Department for Energy Security & Net Zero

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Mapping greenhouse gas emissions & removals for the land use, land-use change & forestry sector

A report of the National Atmospheric Emissions Inventory 1990-2022

Prepared by the UK Centre for Ecology & Hydrology for the Department for Energy Security and Net Zero.

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Land Use, Land-Use Change and Forestry in the National Inventory

The Department for Energy Security and Net Zero (DESNZ) takes the lead in the UK in preparing the annual Inventory of Greenhouse Gas Emissions for the United Nations Framework Convention on Climate Change (UNFCCC). DESNZ contract Ricardo to compile the overall greenhouse gas emissions inventory and they in turn subcontract the UK Centre for Ecology and Hydrology (UKCEH) and Forest Research (FR) to prepare the data relating to Land Use, Land-Use Change and Forestry (LULUCF) in the UK.

This report is prepared in order to describe the method used to spatially disaggregate the emissions and removals in the LULUCF sector to enable the compilation of LULUCF estimates for Local Authorities (LAs) as part of DESNZ's assistance to LAs in tracking progress on decarbonisation.

The LULUCF data reported to the annual inventory is prepared in accordance with the reporting requirements of the UNFCCC. These estimates are made using dynamic models of changes in stored carbon, driven by land use change data. For forestry, the CARBINE model (developed and run by FR) deals with plant carbon, dead organic matter, soil carbon and harvested wood products and is driven by the area of land newly afforested each year, management practices and harvesting. Changes in soil carbon are driven by estimated time series of land use transitions between grassland, cropland, forest land and settlement land uses. These models, and those for other LULUCF activities (e.g. nitrogen fertilisation of forest soils, drainage and rewetting of organic soils), are run for each of the four countries of the UK to report emissions and removals of greenhouse gases (CO_2, CH_4 and N_2O). Until the 1990-2004 inventory (submitted in 2006) no data were reported in map format at a scale below the Devolved Administrations (DAs) (England, Scotland, Wales and Northern Ireland); here we report results from methods to provide estimates of LULUCF emissions and removals at the scale of LA within the UK for the 2022 inventory year (published in 2024).

The LULUCF Sector differs from other sectors in the Greenhouse Gas Inventory in that it contains both sources and sinks of greenhouse gases. The sources, or emissions *to the atmosphere*, are given as positive values; the sinks, or removals *from the atmosphere*, are given as negative values. The values reported here are given as net emissions/removals, i.e., the sum of emissions and removals for each category.

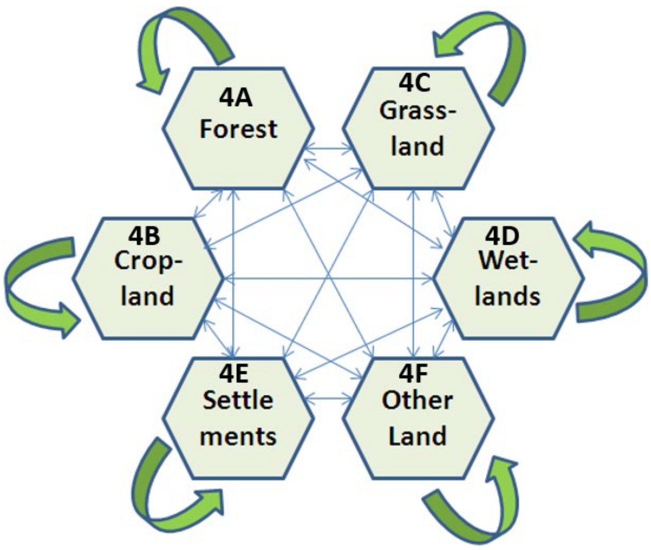
Land Use Categories

The IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006, IPCC 2014) describes a uniform structure for reporting emissions and removals of greenhouse gases. This format for reporting can be seen as "land based"; all land in the country must be identified as having remained in one of six classes since a previous survey, or as having changed to a different (identified) class in that period. The six land classes are A: Forest Land, B: Cropland, C: Grassland, D: Wetlands, E: Settlements and F: Other land. There is a seventh category for the pool of harvested wood products, category G.

The IPCC (2006) guidelines for LULUCF accommodate differences in national land-use classification systems. Emissions from the drainage and rewetting of peatlands, are reported under all LULUCF land use categories. For the purposes of this report peatlands and organic soils may be considered synonymous. These are compiled following guidance for estimating emissions from inland organic soils set out in chapters 2 and 3 of the 2013 IPCC Wetlands Supplement, and employing the Tier 2 methodological approach for implementation described in the BEIS-funded wetlands report (Evans et al. 2017), with additional updates summarised in section A.3.4 of the National Inventory Report Annexes (Brown et al. 2024). Emissions from drained and rewetted organic soils have been allocated to their local authorities in the UK using the peat condition mapping outputs from Evans et al. (2017) alongside spatial location of rewetting and peat extraction activities. The majority of peatland area is reported in the Grassland category, which includes semi-natural bog categories, extensive and intensive grassland, and rewetted bog or fen from semi-natural bog and intensive and extensive grassland. Emissions from active peat extraction (onsite, and off-site for horticultural peat[1]), as well as organic soils affected by historical peat extraction are reported under Wetlands. Naturally occurring emissions and removals from pristine areas of bog and fen, and rewetted bog or fen from Forest Land, Cropland, peat extraction, and pre-1990 rewetted fen are included in LULUCF reporting under Wetlands. Emissions of CO_2, CH_4, and N_2O from drained organic soils under Forest, Cropland and Settlement are reported in those respective categories.

The Other land category is predominantly made up of bare rock and scree and no emissions or removals are reported. In addition, it is assumed that there are very few, if any, transitions of land to a type that is classified as 'Other'.

Figure 1: UK Sector 4 land-use transitions showing categories for carbon stock change. See text for details.



The UK land-use change matrix can be simplified to that shown in Figure 1, including Forest Land (A), Cropland (B), Grassland (C), Wetlands (D), and Settlements (E). For each land use and land-use transition, the change in stocks of carbon in living biomass (above and below ground), dead biomass and soil organic matter should be reported. In Figure 1 each arrow represents the possible change for an area of land between two time points.

Different activities are associated with each land use or land-use change. For example, 'afforestation' refers to all land-use change *to* Forest Land, 'drainage' activity can relate to Forest Land, Cropland, Grassland, Wetlands, and Settlement. 'Peat extraction' affects

[1] While emissions from the combustion of peat used as fuel are reported in the energy sector of the country of consumption.

Wetlands. The change in carbon stocks of living biomass, dead biomass and soil organic matter must be reported for each activity together along with other relevant non-CO_2 gases (i.e. CH_4 and N_2O).

Further subdivision of the classes by ecosystem, administrative region or time of occurrence of change is also encouraged in the IPCC Good Practice Guidance. For the UK, the data are currently subdivided into England, Scotland, Wales and Northern Ireland where possible. Subdivision into smaller units is appropriate for modelling purposes and the development of estimates at local authority scale as described in this report.

Territorial Emissions Sectors

The UK implemented the Territorial Emissions Sectors (TES) structure for domestic inventory reporting in 2024. This report presents the LA LULUCF data in the TES structure for the first time. Details of what is included in each TES category are given in Annex 2.

The activities reported within LULUCF TES (sorted by order of magnitude are listed in Table 1. The data is presented as TES Subsector and Category UK total emissions/removals (Gg CO_2e) for 2022 as reported in the 1990-2022 Inventory (excluding emissions from the UK's Overseas Territories and Crown Dependencies). Full details of methodologies are given in the National Inventory Report (Brown et al. 2024).

Note that the IPCC 5th Assessment Report (AR5) Global Warming Potentials (GWPs) are used to convert N_2O and CH_4 to carbon dioxide equivalents (CO_2e) in this report and dataset.

Each of the activities are described below. Changes in net emissions from the LULUCF Sector over time are dominated by the decrease in CO_2 net emissions. While CH_4 emissions are fairly stable over time, they dominate LULUCF overall net emissions by gas in CO_2 equivalents over the timeseries (Brown et al. 2024). This is due to CH_4 emissions from drained and rewetted organic soils. Emissions of greenhouse gases are produced by undrained modified, rewetted and near natural peatlands (note that CH_4 emissions from near-natural bogs are cancelled out by CO_2 uptake in CO_2-equivalent terms), drainage ditches on peatlands, biomass burning during wildfires or the conversion of Forestry to other land uses. Direct and indirect emissions of N_2O are also produced from nitrogen fertilisation of new forests and soil mineralisation following land-use change. Emissions of non-CO_2 gases from agricultural land (e.g. due to fertilisation) are reported in the Agriculture sector of the Greenhouse Gas Inventory. Estimates in the 2022 inventory for the different GHGs are -6,253.93 Gg CO_2 for carbon dioxide, 5,720.04 Gg CO_2e for methane (or 204.29 Gg CH_4), and 1,291.81 Gg CO_2e for nitrous oxide (or 4.87 Gg N_2O) across the UK in 2022.

Table 1: The UK CO_2e emissions and removals in Land Use, Land-Use change and Forestry for 2022 grouped by Territorial Emissions Subsector and Category. Within each Subsector the Categories have been sorted by order of magnitude.

TES Subsector	TES Category	Gases	2022 Gg CO_2e
Forestry	Forest land remaining forest land	Carbon, N_2O	-18,042.93
	Land converted from forest land	Carbon, CH_4, N_2O	1,948.66
	Land converted to forest land	Carbon, N_2O	47.04
Peatland	Cropland drained	Carbon, CH_4	4,263.25
	Intensive grassland drained	Carbon, CH_4	3,393.38
	Modified bog undrained	Carbon, CH_4, N_2O	2,175.17
	Domestic extraction	Carbon, CH_4, N_2O	2,050.03
	Modified bog drained	Carbon, CH_4, N_2O	846.53
	Eroding modified bog undrained	Carbon, CH_4, N_2O	635.53
	Extensive grassland drained	Carbon, CH_4, N_2O	611.67
	Forest drained	Carbon, CH_4, N_2O	389.04
	Near-natural bog	Carbon, CH_4, N_2O	203.60
	Industrial extraction	Carbon, CH_4, N_2O	188.70
	Eroding modified bog drained	Carbon, CH_4, N_2O	163.83
	Rewetted bog	Carbon, CH_4, N_2O	116.55
	Rewetted fen	Carbon, CH_4, N_2O	84.24
	Settlement drained	Carbon, CH_4, N_2O	30.86
	Rewetted modified bog	Carbon, CH_4, N_2O	23.84
	Near-natural fen	Carbon, CH_4, N_2O	-0.96
Cropland mineral soils under LUC	Grassland converted to cropland	Carbon, N_2O	5,099.58
	Cropland remaining cropland	Carbon	4,308.24
	Settlement converted to cropland	Carbon	-61.78
Grassland mineral soils under LUC	Grassland remaining grassland	Carbon, N_2O	-4,850.48
	Cropland converted to grassland	Carbon	-3,640.76
	Settlement converted to grassland	Carbon	-379.11
Settlement	Settlement remaining settlement	Carbon, N_2O	1,644.68
	Land converted to settlement	Carbon, N_2O	1,489.21
Bioenergy crops	Miscanthus	Carbon	-6.78
	Short rotation coppice	Carbon	-2.12
Other LULUCF	Grassland miscellaneous	Carbon, CH_4, N_2O	457.95
	Cropland miscellaneous	Carbon, CH_4, N_2O	-260.88
	Forest miscellaneous	Carbon, CH_4, N_2O	39.95
	Wetland miscellaneous	Carbon	0.00

* Forestry, Harvested Wood Products is not included in the LA estimates because of insufficient data for distributing the emissions and removals.

Coverage

The methods used for disaggregating each activity from DA to LA scale are described below. The level of spatial detail available differs between activities. For all activities there is currently no spatial activity data available for the Isle of Scilly, hence all LULUCF emissions and removals are estimated as zero for this LA.

Disaggregation Methodologies

The methodology for disaggregating the DA LULUCF data to LA scale spans two main workflows which are described below.

Land Use Change Tracking Maps

Data Preparation

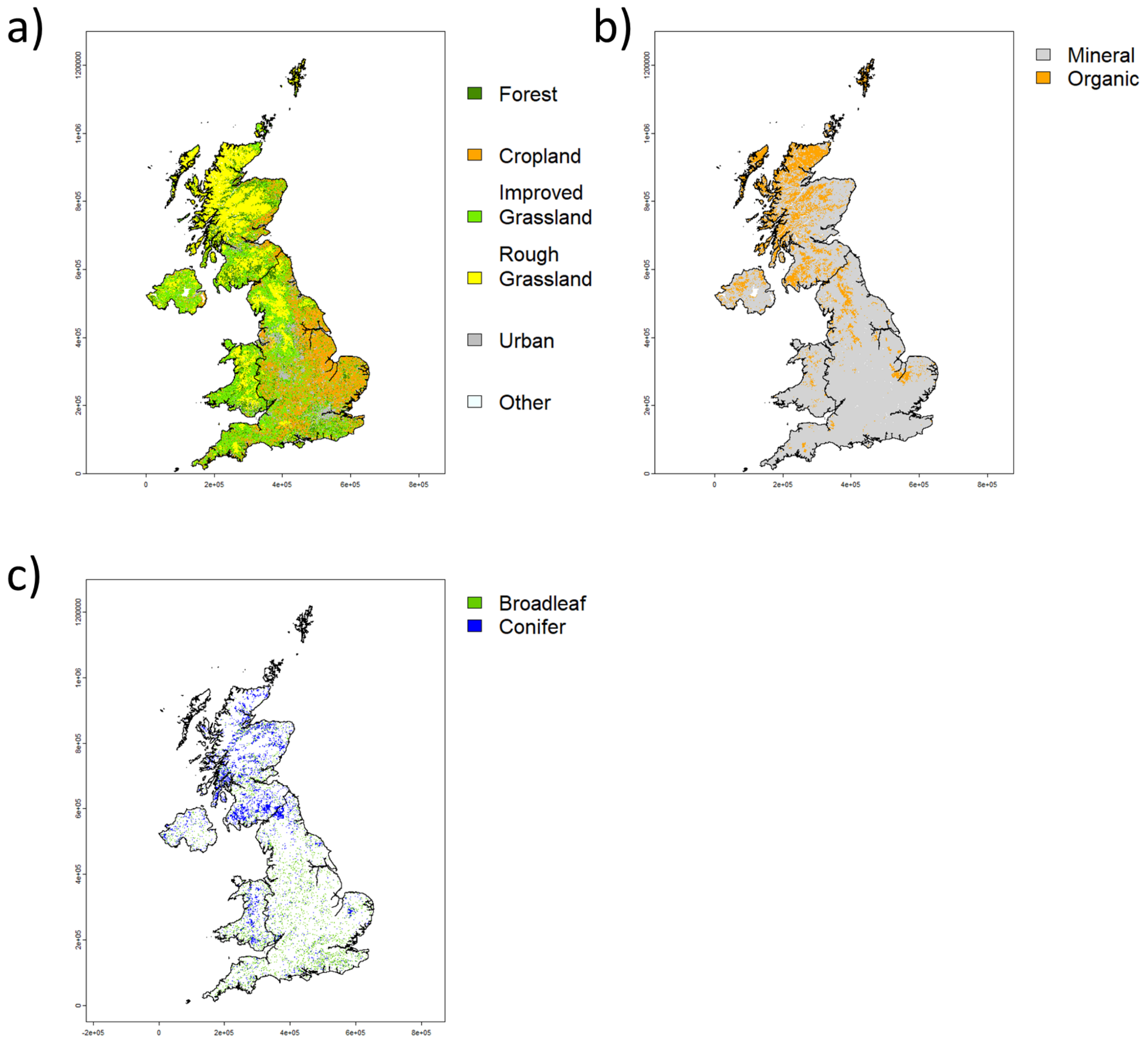
This methodology uses land use change (LUC) variables calculated from the Land Use Change Tracking project (LUC-T) spatial maps (Levy et al. 2020, 2021; Rowland et al. 2021). Outputs from this project include land use classification maps at 100m x 100m spatial resolution and an annual temporal resolution. Land is classified as Forest, Cropland, Grassland (Improved Pasture), Rough Grassland, Urban and Other land. This data is produced using a Bayesian data assimilation approach, with full details provided in the project reports (Levy et al. 2020, 2021; Rowland et al. 2021). An example of the gridded data is shown in Figure 2a.

