

Land Use in the UK

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Abstract

This paper presents the first experimental physical asset accounts for UK Land Use for 2000-2010. These accounts are developed in accordance with the System of Environmental Economic Accounting (SEEA) Central Framework, while showing some flexibility in its implementation for UK specific context. The compilation of these accounts will help to monitor the changes to the breakdown of UK land use over an accounting period. It also provides the methodology used to develop these accounts, discusses issues in implementing SEEA and provides suggestions on improving these accounts over time.

Introduction

In November 2011, in response to the [Natural Environment White Paper](#) (NEWP) commitments, the Office for National Statistics (ONS) published a paper "[Towards a sustainable environment – UK Natural Capital and Ecosystem Accounting](#)" to outline its approach to deliver the 'early changes by 2013' to the UK Environmental Accounts. The paper suggested that in the first instance an asset account for land use and cover should be prioritised in addition to the woodland accounts. In December 2012 the ONS published a roadmap, "[Accounting for the value of nature in the UK](#)", to incorporate the natural capital into the UK Environmental Accounts. As part of the roadmap, ONS set out a timetable to develop land use and land cover accounts. This paper is a first step in developing statistics on land use in the UK. ONS has also published physical asset accounts of UK woodland land use alongside this paper¹.

Land use and land cover data are important for understanding how environmental systems function. Their assessment over time provides a mechanism for gauging the impact that changes in land may have on biodiversity and ecosystems. Knowledge of current land use is needed for formulating sustainable use of land resources. To obtain a complete picture of land management, both land use and cover accounts should be assessed together; however the focus of this paper is only land use. The compilation of land use accounts will help to monitor the changes in the breakdown of UK land use over an accounting period. Land cover accounts are discussed in future work section at the end of this paper.

As discussed in the paper "[Towards a sustainable environment – UK Natural Capital and Ecosystem Accounting](#)", the conceptual model adopted by the UK and the international statistical community for environmental accounts is the United Nations' [System of Economic and Environmental Accounts](#) (SEEA), a satellite system of the System of National Accounts (SNA). The accounts produced under this standard bring environmental and economic information together within a common framework.

¹ See "Measuring UK woodland area and timber resources"

A multi-year process of revision to the SEEA was initiated by the United Nations Statistical Commission (UNSC). The revised SEEA consists of three parts:

- The [Central Framework](#) of agreed concepts, definitions, classifications, accounting rules and tables which, following a period of global consultation, has been adopted as the international statistical standard for environmental-economic accounts by the UNSC in February 2012.
- [Experimental Ecosystem Accounting](#), which following a global consultation has been endorsed by the UNSC as international guidance in February 2013.
- [Extensions and Applications](#), which outlines applications of environmental economic accounting.

ONS aim is to develop land use accounts in accordance with the SEEA Central framework; however, ONS has taken a flexible approach in implementing the SEEA as it acknowledges that countries could show flexibility in implementing the standards depending on their specific needs. Therefore, this paper implements the SEEA whenever possible, discusses and highlights the issues and adopts a flexible approach on developing experimental land use accounts.

Land is an important environmental asset that reflects the activities undertaken and arrangements put in place for the purpose of economic production or the maintenance and restoration of environmental function. Land that is used implies the existence of some human intervention, which is different to land cover. Since there is often confusion between the classification of land use and land cover, this paper starts with a brief discussion of definitions in this context. It then introduces the SEEA suggested classes and an initial account for land use in the UK is constructed. The last two sections discuss the frequency of the accounts and future work on land cover. The methodology to develop land use accounts is given in Annex B.

Difference between land use and land cover

The Food and Agricultural Organisation of the United Nations² defines land use as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it". The land use reflects both the activities undertaken and the changes made to an area for the purposes of economic production or the maintenance and restoration of environmental function³. Land that is "used" implies the existence of some human intervention.

In the SEEA, land cover refers to the observed physical and biological cover of the Earth's land as vegetation or man-made features. In other words, when considering land cover in a strict sense, it should be confined to the description of vegetation and man-made features.

