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Deliverable 3.1
Peatland inventory and mapping

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Peatland inventory and mapping

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With the collaboration of all the partners of the CARE-PEAT Project

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Synopsis

The INTERREG NWE CARE-PEAT project focuses on the reduction of carbon emissions and the increase of C-storage in peatlands by testing innovative technologies and methods on 5 pilot sites located in the North West Europe (Belgium, France, Great-Britain, Ireland, Netherlands). The main objective is to demonstrate and quantify CO_2 emissions and C-storage and by proposing restoration scenarios and solutions for the reduction of CO_2 emissions from peatlands, using advanced management tools developed from pilot sites.

These management numerical tools of peatlands use as input data some characteristics of the sites like:

- Digital Elevation Model;
- Water table and hydrologic data (river, drains…);
- Peat thickness;
- Distribution of the vegetation on the sites ;
- Carbon (CO_2 and CH_4) fluxes according to time;
- Temperature (air, soil);
- Chemical composition of water (DOC, major ions, pH, redox potential…).

This report lists the main data available on each site at the beginning of the project. A focus is done more specifically on the spatializing data in order to feed the future GIS (Geographical Information System)-based model. This review highlights that the level of knowledge of each site is very different. Some sites own long series of data with acquisitions starting since 2014 (for example in La Guette site…), whereas collection is just starting on other sites (like in Cloncrow site or Little Woolden Moss site).

However, these differences between sites is not problematic for the progress of the project. Indeed, the numerical models used for determining carbon fluxes will be first developed on the sites the more documented. The methodology developed on these sites will be useful for other sites. At last, this inventory is just a first step and obviously, the data acquired during the project will feed the numerical models.

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1. Introduction

Peatlands are complex ecosystems because their functioning is a mix of hydrological, biochemical and biological processes. Different methods are used to understand and predict their functioning regarding Carbon fluxes. In the INTERREG North-West Europe CARE-PEAT project, different measuring methods (on the ground, with drones and satellites) will be tested and related to each other to achieve producing an integrated numerical model which can predict C-emissions and sequestration in different peatlands and with a relative simple and applicable method.

However, before starting this data acquisition phase and developing a numerical model, a first step is to do an inventory of existing data on each site. Indeed, it is of main interest before the beginning of the project to determine the baseline and to have an overview of all existing data on the five pilot sites selected for the project.

This report is constituted by five chapters, each one dedicated to one pilot site of the INTERREG NWE CARE-PEAT project. All partners involved in the project contributed to this task by listing their respective available data. The collect is mainly focused on the data useful for the next model development, i.e.:

- Digital Elevation Model of each pilot site;
- Data of water table ;
- Peat thickness ;
- Hydrologic data (river, drains…);
- Distribution of the vegetation on the sites ;
- Carbon (CO_2 and CH_4) fluxes according to time ;
- Temperature (air, soil);
- Chemical composition of water (DOC, major ions, pH, redox potential…).

In this report, a specific focus is done on the spatialization of the available data. Indeed, during the project, a GIS (Geographical Information System)-based model will be developed in order to evaluate carbon fluxes at the peatland scale. The objective is to try to model the complexity of each site considering the heterogeneity of the parameters listed above. Better the site characterization will be, better the model prediction will be.

This report mainly focuses on the spatializing data of each site. However, additional information can be obtained in the complementary report WP T3 “Transnational preparation, implementation and demonstration of new techniques and methods to restore C-sequestrations in peatlands”.

2. Vallei van de Zwarte Beek (BELGIUM)

‘‘Vallei van de Zwarte Beek’’ is a large nature reserve located in Flanders. It is a unique preserved but degraded lowland peatland. This site is mainly degraded due to drainage, manmade structure (e.g. ponds, dikes, parcelisation,…). In this project, 250 ha will be restored to stop C-emissions and restore net C-storage. The restored zones are part of the seven green zones presented in Figure 1.

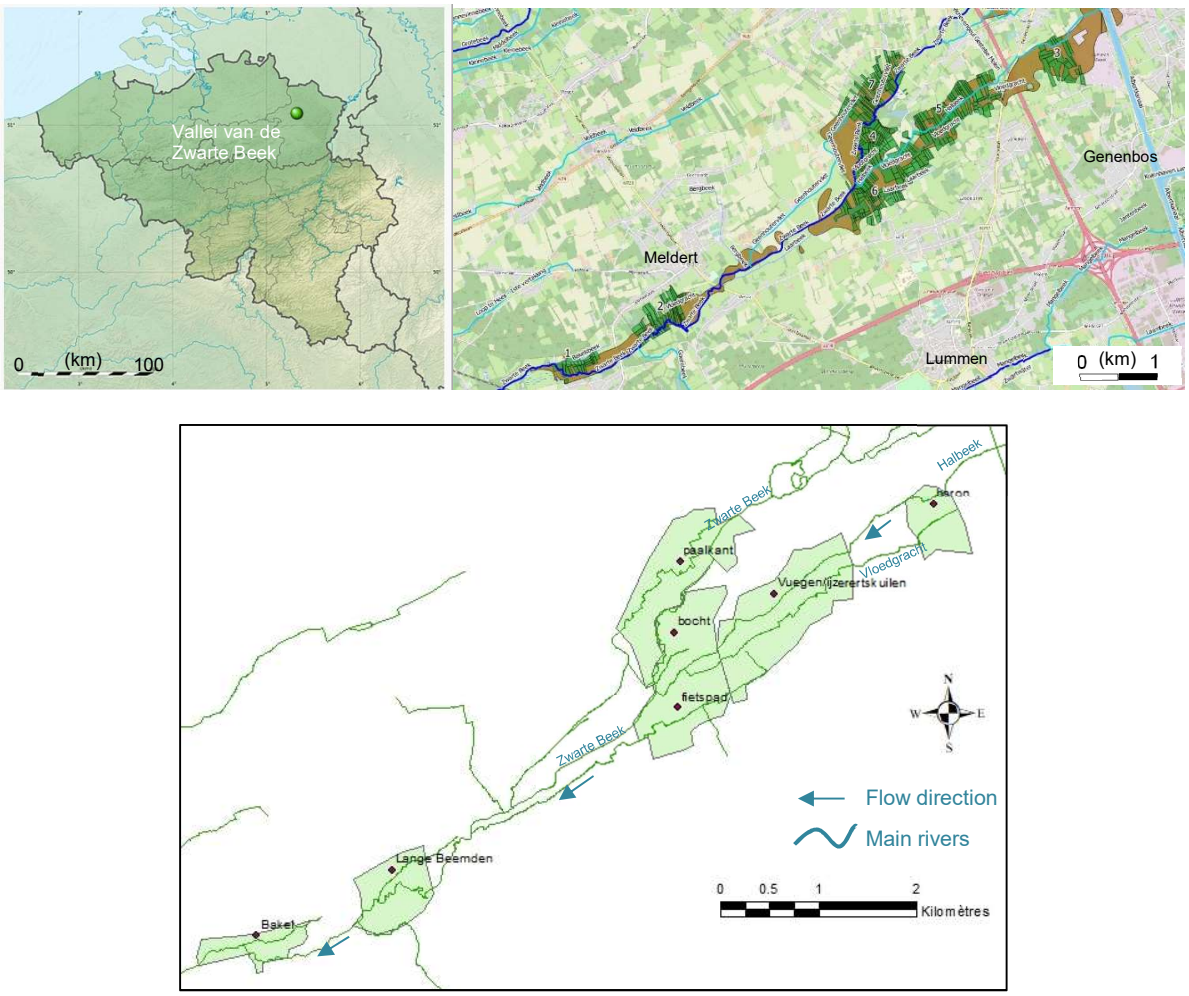

Figure 1 : Map of the Vallei van de Zwarte Beek site with the names of the seven restored zones

It is important to remark that a seventh zone more upstream is more preserved but still under influence of drainage. Restoration process started in 2014-2015 on this zone and will be refined during the CARE-PEAT project.

