

8. MONITORING

As a flood control area with controlled reduced tide (FCA-CRT), Bergenmeersen is expected to make a significant contribution to natural quality in the Scheldt estuary. Via a sophisticated sluice construction with combined inlets and outlets above each other, a reduced tide is introduced into the polder, while retaining the spring/neap tide variation. The purpose: a functional mud flat and marsh ecosystem. A monitoring programme was developed to examine whether these nature objectives are actually being achieved and to make adjustments where necessary.

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8.1 MONEOS: a coordinating monitoring programme

A coordinating monitoring programme, MONEOS, was drawn up for the Scheldt estuary. This programme describes three types of monitoring: system monitoring, research monitoring and project monitoring.

- **System monitoring** is a long-running programme that monitors all the basic parameters for the smooth operation of the Scheldt ecosystem. This includes, among other things, standard measurements of the water quality in the Scheldt. System monitoring also covers water levels and the safety-related functioning of the FCAs in the Scheldt basin, such as Bergenmeersen.
- **Research monitoring** encompasses the detailed monitoring of pilot projects to gain greater insight. The Lippenbroek is one such research monitoring project, in which knowledge is gathered for the development of other FCA-CRTs, of which Bergenmeersen is one.
- **Project monitoring.** During the first three years after the area starts up, a project monitoring programme examines the extent to which the area is meeting the set expectations and whether it is evolving in the right direction. Keeping a finger on the pulse allows possible problems to be detected earlier. This makes adaptive management and adjustment possible. Project monitoring is the best tool for this. The MONEOS report describes project monitoring as monitoring that is carried out – in addition to regular system monitoring – to measure certain parameters with an increased frequency, limited in time and space. After a period of three years, an evaluation is carried out. If everything is progressing as desired, project

monitoring can be run down and the area included in the regular system monitoring.

8.2 Most suitable tide

Accurately setting the most suitable tide is vitally important to the successful development of an FCA-CRT. After all, for estuarine nature, that tide is the driving force behind ecological development. The volume of water (and suspended material) exchanged, the flooding frequency, duration and height, will be decisive for the development of the area. The success of the Bergenmeersen project therefore depends entirely on setting the right tide. Initial monitoring activities focus entirely on setting the tide, during which the desired final picture and the prevailing preconditions are taken into consideration. As an extra framework condition for Bergenmeersen, special attention is being paid to the sandfly issue.

First, an improved digital height model (DHM) needs to be created. Based on that DHM, the water heights and flooded areas can be estimated for different inflow volumes. The inflow and outflow volumes for average, neap and spring tides on the Upper Sea Scheldt were calculated by Flanders Hydraulics Research when determining the sluice dimensions.

The sluice configuration that followed from the modelling study forms the starting point for further refining the heights of the stop-logs. Specifically, experience from the Lippenbroek shows that minor discrepancies between model and reality, for example in the DHM, can produce differences in flooded area. The inflowing water volume can be adjusted by raising or lowering



Figure 8.1. SET measurement

stop-logs, and therefore also the flooded area. Particular attention is paid here to the differences in flooded area between spring and neap tide. These differences determine the frequency of flooding and are decisive for the development of a diverse ecosystem.

As well as setting the right tide, it is vital that sedimentation is steered in the right direction. More water means more sediment flowing in. The most suitable tide will be a compromise between a tide that is sufficient for nature development and a tide that limits sedimentation as much as possible. Specifically for Bergenmeersen, mud flat zones near the residential area must also be avoided to combat sandflies. The sluice configuration of an FCA-CRT is there-

fore not static. It forms part of the management with which the various objectives of the area will be aligned with each other over the coming years.

Producing a good digital height model

A good, up-to-date digital height model (DHM) is needed. In the land study, the morphology (also depth) of the channel system is also surveyed. This is necessary to accurately monitor silting-up in the channels during the start-up phase. The land surveys are carried out using an RTK (real-time kinematic) GPS to obtain an accurate picture of the topography. Such an RTK-GPS determines its position through ten satellites plus correction factors continually sent through by a reference station. This allows the position to be determined accurately to within a few centimetres.

Multiple level measurements are needed to monitor the tide during the start-up phase, but also to manage the sluices at a later stage according to the development of the area. In Bergenmeersen, the water level will be recorded every 10 minutes at 5 locations during the start-up phase. One gauge will be located near the sluice complex. The others will be spread over the site. This allows the duration, height and frequency of flooding to be determined in large parts of the area, which in turn enables slow-draining parts and parts with a high flood duration to be properly mapped out. This is extremely important for monitoring sandflies, for example.