The above definitions show that there is a direct link between land use and land cover. For example, "recreation area" is a land use term that may be applicable to different land cover types, for instance, sandy surfaces like a beach, a built-up area like a playground; or woodlands⁴.

² FAO Corporate document repository - <http://www.fao.org/docrep/008/y7220e/y7220e06.htm>

³ Source: SEEA Central Framework

⁴ Further details are provided in Annex B

Land use classification

The SEEA classification for land consists of seven main categories. Within each classification type there are various categories of use. The categories are not defined on the basis of economic activity but on the general purpose and role of the area. In most cases this will be in line with the economic activity but in some cases the area considered to be in general use may be larger than the area being used for economic production. For example, for areas of woodland not intended to be used for economic production might be used for maintenance and restoration of environmental functions or has no human activity associated with them.

The land use classification suggested by the SEEA Central Framework is given in table 1 below:

Table 1: Land Use Classification⁵

1 Land
1.1 Agriculture
1.2 Forestry
1.3 Land used for aquaculture
1.4 Use of built up and related areas
1.5 Land used for maintenance and restoration of environmental functions
1.6 Other uses of land not elsewhere classified
1.7 Land not in use
2 Inland waters
2.1 Inland waters used for aquaculture or holding facilities
2.2 Inland waters used for maintenance and restoration of environmental
2.3 Other uses of inland waters not elsewhere classified
2.4 Inland waters not in use

Source: SEEA Central Framework.

The objective of land use accounting, in physical terms, is to describe land use and its changes over an accounting period. A land use account using the above classification (Table 1) can potentially provide a complete breakdown of national land use; however, the land use classification above is not relevant to the UK. It is also possible to construct basic physical asset account for individual resources. ONS has published physical asset accounts of UK woodland land use alongside this paper⁶. UK woodland accounts are a sub-set of land use accounts and similarly physical asset accounts for other land use could also be constructed for an in depth analysis on a particular land use.

The purpose of the land use accounting structure is to measure the total land area in the UK under different land uses. It records the opening and closing stock and changes in the area between two accounting periods. The SEEA Central Framework provides a structure for physical asset account for individual land use categories. This paper uses a similar structure to develop the physical asset account for UK land.

⁵ See Annex A for definitions

⁶ See "Measuring UK woodland area and timber resources"

Physical asset account for land use

An experimental⁷ physical asset account for UK land for 2000-2010 is given in Table 2. The physical land use accounts are not entirely consistent with the land use classification given in Table 1. In the UK, the land is not routinely classified as shown in Table 1 and data are not available for some of these land use classes. The data, except forestry, used to develop these experimental statistics are obtained from the Centre for Social and Economic Research on the Global Environment (CSERGE), which has generated a dataset describing classes of non-overlapping land use. The data for forestry is taken from Forestry Statistics (2000 and 2010). This paper has combined some of the classifications together and broken down the two largest land use classifications – agricultural and forestry - into further sub-classes. This will avoid double counting and provide visible changes in the land use.

A brief description of land use classes⁸ that are used to develop UK land use accounts is given below, while detailed definitions of all the classifications provided in table 1 are given in Annex A.

Agriculture accounts for almost 75% of land use in the UK. They are also broken down further into different categories, for example, arable crops, grasslands, and other farmland.

Forestry accounts for almost 13% of land use in the UK. This has been broken down further into coniferous and broadleaved. ONS is today publishing a physical asset account on UK woodland area, which provides detailed accounts on woodland area and timber resources within the woodland⁹.

Use of built up and related areas, for example, residential and commercial areas, roads and urban green space. This accounts for around 10% of the land use in the UK. This is renamed as ‘Urban and developed land’ in table 2.

Land not elsewhere classified is the combination of land used for maintenance and restoration of environmental functions and other uses of land not elsewhere classified. The following sites are included within this classification:

- Sites of special scientific interest.
- Natural nature reserves.
- Local nature reserves.
- Special protection areas.
- Special areas of conservation.
- Ramsar convention sites (The convention on wetlands of international importance).
- The Royal Society for the Protection of Birds.

