

# INTERREG CARE-PEAT

## The Care-Peat impact within the Valley of the Zwarte Beek



## REPORT

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## Summary

The Valley of the Zwarte Beek is with its 2000 ha Natuurpunt's biggest and best-preserved peatland in Flanders. Whilst the upstream area has some pristineness left, the Midstream area was heavily drained for agriculture and the peat layer is degraded by now. However, this Midstream region is of utmost importance for nature, climate and water.

250 ha within this Midstream region was restored within the Care-Peat project. It was a long and exhausting process before the actual rewetting could start, starting with trial and error with sandbags, a hydrological study, and a lot of permit request. The restoration could only proceed slowly. But at the end of the project, the restoration works were all completed and the results look very promising. 15 km of local ditches were closed and near the end of the project, the last permit was granted. With this permit 2.7 km of major waterways could be relevelled up to 20 cm below ground level. The results of these works will become clear during the coming years.

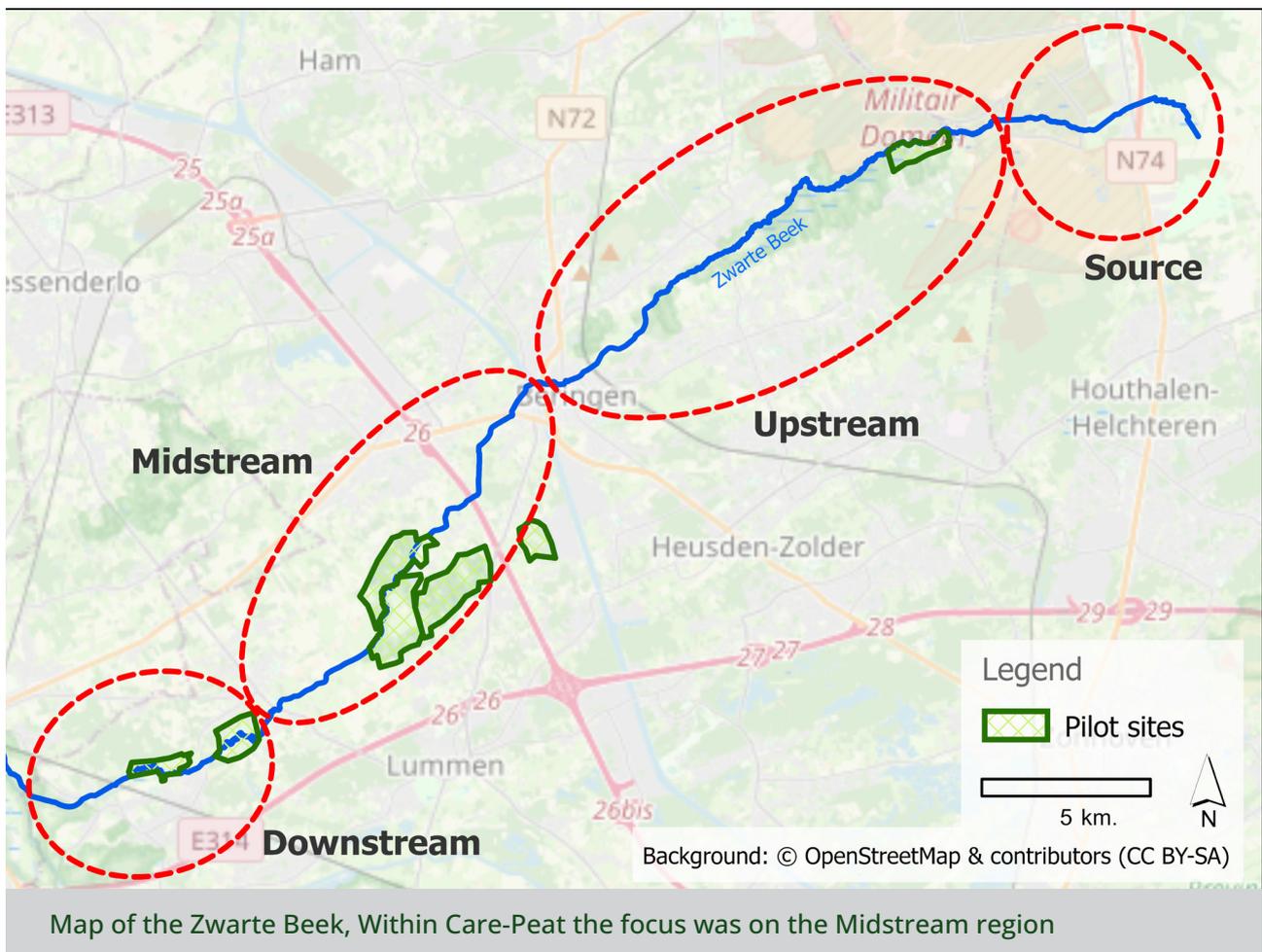
Within Care-Peat an adaptive management strategy was developed to manage and improve the habitats and biodiversity in the Zwarte Beek. Marsh tractors are used on the drier soils, whilst track mowers are used to manage dominant species in the wetter parts of the valley. Furthermore, on the best developed patches, precision management is needed to get an even better state of conservation. During the project Greenhouse gasses were measured with the closed chamber technique. This allows us to understand by how much the carbon emissions have actually reduced due to the restoration works. Also, the hydrology is monitored with an extensive network of piezometers installed throughout the Care-Peat site.

Flanders is very fragmented, thus in order to perform ecosystem restoration, much of cooperation is needed from local stakeholders. These stakeholders include local landowners, farmers, inhabitants, but also water managers, governments, farming organisations, amongst others. Through multiple stakeholder meetings and different workshops, information sessions, events, ad-hoc meetings and presentations, a real mind shift for peatland restoration was created. Before Care-Peat, the common water management was mainly based on draining and removing the water towards bigger rivers and finally to the sea. But during the Care-Peat project, more and more awareness was risen for rewetting and infiltration water buffering. In the end a very close collaboration with the stakeholders was established and these will continue after the project, ensuring future restoration of Flanders biggest peatland: The Valley of the Zwarte Beek.



# Valley of the Zwarte Beek: Midstream





The Valley of the Zwarte Beek stretches out over 30km and consists of a slender ground water fed iron-rich fen peatland over an area of around 750 ha. The natural surroundings of the peatland are heathland (with peat bog like situations), grasslands and woodland. There is also farmland and some residential areas where consultation will be needed during the restoration process, and a military domain on the heathland area. Natuurpunt manage the site, with help from volunteers and labour teams, and also work with farmers in the area. The area is designated a 'heritage landscape' which has some protection for cultural heritage.

The habitat at the site consists of European habitat 7140 quaking bogs and transition mires (EUNIS D2.222) and wet grasslands, mostly degraded, with some still in very good wetland condition (EUNIS E3.411). The main vegetation is grassland and small sedges with some alder forest in between and some small areas of Sphagnum moss. The site is host to the largest population of Common snipe (*Gallinago gallinago*) in Flanders, the very rare Large marsh grasshopper (*Stethophyma grossum*) and is also important for the occasionally-breeding Spotted crane (*Porzana porzana*). The very rare Corncrake (*Crex crex*) is sometimes present together with other breeding birds including the Curlew (*Numenius arquata*).

One of the most underrated parts of the Valley of the Zwarte Beek must be the Midstream. On this lower third of the valley, the peatland becomes the widest. Stretching out to almost 1500m wide this peatland (on average 1,5m deep) can hold approximate 3.000.000 to 6.000.000 m<sup>3</sup> of water and has a huge carbon storage capacity. It is therefore called the upside-down rainforest; hidden from the eye and the awareness of the surrounding communities.

