

National Atmospheric Emissions Inventory

Mapping Carbon Emissions & Removals for the Land Use, Land Use Change & Forestry Sector

Report based on the 1990-2017 Inventory

Prepared by the Centre for Ecology & Hydrology for the Department for Business, Energy & Industrial Strategy.

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

The Department for Business, Energy and Industrial Strategy (BEIS) 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). BEIS contract Ricardo Energy & Environment (REE) to compile the overall greenhouse gas emissions inventory and they in turn subcontract the Natural Environment Research Council Centre for Ecology and Hydrology (CEH) 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 as part of BEIS's assistance to Local Authorities in tracking progress on decarbonisation.

The LULUCF data reported to the annual inventory is prepared in accordance with the reporting requirements of the UNFCCC. However, in addition the UK is required to provide reports to both the EU and the UNFCCC on progress towards its Kyoto Protocol (KP) target following KP reporting requirements. These are substantially different in coverage and approach. The data provided in this report are taken from the UNFCCC reporting data set and are consistent with current UK Carbon Budgets approaches.

For KP reporting, Article 3.3 of the Kyoto Protocol requires Parties in meeting their emissions reduction commitments to account for Afforestation, Reforestation and Deforestation (ARD) since 1990. Accounting for ARD under Article 3.3 requires i) a definition of forest, ii) knowledge of forest type and planting/deforestation date, iii) geographical location, and iv) a method to distinguish deforestation from areas harvested and replanted. Article 3.4 of the Kyoto Protocol allows Parties flexibility to choose Forest Management, Cropland Management, Grazing Land Management, Wetland Drainage and Rewetting and Re-vegetation towards meeting commitments. For the first commitment period of the Kyoto Protocol from 2008 to 2012, the UK only elected Forest Management as an activity under Article 3.4. For the second commitment period from 2013 to 2020 Forest Management reporting is mandatory and the UK has elected to also include Cropland Management, Grazing Land Management and Wetland Drainage and Rewetting.

CEH prepares LULUCF estimates annually, following both UNFCCC and KP approaches for inclusion in the UK GHG Inventory. These estimates are made using dynamic models of changes in stored carbon, driven by land use change data. For forestry, the model (owned and run by FR) deals with plant carbon, dead organic matter, soil 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 semi-natural grassland, improved pasture, cropland, forest land and settlement land uses. These models, and those for other LULUCF activities, are run for each of the four devolved administrative regions of the UK. Until the 1990-2004 inventory (submitted in 2006) no data were reported in map format at a scale below the devolved administrations (England, Scotland, Wales and Northern Ireland); here we report results from methods to provide estimates of LULUCF emissions and removals at the scale of local authority (LA) within the UK for the 2017 inventory year (submitted in 2019).

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.

1.1 Categories

The IPCC Guidelines for National Greenhouse for National Greenhouse Gas Inventories (IPCC 2006) 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 harvested wood products: Category G.

The IPCC (2006) inventory guidelines accommodate differences in national land-use classification systems. In current UK reporting, the Wetlands category only includes peat workings and inland waters. Emissions from peat extraction sites have been allocated to their local authorities in the UK. Bogs, marshes and fens are assumed to be used for grazing and are included in the Grassland category. Naturally occurring emissions and removals from pristine areas of bog, marsh and fen are not currently included in LULUCF reporting.

Emissions from drained organic soils under Cropland and improved Grassland are reported in those respective categories. Emissions from drained organic soils under semi-natural Grassland are not currently captured in the LULUCF inventory, but these will be addressed when the results of a recently published BEIS-funded research project (Evans *et al.*, 2017) on the implementation of the IPCC Wetlands Supplement guidance for peatlands (IPCC, 2014) is implemented into the LULUCF inventory. 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'.

The UK land use change matrix can be simplified to that shown in Figure 1, including only Forest Land (A), Cropland (B), Grassland (C) and Settlements (E) (shown clockwise from top left). 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 showing the corresponding category designation; '1' refers to land that has not changed use (e.g. 4A1 is for Forest Land remaining Forest Land), '2' refers to land that has undergone change (e.g. 4A2.1 is for Cropland converted to Forest Land). The very small areas of conversion between Wetland and Grassland as a result of peat extraction activity and site restoration are not shown on this diagram.

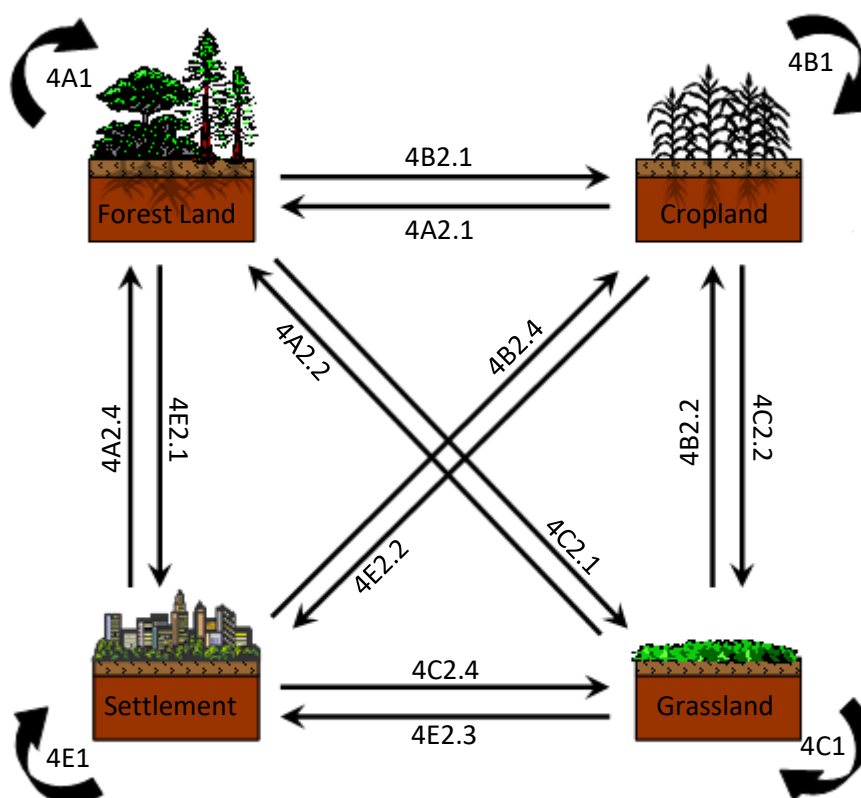


Figure 1: UK Sector 4 land use transitions showing categories for carbon stock change. See text for details.

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 and Grassland and 'peat extraction' affects Wetlands remaining Wetlands. However, transitions to or from Wetlands are very small and therefore this category is not shown in Figure 1. The change in carbon stocks of living biomass, dead biomass and soil organic matter must be reported for each activity together with other relevant non-carbon changes.

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, such as 20 km × 20 km regions, is appropriate for modelling purposes and the development of estimates at local authority scale as described in this report.

1.2 Activities

The activities within LULUCF are listed in Table 1. The main category designations are listed with the activity description and the UK total emissions/removals (Gg C) for 2017 as reported in the 1990-2017 Inventory (excluding emissions from OTs and CDs). The activities are sorted in order of magnitude and divided into five groups; afforestation, emissions from soils due to land use change, emissions from soils due to drainage, minor emissions and categories assumed to have zero emissions/removals for the UK. Full details are given in the National Inventory Report (Brown et al, 2019).