This data is then supplemented with soil and forest type data.

A raster soil type map (showing locations of mineral and organic soils) at 100m grid scale is produced from the organic soil basemaps in England, Scotland, Wales and Northern Ireland (see Figure 2). The gridded data is shown in Figure 2b.

Maps of forest type are produced for each year, assigning each 100m x 100m forest grid cell in the LUC-T land use maps as either broadleaf or conifer. Forest type data for 2005, 2010, 2015, 2018 and 2020 for GB, and 2020 for NI (produced for the LUC-T project as described in Rowland et al. 2021), are re-categorised to broadleaf and conifer, with an ‘unspecified’ category assigned to useful remaining data, such as that classified as ‘woodland’ or ‘unknown’. This unspecified data is then reassigned to broadleaf or conifer based on the nearest neighbour. Subsequently, for each LUC-T land use map from 1985-current inventory year, the forest type data from the closest year available is used, and forest grid cells are categorised as broadleaf or conifer based the value from the forest type map intersecting the grid cell location. As the LUC-T land use maps are produced from a probabilistic model, plus forest type data does not have 100% coverage, not all forest grid cells will align with forest inventory data. In this case, if the grid cell location from the land use map does not intersect forest on the forest type map, the closest broadleaf/conifer value to the grid cell is used. Figure 2c shows an example of the gridded data output.

Figure 2: Raster files used as inputs for calculating spatial variables. (a) Land use categories from LUC-T in 2020; (b) Soil types; (c) Forest types in 2020.



Calculating Spatial LUC Variables

The spatial LUC variables are calculated based on the three sets of maps: land use, soil type and forest type. The spatial variables to be calculated fall into five categories:

- **Current land use**
  Grid cells where the land use in the year being considered (2005-current inventory year) and the soil type matches the condition.
  e.g. Current Cropland on mineral soil
- **Land use changes in the last year**
  Grid cells where the current land use and the land use in the previous year (for 2005-current inventory year, so requires data 2004-current inventory year), as well as the soil type match the conditions.
  e.g. Settlement to Cropland in the last year on all soils
- **Land use changes in the last three years**

Grid cells where the current land use and the most recent land use change in the previous three years, as well as the soil type, match the conditions (requires data 2002-current inventory year)
e.g. Grassland to Forest Organic in the previous three years

- **Land use changes in the last 20 years**
  Grid cells where the current land use and the most recent land use change in the previous 20 years, as well as the soil type, match the conditions. In some cases the land use prior to the change is specified and in others it can be any land use. (requires data 1985-current inventory year)
  e.g. Cropland to Forest Mineral < 20 years
- **Land remaining the same land use for at least the last 20 years**
  Grid cells where the current land use, soil type and forest type (for forest land use cells) match the condition and the grid cell has remained in the same land use for at least the last 20 years (requires data 1985-current inventory year)
  e.g. Broadleaf Forest on Mineral >= 20 years

A full list of the spatial variables required are in Annex 1, matched to the emissions/removals they are used to disaggregate. The columns “Group”, “From Land Use”, “To Land Use” and “Soil Type” specify how the variable is defined.

The spatial LUC variables are calculated for each year in the disaggregation time series (2005-current inventory year), by looking back over the 20 years prior to each year. Where a grid cell has undergone multiple land use changes within the previous 20-year period, only the most recent land use change is considered when categorising it into the variables.

This produces 100m x 100m spatially gridded data for each year covering the whole UK for each spatial variable.

Disaggregating Emissions / Removals

LULUCF Inventory totals are disaggregated to LAs according to the spatial LUC variables. Each inventory emissions/removal total is disaggregated based on the number of grid cells from the relevant spatial LUC variable within the LA polygons. Inventory emissions are matched with spatial variables to be used for disaggregation as in Table A1. The number of grid cells from the relevant spatial LUC variable in each polygon is divided by the total number in the DA. The proportions are calculated for each year (2005-current inventory year). When calculating how many grid cells are in each polygon, grid cells are assigned to polygons based on whether the midpoint of the cell lies within the polygon. To apportion the emissions/removals DA totals for each year from the inventory are multiplied by the spatial LUC variable proportions for the year associated with each polygon. In cases where, for a given spatial LUC variable and year, a DA contains no grid cells for that spatial variable but there is a non-zero emission/removal total to disaggregate, the proportions from the most recent year with grid cells in the DA are used. In cases where the LUC-T data has not been produced for the current inventory year, proportions from the previous year are used for all spatial LUC variables (this is the case for 2021 and 2022 as currently the LUC-T methodology only runs to 2020).

Organic Soil Maps

This methodology utilises organic soil base maps of peatland condition and Google Earth data of active peat extraction. Firstly, using point location data for organic soil rewetting sites, annual areas of peatland rewetting are added to the polygon organic soil base maps to create an annual timeseries of peatland condition category which includes accounting of rewetting activity. Secondly, annual peat extraction polygon areas derived from Google Earth imagery are used to calculate annual maps of active peat extraction and rewetted peat extraction. The peatland condition category and peat extraction timeseries can then be intersected with LA boundaries. See Table 2 below for details on input data.

Table 2: Details of data inputs used in organic soil rewetting and peat extraction calculations.

Layer	Year	Description	Reference
England base map	2013	Organic soil vector polygon data covering England, including peatland condition category	Evans et al. (2017); Brown et al. 2024
Scotland base map	1990	Organic soil vector polygon data covering Scotland, including peatland condition category	Evans et al. (2017); Brown et al. 2024
Wales base map	1990	Organic soil vector polygon data covering Wales, including peatland condition category	Evans et al. (2017); Brown et al. 2024
NI base map	2007	Organic soil vector polygon data covering Northern Ireland, including peatland condition category	Evans et al. (2017); Brown et al. 2024
Rewetting sites	2000 - 2012	Rewetting site data covering E/S/W/NI. Includes XY location, total area and peatland condition category. Rewetting is known to occur between 2000-2012 but no specific year given	Evans et al. (2017); Brown et al. 2024
Scotland rewetting sites post 2012	2013 - current year	Scotland year-specific rewetting data from 2013 onwards. Includes XY location and peatland condition category	Peatland Action
Peat Extraction annual shapefiles	2002, 2005, 2010, 2014 - current year	Peat extraction extent shapefiles created from Google Earth imagery. Covering E/S/W/NI	Brown et al. 2024

Local Authority boundaries E/S/W	2023	Local authority boundary vector polygon shapefile for E/S/W	statistics.gov.uk
Local Authority Boundaries NI	2012	Local authority boundary vector polygon shapefile for NI. NI is a separate shapefile due to different coordinate system	opendatani.gov.uk

Data Preparation

Due to some non-spatial (e.g. DA level) data used in the main LULUCF inventory, preparation of the organic base maps and rewetting site data is required before they can be used for spatial disaggregation.

Drainage and bare peat assumptions for mapped areas of ‘Eroded’ Bog are applied to LAs by splitting ‘Eroded’ polygons proportionally between four peatland condition categories (Eroding Drained, Eroding Undrained, Modified Bog Drained, Modified Bog Undrained). For each DA the Eroded polygons from the organic base map are selected and split based on DA specific proportions. Each polygon is split individually into the four categories to ensure equal distribution across the DA.

Rewetting site data is given as point location data with peatland condition category and total area rewetted for each site. In the main LULUCF inventory, Modified Bog sites are rewetted from three different peatland condition categories (Modified Bog, Extensive Grassland and Eroding Modified Bog, based on DA specific proportions). To calculate spatially explicit rewetting from the correct peatland condition category all Modified Bog rewetting sites are split into three with areas calculated based on DA specific proportions.

Further, additional site information is required and calculated for each site prior to running rewetting calculations, including:

- Average rewetting (2000 – 2012): Rewetting is known to occur between 2000 – 2012 but as no specific year is given the 2000 – 2012 average is removed annually (note that for Scotland post-2012 year specific rewetting is given and therefore averages are not required).
- Site minimum and maximum: rewetting site calculations are unlikely to find an area of the exact average rewetting area. The site minimum and maximum provide upper and lower thresholds in which to calculate area that still rounds to the correct area in hectares.
- Peatland condition match variable: peatland condition category names vary slightly between data inputs; this variable ensures rewetting site soil categories can be matched to the organic base maps.

Calculation Methodology

The following methodology is used to create a timeseries of organic soil maps for each DA.

1. Using peat extraction spatial data create an annual timeseries of peat extraction areas (including rewetted peat extraction sites where peat extraction areas decrease). Peat

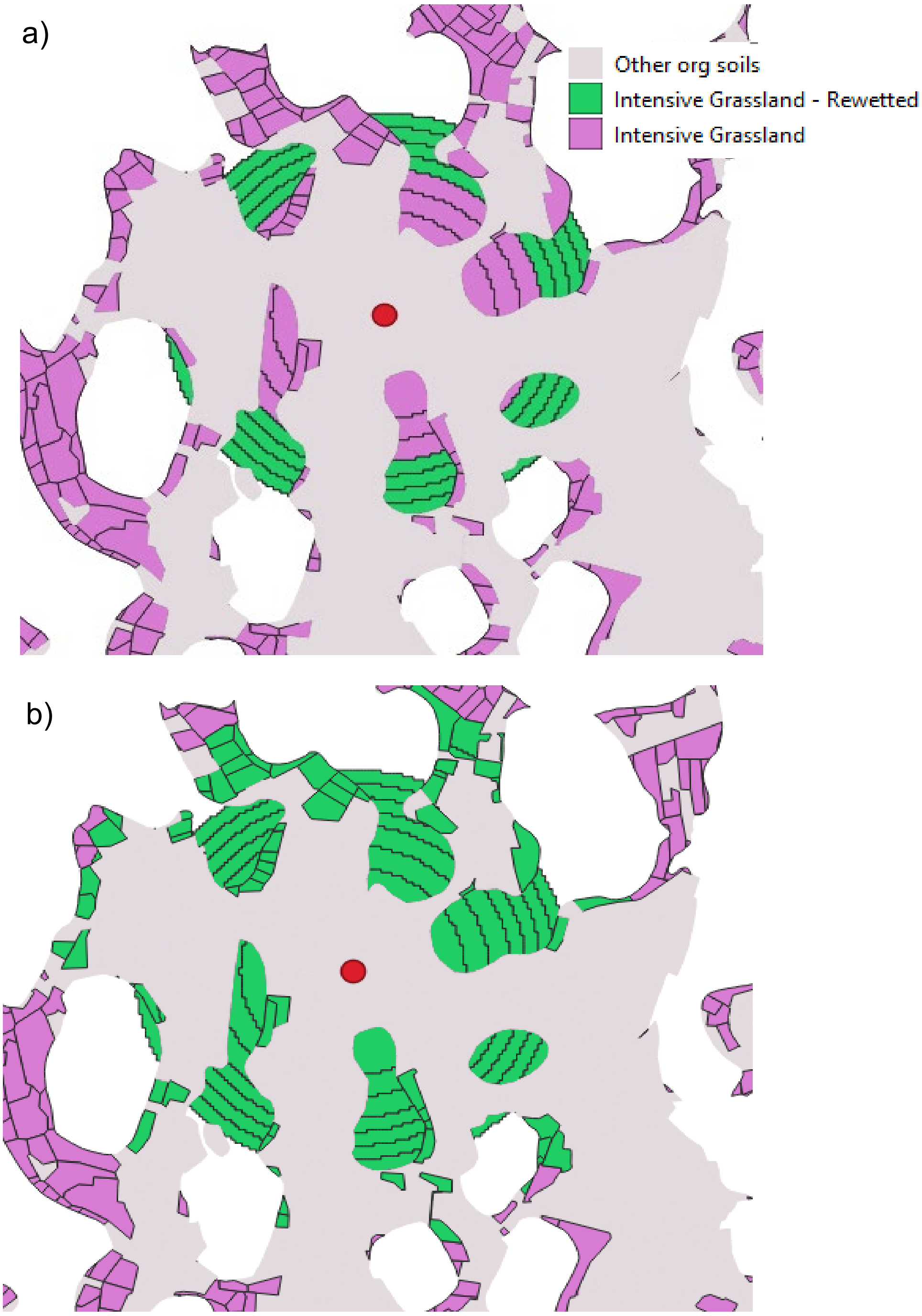
extraction areas are not available for all years in the timeseries - the missing years are filled in linearly with the difference between available years. Land to peat extraction is calculated in LULUCF from three grassland categories based on DA specific proportions. The underlying peatland condition categories in the organic base maps are not necessarily consistent with this assumption. Therefore, the peat extraction timeseries is not combined into the organic soil maps. However, to ensure spatially consistent cumulative areas the merged peat extraction areas are intersected with the organic base layer to identify organic areas that should not be used in rewetting calculations.

2. For each site in the rewetting site dataset (point location datasets with variable fixed - point uncertainties) the aim is to reassign areas of relevant initial peatland condition to rewetted. Where no year specific data for rewetting exists the average annual rewetting area is used. Rewetting is assumed to be spatially correlated to the site (i.e. rewetting occurs in soils closest to the point identifying the site location). When every site in the year has been calculated, this map is used as the input for the next year of calculations.
3. The baseline year for England and NI are in the middle of the timeseries. To deal with this, areas are retrospectively added in to the timeseries from baseline year to 2000 using the same assumptions as the main rewetting calculations. Although the final disaggregation is only required from 2005, rewetting must be calculated back to 2000 to ensure consistent cumulative areas.
4. Intersect the peat extraction timeseries and organic rewetting timeseries with LA boundary data.

Examples of rewetted calculations are given in Figure 3 which shows rewetting in Northern Ireland in 2003 for an Intensive Grassland rewetting site. As the baseline for Northern Ireland is 2007, retrospective areas were added in to 2000 – the concentric circles in Figure 3a. There are 4 years of rewetting shown in green (i.e. 2000 – 2003), with the non-rewetted Intensive grassland shown in purple.

Figure 3b below shows the same site in NI in the year 2010. As the figure shows, the entirety of the retrospectively added areas have been rewetted, and rewetting areas after the baseline year are being summed from the base map polygons. Restoration activity data supplied as polygon features rather than point-locations would improve this representation.

Figure 3: Organic soil rewetting calculations for an intensive grassland rewetting site in Northern Ireland (red dot). Where: (a) demonstrates retrospective area addition for 2000-2003; (b) demonstrates cumulative rewetting in 2010.



Disaggregating Emissions / Removals

The analysis described above produces tables with the area of each peatland condition category in each LA in each year, for each DA. These areas are converted to proportions of the DA total for each peatland category in each LA. These proportions are then used to disaggregate the DA emissions/removals totals by multiplying the DA totals by the peatland category area proportions. The emission/removal totals are disaggregated according to peatland condition category. The current peatland condition category (for each year) is used to disaggregate the emissions.

Forestry

For the National Inventory, the carbon uptake by forests planted in the UK is calculated by a carbon accounting model, CARBINE, as gains and losses in pools of carbon in standing trees, litter and soil in conifer and broadleaf forests and in harvested wood products. Forests accumulate carbon (by removing CO_2 from the atmosphere) in their biomass and soils as they grow, but timber harvesting, planting activities and drainage disturb this accumulation and result in loss of carbon via emissions of carbon dioxide, and other greenhouse gases to the atmosphere. The net carbon stock change at any one time depends on the balance between these different activities. Forestry management cycles operate over long timescales (40+ years), so the rate of carbon dioxide removal *now* is driven by the rate of forest planting in previous decades. Three parameters are required for the model; a) areas of new forest planted in each year in the past, b) areas deforested each year and c) management/harvesting pattern.

For mapping at LA scale, the mineral soil and biomass (living biomass, dead wood and litter) carbon stock change from the CARBINE model for England, Scotland, Wales and Northern Ireland were disaggregated using the LUC-T methodology. Similarly the N_2O from mineralisation and fertilisation and the Carbon, N_2O and CH_4 from controlled burning following deforestation were disaggregated using the LUC-T methodology.