Whilst the upstream part had some pristineness left this midstream site is in contrast severely degraded due to intensive land use. The central area has a very extensive drainage network resulting in groundwater levels dropping deeply below surface, for extended periods of time. As a result, this has the effect that the surface-level dropped 30cm in the last 3 decades and thus enhancing even more problems of extreme drought and inundation. To stop this peat degradation a systemic approach was needed.

The Care-Peat project aimed at restoring 250 ha of former drained crop and farmland in the Midstream. Hydrological measurements were taken in the past 4 years. Blocking ditches, habitat restoration, adaptive creek management and removal of man-made structures initiated the recovery process of a diffuse groundwater-flow through system. This part of the Valley is still highly fragmented and one of the major objectives is to resolve this within the next few years so that ecosystem recovery can start its next stage.

The Care-Peat project brought other incentives to the Midstream like raising the awareness and the need for further research on degraded peatlands, adaptive land management on private land and the quantification of ecosystem services. The first results of system restoration are visible as key-species for the European habitat 7140 'Transition mires and quaking bogs', previously reduced to small relicts, are more and more present.

# Restoration works



## 2.1 Rewetting

### 2.1.1 Introduction

In the Valley of the Zwarte Beek, the rewetting works mainly consisted of closing of internal ditches and releveling of larger creeks. These works are rather simple to carry out, but there has been a huge process before the actual rewetting. In this report this process in Chronological order.

### 2.1.2 Sand bags

Before Natuurpunt started with permanently rewetting the area, some experiments with sandbags were performed to provide rough estimates of the effects of closing waterways and ditches on the surrounding area. Using this in the initial stages as trial and error gave us the chance to predict the impact on ground and neighbouring stakeholders. These tests with sandbags were successful, there were no complaints that grounds became too wet and the effects from closing these ditches were actually far less than imagined. Knowing that, restoration could be much better with more drastic measures in order to restore water table at the pilot site.



Use of sandbags to simulate the effect of closing ditches.

### 2.1.3 Closing of internal ditches

Drainage on the pilot site consisted of different scales. First there were the internal ditches, within a parcel of land or in between two parcels. These small local ditches end up in small creeks or other ditches, managed by the water managers or the municipalities. These then again ended in bigger creeks taking the water away from the pilot site. In total there were about 80 km of ditches and creeks on the pilot site. As a result, the pilot site was bone-dry during summer. To rewet this area, Care-Peat started at the beginning, with the local internal ditches. Wherever Natuurpunt owned both sides of the internal ditches, these were closed. If there were other owners on at least one side of these ditches, these couldn't be closed, since this could impact their grounds and people legally have the right to drain their parcels in Belgium.

Bearing this in mind all ditches that could be closed were selected using a computer analysis. After this, these ditches were field-checked. Whenever these ditches actually drained the area (don't have a dead end) and were deeper than 20 cm they were added on the list with ditches to close. In total 15 km of local ditches were selected this way, however, in order to close these a permit was needed. The permit was granted in September 2021. The closing of all these ditches was carried out by sub-partner NLZ spread throughout the project. The time window to close these ditches was rather small. During breeding season, the pilot site is safeguarded from big works to avoid disturbance for breeding birds, and in winter the area is too wet to carry out rewetting works. In general, these works needed to be done from mid-July until November and from February to March.

The ditches were closed using local material. A lot of ditches had elevated banks, these banks consisted of the original material that was dug out to create the ditches. If there were no elevations next to the ditch, a small scraped-off layer of adjacent ground was used to fill them up. Scraping of such a small layer of ground takes very precise work with a crane with a smooth basket.

Closing these ditches gives the rainwater the chance to infiltrate again within the peat layer. This way the sponge-function is reactivated. Still this is not enough to buffer the water all year round. In order to retain the water during summer, the bigger creeks needed to be relevelled as well or water management needed to be adapted.



Christof Van Ackere

Recently closed internal ditch, the adjacent ground is used to fill the ditch.



Christof Van Ackere

Recently closed internal ditches, aerial view

## 2.1.4 Adaptive management on category 2 waterways

In Flanders, waterways are divided into different categories. Category 1 waterways (like the Zwarte Beek) are the biggest unnavigable creeks and are managed by the government. Category 2 waterways are slightly smaller and managed by the Province and watering. Category 3 waterways are even smaller and are managed by the cities. The smallest waterways and ditches are so called 'Unclassified waterways.

During the Care-Peat regional platform meetings with all stakeholders, the need for adaptive water management was discussed. Before Care-Peat the management was based on flood prevention and drainage in function of agriculture. Waterways were cleared thoroughly twice a year. As a result, the creeks got deeper and deeper. The creeks have an influence of up to 200 m into the peatland, resulting in a deeply drained peatland in summer.

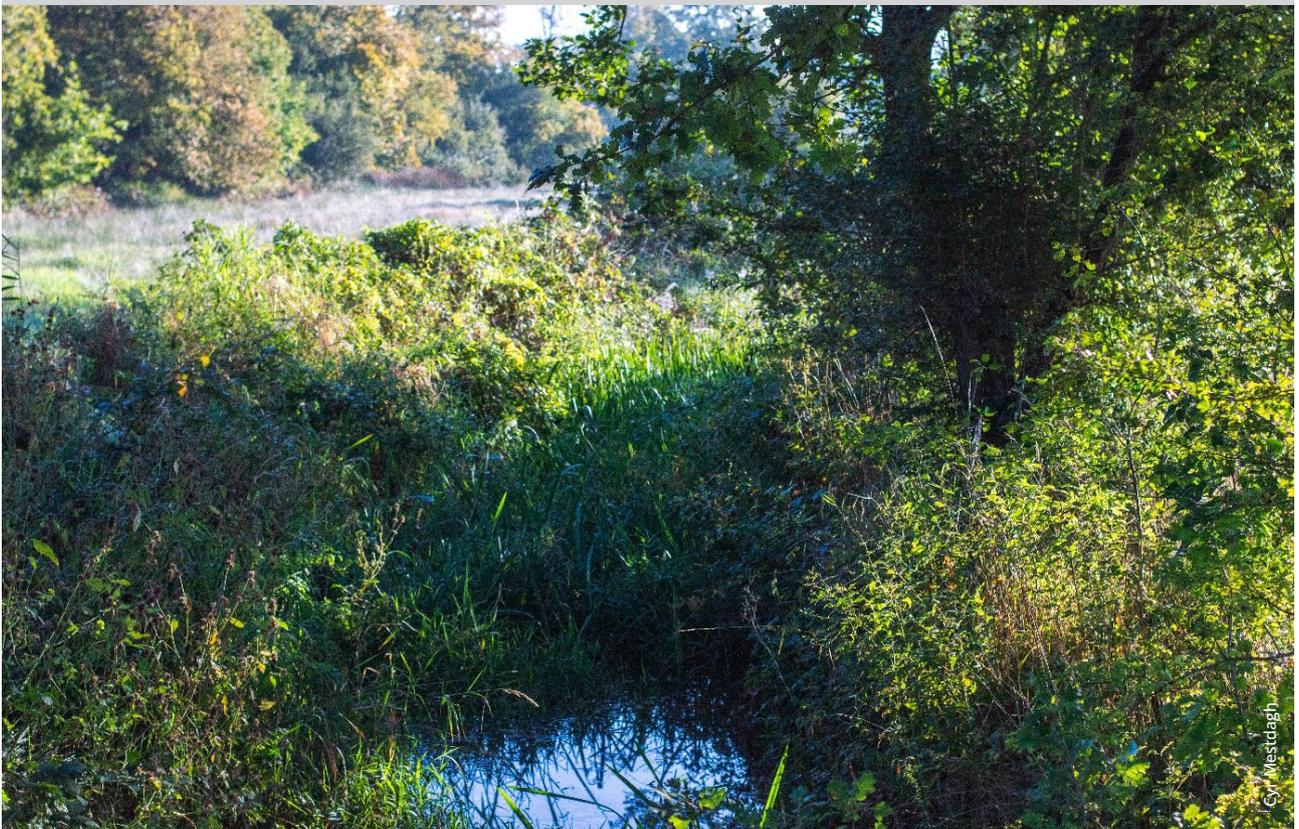
Within Care-Peat this water management on some creeks is changed, where nature targets are the priority. These creeks are now only mown on the creek banks, no clearance within the water is done. The mowing of the creek banks was an important factor for the water managers to make sure the creeks will still be accessible if something would happen, or some works would need to be done there. This change in water management resulted in a year-round higher water table within the creeks and in the surrounding peatland.