Table 1: The UK CO₂-C emissions and removals in Sector 4 (Land Use, Land Use change and Forestry) for 2017 sorted in order of magnitude.

Category	Activity	2017 UK total Gg CO ₂ -C emission (+) or removal (-)	Group
4A	Land converted to Forest land and land remaining Forest Land (not including emissions from wildfires)	-4964.69	Forest Land
4B	Land converted to Cropland and land remaining Cropland (change in soil carbon not including losses from drainage of organic soils)	2763.31	Emissions from soils due to land use change
4C	Land converted to Grassland and land remaining Grassland (change in soil carbon not including losses from drainage of organic soils)	-2755.07	Emissions from soils due to land use change
4E	Land converted to Settlement and land remaining Settlement (change in soil carbon)	1651.38	Emissions from soils due to land use change
4G*	Harvested Wood Products	-549.74	NA
4B1	Cropland remaining Cropland (drainage of organic soils)	464.15	Emissions from soils due to drainage
4B1	Cropland remaining Cropland (cropland soil management practices)	-173.88	Minor emissions
4C2	Non-Forest land converted to Grassland (change in non-forest living biomass)	141.62	Minor emissions
4C2	Forest Land converted to Grassland (deforestation to grassland – not including soil changes)	141.02	Minor emissions
4D1	Wetlands remaining Wetlands (peat extraction)	91.85	Minor emissions
4E2	Forest Land converted to Settlement (deforestation to settlement – not including soil changes)	82.71	Minor emissions
4B2	Non-Forest land converted to Cropland (change in non-forest living biomass)	-78.70	Minor emissions
4C1	Grassland remaining Grassland (drainage of organic soils)	48.22	Emissions from soils due to drainage
4E2	Non-Forest land converted to Settlements (change in non-forest living biomass)	18.48	Minor emissions
4C1	Grassland remaining Grassland (grassland biomass management practices)	14.97	Minor emissions
4A1	Forest Wildfires	8.09	Minor emissions
4B1	Cropland remaining Cropland (cropland biomass management practices)	8.08	Minor emissions
4B2*	Forest Land converted to Cropland (deforestation to crop – not including soil changes)	0.00	Minor emissions

* Sector 4G (Harvested Wood Products) is not included in the LA estimates because of insufficient data for distributing the emissions and removals. *There were no areas of Forest Land to Cropland conversion in 2017.

Each of the three groups of activities are described below. Emissions and removals from the LULUCF Sector are predominantly of CO₂. Emissions of other greenhouse gases are produced by biomass burning during wildfires or the conversion of Forest Land to Cropland, Grassland or Settlements (CH₄, N₂O, NO_x and CO). Direct and indirect emissions of N₂O are also produced from nitrogen fertilisation of new forests and soil mineralisation following land use change. Estimates of N₂O and CH₄ emissions from these sources are included in the 2017 inventory (1.1 Gg CH₄ or 7.7 Gg Ce (Carbon equivalents) for methane and 4.7 Gg N₂O or 382.4 Gg Ce for nitrous oxide across the UK in 2017). Emissions of these non-CO₂ gases from agricultural land (e.g. due to fertilisation) are reported in the Agriculture sector of the Greenhouse Gas Inventory. Only changes in carbon resulting from emissions and removals of CO₂ are included in this report.

2 Forest Land

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 CO₂ from the atmosphere) in their biomass and soils as they grow, but timber harvesting and planting activities disturb this accumulation and result in loss of carbon via emissions of carbon dioxide, and other carbon-containing substances, 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 types of input data are required for the model; a) areas of new forest planted in each year in the past, b) the stemwood growth rate and c) management/harvesting pattern.

The national estimates use the combined area of new private and state planting from 1920 to 2017 and estimated planting areas for pre-1920 for England, Scotland, Wales and Northern Ireland sub-divided into conifers and broadleaves. For mapping at LA scale, the results from the CARBINE model for England, Scotland, Wales and Northern Ireland were disaggregated to 20 km × 20 km grid squares across the UK using historic average estimates of planting data reformatted to this scale. The disaggregated data were then combined to provide estimates per local authority. This is achieved by taking the 20 km grid square data and disaggregating further to every 1 km square in the UK. Up to 400 1 km grid squares make up one cell in the 20km resolution map, however in coastal regions where cells fall in the sea the flux is apportioned to the land-based 1km data points enclosed within the 20km cell. These smaller units can then be combined according to the LA boundaries (see Figure 2).

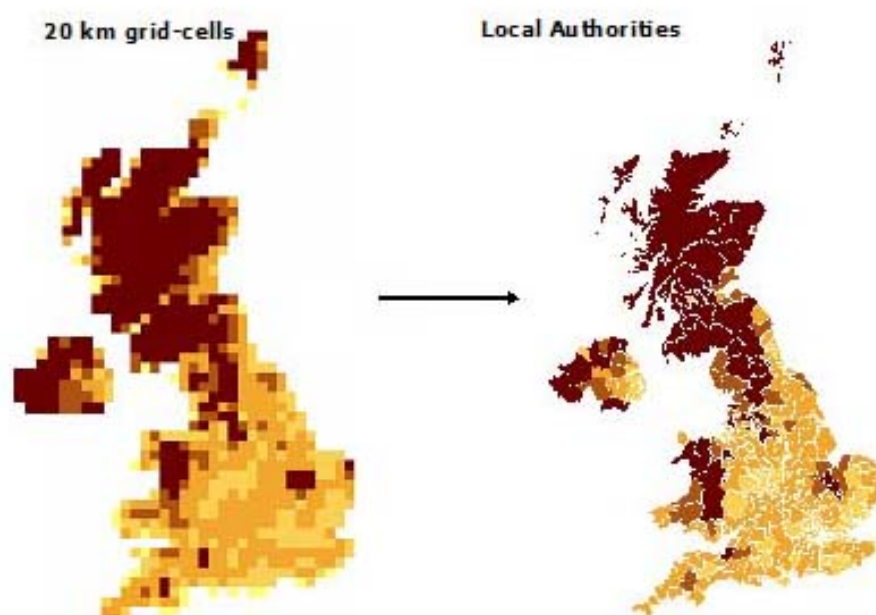


Figure 2: Model output is generated for 852 20 × 20 km squares across the UK, which is further disaggregated to 245, 655 1 × 1 km land-based squares (not shown). Data are combined to provide estimates for each local authority (data for illustration only).

Figure 3 shows the distribution of carbon removals due to forest land across the UK expressed as tonnes of Carbon per square kilometre (tC per km²). Maps of total carbon 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. The distribution of forest carbon removals is directly linked to the location of forests (Forestry Commission, 2018), for example close to half of the forest land in England is in the north, which is clearly visible from the large sink in that area.

