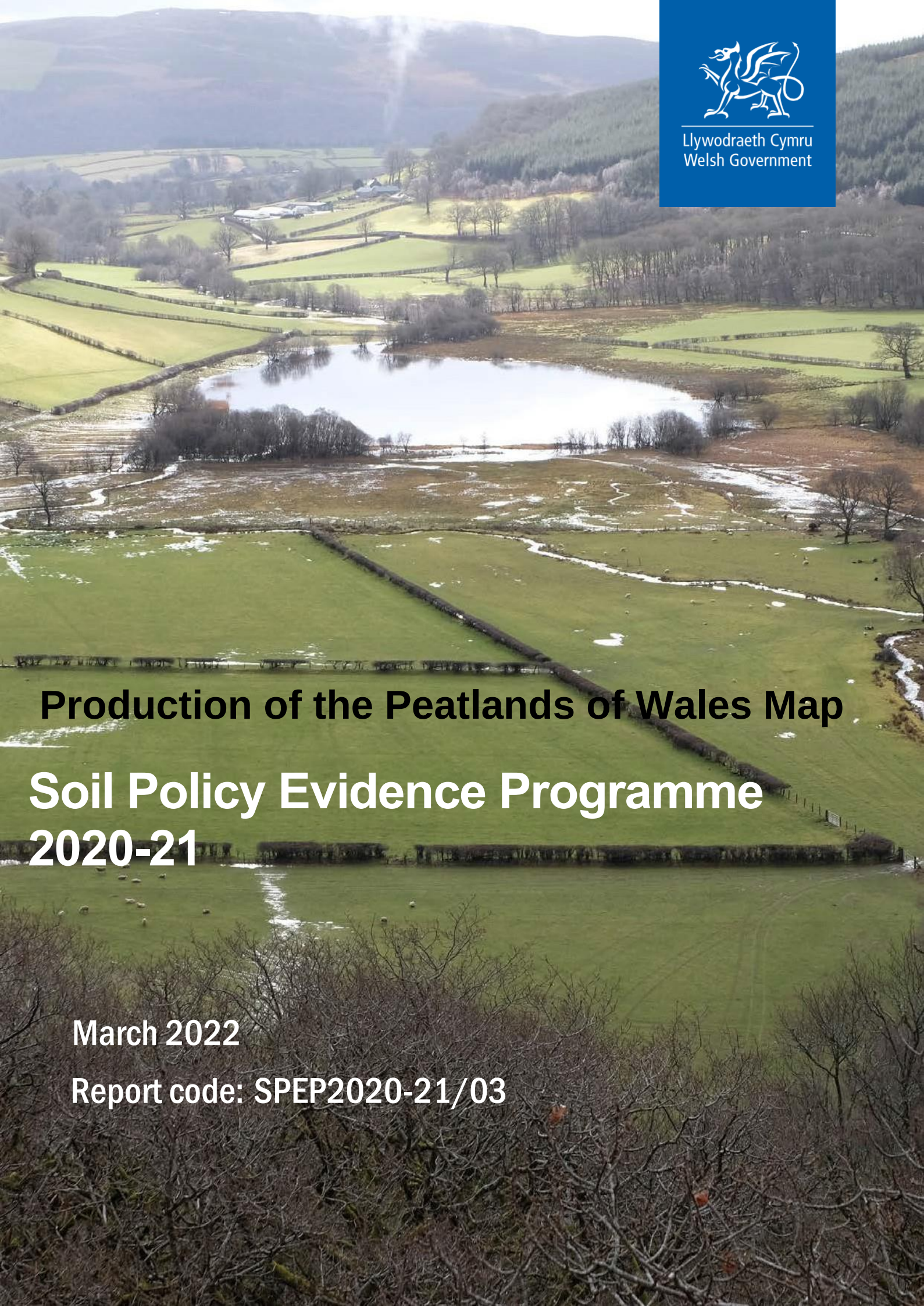

Llywodraeth Cymru
Welsh Government

# Production of the Peatlands of Wales Map

# Soil Policy Evidence Programme 2020-21

March 2022

Report code: SPEP2020-21/03

# Contents

# Figures

# Tables



*Cover Illustration: This image shows a soil pit dug on the Crowdy series at Llanwthwl, Powys (SN 960 610) by Richard Hartnup for the National Soil Inventory.*

# 1 Introduction

Peatlands in Wales are a large natural store of carbon, support key habitats and species, and can hold large volumes of water. However, in many areas in Wales the peat is in unfavourable condition, which limits the delivery of these benefits. The National Peatland Action Programme (NPAP), an initial five-year peatland restoration programme for Wales, was launched in 2020 by the Welsh Government and is being delivered by Natural Resources Wales (NRW). For effective targeting and monitoring of peatland restoration, a baseline of the peatland area is required. The Unified Peat Map of Wales was produced in 2015 (Evans et al., 2015) from several available peat data sources. Since then, a significant amount of additional data from detailed soil survey records and specific point survey observations of peat presence and depth has been made available. This project used the additional detailed data sources and the original data used in the Unified Peat Map to produce an updated map of the Peatlands of Wales. The new Peatlands of Wales map represents a compilation of existing data sources that maps the peatland areas in Wales, and estimates peat depth, carbon stock (store) and greenhouse gas emissions.

The new peat map was developed on a 50m grid specification from the Welsh Government. This matched the scale used in recent maps produced to assist policy such as the Soils of Wales (Keay, 2020) and the predicted Agricultural Land Classification (Welsh Government 2020). The Peatlands of Wales map is intended to be used as a 'living map', where a 50m grid can be updated with new information when it becomes available through monitoring, surveys and measurements of peat presence, depth, condition, carbon stored, and greenhouse gas (GHG) emissions. It will help NRW to identify areas warranting dedicated peat surveys to further elucidate the peatland resource in Wales as well as to identify opportunities for and potential outcomes of restoration under the National Peatlands Action Programme (NPAP). It can also be used as a dataset to develop and validate peatland area and depth estimates that have been predicted from models or remote sensing.

The project produced (i) a new national peatland map of Wales which incorporates new relevant Soil Survey of England and Wales (SSEW) mapping evidence and other suitable peat mapping evidence, (ii) estimates of peat depth from available information (iii) estimates of carbon stocks based on peat carbon data and peat depth and iv) estimates of greenhouse gas emissions from peatlands based on standardised emissions from peat under different habitats and land use.

# 2 Peat definition

Peat soils are defined by the Soil Survey of England and Wales as soil profiles containing >40cm of peat (examples include the Adventurers', Altcar, Crowdy, Floriston, Hepste and Winter Hill soil series). This definition also includes alluvial soils that have mineral horizons over deep peat (Wensum and Midelney series). The major group of peat Soils are defined as organic soils derived for the most part from partially decomposed plant remains that accumulated under waterlogged conditions.

Peat Soils are required to have (Avery, 1980):
1. More than 40cm of organic (O horizon) material within the upper 80cm, excluding fresh litter and living moss; or
2. More than 30cm of organic (O horizon) material resting directly on bedrock (R or Cr) or skeletal material (in situ angular broken-up rock).

This thickness (>40cm, except over rock or very stony material when it is >30cm) differentiates peat soils from organo-mineral soils that have peaty topsoil and mineral subsoils (such as Podzols). The definition of peat soils, having a thickness of more than 40cm of organic material within the upper 80cm of a soil profile, resulted from the extensive field observations of experienced soil survey staff during the field mapping of regional and national surveys (Cranfield University, 2022b). The definition is in accordance with international soil classification systems (e.g. the World Reference Base for Soil Resources, see below). It also fits the concept of the 'Reference Section' as defined by Clayden and Hollis (1984, p24), which underpins soil series definitions across England and Wales. The Reference Section is the depth to which diagnostic features and properties are assessed in order to derive the classification of the soil. The Reference Section for fundamental soil properties is 80cm or the depth to coherent rock, rock rubble or gravel, whichever is the shallower. Terms used to characterize the diagnostic properties of soil types thus tend to be based on those within at least half of this depth (40cm). The depth of 80cm was not an arbitrary selection but can be equated to a depth within which the majority of vegetative root systems, including trees and their associated mycorrhizal networks occur (Dobson, 1995). It ensures that the diagnostic characteristics used to define soil types are relevant for any type of vegetative cover and the ecosystems associated with them (including natural, semi natural and agricultural systems). This definition also aligns with international soil classification systems. The World Reference Base (WRB) for Soil Resources (IUSS Working Group, 2014), an international soil correlation system, also defined Peat soils as having organic material greater than 40cm. In WRB peat soils are referred to as Histosols and defined as follows:

World Reference Base for Soil Resources definition of Peat soils
Histosols have organic material starting <=40cm from the soil surface and having within <=100cm of the soil surface a combined thickness of either:
(i) >=60cm if =>75% (by volume) of the material consists of moss fibres; or
(ii) =>40cm in other material.

# 3 Data Sources

Several sources of peat data were drawn together to establish the new map of peatlands in Wales. Table 1 lists the map sources and further descriptions of each data source are provided in the following sections.

*Table 1 Primary data sources used for the development of the new Peatland of Wales map*

| Owner | Data Source | Citation |
|---|---|---|
| Cranfield University (CU) (data held in the Land Information System LandIS) | National Soil Map (NATMAP) | Rudeforth et al (1983) |
| | Published and Unpublished Detailed Soil Mapping | |
| | Detailed soil mapping of Wales | Keay (2020b) |
| | Rabbit Squares | Trout et al (2000) |
| | Farm Mapping | Keay (2020b) |
| | Surveyed Site Data | |
| | National Soil Inventory | McGrath and Loveland (1992) |
| | Auger bores | Burton (1983) |
| | Soil Pit profiles | Rudeforth et al (1983) (examples) |
| British Geological Survey (BGS) | BGS Geology: 50k dataset (V8) - Superficial Peat | (Armstrong et al, 2016) |
| | BGS Onshore GeoIndex boreholes: Records of boreholes, shafts and wells from all forms of drilling and ground investigation work. Includes scans of paper records and digital records (including AGS). | BGS Onshore GeoIndex https://www.bgs.ac.uk/datasets/boreholes-index/ |
| Natural Resources Wales (NRW) | Phase 1 Habitat Survey | Blackstock et al (2010) 'All Wales Phase 1 Terrestrial - Mosaic Layer Voronoi' |
| | Forestry Commission Soil Map | Pyatt, 1982; Kennedy, 2002 |
| | Phase 2 Lowland Peatland Survey of Wales (2020 Deep Peat) | Bosanquet et al (2013) |
| | NRW Peat Depth Dataset | |
| ADAS | Peatland Condition Survey | Forster Brown & Shepherd (2021) |
| Welsh Government | Agricultural Land Classification (ALC) Point Data | Keay (2020a) |

## 3.1 Cranfield University (CU)

### 3.1.1 National Soil Map (Soil Survey of England and Wales)

**Associations dominated by peat**

The National Soil Map (NATMAP) is a 1:250,000 scale map of England and Wales, showing the locations of 297 geographic soil associations identified by the most frequently occurring soil series and by combinations of ancillary series. The national map was divided into six regions which were each accompanied by a bulletin providing detailed information on the soil associations (Rudeforth et al 1984). The proportions of soil series in each soil association have been modified from the national proportions using the knowledge of local soil surveyors to better reflect the situation in Wales.

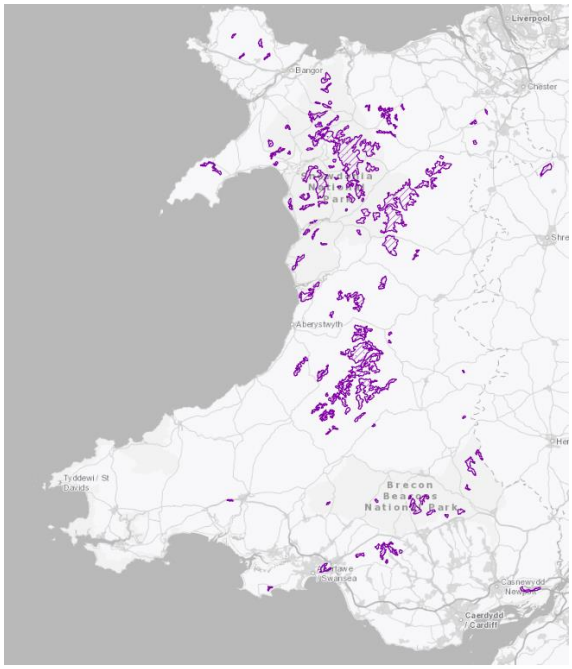


*Figure 1 National Soil Map Associations dominated by peat*

The soil associations dominated by peat soil series (comprising 50% or greater of the association) on NATMAP were selected (Figure 1 and Table 2). The minor peat series are mentioned in the soil association description in Rudeforth et al 1984 but covered less than 5% of the association and are not included in the standard soil series components for the association. The exact location of peat within these mapped areas cannot be spatially resolved from the NATMAP but where other data sources have identified areas of peat they act as a corroboration that peat could exist at that location as described in section 4.

