Lippenbroek

Location
Lower Scheldt Estuary (Zeeschelde), Belgium (Long: 51.0854873362752 Lat: 4.17170843129864).

Design and Size
The controlled reduced tide (CRT) concept is relatively new and therefore before it could be applied on a large scale (as anticipated for many flood storage polders along the Belgian Scheldt) it had to undergo thorough testing. For this reason the 10ha pilot project at Lippenbroek was implemented in the freshwater tidal part of the Scheldt Estuary in 2006. As it was to be a pilot for CRT in a flood storage area, construction included the building of an overflow dike as well as a high inlet sluice for the CRT function.

The high inlet sluice has an invert level of approximately 4.8mTAW (the Belgian Ordnance Datum) – which equates to approximately –1mMHWS. The inlet sluice is 12.75m long; the three culverts it contains are each 0.75m wide and 1.1m high. Shot beams front the inlet sluice at Lippenbroek and enable fine-tuning of the invert levels. The most suitable sluice configuration was determined through several test wettings. For the outflow, a pre-existing outfall sluice, which is about 10m to the left of the inlet sluice structure, is utilised. Its invert level is at 1.5mTAW; it is 40.2m long and has a 1.5m diameter. An artificial creek was dug connecting the inlet sluice level with the existing polder ditch. The danger of channels short-circuiting was diminished by subduing the channel along the foot of the ring dike (personal communication with Tom Maris, University of Antwerp and Cox et al., 2006). An intensive monitoring programme was initiated, and the first results are now available.


The inlet sluice at high tide (Taken by: O. Beauchard, ECOBE)

Date of realignment
March 2006

Promoters and Objectives
The University of Antwerp leads the research and management of the project. The research fits mainly in the framework of OMES (a multidisciplinary research study on the environmental effects of the SIGMA plan on the estuarine environment of the Belgian part of the Scheldt), which is funded by W&Z (the Flemish Agency for Waterways and the Brussels-Scheldt Sea Canal).

Funding
Provided by ANB (the Flemish Nature and Forestry Agency) (owns Lippenbroek).

Planning Requirements and Consultation
[sorry, no information available at present]

Monitoring
An extensive monitoring programme has been initiated to research the development of the intertidal habitats. Nine research groups from different universities and research institutes are working together to achieve optimal linkage of results on the following factors:

Basic water quality (4/annum)
Bioturbation (4/annum)
Birds (52/annum)
Creek morphology (2/annum)
Fish (2/annum)
Ground compaction (4/annum)
Light climate (4/annum)
Macro-invertebrates 10 (4/annum)
Sediment size (4/annum)
Sedimentation/erosion (4/annum)
Soil heavy metal (4/annum)
Soil nutrients (4/annum)
Suspended solids (continuous)
Tidal regime (continuous)
Vegetation (4/annum)
Water balance (continuous)
Water heavy metal (4/annum)

Findings and Lessons (mostly derived from Maris et al., 2008)

Sedimentation:

With respect to sedimentation, the authors point out that whilst sedimentation is on the one hand desired in tidal marshes there are also associated negative implications. The input of fresh sediment enables the advancement of typical marsh morphology and marsh soil, which in turn promotes the establishment of estuarine vegetation and fauna. Conversely excessive sedimentation is to be avoided in a flood storage polder, as this leads to decreased water storage capacity. Due to the enclosed nature of a flood storage polder, the environment is less dynamic and thus the potential for sedimentation is increased, particularly during longer stagnant phases. At Lippenbroek, at all but one of the 10 sedimentation measurement sites, net sedimentation was observed between March 2006 and November 2007, varying between 0.5 to 12.5 cm/year. 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.

Fauna:

Macro invertebrate monitoring shows that there has been a drastic shift from terrestrial species to more aquatic and estuarine species.

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. Of the 4089 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.

In order for a CRT to fulfil a role for fish, safe passage of the sluices is required. Monitoring indicates that nearly all fish species observed in the Scheldt Estuary were also observed in the polder, frequently in large numbers. Net captures show that only small numbers of fish enter the polder via the inlet sluice, however, the fish find their way into the polder via the outlet sluice (pers. comm. Simoens et al.). Fish might be attracted by the oxygen rich water which leaves the polder, and thus migrate into the polder against the outflow of water.

Flora:

The vegetation monitoring shows a drastic shift in the direction of water tolerant species. Even relatively stress resistant species such as the large nettle and hairy wild rose were replaced by true marsh species within a relatively short time. Colonisation by *Lythrum salicaria*, *Typha latifolia*, *Veronica*, *Phragmites australis* and willow *Salix* occurred within one year, whereas at lower elevations vegetation has been replaced by mudflat.

Water Quality:

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. On warm, sunny summer days, oxygen reaches even higher values as light penetrates easily through the thin water layer in the polder and oxygen production by primary producers leads to over saturation.

Regulated Tidal Exchange operation:

When compared with the Scheldt, high-water levels in Lippenbroek are around 3m lower in elevation, without significantly affecting the pattern of spring and neap tides (Figure 1). Important parts of the polder therefore receive flooding frequencies comparable to those of the fronting saltmarshes. However, the high inlet/low outlet technique does lead to a distortion of the tidal movement; the tidal curve is no longer sinuous but has a stagnant phase (Figure 2). This is due to water only flowing in around high water ('top of the tide'), and only exiting once water levels outside in the estuary have fallen low enough for the gravity controlled outfall sluice to open. The authors stressed that the inlet structure had to be sufficiently high, to achieve a significant difference in ingress duration and volume, and thus bring about a large variation in water levels. It was also highlighted that flood frequencies are mainly stipulated by the sluice configuration, no longer by the elevation in relation to the tidal frame; this allows marsh development in lower lying areas.

