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Ecological and societal impact of the Care-Peat project – The La Guette pilot site as a showcase to promote Carbon sequestration in French peatlands.

REPORT

Ecological and societal impact of the Care-Peat project – The La Guette pilot site as a showcase to promote Carbon sequestration in French peatlands.

Author(s)

Gogo Sébastien, Université de Rennes (ex-Université d'Orléans)
Laggoun Fatima, CNRS
Mazeron Juliette
Jacotot Adrien, INRAE (ex-Université d'Orléans)

Date

June 2023

Contact information

Katrien Wijns | Project coordinator Interreg Care-Peat
Natuurpunt Beheer | Coxiestraat 11, 2800 Mechelen, Belgium
katrien.wijns@natuurpunt.be | +32 (0)497/05.29.21
www.nweurope.eu/care-peat

This project is made possible by Interreg North-West Europe

Table of contents

Summary

In North-West Europe, most peatlands are disturbed locally by human activities. Typically, such activities (e.g. extraction, forestry, agriculture) require initial draining of wetlands, causing a decrease in the level of the water table. As peatlands naturally function as a carbon (C) sink for the atmosphere, the lowering of the water table leads to increased availability of oxygen over greater peat thickness, resulting in peat mineralization. The ecosystem then develops into a source of C for the atmosphere, in turn providing a net contribution to global warming.

Restoring disturbed peatlands is therefore an effective means of mitigating anthropogenic disturbances on the climate, through sustainable storage of C in the soil. However, until now, site managers have mainly evaluated peatland restoration and success by using biodiversity factors estimated through flora and fauna criteria. Despite the growing importance of "storage of C" criteria, little is known on this subject, and therefore the current transfer of knowledge to site managers remains to be very poor. This is why, through the establishment of 5 pilots in the North-West European region, the Care-Peat project aims to highlight good management practices for the restoration of C storage capacity of peatlands. This report details the ecological and societal impacts of restoration works undertaken at the French pilot site La Guette. The Care-Peat project capitalises on previous restoration works realised in a Région Centre Val de Loire project (CarBioDiv) on both hydrology and vegetation, where actions were undertaken on vegetation in small plots (4 m^2). The main objective of the Care-Peat project was therefore to replicate the same treatments over a much wider area (1600 m^2) to store more C in the long term and avoid negative side effects.

Restoration work involved stripping the vegetation and peat, and then setting up *Sphagnum* in patches, and, where *Sphagnum* species coverage on site was relatively rare, through "stem by stem" planting. *Sphagnum* was chosen because this moss is very efficient in the sequestration and storage of C, and because it is already abundant on site. The transplanted *Sphagnum* originated from both the stripped area, and from other parts of the La Guette peatland. The initial results on vegetation are positive, as the *Sphagnum* generally survived and tended to expand within the restored site areas, producing a positive effect on C fluxes.

Description of the sites

The La Guette peatland (Neuvy sur Barangeon, 200 km south of Paris, Fig. 1) is one of the five European sites on which a pilot would be installed. It is a poor fen (EUNIS code Q22), where various disturbances (e.g. hydrological degradation, fire) have led to the dominance of *Molinia caerulea*. This site is drained by a ditch located along a road at the outlet of the peatland. This has caused not only a general drop in the site water table level, but also an increase in water table fluctuations that are favourable to the appearance of less desirable species (*Molinia caerulea*, *Betula spp, Pinus sylvestris*) at the expense of typical peatland species (*Eriophorum angustifolium, Rhynchospora alba*) including *Sphagnum*, a major producer of peat. Restoration works were carried out as part of a regional project.

Restoration works

The objective for this pilot was to increase the scale of restoration works tested in the previous Région Centre Val de Loire project (CarBioDiv), by stripping peat on the first 5 cm of top soil, and then planting *Sphagnum* in patches, in two zones of approximately 20 m x 30 m. The stripping of the peat is intended to induce the growth of several plant species of interest. This is expected to increase floristic diversity beyond the quantities present before restoration activities, in addition to benefiting site C storage capacity through a significant increase in *Sphagnum* cover.