Figure 4 shows the distribution of carbon stock change (biomass and mineral soil) and emissions from mineral soil drainage due to forest land remaining forest land (> 20 years old) per local authority area expressed as tonnes of carbon dioxide per square kilometre (tCO_2 per km^2). Maps of total CO_2 emissions/removals per LA can be misleading due to the wide range of areas across authorities – maps tend to be dominated by the Highland region of Scotland, therefore tCO_2 per km^2 are presented instead.

Figure 5 shows the distribution of carbon stock change (biomass and mineral soil) and emissions from mineral soil drainage for land converted to forest land (< 20 years prior to the reporting year) by local authority. In some local authorities there are net emissions for this category as within the 20 year time period the carbon gains from the forest biomass do not yet outweigh the losses from the soil disturbance.

Figure 6 shows the distribution of carbon stock change (biomass and mineral soil), emissions from mineral soil drainage and emissions from controlled burning following land converted from forest land (deforestation) by local authority. The biomass losses and controlled burning emissions are assumed to occur in the year of deforestation whereas the mineral soil carbon stock change occurs over much longer timescales.

Figure 4: Distribution of Forestry: Forest land remaining forest land net emissions/removals from the atmosphere in 2022 per local authority area expressed as tCO_2 per km^2.

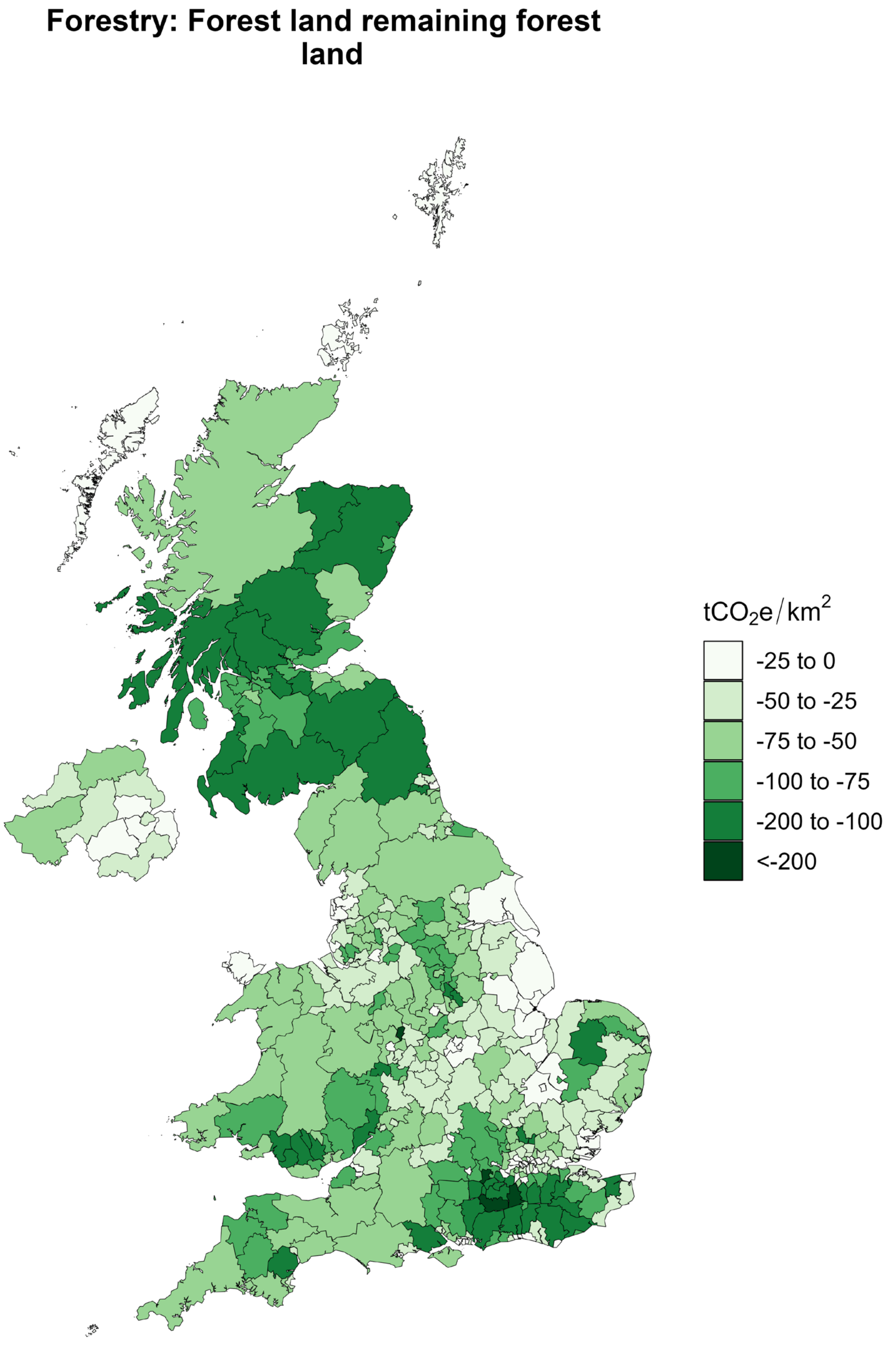


Figure 5: Distribution of Forestry: Land converted to forest land net emissions/removals from the atmosphere in 2022 per local authority area (tCO_2e/km^2).

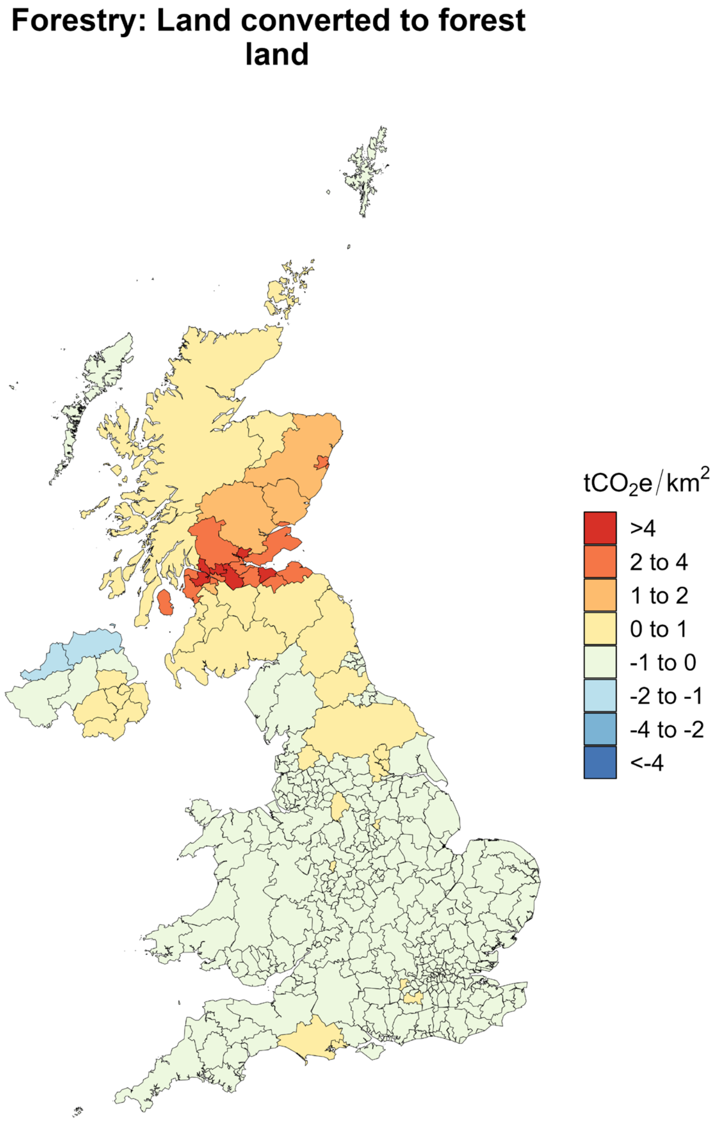
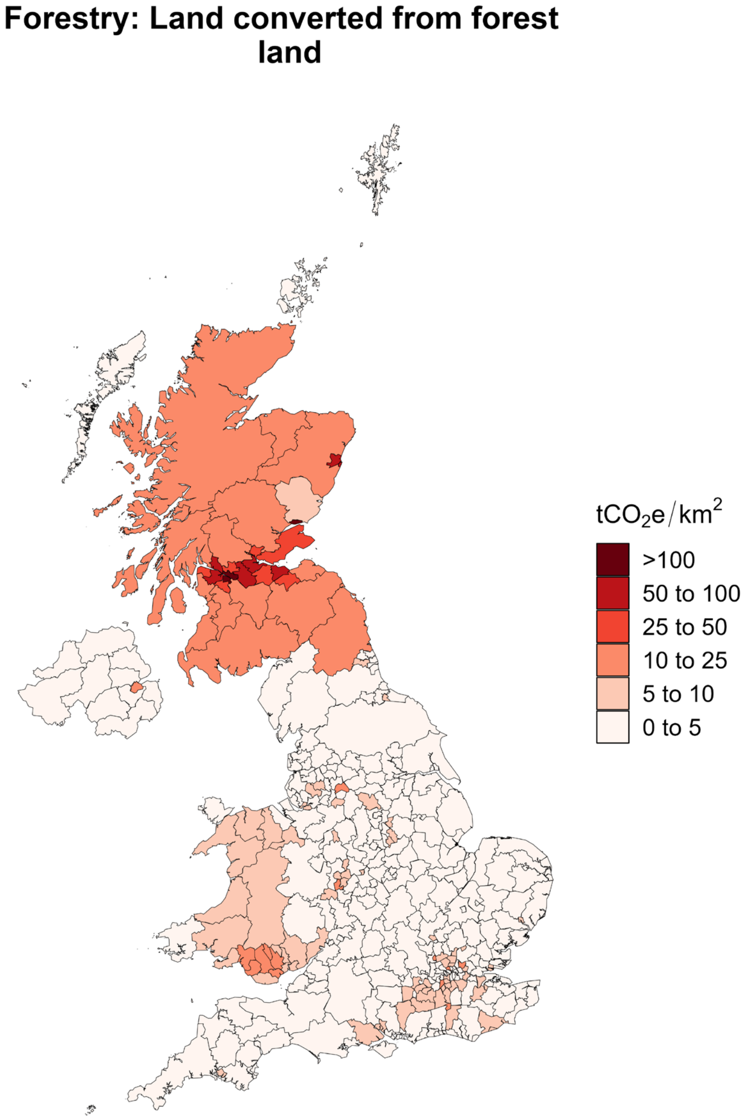


Figure 6: Distribution of Forestry: Land converted from forest land net emissions/removals from the atmosphere in 2022 per local authority area (tCO_2e/km^2).

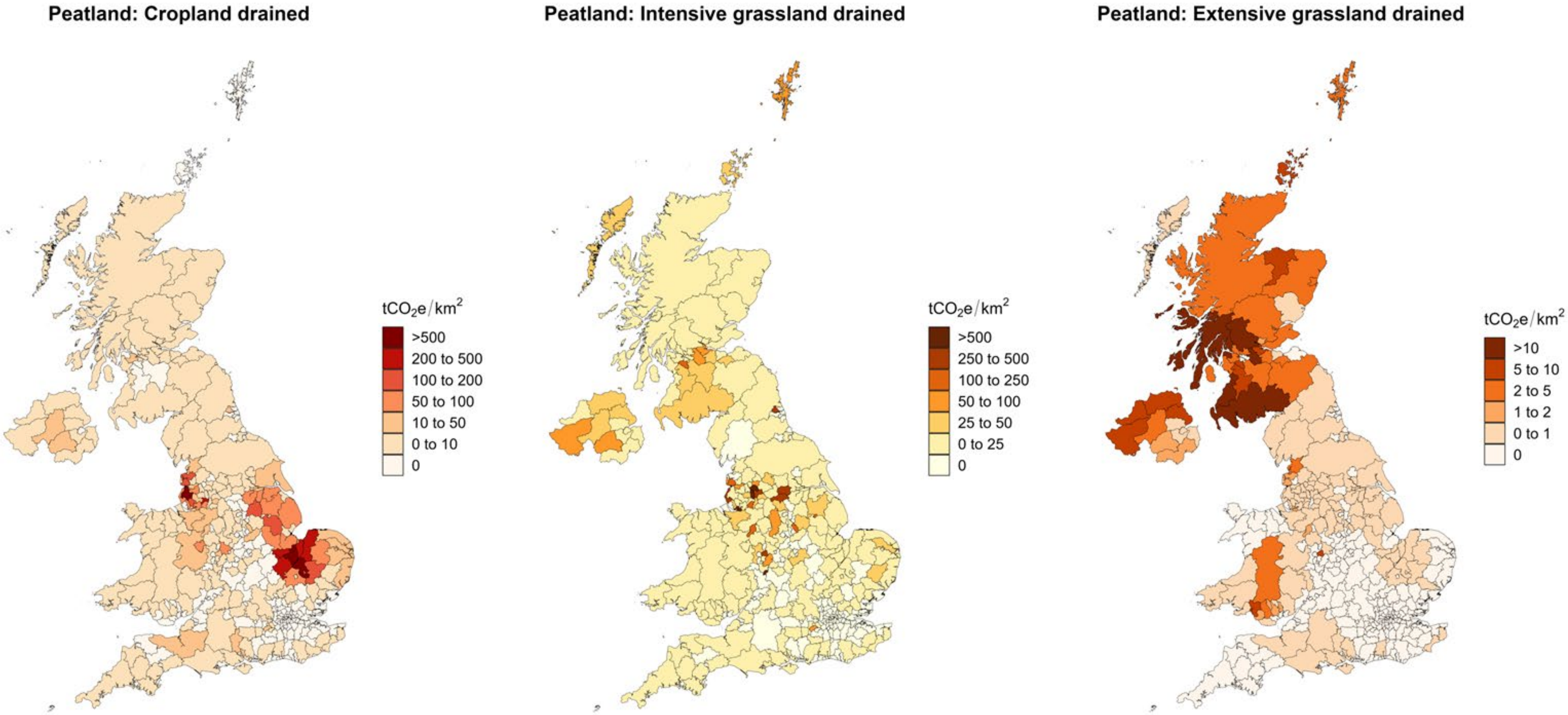


Peatland

Agricultural

Most peatlands in the UK were drained many decades ago for agricultural purposes and continue to lose carbon from the soil as CO_2, as well as emit significant amounts of N_2O associated with organic matter decomposition. Emissions from drained organic soils under Cropland are largely concentrated in the East, North Midlands and Northwest of England and are associated with deep (>40cm depth) and wasted peat (organic soils that were previously deep peat, and now mapped as retaining less than 40 cm of peat). Like Cropland, Intensive Grassland, defined as grassland which has been fertilised, ploughed and re-seeded, high-density grazed or hay-cropped, has high GHG emissions per unit area and also occur on wasted peat in England. Extensive Grassland, defined as unfertilised permanent grassland, lower-density grazed or hay-cropped, follows a slightly different spatial pattern to intensive grassland as these peatlands typically occur at higher elevations, though are mapped as grazing land below the upland boundaries (Figure 7).

Figure 7: Net carbon dioxide and methane emissions Peatland: Cropland drained, Intensive Grassland drained and Extensive Grassland drained per local authority area (tCO_2e/km^2) in 2022.