This measure alone is not enough to rewet the peat soil enough to stop peat degradation and thus reduce CO<sub>2</sub> emissions, but it is an important step towards restoration and in combination with other measures, it does have a real positive effect on the hydrology of the pilot site.



Christof Van Wyk

Waterway without adapted clearance (management before Care-Peat)



Cy Westdaagh

Waterway with adapted clearance (management after Care-Peat)

### 2.1.5 Relevelling of some category 2 waterways

These category 2 waterways consist of bigger creeks, managed by the province and the watering. During the project regional platform meetings, these urgently needed measures to restore the peatland were discussed. In the end 4 parts of category 2 creeks were selected that would be relevelled up to 20 cm below ground level. In total 3.7 km. For this selection, the focus was on upstream parts, where both sides of the creek are owned by Natuurpunt. In order to work on category 2 waterways, a permit was needed. To get this permit a very long and exhausting set of procedures was followed.

But in the end, the permit was finally granted in September 2022. Although the authorisation of the watering for 1 km of waterway (out of the 3.7 km) is still need. In October 2022 Natuurpunt started with relevelling these creeks and worked hard to finish it before the end of the year. In the meantime, Natuurpunt had meetings with the watering to discuss the authorisation for that last kilometer. But until now, they did not approve the restoration works.

Relevelling of the category 2 waterways was done in the same way as with the internal ditches by Natuurpunt's sub-partner NLZ. Whenever there was an elevated creek bank present, this ground was used to relevel them. If not, a small scraped-off layer of the adjacent 10 m-zone was used instead. In first instance the creeks were filled up completely, since the soil will settle and lower again at least by 20 cm. After 1 month the soil already lowered by 15 centimetres, and it is still settling.



Christof Van Ackere

Relevelling works with digger.



Christof Van Ackere

Relevelled creek, right after the works.



Christof Van Ackere

Relevelled creek a month after the works.



Christof Van Ackere

Rewetted area on the pilot site.



Wim Dirckx

Newborn cranes, the one and only breeding pair in Belgium thanks to the peatland restoration in the Valley of the Zwarte Beek.

## 2.2 Adaptive management

In order to achieve restoration of drained peatlands adaptive management is necessary. Conventional management techniques are not possible once the area is rewetted because the conventional machines are very heavy and would get stuck. However, after rewetting mowing is still necessary to avoid a blanket of dominant species such as Common Rush, Reed Canary-grass or Reed Sweet-grass. Even when it is still physically possible to mow the rewetted peatlands with conventional machines, it is not a good management option. Using conventional machines would lead to severe compaction of the soil. This has a very big impact on peat soils, since peat soils need to work as a sponge and thus keep their loose structure. If the soil is compressed, the peat loses its water absorbing functioning. In agriculture there is a principle that says that you can use the best (largest) machines and the soil will adapt to this. This can be seen in the market for tractors, haying and mowing materials.

When peatlands are being restored, Natuurpunt use an adaptive management technique that goes by the opposite principle: The soil determines which machines can be used in order to avoid all disturbances. With this reason some specialised material was bought within the Interreg Care-Peat project.

Natuurpunt performs three types of adaptive mowing management depending on how wet the soil is.

- Mowing with the marsh tractors on the moderately wet soils.
- Mowing with the track mower on wet soils
- Specialised precision management with the mono-axle and brush cutters on the most wet and most sensitive parts of the reserve.

Furthermore, grazing was stopped in the wet parts, because the cows used for grazing had a big impact on soil compaction/disturbance.

In the future, larger parts of the valley will be rewetted. Thus, the need for precision management will keep increasing. In order to be able to manage everything nature management will need to keep adapting in order to protect certain species, increase management efficiency and adapt to the ever-decreasing accessibility of the terrain.

## 2.2.1 Tractor mowing

Within the Care-Peat project, two marsh tractors were bought. Together with these tractors, haying sets were purchased. Within these haying set there is a front loader, a multidisc rotary mower for each tractor, a hay tedder for each tractor, a rugger, a belt rake and a baler.



Marsh tractor with baler used on the Care-Peat pilot site.

### Marsh tractor

A marsh tractor is a small, lightweight tractor with broadened, low-pressure tires without tread profile. These tractors can be used on wet soils (but the water level needs to be below the surface). The tractors were selected based on their low weight, low emission, but still they are quite ergonomic for the labourer. Within these criteria Natuurpunt bought the tractors that had the best price/quality. However, the market to buy marsh tractors is currently very limited, this may expand when adaptive management techniques are more generally used. Natuurpunt has a lot of experience with these machines, so they knew exactly what to expect from these machines and have positive experiences with these marsh tractors. They fit perfectly within the model for adaptive management in wet nature. They are very user-friendly and they meet the criteria of the working standards (which requires good ergonomics and extra options like air-conditioning).

The marsh tractors are used in areas where it is too wet to use normal (large and heavy) tractors. When conditions get too wet a track mower is used instead. For Natuurpunt this is the standard equipment for rewetted grasslands. It is the most important mowing machine. When you look at the valley system, these marsh tractors are used on the flanks. In the highest part conventional agriculture can be found. In the lowest parts of the valley adaptive management with track mowers is needed due to the wet condition. In the most wet and sensitive parts, precision management is needed. Marsh tractors are thus essential in order to do the transformation management from intensive grassland to restored peatland ecosystems. Contractors do not own these specialised machines, since the demands on the market are for very large and heavy machines, this again indicates the need to buy these machines ourselves in order to be able to perform adaptive management techniques. When comparing these with track mowers, the marsh tractors are much cheaper in purchase and maintenance.

### Haying material

When using normal (heavy) haying material, the advantage of the lightweight tractors would be minimal. Specialised haying material is needed to hay grasslands on peat soils. The haying material is selected by their weight and robustness, the lowest weight material was chosen, but machines still need to be quite robust. Cutter bars (here multidisc rotary mowers) are preferred instead of flail mowers. Flail mowers tend to be more destructive. These wreck the plants instead of making a clean cut, but flail mowers also destroy microstructures like sphagnum- or sedge hummocks. Flail mowers could only be used during the very first stages. The hay tedders, rigger and belt rake are needed to loosen and turn the cut grass respectively. The bale press is a small, lightweight bale press, which is actually not common on the market. This is also one of the specialised materials contractors don't have. The purchase of a bale press was thus essential for haying.