2.1. DIGITAL ELEVATION MODEL

The Digital Elevation Model is available for the entire pilot-site. The grid is available with an accuracy of 0.25 m. An overview of the Digital Elevation Model of the different patches is given in Figure 2.

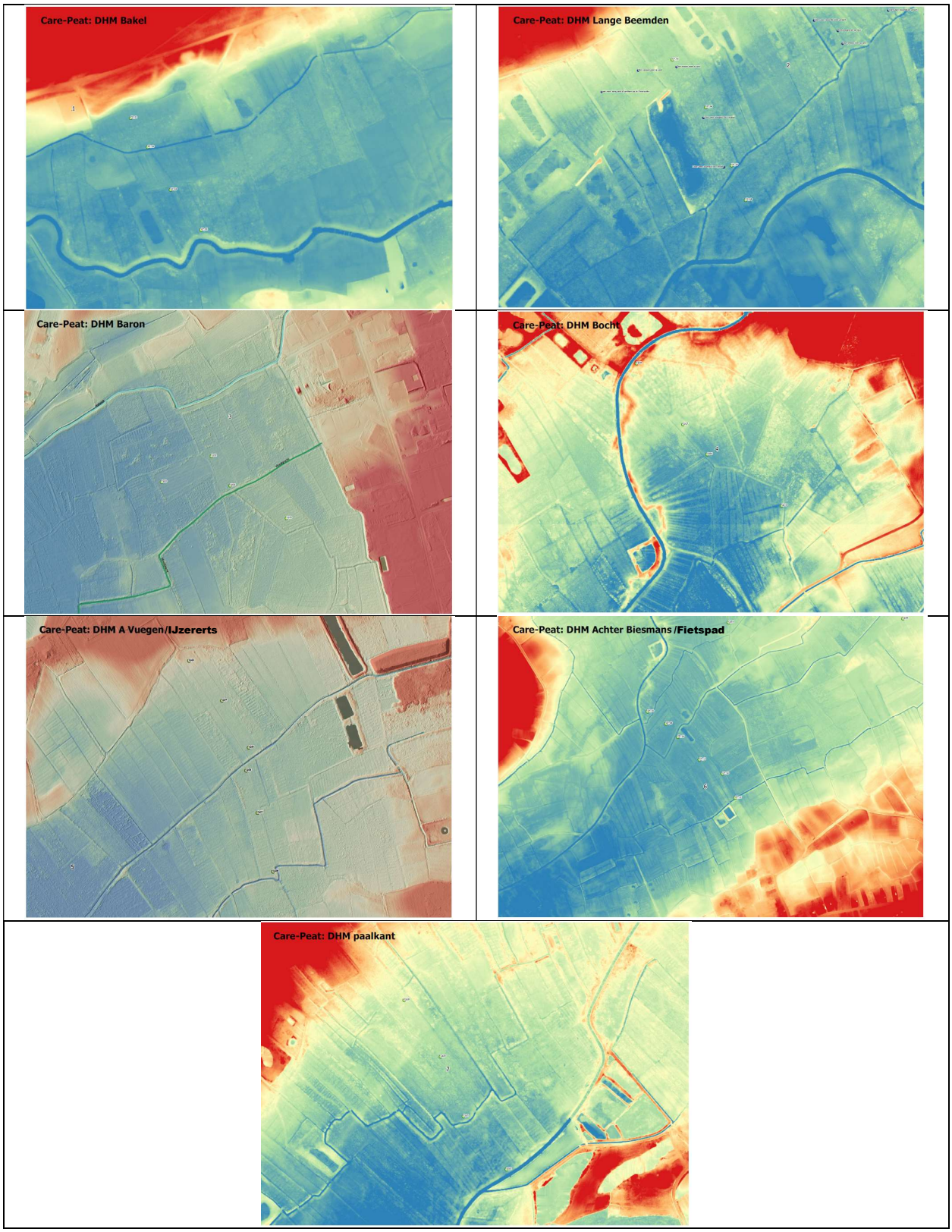

Figure 2 : Interpolation of the Digital Elevation Model for the seven restored zones of the Vallei van de Zwarte Beek site (In red the high elevation zones and in blue the lower zones)

2.2. PEAT THICKNESS

Peat thickness is mainly measured in the southern part of the site, in the patches of Baker and Lange Beemden (Figure 3). Other measurements were also done in the Paalkant zone. The average peat thickness is about 150-200 cm for the entire site but higher thicknesses (up to 700 cm) are observed in the deepest point 'paleovalley' (in the upstream of the Zwarte Beek Valley[1] not shown in the Figure 3). The peat thickness will not be measured on the entire site during the project. However, maps will be updated as soon this process is completed.

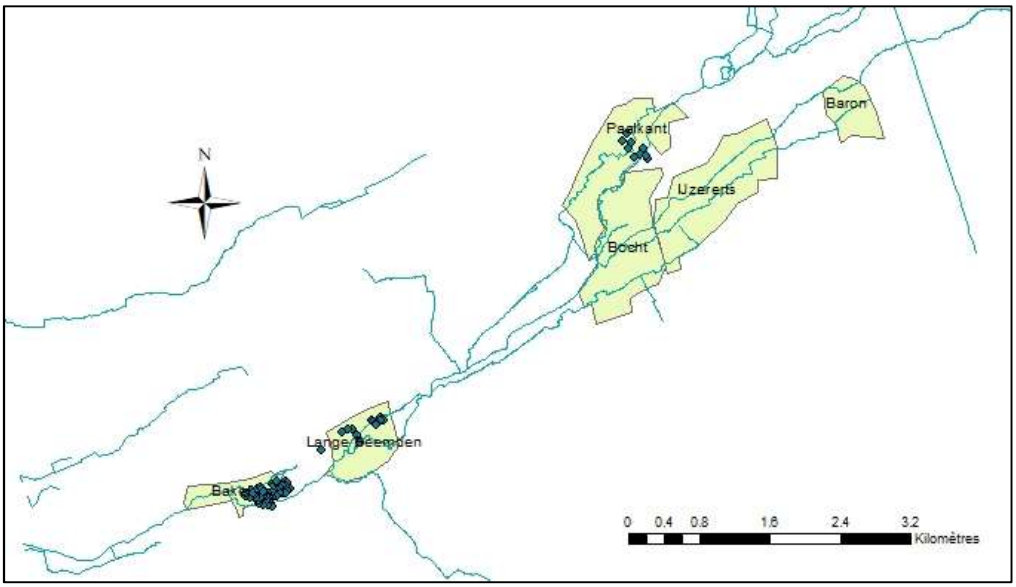

Figure 3 : Map of the measurement points (blue dots) of the peat thickness for the Vallei van de Zwarte Beek site. All the blue dots are surveys done.

2.3. VEGETATION SURVEY

Vegetation surveys were done during two campaigns, in April-May 2018 and in April to June 2019 (Figure 4). These data will be used and extrapolate in order to characterize the vegetation cover of each zone.