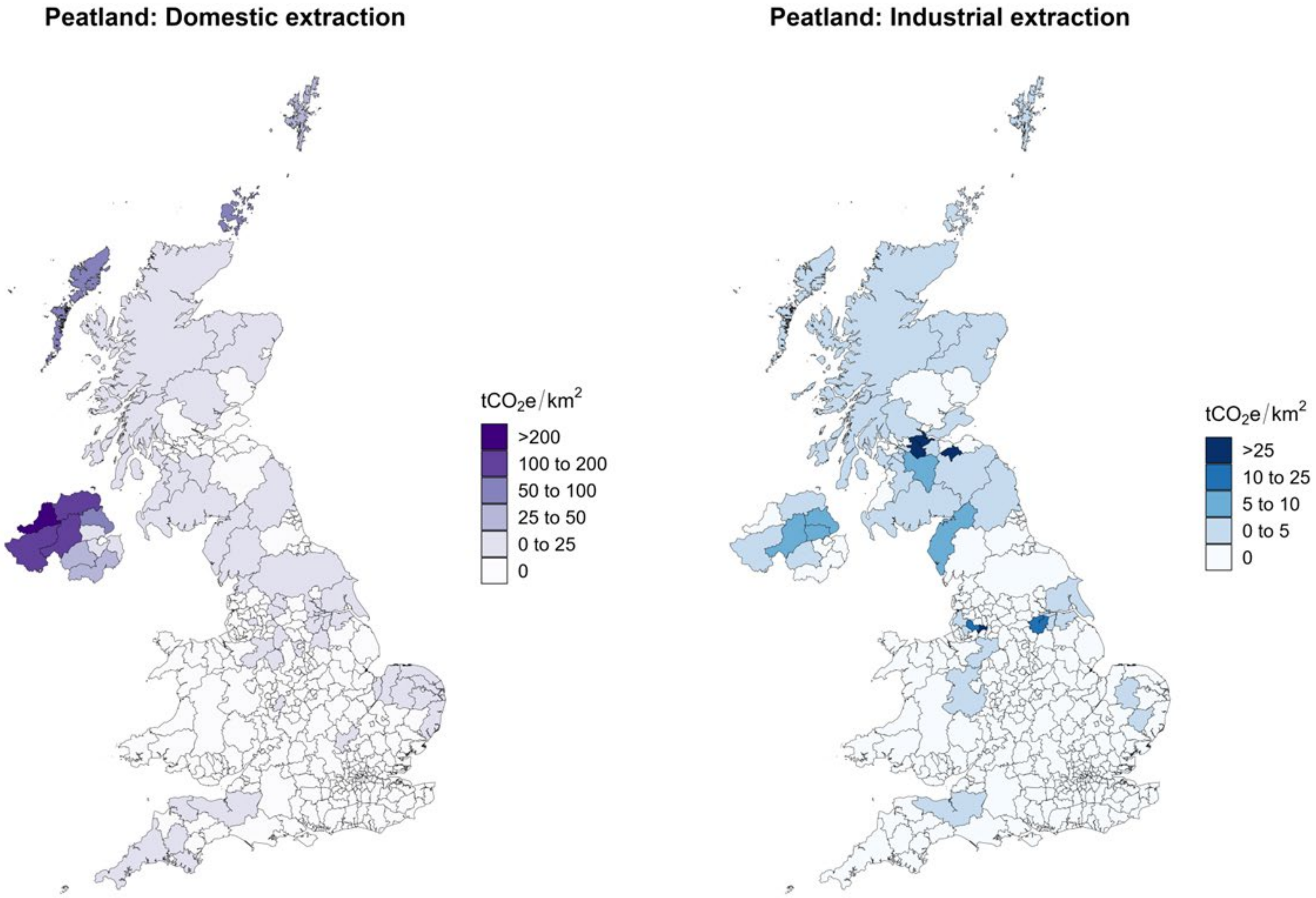


Peat Extraction

On-site CO_2, CH_4 and N_2O emissions and off-site CO_2 emissions from Domestic Peat Extraction for fuel and Industrial Peat Extraction for horticulture are calculated for the LULUCF inventory based on data published in the *Mineral Extraction in Great Britain Business Monitor PA1007* which provides data on the volume of domestic and industrial peat extracted, and *The UK Growing Media Monitor* (GMA 2023) which gives data on volumes of horticultural peat sold, the BGS *Directory of Mines and Quarries (DMQ)* and BritPits database, and peat condition mapping outputs from Evans et al. (2017) which gives the location of peat extraction sites, and the UKCEH Google Earth dataset which provides information on the area and activity of peat extraction sites. The DMQ and BritPits data give the location of origin of active peat extraction, and mapping outputs from the BEIS-funded Wetlands Supplement project (Evans et al. 2017) also provide areas of historical domestic and industrial extraction, we have assumed that the carbon emission applies to this combined area (see Brown et al. 2024).

Emissions are disaggregated using the organic soil maps methodology. Local authorities with no peatland extraction activities have zero emissions from peat extraction.

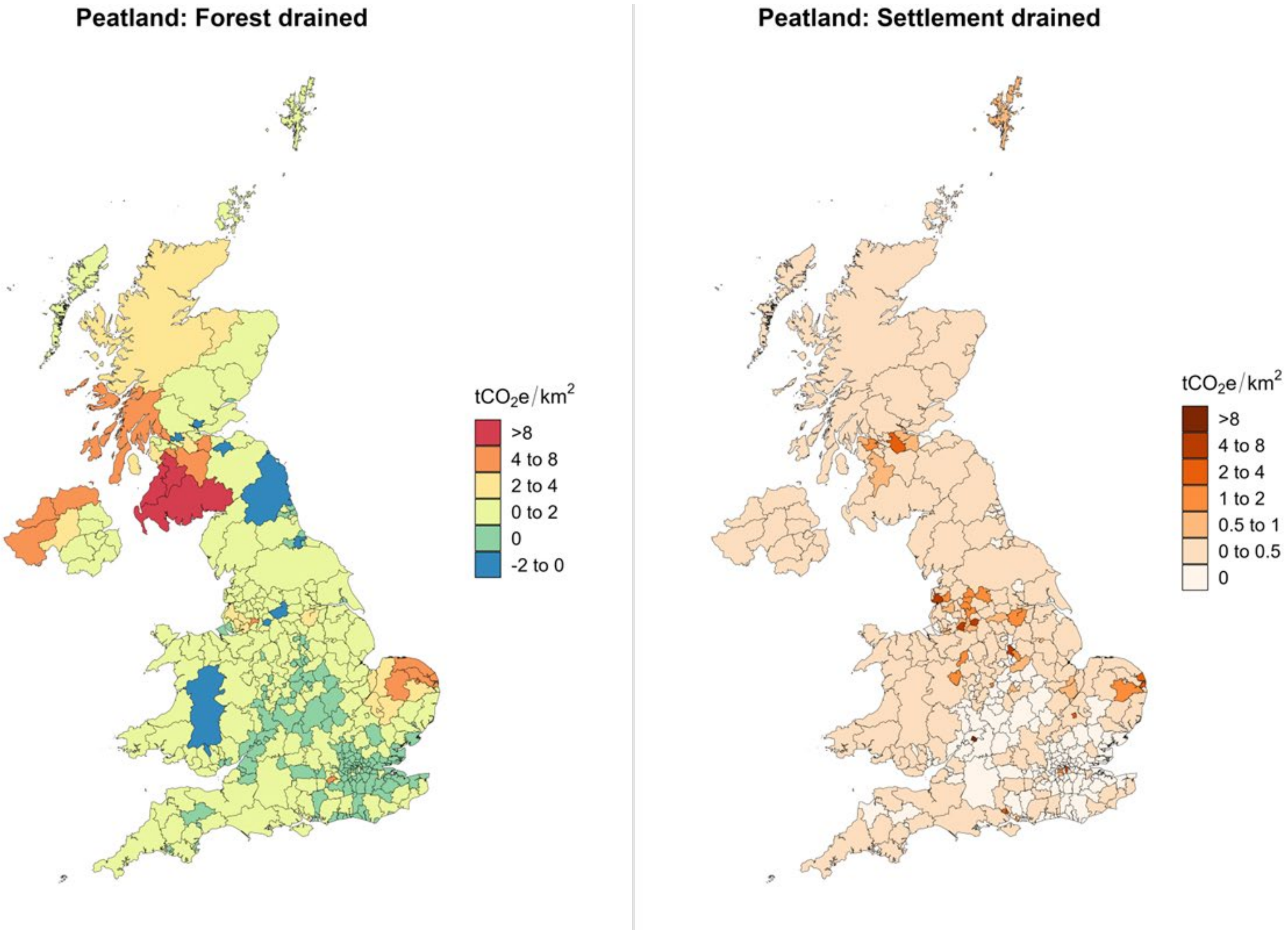
Figure 8: Net carbon dioxide, methane and nitrous oxide emissions from Peatlands: Domestic extraction and Industrial extraction per local authority area (tCO_2e/km^2) in 2022.



Forest and Settlement

Net emissions due to drainage of organic soils under Forest Land and Settlement are shown in Figure 9. Forest drained includes soil carbon stock change from CARBINE modelling, CO_2 emissions from indirect fluvial export of particulate organic carbon (POC) and dissolved organic carbon (DOC), emissions of direct CH_4, indirect CH_4 from ditches, and N_2O emissions, which are disaggregated to LA scale using the organic soil map methodology. The distribution of emissions from drained organic soils under Forest is focused in Scotland where peat extent and the location of forests are both high (Figures 4 & 5). Net emissions are close to zero in some LAs where accumulation of new carbon from litter inputs to the soil counterbalances the loss of old carbon due to drainage of the soil. Emissions from Settlement on organic soils mostly occur in lowland regions where population density is higher.

Figure 9: Net carbon dioxide, methane and nitrous oxide emissions from Peatlands: Forest drained and Settlement drained per local authority area (tCO_2e/km^2) in 2022.



Upland - Modified

Large areas of UK peatlands are in a semi-natural state, predominantly heather- and grass-dominated bog that are modified to a degree by drainage, grazing and burning-management practices, which affects the strength of carbon sequestration. Emissions of CO_2, CH_4 and N_2O

from drained and undrained Modified Bog and Eroding Modified Bog (bare peat) were disaggregated to the LA level using the organic soil maps methodology, and are reported under Grassland. The emissions from these peatland habitats are distributed similarly across the UK, with patterns of highest emissions for semi-natural peatlands (drained and undrained modified bog and eroding modified bog) in the Highlands and Islands of Scotland, the Pennines in Northern England, North West and Mid Wales, and North and West Northern Ireland (Figures 10 & 11).

Figure 10: Net carbon dioxide, methane and nitrous oxide emissions from Peatlands: Modified Bog drained and Eroding Modified Bog drained per local authority area (tCO_2e/km^2) in 2022.

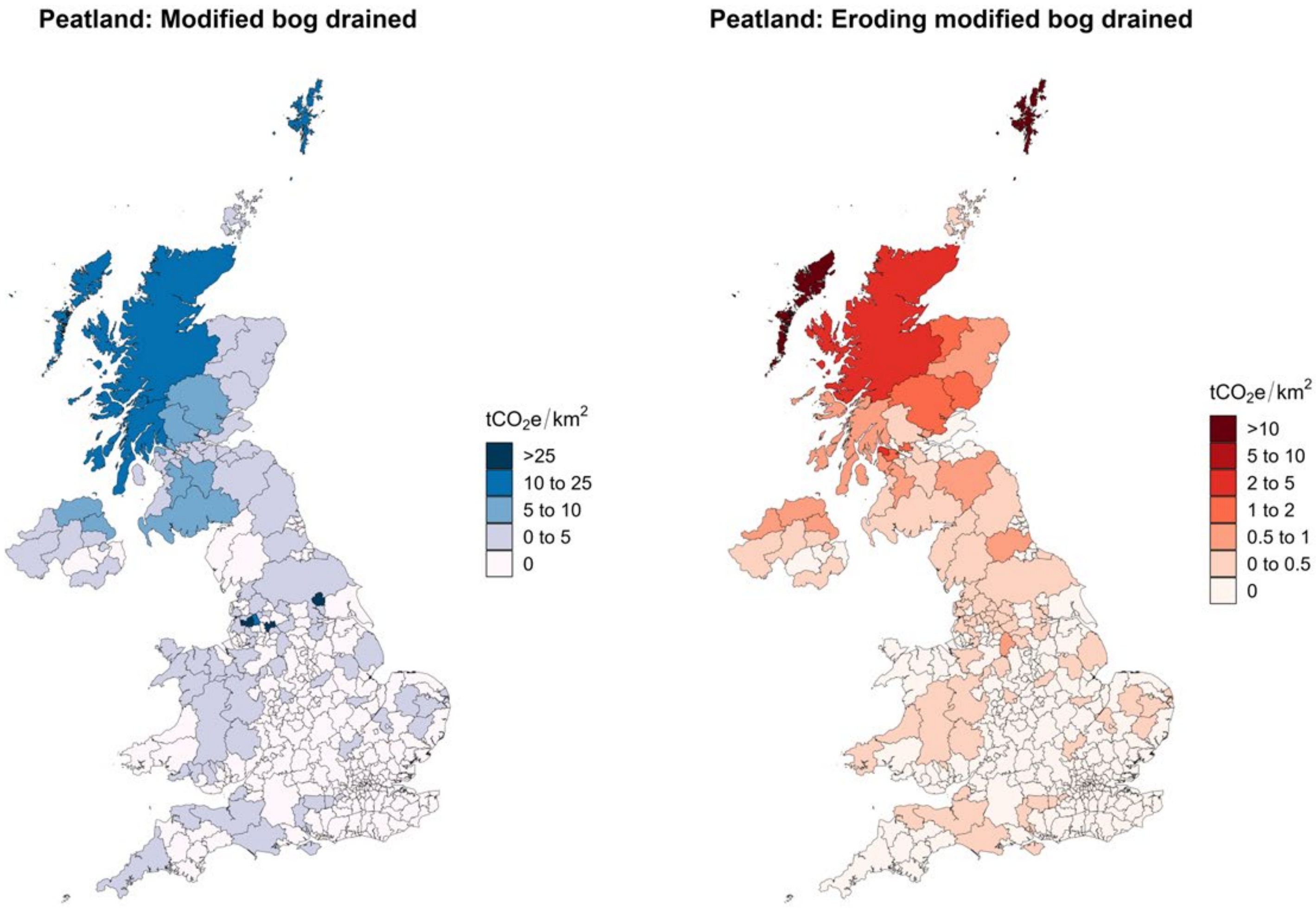
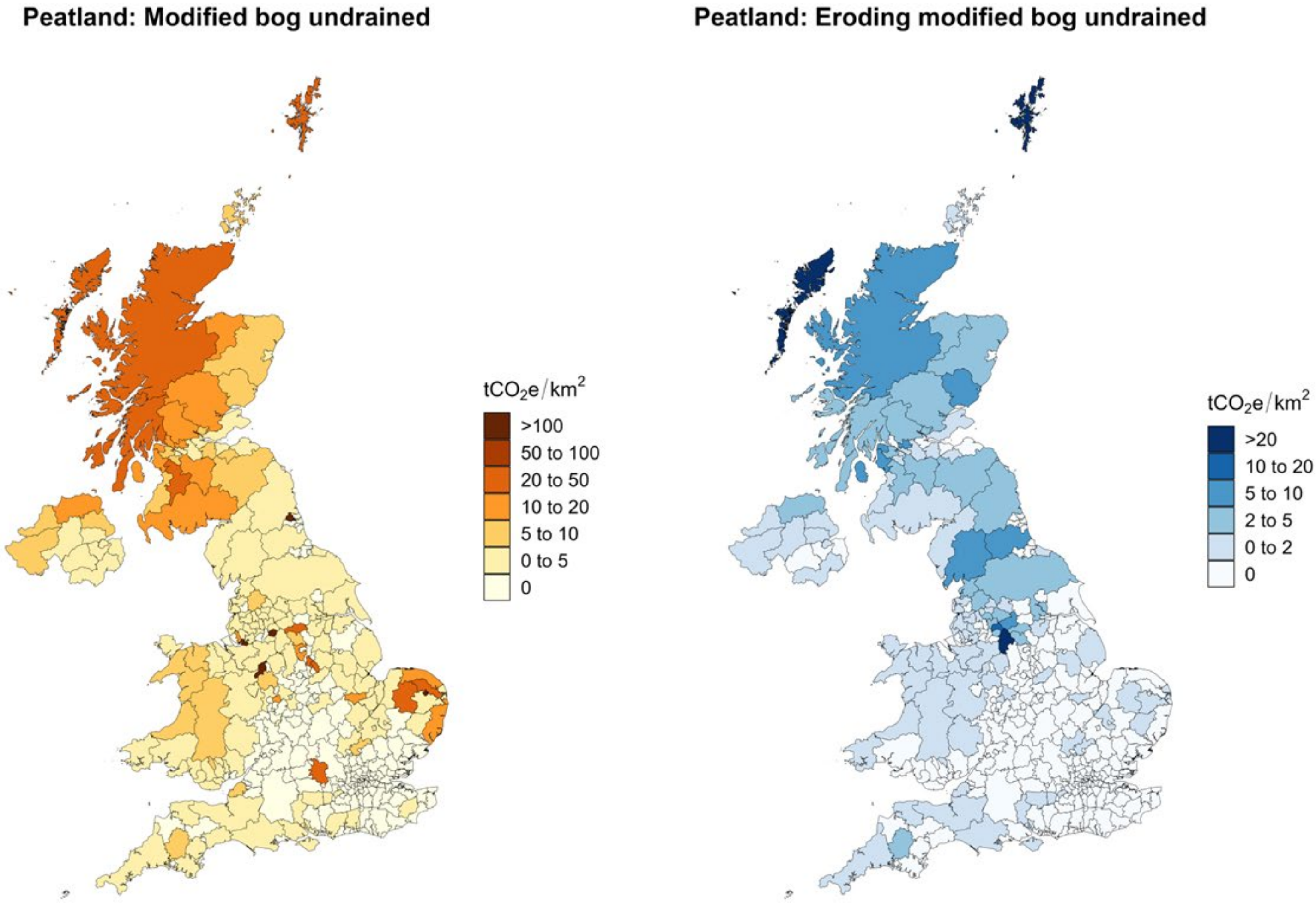