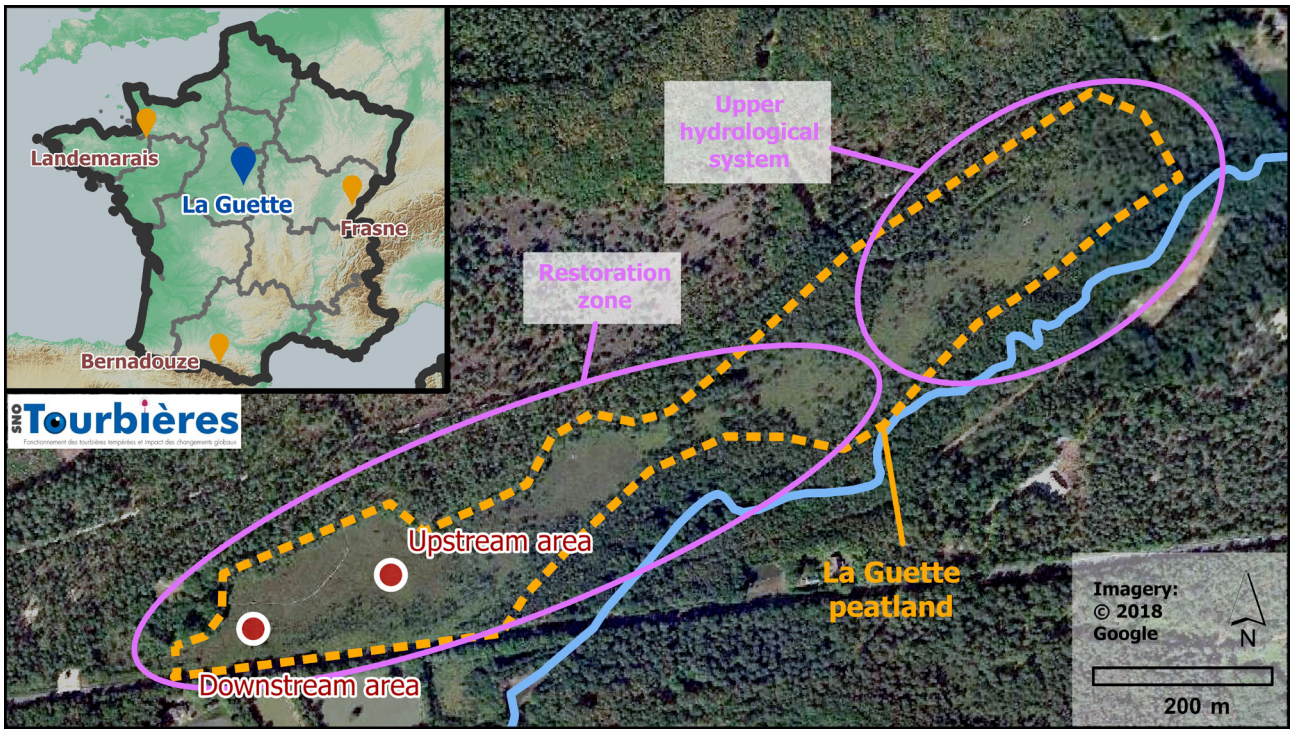


Figure 1: Localisation of the La Guette peatland and the two restored area within the pilot. The downstream area is relatively wetter than the upstream area. These two areas were chosen to highlight water table depth effect on restoration.

2.1 Administrative procedure

Because some protected species may be destroyed in the process of restoration, all the authorisations required had to be obtained beforehand. The administrative process began in April 2019 through discussions with Francis Ollivereau, member of the regional biodiversity authority (Conseil Scientifique Régional du Patrimoine Naturel – CSRPN) that delivers advice to different state organisations. Overall, the process involved:

- Writing application documents required by the CSRPN,
- Presentation of the project to the CSRPN.
- Submission of a form to the environmental service of the County, Direction of the Territory of the Cher department (Direction Départementale des Territoires du Cher, DDT 18).

The procedure successfully concluded in June 2020, enabling the start of on-site restoration.

2.2 Peat stripping

Restoration works in the La Guette peatland consisted of stripping vegetation, dominated by common species that promotes C losses, such as *Molinia caerulea* and ericaceous shrubs, in addition to stripping the first 10 to 20 cm of supporting peat (Fig. 2). Tools suitable to avoid any irreversible damage to the site, such as a dedicated small mechanical digger were used (Fig. 3). To provide access to the restoration areas, the workers placed large wooden boards across the existing peatland. This enabled the dissemination of pressure when transporting machines to the stripping areas, thus minimising disturbances on the underlying peat and vegetation (Fig. 4).