Sector 4A: (Forest Land)

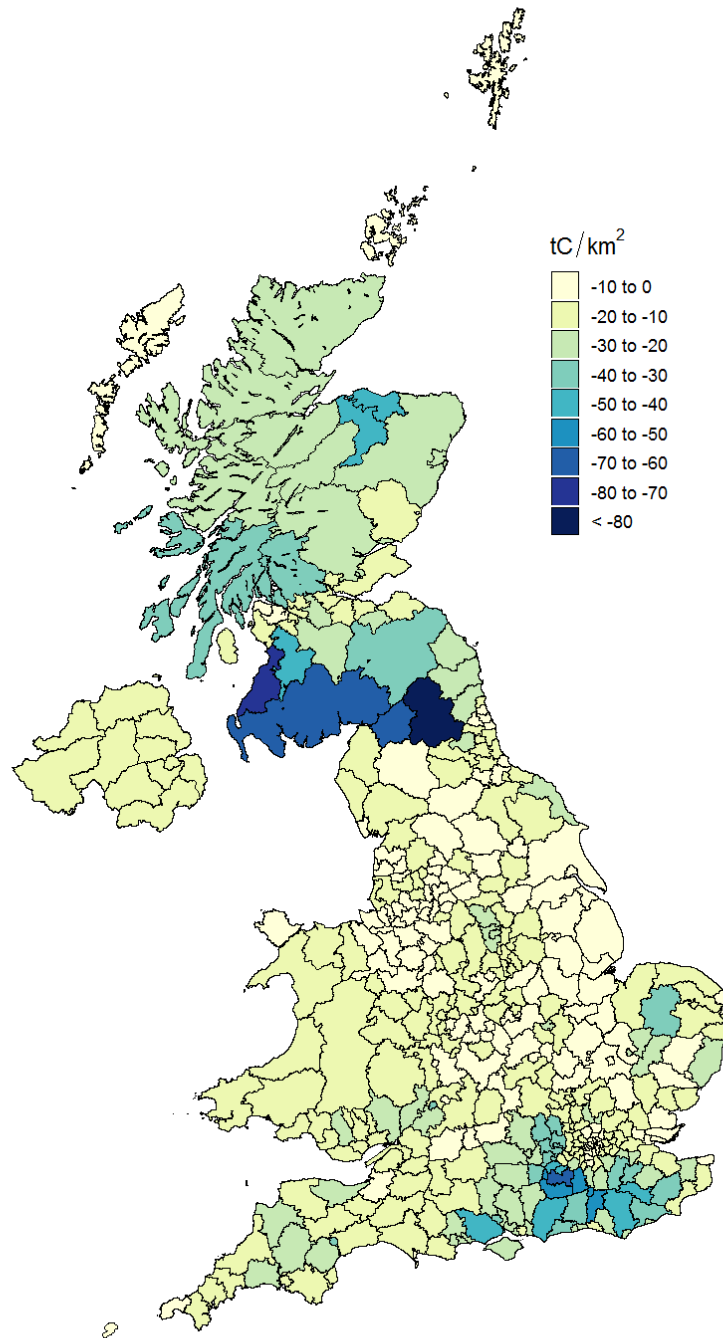


Figure 3: Distribution of carbon removals from the atmosphere in 2017 due to forest land across the UK expressed as tC per km².

3 Emissions from soils due to land use change - Cropland, Grassland, Settlements

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 results in ongoing emissions or removals which continue for decades after the change in

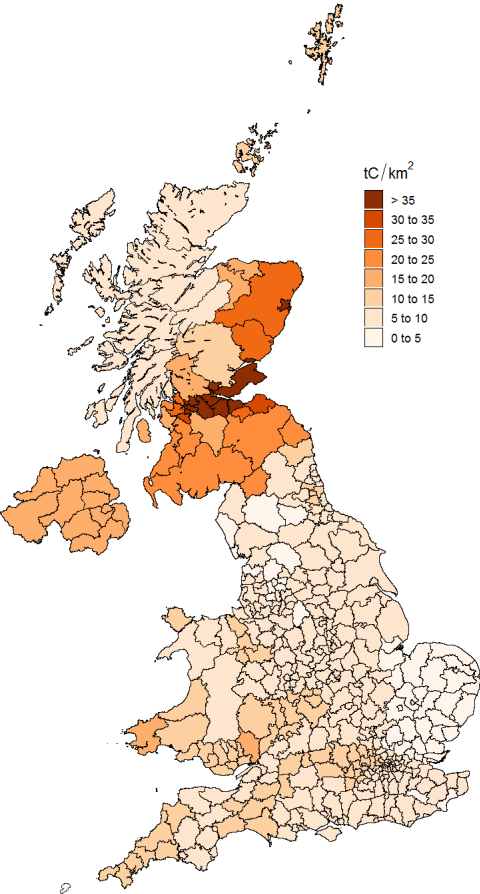
land use until equilibrium carbon stocks characteristic of the new land use are reached. Also, any initial disturbance of the soil will release carbon from soils to the atmosphere as CO₂.

For the LULUCF inventory, the method for assessing changes in soil carbon stock due to land use change links a matrix of area changes coming mainly from land surveys to a dynamic model of carbon stock change. For Great Britain, matrices from the Monitoring Landscape Change data from 1947 & 1980 (MLC, 1986) and the Countryside Surveys (CS) of 1984, 1990, 2000 and 2007 are used and the rates observed after 2007 obtained by extrapolating rates of change observed pre-2007.

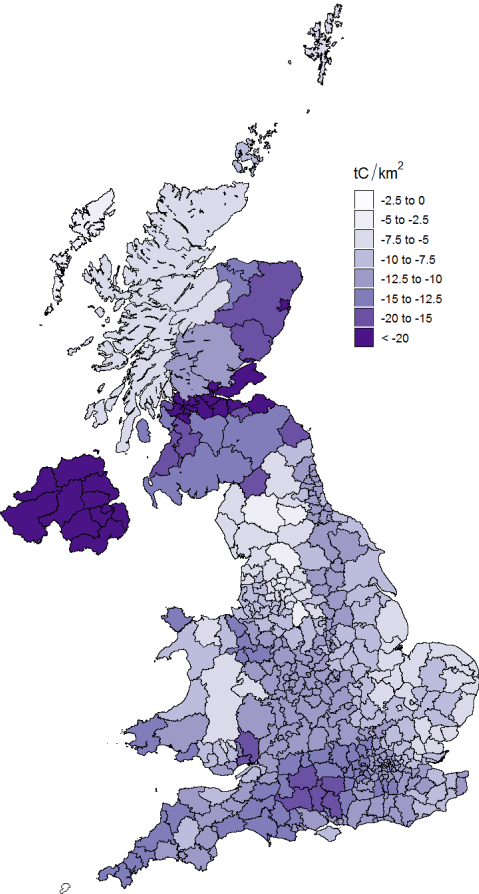
In Northern Ireland, for 1990 to 1998 and 1998 to 2007, a matrix for the whole of Northern Ireland was available from the Northern Ireland Countryside Survey (Cooper, McCann and Rogers 2009). The only data available pre-1990 for Northern Ireland are land use areas from the Agricultural Census and the Forest Service (Cruickshank and Tomlinson 2000). Matrices of land use change were then estimated for 1970-80 and 1980-90 using area data. The basis of the method devised assumed that the relationship between the matrix of land use transitions for 1990-1998 and the area data for 1990 is the same as the relationship between the matrix and area data for each of two earlier periods – 1970-79 and 1980-89. The matrices developed by this approach were used to extrapolate areas of land use transition back to 1950 to match the start year in the rest of the UK.