Haying grasslands is done whenever possible. Mostly this has the big advantage that Nitrogen is removed from enriched grassland. In this case haying is not done with the main intention to remove Nitrogen, but to reduce the dominance of some species like Common Rush, Reed Sweet-grass and Reed Canary-grass. But also, *Caltha palustris* hayfield and small sedge vegetations can be hayed with these small, lightweight, low impact haying materials. Another big advantage to haying is that it provides an extra income, since hay can be used as cattle food. In nature management haying (or at least mowing and removing) is needed during the transformation towards protected habitat types, but also during regular management. Also, when areas get too wet to use conventional techniques, this is very important if you want to restore peatlands to their full potential. When rewetting is already in an advanced stage, track mowers are needed in the lowest parts to continue this mowing regime.

## 2.2.2 Track mower

During the purchase of the track mower, attention was paid to the weight, ergonomics and emission scores, as for the other machines. Also, the produced noise was considered, both inside the cabin (to protect the driver) as outside the cabin (to avoid disturbance). By choosing a quite silent track mower, disturbance of resting birds and mammals is avoided and restoring peatlands can be carried on without drawbacks on the present fauna. The track mower has a low maintenance, which reduced the costs as well. Selection of the track mower was based on previous experiences in other projects like Interreg GrasGoed. Natuurpunt included the knowhow of Interreg GrasGoed within the best-practice of Interreg Care-Peat. This track mower is used together with a pick-up machine (also on tracks). This way the soil is not covered with plants after mowing. Choosing for a separate pick-up machine has the advantage that mowing goes faster. A pick-up machine works twice as fast compared to a track mower. Thus, two track mowers can be used for one pick-up machine, or the pick-up machine can start when the track mower is halfway.



Care-Peat Track mower with pick-up machine on the background.

When performing system restoration of peatlands, you need to deal with both the real peat valley core areas, as well as the valley flanks and the infiltration areas in the upper parts. Where adaptive management with marsh tractors can be done on the flanks, track mowers are needed to manage the core areas after the first stages of rewetting. These areas are only a part of the whole system, nevertheless they are of vital importance for the valley ecosystem. Adaptive management plays a very important role in restoring the core of the valley system. In order to achieve restored peatlands with transition mires, quacking bogs and small sedge vegetation, mowing is needed. Initially this might be possible with marsh tractors if the soil is desiccated. In this case these grounds were drained and grazed upon with cattle. This resulted in a monotonous landscape with some very dominant species like Common Rush. To restrict the growth of these dominant species an active mowing regime is needed. This mowing needs to be done with track mowers in order to preserve the soil layer and prevent compaction or destruction. The norms are between 0.040kg/cm<sup>2</sup> and 0.100kg/cm<sup>2</sup>. On peat soils, the soil pressure should be as low as possible. Moreover, the tracks of track mowers may not be designed for extra grip. These tracks need to be water permeable, bendable and rounded in order to preserve the turf.

The choice of the machine is thus important. Likewise, space and time are important as well. Nature conservationists work with so called mowing windows. These are predefined periods during which a parcel needs to be mown. This predefined period is depending on the vegetation type. Within these mowing windows, the mowing should be carried out on the driest moments. When considering the spatial component of mowing, a zone of 20% should remain during the complete growing season. Ideally these remain until the end of the second growing season. These leftover strips should vary between the years and include the wet-dry gradients present. These zones serve as refuge for species like amphibians, some plant species and insects, but are also food sources for birds like Stonechats and Red-backed shrikes.

Natuurpunt's first experiences are that the machine is very user-friendly and works as expected. Only in the most wet parts the load bearing capacity of the soil is too low, even for this machine. On these parts precision management is needed for the last transformations towards restored peatlands.

In order to save emission and man hours, a transport was bought that can carry both the track mower and a pick-up machine together. This should give the ability to transport the mow-pick-up combination in one time, by one person.



Front view of the track mower equipped with cutter bar and belt rake.

### 2.2.3 precision management

As stated above, the track mower can't be used on the most wet and sensitive parts of the valley. These sensitive parts include quaking bogs, small parts with sedge- and sphagnum hummocks or parts with very rare and sensitive species. precision management is needed here in order to complete the last stages of peatland restoration. On these plots some dominant grasses and rushes may still be occurring, there can still be shrub growth,... To finalise the restoration on these parts some adaptive materials were bought. These materials include a two-wheel tractor and three electric brush cutters and electric chainsaws.

#### Two-wheel Tractor

The two-wheel tractor is equipped with a cutter bar and a belt rake. This small machine can be used to mow larger areas of these very wet or sensitive parcels. With its light weight and broad, low-pressure tires, the two-wheel tractor is adaptive for peatland management. For the purchase of this two-wheel tractor, also emission scores were considered and the machine with the lowest emission was chosen. The two-wheel tractor is used in the field and generally works as expected. There are only some minor technical difficulties with this machine, since the workers are used to a brand of two-wheel tractors. However, this will only be a short-term adaptation and doesn't weigh up to the advantages of this lightweight machine. In order to move this two-wheel tractor to the different parts of the valley, a small trailer was bought.



Two-wheel tractor, used on large sensitive parts in the valley.

## Electrical brush cutter and electrical chainsaw

Brush cutters are needed to cut some dominant species growing on the edges or on some small parts. Electrical chainsaws are needed to manage growth of shrubs and trees on the small sedge vegetations or transition mires. As like the other precision management, these materials are needed for the final steps of restoration. This way the peatlands can be restored to their full potential. 3 of each were bought, together with some extra batteries.



Two of the three brush cutters bought in Care-Peat and one of the three electrical chainsaws bought.

Electrical machines were chosen because these don't use fossil fuels. These are also much lighter and ergonomic for the user, which makes working on difficult terrains like peatlands much easier. In order to choose the best value for price, a market research was done on the available electrical materials. These machines are quite new and it is very important that cost-effective materials are bought. Another advantage of electrical materials, is that they don't produce much noise. Since these materials are used in the parts of the valley that are already in an advanced stage of restoration, some birds and mammals are already breeding, resting or feeding in the peatlands. Electrical materials make it possible to work on some adjacent parts during the breeding season or on the sensitive parts during other moments of the year, without disturbing the present fauna.

There are still some disadvantages that come with electrical materials. One very obvious one is the battery life. Once the batteries are empty, they need to load during quite some time before they can be used again. In order to overcome this problem, battery packs were bought together with the brush cutters and chainsaws, so that the field workers can use them during a complete day and these could load overnight. Another disadvantage is that these materials are less powerful compared to conventional machines. For most of the works this is no issue, but big trees need to be removed or the brush cutter is needed in very dense vegetation, conventional machines could supplement the electrical machines in these specific situations. These new techniques are still being idealised and in the future the disadvantages will be tackled. Nonetheless, the advantages of the electrical equipment are much bigger compared to the few disadvantages. Certainly, the ability to work silently gives a lot of opportunities for using these in peatlands and nature areas in general.