[1] F. AUGUSTIJNS (2019) - Holocene Vegetation Reconstruction of the Zwarte Beek Catchment, Campine Area (Belgium)APollen-based and Multivariate Statistical Approach. Thesis, KU Leuven and Gent University.

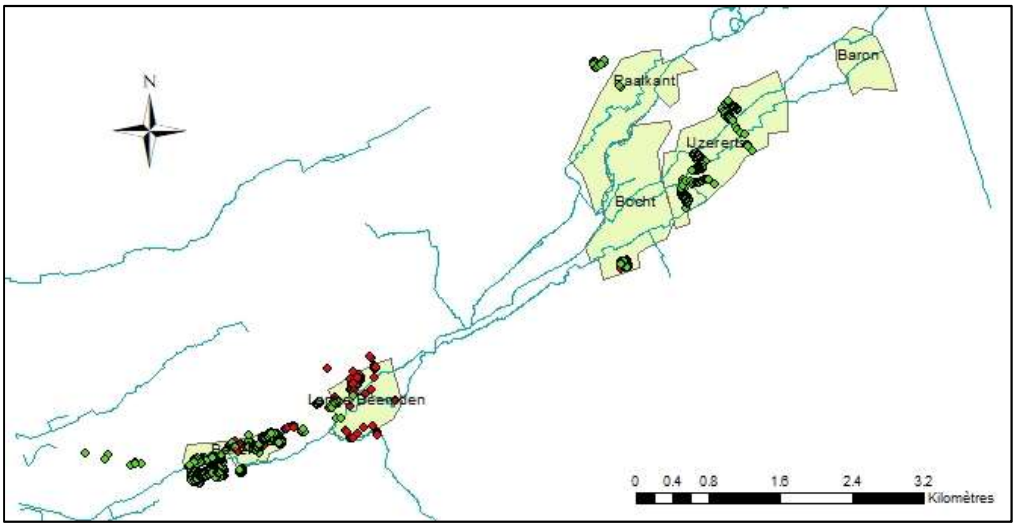

Figure 4 : Map of the vegetation survey for the Vallei van de Zwarte Beek site done in 2018 (red dots) and in 2019 (green dots)

2.4. CHEMICAL COMPOSITION OF WATERS

Chemical compositions of water (DOC, major ions, pH, redox potential…) are not measured regularly in the pilot area. However, soil and water samplings were made by MMU partner during summer 2019 and results are delivered by Manchester University (see report WP T3). These data will be used as inputs for models. Moreover, additional samples will be necessary to detect all external negative influences on the restoration process.

2.5. PERMANENT MONITORING

2.5.1. Water tables

Recently (July 2019), 35 piezometers are installed in mainly 8 locations (see Figure 5). The sensors measure aquatic pressure (with correction of the atmospheric pressure) and water temperature. Data are collected every few months. It is too early at this point to have data on the hydrologic network.

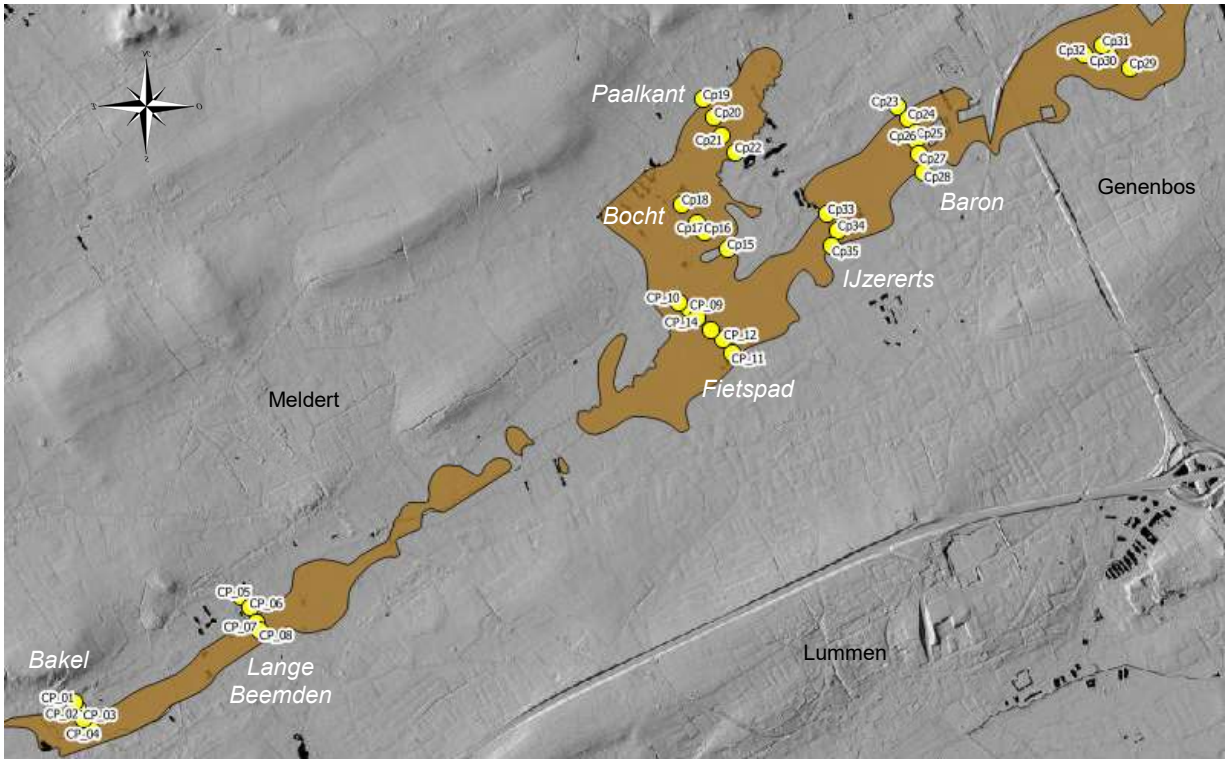

Figure 5 : Map of the main instruments installed on the Vallei van de Zwarte Beek site. Labels on yellow dots correspond to the names of the piezometers whereas white labels are the names of the investigated zones.

2.5.2. Meteorological measurements

Temperature of air and soil are not available, but groundwater temperature is recorded in the piezometers. Air temperature can however be delivered by VMM (Flanders Environment Agency), using weather and radar tower located nearby.

2.6. MISSING DATA

Carbon (CO_2 and CH_4) fluxes according to time are not yet measured.

3. La Guette site (FRANCE)

The La Guette peatland is a pilot site located in Sologne, in the Cher department, on the territory of the municipality of Neuvy-sur-Barangeon, 80 km south of Orléans (Figure 6). La Guette peatland is one of the four sites of the SNO-Tourbières (INSU-CNRS). All the sites of the SNO-Tourbières are part of OZCAR (French Observatory on the critical zone). The site was hydrologically disturbed decades ago by the construction of a road across the peatland. Restoration works were undertaken in 2014 to raise the water table depth. The site is equipped with an Eddy-covariance station since 2017 that continuously measures CO_2 and CH_4 fluxes and has been labelled to ICOS (Integrated Carbon Observation System) in spring 2019 as an associate site.