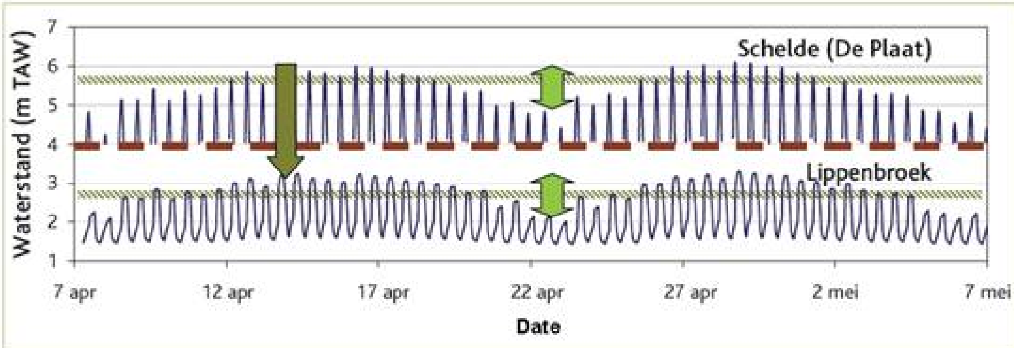

Figure 1. Spring-Neap Tide Amplitude Comparison Scheldt Estuary – Lippenbroek (Showing Two Spring-Neap Cycles in April/May 2006) (Source: Maris et al., 2008)

The high tide water levels in Lippenbroek are clearly lower (dark green arrow). The spring/neap tide variation meanwhile is sustained (light green arrow). The dark green dashed line shows the mean high water mark.

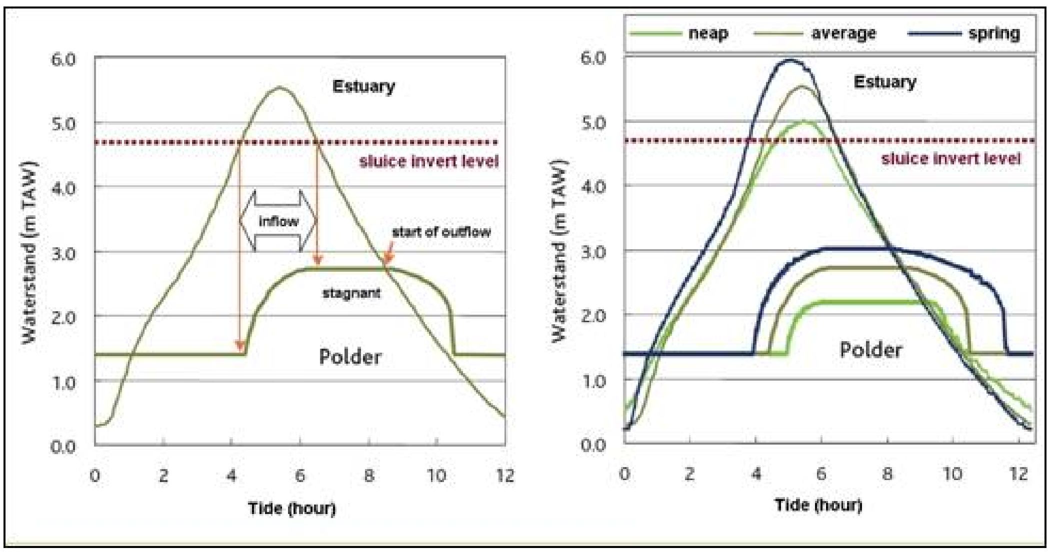

Figure 2. 1D-Modelling Tidal Curve Comparison Scheldt-Lippenbroek for an Average Tide (Left) and for Neap, Average and Spring Tides (Right) (Source: Maris et al., 2008)

In summary, the CRT technique employed at Lippenbroek is an interesting new concept with 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 the wider estuary. The technique also enables the establishment of saltmarsh vegetation 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, the flood duration and low-turbidity stage in the site is longer than on fronting marshes. Whilst this does not appear to directly affect fauna, it would influence sedimentation as there would be a prolonged stagnant/slack phase.

Contacts

[sorry, no information available at present]

Other Information

Cox, T., Maris, T., de Vleeschauwer, P., de Mulder, T., Soetaert, K. & Meire, P., 2006. Flood control areas as an opportunity to restore estuarine habitat. Ecological Engineering 28(1), 55-63.

Maris, T., Cox, T., Jacobs, S., Beauchard, O., Teuchies, J., van Liefferinge, C., Temmerman, S., van den Bruwaene, W. & Meire, P., 2008. Natuurontwikkeling in het Lippenbroek - herstel van estuariene natuur via een gecontroleerd gereduceerd getij. Natuur.focus 7(1), 21-27.

Maris T., Cox T., Temmerman S., De Vleeschauwer P., Van Damme S., De Mulder T., Van den Bergh E. and Meire P., 2007. Tuning the tide: creating ecological conditions for tidal marsh development in a controlled inundation area. Hydrobiologia 588, 31-43.