## 2.3 Adaptive management summary

Adaptive materials like marsh tractors, track mowers and electrical manual materials are needed to restore wet ecosystems like peatlands. These machines are all lightweight, equipped with low-pressure tires and environmentally friendlier. Marsh tractors should be used as much as possible until the soil is too wet for them to hay without disturbing the soil. These machines give the chance to hay on the peatlands and give thus create a win-win of removing dominant plants and some phosphorous at one side and get some income for selling the high-quality hay. At the point the soil gets too wet for marsh tractors, track mowers take over in order to get the peatlands to the next level of restoration.

To finalise restoration, precision management needs to be done during the last stages of development. Electrical materials give an extra advantage with their reduced noise. This way fauna is not disturbed when managing nature reserves. These materials are quite user-friendly, ergonomic in use and are really of great value to be able to restore peatlands.



Adaptive management with track mowers on the rewetted pilot site

# Monitoring



### 3.1 Hydrology

The actual impact of the rewetting works will become visible during the coming years. For now, only a first impression can be discussed, which is heavily impacted by yearly differences. By looking at water level data from the installed divers, you can see that in the ‘Bocht van Laren’ (the biggest part of the pilot site), the water level was 14.25 cm higher in 2021 compared to 2020. This is probably the first result of the first rewetting measures. These values are corrected for the very wet month of July in 2021 and the drought in July and August 2020. The increase in water table caused by the other rewetting works done from the end of 2021 onwards is not yet included. You can see that the Zwarte Beek itself also has a big draining impact on the nature reserve, future measures on this creek will be needed in order to restore the complete peatland ecosystem in the Valley of the Zwarte Beek.



Figure A: First effects of rewetting by closing internal ditches. The water table was higher in 2021. This data comes from 4 divers on the pilot site in a line towards the Zwarte Beek. Note that the water level near the Zwarte Beek is much lower than away from it. These results only represent 1 year, when the works were still going on. Better results will only be visible within a few years.

## 3.2 Greenhouse gasses

The first results from the greenhouse gas measurements suggest a much lower CO<sub>2</sub>-emission after the first rewetting works. Indeed, even these results need to be refined and confirmed all along the next years, the first measurements after the rewetting suggest that the restoration works had involved a valuable decrease of the carbon emissions of about 15 tCO<sub>2</sub>/ha/year.

This value is confirmed by the modelling of GHG fluxes at the interface between peatland and atmosphere. During the Care-Peat project, a Decision Support Tool was developed with the aim to predict the carbon emissions from peatlands. This tool which take into account the water table depth and weather conditions for the estimation of the fluxes predicts that a raising of the water table of about 30 cm shall reduce the GHG emissions by about 19 +/- 1 tCO<sub>2</sub>/ha/year.

Both field measurements and model estimations are consistent and confirm the positive impact of rewetting on carbon emissions.



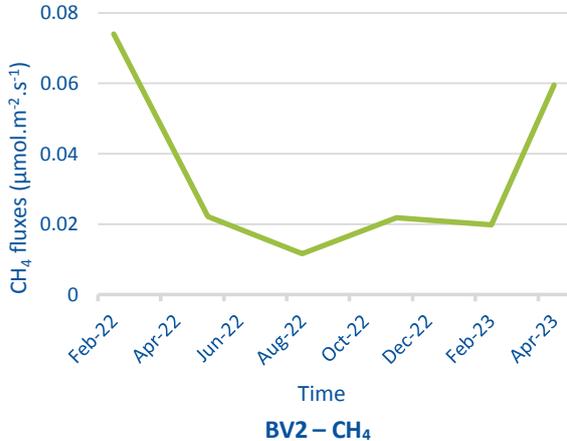
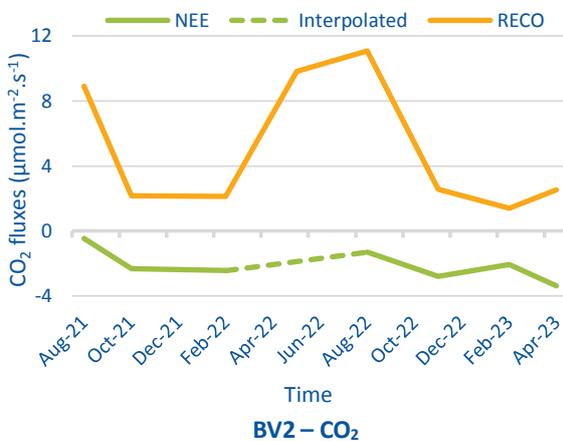
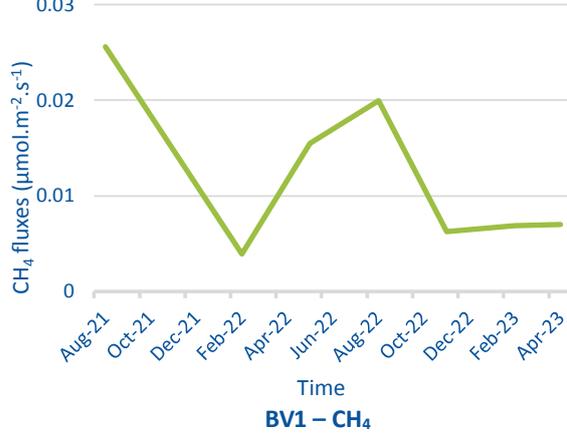
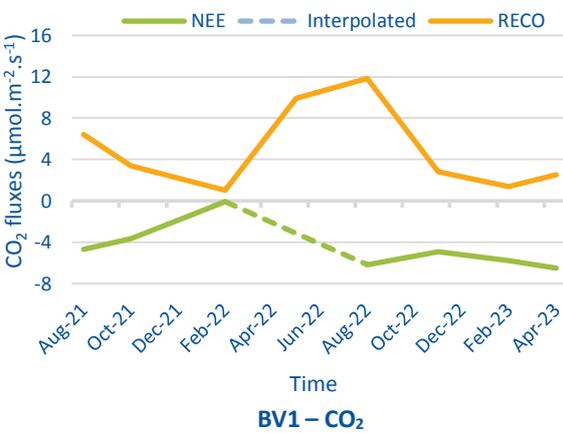
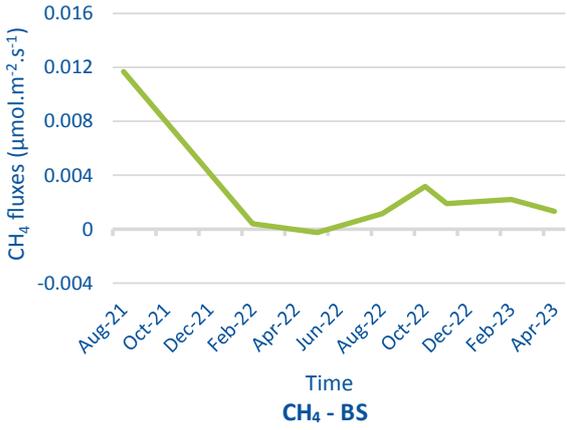
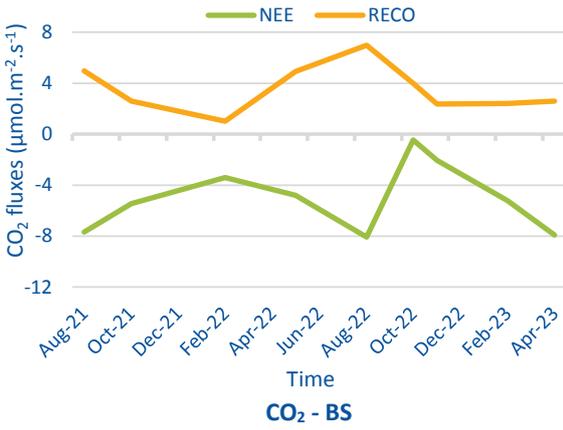
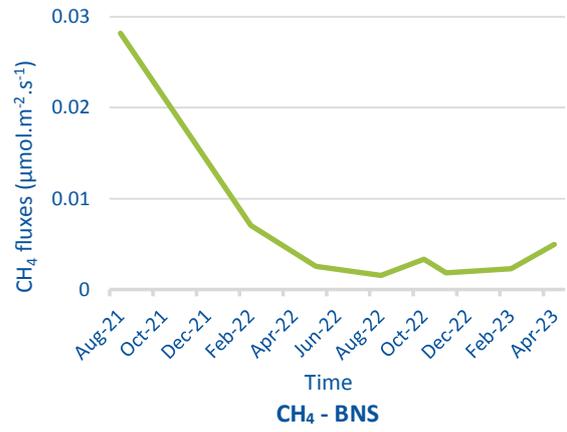
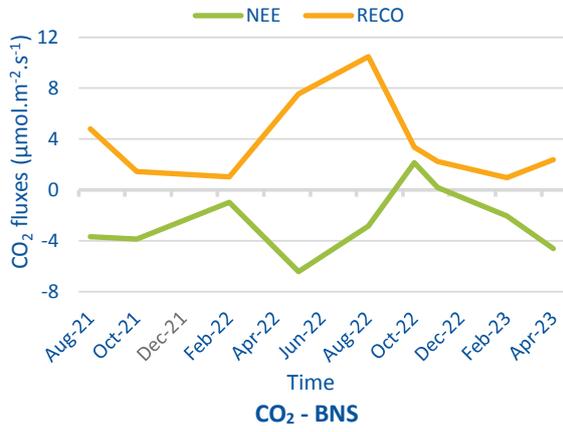