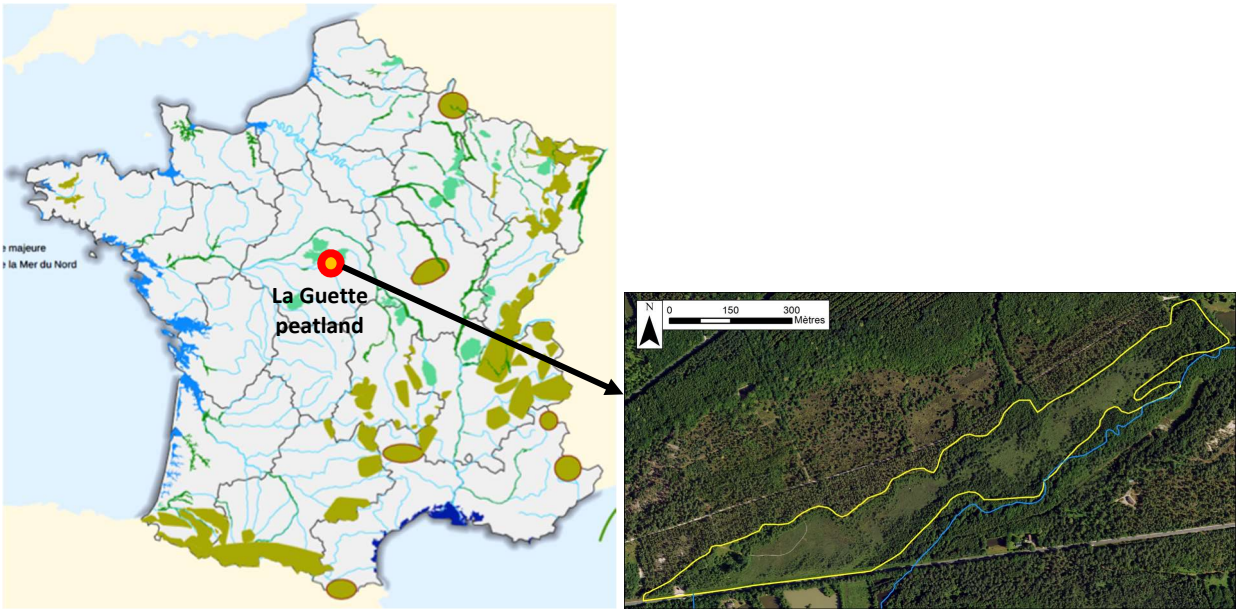

Figure 6 : Map of the localization of the La Guette site in France and aerian view of the site. Yellow line on the right figure delimits the peat zone.

The first purpose of this site is to set up a long term monitoring of C fluxes to estimate how the ecosystem will respond to environmental changes. The second purpose is to host scientific projects on specific questions in the frame of short term experiment or sampling.The site investigation started in the beginning of the 1990's, different data are already available.

3.1. THE DIGITAL ELEVATION MODEL

The total surface area of the site is 23 hectares. The extension is given in Figure 7. The digital Elevation Model exists for the entire zone. It is available with a grid of 2.7 m x 2.7 m. The altitude values range between 148.22 and 153.70 m AMSL[2]. Altitude data derive from field surveys.

[2] *Above Mean Sea Level*

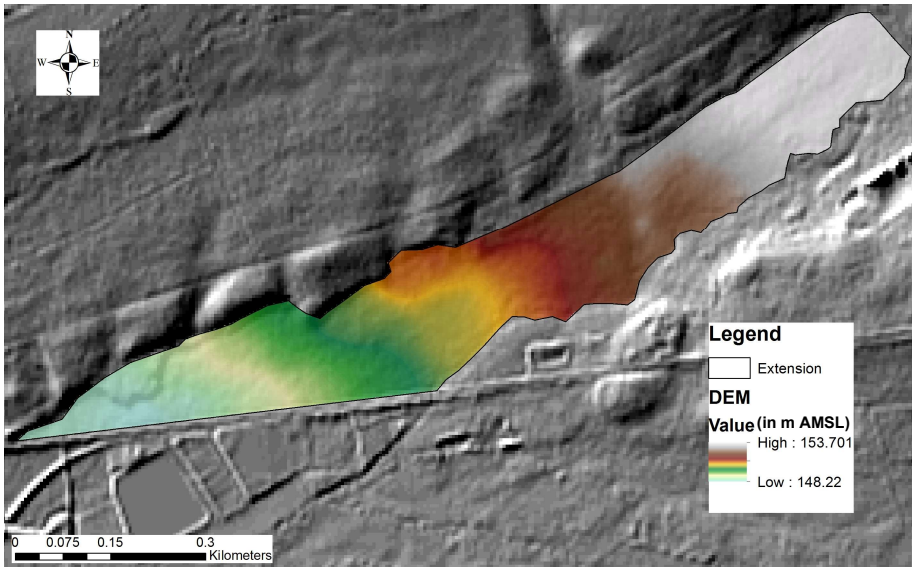

Figure 7 : Digital Elevation Model of the La Guette site

3.2. THE PEAT THICKNESS

The peat thickness was measured during a sampling campaign in 2004 (Figure 8). Surveys with an auger allowed to determine that the peat thickness mainly ranges between 40 and 100 cm with a mean value of about 80 cm. Figure 8 shows that the peat thicknesses are higher in the lower part of the peatland zone. The grid of the peat thickness was obtained by kriging.

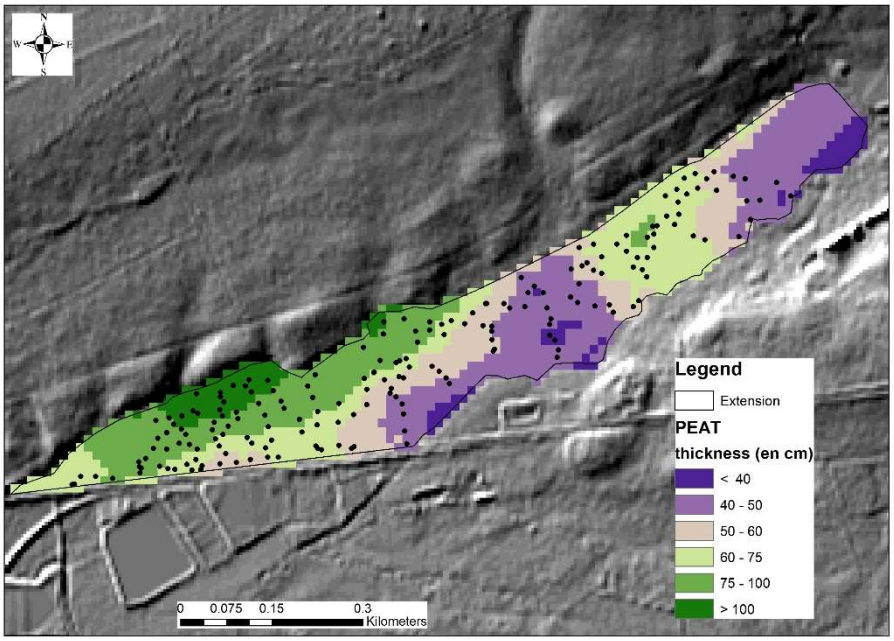

Figure 8 : Interpolation of the peat thickness for the La Guette site. All the black dots are surveys done with an auger.

3.3. CHEMICAL COMPOSITION OF WATERS

Chemical compositions of water (DOC, major ions, pH, redox potential…) are not measured regularly in the pilot area. However, soil and water samplings were made by MMU partner during summer 2019 and results are delivered by Manchester University (see report WP T3). These data will be used as inputs for models.