SET measuring set-ups (surface elevation table) are recommended for monitoring sedimentation. Five SET set-ups are

installed. A SET set-up allows changes in the bottom level as a result of sedimentation or erosion to be accurately measured (to within 1 mm). The set-up is useful during the start-up phase, but especially to continue to track sedimentation closely in the years that follow. A SET set-up consists of a fixed pole in the ground. To this is attached a level movable arm. Using ten or so vertical rods, the distance from the bottom of the marsh to this arm is measured. The distance measurement is repeated with the arm in 4 different directions. The SET measurement is repeated every 2 months. This allows the slightest change in bottom level around the SET pole to be accurately recorded. To avoid changes in the relief at the SET through walking on it, 2 benches are used. By carrying out measurements from on these benches it is possible to avoid disturbing the soil.

8.3 Starting up the flood area

Before the sluices are opened when the flood area starts, the threshold levels in these sluices must be selected. Determining the correct threshold level requires attention. The tide must be set as favourably as possible to be able to achieve the objective of the FCA-CRT as much as possible: a functional intertidal area that contributes to the operation of the Scheldt ecosystem. The area must also be managed sustainably and must not cause any nuisances for local residents (sandflies). Finally, the safety function as an FCA must never be jeopardised. All of which imposes clear preconditions for the (reduced) tide.

With the new DHM and the information from the preparatory study and the model output (based on previous and new sluice calculations), an estimate can be made of the flooded areas for different tidal levels in the Upper Sea Scheldt. Based on this, an initial stop-log configuration is chosen. Stop-logs are inserted to the desired level and the sluices are opened for a few tides. The tide is monitored and evaluated at various places in the polder. Does the tide meet the requirements? Where is adjustment needed? Is there any significant sedimentation? With the knowledge from measurements taken with this first stop-log configuration, a new configuration is drawn up. This is repeated several times in an iterative process to reach the most suitable configuration.

As soon as a potentially suitable configuration has been obtained, the newly set tide will be monitored closely for a few spring/neap tide cycles. Considerable attention will also be paid to sedimentation and erosion processes. Based on detailed measurements, a forecast will be made for the morphological evolution of the area. Detailed surveys of the thalweg of creeks, of a number of fixed ditches and SET measurements are designed to help map out sedimentation and erosion. A number of targeted thirteen-hour measurements are also carried out, paying particular attention to the inflow and outflow of floating material to then draw up water and sediment balances. If necessary, the sluice configuration is further adjusted on the basis of these insights.

After the start-up phase there are two possibilities: either a fixed tide is chosen that is maintained without being changed, or a tide is chosen that is adapted over time.

8.3.1 Unchanged sluice configuration

As soon as a favourable tide is found during the start-up phase, the tide is set and maintained. That is the option that was applied in the Lippenbroek. There, the stop-log configuration remained unchanged from the start of the flood area. However, choosing unchanged sluice parameters does not mean that changes to the sluices are never required. Through the action of the tide, the morphology of the area will change. This has an influence on the tide. Minor changes to the sluices may therefore be required to maintain the same flooding frequencies despite a changing morphology.

8.3.2 Adaptive management

In a new FCA-CRT it may be desirable to allow more tidal influence at the onset. As a result, morphodynamic processes such as sedimentation and erosion can play a bigger role. Thus, the area may evolve more quickly towards the desired mud flat and marsh area. Creeks may be formed more quickly, depressions may be filled in more quickly, and compact polder clay may be covered more quickly with a layer of typical marsh sediment rich in benthic life. After such an initial period of strong tidal action, as a consequence of which the area has undergone a first series of rapid morphological changes, the tide can be modified. After all, maintaining a tidal travel that is too large can lead to excessive silting-up of the area in the long term. The tide must then be further reduced to a typical controlled reduced tide.

Because of the sandfly problem in Bergenmeersen, water-saturated mud must be

avoided near the ring dyke. It is therefore better to avoid an overly strong tidal action in the initial phase. However, increased water levels during average or spring tides do not lead in and of themselves to more mud flat zones near the ring dyke. It is therefore worth considering setting the tide a little stronger at the start, to promote faster creek development. After all, if the drainage of certain parts of the flood area is not running smoothly enough at the start because of the lack of a well-developed, branched system of creeks, this could encourage the proliferation of sandflies.

8.4 Project monitoring in the initial phase

On the one hand, starting up the FCA-CRT requires detailed monitoring of the tide, to be able to choose the desired stop-log configuration. On the other hand, monitoring of sedimentation and erosion, vegetation, nutrient exchange, development of benthic life and fish is recommended. After all, the flood area has multiple nature objectives. Among other things, specific habitats with associated species are sought. Ecological functions are also linked to the area, such as nutrient cycling (see Chapter 4).

Below you will find an overview of all monitoring efforts.

Sedimentation and erosion

Four times a year, the soil level is monitored by means of five SET set-ups. Twice a year the development of creeks is monitored, as well as a few ditches, with Total Station and/or RTK-GPS.

Vegetation

Three times a year, permanent squares are measured by the five SET set-ups. In addition, a vegetation map covering the whole area is produced each year.