Figure B: Figure 12. Time series of GHG fluxes in Valley of Zwarte Beek

### 3.3 Earth Observation analysis

Earth observation analysis was undertaken for the Zwarte Beek pilot site, to investigate the benefits of remotely sensed optical satellite imagery to monitor environmental change from peatland restoration. Initial observations were generated from time series (April 2018 – June 2023) Sentinel-2 image data (European Space Agency, Copernicus programme) for sample points placed across non-woody vegetation treatment areas.

The Optical Trapezoid Model (OPTRAM; Sadeghi et al. 2017, Remote Sensing of Environment 198) indicates soil moisture as a response between short-wave infrared reflection and vegetation activity (NDVI) and requires a suitably large dataset to project patterns in two-dimensional point cloud space. OPTRAM has been successfully employed in other peatland studies to analyse Water table depth. Here, OPTRAM estimates per point were aggregated to quarterly averages, to provide a consistent a time-lag for the corresponding 'distance from' Zwarte Beek buffer. Patterns between Water table depth and OPTRAM ( $0 > 1 =$  Dry to saturated soil moisture) are somewhat comparable (**Figure c**) as: a) values recorded for 2020 and 2021 generally increase in value the further away from the Zwarte Beek, b) values for 2021 are also generally higher than 2020.



Figure C: OPTRAM values aggregated for points within 'distance from' Zwarte Beek buffer for years 2020 and 2021

Trends decomposed from seasonal variation in OPTRAM values over the approximate five-year analysis period indicates the longer-term impacts of restoration works (**Figure D**). Here, following a period of limited change from mid-2019, OPTRAM values improve sharply after the restoration period. This pattern is also observed for the Normalised Difference Moisture Index (NDMI), which indicates moisture content in vegetation, and may therefore evidence improvements in WTD post on-site monitoring.

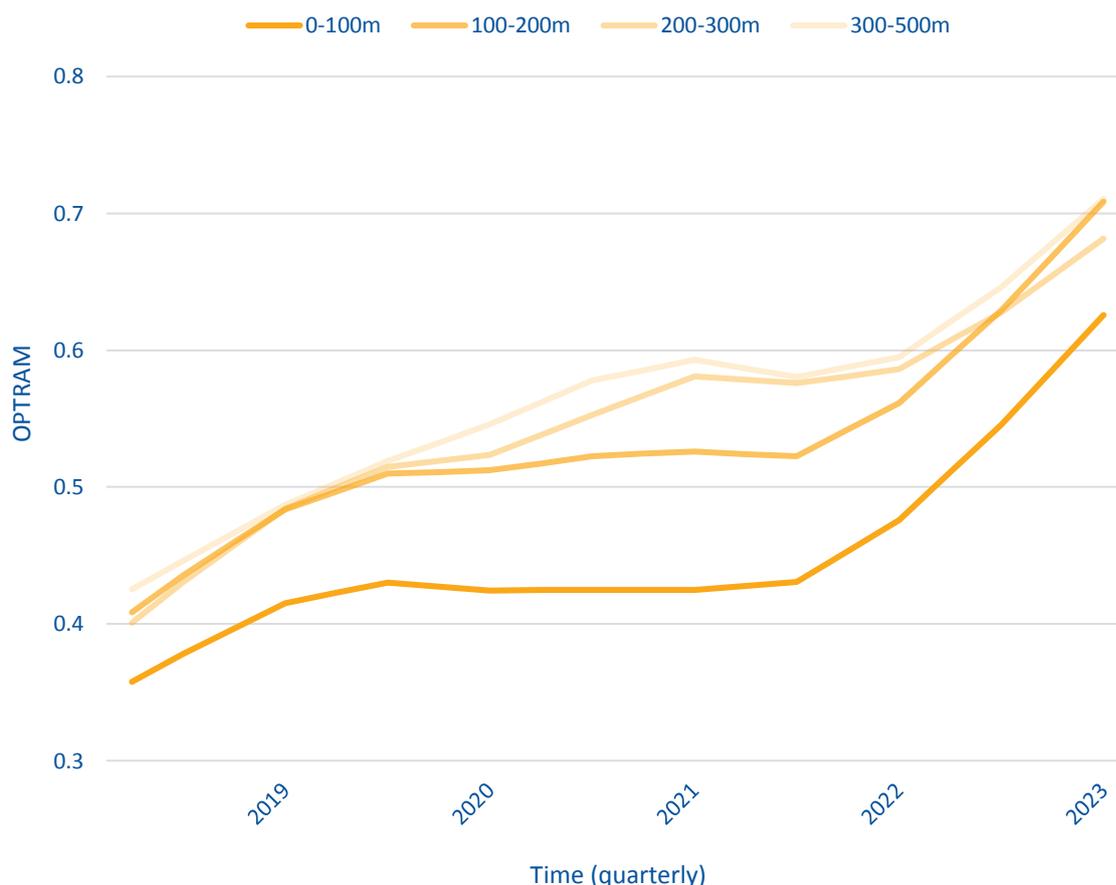


Figure D: Trends decomposed from five-year time series OPTRAM values per 'distance from' Zwarte Beek buffer

In contrast vegetation indices, the Normalised Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI), evidence a minimal downward trend in values. Further site investigation may be beneficial to assess whether this represents a transition to more beneficial habitat species and conditions. All earth observation outputs are currently indicative and require further cross-validation to site conditions over a longer monitoring period. However, positive correspondence between site and remotely sensed measurements indicate potential benefits in earth observation analysis for peatland restoration monitoring.