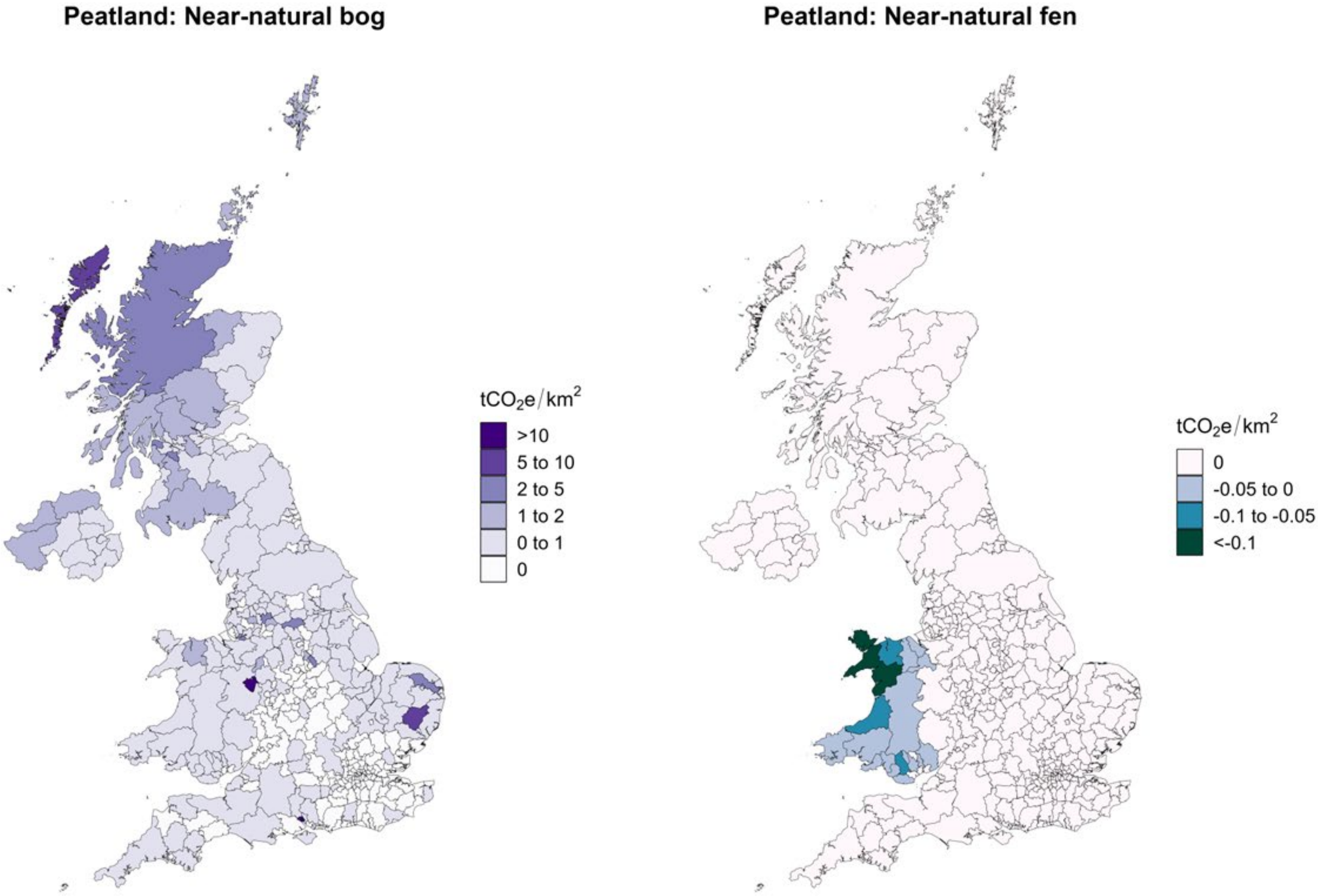
Figure 11: Net carbon dioxide, methane and nitrous oxide emissions from Peatlands: Modified bog undrained and Eroding modified bog undrained per local authority area (tCO_2e/km^2) in 2022.



Upland - Near-Natural

In a natural state, peatlands are important long-term sinks for carbon, which is counterbalanced by similar emissions of methane in CO_2 equivalent terms (N_2O emissions from undrained near-natural peatlands are assumed to be negligible). Using the more recent GWP values from AR5 has increased the contribution of methane, which results in a net emission from near natural bog and slight net sink from near natural fen, however near-natural peatlands remain close to carbon neutral. The emissions / removals for Near-Natural Bog and Fen are disaggregated using the organic soil map methodology. The area of Near Natural Fen that could be definitely mapped from available datasets is small, thus Near-Natural Fen is largely included with Near Natural Bog, with the exception of Wales (Evans et al. 2017).

Figure 12: Net carbon dioxide, methane and nitrous oxide emissions from Peatland: Near-Natural Bog and Near-Natural Fen per local authority area (tCO_2e/km^2) in 2022.

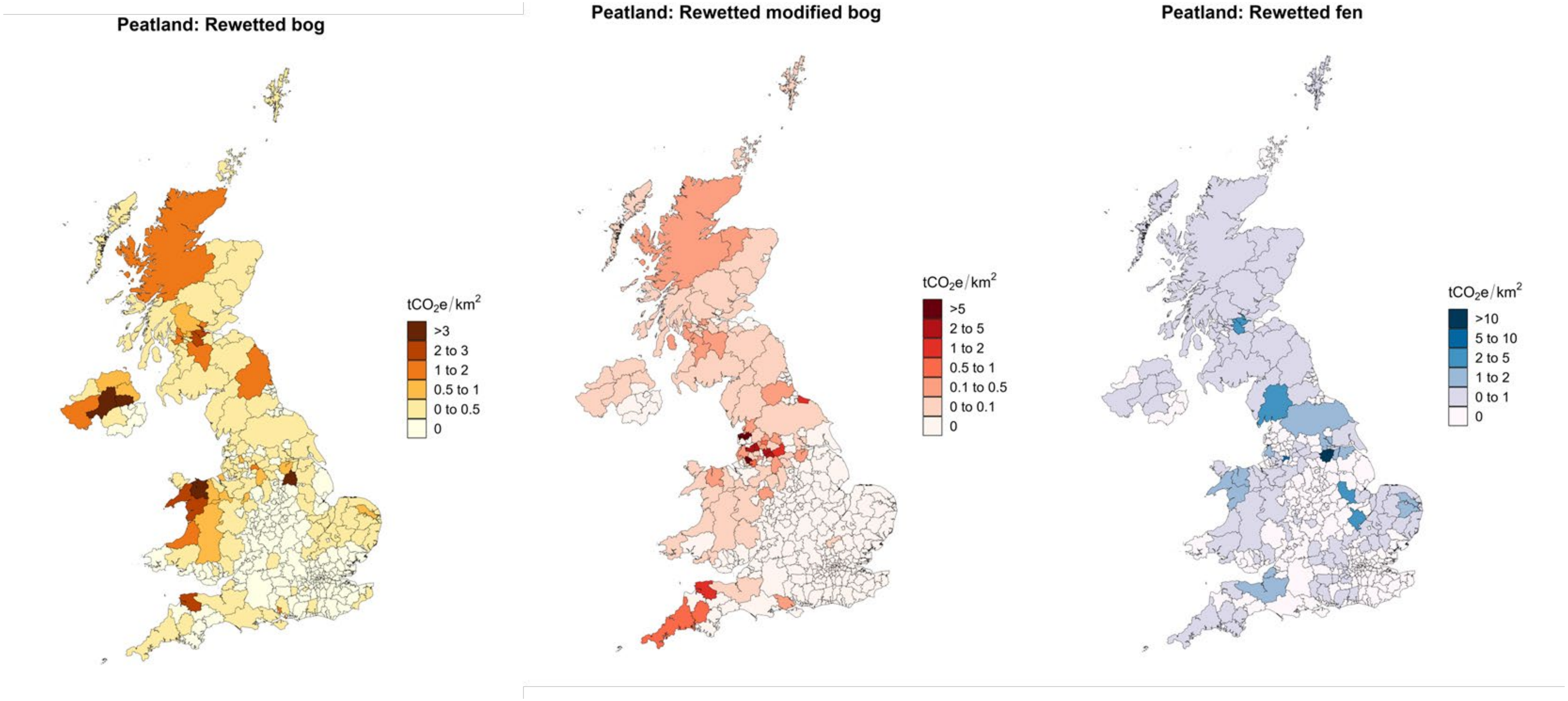


Rewetted

Rewetted peatlands are reported under Grassland and Wetland categories (see LULUCF category description in the Categories section). Rewetting has largely occurred from 2000 onwards and is increasing in practice as regions attempt to restore natural functioning of peatlands and long-term sinks for carbon. Disaggregation is carried out using the organic soil maps methodology. LAs with lands that have undergone peatland restoration (rewetting) are shown in Figure 14 as those exhibiting either a small source or near zero CO_2e emissions. Separate emissions factors are applied to rewetted peatlands depending on the starting condition of the restored lands to take account of the faster trajectory for restoration success associated with rewetting habitats that already have semi-natural vegetation and are functioning in a near-healthy state (see Section A3.4.7.2 of the NIR, Brown et al. 2024). Accordingly, rewetted semi-natural habitats, reported as Rewetted Modified Bog under Grassland, have the lowest emission factors. Rewetted Fen (from cropland, intensive and extensive grassland) and Rewetted Bog (from forest, extracted, and eroding modified bog) are from more heavily modified peatlands and are a small source of GHG emissions.

The mitigation impacts of peatland restoration are largely from avoided soil emissions due to the conversion of drained organic soils to rewetted peatlands, which are accounted for in the final emissions from remaining drained peatlands in Figures 7-10 using the organic soil maps methodology.

Figure 13: Net carbon dioxide, methane and nitrous oxide emissions from Peatlands: Rewetted Bog, Rewetted Modified Bog and Rewetted Fen per local authority area (tCO_2e/km^2) in 2022.



Cropland and Grassland Mineral Soils Under LUC

Changes from one land use type to another will result in a change in soil carbon stocks over time. The change in vegetation cover and management will affect the amount of carbon that goes into the soil from biomass decomposition. This is represented by emissions or removals which continue for decades after the change in land use until equilibrium carbon stocks characteristic of the new land use are reached. Also, any initial disturbance of the soil is represented by a release of carbon from soils to the atmosphere as CO_2. When the LUC results in soil carbon emissions the corresponding direct and indirect N_2O emissions from soil mineralisation are also calculated.

For the LULUCF inventory, the method for assessing changes in soil carbon stock due to land-use change on mineral soil links a matrix of area changes at country level to a dynamic model of carbon stock change. In the 1990-2020 inventory a major improvement was made to the land use change matrices which are now derived annually using a Bayesian data assimilation approach combining data from Earth Observation, land cover surveys and agricultural land statistics (Brown et al 2024, Annex section A 3.4.2).

The LUC-T methodology is used to disaggregate to LA scale (see Figure 2). The pattern of emissions and removals across the UK for each land-use type is dependent on the ratio of land-use change in each LA in relation to the total for that devolved administration. For example, the majority of land-use change to both Cropland and Grassland in Scotland occurs in the south and east of the country.

Figure 14 shows the distributions of net emissions/removals from mineral soils as a result of land use change for Cropland remaining Cropland (> 20 years old) and for Grassland and Settlement converted to Cropland within the last 20 years.

Figure 15 shows the same for Grassland remaining Grassland and for Cropland and Settlement converted to Grassland.

Figure 14: Distribution of Cropland mineral soils under LUC: Cropland remaining cropland, Grassland converted to cropland and Settlement converted to cropland net emissions/removals (tCO_2/km^2) in 2022.