The excavated peat (full of seeds of *Molinia caerulea* and ericaceous shrubs) was placed in a margin of the peatland to form a bund, where such common species are already present with birch (Fig. 5). The bund can filter water from upstream, as well as prevent birch that were cut to grow again from the basis of their trunk. In the end, two areas of 20 m x 30 m were stripped, with drier conditions recorded for the upstream area (Fig. 6A) over the downstream area (Fig. 6B).

Figure 2. Peat stripping of the first 10 to 20 cm.

Figure 3. Peat stripping with low pressure small excavator dedicated to work in peatlands.

Figure 4. Path made of large wooden boards to avoid disturbance.

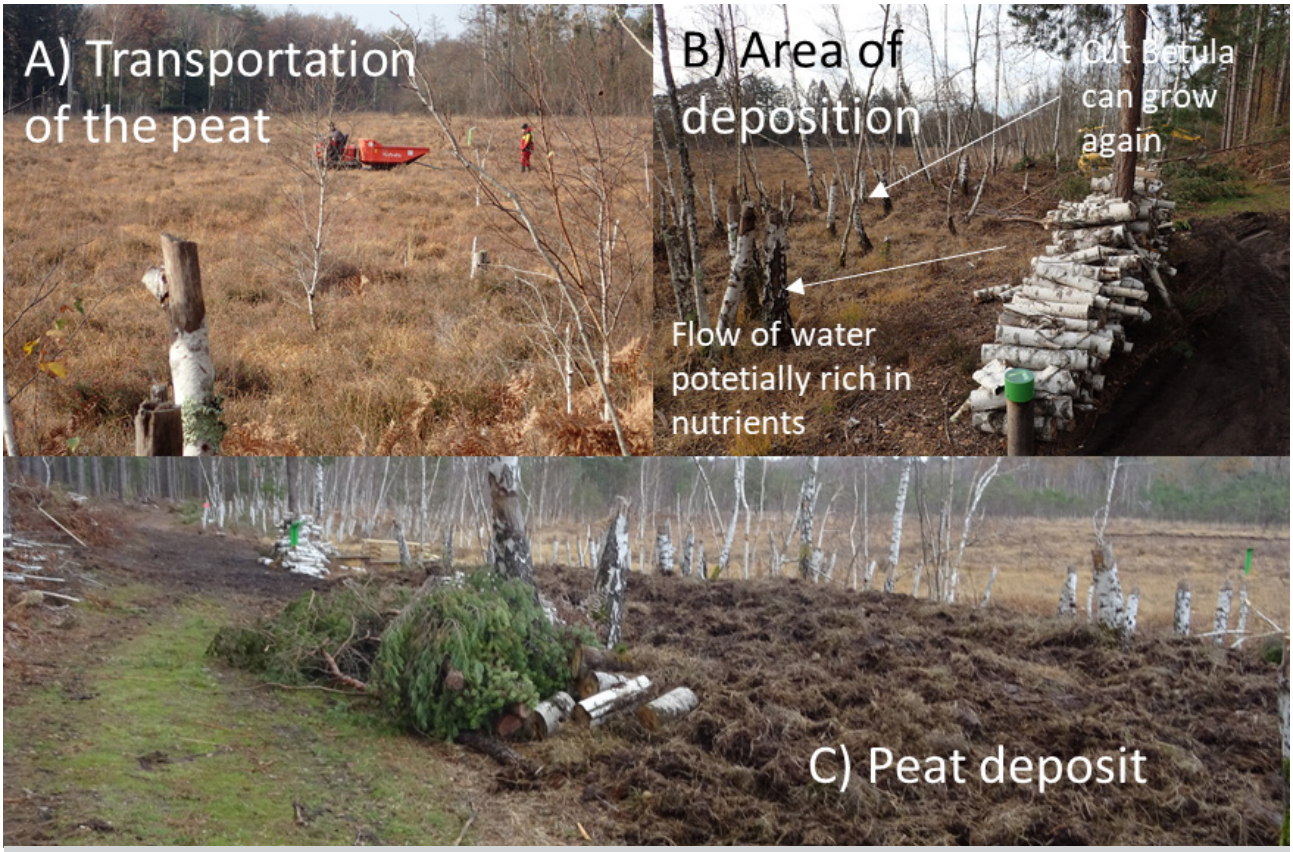


Figure 5. Transportation (A) and area of peat deposition (B, C).