*Table 2 Soil Survey of England and Wales (SSEW) National Map Associations dominated by peat. % values relate to the % cover of the Series within the Association based on Welsh data.*

| Map Unit | Association Name | Peat soil Series (% cover within association based on England and Wales data) | Non-Peat Series (%) | Minor Peat Series (<5%) |
|---|---|---|---|---|
| 813a | Midelney | Midelney (55%), Wensum (15%) | Windrush (10%) Fladbury (10%) | Altcar and Adventurers |
| 1013a | Crowdy 1 | Crowdy (59%) | Wilcocks (10%) Hafren (10%) Skiddaw (7%) Hiraethog (5%) | Winter Hill, Hepste |
| 1013b | Crowdy 2 | Crowdy (50%), Winter Hill (15%), Floriston (5%) | Hiraethog (10%) Laployd (10%) Manod (2%) | |
| 1022a | Altcar 1 | Altcar (50%) Adventurers' (30%) | | Midelney |

| Map Unit | Association Name | Peat soil Series (% cover within association based on England and Wales data) | Non-Peat Series (%) | Minor Peat Series (<5%) |
|---|---|---|---|---|
| 1024a | Adventurers' 1 | Adventurers' (70%), Altcar (30%) | | |
| 1024b | Adventurers' 2 | Adventurers' (60%), Altcar (20%) | Isleham (20%) | |

### Associations with peat as a sub-dominant (secondary) series

These soil associations are dominated by a non-peat soil but an ancillary soil is identified as a Peat soil (covering at least 5% of the association; Table 3). The exact location of peat within these areas cannot be spatially resolved from the NATMAP but where other data sources have identified areas of peat they act as a corroboration that peat could exist as described in section 4.

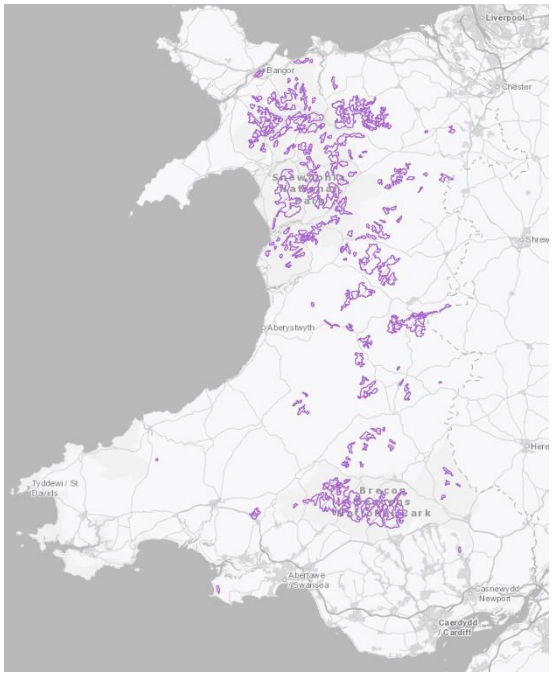


*Figure 2 SSEW National Map Associations with peat as a sub-dominant series*

*Table 3 SSEW National Map Associations with peat as a secondary series. % values relate to the % cover of the Series within the Association based on Welsh data.*

| Map Unit | Association Name | Main Peat Series (%) | Non Peat Series | Minor Peat Series |
|---|---|---|---|---|
| 311a | Revidge (30%) | Crowdy (20%) Winter Hill (20%) | | |
| 311b | Skiddaw (40%) | Winter Hill (10%) | Hiraethog (25%) | Hillside flushes - Wilcocks/Longmoss |
| 311e | Bangor (40%) | Crowdy (15%) Winter Hill (15%) | | |
| 721d | Wilcocks 2 (50%) | Crowdy (15%) Winter Hill (15%) | Hafren (10%) | |
| 721e | Wenallt (70%) | Crowdy (15%) | Cray (10%) | |
| 861b | Isleham 2 (31%) | Adventurers' (29%) | Ollerton (20%) Blackwood (20%) | |
| 871a | Laploy d (55%) | Crowdy (10%) | Fordham (20%) | |

### 3.1.2 Detailed soil mapping of Wales

Over the years, many detailed maps were created by the Soil Survey of England and Wales. These were originally mapped at a scale of 1 inch to a mile (1:63,360 scale) but later covered 10 x 10km areas at a scale of 1:25,000. These maps were combined in the Soils of Wales map as part of the Capability, suitability and climate programme (CSCP02) (Keay 2020b). Areas identified as peat soil series were extracted from this map (Figure 3).

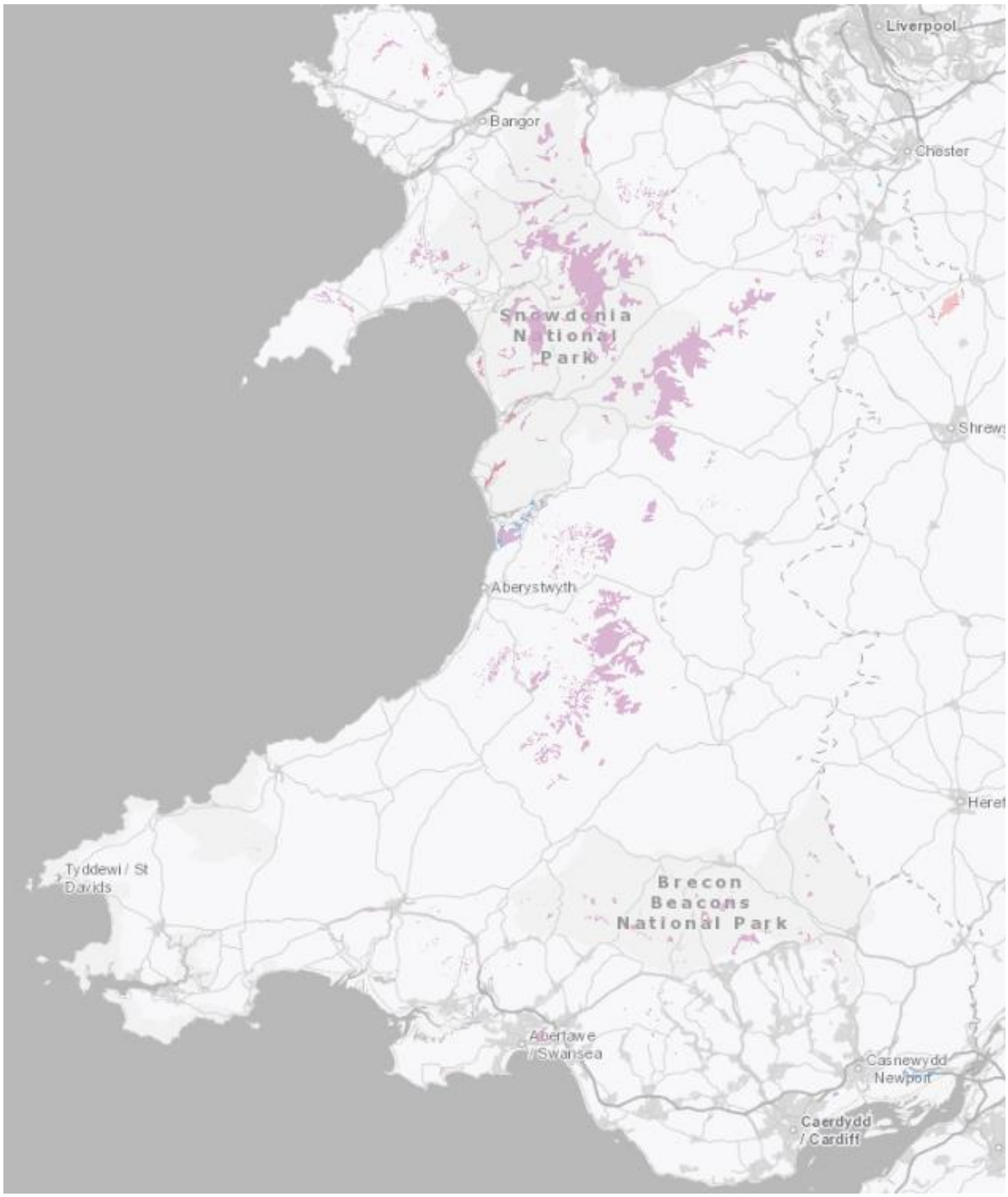


*Figure 3 Areas of peat on published detailed soil mapping at 1:25,000 and 1:63,360 scale*

### 3.1.3 Farm maps and “Rabbit” Squares

In addition to the published sources of more detailed soil data, Cranfield University also hold several unpublished soil maps at a farm scale These were digitised as part of the CSCP programme (Keay, 2020b). Other detailed surveys include 50 1km soil surveys undertaken as part of the MAFF National Rabbit Survey 1980-86 (Trout et al, 2000). Only 6 of the 50 “rabbit” squares in Wales have some peat identified in the 1km survey square. (Figure 4).

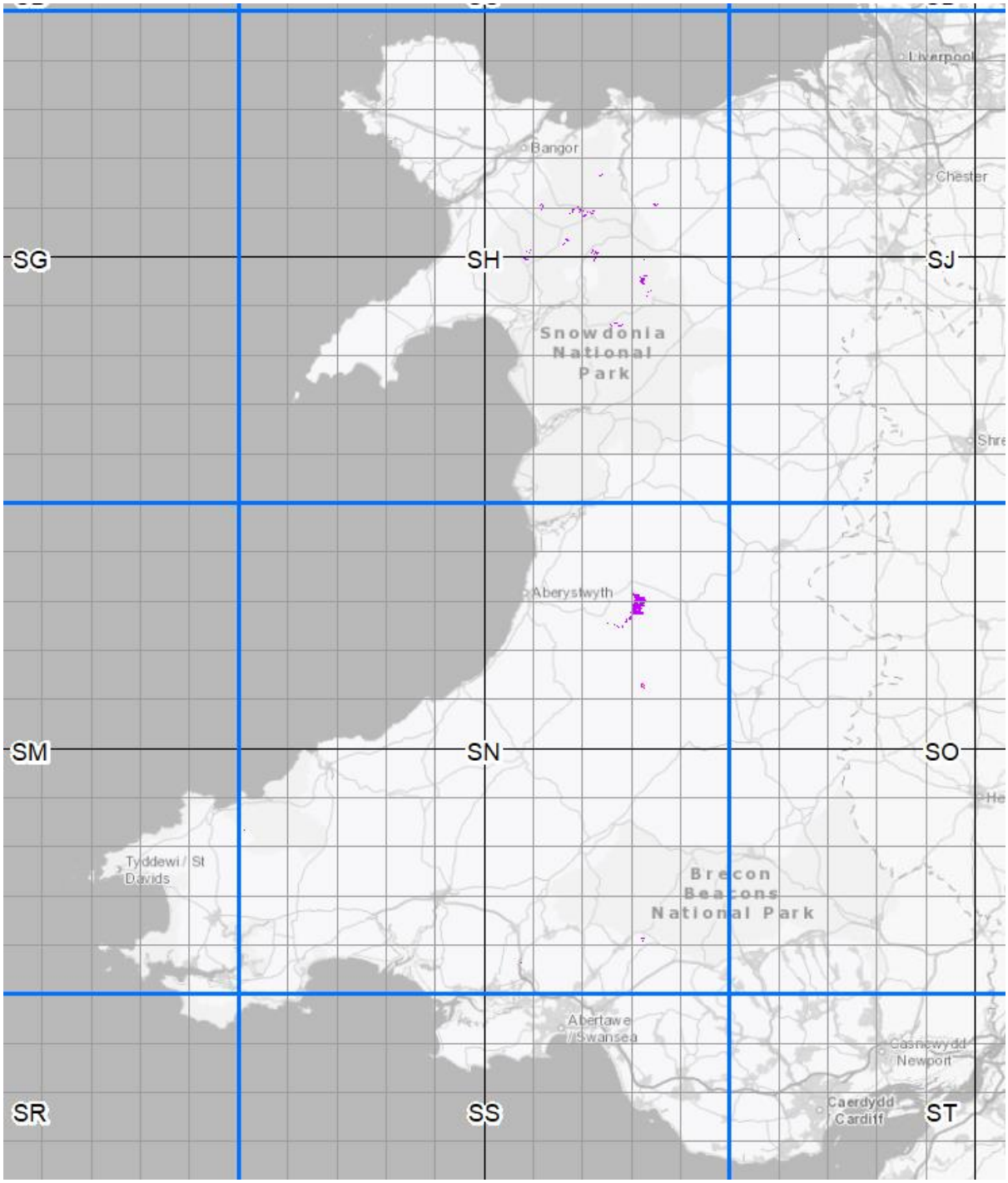


*Figure 4 Area of peat from SSEW Farm mapping and 1km “Rabbit” Squares*

### 3.1.4 Surveyed Site Data

In the Land Information System (LandIS) Cranfield University holds extensive data recorded in the field by soil surveyors and written up in notebooks or on standard recording cards. Much of this data has been captured digitally and is held in various datasets. These records represent point data from surveyors' direct observation and interpretation of the soil at specific locations in the landscape. Information used in this project from these records are 1) identified peat soil series at the location 2) depth of peat 3) organic carbon and bulk density of the peat soil series. The following lists the main sources of site data that contributed to the Peatland of Wales map with links to further information provided:

- National Soil Inventory (NSI) (LandIS National Soil Inventory)
    - NSI data covers England and Wales on a regular 5 km grid and provides detailed information of the soil series and a soil profile description for each intersect of the grid. It also contains samples and analysis of the soil at the location for the topsoil (0-15cm). Information extracted: soil series (for peat presence) and peat depth. Analytical information from the soil sample was used to characterise the organic carbon content for peat soils.