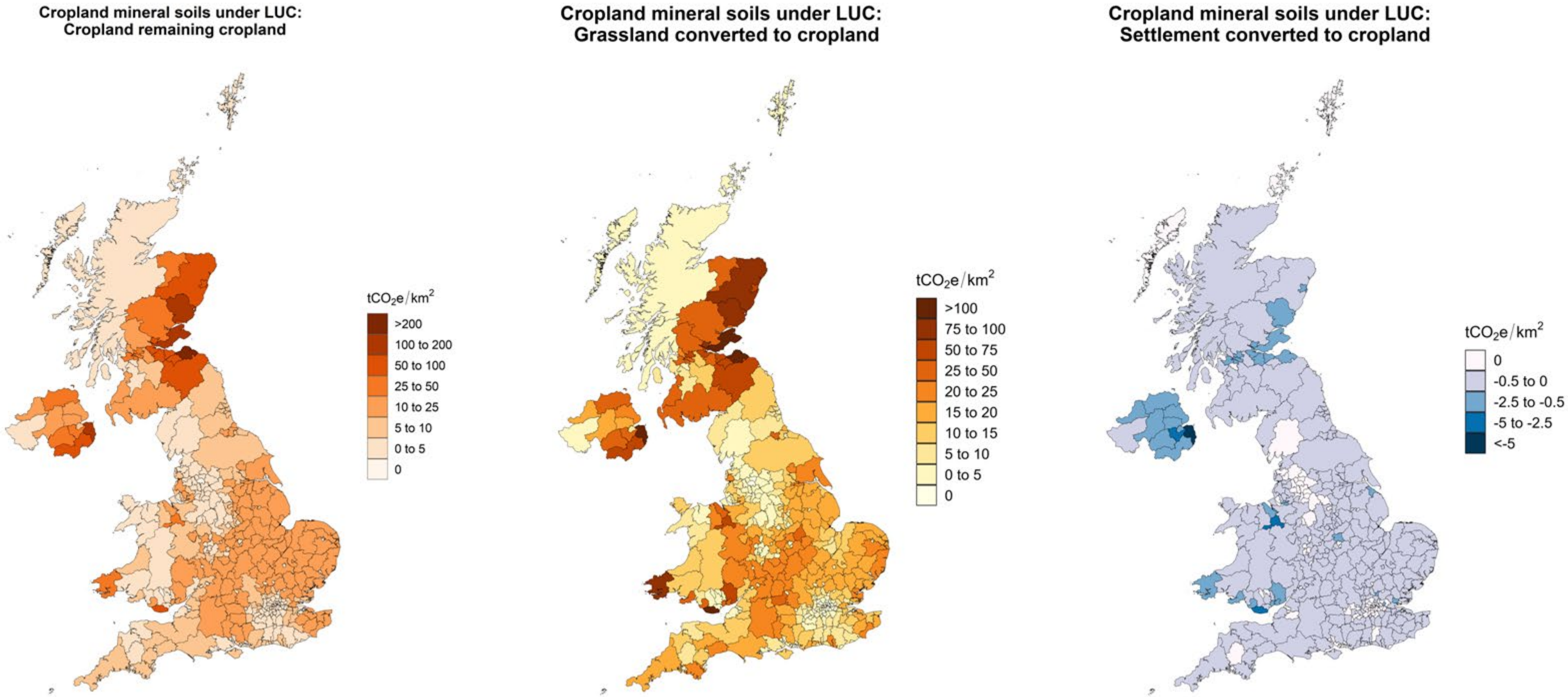
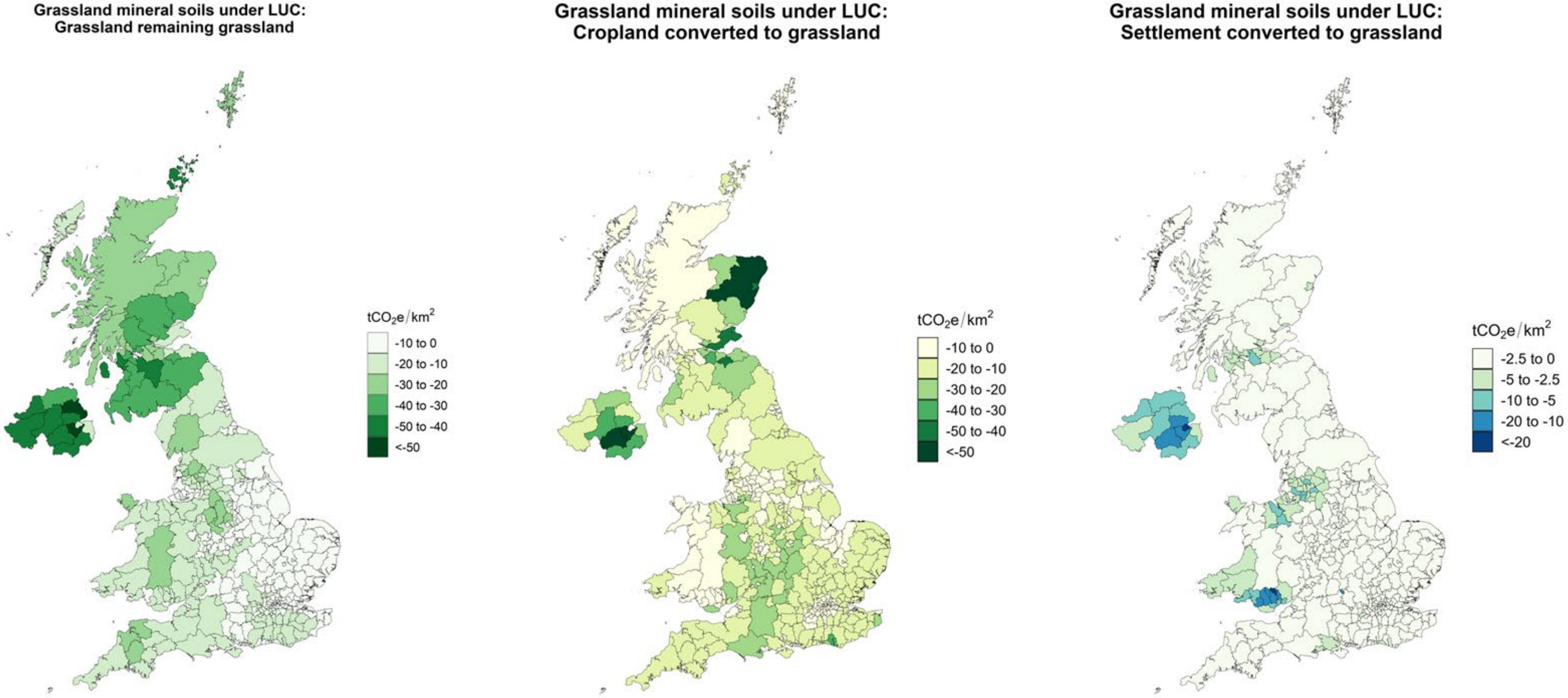


Figure 15: Distribution of Grassland mineral soils under LUC: Grassland remaining grassland, Cropland converted to grassland and Settlement converted to grassland net emissions/removals (tCO_2/km^2) in 2022.



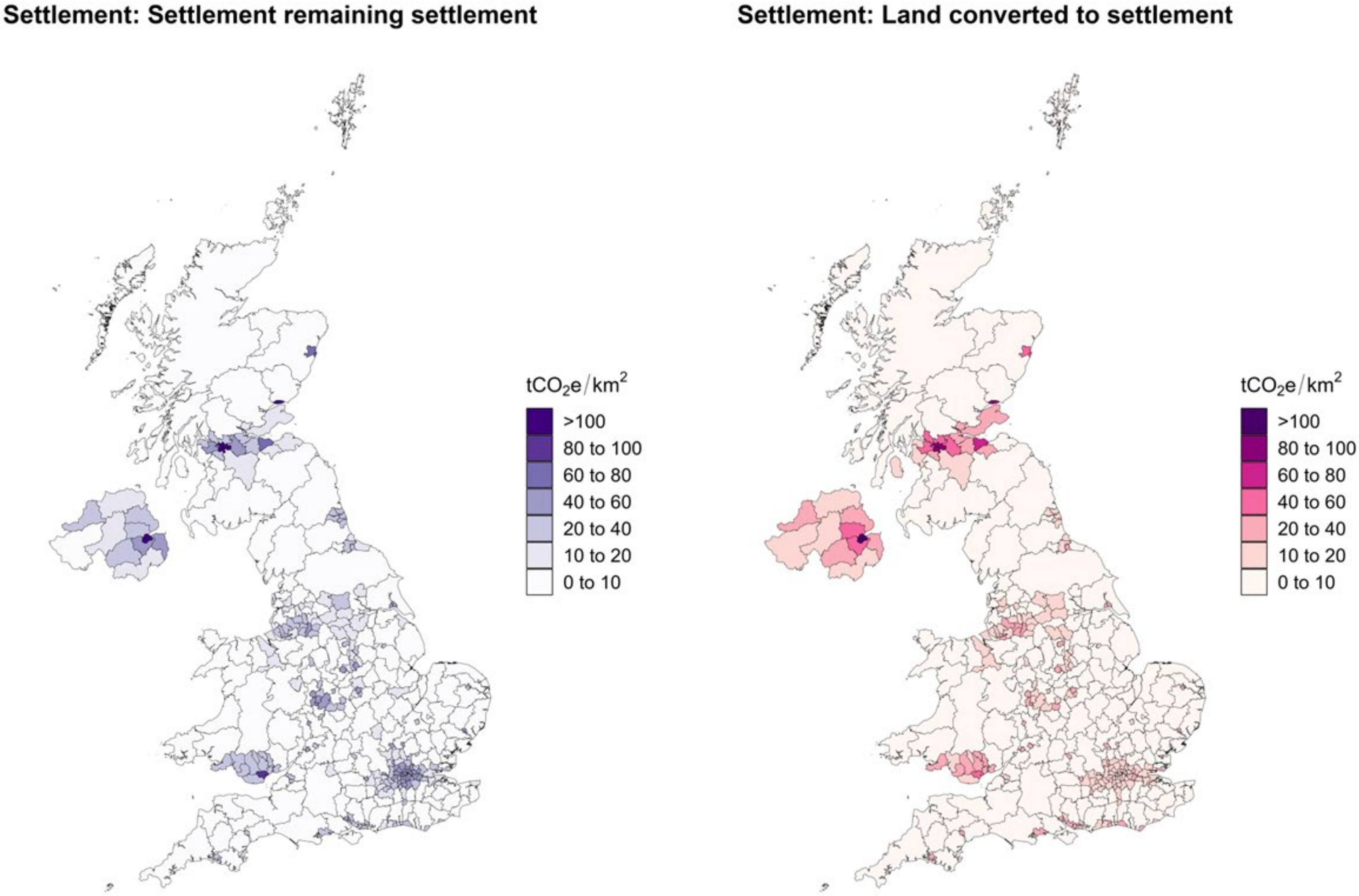
Settlement

The mineral soil carbon stock changes and direct and indirect N_2O emissions from Land use change to Settlement are calculated in the same way as described for Cropland and Grassland above.

The different land-use types have different biomass carbon densities per area at equilibrium. Change from one land use type to another can result in an increase or decrease in biomass carbon density per area. For the LULUCF inventory, estimates of emissions and removals from non-forest biomass are made using the Countryside Survey Land-Use Change matrix approach. Changes in carbon stocks in biomass due to land-use change are based on the same area matrices used for estimating changes in carbon stocks in soils. The biomass carbon density per area for Settlement was assigned by expert judgement based on the work of Milne and Brown (1997). Average biomass densities per area for Cropland and Grassland used in the non-forest biomass LUC model are the same as those used in the cropland and grassland management calculations, based on a UK-relevant literature review in Moxley et al. (2014). Five basic land uses were assigned initial biomass carbon densities per area, then the relative occurrence of these land uses in the four countries of the UK were used to calculate mean biomass carbon densities per area for each of the IPCC types, Cropland, Grassland and Settlements. The mean biomass carbon densities per area for each land type were then weighted by the relative proportions of change occurring between land types in the same way as the calculations for changes in soil carbon densities per area. Changes between these equilibrium biomass carbon densities per area were assumed to happen in a single year. The emissions / removals from biomass losses occurring from land use change to Settlement are disaggregated to LA using the LUC-T methodology.

Figure 16 presents the net soil emissions for Settlement remaining Settlement (> 20 years old) and soil and biomass emissions for all land uses converted to Settlement. As expected, the net emissions are concentrated in urban areas of the UK due to expansion of existing towns and cities.

Figure 16: Distribution of Settlement: Settlement remaining settlement and Land converted to Settlement net emissions/removals (tCO_2/km^2) in 2022.



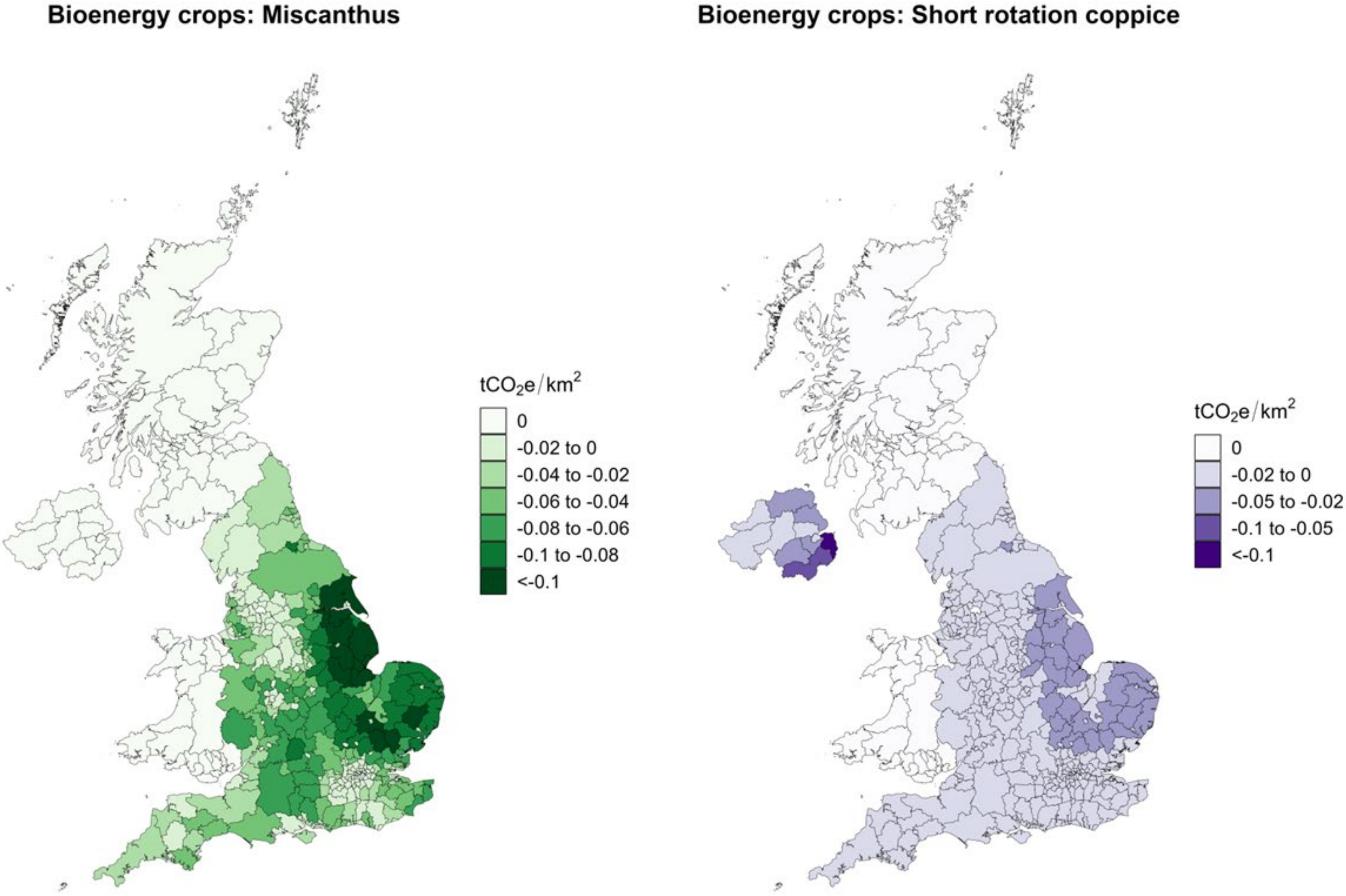
Bioenergy Crops

Emissions and removals for two bioenergy crops, *Miscanthus* and short rotation coppice arise from cropland management calculations for both soil and biomass.

Soil cropland management activities including inputs of fertiliser, manure and crop residues have an impact on soil carbon stocks. Data on the areas under the main crop types are obtained from the annual June Agricultural Censuses carried out by each UK administration Defra, 2023a; Welsh Government, 2022; Scottish Government, 2021; DAERA, 2023). Data on the areas of Cropland receiving inputs of manure, fertiliser and crop residues are obtained from the annual British Survey of Fertiliser Practice (Defra 2023b).

Changes in biomass carbon stocks arising from cropland management include change between annual crops, orchards, bioenergy crops and set aside and fallow. Information on emission factors were derived from a literature review described in Moxley et al. (2014). The emissions and removals are disaggregated to the LA level using the LUC-T methodology based on the areas of total Cropland. Figure 17 shows the combined soil and biomass net emissions/ removals for the bioenergy crops. Note that activity data for *Miscanthus* is only available for England and for short rotation coppice is only available for England and Northern Ireland.

Figure 17: Distribution of Bioenergy crops: *Miscanthus* and Short rotation coppice net emissions/ removals (tCO_2/km^2) in 2022.



Other LULUCF

Within the TES classification there are some LULUCF emissions / removals which do not fall within any of the main sub-sectors described above. These have been grouped to Other LULUCF and contain miscellaneous emissions for Forest, Cropland, Grassland and Wetland.

The Forest miscellaneous category contains only emissions from wildfires occurring on forest land.

The Cropland miscellaneous category contains emissions/removals from non-forest biomass as a result of land use change, from mineral soils and biomass from management of non-bioenergy crops and from wildfires on cropland.

The Grassland miscellaneous category contains emissions/removals from non-forest biomass as a result of land use change, from biomass from grassland management and from wildfires on grassland.

The Wetlands miscellaneous category contains only emissions from biomass losses upon reservoir creation.

Information on areas of wildfires on forest, cropland and grassland in Great Britain and in Northern Ireland are available from the Fire Service Incident Response System (IRS). This dataset is available at individual grid referenced fire level for Great Britain and as a national total for Northern Ireland. Hence, in Great Britain wildfires can be assigned to the LA in which they occurred, and in Northern Ireland the emissions are assigned to LAs in proportion to the total area of forest, crop or grassland in each LA. Data for non-forest wildfires in England from 2015-2017 were not supplied with coordinates. For these incidents emissions were assigned proportionally between the LAs within the fire service boundary in which the incident occurred. In 2022 there were no wildfires on Forest or Cropland in Wales.