Figure 6. Overview of the stripped area.

2.3 *Sphagnum* planting

Sphagnum for planting the stripped areas was collected wholly from within the La Guette peatland. In the stripped areas themselves, existing *Sphagnum* patches were carefully removed and stored prior to actual stripping, and then replanted within the exposed peat. Additional *Sphagnum* plants were gathered from outside the stripped areas as required and were sampled to provide enough materials to set up 7 to 10 dense patches per restored plot (Fig. 7). In the wet conditions of the downstream area, the water table was at the surface of the peat profile, therefore some *Sphagnum* plots tended to spread, which in the long term may favour the growth of *Sphagnum* within the restored area.

Figure 7. Example of a dense *Sphagnum* patch within the downstream (wet) restored plot.

In the wet area, a second technique of *Sphagnum* installation was designed: “stem by stem”. It consisted in taking *sphagnum capitulum*, with a few centimetres of stem, to plant specimens individually. This technique can be used where there is low abundance of a species, or where the site as a whole, has low *sphagnum* cover. In the case of La Guette, this technique was used with *Sphagnum magellanicum*, which has very low abundance in La Guette (Fig. 8).

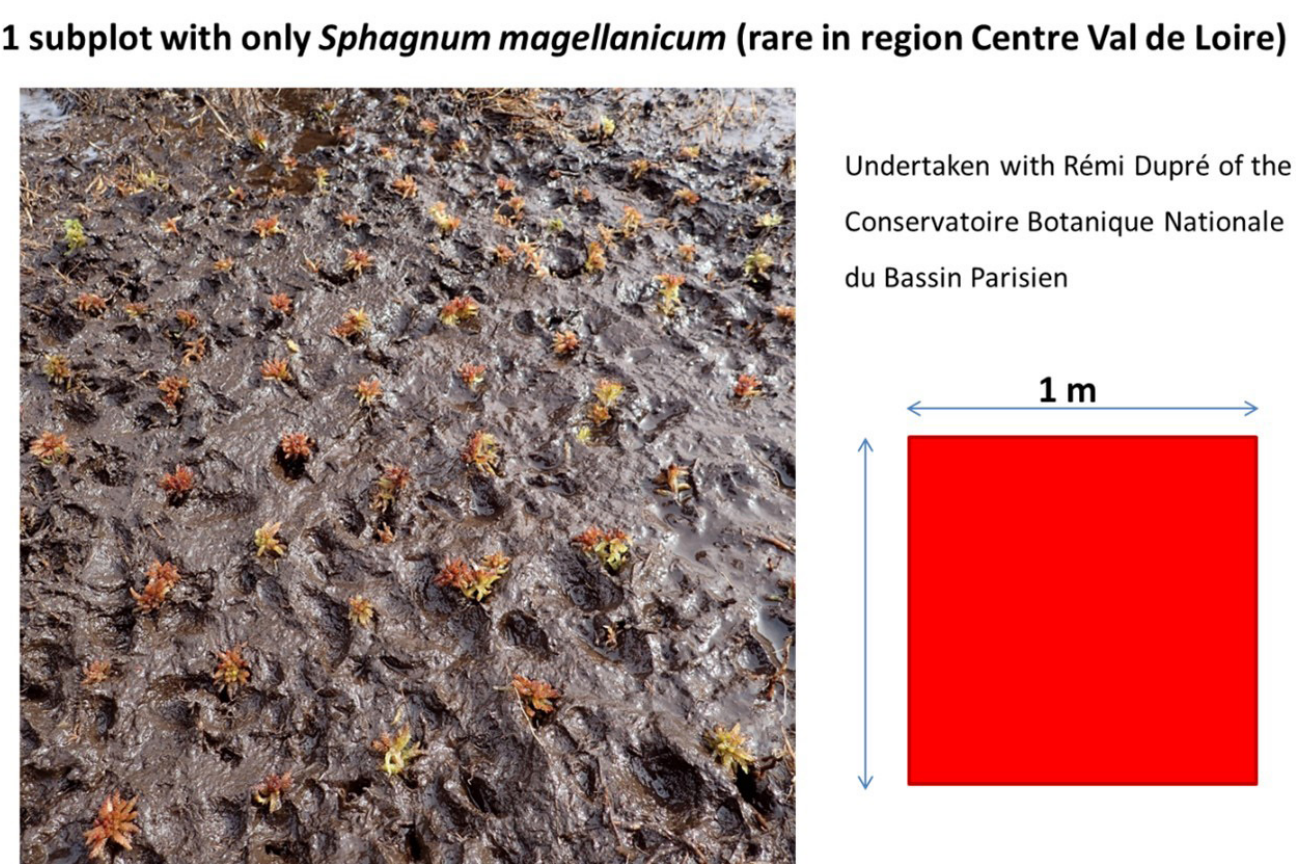