Land not in use. As the name suggests, this category includes any land use that is not classified under any other category. There is a danger of double counting within this classification. It includes land with no visible

⁷ Experimental statistics are those that are published at an early stage to involve users in their development

⁸ **Land used for aquaculture** is not included in the above description because data in the UK are very limited. Scotland has the largest area of land use for aquaculture but there are no data readily available. This class is not included in our experimental land use account.

⁹ See paper “Measuring UK woodland area and timber resources”

human activity, flooded land including bogs and marshes which might also be classed as wetlands and included in land used for maintenance of environmental functions.

Inland Waters consist of many subcategories (table 1) and data for all the categories is limited in the UK. Based on data availability, two new sub-classes are included in the land use account

- Freshwater – includes fresh water and floodplain including rivers, lakes and canals.
- Marine and coastal – includes salt marsh and littoral (and sub-littoral) rocks and sediments.

Based on the classification discussed above, table 2 shows the initial physical asset accounts for land use in the UK. An important accounting objective is to measure the actual addition and reduction between time periods. However, due to data limitations, it is challenging to measure any improvement and reduction between these two accounting periods and therefore any changes between 2000 and 2010 are recorded as net change. The methodology and a detail of data sources are given in Annex B.

Table 2: Physical asset account for land use in the UK (2000 – 2010)¹⁰

	Total Agriculture	Crops and bare fallow (including horticulture)	Rough grazing (sole right)	Permanent grassland (> 5yrs)	Temporary grassland (< 5yrs)	Other farmland (roads, buildings, yards etc.)	Total Forestry	Broadleaved	Coniferous	Urban and developed land	Marine and coastal	Freshwater	Land not elsewhere classified	Total
Opening stock 2000 Area (thousand ha)	15,298	4,623	4,211	4,754	1,061	648	2,954,	1,375	1,580	2,607	352	212	1,710	22,972
<i>Net additions/Reduction</i>	35	-63	-297	505	47	-156	105	82	23	141	30	37	-52	-¹¹
Closing stock 2010 Area (thousand ha)	15,333	4,560	3,914	5,259	1,108	492	3,059	1,457	1,603	2,748	382	249	1,658	23,429

¹⁰ Forestry includes Northern Ireland data.

¹¹ It is not possible to show that the total area in the UK is increasing or decreasing because only forestry includes Northern Ireland data.

Data Sources

- The June Survey of Agricultural and Horticultural activity is undertaken as a full census every ten years and as a sample survey in intervening years. The last full census was in 2010. The June Survey is undertaken independently in England, Scotland and Wales and results are released in aggregated spatial units. June Survey data are not available for all years from these data sources. Furthermore, data are released in different aggregations of categories for different countries. The annual report 'Agriculture in the United Kingdom' is published by Defra and provides UK-level statistics on utilised agricultural land.¹²
- Forestry data are taken directly from the Forestry Statistics (2000, 2010). Forestry data has not been taken from CSERGE dataset because ONS is using Forestry Statistics to develop its woodland accounts and to be consistent with the publication it is using the same data source.
- The spatial distribution of developed land use (urban areas) can be found from Ordnance Survey's GIS data product Meridian Developed Land Use Areas. This dataset gives a generalised footprint of urban and suburban areas and therefore includes urban green spaces. The coverage of urban land can be obtained from the Centre for Ecology and Hydrology (CEH) Land Cover Map. Information on new housing can be found in local development plans.
- Freshwater, marine and coastal areas (unknown use) are adequately represented by CEH's Land Cover Map.

Frequency of accounts

The accounts presented in this paper are experimental statistics. The ultimate aim of developing these accounts is to incorporate them into the UK Environmental Accounts. Once these accounts are part of the UK Environmental Accounts, they will be published regularly to show the changes in the land use.

Generally, land area does not change significantly over a short period of time and therefore it is reasonable to only develop comprehensive land use accounts every few years. Although large amounts of data are available for land use, there remain data gaps that need to be addressed. This will require additional work exploring other data sources and possibly making further changes to the classifications.