### 3.4 Progression towards conservation goals

The habitat at the site consists of European habitat 7140 quaking bogs and transition mires (EUNIS D2.222) and wet grasslands, mostly degraded, with some still in very good wetland condition (EUNIS E3.411). The main vegetation is grassland and small sedges with some alder forest in between and some small areas of Sphagnum moss. The site is host to the largest population of Common snipe (*Gallinago gallinago*) in Flanders, the very rare Large marsh grasshopper (*Stethophyma grossum*) and is also important for the occasionally-breeding Spotted crane (*Porzana porzana*). The very rare Corncrake (*Crex crex*) is sometimes present together with other breeding birds including the Curlew (*Numenius arquata*).

Currently the pilot site is not yet fully developed as transition mire. There are still a lot of dominant species present like Common Rush and Reed-sweet Grass. Adaptive management is needed to further develop the site to a small sedge vegetation. Some sedge and other indicator species are already present and are spreading. There is still too much drainage going on in the area to achieve a perfect status of conservation, but thanks to the Care-Peat projects, big progresses were made. to the Care-Peat project. Further works are planned in the future. However, some relict species that were previously found only in the ditches are now spreading through the parcels and developing into important vegetation.

Also, peatland specialist animals are colonising the area again. In 2021, the first breeding Cranes in Belgium chose the valley of the Zwarte Beek as breeding grounds. Other bird species like Spotted Crane, Common Snipe, Curlew,... discovered the restored Care-Peat site. Furthermore, Arthropods are starting to appear again.



# Stakeholder involvement



## 4.1 Introduction

The involvement of stakeholders was very important in order to achieve the targets within the Care-Peat project. A shift in mentality was needed for people to understand the need of rewetting and closing up ditches instead of digging ditches to 'manage' the water, like was done previously. Progressive understanding showed us that ditches are no good in peatland, while some decennia ago ditches were dug in order to restore the peatlands in the Zwarte Beek. All these common practices pinned the idea that water need to be carried away as fast as possible to solve all the problems. During this project it was proven that this idea doesn't hold for peatlands. Local farmers, inhabitants and the volunteers of Natuurpunt were involved. The local volunteers played a very important role in this involvement of other stakeholders, since they have their local connections with all interested or affected parties. Here a short overview of the different stakeholders and how they were involved within the project is given. Furthermore, also Governments, like city councils, the Province, VLM and VMM, were included and close collaborations with them were set up. Apart from the broad public, water managers play a very important role in peatland restoration. A lot of meeting and ad hoc discussions were held with the water managers to align water management and work together in order to get the best possible result.

## 4.2 Water managers

The waterways in Flanders are no private properties and are managed by different water managers. These non-navigable waterways are divided into different categories. Category 1 are the biggest and are managed by the VMM (Flemish environmental agency of the Flemish government). Category 2 waterways are generally managed by the Province. Category 3 waterways are generally managed by the cities. Non-classified waterways are managed by the cities, ANB (Agency for nature and forest of the Flemish government) or by the local landowners depending on where these are situated. Sometimes category 2 and 3 waterways are managed by a watering. A watering is an independent public administration responsible for water management in a particular area. In the Valley of the Zwarte Beek there are no category 1 waterways, but there are Category 2, 3 and non-classified waterways. The non-classified waterways are mostly located next to roads and managed by the cities. The category 2 and 3 waterways are running through the peatland and were initially managed by 2 waterings, but during the project this changed to 1 watering and category 2 waterways are the responsibility of the province, but they work together with the watering to carry it out. Some waterways also changed from category 3 to 2.

This tangled web of different water managers, waterway categories and changes through time make it very important to have a very good involvement of all the water managers within the Care-Peat project, since these ditches and waterways need to be closed in order to preserve the peatlands. In order to achieve this, 11 stakeholder meeting are already organised, supplemented with a lot of small one on one meetings with water managers. Within the project a cooperation was established and as a result there is now an adaptive clearance regime in the valley. The local ditches within the parcels are own property and could be closed anyway. But for closing or releveling some of the category 2 waterways draining the peatland, a permit was needed. This procedure is still running, and even if the permit is granted, the watering still needs to give their permission to carry out the works.

### 4.2.1 Stakeholder meetings

13 stakeholder meetings were held to discuss the water management in the Valley of the Zwarte Beek. 4 of these meetings also focussed on establishing the regional platform.

During these meetings went through all the different waterways, discussing management, drainage, water quality, issues like floods, sewage water, releveling of the waterways. Also, more general things were discussed if they had an influence on water management within the valley like: the hydrological study carried out by the University of Antwerp, events, restoration works, how peatlands function, new projects in the area, ...



Stakeholder meeting on the Care-Peat pilot site.

## 4.2.2 Results of these stakeholder meetings

During all those meetings with the water managers there was elaborated a lot on the functioning of peatlands. Explaining their water retaining function and their function as a sponge, taking up all the water and why it is important to keep these peatlands wet to avoid peat degradation in order to retain this function. To save the peat from degradation a cooperation was needed. These meetings allowed a collaboration like that and made us think about solutions for avoiding drainage of the peat layer. In the end 2 important measures were brought forward, a first temporary, but fast measure was an adaptive management of the water ways. The second measure was the closing of certain waterways, for this a permit was needed. During this procedure for the permit, the water managers were convinced of its importance and without this close cooperation with water managers, the water managers would certainly have submitted a negative advice for this permit. Now, after a long procedure, the permit was granted (although people can still lodge an appeal on this decision). Only because of the Care-Peat project and the cooperations that were created within, measures like this are made possible.

This cooperation will be maintained in the form of the regional platform. In the end Care-Peat strives towards a written cooperation agreement with these stakeholders.

## 4.2.3 Adapted ditch cleanings in function of peatlands restoration

Agreements upon adaptive waterway management on waterways running through the peat layer were made on the parts where Natuurpunt owns the parcels at both sides. Before the Care-Peat project started, all these waterways were cleaned completely. The banks were mown and the bottom of the waterways were scooped out by digger. The management was focused on getting the water away as fast and efficient as possible with the idea this would avoid floods. After all these meetings there was agreed that the waterways will not be scooped out anymore in order to slow down the waterflow and keep the water in the system longer. This shift in management was very big (and necessary). Knowing that in history ditches and waterways were dug out as water management measure, it is quite hard to create a mind shift towards the opposite management with the same target: avoiding floods and droughts. There is still a path next to the waterways that is cleared and mown, so the diggers can still get to all places if it would be needed at some point.

This adapted water management is not enough in order to protect peatlands, but it is a first big step towards raising awareness of peatlands and how they should be managed. For now, this helps rewetting the peatlands without any costs. It actually saves the water managers some money.

During the last meeting the Province showed some plans they had for the future with the waterways. They plan on closing up waterways in the Valley of the Zwarte Beek in the coming years.

They considered all the waterways and made plans to relevel them or close them. Before Care-Peat, this would have been unthinkable. This again shows how important close collaborations with all stakeholders are, and how strong and effective these can be. These new techniques are still being idealised and in the future the disadvantages will be tackled. Nonetheless, the advantages of the electrical equipment are much bigger compared to the few disadvantages. Certainly, the ability to work silently gives a lot of opportunities for using these in peatlands and nature areas in general.