Figure 8. example of a stem by stem transplantation expriment with a rare species in Centre val de Loire region: *Sphagnum magellanicum*

2.4 Walk-board installation

Removable walk-boards were installed to enable access across the restored areas without walking on the *Sphagnum* plots. All walk-boards were brought onto site in November 2020 (Fig. 9) and were constructed according to the requisite instructions provided by the CNRS. Installation was conducted in February 2021, at the same time as installation of the collars for the GHG measurements (Fig. 10). Once the walk-boards were established, monitoring could begin in April 2021.

Figure 9. Walk-board constructed by Jura Natura Service.

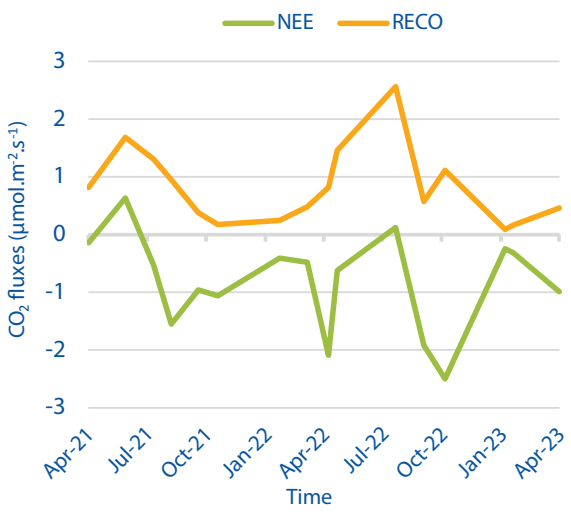
Figure 10. Walk-board installed in the wet restored plots closed to the GHG flux measurements plots, allowing the measurements to be done without trampling around the plot.

Monitoring and Restoration Outcomes

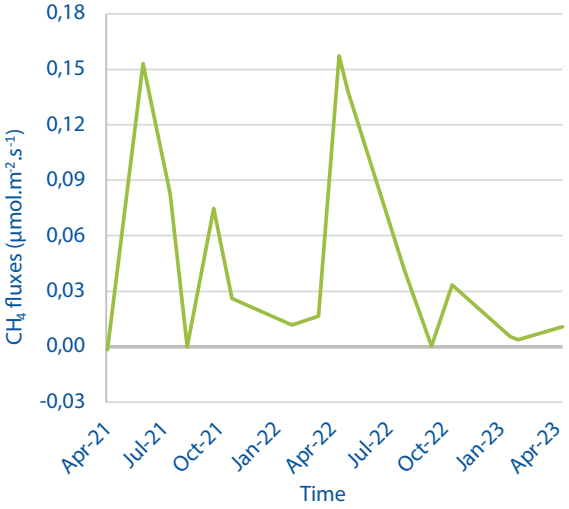
3.1 Monitoring plots and results

Monitoring in La Guette peatland started in April 2021 and finished in April 2023. Collars were set up in the restored area (n=6) and in a control area (n=6) dominated by *Molinia caerulea*. Thanks to these walk-boards, measuring can be done without trampling of the site (Fig. 11). When possible, nets were used to assess the response of the system to varying radiation intensity.