Therefore, ONS recommends that these accounts should be updated every five years. This timeline is consistent with the woodland area account that ONS has published alongside this article in a paper "Measuring UK woodland and timber resources".

¹² For example Defra et al 2011- Department for Environment, Food, and Rural Affairs (United Kingdom); Department of Agriculture and Rural Development (Northern Ireland); The Department for Rural Affairs and Heritage, Welsh Assembly Government; Rural and Environment Research and Analysis Directorate, The Scottish Government, (2011) Agriculture in the United Kingdom 2011, Office for National Statistics, Newport, UK

Future Work

There are a number of data gaps and limitations in implementing the SEEA accounting structure. Some of the breakdowns suggested by SEEA are not best suited to the UK and where they are appropriate, the data are not available. ONS will explore other data sources such as Department for Communities and Local Government dataset and other sources to address these gaps. Since it has been recommended that the accounts should be updated every five years, the focus during the next five years should be on improving these accounts so they are fit for purpose.

There is a direct link between land use and land cover and to understand and analyse the changes in the ecosystems and ecosystem services, it is important to develop both accounts. As a next step, ONS will explore the development of land cover accounts. The plans for land cover accounts were published in the ONS roadmap "[Accounting for the nature of value in the UK](#)" in December 2012.

Appendices

Annex A – SEEA Classification definitions

Agriculture

This category includes: land under temporary crops, land under temporary meadows and pastures, land with temporary fallow, land under permanent crops, land under permanent meadows and pastures and land under protective cover.

It also includes tilled and fallow land, naturally grown permanent meadows and pastures used for grazing, animal feeding or agricultural purpose. Scattered land under farm buildings, yards and their annexes, permanently uncultivated land, such as uncultivated patches, banks, footpaths, ditches, headlands and shoulders are traditionally included.

Forestry

Forestry includes forest land, primary regenerated forest, other naturally regenerated forest, planted forest and other wooded land. The scope of the forest and other wooded land account follows a land use perspective. Thus, it does not include land that is predominantly under agricultural or urban land use.

Land used for aquaculture

Land used for aquaculture facilities and fish farming activities. Also included is land used for hatcheries, and managed grow out sites on land, for example, artificial units of varying size like ponds and tanks.

Aquaculture refers to the farming of aquatic organisms for example: fish, molluscs, crustaceans, aquatic plants etc. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding and protection from predators.

Use of built up and related areas

Land affected or adapted by man, under buildings, roads, mines, quarries and any other facilities, including their supporting spaces, deliberately installed for human activities. Also included are certain types of open land (non built-up land), which are closely related to these activities, such as waste tips, derelict land in built-up areas, junk yards, city parks and gardens.

Also included is land used for construction (including abandoned areas), manufacturing activities, land used for technical infrastructure for example, telecommunications networks, electrical energy, transport and storage, commercial, financial and public services, recreational facilities and residential.

Land used for maintenance and restoration of environmental functions

This classification includes protected areas as defined by the International Union for Conservation of Nature (IUCN).

Protected areas should aim where appropriate to:

- Conserve significant landscape features.
- Provide regulatory ecosystem services, including buffering against the impacts of climate change.
- Conserve natural and scenic areas of national and international significance.
- Deliver recreational and other benefits to residential and local communities.
- Facilitate low-impact scientific research activities and ecological monitoring related to the protected area.
- Help to provide educational opportunities.
- Help to develop public support for protection.

Other uses of land not elsewhere classified

Land used for uses not elsewhere classified.

Land not in use

Areas of land not in use have no visible indications of human activity, or institutional arrangements for the purpose of economic production, or the purpose of economic production, or the maintenance and restoration of environmental functions and where ecological processes are not significantly disturbed.

Inland waters

Inland waters are areas corresponding to natural or artificial water courses, serving to drain natural or artificial bodies of water, including lakes, reservoirs, rivers, brooks, streams, ponds, inland canals, dams and other land-locked (usually freshwater) waters. The banks constitute limits whether the water is present or not.