Benthos

Twice a year the benthos is sampled in at least five locations (certainly the five SET locations). Benthos sampling is useful for monitoring the quality of the intertidal area as a suitable habitat.

Thirteen-hour campaigns

To monitor the area's functionality in terms of water quality, there are four thirteen-hour campaigns each year. During such a campaign, the water quality is sampled every hour for a complete tidal cycle. The following parameters are determined: floating materials, chlorophyll a, biochemical oxygen demand, nitrogen (ammonium, nitrate, nitrite, Kjeldahl nitrogen), phosphorus (phosphate and total phosphorus) and silicon (dissolved and biogenic). Oxygen, pH, conductivity, temperature and turbidity are continually monitored during the campaigns. These parameters will also be continually monitored for a few days before and after each campaign.

Based on the thirteen-hour campaigns, mass balances will be produced for the various substances. This allows the area's contribution to general water quality in the Scheldt to be estimated. This is intended to show whether the objectives set within the framework of European nature objectives are being achieved.

Table 8.1. Results of fish monitoring in Bergenmeersen (May 2013)

	21/05/2013 Electrical	22/05/2013 Shoot trap	22/05/2013 Net trap
Common roach	0	7	0
Stone moroko	2	12	2
Flounder (larvae)	165	1	0
Three-spined stickleback	79	130	13
Prussian carp	0	2	1
European chub	1	0	0
Common rudd	0	1	0
European smelt (larvae)	3	0	0
Ten-spined stickleback	84	10	1
Species	6	7	4
Number of individuals	331	163	17
Chinese crab	1	3	14

Fish monitoring

During the project monitoring phase, the extent to which the area is being used by fish will be monitored. This monitoring is carried out by the Research Institute for Nature and Forest (INBO).

In April 2009 the baseline assessment was carried out. Fish were caught in the central channel in Bergenmeersen, one of the few water-retaining channels. At the time, only two species were caught: three-spined stickleback and ten-spined stickleback.

In May 2013, approximately one month after the area became operational, fish were caught electrically in the creek. Two traps were also placed for a period of 24 hours. A total of 9 species were caught. The presence of flounder larvae (on average 2.3 cm) indicates that this species is using

the area as nursery habitat (incubator function). Several European smelt larvae were also caught. Table 8.1 shows the results (number of individuals per species). Clearly the pioneer species Prussian carp, stone moroko and common roach have very quickly found their way to the new area. The presence of European chub is remarkable. This species was caught only once in the last 10 years in the Sea Scheldt.



Figure 8.2. Young flounder

Bird monitoring

The agricultural area that Bergenmeersen was until recently was home to only a limited number of summer bird species. An inventory in 2008 recorded several territories of reed birds (Eurasian reed warbler, bluethroat and common reed bunting) and meadow and farmland birds (northern lapwing and grey partridge).

From the start of the work in April 2012, and certainly in the spring of 2013, the work zone attracted many waders (such as common redshanks, spotted redshanks, common greenshanks, common snipes and little ringed plovers) and a few waterfowl (such as northern pintails). In the first few weeks after the FCA-CRT became operational, the area also became very attractive to (transitory) waders and waterfowl. In addition to the species mentioned above, there were also black-tailed godwits, whimbrels, pied avocets, ruffs, red knots, common ringed plovers, wood sandpipers, northern shovelers, garganey, black terns and little gulls.

The first inventory of summer birds in Bergenmeersen (23 May 2013) recorded breeding attempts by northern lapwings and little ringed plovers. The first regional breeding attempt by common redshanks was also recorded, the first "new" summer bird after the CRT had been operational for just one month.

Changes in the (summer) bird community will be monitored by the Agency for Nature and Forest over the coming years.

Flow rates through the sluices

By measuring flow rates and sediment at the inlet and outlet sluices, water and sedi-

ment balances can be drawn up and the amount of sediment that remains in the area estimated. The remaining quantities of sediment can be converted into sedimentation heights using sediment densities measured in situ and then compared with SET measurements.

Monitoring for sandflies

Because the area is close to habitation, a suitable programme for monitoring sandflies is advisable. No traps will be used. On the one hand, there is no evidence of the need to catch sandflies. On the other hand, the use of traps for monitoring draws too much attention to a problem that may not even exist. The suitable habitat is therefore monitored, linked to monitoring of sandfly larvae. This allows the potential of the area for sandflies to be estimated. Measures against sandflies, such as the raised ridge against the ring dyke, and measures for tide and drainage can also be evaluated. This allows better planning and more efficient management of future FCA-CRTs. If there are problems in Bergenmeersen, the measurements will help adapt management better.

8.5 References

- **MONEOS. Geïntegreerde monitoring van het Schelde-estuarium.** (*Integrated monitoring of the Scheldt estuary.*) P. Meire et al. (2008), ECOBE Report 08-R-113. University of Antwerp / www.vliz.be/imisdocs/publications/136078.pdf
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