Lippenbroek Regulated Tidal Exchange Scheme, Belgium

Year of issue

2025

Summary

The Lippenbroek project, launched in 2006 in Hamme (Belgium) as part of the Sigma Plan, implements an innovative sponge measure that combines flood protection with ecological restoration through a Controlled Reduced Tide (CRT) system. Established on a former 10-hectare polder, the site receives tidal water through regulated culverts, recreating an intertidal environment favorable to freshwater wetland habitats. The objectives were to store floodwaters, restore estuarine habitats, and test the CRT concept for future applications. The results have been highly positive: improved water quality, rapid vegetation development, increased biodiversity, and natural morphological evolution. The site's success makes it a model for estuarine restoration in the Scheldt estuary.

In 2025, it remains very relevant as a demonstrator site, and still is a research area.

Photo Gallery



Location

51.085, 4.171

Project

NWRM

National ID

Belgium_02

Sector

Hydromorphology

Installation Date

2006

Implementation status

Completed

Contact

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Overview

Location of the project

The site lies along the tidal section of the River Scheldt, just downstream from the confluence with the Dender River. it is situated within the floodplain of the Scheldt estuary.

Sponge measures implemented in the case study

Floodplain restoration and management

Objectives

Research : does it work and can it be implemented on large scale to restore tidal nature in combination with flood safety.

Involved partners

Authority type	Authority name	Authority role	Authority responsibility
Architects / Engineers	ABPmer	Determination of design details of the measure	Responsible
Research institute / University	University of Antwerp, W and Z	Monitoring	Supporting
Research institute / University	Ecosystem Management Research Group	Monitoring	Supporting

Site Information

Climate Zone

Cool temperate moist

Precipitation

800.00 mm

Temperature (°C)

11.00 °C

Elevation range

2 m

Slope range

Flat

Groundwater level

Compacted clay layer (former polder)

Vegetation class

Freshwater estuarine vegetation

WFD Ecological status

Bad

WFD Chemical status

Failing to achieve good

Water quality status

High N and P input. Pollutants (metals, PFAS, ...)

Design and Implementation

Project scale

Meso

Project scale specifications

While relatively small in size, its function as a pilot site for the Controlled Reduced Tide (CRT) system gives it strategic importance within the catchment-wide Sigma Plan for the Scheldt estuary.

Project area specifications

Small pilot site of 10 ha (as a pilot for about 2000 ha of this kind of nature restoration in the Schelde)

Size

10.00

Size unit

ha

Basis of design

The Lippenbroek measure primarily addresses tidal flooding rather than specific storm events like the 1-year or 2-year storm. The system is designed to manage tidal surges and extreme water levels associated with storms, using controlled tidal exchange to manage flood risks. It focuses more on long-term flood resilience and habitat restoration than on specific rainfall-based storm events.

Principles

Combination of flood defense and nature restoration: new concept of Flood Control Area with Controlled Reduced Tide.

Factor constraints

Main constraint : Site’s elevation. Low elevation = large storage capacity

Constraints

Scheme implementation was slowed by financial aspects and public opinion - consequently the project took a long time to materialise.

Favourable preconditions

The scheme was made possible by a desire for integrated water management.

Financing

Financing authorities

Authority name	Type of funding	Comments
Flemish government	National funds	The Lippenbroek project was financed by the Flemish government as part of the Sigma Plan for flood protection and ecological restoration in the Scheldt estuary. Additionally, funding came from EU financial mechanisms, supporting water management and environmental restoration projects across Europe.
European Union	EU-funds: Cohesion and regional development funds	—

Authority name	Type of funding	Comments
ANB (agency for Nature and forest)	National funds	—
DVW (Flemish Waterways)	National funds	—

Policy and Governance

Policy description

The Lippenbroek project serves as a demonstration site that tackles two major challenges: increasing flood risk in the Scheldt estuary due to climate change and sea level rise, and the severe loss of natural estuarine habitats from historical land reclamation and dike construction. These issues are linked to hydromorphological pressures identified under the EU Water Framework Directive. By implementing a Controlled Reduced Tide system, the project delivers improved flood defence while enabling habitat creation through the restoration of tidal wetland functions. This dual-purpose approach supports WFD objectives by reconnecting floodplains and enhancing ecological status in transitional waters.