3.4. PERMANENT MONITORING

The site is instrumented with permanent instruments located in different parts of the peatland (Figure 9).

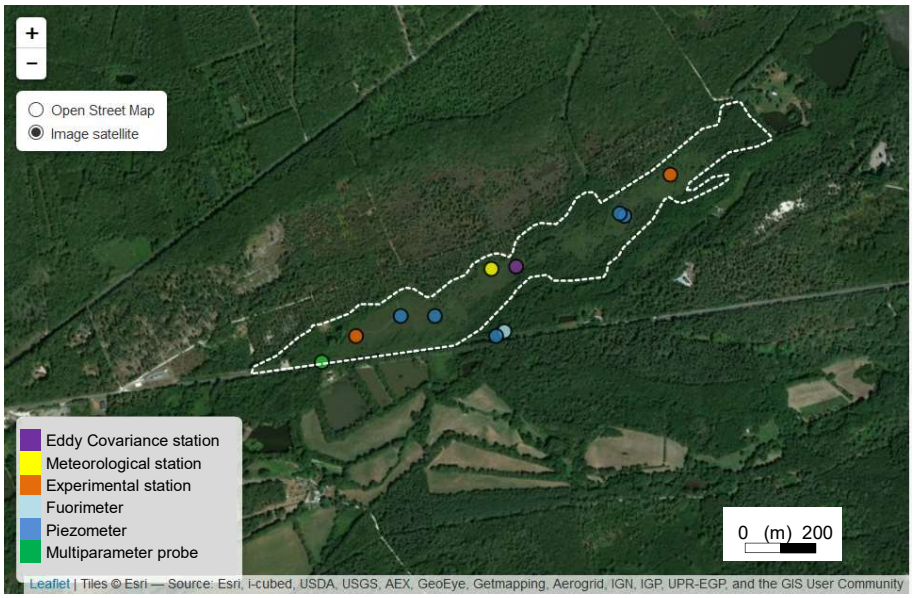

Figure 9 : Map of the main instruments installed on the La Guette site. The white dashed line delimits the extension of the peat zone.

3.4.1. The water table elevation

The water table elevation varies and depends on seasons, rainfall, temperature… Piezometers are installed in different places of the peatland since 2008. Monitoring of the water level is done in these different parts of the aquifer. These records exist and are available for each piezometer (Figure 10).

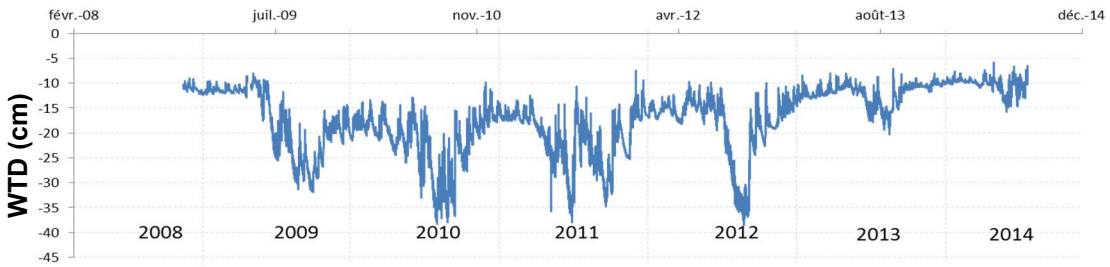

Figure 10 : Recording of the water level elevation at one of the piezometer installed in the center part of the La Guette site.

Piezometers measure regularly water levels in the peatland zone but they are few in numbers with respect to the total surface area of the peatland. It is then difficult to extrapolate the water level to other places. However, in 2004, i.e. before the hydraulic restoration of the site, a measurement campaign was done in order to determine the water level in different parts of the peatland (Figure 11). The water level during the spring 2004 was about 10 to 20 cm under the peatland surface. The grid of the unsaturated zone thickness was obtained by kriging.

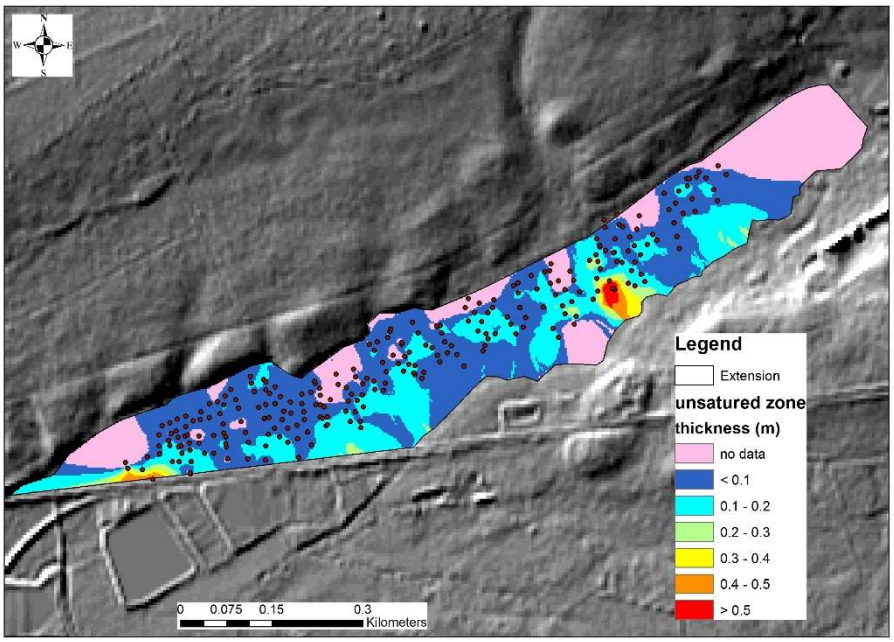

Figure 11 : Interpolation of the unsaturated zone thickness for the La Guette site. All the dots are surveys done in 2004.

3.4.2. The CO_2 and CH_4 emissions

Measurements of CO_2 and CH_4 fluxes are done since 2013 and 2014 on the site by closed chamber incubations. Since 2017, an Eddy-covariance station is also used to determine these fluxes (Figures 12 and 13).

Figure 12 : View of the eddy-covariance station installed on the La Guette site.

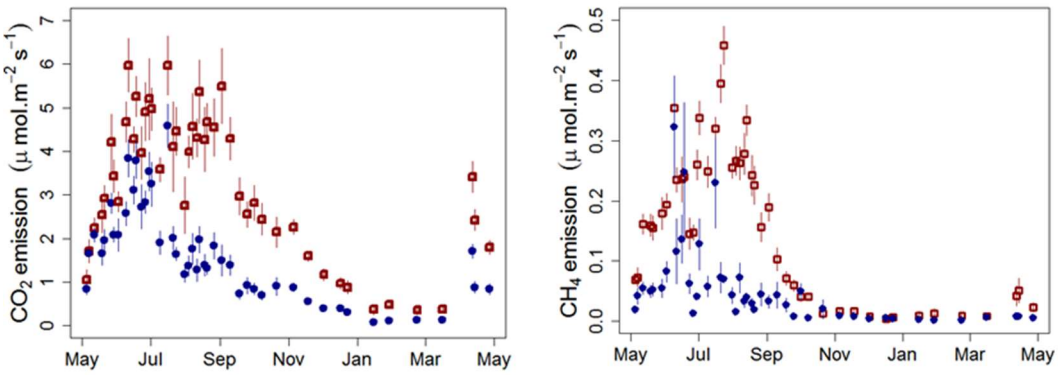

Figure 13 : Recording of CO_2 and CH_4 emissions on the La Guette site (May 2013 to May 2014).