This classification is broken down by inland waters used for aquaculture or holding facilities, inland waters used for maintenance and restoration of environmental functions, other uses of inland waters n.e.c and inland waters not in use.

Annex B

CSERGE Dataset¹³

The Centre for Social and Economic Research on the Global Environment (CSERGE) has generated a dataset describing classes of non-overlapping land use which has utility for research at a range of spatial scales. It is the most comprehensive definition of the physical stock of land types in Great Britain for the purposes of ecosystem assessment¹⁴.

Inconsistent correspondence between land cover and land use datasets and concerns over their thematic, temporal and spatial accuracy led CSERGE to question the fitness of individual off-the-shelf datasets. In response, CSERGE have combined several datasets to generate a custom product. In brief, satellite-derived land cover data and ancillary spatial data were used to locate areas that are likely to be functional e.g. used for agricultural production or urban activities. Results from the June Agricultural Survey were used to refine the spatial distribution of arable and grassland and subdivide categorisation where appropriate. A Geographical Information System (GIS) was used to interrogate and integrate data but the final output dataset is also available in spreadsheet format and/or as statistical summaries at different spatial resolutions.

Objectives

The land use dataset was developed to serve the following roles:

- To provide a complete picture of the spatial distribution of land use.
- To generate spatially consistent land use data across time (i.e. apply a reliable methodology).
- To include England, Scotland and Wales.
- To be fit for purpose at multiple levels: 2 km, regional, watershed and national-level.
- To be used in conjunction with other data to allow the derivation of trends and indicators of change.
- To be consistent with the demands of an interdisciplinary team.
- To be used for the spatial re-distribution of other data e.g. heads of livestock.

Data sources overview

Two main data sources were used to generate the CSERGE definition of land use: satellite-derived digital land cover maps and survey data on agricultural land use practices.

The physical material at the surface of the earth, land cover, can be observed through field survey or via analysis of remotely sensed imagery. The Centre for Ecology and Hydrology (CEH) has produced three digital Land Cover Maps for the UK: *LCM1990*, *LCM2000* and *LCM2007*. For each Land Cover Map, imagery taken

¹³ CSERGE research is funded by the Social and Environmental Economic Research (SEER) project (ESRC Funder Ref: RES-060-25-0063)

over several years is reclassified on a pixel-by-pixel basis into land cover types. Ground reference data from field reconnaissance surveys are used to identify image segments of known land cover. These form 'training areas' used to calculate the spectral reflectance statistics for each land cover class to refine the classification. The more recent Land Cover Map is also augmented with digital cartographic boundaries. This product is available as (vector) polygon data or gridded (raster) data for use in a GIS. CSERGE used a 25 m raster product.

Land use reflects the functional dimension of Earth's surface. Land use in the UK is dominated by agriculture which accounts for 18.3 million hectares or 74.8% of the total surface area (Defra et al., 2011¹⁵). The June Survey of Agricultural and Horticultural Activity is a source of high quality land use data with national coverage. The June Survey is undertaken as a full census every ten years and as a sample survey in intervening years. The last full census was in 2010. The June Survey is undertaken independently in England, Scotland and Wales and results are released in aggregated spatial units. These data can either be obtained in the form of a regular grid known as the '*agcensus*' (available at 2 km, 5 km and 10 km resolutions from EDINA, <http://edina.ac.uk/agcensus/>) or for administrative boundaries such as counties and regions (see details in Table A1). Due to protection against the disclosure of information on individual holdings, there are caveats associated with the use of these 'ready-made' datasets for spatially explicit research. Broadly speaking, *agcensus* data can be inaccurate at fine resolutions due to spatial reworking and re-distribution of holding data, and while statistics for administrative boundaries are more accurate, many data are suppressed to preserve anonymity or released at a higher level geography where the resolution is too coarse. To combat these shortfalls, both data formats were used.

Ancillary datasets were employed to identify areas of non-agricultural land use to refine the CSERGE classification. All data sources are listed in Table A1 and their manipulation is discussed in the next section.