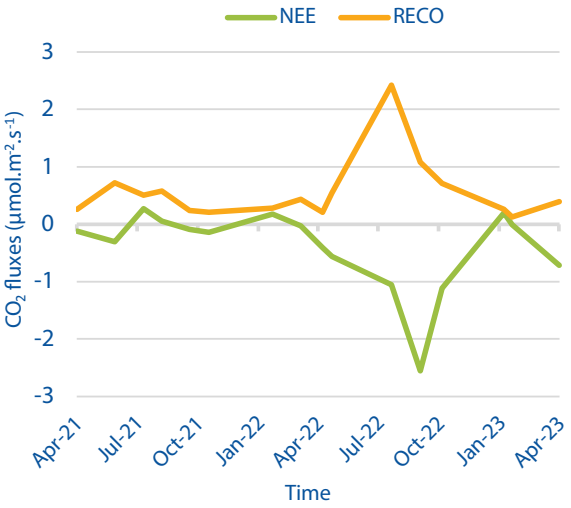
Figure 11. Examples of GHG flux measurements with the operator and the equipment installed on the walk-board.



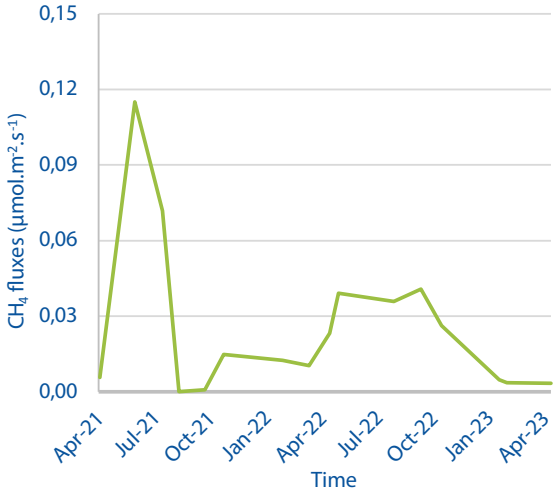
Restored Sphagnum – CO_2



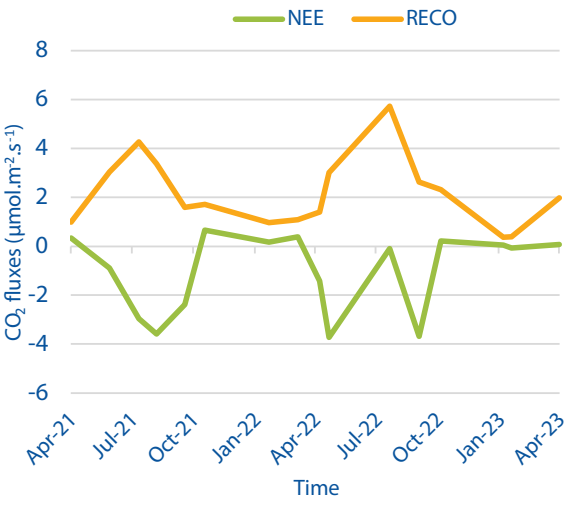
Restored Sphagnum – CH_4



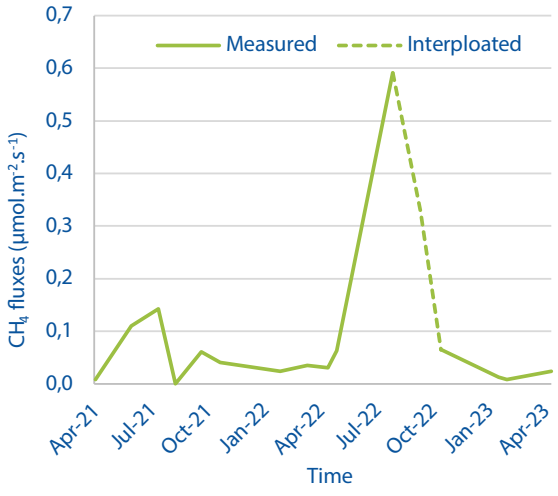
Restored Bare peat – CH_4



Restored Bare peat – CH_4



Control – CO_2



Control – CH_4

Figure 12. Time series of GHG fluxes in La Guette peatland.

3.2 Earth Observation analysis

Earth observation analysis was undertaken for the La Guette 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 located within the Upstream and Downstream plot areas. To provide a consistent time lag for further analysis, extracted index values were aggregated to quarterly averages.