3.4.3. Meteorological measurements

A meteorological station, located close to the eddy-covariance station, allows recording air and soil temperature, relative humidity, wind (direction and strength), photosynthetically active radiations, soil water content, rainfall, etc…

4. Winmarleigh Moss and Little Woolden Moss sites (GREAT-BRITAIN)

Two sites are selected in Great Britain in the CARE-PEAT project.

Winmarleigh Moss is a lowland raised bog situated in rural Lancashire. The 89 ha SSSI (Site of Special Scientific Interest) is surrounded by farmland, the drainage of which adversely impacts this restoration site, reducing C storage. Environments of this type are increasingly rare and much of the remaining bogland in Lancashire is in declining condition i.e. it is drying out and will eventually cease to be bog. 20 ha of reclaimed grassland adjoining the site is being purchased by LWT (Lancashire Wildlife Trust), on which a 4 ha Sphagnum farm and adjacent intermediate habitat will be created.

At the 107 ha Little Woolden Moss, a former peat-extraction site fully owned by LWT, ongoing restoration will be enhanced by a 2 ha pilot of companion species planting to upscale and demonstrate research findings on the C benefits of specific plant mixes.

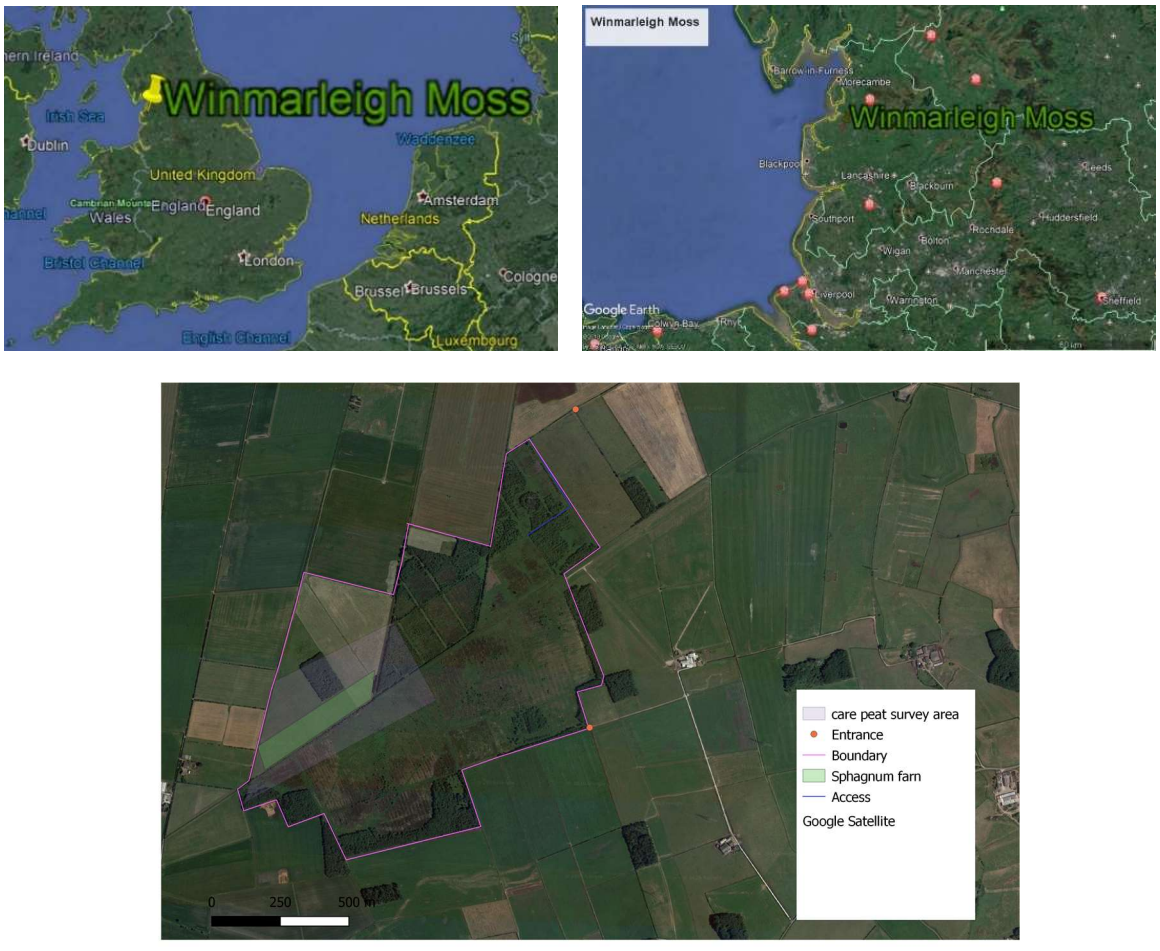

Figure 14 : Localization and map of the Winmarleigh Moss site.

Figure 15 : Localization and map of the Little Woolden Moss site.

4.1. AVAILABLE DATA

During the site visit in September 2019, surface water samplings are done in order to determine anions and cations for both sites. Metals concentrations in water and DOC are also measured. Data are available in the report WP T3. Soil samplings are also done and anions and cations concentrations are measured.

Much data is available for LWM from nearby plots, mainly meteorological data since early 2018. On nearby Sphagnum farming plots (about 200 m from the current site), CO_2, methane and water table are measured at least monthly since October 2018. We have further monthly greenhouse gases and water table data from a site on Astley Moss ~ 2km from LWM where CO_2 and methane are monitored over a range of vegetation types (this work was used to guide the species mix we will plant on LWM). Detailed information on these sites can be obtained from the Final report on project SP1210 released in 2017[3].

4.2. MISSING DATA

For the time being, water table levels are indicative but regular measurements will start soon. Indeed, for both sites, regular monitoring of water table data will commence in February 2020.

The average peat thickness is generally from 150 to 300 cm but new measurements will be done during the next site visits.

Hydrological data were acquired at the beginning of the project (summer 2019) with drone measurements.

Measurements of CO_2 and CH_4 fluxes will start in February 2020 for both sites.

[3] Chris Evans et al. (2017) - Final report on project SP1210: Lowland peatland systems in England and Wales – evaluating greenhouse gas fluxes and carbon balances. http://sciencesearch.defra.gov.uk/Document.aspx?Document=14106_Report_FINAL.pdf. Page 58 onwards.

5. Cavemount bog and cloncrow bog sites (IRELAND)

Two sites are selected in Ireland for the CARE-PEAT project. The first one is a former industrial bog, Cavemount Bog, 503.5 ha, that contains bare peat. This site will be mainly used for measurements, no investment. It will be used to realize adequate carbon modelling scenarios and to develop outcomes for alternative landscape strategies and scenarios.

The investment site is a degraded peatland, Cloncrow Bog (28 ha), that contains a raised and cutover bog (owned by sub-partner the National Parks & Wildlife Service - NPWS). The main restoration tasks are to plug the existing site drainage network via peat dams to restore hydrology and purchase (or compensation) of 5. Four ha of private lands adjoining the site to increase the restoration potential.