Land ownership

Agency for Nature and forestry (Regional government)

Policy targets

Peak-flow reduction

Improved Biodiversity

Policy pressure

Directive	Relevant pressure
WFD identified pressure	Hydrological regime – flow regulation and morphological alterations
WFD identified pressure	Morphological conditions – river and floodplain disconnection

Pressure remarks

The Lippenbroek site reconnects former floodplains to tidal dynamics, and restores the natural tidal regime (altered by embankments, sluices, and water level control).

Requirement directive

Requirement directive	Specification

WFD-achievement of good ecological status	—
Other EU	Natura 2000

Part of a wider plan

Yes

Wider plan

Wider plan type	Wider plan focus	Name	Comments
Regional	Water	Sigma Plan	The Sigma Plan focuses primarily on flood protection and ecological restoration in the Scheldt estuary and its tributaries in Flanders, Belgium. Its main goals are to protect people and infrastructure from tidal flooding (water management focus) while restoring natural estuarine habitats.

Public consultation

No

Has contractual arrangements

No

Impacts and Monitoring

Monitoring System

Monitoring requirements

Monitoring focused on evaluating tidal dynamics, sedimentation, water quality, and biodiversity to assess the ecological development of the site. It was an essential part of the pilot project to validate the Controlled Reduced Tide CRT concept.

Monitoring parameters

Accretion or erosion on site; tidal levels and velocities; creek morphology; suspended solids; soil nutrients; water quality (incl. metals); light climate; bioturbation; invertebrates; vegetation; birds; fish;

Maintenance

Maintenance requirements

Regular checks of inlets/outlets, managing sediment build-up, and ensuring tidal flow meets ecological and flood safety goals, with minimal intervention in the wetland to let nature take the lead.

Impact Assessment Methodology

Performance impact assessment method

Unknown

Performance impact estimation information

Tracking tidal inflow/outflow, measuring sedimentation rates, and assessing vegetation and species development over time. The site’s function as a pilot allowed for adaptive management based on observed data.

Socio-economic Impacts

Direct benefits

Enhanced safety increases property protection and public security, which supports local economic stability and reduces potential disaster recovery costs. By combining flood control with habitat restoration, the project reduces the need for expensive hard infrastructure, offering long-term savings in flood defense.
Negative: Appearance of biting midge

Ancillary benefits

Demonstration value and upscaling potential

Ancillary benefits information

The successful operation of Lippenbroek has demonstrated the viability of Controlled Reduced Tide (CRT) systems and directly informed the planned expansion of over 1500 ha of similar CRT marshes within the Scheldt estuary.

Biophysical impacts: Hydrology

Hydrological effects

The CRT at Lippenbroek reintroduced tidal flow, altering water levels, flooding frequency, and sedimentation, thus reshaping local hydrology and mimicking natural tidal marsh dynamics.

Information on retained water

Average water exchange volume: neap tide: ~4,000m3 (none on the lower neap tides)

Information on increased water storage

spring tide : ~40,000m3

Information on increased landscape storage capacity

The Lippenbroek measure improves total landscape water storage through multiple mechanisms. Soil moisture is high in sedimented zones, especially in the upper layers, due to fine particles and organic matter accumulation. The development of vegetated marshes supports significant evapotranspiration, contributing to local water cycling. The CRT system also regulates runoff, buffering tidal inflows and slowing drainage, which reduces hydrological peaks and encourages sediment deposition. Additionally, the formation of tidal creeks has enhanced infiltration, improving subsurface water exchange even in formerly compacted soils.

Information on Restoring hydraulic connection

This system re-established a semi-diurnal tidal exchange via a network of sluices and culverts, allowing water to flow in and out in a regulated manner..

Biophysical impacts: Biodiversity

Improved biodiversity

Yes

Information on improved biodiversity

With regards to birds, despite the high degree of disruption by humans (including site visitors,cyclists and walkers on the dike), a clear change in the numbers and species of birds using the site could be observed when compared to baseline conditions. Of the 4,089 individuals observed during the first year of monitoring, 30% were benthic foragers (19 species), 54% wetland-generalists (11 species), 8% terrestrial generalists (18 species) and 8% woodland birds (13 species). Occasionally night herons Nycticorax nycticorax and spoonbills Platalea leucorodia were observed feeding (Maris et al., 2008). In order for a CRT to fulfil a role for fish, safe passage of the cluvers/sluices is required.