On-site the downstream area was observed as wetter than the upstream area after stripping. This is reflected in generally higher observed Normalised difference moisture index (NDMI) and Normalised soil moisture index (NSMI) values, which provide a measure of vegetation and soil moisture respectively, during post-restoration transition from bare soil to plant growth. As shown in **Figure A** there is also evidence of greater seasonal variation in values for both areas post-restoration, in addition to greater similarity in index values, which may indicate some regularisation of conditions across sites through Sphagnum planting.

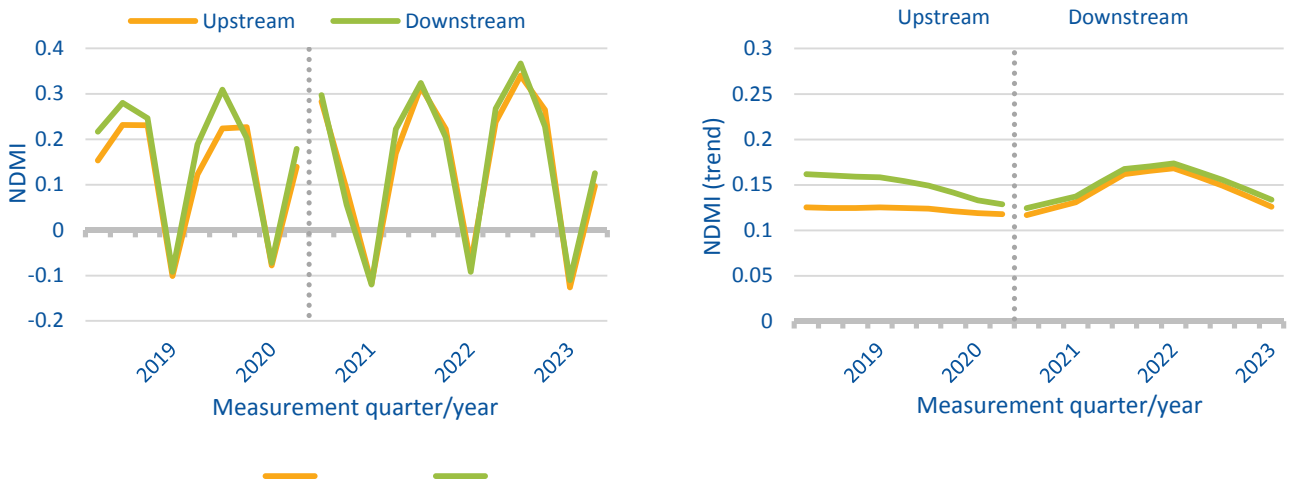


Figure A: Pre and post restoration variation in NDMI values (left) and decomposed trends (right)

Post-restoration patterns in vegetation indices, the Normalised difference vegetation index (NDVI) and Enhanced vegetation index (EVI) correlate to patterns observed for the respective moisture indices. While post-restoration NDVI and EVI values are generally higher for the downstream area, the difference in EVI values appears to be declining steadily over time (**Figure B**) which may also infer regularisation of vegetation conditions across both pilot sites. Further cross-validation will be beneficial to investigate the relationship between earth observation and on-site measurements and generate advanced indices and soil moisture/leaf condition models. Given the short post-restoration monitoring period, any relationships inferred here are currently indicatory.