Time series of land use change in 20 × 20 km grid-cells (to match those used for the afforestation fluxes) have been developed using the Countryside Surveys covering periods 1984 to 1990, 1990 to 1998 and 1998 to 2007. The land use change matrices for the 20 × 20 km grid-cells are scaled to match those used in estimates of emissions and removals for the devolved administration areas in the United Kingdom. These matrices are then used for each grid-cell as input to the soil carbon model. The data are then combined to give estimates per local authority region (see Figure 4). 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 (England, Scotland, Wales and Northern Ireland). For example, the majority of land use change to both Cropland and Grassland in Scotland occurs in the south and east of the country. For Northern Ireland there is no spatial information available so the values for each LA are the same.

Sector 4B (Cropland Soil)



Sector 4C (Grassland Soil)



Sector 4E (Settlement Soil)

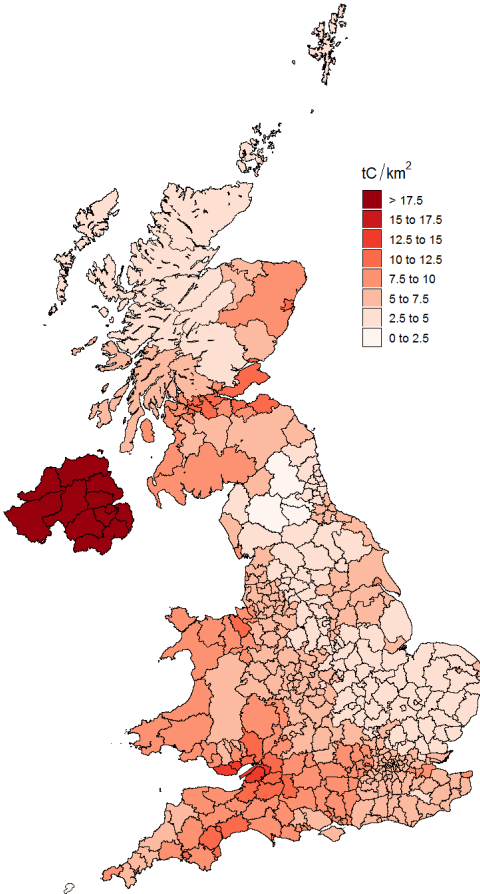


Figure 4: Emissions in 2017 from soil due to land use change (tC/km²) for conversion of all land types to (a) Cropland (b) Grassland and (c) Settlements.

4 Emissions from soils due to drainage of organic soils – Cropland, Grassland

Lowland wetlands were drained many decades ago for agricultural purposes and continue to lose carbon from the soil as CO₂. The method for estimating drained areas at both the UK and LA scale is to compare maps of histosol (organic soil) areas with maps of land use (Steve Anthony, ADAS *pers. comm*). Emissions are then calculated from the areas using a simple Tier 1 approach. Figure 5 shows the estimated distribution of emissions (tC/km²).

Sector 4B (Cropland, Organic Soil Drainage)

Sector 4C (Grassland, Organic Soil Drainage)

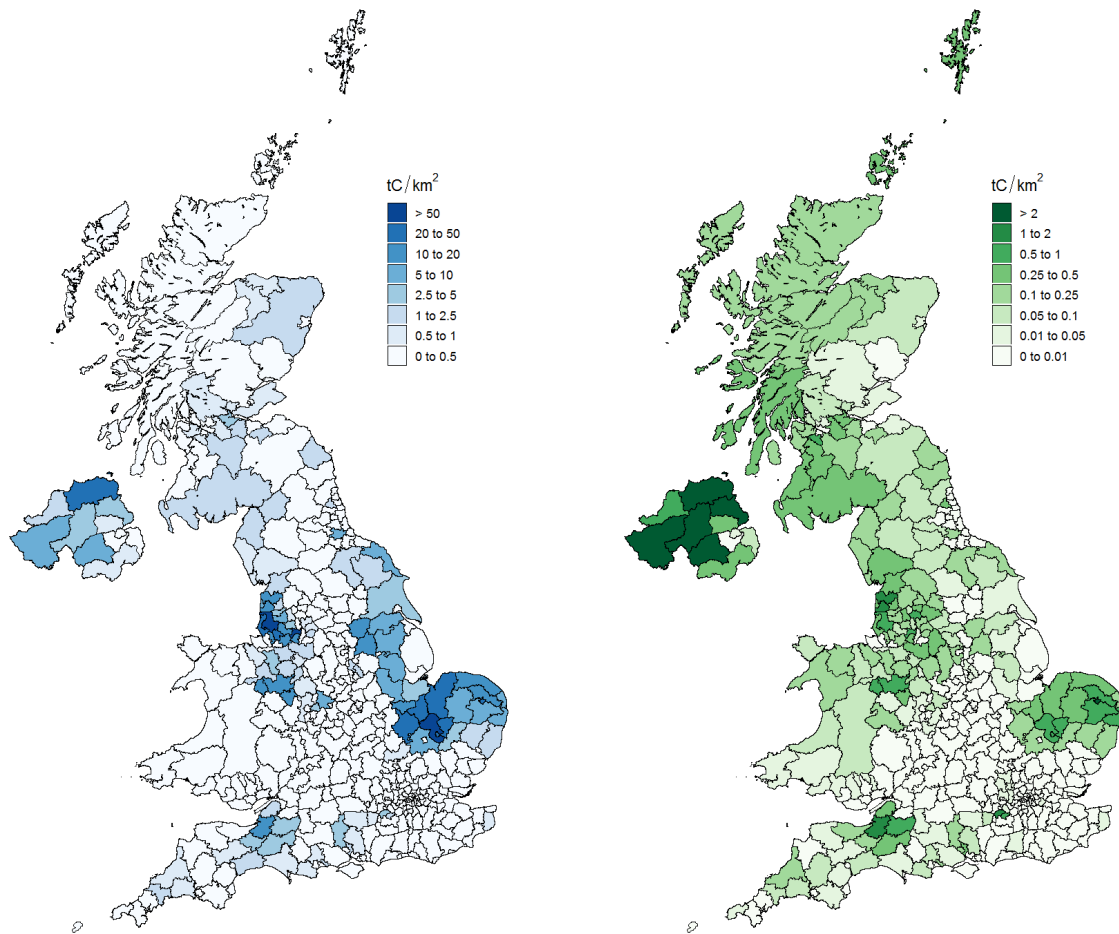


Figure 5: Carbon emissions in 2017 due to drainage of organic soils under Cropland and improved Grassland (tC/km²) in previous years.