¹⁵ For example Defra et al 2011- Department for Environment, Food, and Rural Affairs (United Kingdom); Department of Agriculture and Rural Development (Northern Ireland); The Department for Rural Affairs and Heritage, Welsh Assembly Government; Rural and Environment Research and Analysis Directorate, The Scottish Government, (2011) Agriculture in the United Kingdom 2011, Office for National Statistics, Newport, UK

Table A1: Raw data sources and temporal data available to describe target years 2000 and 2010

Land cover and land use	Data description	Data type	Extent	Data source(s)	Target year 2000	Target year 2010
<i>STAGES 1 & 2</i>						
General land cover	Land Cover Map	25 m raster grid	GB	CEH	<i>c.2000</i>	<i>c.2007</i>
Coniferous or deciduous land cover	National Inventory for Woodland and Trees	GIS polygon file	GB	Forestry Commission	2002	2002
Urban and developed land use	Developed Land Use Areas	GIS polygon file	GB	OS Meridian	2009	2009
	Roads and railways	GIS polyline files	GB	OS Meridian	2009	2009
<i>STAGES 3 & 4</i>						
Agriculture	Processed June Agricultural Survey(s)	2 km agcensus	GB	EDINA	2004	2010
		Spreadsheet of county-level statistics	E	Defra	2000	2010
		Table for agricultural region statistics	S	ERSA	2001	2010
		Spreadsheet of Small Area statistics	W	National Assembly for Wales	2003	2010
	OS Open Data (county and region boundaries)	GIS polygon files	E & S	OS OpenData	2011	2011
	Small Area boundaries	GIS polygon file	W	National Assembly for Wales	2001	2001

Abbreviations used: CEH = Centre for Ecology and Hydrology; OS = Ordnance Survey; ERSa = Economic Report on Scottish Agriculture; E = England; W = Wales; S = Scotland; GB = Great Britain

Methodology

Overview

Data from multiple source geographies (Table A1) were translated into a common spatial unit which described general classes of non-overlapping land use and land cover. This was performed for two target years (2000 and 2010)¹⁶. Data were integrated to a common spatial unit (2 km × 2 km cell), with this choice of resolution being a lowest common denominator given the highest detail at which agricultural land use data could be obtained. The stages of data integration can be summarised as:

- Stage 1: Reclassify existing Land Cover Maps and examine summary statistics.
- Stage 2: Augment reclassified Maps with other data pertaining to non-agricultural land cover and land use (e.g. urban or forestry).
- Stage 3: Test for correlation between agricultural land cover and land use data.
- Stage 4: Perform redistribution of agricultural land use using available georeferenced data and statistics.

Detailed description

Stages 1 and 2

The 25 m resolution raster products for *LCM2000* (Fuller et al, 2002) and *LCM2007* (Morton et al, 2011) were used as raw data for target years 2000 and 2010 respectively. Maximum available thematic resolution was 26 or 23 classes of land cover (*LCM2000* and *LCM2007* respectively); however, this level of thematic detail was not required for analysis at the national extent. Ten land cover categories were used, corresponding to *LCM2000* and *LCM2007* Aggregate Classes (Fuller et al, 2002; Morton et al, 2011) and also consistent with habitat mapping as part of the first phase of UK-NEA (2011). These classes were: enclosed farmland; improved grassland; semi-natural (other) grassland; mountains, moors and heathland; deciduous woodland; coniferous woodland; urban and developed land; marine; coastal margins; and freshwater.

A simple cross-tabulation was performed to look at land cover change on a cell-by-cell basis across two time periods. Reasonable correlation with small changes in land cover were expected, e.g. due to development and small differences in the methodology between *LCM2000* and *LCM2007*. However, the results of the comparison did not always perform as anticipated and there was considerable movement across many classes. To combat this, reclassified Land Cover Map data (for both target years) were augmented with Forestry Commission boundaries of existing woodland, Ordnance Survey data on Roads and Railways and Developed Land Use Areas (Table A1). These enabled a more reliable indication of non-agricultural land use extent.