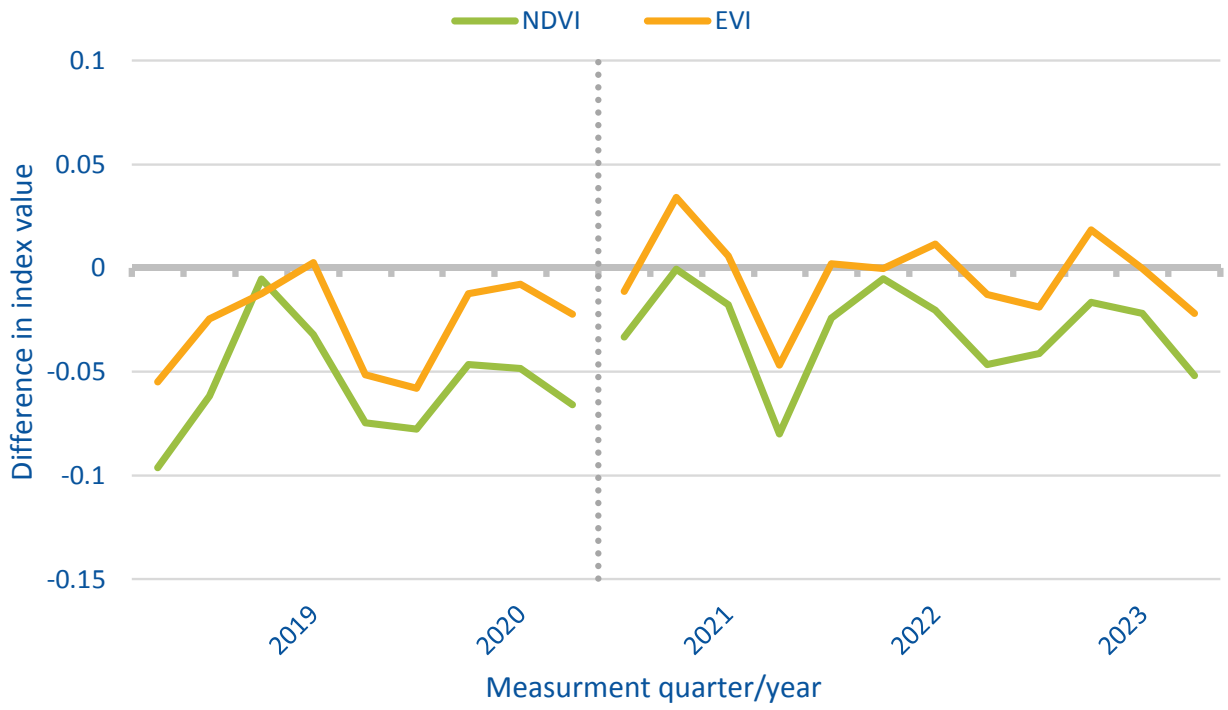


Figure B Pre and post restoration variation in NDVI and EVI values differences between pilot sites (Difference value = Upstream value – Downstream value)

3.3 Restoration results

Restoration actions were undertaken in two areas to test the effect of varying water table depth on *Sphagnum* growth. As expected, the *Sphagnum* patches tend to expand at a faster rate in the wettest area, which clearly confirms that good hydrological restoration maximises the chance for successful *Sphagnum* installation. Co-benefits were clearly seen with the rapid colonisation of the bare peat with typical plants of acidic fens, such as *Eriophorum spp, Rynchospora alba, Drosera spp.*, and many other graminoid species.

Concerning the *Sphagnum* installation, two techniques were implemented: the patch installation and the "stem by stem". The patch installation was clearly beneficial to the survival of *Sphagnum*. In contrast, *Sphagnum* installed "stem by stem" did not survive the extremely hot summers in 2022 and 2023.

Overall, the *Sphagnum* patches are expected to grow in the coming years. To support this, a large area has been stripped to limit the progression of *Molinia caerulea*. Whilst this species is currently growing, the relatively high water table should constrict growth in the future, and in turn stimulate further development of the planted *Sphagnum*. However, it should be noted, that overall restoration success is highly dependent on the frequency and intensity of droughts, which have been frequently observed in the region in recent years.

Stakeholder engagement

Stakeholder engagement was conducted through both web conferences (September, 2020 and 2021) and in person workshops (May 2023; Fig. 13 and 14) and attracted a positive and substantial response form a wide array of interested partners, spanning site managers to members of local authorities. Overall, Care-Peat engagement in France proved highly beneficial, by providing a hub to discuss good restoration practises, in addition to enabling the Pole Relais Tourbières (PRT) to disseminate information towards managers regarding the Low Carbon Label. This label, which is currently being defined by the PRT, will soon be released to promote French peatland restoration with a focus on C sequestration and storage.

Figure 13. Field visit of the La Guette peatland site in May 2023.

Figure 14. Workshop in May 2023 with managers on the French Low Carbon Label.

Overall conclusion

In the last ten years, peatland restoration and conservation has undergone a complete change of paradigm, from biodiversity driven actions towards C sequestration focused practises (involving hydrological restoration and biodiversity co-benefit). The Care-Peat project was a powerful engine that has driven this change forward. Through concrete action and large communication strategy within the framework of Care-Peat, the “before and after” pilot site demonstration at La Guette is now an important resource for French peatland restoration dynamics.

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