Emissions/removals from non-forest biomass arising from land use change to Cropland and Grassland are calculated and disaggregated in the same way as for Settlement (described above).

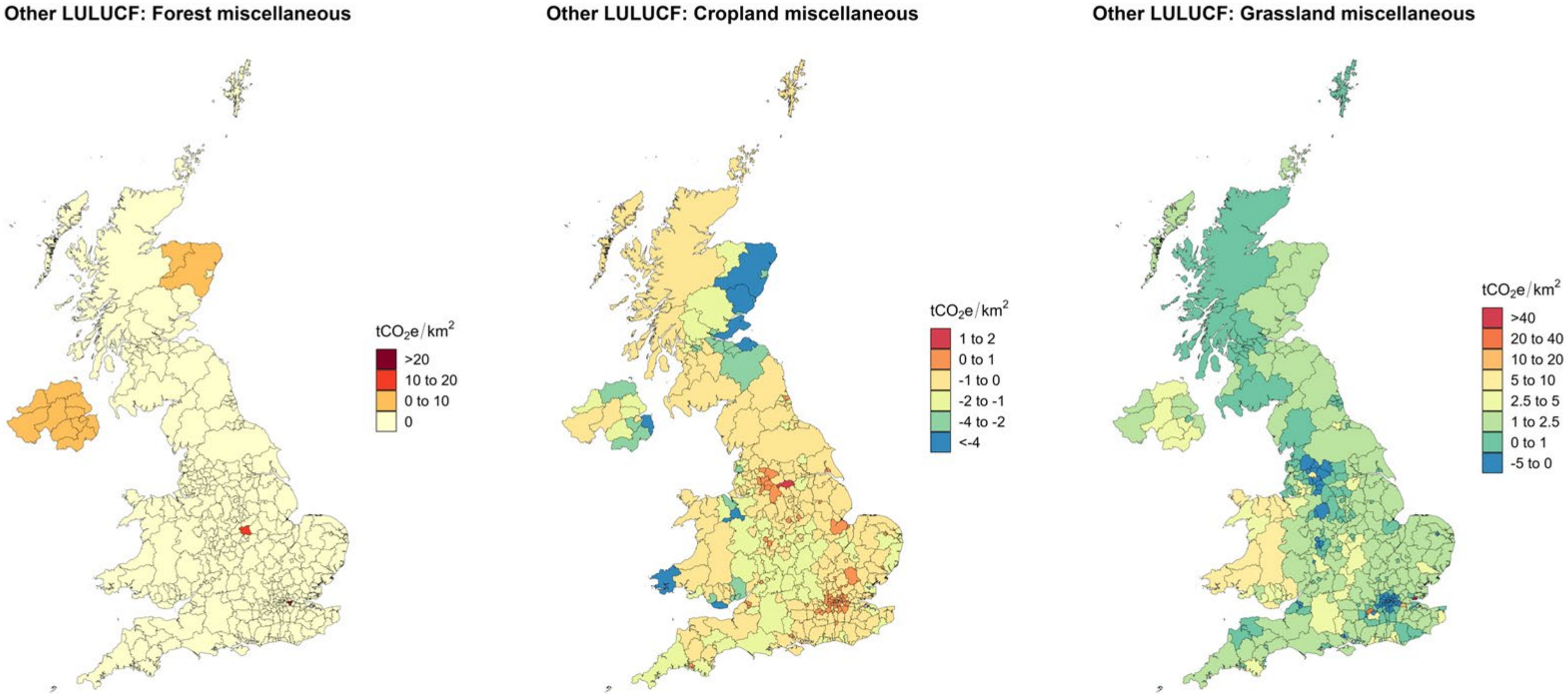
Emissions/removals from cropland management activities for non-bioenergy crops are calculated and disaggregated in the same way as for bioenergy crops (described above).

Changes in biomass carbon stocks arising from Grassland management activities include change between shrubby and non-shrubby grassland types and hedge creation and removal. Data on areas of grassland types are derived from the Countryside Surveys of 1990, 1998 and 2007. Information on emission factors were derived from a literature review described in Moxley et al. (2014). The emissions and removals are disaggregated to the LA level using the LUC-T methodology.

Emissions from biomass losses upon reservoir creation (over 1km^2) are calculated using a range of activity data on new reservoirs created since 1990. Only five large reservoirs have been established in the UK since 1990, three in England and one each in Scotland and Wales. No new reservoirs were created in 2022, hence no emissions map is presented in this report.

Figure 18 shows the net emissions/ removals for the Forest, Cropland and Grassland miscellaneous categories for 2022.

Figure 18: Distribution of Other LULUCF: Forest miscellaneous, Cropland miscellaneous and Grassland miscellaneous net emissions/ removals (tCO_2/km^2) in 2022.



LULUCF Totals

The total greenhouse gas emissions and removals for the UK land use, land-use change and forestry sector (excluding harvested wood products which cannot be mapped) are shown in Figure 19. Maps of emissions and removals of individual gases, CO_2, CH_4, and N_2O are shown in Figures 20-22.

Figure 19: Emissions or removals of GHGs from land use, land-use change and forestry per local authority area (tCO_2e/km^2) in 2022.

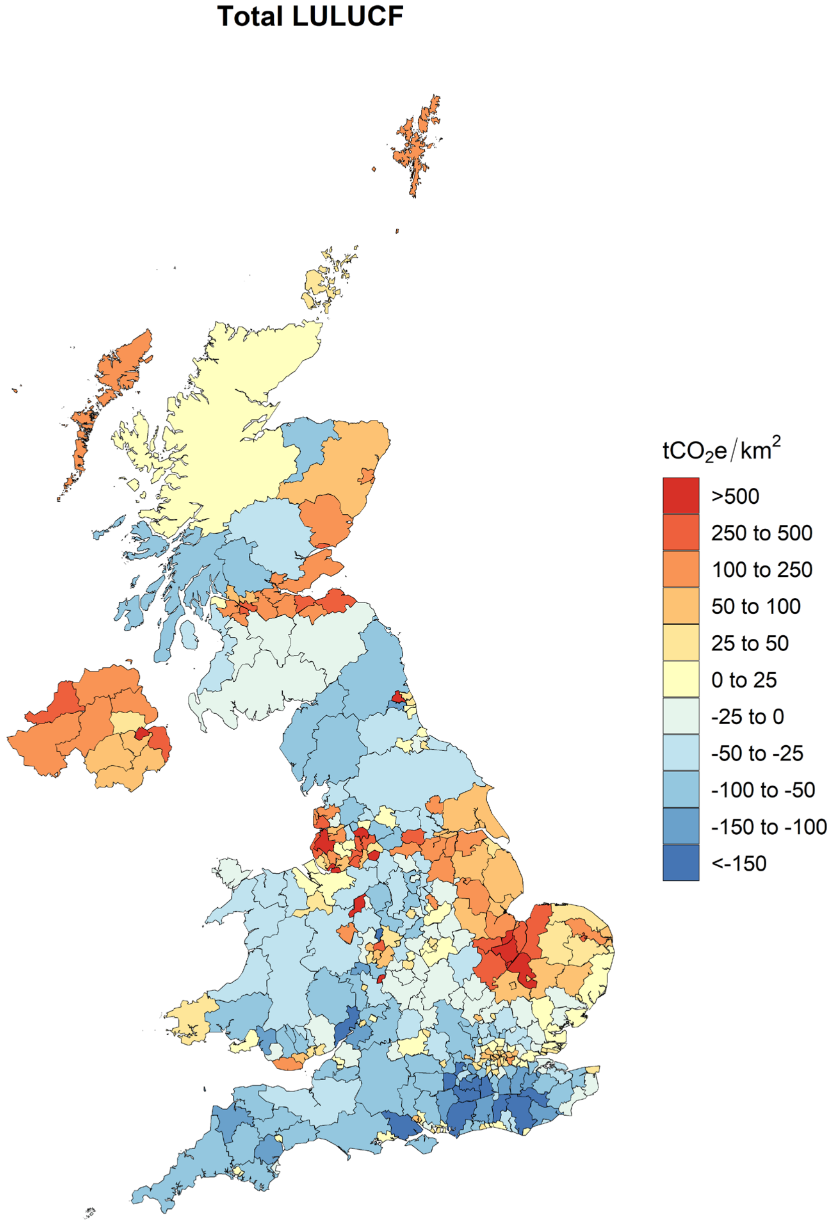


Figure 20: Emissions or removals of carbon from land use, land-use change and forestry per local authority area (tCO_2e/km^2) in 2022.

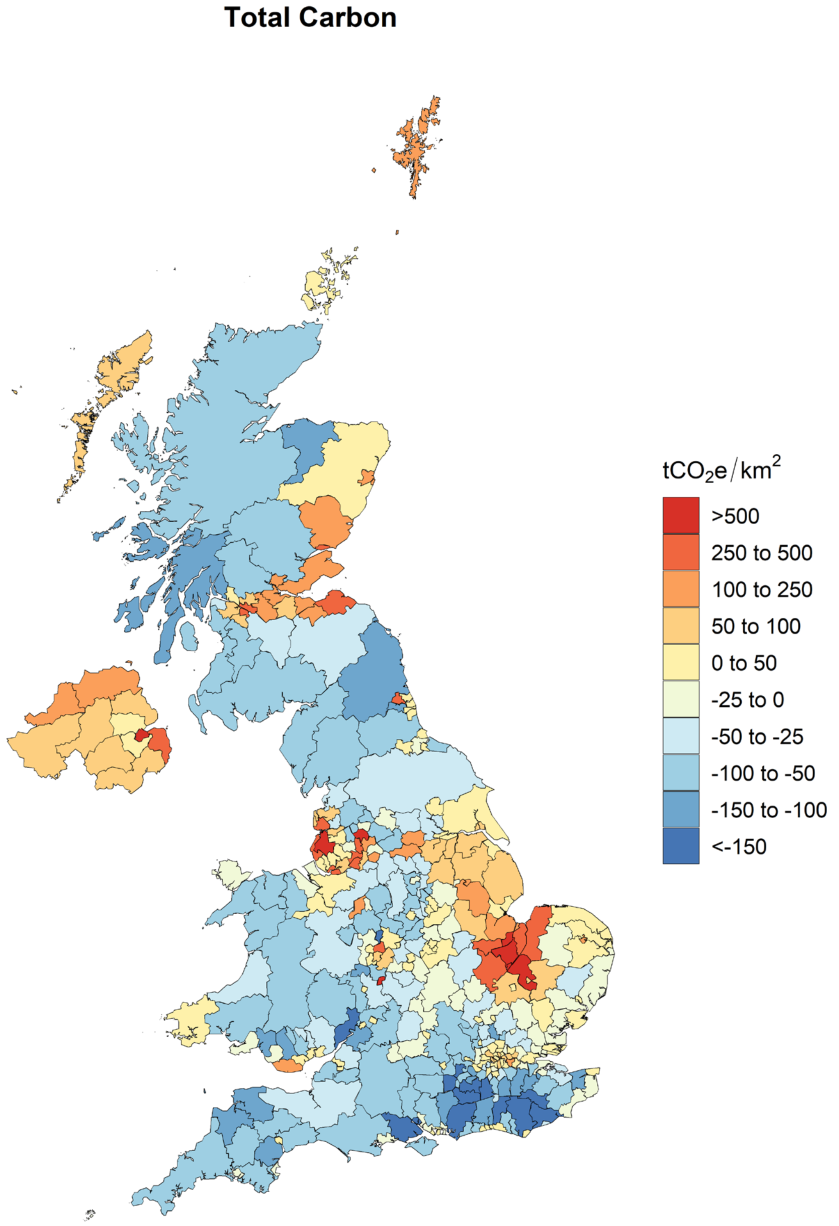


Figure 21: Emissions or removals of methane from land use, land-use change and forestry per local authority area (tCO_2e/km^2) in 2022.

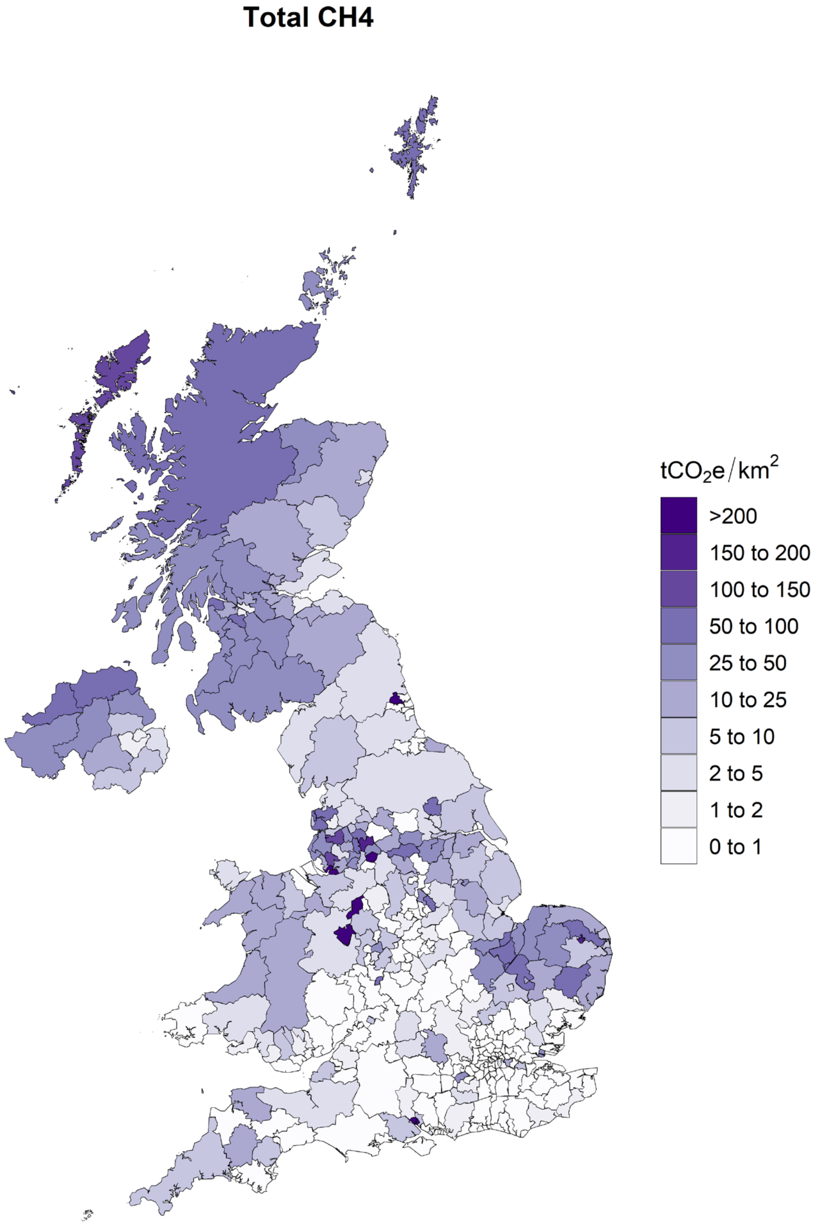
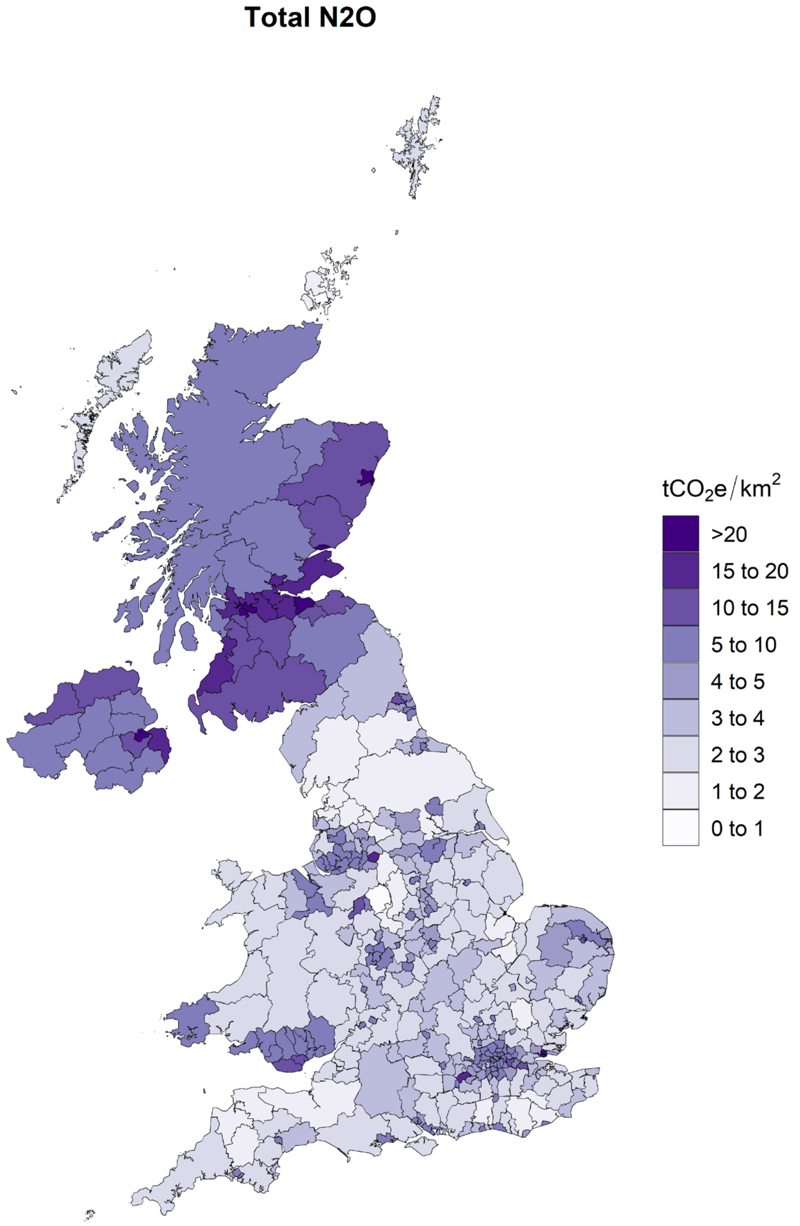


Figure 22: Emissions or removals of nitrous oxide from land use, land-use change and forestry per local authority area (tCO_2e/km^2) in 2022.