Biophysical impacts: Water & Soil Quality

Water quality overall improvements

N/A info

Information on water quality overall

With respect to water quality, the oxygen enriching impact, which is mostly due to the high inlet sluices acting as aerators, has been described as "striking". At the sluices, an immediate increase of up to 60% has been observed and a further 20% enrichment has been attributed to surface oxygenation. The restored marsh acts as a biogeochemical filter, especially serving as a sink for nitrogen and phosphorus, improving the water quality of the estuary.

Information on water quality improvements (P)

Over 10 years, the site evolved from a Phosphorus source to a Pohsphorus sink.

Information on water quality Improvements (N)

The site acted as a nitrogen sink immediately after implementation.

Soil quality overall improvements

N/A info

Information on soil quality overall improvements

Biodiversity enhanced

Information on soil quality, overall soil physical properties

Sedimentation was strongly related to flooding frequency; i.e. the highest sedimentation rate was observed at sites inundated around 85% of the time. The average sedimentation rate is currently fairly high at approximately 4 cm/year. The lowest sites are accreting fastest, hence the polder is loosing slope. Outside the polder, in natural marshes, an increase in elevation would lead to a decrease in flooding frequency, and a consequent gradual decrease in sedimentation. Conversely in the CRT the flooding frequency is not directly coupled to elevation; the intake volume is stipulated by the sluice configuration.

Ecosystem erosion control

Yes

Biophysical impacts: Others

Ecosystem impact climate regulation

No specific impact

Information on ecosystem impact climate regulation

Not mentioned

Lessons Learned

Key lessons

The Controlled Reduced Tide (CRT) technique employed at Lippenbroek has potential applicability for habitat creation along other heavily developed estuaries. It furthermore represents a technique which can significantly reduce the tidal prism of a site, without compromising the development of a range of intertidal habitats, thus minimising potential negative effects on small estuary systems. The technique also enables the establishment of intertidal habitats at lower elevations in the tidal frame than those of intertidal systems fronting a defence, and would thus be of potential use in areas where land levels behind a defence are relatively low compared to fronting levels. However, longer flood duration and low-turbidity stages may lead to higher accretion rates than in adjacent natural systems (ABPmer, 2008). Although this measure does reduce the sediment inflow, there is still high sedimentaation causing a need for maintenance, about 70 % of solid particles entering the area with tides stay there.

Barriers

Barrier type	Barrier role	Comments
Attitude of the public	Secondary barrier	—
Lacking financing sources	Main barrier	—
Legal obligations / restrictions	Secondary barrier	Regulatory obstacles causing delay

Drivers

Driver type	Driver role	Comments
Past flooding events	Main driver	—
Other	—	Loss of goods and services (loss of intertidal habitats)
Other	—	Loss of ecosystem functions (and thus loss of safety)
Balancing different objectives	Main driver	The need to test this new approach to combine a flood control area with a new technique of controlled reduced tide, before implementing it on large scale.

Success factors

Success factor type	Success factor role	Comments
Attitude of relevant stakeholders	Secondary factor	Good cooperation with all partners involved

Transferability

Any other embanked site with low elevation along the estuary. Opportunities exist in estuarine and coastal floodplain areas, but challenges include the cost of infrastructure, ensuring stakeholder support, and adapting the system to local conditions. Overall, the concept could be transferable to other flood-prone coastal areas with similar ecological goals.

Basin characteristics influence

The tidal nature of the Scheldt estuary, the flat topography, and the site's location within a former agricultural polder make it ideal for controlled tidal exchange, allowing natural sedimentation and habitat development.

Sources

Sources

Case Study: Lippenbroek Regulated Tidal Exchange Scheme

ABP MER news

Flood control areas as an opportunity to restore estuarine habitat. Ecological Engineering 28(1), 55-63.

Tuning the tide: creating ecological conditions for tidal marsh development in a controlled inundation area. Hydrobiologia 588, 31-43.

Restoring ecosystem functions in heavily disturbed estuary