to give more “space” to the river
S.I.	3.1/3.2	Decrease of water and sediment chemical quality				X		Wetlands proved to improve the water and sediment quality
D.I.	1.3	Land claim during the last about 100 years				X		Opportunity to give some land back to the river
D.I.	1.7	Relative Sea Level Rise				X		Opportunity to increase the flood areas at locations without (or with less) socio-economic costs
D.I.	2.4	Maintenance dredging				X		Sedimentation on the wetland means less sediment in the main river

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

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

The Heusden LO wetland is part of the **‘Scheldt and Durme estuary from the Dutch border to Gent’ (BE2300006)**, a protected area under the Habitat Directive. This measure is about the creation of a new tidal wetland in the freshwater zone of the Sea Scheldt, where mudflats and marshes are scarce. Hence, this measure contributes to the protection and conservation of intertidal wetlands in this protected area and enhances the connectivity in the area.
The Heusden LO wetland does not belong to the Bird Directive areas.

Conservation objectives (Sea Scheldt; Zeeschelde)	**Specification**	**Effect?**					**Short explanation**
		- -	**-**	**0**	**+**	**++**	
Protected habitats: estuary	Tidal wetland (freshwater)				X		Newly created freshwater tidal wetland in the protected area BE2300006, and quality improvement for this type of habitat.

4 Crux of the matter

Lessons can be learned from the way the Heusden LO wetland is restored. The new inland dike is not fortified with stone rubble, and the topography of the restored site was not altered. The old dike was not lowered to MLW level as planned but rather to MHW. However, the results showed that the restoration of the Heusden LO wetland was a success to create a tidal wetland in the freshwater zone of the Sea Scheldt (Zeeschelde).
A detailed evaluation of the monitoring methods is available. For future projects it is recommended to start with the monitoring plan already in the planning phase with clear cost estimation and clear agreements on execution and reporting; make a clear distinction between "site success monitoring" and "impact verification monitoring"; make a photographic survey on a yearly basis to improve interpretation of collected data; optimise the comparability of monitoring results of zoobenthos with that of other countries; monitoring of birds and fishes needs to be done from the beginning following fixed protocol; experimental research is needed to monitor benthic primary production; and investigate the monitoring of floristic quality of marsh vegetation.
An important knowledge gap exists on the identification of factors that can explain all changes in vegetation development. The inundation frequency cannot be the only factor. Also changes in elevation should be investigated better and the impact of local estuarine characteristics such as sediment balance.

5 References

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