- Auger Bore Records (LandIS Auger bores)
    - The Soil Survey of England and Wales surveyed many sites during its active years of mapping, describing and sampling soils between 1939 and 1987.
    - The standardised field description cards were designed to cater for semi-detailed, detailed and ad hoc surveys.
    - The Auger Bore records capture the soil series and description of the soil profile examined by auger bore.
    - Information extracted: soil series (soil characterised as a peat soil and used to determine peat presence) and peat depth (where the depth of peat is also captured on the record).
- Soil Pits
    - Detailed soil pits were dug to characterise the numerous soil series identified in the soil taxonomic system used in England and Wales. Many of these detailed records are published in the records, memoirs and bulletins that accompany the national soil map and other detailed maps.
    - A full soil profile pit was excavated at the location, soil series identified, with full profile description and samples of each horizon.
    - Information extracted: soil series (for peat presence) and peat depth. Analytical information from the soil samples was also used to characterise the organic carbon content and bulk density for peat soils.

## 3.2 British Geological Survey (BGS)

### 3.2.1 GB 50k Superficial Peat

The BGS data comes from two sources: primarily extracted from BGS Geology 50,000 scale mapping (DigMapGB-50) (Armstrong et al, 2016) where the Superficial deposits are classified as ‘peat’. The second source is for Anglesey only and is taken from an unpublished 1:10,000 scale superficial geology map.

### 3.2.2 BGS Onshore GeoIndex

The Single Onshore Borehole Index (SOBI) is an index of over one million records of boreholes, shafts and wells from all forms of drilling and site investigation work held by the BGS downloadable at BGS SOBI.

This index was uploaded to ArcGIS and intersected with the Welsh BGS peat layer to produce a spreadsheet of potential peat sites. 1033 potential peat boreholes were identified. The index includes links to the downloadable source records for most of these sites. In a painstaking manual process 540 of the 1033 records were examined by Pete Jones of NRW for evidence of peat within the bore record. Where peat was identified the depth was noted (start, end and thickness) and a description captured for up to 5 peat layers. From this work 180 sites with measured peat thicknesses were extracted.

## 3.3 National Resources Wales (NRW)

### 3.3.1 Phase 1 Habitat Survey of Wales

Natural Resources Wales holds this dataset which shows comprehensive habitat cover data for the whole of Wales (Blackstock et al 2010). Within the Phase 1 habitat classification (JNCC, 2010) mapping of some habitat types is conditional on a peat depth of 50 cm (Table 4).

In the Unified Peat Map (Evans 2015) the 'All Wales Phase 1 Terrestrial - Mosaic Layer Voronoi' (subsequently referred to as the 'Voronoi dataset') was used and they extracted areas where the Phase1 habitat code (referred to as PHASE1_COD in the data attribute table) began with "E" (bog, flushed areas, fen and bare peat). In this project we also extracted the "E" class habitats (Table 4) from the Voronoi dataset. In the Voronoi dataset some sites were a mosaic of several classes, with the proportion of each class identified in the "label" field (for example "Mosaic of: 33% E.1.6.1,33% B.1.1,33% E.2.1"). Where a mosaic had >50% of any "E" class habitat (in the example given, this would be 67%), those mosaic areas were included. For each 50m grid, the area covered by classes E1, E3 and E4 (Bog, Fen and bare peat) are separated from those in E2 (flush/spring), reflecting the widespread occurrence of E2 on shallow peat soils/other soil types - i.e., not deep peat. This allows the classes to be treated separately. Note that it is possible for a cell to be in both classes where it is covered by a mosaic, if the mosaic only had a patch of E2 it was still included in the flush peat area as well as the bog peat area (this represented 180km$^2$ flush out of 890km$^2$ of mosaics with peat within them, this over represents the flush peat by only about 30km$^2$).

The Phase 1 map was also used to create a dissolved map of the 14 Broad Habitat Condition Categories (Table 13), the dominant broad habitat condition category represented in each 50m cell is used to assign a GHG emission value. The broad habitat condition categories correspond to the published emissions factors in Evans et al (2017).

*Table 4 Habitats considered to be peat in the Phase 1 Habitat Survey (JNCC, 2010)*

| Phase1 Habitat Code | Phase 1 Habitat Category | Conditional on Peat depth of 50 cm? |
|---|---|---|
| E.1 | Bog | yes |
| E.1.6.1 | Blanket bog | yes |
| E.1.6.2 | Raised bog | yes |
| E.1.7 | Wet modified bog | yes |
| E.1.8 | Dry modified bog | yes |
| E.2 | Flush and spring | no |
| E.2.1 | Acid/Neutral flush | no |
| E.2.2 | Basic flush | no |
| E.2.3 | Bryophyte-dominated spring | no |
| E.3 | Fen | yes |
| E.3.1 | Valley mire | yes |
| E.3.1.1 | Valley mire | yes |
| E.3.2 | Basin mire | yes |
| E.3.2.1 | Basin mire | yes |
| E.3.3 | Flood-plain mire | yes |
| E.3.3.1 | Flood-plain mire | yes |
| E.4 | Bare peat | yes |

### 3.3.2 Phase 2 Lowland Peatland Survey of Wales (2020 Deep Peat)

The Lowland Peatland Survey of Wales (LPSW) was to characterise and evaluate the vegetation cover of lowland peatlands in Wales based upon a programme of plant (sub-) community level sampling and mapping (Bosanquet et al, 2013). A map delineating 238 deep peat areas in Wales was provided with 5132 sites where the vegetation was surveyed using quadrats and the depth of peat was achieved by using a narrow (c. 5 mm diameter) fibreglass pole with insulating tape marking 50 cm, the peat depth threshold employed in the Phase I habitat classification for a range of critical habitat splits.

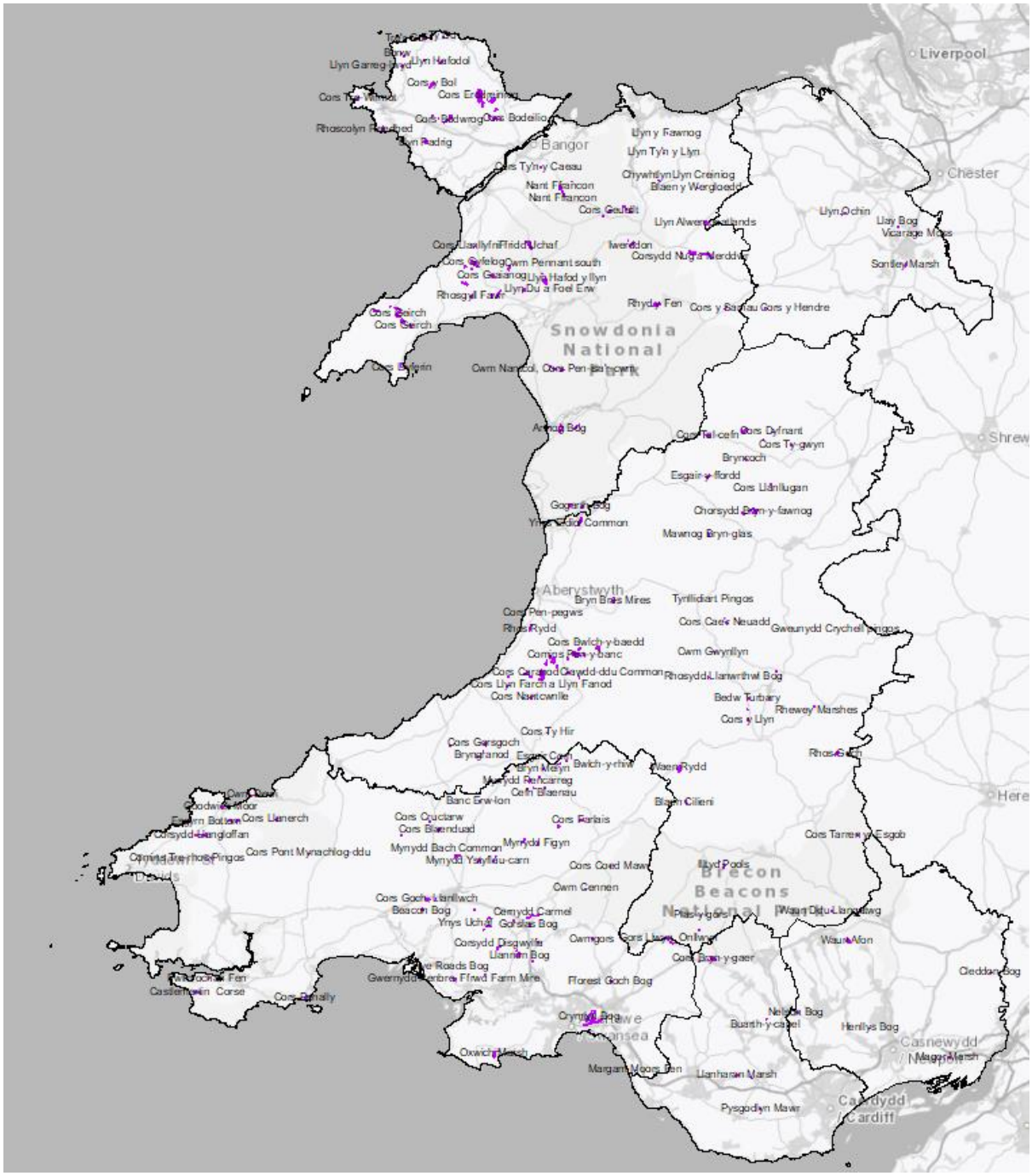


*Figure 5 Distribution of deep peat sites identified in the NRW Phase 2 Lowland Peat Survey*

### 3.3.3 Forestry Commission Soil Maps

Natural Resources Wales provided forest mapping digitised by the Forestry Commission from old paper soil surveys, many of which were surveyed by the Soil Survey of England and Wales (Pyatt, 1982; Kennedy, 2002). Areas from this mapping are included where classified as a deep peat soil (soil groups 8, 9, 10,11 or 14, Table 5). 'Mosaic' areas in the mapping contained multiple soil classes and the proportion of the soil class is stated in the mosaic. The mosaic areas were included only when deep peat classes covered more than 50% of the mosaic.