Ref: RES-060-25-0063)

Stage 3

In some cases land cover classes may be synonymous with land use (Morton et al, 2011). Often, however, variability of land use is greater than the variability of land cover because one land cover can fulfil different functions, i.e. the relationship is not one-to-one (Gong and Weber, 2009). Nevertheless, land cover data can provide a useful framework within which to map agricultural land use (e.g. Posen et al, 2011). The simplified matrix in Table A2 depicts a hypothesis of the likely relationship between CSERGE-reclassified land cover (Stages 1 and 2) and broad categories of agricultural land use.

Using the groupings in Table A2, summaries from land cover derived dataset were compared with national-level June Survey statistics for agriculture (SEERAD, 2001; SGRPID, 2011). Considerable disparities in total areas were observed. For example, the total area of temporary and permanent grassland land use in the June Survey was greater than the Improved grassland land cover category; in contrast, Arable, horticulture & fallow was less than the Enclosed farmland land cover.

CSERGE research also made use of the 2004 and 2010 *agcensus* data product at the highest resolution (2 km × 2 km cell). However, from this product, it is possible for observations of agricultural land to exceed the physical area of zones (see discussion in Comber et al, 2008; Posen et al, 2011). CSERGE analysis found particular problems in Scotland and Wales. For example, in 2010 *agcensus* data for Scotland approximately a quarter of 2 km cells are reported with an area > 400 ha. We attribute this to sprawling grass and grazing land allocated to a single farm holding.

Table A2: Land cover vs. agricultural land use matrix. Anticipated correspondence is marked with an ‘x’

		Land cover-derived classes					
		Enclosed farmland	Improved grass	Other grass	Mountains, moors & heaths	Deciduous	Coniferous
Land use	Arable, horticulture & fallow	x					
	Permanent grassland		x				
	Temporary grassland		x				
	Rough grazing			x	x		
	Farm woodland					x	x
	Other land on farm	x					

A second round of correlation testing was performed to provide an indication of the strength of the relationship between land use and land cover at the 2 km level (using groupings demonstrated in Table A2). The theory was that if a set of simple rules could establish the link between land cover and land use then there would be no real need to implement more sophisticated methodologies. A cell-by-cell comparison was performed for >2000 randomly sampled cells across Great Britain. Results of these initial analyses informed the following decisions:

- The 2 km level *agcensus* data could be used to subdivide total arable land in a corresponding 2 km cell into different types of crops.
- Higher level geographies were needed to define the total arable land in a 2 km cell and refine the distribution of types of grassland and grazing¹⁷.

Stage 4

County- and Unitary Authority-level spreadsheet June Survey data for 2000 and 2010 were downloaded for England. Similar summaries were obtained for Welsh Agricultural Regions. Scottish regional data were obtained as PDF files from the Economic Report on Scottish Agriculture (ERSA). These data were amalgamated into one dataset of six broad land use categories (compatible definitions across time and for each country)¹⁸. These tabulated data were joined to spatial boundary data in a GIS (data sources as per Table A1). The implicit assumption was that the variables of interest (land use types) were evenly distributed across these source zones.

It was then necessary to redistribute the above June Survey data (at county/ regional source zone level) within the locations defined by appropriate land cover classes. The high resolution (25 m × 25 m grid) reclassified land cover data were used to restrict probable locations for agricultural land use within each source zone. Geographic boundaries were overlain on the land cover grid. Given that the area of land use in each source zone was known, we satisfied these observations by scaling the 25 m resolution land cover-derived classes. Where this could not be achieved through correspondence of categories in Table A2, second tier categories were used. Then, each broad land use type (at 25 m resolution) was summed for a set of target zones – a regular grid of 2 km cells.

In the final step of processing, relevant crop types were extracted from the 2004 and 2010 *agcensus* (2 km resolution) datasets. Total arable, horticulture & fallow land in the 2 km target zones were refined into different crop types using overlying *agcensus* data (by apply corresponding areal proportions).

¹⁷ Greater confidence was given to the administrative-level statistics as although these are aggregated for farms within an area, they are not subject to redistribution algorithms used in the production of the *agcensus*.