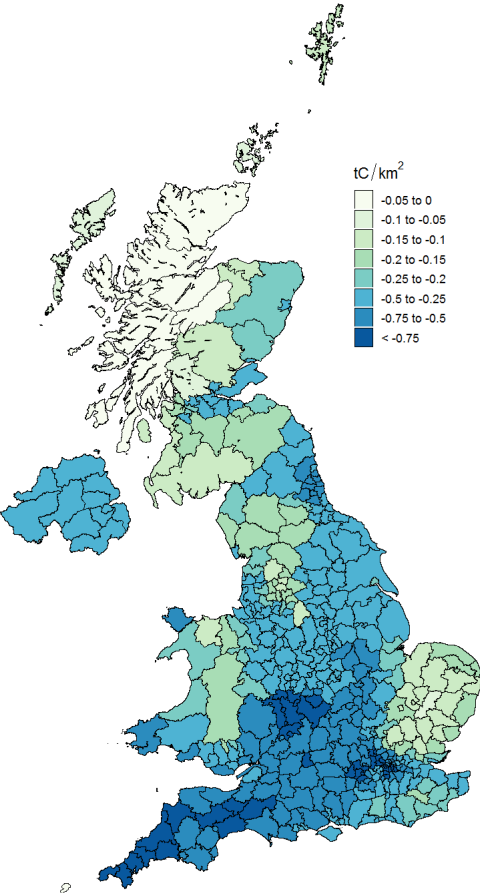
5 Estimates of various minor emissions

5.1 Non-Forest Biomass

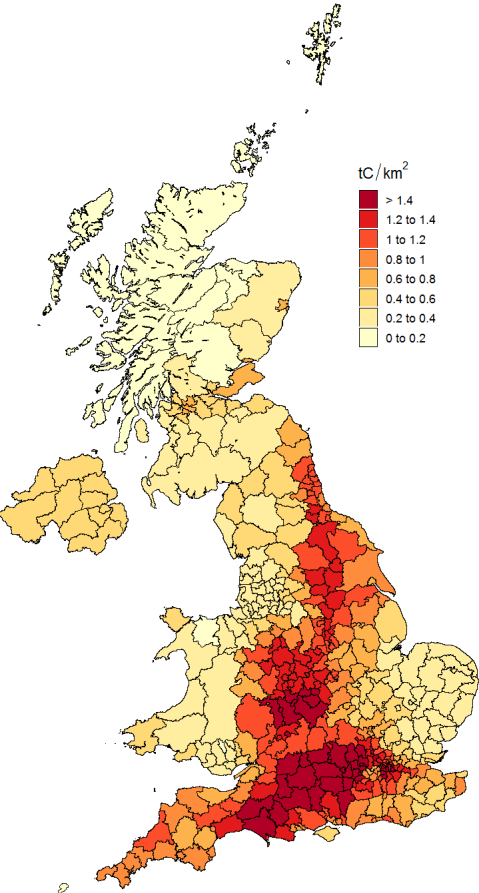
The different land use types have different biomass carbon area densities at equilibrium. Change from one land use type to another can result in an increase or decrease in biomass carbon area density. This category describes the annual change in the carbon stock in vegetation biomass due to all land use change to Grassland, Cropland or Settlements, excluding forests and woodland.

For the LULUCF inventory, estimates of emissions and removals for this category 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 area density for each land type was assigned by expert judgement based on the work of Milne and Brown (1997). Five basic land uses were assigned initial biomass carbon area densities, then the relative occurrence of these land uses in the four countries of the UK were used to calculate mean biomass carbon area densities for each of the IPCC types, Cropland, Grassland and Settlements. The mean biomass carbon area densities 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 area densities. This year the average biomass area densities for Cropland and Grassland used in the non-forest biomass LUC model have been updated to those used in the cropland and grassland management calculations, based on a UK-relevant literature review in Moxley *et al.* (2014). Changes between these equilibrium biomass carbon area densities were assumed to happen in a single year. This matrix approach was extended and applied to each 20 km × 20 km grid square across the UK, and the results combined to give estimates for each local authority (see Figure 6).

Sector 4B2 (Cropland, Non-Forest Biomass)



Sector 4C2 (Grassland, Non-Forest Biomass)



Sector 4E2 (Settlement, Non-Forest Biomass)

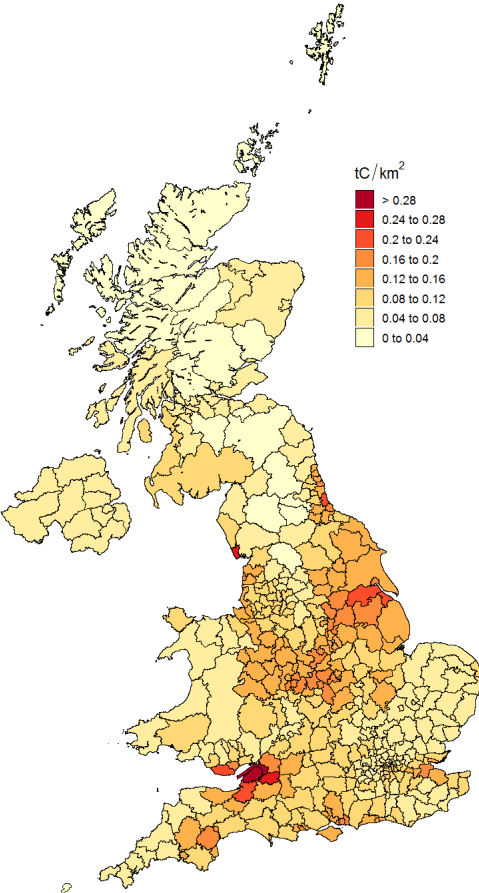


Figure 6: Carbon emissions and removals in 2017 across the UK due to changes in living biomass (tC/km²) following land use change to Cropland (4B2), Grassland (4C) or Settlements (4E).

5.2 Peat Extraction

Carbon emissions from peat extraction are calculated for the LULUCF inventory based on data published in the *Mineral Extraction in Great Britain Business Monitor PA1007* which gives data on volumes of peat sold, the *Directory of Mines and Quarries (DMQ)* which gives the location of peat extraction sites, and Google Earth which provides information on the area of peat extraction sites. The publication of the peat extraction data has been discontinued from 2014, so for 2015 onwards the 2005-2014 average value is used. The DMQ data give the location of origin of the peat and we have assumed that the carbon emission applies to this area (see Figure 7).

Due to rounding errors in the published figures, the sum of the extraction areas for the regions does not exactly equal the national totals. Local authorities with no peatland extraction activities have zero emissions from peat extraction. Whereas in LAs with peat extraction, the total emissions resulting from peat extraction in each country were adjusted in proportion to the area of peat extraction per LA so that the total equals the submitted national emission. Emissions from peat extraction are reported in category 4D (Wetlands).

Sector 4D1 (Wetland, Peat Extraction)

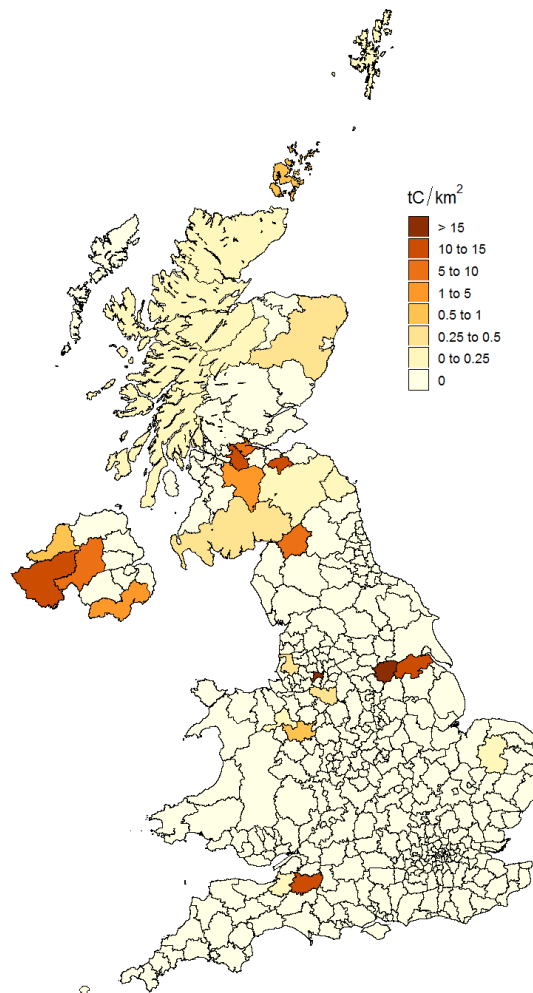


Figure 7: Carbon emissions in 2017 (tC/km²) resulting from the extraction of peat for horticultural use. This is part of the Wetlands category.