*Table 5 Peatland Types from Forestry Commission data where classes are identified as deep peat (depth 45 cm or more)*

| | Soil Group | Soil Type | Soil code/ class |
|---|---|---|---|
| Flushed Peatlands | 8. *Juncus* bogs (Basin bogs) | *Phragmites* bog | 8a |
| | | *Juncus articulatus* or *acutiflorus* bog | 8b |
| | | *Juncus effusus* bog | 8c |
| | | *Carex* bog | 8d |
| Flushed Peatlands | 9. *Molinia* bogs (Flushed blanket bogs) | *Molinia, Myrica, Salix* bog | 9a |
| | | Tussocky *Molinia* bog*; Molinia, Calluna* bog | 9b |
| | | Tussocky *Molinia, Eriophorum vaginatum* Bog | 9c |
| | | Non-tussocky *Molinia, Eriophorum Vaginatum, Trichophorum* bog | 9d |
| | | *Trichophorum, Calluna, Eriophorum, Molinia* Bog (weakly flushed blanket bog) | 9e |
| Unflushed Peatlands | 10. *Sphagnum* bogs (Flat or raised bogs) | Lowland Sphagnum bog | 10a |
| | | Upland Sphagnum bog | 10b |
| | 11. *Calluna, Eriophorum, Trichophorum* bogs (Unflushed blanket bogs) | *Calluna* blanket bog | 11a |
| | | *Calluna, Eriophorum vaginatum* blanket bog | 11b |
| | | *Trichophorum, Calluna* blanket bog | 11c |
| | | Eriophorum blanket bog | 11d |
| | 14. Eroded bogs | Eroded (shallow hagging) | 14 |
| | | Deeply hagged bog | 14h |
| | | Pooled bog | 14w |

(Explanatory comments in parenthesis)

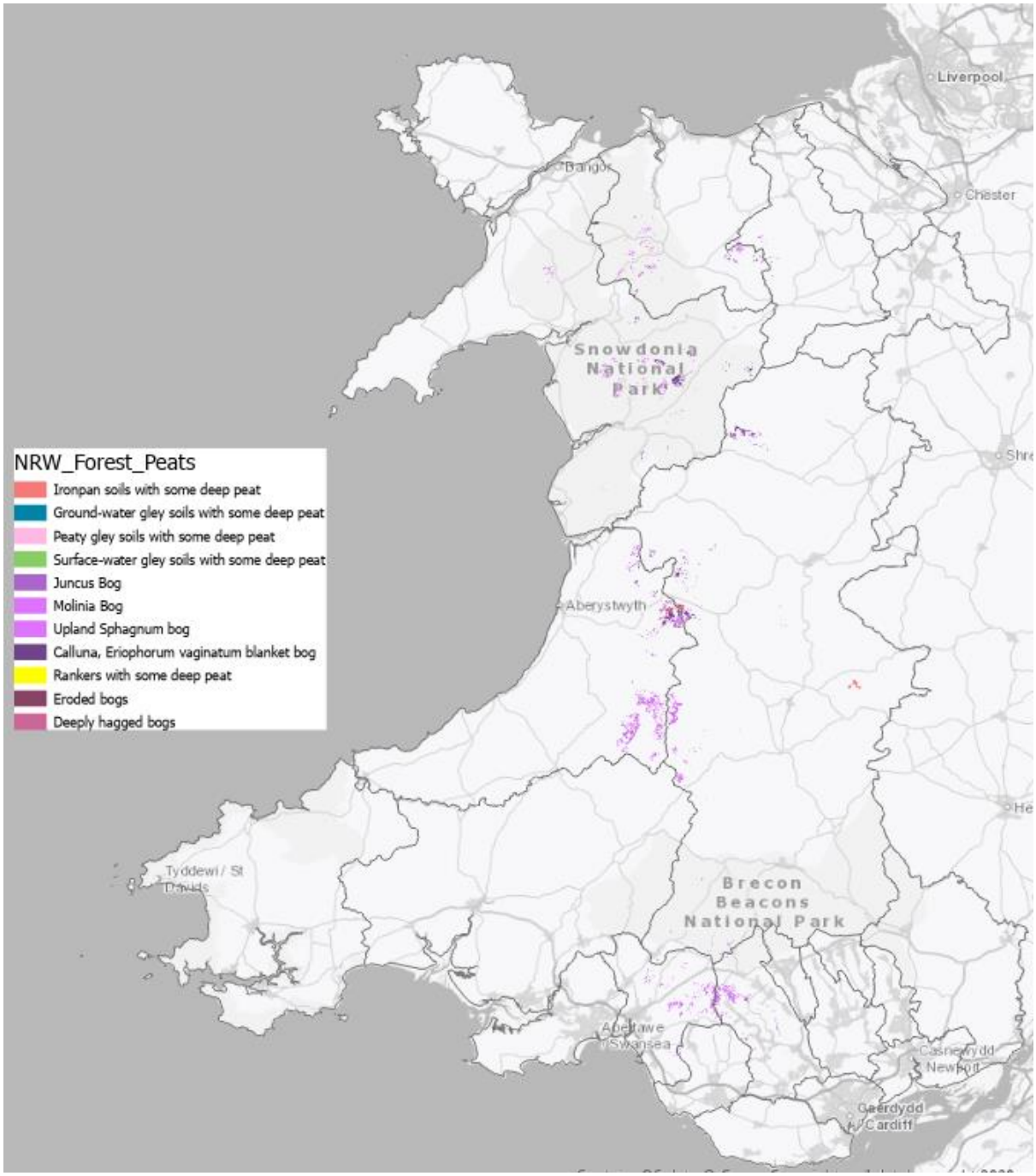


*Figure 6 Distribution of peat soil types from the Forestry Commission Forest Soils mapping*

### 3.3.4 NRW Peat Depth Dataset

This data set is a collation of 36294 peat depth data points from 29 locations across Wales. The data contains information collected by NRW and 3rd parties using a range of methods including peat probes and, less frequently, auger cores and soil pits. Reported peat depth estimates and measurements are standardised to the nearest centimetre. Values represent the shallowest depth reported for each point surveyed whereby the lowest value is recorded when a range was reported in the source data and where the peat depth is 'greater than' the value given, this value is reported as the minimum peat depth for the point.


*Figure 7 Map showing the distribution of surveyed locations from the NRW Peat Depth Dataset*

## 3.4 ADAS

### 3.4.1 Peatland Condition Survey (SPEP 2019-20/11)

ADAS provided mapping from 8 peatland habitat condition survey projects from a project commissioned by the Welsh Government (with support from NRW) to support the National Peatlands Action Programme (NPAP) (NRW, 2020). A range of peatland sites across Wales were targeted: Bwlch Y Groes, Claerwen, Cors y Sarnau, Craig y Fan Ddu, Hafod Elwy, Mynydd Du, Waun Fignen Felen and Waun Rydd. Most of these sites were blanket mires, with the exception of Waun Rydd (Lowland Raised Bog) and Cors y Sarnau (Lowland Fen and formerly afforested lowland raised bog) – see Forster-Brown et al (2021) for further information. The survey maps were classified into peatland habitat condition classes, with accompanying information on peat depths. On each map there were up to 9 categories an explanation of these categories accompanied each map but differed between the maps. For this project the categories were assessed and those that represented deep peats were collated into an ADAS_PEAT dataset and included in the Peatlands of Wales map in addition to the corresponding peat depth data.

### 3.4.2 Peatland Depth and Bulk Density Survey (SPEP 2020-21/06)

This project was commissioned by Welsh Government to support the development of the Peatlands of Wales map. The site selection and survey methodology were developed in consultation with NRW Lead Specialist Advisor on Peatlands. The survey was undertaken by ADAS between September 2020 and March 2021.

The purpose of this project was to:

(i) support the development of a new national peat map of Wales,

(ii) support the development of new GIS data layers containing information on carbon stocks and greenhouse gas emissions from peat

(iii) support the development and delivery of the emerging National Peatland Action Programme

The project required the collection of peat body depth, bulk density and, if necessary, lab samples to support direct organic carbon measurements. Peat thickness data were provided for 276 locations across 6 sites. In 76 locations peat samples were taken at different depth ranges, not all depth ranges were continuous, resulting in gaps in the peat profile. The samples were analysed for bulk density and carbon content. The carbon stock in the sampled depth ranges was calculated. To determine the measured carbon stock for the complete peat profile the stock was extrapolated between the sampled layers using the average stock of the layer above and below and adjusted by the width of the gap. The stock was determined to the maximum depth of the peat measured in the condition survey project.

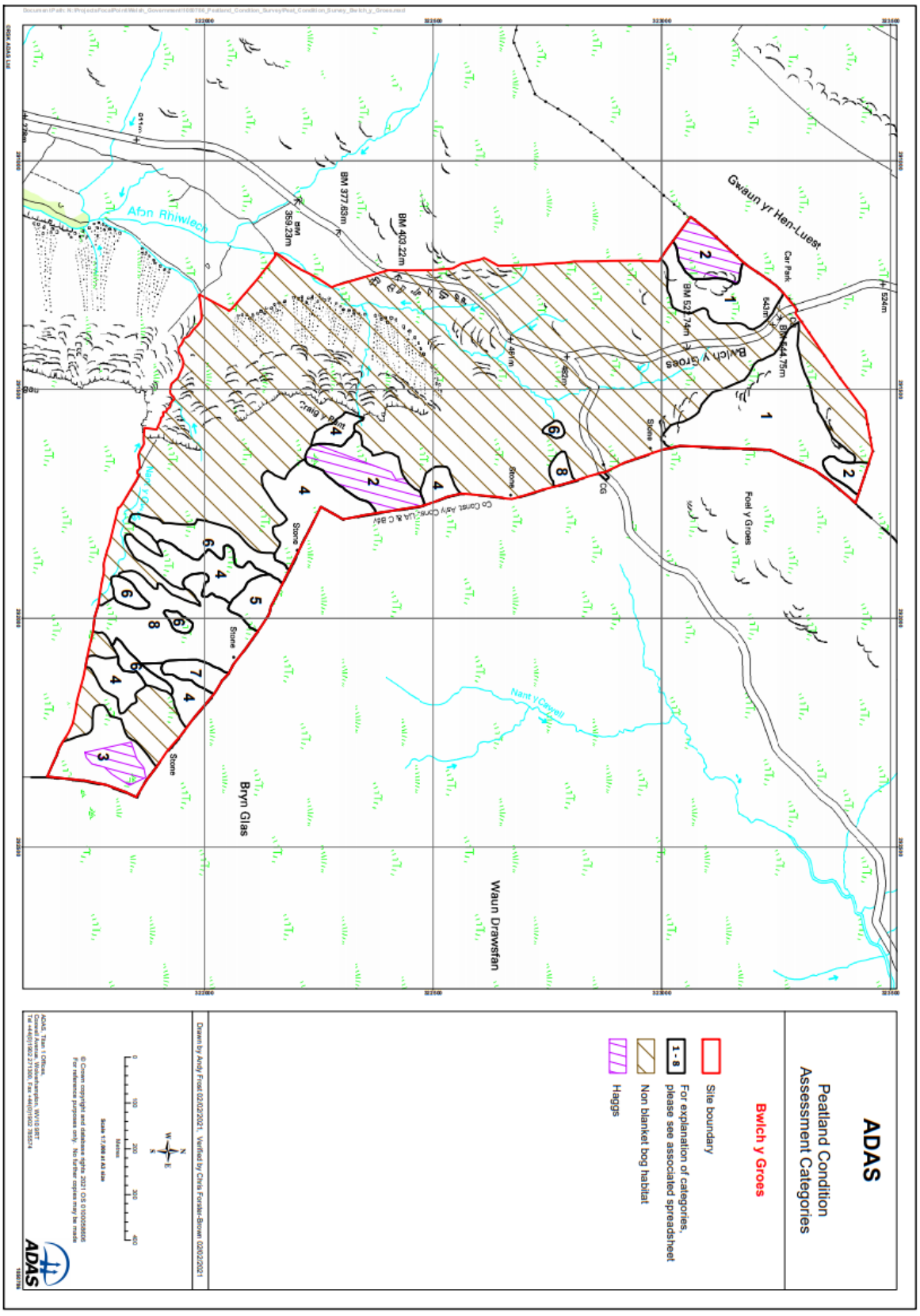


*Figure 8 Example ADAS Peat Condition map – see Forster-Brown et al., 2021.*

## 3.5 Welsh Government

### 3.5.1 Agricultural Land Classification mapping

The Welsh Government undertook many surveys between 1977 to 2019 to assess the Agricultural Land Classification of sites which were being considered for development. As part of the assessment process many auger bore observations were taken by the soil surveyors, often on a 100m grid, this data was collected in notebooks and sample cards. As part of the Capability, suitability and climate programme (CSCP01) (Keay 2020a) this data was captured digitally, the maps were digitised and the soil auger data captured in tabular form. The profile data described included a texture classification, it was therefore possible to assess the thickness of peat (horizons classified as either peat (P), loamy peat (LP) or Sandy peat (SP)) for each profile. This provided measurements of peat thickness for 13,449 additional points (Figure 9).