¹⁸ i. Arable, horticulture & fallow; ii. Temporary grassland; iii. Permanent grassland; iv. Sole-right rough grazing; v. Farm woodland; vi. All other land on farm.

Results

Table A3 presents an update of Table A2, depicting the categories of land cover that were needed to satisfy observed land use data.

Final output was a 2 km × 2 km raster grid representing percent of total area of land type. Maximum thematic resolution of this dataset is 25 classes covering a spectrum of land use and land cover categories. This output was produced for each target year.

Due to the regular gridded nature of the dataset, each 2 km grid cell can be assigned a geographic reference (e.g. British National Grid Easting and Northing) and exported to spreadsheet format for use outside of a GIS. Data can also be aggregated to be used at different spatial and thematic scales. In Table A4, land use is aggregated to 11 broad categories at a national scale.

Table A3: Updated land cover vs. agricultural land use matrix. Anticipated correspondence is marked with an 'x' and actual correspondence is marked with '(x)'

		Land cover-derived classes					
		Enclosed farmland	Improved grass	Other grass	Mountains, moors & heaths	Deciduous	Coniferous
Land use	Arable, horticulture & fallow	x					
	Permanent grassland	(x)	x	(x)	(x)		
	Temporary grassland	(x)	x	(x)	(x)		
	Rough grazing			x	x		
	Farm woodland					x	x
	Other land on farm	x	(x)				

Table A4: CSERGE definition of potential land use for the target years 2000 and 2010¹⁹

	Area (ha) 2000	% 2000	Area (ha) 2010	% 2010	% change
FARM					
ESTIMATED TOTAL AGRICULTURAL AREA	15,791,011	67.9	16,097,337	69.1	1.2
Crops and bare fallow (including horticulture)	4,623,394	19.9	4,560,095	19.6	-0.3
Rough grazing (sole right)	4,211,367	18.1	3,913,729	16.8	-1.3
Permanent grassland (> 5yrs)	4,754,225	20.4	5,259,400	22.6	2.2
Temporary grassland (< 5yrs)	1,060,984	4.6	1,107,626	4.8	0.2
Farm woodland	492,743	2.1	764,063	3.3	1.2
Other farmland (roads, buildings, yards etc.)	648,298	2.8	492,424	2.1	-0.7
NON-FARM					
Urban and developed land	2,607,465	11.2	2,747,848	11.8	0.6
Marine and coastal	352,306	1.5	382,222	1.7	0.2
Freshwater	211,833	0.9	248,539	1.1	0.2
Non-farm grass, mountains, moors and heath	1,709,945	7.3	1,658,405	7.1	-0.2
Non-farm wood	2,609,203	11.2	2,147,413	9.2	-2
TOTAL	23,281,763	100	23,281,763	100	

Discussion

Interpretation of the CSERGE dataset

CSERGE offer two points to guide potential users of this dataset and its derivative statistics:

- Despite offering great flexibility in terms of spatial scale, CSERGE do not advise the use of this dataset at a very local scale due to the inherent uncertainties in the base data layers and the assumptions required during integration.
- Assumptions have been made about the stability of land use and land cover within the time periods for different data sources. CSERGE provide target years as a guide.

For these reasons, the CSERGE land use definition is more adequately described as a dataset representing the potential distribution of land use and land cover for a particular timeframe. Confidence in the absolute values increases as the 2 km resolution spatial data are aggregated to higher level geographies. Greatest confidence is given in the national-level summaries of broad land use categories (Table A4).

¹⁹ Land use statistics for 2000 and 2010 are more accurately described using ranges 2000-05 and 2007-10 (see input data from Table A1)

The CSERGE definition of land use can be manipulated easily into different spatial and thematic resolutions. While not entirely inconsistent with international standards (e.g. System of Environmental-Economic Accounting (SEEA)), the classification has maximised the suitability for Great Britain land use (with a possible extension to UK extent).

Physical asset account for land use in the UK

Based on the above methodology, Table 2 in the main section of this paper provides estimates for opening (2000) and closing (2010) stocks for physical asset accounts for land use in the UK.

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