Uncertainties

The uncertainties in calculating the LULUCF inventory are described in an annex of the National Inventory Report (see Table A 3.4.32 in Brown et al. 2024) and range from 12-197% for CO_2, 34-92% for CH_4 and 34-240% for N_2O in 2022 depending on the LULUCF sector activity. Additional uncertainty is associated with disaggregating the dataset to LA scale. It is estimated that the uncertainty in the disaggregation process is in the range of 20-30% on decadal timescales, though probably higher for annual estimates.

There is low uncertainty in the LA mapping of emissions associated with wildfire occurrence and emissions from organic soils due to fine-scale spatial input data.

Moderate uncertainty in the disaggregation process is attributed to emissions from soils due to land-use change, soils due to drainage, and the minor categories where the LUC-T disaggregation methods were employed (such as Non-Forest Biomass on Cropland and Grassland). The LUC-T methodology is probabilistic, therefore although spatial location of unchanged land and the trend in land use change is well constrained, the spatial location and timing of land use change is less certain.

There is higher uncertainty in the mapping of deforestation than the other land use changes which use the LUC-T methodology, due to challenges in identifying deforestation rather than land felled and awaiting restocking. Hence, the area of land remaining forest is used to disaggregate deforestation emissions. Similarly, the yearly evolution of the forest sink at LA level is assumed to follow the country level estimates relatively closely, but without explicit representation of forest management operations (including clear-fell operations) this introduces high uncertainty associated with the forest sink reported at LA scale for specific years.

Recalculations

The National Inventory is often updated to include improved, or new, datasets and modelling techniques. More detailed descriptions of the changes can be found in the UK National Inventory Report and annexes (Brown et al. 2024).

Table 3: Details of the major changes to emissions / removals between the 2021 and 2022 LULUCF inventories.

Description of Change	Reason for Change	TES Sub-Sector Affected	1990-2021 Inventory 2021 UK Value ($GgCO_2e$)	1990-2022 Inventory 2021 UK Value ($GgCO_2e$)	1990-2022 Inventory 2022 UK Value ($GgCO_2e$)
Fix to the soil model component of the CARBINE model. Inclusion of urban trees and inclusion of wood production from private forests in Northern Ireland for the first time. Minor updates to planting estimates and wood production statistics.	Error correction and inclusion of new data.	Forestry	-18,023.60	-16,425.82	-16,047.23
Inclusion of new peat extraction volume data for Northern Ireland. Changes to the baseline peatland (organic soil) areas. Changes to forest planting on organic soil.	Utilisation of new data source and error correction.	Peatland	15,452.06	15,288.36	15,175.26
		LULUCF Total[2]	**3,120.60**	**2,775.18**	**2,965.69**

[2] This is the total emissions / removals for all LA categories both recalculated and unchanged (excludes Harvested Wood Products as this is not disaggregated to LA scale).

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Annex 1

Inventory categories and spatial variables used for LUC-T disaggregation

Inventory emission category	Gas	Spatial Variable	Group	From Land Use	To Land Use	Soil Type
Remaining broadleaf forest on mineral soil & biomass CSC	Carbon	Broadleaf Mineral >= 20 years	Remaining Land	NA	Forest Broadleaf	Mineral
To broadleaf forest on mineral soil & biomass CSC	Carbon	Broadleaf Mineral < 20 years	20 year LUC	Any	Forest Broadleaf	Mineral
Remaining conifer forest on mineral soil & biomass CSC	Carbon	Conifer Mineral >= 20 years	Remaining Land	NA	Forest Conifer	Mineral
To conifer forest on mineral soil & biomass CSC	Carbon	Conifer Mineral < 20 years	20 year LUC	Any	Forest Conifer	Mineral
Remaining broadleaf forest on organic soil & biomass CSC	Carbon	Broadleaf Organic >= 20 years	Remaining Land	NA	Forest Broadleaf	Organic
To broadleaf forest on organic soil & biomass CSC	Carbon	Broadleaf Organic < 20 years	20 year LUC	Any	Forest Broadleaf	Organic
Remaining conifer forest on organic soil & biomass CSC	Carbon	Conifer Organic >= 20 years	Remaining Land	NA	Forest Conifer	Organic

Inventory emission category	Gas	Spatial Variable	Group	From Land Use	To Land Use	Soil Type
To conifer forest on organic soil & biomass CSC	Carbon	Conifer Organic < 20 years	20 year LUC	Any	Forest Conifer	Organic
Remaining forest on mineral soil draining and rewetting	N2O	Current Forest Mineral	Current Land Use	NA	Forest	Mineral
To forest inorganic fertiliser application and indirect N2O (deposition and leaching)	N2O	Grassland to Forest Organic in previous three years and Settlement to Forest in previous three years	Change in previous three years	Grassland Settlement	Forest Forest	Organic All
Cropland to forest land use change soils direct N2O and indirect N2O (leaching)	N2O	Cropland to Forest Mineral < 20 years	20 year LUC	Cropland	Forest	Mineral
Grassland to forest land use change soils direct N2O and indirect N2O (leaching)	N2O	Grassland to Forest Mineral < 20 years	20 year LUC	Grassland	Forest	Mineral
Settlement to forest land use change soils direct N2O and indirect N2O (leaching)	N2O	Settlement to Forest Mineral < 20 years	20 year LUC	Settlement	Forest	Mineral
Cropland management soil	Carbon	Current Cropland Mineral	Current Land Use	NA	Cropland	Mineral
Cropland management biomass	Carbon	Current Cropland	Current Land Use	NA	Cropland	All

Inventory emission category	Gas	Spatial Variable	Group	From Land Use	To Land Use	Soil Type
Cropland remaining Cropland CSC	Carbon	Cropland Mineral >= 20 years	Remaining Land	NA	Cropland	Mineral
Grassland to Cropland Non-forest Biomass	Carbon	Grassland to Cropland in the last year	Change in previous year	Grassland	Cropland	All
Settlement to Cropland Non-forest Biomass	Carbon	Settlement to Cropland in the last year	Change in previous year	Settlement	Cropland	All
Forest to Cropland land use change soils: CSC, direct N2O and indirect N2O (leaching)	Carbon, N2O	Forest to Cropland Mineral < 20 years	20 year LUC	Forest	Cropland	Mineral
Grassland to Cropland land use change soils: CSC, direct N2O and indirect N2O (leaching)	Carbon, N2O	Grassland to Cropland Mineral < 20 years	20 year LUC	Grassland	Cropland	Mineral
Settlement to Cropland land use change soils CSC	Carbon	Settlement to Cropland Mineral < 20 years	20 year LUC	Settlement	Cropland	Mineral
Deforestation to Cropland: Dead Organic Matter, Living Biomass, Burning	Carbon, N2O, CH4	Forest to Cropland in the last year	Change in previous year	Forest	Cropland	All
Grassland management biomass	Carbon	Current Grassland	Current land use	NA	Grassland	All

Inventory emission category	Gas	Spatial Variable	Group	From Land Use	To Land Use	Soil Type
Grassland remaining Grassland: CSC, direct N2O and indirect N2O (leaching)	Carbon, N2O	Grassland Mineral >= 20 years	Remaining land	NA	Grassland	Mineral
Cropland to Grassland Non-forest Biomass	Carbon	Cropland to Grassland in the last year	Change in previous year	Cropland	Grassland	All
Settlement to Grassland Non-forest Biomass	Carbon	Settlement to Grassland in the last year	Change in previous year	Settlement	Grassland	All
Deforestation to Grassland: Dead Organic Matter, Living Biomass, Burning	Carbon, N2O, CH4	Forest to Grassland in the last year	Change in previous year	Forest	Grassland	All
Forest to Grassland Land Use Change soils: CSC, direct N2O and indirect N2O (leaching)	Carbon, N2O	Forest to Grassland Mineral < 20 years	20 year LUC	Forest	Grassland	Mineral
Cropland to Grassland Land Use Change soils: CSC	Carbon	Cropland to Grassland Mineral < 20 years	20 year LUC	Cropland	Grassland	Mineral
Settlement to Grassland Land Use Change soils CSC	Carbon	Settlement to Grassland Mineral < 20 years	20 year LUC	Settlement	Grassland	Mineral
Settlement remaining Settlement: CSC, direct N2O and indirect N2O (leaching)	Carbon, N2O	Settlement Mineral >= 20 years	Remaining land	NA	Settlement	Mineral

Inventory emission category	Gas	Spatial Variable	Group	From Land Use	To Land Use	Soil Type
Deforestation to Settlement: Dead Organic Matter, Living Biomass, Burning	Carbon, N2O, CH4	Forest to Settlement in the last year	Change in previous year	Forest	Settlement	All
Forest to Settlement Land Use Change soils: CSC, direct N2O and indirect N2O (leaching)	Carbon, N2O	Forest to Settlement Mineral < 20 years	20 year LUC	Forest	Settlement	Mineral
Cropland to Settlement Land Use Change soils: CSC, direct N2O and indirect N2O (leaching)	Carbon, N2O	Cropland to Settlement Mineral < 20 years	20 year LUC	Cropland	Settlement	Mineral
Grassland to Settlement Land Use Change soils: CSC, direct N2O and indirect N2O (leaching)	Carbon, N2O	Grassland to Settlement Mineral < 20 years	20 year LUC	Grassland	Settlement	Mineral
Cropland to Settlement Non-forest Biomass	Carbon	Cropland to Settlement in last year	Change in previous year	Cropland	Settlement	All
Grassland to Settlement Non-forest Biomass	Carbon	Grassland to Settlement in last year	Change in previous year	Grassland	Settlement	All
Forest Wildfires	Carbon, N2O, CH4	Current Forest	Current Land Use	NA	Forest	All
Cropland Wildfires	N2O, CH4	Current Cropland	Current Land Use	NA	Cropland	All

Inventory emission category	Gas	Spatial Variable	Group	From Land Use	To Land Use	Soil Type
Grassland Wildfires	N2O, CH4	Current Grassland	Current Land Use	NA	Grassland	All

Annex 2

Territorial Emissions Sector descriptions

TES Subsector	TES Category	Notes
Forestry	Forest land remaining forest land	Carbon stock change in biomass and mineral soils for forests > 20 years old. Emissions from drainage of mineral soils under forest.
	Land converted from forest land	Carbon stock change in biomass and mineral soils from deforested land. Direct and indirect N_2O emissions from soil mineralisation following deforestation. Emissions from controlled burning following deforestation.
	Land converted to forest land	Carbon stock change in biomass and mineral soils from forests < 20 years old. Direct and indirect N_2O emissions from soil mineralisation from forests < 20 years old. Direct and indirect N_2O emissions from forest fertilisation.
	Harvested wood products	Carbon stock change from harvested wood products from all forest.
Cropland mineral soils change	Cropland remaining cropland	Carbon stock change in mineral soils from cropland > 20 years old. Direct and indirect N_2O emissions from soil mineralisation from cropland >20 years old are reported in the Agriculture sector.
	Grassland converted to cropland	Carbon stock change in mineral soils from cropland < 20 years old. Direct and indirect N_2O emissions from soil mineralisation.
	Settlement converted to cropland	Carbon stock change in mineral soils from cropland < 20 years old.
Grassland mineral soils change	Cropland converted to grassland	Carbon stock change in mineral soils from grassland < 20 years old.
	Grassland remaining grassland	Carbon stock change in mineral soils from grassland > 20 years old. Direct and indirect N_2O emissions from soil mineralisation.
	Settlement converted to grassland	Carbon stock change in mineral soils from grassland < 20 years old.

TES Subsector	TES Category	Notes
Peatland	Cropland drained	Emissions from drained cropland on organic soils. Not including N_2O which is reported in the Agriculture sector.
	Domestic extraction	On-site emissions from domestic peat extraction (fuel use).
	Eroding modified bog drained	Emissions from drained eroding modified bog (bare peat).
	Eroding modified bog undrained	Emissions from undrained eroding modified bog (bare peat).
	Extensive grassland drained	Emissions from drained extensive grassland on organic soils.
	Forest drained	Emissions from drained forest on organic soils.
	Industrial extraction	On-site and off-site emissions from industrial peat extraction (horticultural use).
	Intensive grassland drained	Emissions from drained intensive grassland on organic soils. Not including N_2O which is reported in the Agriculture sector.
	Modified bog drained	Emissions from drained modified bog (semi-natural heather and grass dominated bog).
	Modified bog undrained	Emissions from undrained modified bog (semi-natural heather and grass dominated bog).
	Near-natural bog	Emissions/removals from near-natural bog.
	Near-natural fen	Emissions/removals from near-natural fen.
	Rewetted bog	Emissions from rewetted bog.
	Rewetted fen	Emissions from rewetted fen.
	Rewetted modified bog	Emissions from rewetted modified (semi-natural) bog.
	Settlement drained	Emissions from drained settlement on organic soils.
Settlement	Settlement remaining settlement	Carbon stock change in mineral soils from settlement > 20 years old. Direct and indirect N_2O emissions from soil mineralisation.
	Land converted to settlement	Carbon stock change in mineral soils and biomass from settlement < 20 years old. Direct and indirect N_2O emissions from soil mineralisation.
Bioenergy crops	Miscanthus	Carbon stock change in biomass and mineral soils from the management of *Miscanthus* crops.
	Short rotation coppice	Carbon stock change in biomass and mineral soils from the management of short rotation coppice crops.
Other LULUCF	Forest miscellaneous	Emissions from wildfires on forest land.
	Cropland miscellaneous	Emissions from wildfires on cropland. Carbon stock change from non-forest biomass on land converted to cropland. Carbon stock change in biomass and mineral soils from the management of non-bioenergy crops.

TES Subsector	TES Category	Notes
	Grassland miscellaneous	Emissions from wildfires on grassland. Carbon stock change from non-forest biomass on land converted to grassland. Carbon stock change in biomass from grassland management.
	Wetland miscellaneous	Carbon stock change in biomass from reservoir creation.

This publication is available from: https://www.gov.uk/government/statistics/uk-local-authority-and-regional-greenhouse-gas-emissions-statistics-2005-to-2022