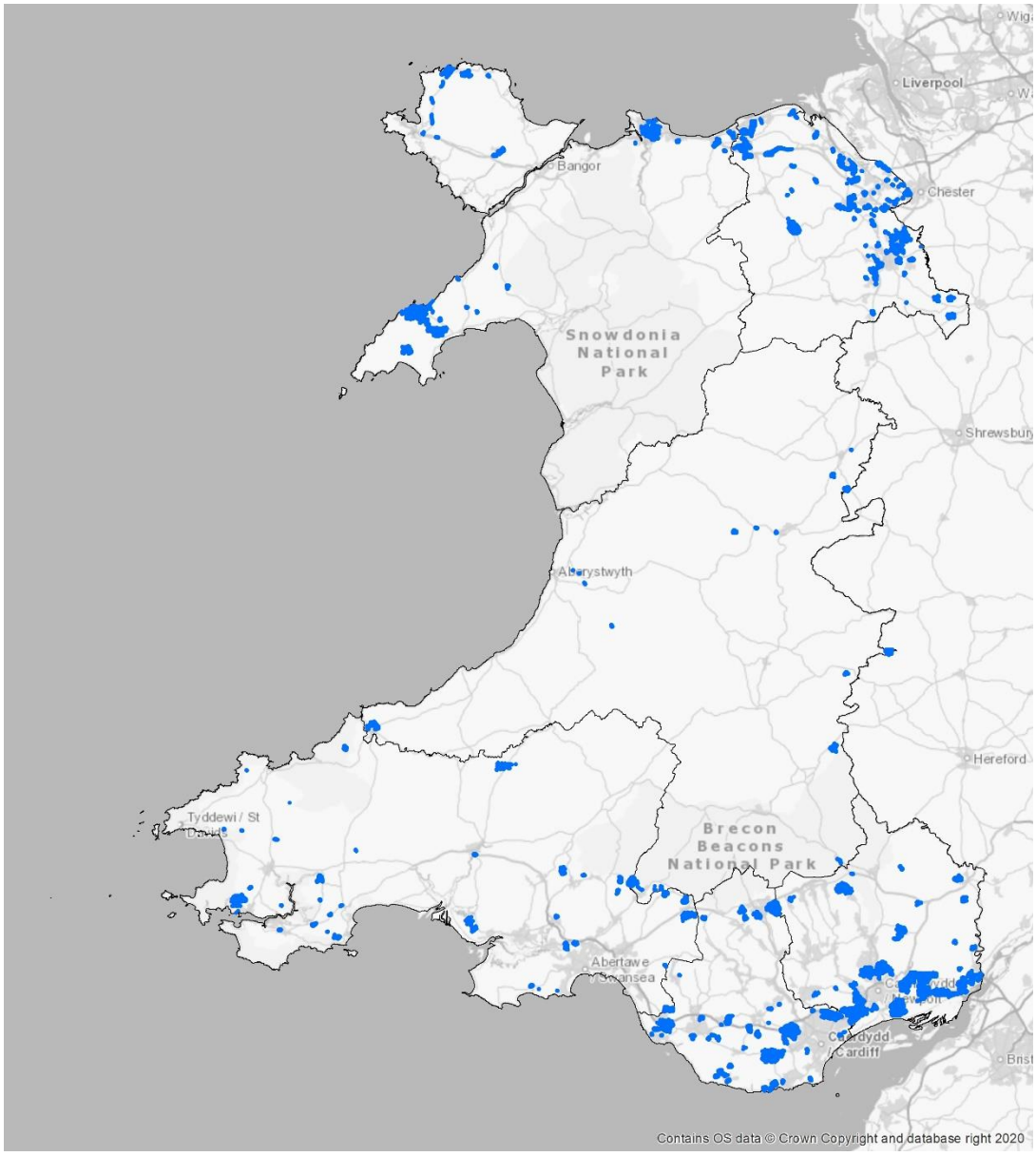


*Figure 9 Coverage of auger bores from the Welsh Government ALC mapping Programme*

# 4 Creating the 50m Peatlands of Wales Map

A requirement of the contract was to make the new Peatland of Wales map on a 50m grid, to align with the Predictive Agricultural Land Classification Map of Wales (version 2) (Welsh Government, 2020). The concept was to utilise various data sources to identify the likely presence of deep peat (> 40cm depth) in each 50m grid from all the available evidence. The data sources have different confidence in identifying peat within the grid square due to the nature of the data collection, original remit for the survey and mapping scale. Table 6 summarises the rationale used to determine the confidence of the data sources used to identify peat presence within a 50m grid cell. Further explanations are provided below.

*Table 6 Rationale of the confidence of the peat data sources used to determine the likely presence of peat in a 50m grid cell.*

| Data type | Data Sources | Rationale |
|---|---|---|
| Point data | National Soil Inventory<br>Auger bores<br>Soil Pit profiles<br>BGS onshore GeoIndex (boreholes)<br>NRW Peat Depth Dataset<br>ADAS Peatland Condition Survey (points)<br>WG Agricultural Land Classification Points Data | High confidence of peat presence. Direct observation of peat within the 50m grid cell based on soil excavated from an auger boring or soil pit or estimated using a peat probe. These data sources can be used alone to indicate deep peat presence in a 50m grid cell. |
| Detailed peat surveys | NRW Phase 2 Lowland Peatland Survey of Wales<br>ADAS Peatland Condition Survey (maps) | High confidence of peat presence. Detailed peat habitat mapping surveys often with observations at frequent intervals to map peat areas for the analysis of peat condition or habitat composition and quality. These data sources can be used alone to indicate deep peat presence in a 50m grid cell. |
| Detailed soil/habitat mapping | NRW Phase 1 Habitat Survey (lowland)<br>Forestry Commission Soil Map<br>Detailed soil mapping of Wales CU (excluding 1:63,000 scale maps) | High to moderate confidence of peat presence. Detailed mapping surveys of soils or habitats, with a high likelihood the original map unit is dominated by peat soil. |
| Coarser scale soil mapping/ habitat mapping/ geological mapping | NRW Phase 1 Habitat Survey (upland and flush sites)<br>BGS Superficial Geology: 50k dataset<br>CU NATMAP and CU 1:63,000 soil mapping | Moderate confidence of peat presence. Coarser scale soil maps do not spatially resolve peat areas within the mapping units. Map units contain peat and non-peat soils, with peat soils being subdominant. Geological mapping focuses on ‘superficial geology’ not soil. Upland phase 1 habitat survey has lower confidence than in lowland areas. |

High confidence is attached to the attributed point data (Table 6) where a surveyor had directly observed and recorded the soil at a specific point location as part of a soil or peat mapping programme. The thickness (or depth) of peat was also often recorded at the site. Across Wales 75,645 sites were identified in this way, 31,645 had no peat recorded and 28,045 were identified as deep peat (>=40cm). In the situation where a 50m grid only had surveyed points showing there was no peat at that location then the site was not included in the map. 50m grids which contained point observations of deep peat were included in the peatlands map even if other mapped data indicated there was no peat present at that location.

Detailed peat surveys (Table 6) such as the NRW phase 2 Lowland Peatland Survey and ADAS Peat condition mapping are mapped at a highly detailed scale, often with numerous auger bore or peat probe observations within the mapping units to corroborate peat presence and depth. 50m grid cells that intersect with these map units are identified as peat. These detailed map units are considered accurate enough to use to directly identify a 50m grid as peat, without any other corroborating evidence from other sources. When the map unit only partially covers the 50m grid cell (for these detailed maps this was set at 20% or less) it is not identified as having peat present.

Detailed soil or habitat surveys (Table 6) are likely to be conducted at a scale where the resulting map units have reasonable purity i.e. the map units contain almost exclusively one type of soil or habitat. Although in some cases mosaics or complexes, that contain mixtures of habitats or soil respectively, are mapped. These sources are mapped at a slightly coarser scale than the detailed peat surveys and thus require a greater proportion of the peat map units to cover the 50m grid (>50%) for the 50m grid to be included in the peat map.

Coarser scale soil mapping or geological mapping has moderate confidence on the likelihood of determining the presence of peat within a 50m grid. For example, the National Soil Map (NATMAP) only maps associations of soils at 1:250,000 scale. For soil associations where the dominant soil is a peat soil, there may also be subdominant series of non-peat soils. This is why the National Soil map was not included in the original Unified peat map as it over-estimated the area of peat. In this analysis, the National Soil Map and soil mapping at 1:63,000 are only included when > 50 % of the 50m grid is covered by a peat map unit and peat presence is further corroborated by another data source from Table 6.

Likewise, the BGS Superficial Geology mapping and Phase 1 upland habitat surveys were considered to be less accurate at identifying the deep peats, often including peaty podzols and other soils with a thin layer of peat at the surface within ostensibly peaty polygons. The mapping of superficial geology was intended to show material under the soil profile such as deep or buried peat, it does not include peat entirely within 1m of the surface (McMillan & Powell, 1999). This mapping can both underestimate or overestimate the extent of peat. These data sources are only included when > 50 % of the 50m grid is covered by a peat map unit and peat presence is further corroborated by another data source from Table 6.

Figure 10 shows the flow chart of how each 50m grid was assessed with each data source. To identify peat presence in the 50m grid a scoring system was devised which identified if a particular peat data source was present within the 50m grid cell. Each peat data source had a score of 1 or 2, depending on the confidence of the data sources described above. For a 50m grid to be identified as deep peat, a score of at least 2 is required. A running score was kept of the sources that indicated peat, which allows every cell to be assessed for the strength of the available evidence. The final peat map was then created by extracting only the 50m cells with a score of 2 or more (Figure 11). A final check on non-soil areas was also determined by excluding cells that had > 80% water (identified on the NRW Phase 1 Habitat

mapping) or were identified as urban areas (identified on the ALC Predictive Map (version 2) (Table 7).

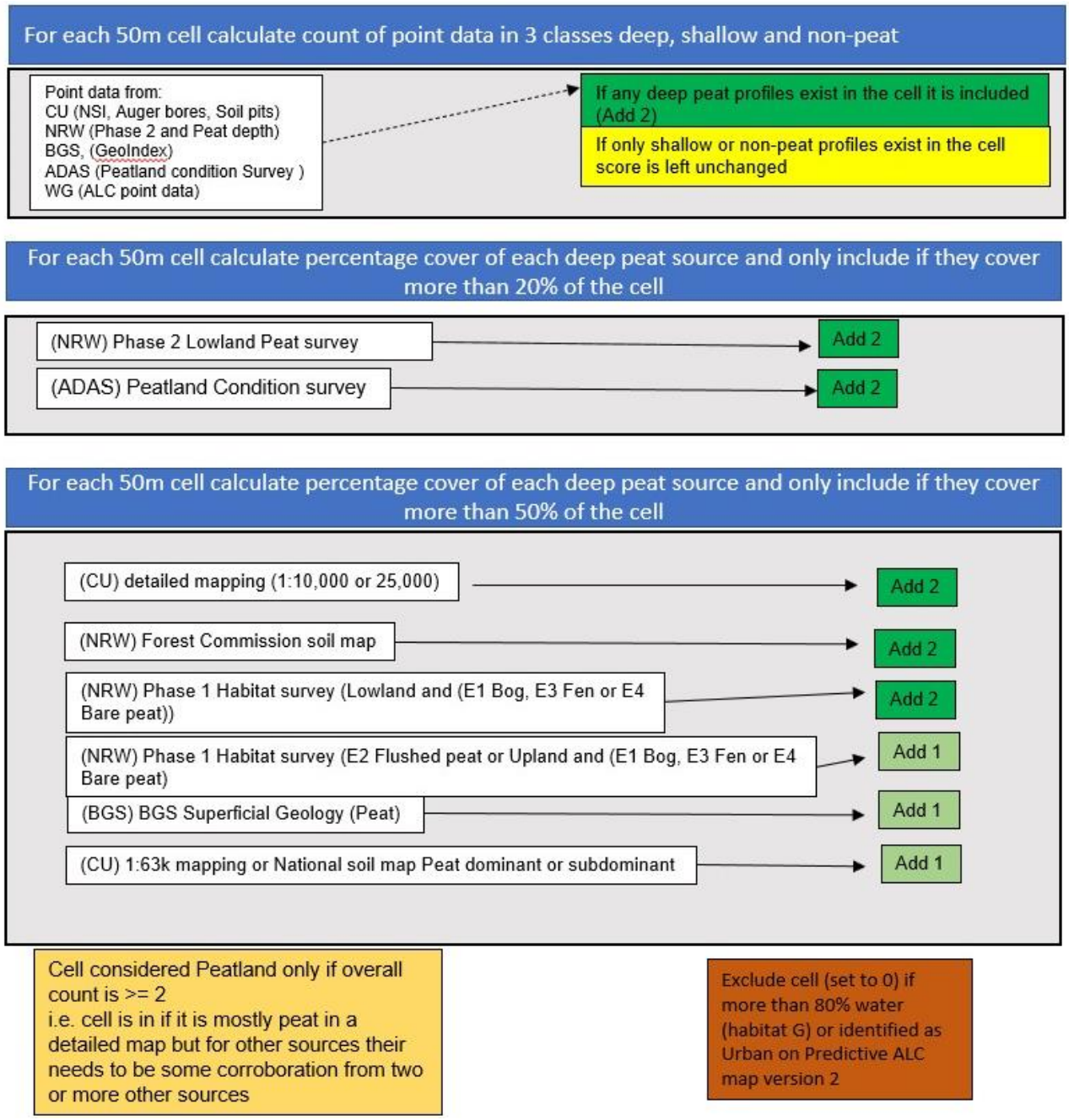


*Figure 10 Peatland mapping flowchart for the scoring of data sources used to identify peat presence in a 50m grid cell*