## 4.3 Volunteers

Volunteers are the driving force of Natuurpunt. Each local department functions solely on volunteers. These volunteers take care of some management, they have contacts with local inhabitants, farmers, city councils, ... The volunteers within Natuurpunt are responsible for the purchase of lands to restore to nature reserves. They are also responsible for user agreements on Natuurpunt grounds. These volunteers are key for the restoration of the peatlands in the Valley of the Zwarte Beek. Different local departments are active here, since the area is quite big. Mostly Natuurpunt Lummen and Natuurpunt Beringen are involved within the Care-Peat project. They had most of the contacts with all the local stakeholders, while the professional team had contact with the different government departments, like the VMM, VLM, ANB and the Province.

The volunteers made sure all the actions were communicated with local persons, they did that by spreading flyers, talking to people, going to the city councils,... They were also very active on events to help for the practical organisation and to give some explanations on what Care-Peat is doing in the valley.

## 4.4 Local inhabitants

Local inhabitants can be impacted by rewetting measures, since houses are never far anywhere in Flanders. The local inhabitants were informed with flyers, local news posts, articles,... These local inhabitants need to be informed on what will happen and whether they would be impacted or not. The hydrological study that was carried out also focused on impacts on local inhabitants and farmers.

This study was used to select the impacted parcels. No houses would be impacted according to the model, since these lie higher up the flanks of the valley. Still the local inhabitants needed to be assured of this, and therefore a workshop was held especially for local inhabitants.



Info session for local landowners

## 4.5 Farmers

Apart from collaborations with agricultural associations, cooperation with farmers is very important. Natuurpunt cooperates with farmers in different ways.

- There are agreements with some farmers on the cuttings resulting from the mowing management of the peatlands. These cuttings are composted and farmers can use this as a fertiliser.
- There were agreements with farmers on grazing of the peatlands with cattle.
- In some places there are agreements that farmers hay the parcels and they can keep the money they make from that as a compensation.

All these collaborations are generally not adapted to peatlands. In order to restore (rewet) the peat, Natuurpunt needed to adapt these agreements and involve and inform them on the measures that were taken. In the first place the mowing needed to be done with adapted mowing machines after the area is rewetted.

This couldn't be done anymore by farmers, so now Natuurpunt does all of the mowing with the marsh tractors and the track mower. Cattle grazing results in disturbance of the soil and thus peat degradation. No cattle could be placed anymore in the valley, only on the flanks that are situated higher up. Apart from these changes in existing agreements, also local farmers that could be impacted by rewetting needed to be informed. Natuurpunt offered them to buy their land if they feared it wouldn't be useful anymore for farming. If they didn't want to sell, exchange grounds were proposed with similar parcels outside the valley. This happened in close cooperation with the VMM. In the end, only little active farming land is left in the valley, and those lands left are no productive cropland.

## 4.6 Governments

Different governmental departments and city councils were included within the project. The project was explained to all the city councils (Beringen, Lummen and Halen). With the city of Lummen different meetings were held to fully explain intentions of Natuurpunt and the Care-Peat project. Even a cycling tour through the area was held with the board.

Natuurpunt has different collaborations with the province. There are the meetings with them and the water managers to discuss the adapted management of the different creeks, but there are also meetings to discuss the purchase of land within the project area. Now there is an active land purchase going on within a perimeter that is agreed upon with the province. The province buys lands within this perimeter and Natuurpunt take these in their management and include them in a Nature management plan. Thus, the complete peatland ecosystem can be rewetted. In Autumn 2022 the deputy came to the Care-Peat pilot site to see the works. The fact that they give attention to this is positive. It is not common that they visit their terrains. This will give us even more opportunities to push for structural measures, system restoration and land purchase.

With the VLM (Flemish Land Society) Natuurpunt has agreements on ground trading. When Natuurpunt wants to buy land from a farmer, but this farmer needs it for agriculture, the VLM helps us to search for another parcel outside the valley which is useful for agriculture and can be traded for the grounds of the farmer within the valley.

With the three city councils, collaborations depend on the willingness of the specific cities. With the city of Lummen Natuurpunt has an intensive collaboration. Also, the city of Halen supports the Care-Peat project, since it matches perfectly with their climate policy. Whereas the city of Beringen is hard to reach. There is not much consultation, while they are invited every time. They give negative advises to the permits, because of few concerns or doubts of local inhabitants. They are not present during stakeholder meetings where was elaborated on the hydrological system.

Apart from these local collaborations, Care-Peat also focusses on the larger image for peatlands in general. Therefore, we try to involve policy makers within the project to show the importance and relevance of peatland restoration. The Commission for Integral Water management (CIW) visited the Care-Peat pilot site. Here was elaborated on the things Care-Peat achieved and the things that still put a brake on peatland restoration. Based on this the CIW will make a report for the ministry with suggestions for policies that can help us restore and protect peatlands in Flanders. If the minister decides to change some old policies towards a peat friendly alternative, future peatland restoration might go to the next level.

## 4.7 Care-Peat mind shift

The Care-Peat project set the tone for peatland restoration in the Valley of the Zwarte Beek and for the whole of Flanders. Within this project Natuurpunt was able to create a mind shift on local water management. But also had a big influence on peatland policy in Flanders. Stakeholder involvement was a really important part of this project and will continue in the coming years.

Both the stakeholder mind shift and peatland friendly policies being made now, will make future restoration easier and allow us to look at an ecosystem scale.



Maarten Jacobs

Inspiration day for local stakeholders, nature managers and water managers



Katrien Wijns

Inspiration day for local stakeholders, nature managers and water managers

# Conclusion



Care-Peat uncovered a lot of issues in peatland restoration. But in the end, all the planned rewetting works were carried out successfully. The effects of the rewetting are already starting to get visible and look very promising, since peatland specific plant species are starting to spread throughout the pilot site. Furthermore, the water table already seems to have increase by 14cm just by the very first small rewetting works. The results of the majority of the works will only become visible during the coming years. As for the greenhouse gasses, first results indicate that CO<sub>2</sub>-emissions already decreased with 15tt CO<sub>2</sub>/ha/year, right after the very first rewetting works. The final results will give a better estimation of the actual GHG-reduction.

The Care-Peat project set the tone for peatland restoration in the Valley of the Zwarte Beek and for the whole of Flanders. Within this project Natuurpunt was able to create a mind shift on local water management. But also had a big influence on peatland policy in Flanders. Stakeholder involvement was a really important part of this project and will continue in the coming years. Both the stakeholder mind shift and peatland friendly policies being made now, will make future restoration easier and allow us to look at an ecosystem scale.

# Future plans



After Care-Peat, the restoration of the Zwarte Beek will not stop, nor be finished. There are still a lot of other parts of the valley that need to be and will be restored. New projects will come or are being carried out already. Also, the Care-Peat pilot site can still be further improved. Once the remaining parcels can be bought, a system wide restoration can be achieved. There are still ditches and creeks present in the area that aren't restored yet, but will be restored once all parcels are in management of Natuurpunt. Natuurpunt has an active land purchase/ land change policy and hopes the last remaining parcels of land in the city of Lummen will be bought in 8 years.

Apart from future big projects, the adaptive management will continue until all dominant species are removed and the area can be self-developing. But that won't be for the near future. Management will get more intensive in the future. More precision management will be needed as the valley developpes, track mowers will be needed where marsh tractors are used now and the terrain will get less and less accessible. Management will thus need to keep adapting to the changing, wet conditions of the Valley of the Zwarte Beek.



Care-Peat pilot site before restoration



Cyr Mestdagh

Care-Peat pilot site after restoration

# Interreg



EUROPEAN UNION

## North-West Europe

### Care-Peat

European Regional Development Fund