5.3 Deforestation

Emissions due to deforestation are disaggregated into deforestation to Cropland (reported in 4B, and only occurring in England and Scotland up to 2006 and 2005 respectively), Grassland (4C) and Settlements (4E).

The area of land deforested in each Local Authority is not currently available so we assume that the area deforested is proportional to the total area of forest in each LA. We also assume that the relative conversion of forest to either Cropland, Grassland or Settlement is the same for each LA (see Figure 8, this does not show Deforestation to Cropland as this was zero in 2017).

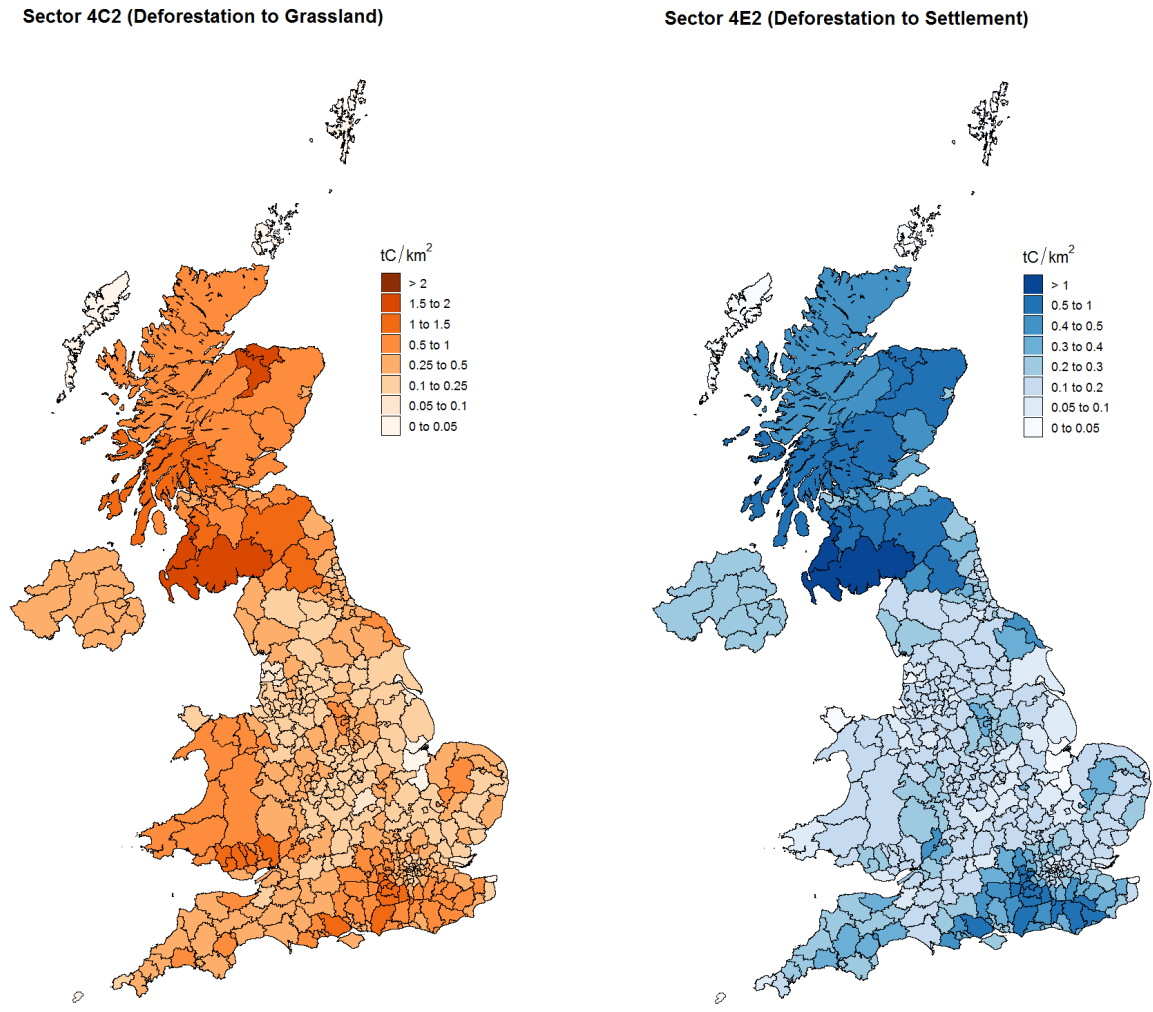


Figure 8: Emissions of carbon in 2017 resulting from deforestation to Grassland or Settlements (tC/km²).

5.4 Wildfires

Information on areas of wildfires on forest land in Great Britain and in Northern Ireland is available from the Fire Service Incident Reporting 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 fires can be assigned to the LA in which they occurred, and in Northern Ireland the emissions are assigned between LAs in proportion to the total area of forest land in each LA. Forest wildfires only occurred in Scotland and Northern Ireland in 2017 as shown in Figure 9.

Sector 4A (Forest Land, Wildfires)

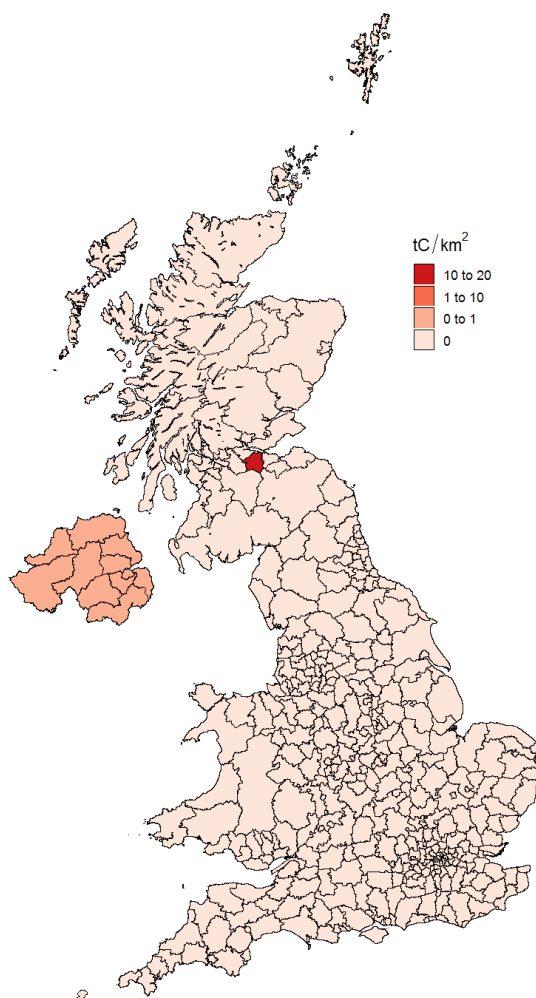


Figure 9: Emissions due to forest wildfires in 2017 (tC/km²).

5.5 Cropland Management 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, 2017; Welsh Government, 2017; Scottish Government, 2017; DAERA, 2018). 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, 2018 and previous editions). The emissions were disaggregated to the LA level using the same methodology as for Cropland soil emissions. The resulting assignment by LA is shown in Figure 10.