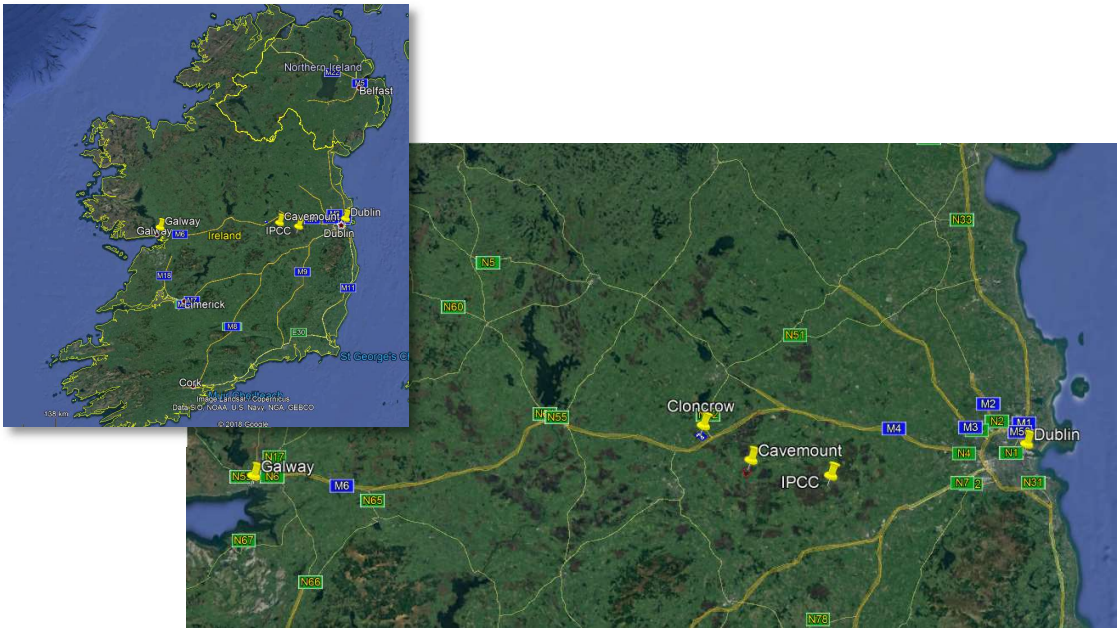

Figure 16 : Localization and map of the Cavemount and cloncrow sites.

Figure 17 : General location of the Cloncrow Pilot. Blue area : entire bog (a Natural Heritage Area) of ~200 ha; white zone : pilot site of ~26 ha

5.1. AVAILABLE DATA

At the Cloncrow site, three monitoring stations are installed. From June to November 2019, they collected hourly and since November collected at 15 min intervals for the following:

- Air temperature and precipitation, at one location (precipitation only since November 2019);
- Soil temperature and moisture (at 10 cm depth), at three locations;
- Water temperature and water levels at five locations (six beginning in January-February 2020).

The vegetation cover was determined for the Cloncrow site with an accurate characterization of species. However, we do not have a map about the spatial distribution of these species.

Chemical composition of water are available after the sampling and the measurements done by MMU partner. All the data are listed in the complementary report (WP T3) and these data will be used as input data for the models. Hypothesis on the extrapolation of these data to the entire peatland will be discussed in future reports.

5.2. MISSING DATA

Digital Elevation Models of each site are not available but this acquisition was done during the drone flight completed in October 2019. The data will be available soon.

Peat thickness varies from 3 to 5 m at the Cloncrow site but more accurate measurements will be done during the project.

The NPWS (National parks and Wildlife Service) is installing a flume for measuring discharge the December 17th at the site. Thus, collection is starting from this date.

Carbon fluxes will be acquired from the beginning of January 2020.

6. De Wieden site (THE NETHERLANDS)

The Dutch pilot in the CARE-PEAT project will be realized in the nature reserve “De Wieden”, part of ‘‘Weerribben -Wieden’’ in the Netherlands which is appointed as a Natura 2000 area. De Wieden is created by dredging of peat. This peat was dried on baulks (non-dredged strip) and used as fuel. This dredging of peat was applied from the 16th century till the 2nd World War.

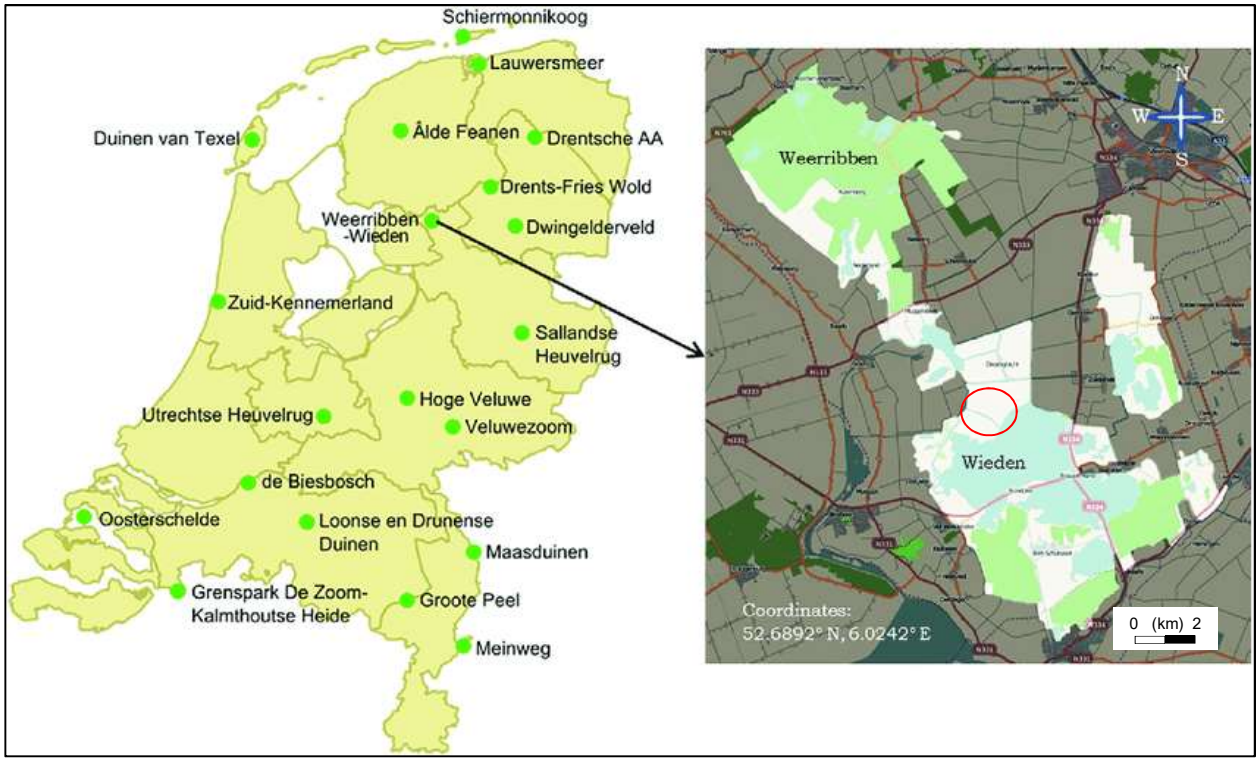

Figure 18 : Weerribben-Wieden National Park in a country map (from https://commons.wikimedia.org/w/index.php?curid=9965609). Red circle on the right figure delimits the restored zone.

6.1. DIGITAL ELEVATION MODEL

Digital Elevation Model is available both :

- With a 0.5 meter resolution. It is given in [m + NAP] (NAP = Normaal Amsterdams Peil) which can be approximated to sea level;
- With a 5 meter resolution, for a larger extent. Elevation is also given in [m + NAP].