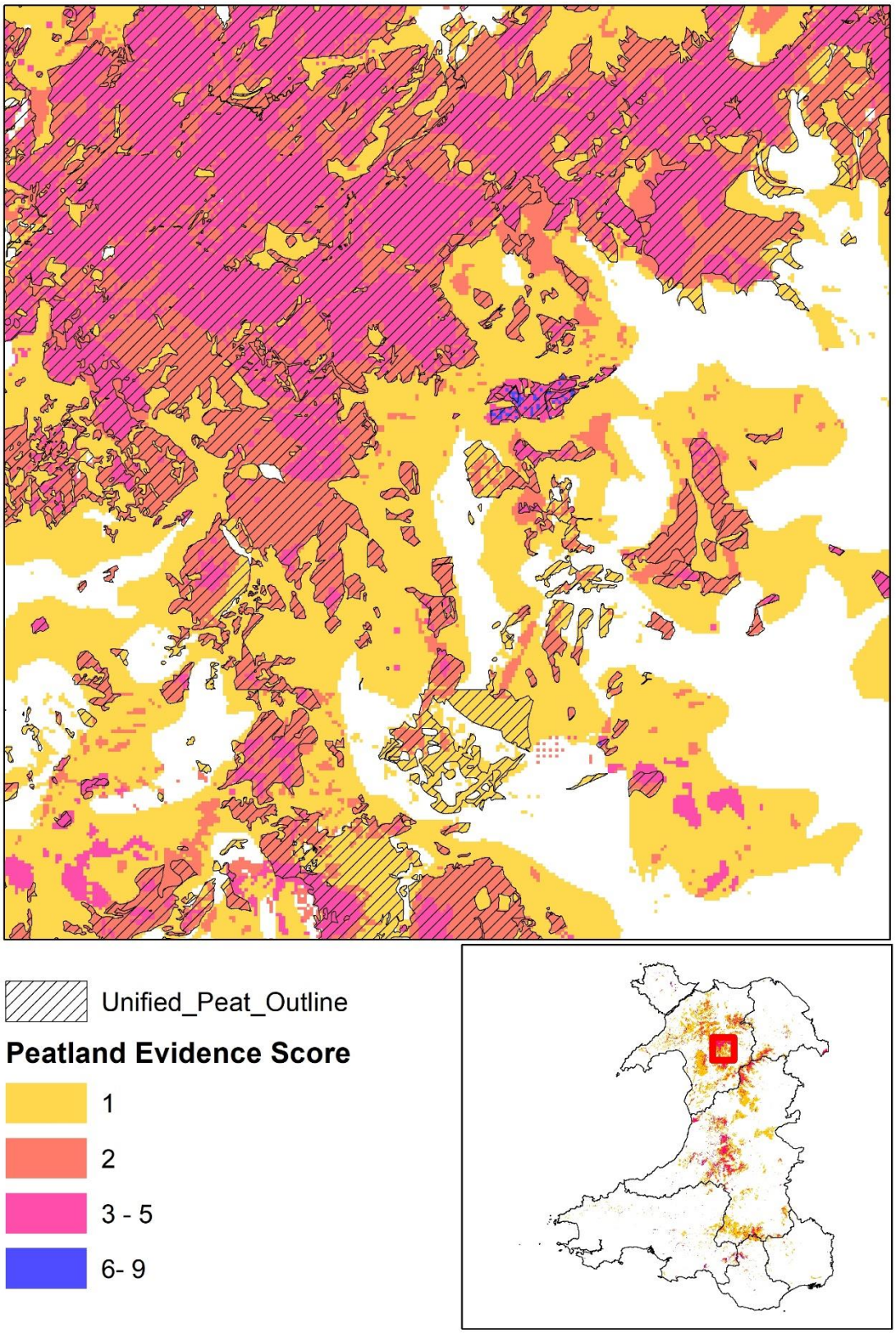


*Figure 11 Peatland Evidence Score showing areas excluded (peatland evidence score 1) and included (peatland evidence score >=2) in the peatlands map and overlain with the original Unified Peat Map*

## 4.1 Data from mapped peat sources

To start the mapping phase a blank 50m grid was created (using the ArcGIS Fishnet command) and clipped to the Welsh Local Authority Boundary. Each of the source maps which identified deep peat soils were then taken in turn, dissolved to a single layer showing only where the deep peat existed and the percentage area of each 50m cell covered by the layer was calculated.

*Table 7 Sources assessed for the proportion of deep peat within each 50m cell*

| Attribute name as it appears in the GIS output | Source Data | Areas identified as deep peat |
|---|---|---|
| NRW_BOG_FEN_MIRE | NRW Phase 1 habitat survey | classes E1, E3, E4 and mosaic with >50% E1, E3 or E4 |
| NRW_FLUSH | NRW Phase 1 habitat survey | classes E2 and mosaic with >50% E2 |
| NRW_FOREST | NRW Forest Peat | deep peat classes (Table 5) |
| NRW_PEAT | NRW Phase 2 Lowland Peat Survey (2020) | Area of polygons defined as peatland |
| CU_PEATDOM | CU National Soil Map (NATMAP) | Dominant Peat Soils – Polygons in the National Map with at least 70% Peat Soil Series within the Association |
| CU_PEATSUBDOM | CU National Soil Map (NATMAP) | Sub-Dominant Peat Soils – Polygons in the National Map with Ancillary peat soil series making up between 5-70% of the Association |
| CU_DETAILED | CU Detailed Soil maps | Polygons classified as one of the peat series taken from the 1:25k, 1:65k, Farm Maps and Rabbit squares |
| BGS_PEAT | BGS superficial geology | lexicon value is PEAT |
| ADAS_PEAT | ADAS Peat condition Survey | Area of deep peat polygons from ADAS Peat Condition survey mapping |
| URBAN | WG Predictive ALC version 2 Map | Used to mask out cells identified as urban |
| WATER | NRW Phase 1 habitat survey | Used to mask out cells which are over 80% Open Water (group G) |
| P1_SURVEY | NRW Phase 1 habitat survey | upland or lowland (dominant in 50m square) – flag used to prioritise the phase 1 lowland survey where the confidence in the identification of peat was higher |

## 4.2 Point data from surveyed site data

There are many sources of actual recorded soil data at specified locations where the surveyor was on the site and used an auger or peat probe or dug a soil pit and described the soil at the site. Where these direct observations indicate deep peat they take precedence over all other indirectly mapped soil data (Figure 9).

A dataset giving the location of all these sites (east, north in British National Grid coordinates) and the thickness (depth) of observed peat in the soil profile (by summing the width of organic horizons down the profile) was generated. These point data are summarized on the 50m grid as counts of observations in three classes: Deep Peat (>= 40cm peat within the upper 80cm of the soil profile), Shallow Peat (>5 and <40cm peat) in the profile and Non-Peat (<=5cm peat in the profile). Only the points identified as deep peat are included in the project to assign a peat presence to the 50m grid. Deep peat point sources that had depth information were used to assign an observed peat depth to the 50 m grid. Where > 1 point observation falls in the 50m grid, the average depth from the points of deep peat is calculated and assigned to the 50 m grid cell.

*Table 8 Sources and number of points observations from surveyed site data. Non-peat <=5cm peat in the profile; Shallow peat >5 and <40cm peat; Deep peat >= 40cm peat within the upper 80cm of the soil profile.*

| Source | total | Non-peat | Shallow peat | Deep peat |
|---|---|---|---|---|
| NRW Peat Depth Dataset | 36294 | 2863 | 11687 | 21744 |
| NRW Phase 2 Lowland Peat Survey (2020) | 5132 | 47 | 534 | 4551 |
| NRW Forest Peat | 641 | 358 | 124 | 159 |
| BGS Onshore GeoIndex | 180 | 94 | 22 | 64 |
| Peatland Condition Survey (point data) | 276 | 27 | 75 | 174 |
| CU National Soil Inventory | 807 | 662 | 101 | 44 |
| CU Auger bores from National Soil Map programme | 13229 | 11043 | 1425 | 761 |
| CU Auger bores from other projects | 1799 | 1516 | 210 | 73 |
| CU Soil pits dataset | 84 | 69 | 11 | 4 |
| CU additional auger bores (location and series only) | 3754 | 2346 | 1065 | 343 |
| WG ALC Post-revision projects | 6213 | 5884 | 273 | 56 |
| WG ALC commercial projects | 2438 | 2382 | 8 | 48 |
| WG ALC Pre-revision projects | 4798 | 4672 | 102 | 24 |
| Total Points | 75645 | 31963 | 15637 | 28045 |

# 5 Thickness of peat soils in Wales

Table 8 indicates that there were 75645 point observations recorded with a peat depth and 28,045 had over 40cm of peat in the top 80cm (deep peat). The deep peat depth observations were directly assigned to the grid cells. This resulted in 19,679 50m grid cells (6%) in the final Peatlands of Wales map with peat depth data determined from direct observations. At these sites the peat thickness was often limited by the length of the auger, probe or profile dug and thus may underestimate the actual thickness of peat. For the majority of 50m grid cells there was no directly observed data of the peat thickness.

In order to estimate peat depth in the 50m grid cells with no direct observational data we explored applying the approaches described in Williamson et al., 2019, that used a relationship between slope and peat depth (Equation 1).

$$Depth = \left(e^{-a*slope}\right) * D_{max} \qquad \textit{Equation 1}$$

Where *a* is a constant -0.189, *slope* is the angle of slope and *Dmax* was set to 300 cm to provide a constraining maximum depth.

To identify if this equation was appropriate to estimate peat depth we used a selection of the auger bores, probes or soil profile data with peat depth information (n = 35287) and slope of the 50m cell taken from the OS Terrain 50 dataset. There was no clear relationship between observed and predicted peat depth using Equation 1 (Figure 12). In neither the Williams et al map nor this new peat thickness map was a dedicated modelling exercise used to define peat depth but they were instead an estimate / intermediate step to facilitate emissions and C storage estimates.

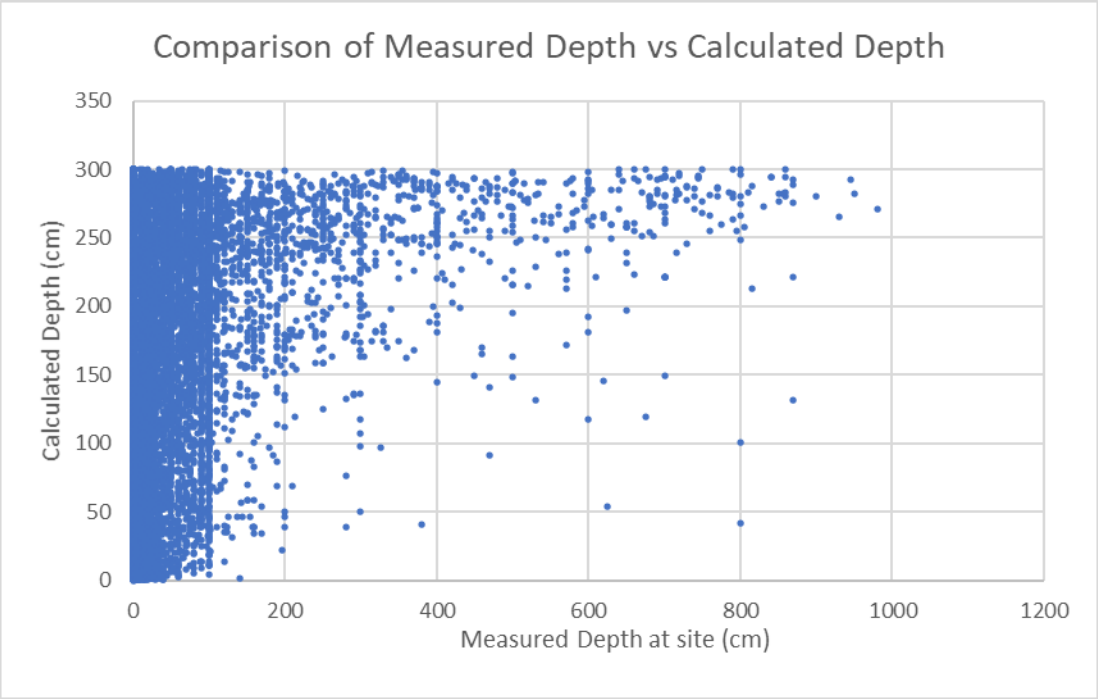


*Figure 12 Comparison of measured depth vs calculated depth using equation in Williamson et al (2019)*

Due to the very uncertain estimates for peat depth using Equation 1, we decided to take a pragmatic approach to determining the peat depth in areas where there were no direct point observations. For each soil series in LandIS (Cranfield University 2022), there are standardised reference profiles for soil profile descriptions and analytical data. Table 9 shows the standardised peat depth for each soil series identified as peat soil in Wales. These depths are based on observations from soil pits and auger bores. We used the dominant soil series in the 50m grid cell identified from the Soils of Wales map, a map that combines all the detailed soil maps produced by the Soil Survey of England and Wales and shows the series from the most detailed map available (Keay, 2020b). Where the peatland of Wales map intersected with a peat soil series, we used the standard peat depth for that series to attribute a peat depth to the 50m grid. In areas where the Soil of Wales map showed a non-peat soil series but peat presence was identified on the Peatland of Wales map, we used a standard minimum peat depth of 40cm. In these areas the peat depth is likely to be underestimated.