Sector 4B (Cropland Management Soils)

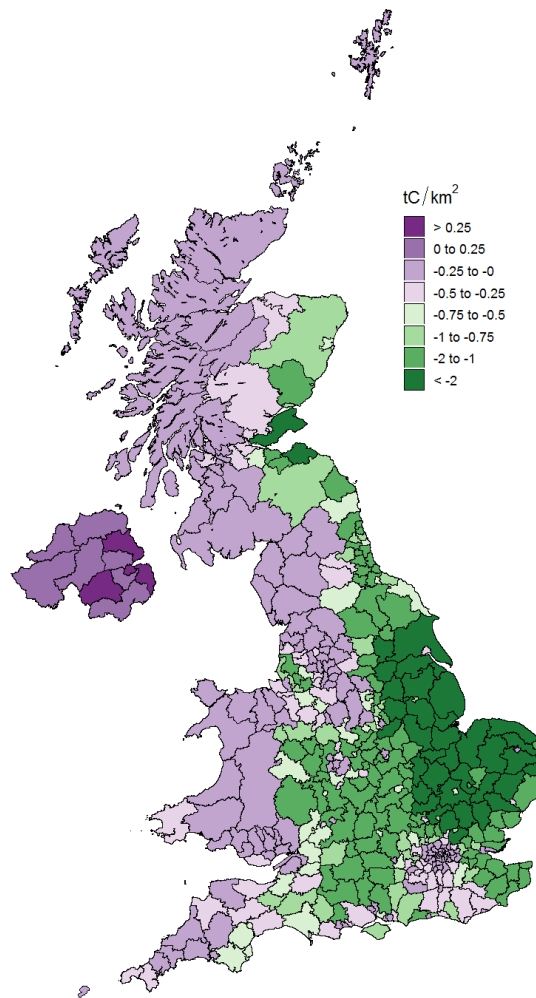


Figure 10: Emissions / removals of carbon in 2017 from Cropland Management soil activities (tC/km²).

5.6 Cropland and Grassland Management Biomass

Changes in biomass carbon stocks arising from Cropland and Grassland management activities are reported in the inventory. These include change between annual crops, orchards, short rotation coppice, set aside and fallow for Cropland and change between shrubby and non-shrubby grassland types and hedge creation and removal for Grassland. Data on the areas under the main crop types are obtained from the annual June Agricultural Censuses carried out by each UK administration (Defra, 2017; Welsh Government, 2017; Scottish Government, 2017; DAERA, 2018). 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 were disaggregated to the LA level using the same methodology as for Cropland and Grassland non-forest biomass emissions. The resulting assignment by LA is shown in Figure 11.

Sector 4B (Cropland Management Biomass)

Sector 4C (Grassland Management Biomass)

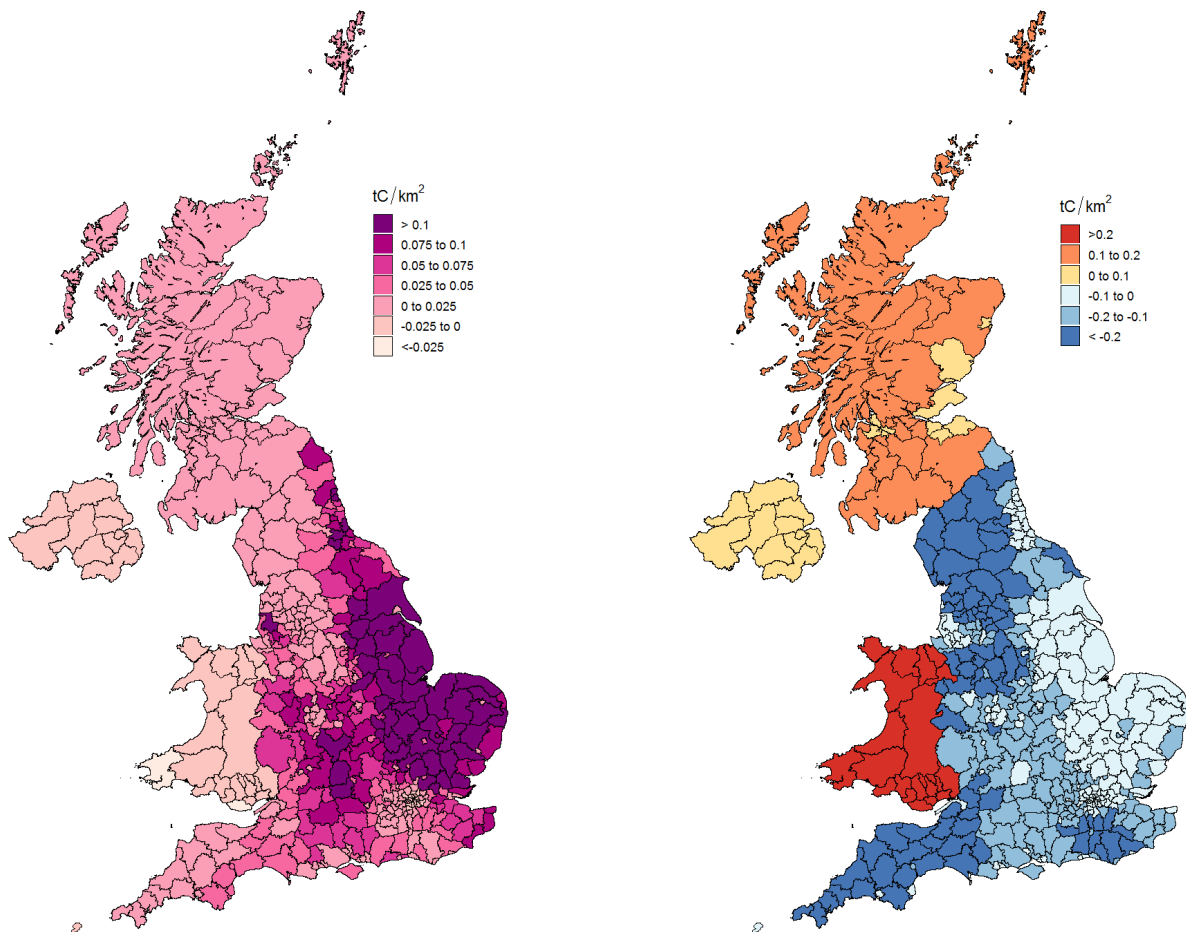


Figure 11: Emissions / removals of carbon in 2017 from Cropland and Grassland Management biomass activities (tC/km²).

6 LULUCF Totals

The total carbon emissions for the UK land use, land use change and forestry sector (excluding harvested wood products which cannot be mapped) are shown in Figure 12.