The Figure 19 integrates the following information:

- The green zones, the peat pits to be excavated in the CARE-PEAT project. The actual position may be slightly changed during the excavation works;
- The orange zone, the foreshore.

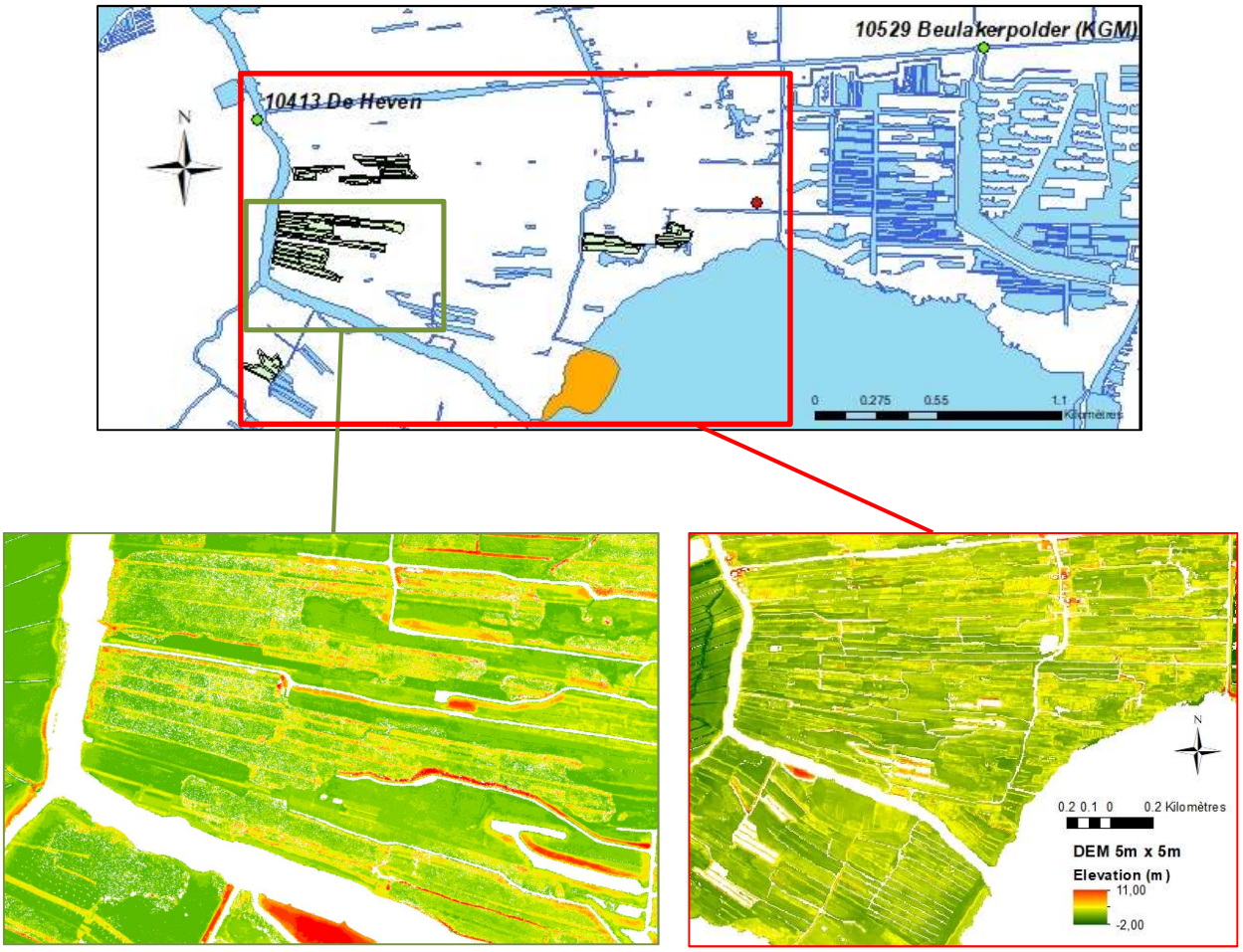

Figure 19 : Map of De Wieden site (top figure): Red dot : the meteorological station; Green dot : piezometric station; Green patches : future restored places ; Orange polygon : submerged peat. Bottom left : Digital Elevation Model (0.5 m x 0.5 m) centered on the future excavated peatland zone. Bottom right: Digital Elevation Model (5 m x 5 m) of a larger part of the peatland zone

6.2. VEGETATION SURVEY

A complete comprehensive vegetation map of the site is available, surveyed according to a Dutch standard protocol.

6.3. CHEMICAL COMPOSITION OF WATERS

Chemical compositions of water (DOC, major ions, pH, redox potential…) are not measured regularly in the pilot area. However, soil and water samplings were made by MMU partner during summer 2019 and results are delivered by Manchester University (see report WP T3). These data will be used as inputs for models

6.4. PERMANENT MONITORING

6.4.1. Water tables

Groundwater is not measured in the pilot area itself, but datasets exist on the surface water levels in the surroundings of the peat pits. They are available as .csv file on three sites (Figure 19):

- De Heven station, 6060 data from 2003 to 2019. Water levels are ranging between -0.53 to -0.89 m;
- Beulakerpolder (KGM) station. 4971 data are available, from August 2005 to November 2019. Water levels are ranging between -0.70 to -0.89 m ;
- Weldweg station (not shown on Figure 19). 6526 data are available, from November 1999 to November 2019. Water levels are ranging between -0.66 to -0.88 m. This location is further away than the two previous ones, but it could be used to study the water level variations in the region.

6.4.2. Meteorological measurements

2 relevant meteorological stations of the Dutch meteorological survey (KNMI) are available on the site:

- a full weather station with a broad set of variables.
- a precipitation station which is closer to the study area (see red dot in Figure 19).

Data of the meteorological stations are available for the last 20 years (since 1999-11-01 to present).

6.5. MISSING DATA

The peat thickness is not yet measured in detailed. Peat thickness is expected to be within the range 0.5-1.5 meters. New measurements will be done during the project.

Carbon (CO_2 and CH_4) fluxes according to time are not yet measured.

7. Conclusions

Before starting the INTERREG NWE CARE-PEAT project and the data acquisition phase, a first step is to make an inventory of existing data on each site. Indeed, these data are of main interest because they constitute the baseline for each site and they are essential inputs for the future development of numerical models.

This report lists the main data available on each site. This review highlights that the level of knowledge of each site is very different. Some sites own long series of data with acquisition starting since 2014 (for example in La Guette Peatland), whereas collection is just starting on other sites (like in Cloncrow site or Little Woolden Moss site).

This review (complementary to the report released in WP T3 Transnational preparation, implementation and demonstration of new techniques and methods to restore C-sequestrations in peatlands) clearly shows that information exists on each site, but these data are often punctual, i.e. on a specific location of the site. These data do not reflect the heterogeneity of the sites, for example in terms of peat thickness or water table. It will be a real challenge during the project to interpolate data and to be able to estimate fluxes at the site scale from localized data.

However, these differences between sites is not problematic for the project progress. Indeed, the numerical models used for determining carbon fluxes will be first developed on sites the more documented and the methodology developed on these sites will be useful for other sites. At last, this inventory is just a first step and obviously, the data acquired during the project will feed the numerical models.

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