*Table 9 Standard depth of peat for peat soils. These were determined using data in LandIS from soil profile and auger bore information (Cranfield University 2020)*

| Soil series | Subgroup | Standard soil series peat depth (cm) |
|---|---|---|
| TREGARON | 8.11 | 40 |
| MIDELNEY | 8.13 | 55 |
| LONGMOSS | 10.11 | 100 |
| WINTER HILL | 10.11 | 120 |
| CROWDY | 10.13 | 100 |
| ALTCAR | 10.22 | 85 |
| ADVENTURERS' | 10.24 | 100 |

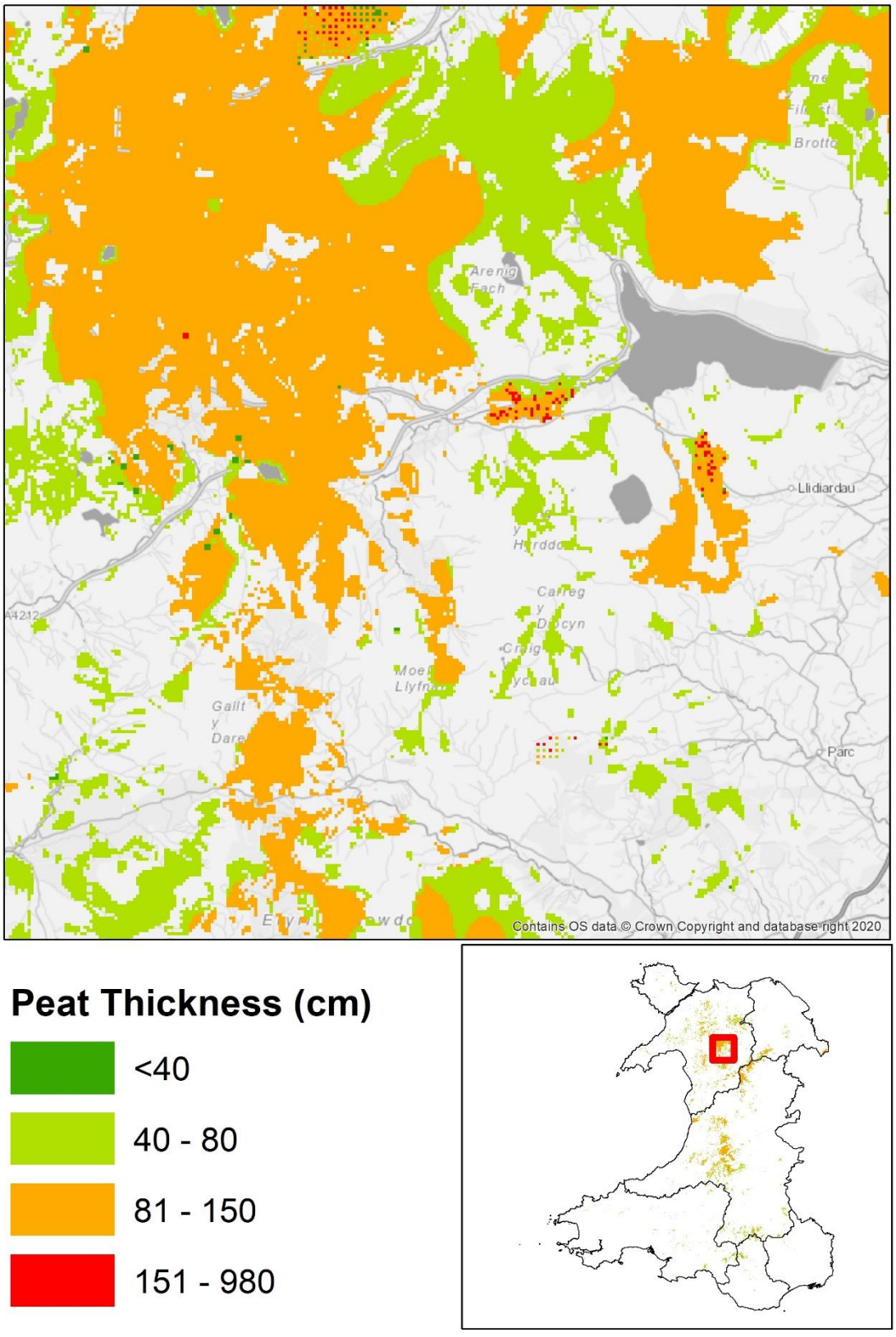


*Figure 13 Estimates of peat thickness (depth) across Wales*

# 6 Carbon Stock

The Carbon stock for each 50m cell was derived using an estimate of the carbon stock derived from standardised profile data using carbon concentration and bulk density from LandIS Soil horizon data for 0-30cm, 30-100cm and 100-150cm depth ranges (Hollis et al., 2012, Gregory et al., 2012) (Table 10).

Where the carbon stock had been measured directly from samples at the grid location (see Section 3.4.2) the measured carbon stock was assigned. Note that although only 76 sites had measured data these represent 274 50m grid cells as many of the sites were in the corners or edges of up to 4 cells.

The carbon stock data was only available for 6 deep peat soil series that occur in Wales. We uses a number of rules that utilised the soil or habitat mapping to assign a relevant carbon stock to the 50m grid cell:

1) If detailed soil mapping identified a peat series from Table 10 in the 50m grid cell, the carbon stock for the corresponding series was assigned to the 50m grid cell.
2) In the absence of detailed soil series mapping, if the 50m grid cell was dominated by soil association 1013a or 1013b from the National Soil Map, the carbon stock was assigned from the Crowdy series.
3) If the 50m grid cell was dominated by soil association 1022a from the National Soil Map then the carbon stock was assigned from the Altcar series
4) If the 50m grid cell was dominated by soil association 1024a from the National Soil Map then the carbon stock was assigned from the Adventurers' series
5) Otherwise, the carbon stock was assigned from the Crowdy series if the 50m grid cell was 'Upland' or from the Adventurers' series if 'Lowland'. The distinction between upland and lowland was defined in the NRW Phase 1 habitat dataset.

The standard series-based carbon stock is calculated to 150cm depth this was then adjusted for each cell by multiplying the 0-150 cm Carbon stock estimate (Table 10) by the assigned peat thickness and dividing by 150, to assign an estimate of stock that is proportionate to the depth of the peat.

The carbon stock was reported in $kg/m^2$, to calculate the total stock within the Peatland of Wales area this was multiplied by the area of the cell in $m^2$ and multiplied by 0.001 to convert the stock to tonnes per 50m cell. The total carbon stock for the new Peatland of Wales was 63,000 kt. This estimate is lower than the estimate in Williamson et al., 2019, primarily due to the smaller area of peatland (822 $km^2$ compared to 906 $km^2$) identified in the new Peatland of Wales map.

The total carbon stock within each NRW Operational Area (Area Statement region) was calculated and compared to the original stocks estimated in Williamson et al (2019) (Table 11).

*Table 10 Standard Carbon Stock by Soil Series (Gregory et al., 2012)*

| | Organic Carbon % | | | Bulk Density (g $cm^3$) | | | Stock (kg/m2) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SERIES_NAME | 0-30 cm | 30-100 cm | 100-150 cm | 0-30 cm | 30-100 cm | 100-150 cm | 0-30 cm | 30-100 cm | 100-150 cm | 0-150 cm |
| ADVENTURERS' | 27.82 | 43.86 | 49 | 0.49 | 0.32 | 0.19 | 39.31 | 95.13 | 46.55 | 180.99 |
| ALTCAR | 34.25 | 54.13 | 57.7 | 0.17 | 0.17 | 0.17 | 17.8 | 65.32 | 49.05 | 132.17 |
| CROWDY | 42.8 | 51.43 | 54 | 0.27 | 0.2 | 0.2 | 33.6 | 72 | 54 | 159.6 |
| LONGMOSS | 45.07 | 49 | 49 | 0.2 | 0.24 | 0.24 | 27.28 | 82.32 | 58.8 | 168.4 |
| MIDELNEY | 4.47 | 19.17 | 31.9 | 1.01 | 0.59 | 0.19 | 12.04 | 31.64 | 30.31 | 73.99 |
| WINTER HILL | 45.47 | 48.19 | 49.7 | 0.22 | 0.24 | 0.24 | 29.88 | 80.95 | 59.64 | 170.47 |

*Table 11 Total Peat Carbon Stock by Welsh NRW Area Statement Region*

| | Peatlands of Wales | | *Williamson et al (2019)* | |
|---|---|---|---|---|
| NRW Operational Areas | Area ($km^2$) | Carbon stock (kt) | Area ($km^2$) | Carbon stock (kt ) |
| North West Wales | 327.4 | 25,881 | 344.8 | 24,123 |
| North East Wales | 43.5 | 3,265 | 45.7 | 3,185 |
| Mid Wales | 381.8 | 30,303 | 426.6 | 31,104 |
| South East Wales | 2.6 | 130 | 5.7 | 630 |
| South Wales Central | 25.3 | 1,383 | 25.5 | 1,908 |
| South West Wales | 41.0 | 2,904 | 57.2 | 4,904 |
| Total | 822 | 63,865 | 906 | 65,854 |

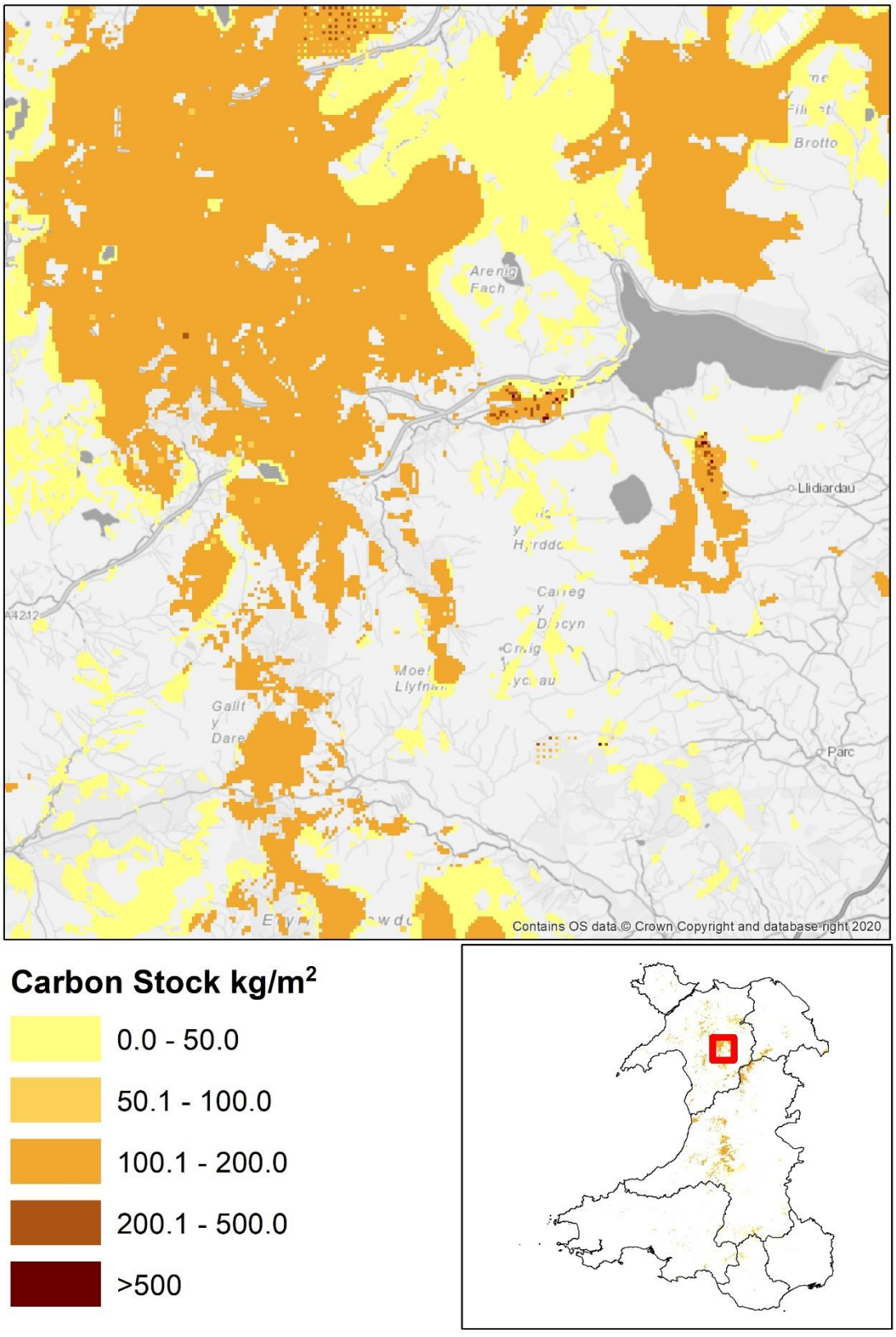


*Figure 14 Estimate of Carbon Stocks in Peat soils across Wales (highlighting an area to show localised variation)*

# 7 Calculation of GHG emissions

As previously described in Williamson et al., (2016), emission factors as listed in Evans et al., (2017) were assigned to each broad habitat condition category for carbon dioxide ($CO_2$) and methane ($CH_4$) as well as an overall emissions estimate (t $CO_2$-e $ha^{-1}$ $yr^{-1}$), based on IPCC AR4 100-year global warming potentials and including $N_2O$ and fluvial carbon flux estimates (Table 13). Each 50m cell was assigned the broad habitat condition class from Table 7 chosen by maximum area. The emission factor by ha was assigned to each cell based on this broad class and then the total GHG emissions (t $yr^{-1}$) calculated by multiplying the area of the cell in $m^2$ multiplied by 0.0001 to convert to hectares. Table 12 shows the total emission factor estimated by NRW Operational area. The Emissions level is a slight increase from that cited in the 2017 BEIS report (Evans et al., 2017) which gives 549 kt $yr^{-1}$ as the baseline (1990) due to changes in the defined extent and location of peatland area.