Sector 4: Total LULUCF

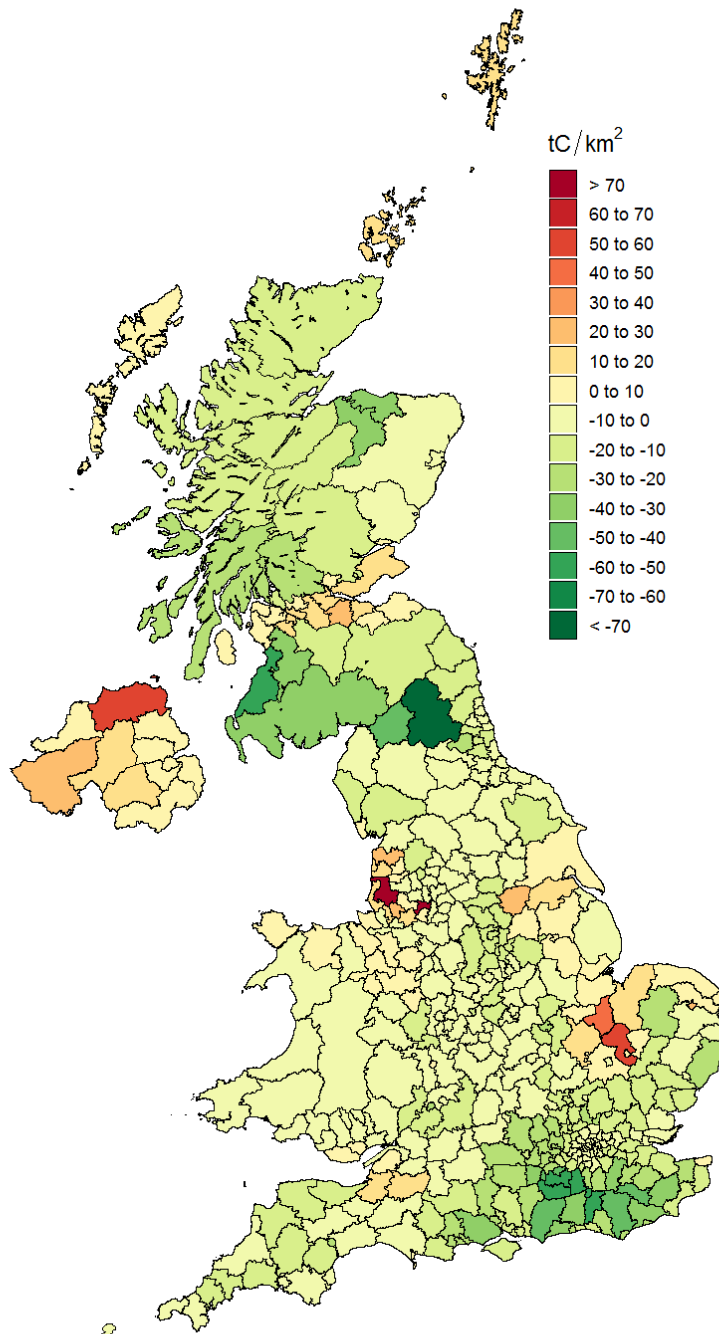


Figure 12: The total carbon emissions or removals in 2017 for Sector 4 across the UK (tC/km²).

7 Uncertainties

The uncertainties in calculating the LULUCF inventory are described in an annex of the National Inventory Report (Brown et al, 2019) and are in the range of 40-50% for CO₂ in 2017. Additional uncertainty is associated with disaggregating the dataset to LA scale. A full uncertainty analysis of this procedure has not been carried out, however, it is estimated that the uncertainty in the disaggregation process is in the range of 20-30 %. There is low uncertainty in the LA mapping of carbon emissions associated with wildfire occurrence and peatland extraction due to fine-scale spatial input data. Moderate uncertainty in the disaggregation process is attributed to emissions from forest land, soils due to land use change, soils due to drainage, and the minor categories where similar input scales and methodology were employed. There is higher uncertainty in the LA mapping of deforestation due to a lack of deforestation data below DA level; hence, a proxy using forested area and total deforestation is applied.

Table 2: Summary of source data and estimated uncertainty associated with the disaggregation of emissions to the local authority level.

Category	Source data used for spatial disaggregation	Uncertainty
Forest Land	UK forestry and planting data from the National Inventory of Woodland and Trees	Moderate
Emissions from soils due to land use change - Cropland, Grassland, Settlements	Countryside Surveys	Moderate
Emissions from soils due to drainage of organic soils – Cropland, Grassland	Histosol (organic soil) areas, land use maps	Moderate/Low
Non-Forest Biomass	Countryside Surveys	Moderate
Peat Extraction	BGS BritPits database co-ordinates	Low
Deforestation	As for Forest Land	High
Wildfires	Fire and rescue service Incident Recording System	Low
Cropland Management Soil	Countryside Surveys	Moderate
Cropland and Grassland Management Biomass	Countryside Surveys	Moderate

8 Recalculations

The National Inventory is often updated to include improved, or new, datasets and modelling techniques. In the 2017 inventory there were a number of changes and improvements (Table 3).

Table 3: Details of all changes between the 2016 and 2017 LULUCF inventories.

Description of Change	Reason for Change	Categories Affected	1990-2016 Inventory 2016 UK Value (GgC)	1990-2017 Inventory 2016 UK Value (GgC)	1990-2017 Inventory 2017 UK Value (GgC)
Reconciliation of harvest volume and forest age data. Error correction of the double-counting of inputs of deadwood in the CARBINE model and adjustment of average biomass area densities. Adjustment of turnover calculations.	Error identification and correction.	4A	-6550.14	-4995.52	-4964.69
Adjustment to uncropped land area.	Correction in the area of set aside and fallow land due to duplication of a year in the input data.	4B1 Cropland remaining cropland (soil management)	-175.90	-180.12	-173.88
		4B1 Cropland remaining cropland (biomass management)	3.39	3.45	8.08

Description of Change	Reason for Change	Categories Affected	1990-2016 Inventory 2016 UK Value (GgC)	1990-2017 Inventory 2016 UK Value (GgC)	1990-2017 Inventory 2017 UK Value (GgC)
Changes to the living biomass area densities for land converted to cropland, grassland, and settlement changes the sign of the carbon stock changes in biomass arising from land use change between these categories.	Inventory improvement in response to a UNFCCC reviewer recommendation.	4B2 Land converted to cropland (non-forest biomass)	36.03	-78.70	-78.70
	Inventory improvement due to new activity data.	4C2 Land converted to grassland (non-forest biomass)	-63.93	140.19	141.62
		4E2 Land converted to settlement (non-forest biomass)	-14.52	18.48	18.48
Updated deforestation areas using new information from the most up-to-date National Forest Inventory. Updated average biomass carbon area densities used in the calculation of emissions from controlled burning following deforestation (arising from the activity data changes in 4A).	Inventory improvement due to new activity data.	4C2 deforestation to grass (not including soil)	179.71	171.40	141.02
	Improvement to ensure consistency over the time series.	4E2 deforestation to settlement (not including soil)	106.85	101.78	82.71
Updated deforestation areas using new information from the most up-to-date National Forest Inventory.	Improvement due to revised activity data.	4C soil	-2727.44	-2728.49	-2755.07

Description of Change	Reason for Change	Categories Affected	1990-2016 Inventory 2016 UK Value (GgC)	1990-2017 Inventory 2016 UK Value (GgC)	1990-2017 Inventory 2017 UK Value (GgC)
		4E soil	1651.40	1654.30	1651.38
Change due to update in the calculation of total area of peat extraction - rather than using a roll-over of the 2015 value, the 2016 value is now from activity data and shows a reduction in peat extraction area due to restoration.	Improve consistency within the model.	4D1 peat extraction	87.19	85.27	91.85
		LULUCF Total¹	-4370.62	-3071.82	-3088.21

¹ This is the total for all categories (both recalculated and unchanged).

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