*Table 12 GHG Emissions by NRW Wales Statement Region*

| **NRW Operational Areas** | **$CO_2$ -e Emissions t $yr^{-1}$** |
|---|---|
| North West Wales | 25,130 |
| North East Wales | 2,161 |
| Mid Wales | 263,185 |
| South East Wales | 46,337 |
| South Wales Central | 20,626 |
| South West Wales | 227,731 |
| **Total** | **585,174** |

*Table 13 Classification of Phase 1 habitats into the Broad Habitat Condition Categories used in the development of new emissions factors by Williamson et al 2016.*

| Broad Code | Broad Habitat Category | Phase1 Habitat Code | Phase 1 Habitat Categories | $CO_2$-e emission factor (t $ha^{-1}$ $yr^{-1}$) |
|---|---|---|---|---|
| BN | near natural bog | E.1.6.1 | Blanket bog | -0.2 |
| | | E.1.6.2 | Raised bog | |
| | | E.2.1 | Acid/neutral flush | |
| BB | modified bog - bracken dominated | C.1.1 | Bracken | 5.6 |
| | | C.1.2 | Scattered bracken | |
| BG | modified bog - grass dominated | B.5.2 | Marshy grassland *Molinia* dominated | 5.6 |
| | | E.1.7 | Wet modified bog | |
| | | E.1.8 | Dry modified bog | |
| | | E.2 | Flush and spring | |
| | | B.5.1 | Marshy grassland *Juncus* dominated | |
| BH | modified bog - heather dominated | D.1.1 | Dry acid heath | 5.6 |
| | | D.1.2 | Dry basic heath | |
| | | D.1.3 | Scattered dry heath | |
| | | D.2 | Wet heath | |
| | | D.3 | Lichen/bryophyte heath | |
| | | D.4 | Dry heath/acid grassland mosaic | |
| | | D.5 | Wet heath/acid grassland mosaic | |
| | | D.6 | Basic dry heath/calcareous grassland mosaic | |
| | | H.8.5 | Coastal heath | |
| | | mosaic | mosaic | |
| BP | bog eroding | E.4 | Bare peat | 5.6 |
| NF | near natural fen | E.2.2 | Basic flush | 3.9 |
| | | E.2.3 | Bryophyte-dominated spring | |
| | | E.3 | Fen | |
| | | E.3.1 | Valley mire | |
| | | E.3.1.1 | Modified valley mire | |
| | | E.3.2 | Basin mire | |
| | | E.3.2.1 | Modified basin mire | |
| | | E.3.3 | Flood-plain mire | |
| | | E.3.3.1 | Modified flood plain mire | |
| GE | extensive grassland | B.1 | Acid grassland | 16.5 |
| | | B.1.1 | Unimproved acid grassland | |
| | | B.1.2 | Semi-improved acid grassland | |
| | | B.2.1 | Unimproved neutral grassland | |
| | | B.3.1 | Unimproved calcareous grassland | |
| | | B.5 | Marshy grassland | |
| | | C.3.1 | Tall ruderal herb | |
| | | C.3.2 | Non-ruderal herb and fern | |
| | | H.8.4 | Coastal grassland | |
| | | H.8.6 | Coastal heath/coastal grassland mosaic | |
| GR | extensive grassland - nutrient rich | B.2.2 | Semi-improved neutral grassland | 25.2 |
| | | B.3.2 | Semi-improved calcareous grassland | |
| | | F.1 | Swamp | |
| | | F.1.1 | Scattered swamp | |
| | | F.2.2 | Inundation vegetation | |
| GI | intensive grassland | B.4 | Improved grassland | 31.9 |
| | | J.1.2 | Amenity grassland | |
| | | J.1.3 | Ephemeral/short perennial | |
| | | J.1.5 | Gardens | |
| WO | woodland | A.1.1.1 | Semi-natural broadleaved woodland | 11.4 |
| | | A.1.1.2 | Planted broadleaved woodland | |
| | | A.1.2.1 | Semi-natural coniferous woodland | |
| | | A.1.2.2 | Planted coniferous woodland | |
| | | A.1.3.1 | Semi-natural mixed woodland | |
| | | A.1.3.2 | Planted mixed woodland | |

| Broad Code | Broad Habitat Category | Phase1 Habitat Code | Phase 1 Habitat Categories | $CO_2$-e emission factor (t $ha^{-1}$ $yr^{-1}$) |
|---|---|---|---|---|
| | | A.2.1 | Dense scrub | |
| | | A.2.2 | Scattered scrub | |
| | | A.3.1 | Scattered broadleaved trees | |
| | | A.3.2 | Scattered coniferous trees | |
| | | A.3.3 | Scattered mixed trees | |
| | | A.4.1 | Felled broadleaved woodland | |
| | | A.4.2 | Felled coniferous woodland | |
| | | A.4.3 | Felled mixed woodland | |
| | | J.1.4 | Introduced scrub | |
| CR | Cropland | J.1.1 | Arable | 36.6 |
| NA | NA | C.2 | Upland species rich ledges | |
| | | G.1 | Standing water | |
| | | G.2 | Running water | |
| | | H.1.1 | Intertidal mud/sand | |
| | | H.1.2 | Intertidal cobbles/shingle | |
| | | H.1.3 | Intertidal rocks/boulders | |
| | | H.2.4 | Scattered salt marsh plants | |
| | | H.2.6 | Salt marsh | |
| | | H.3.1 | Mud/sand above mhw | |
| | | H.3.2 | Shingle/gravel above mhw | |
| | | H.4 | Rocks/boulders above mhw | |
| | | H.6.4 | Dune slack | |
| | | H.6.5 | Dune grassland | |
| | | H.6.6 | Dune heath | |
| | | H.6.7 | Dune scrub | |
| | | H.6.8 | Open dune | |
| | | H.8.1 | Hard cliff | |
| | | H.8.2 | Soft cliff | |
| | | I.1 | Natural rock exposure | |
| | | I.1.1 | Inland cliff | |
| | | I.1.1.1 | Acid/neutral inland cliff | |
| | | I.1.1.2 | Basic inland cliff | |
| | | I.1.2 | Scree | |
| | | I.1.2.1 | Acid/neutral scree | |
| | | I.1.2.2 | Basic scree | |
| | | I.1.3 | Limestone pavement | |
| | | I.1.4 | Other rock exposure | |
| | | I.1.4.1 | Acid/neutral rock | |
| | | I.1.4.2 | Basic rock | |
| | | I.1.5 | Cave | |
| | | I.2.1 | Quarry | |
| | | I.2.2 | Spoil | |
| | | I.2.3 | Mine | |
| | | I.2.4 | Refuse-tip | |
| | | J.3.4 | Caravan site | |
| | | J.3.5 | Sea-wall | |
| | | J.3.6 | Buildings | |
| | | J.3.7 | Track (not comprehensively digitised) | |
| | | J.4 | Bare ground | |
| | | NA | Not accessed land | |
| | | #N/A | Habitat code illegible on the original vegetation map | |

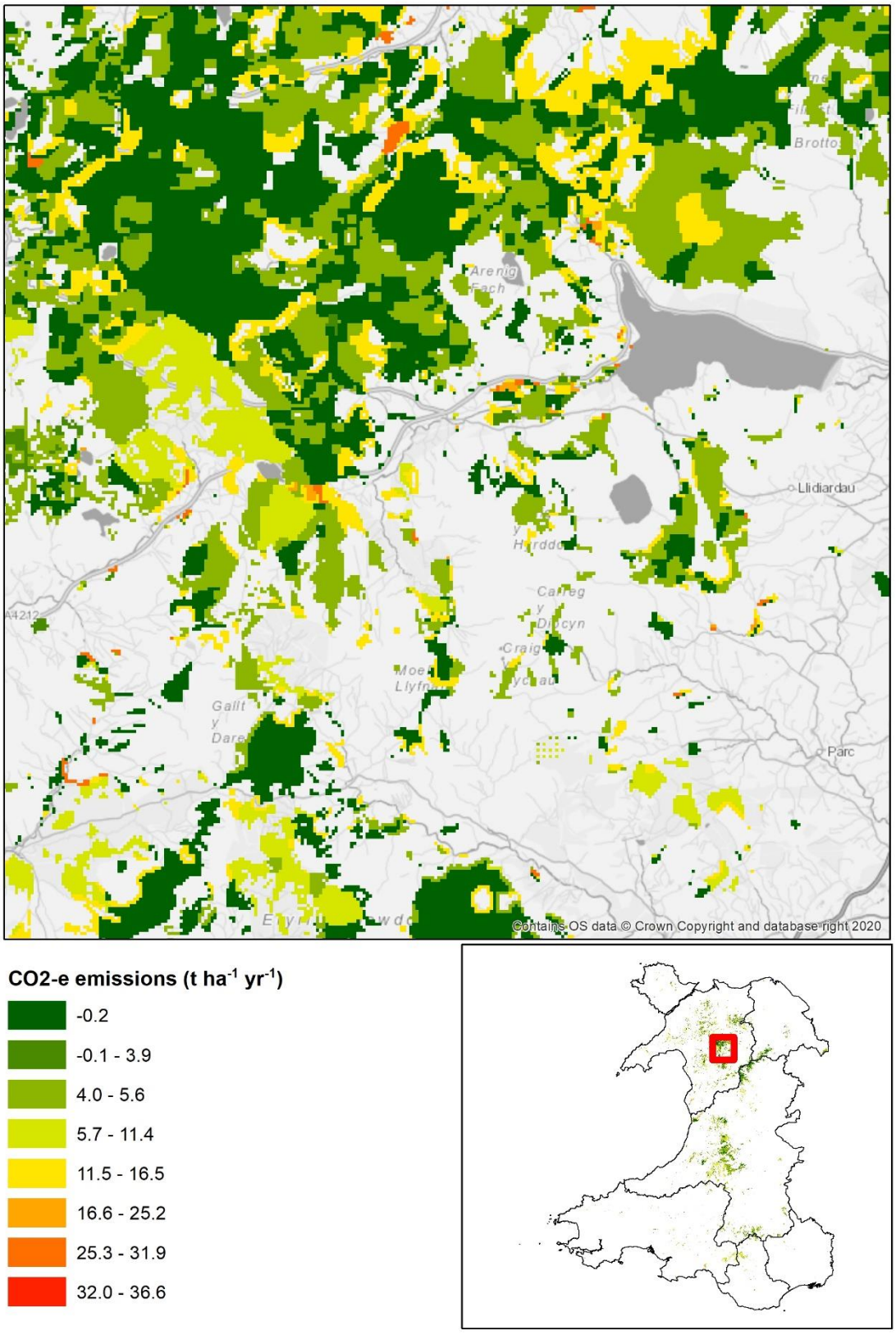


*Figure 15 Greenhouse Gas Emissions from peat soils (highlighting an area to show localised variation)*

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### *Attributions to be used in the mapping:*