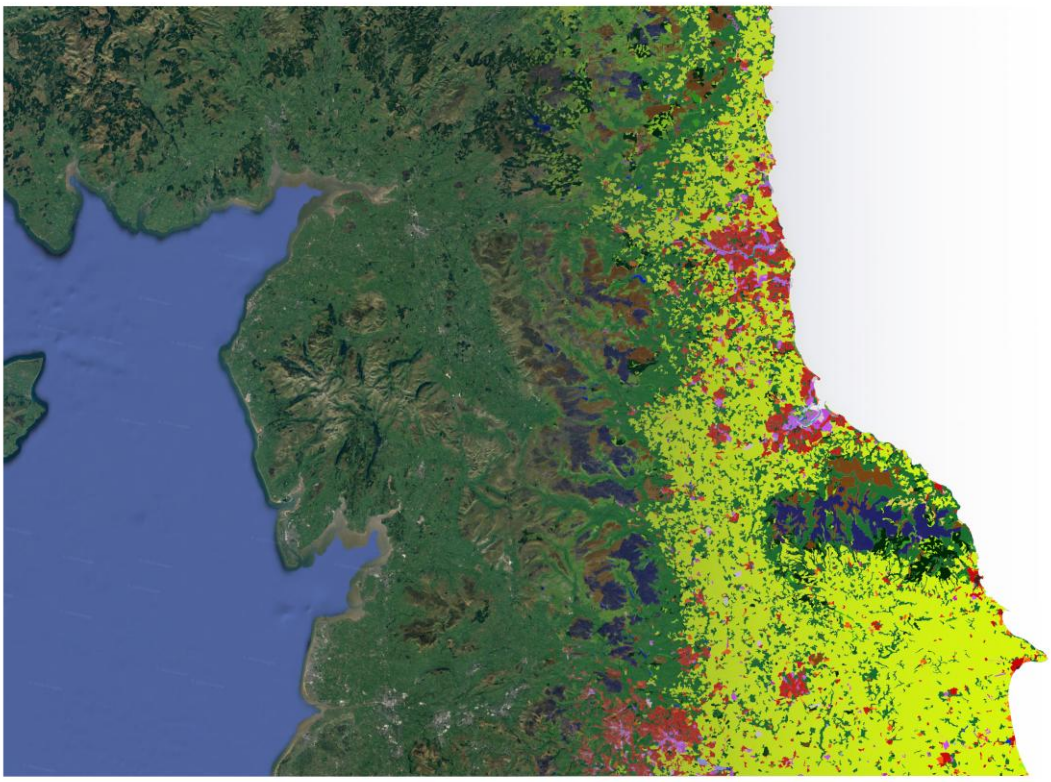
Land Use in the United Kingdom



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SUMMARY

The current report provides a concise overview of recent land use patterns in the United Kingdom. Evaluation of the CORINE 2018 land use dataset indicates that the UK's landscape is dominated by agriculture with, at the very least, 70 % of the land area given over to either arable cultivation (27%) or some form of livestock farming (43%) (grazing of pasture, grassland, heathland etc.). The regions/nations of the UK vary markedly in their land use patterns, with England by far the most built upon (10.3%) whilst Scotland has the most woodland and forested area (16.1%). Valuable carbon sinks, such as peat bog, are commonest in Scotland (16%) whereas in Northern Ireland, England and Wales such areas are much less extensive (<4.0%).

The CORINE data is compared with other data sources, such as the Forestry Commission's woodland statistics, and strengths/weaknesses identified. Limited comparisons of the mapped data with satellite imagery showed, for the most part, reasonably good alignment with the actual use of the land. The data presented here is discussed with respect to the recently published UK Committee on Climate Change report that details the land use objectives that need to be met in order for the UK to become net carbon zero by 2020.

Contents

1. INTRODUCTION

Land use in the UK, Europe and elsewhere is becoming a topic of increasing discussion as a result of the role that various land use regimes play in generating or sequestering greenhouse gasses. Agriculture, for example, is significant producer of CO_2, NOx and CH_4 in the UK and elsewhere and, through its very nature, creates a landscape that often fixes only limited amounts of CO_2. Other, non-farmed, land types such as forestry and peat bogs can, however, act as sinks for CO_2 and serve to reduce the net output of the gas for a given country or region. As such, it is now becoming clear that the way land is managed in the future will play an important role in achieving the net GHG emission reductions needed to slow global climate change as well as determining whether other goals, such as those associated with biodiversity, are similarly met.

Increasing urbanisation and the encroachment of the built environment into the countryside is similarly of significant concern as rural areas are lost and habitats destroyed or fragmented. The construction of new housing to meet critical shortages in some parts of the country, and the need for new or improved transport infrastructure, are seen by many as necessary and politically expedient although there are very clearly costs attached. The ramifications of the ongoing expansion of the built environment are best understood by first examining the extent that it exists at the present time and how it is distributed around the country. Urban areas, roads and many industrial sites form zones what are essentially paved over and, hence, comprise parts of the country that create numerous environmental challenges such as those associated with pollution, flooding, runoff and waste management. As a result, expanding urban areas are in direct conflict with initiatives intended to enhance wildlife diversity, reduce flooding, increase climate change resilience and improve air quality, amongst others, and it is interesting examine their distribution around the UK.

A recent report from the UK Climate Change Committee [1] emphasised the need to change land use in such a way that climate change targets can be met. Ambitious goals have been indicated, particularly with respect to increasing forest/woodland cover and reducing livestock farming (essentially meat production). Whilst there are a number of sources that give land use values for the UK, this report endeavours to examine nations current status using a relatively recent and freely available dataset. Such an undertaking is of value primarily because, as will become apparent, evaluating UK land use is not just simply an exercise in examining absolute values but, instead, also requires a close examination at how land use types are distributed around the country. This is important as citing absolute values for a given land class can be somewhat misleading. Media reports [e.g. 2. 3] that emerged after the publication of the land use maps produced by Rae (2017) [4] (using the CORINE 2012 data), provide examples. Here, total urban land cover values of ca. 6% were cited, giving the impression that the UK is not a particularly built-up country. If the geographic distribution of urban areas is taken into account, the value for England, for example, is much less encouraging at around 10%. The distribution of several other land classes across the UK throw up similarly skewed distributions. Therefore, whilst essentially correct in the values cited, some reporting of land use data has painted a somewhat deceptive picture of the UK as it ignores the extent to which certain land use types are concentrated within given parts of Britain and where expansions/contractions are occurring.

The following maps and statistics are derived from the 2018 CORINE European dataset {2] and provide a brief overview of how land is used in the UK and its constituent parts. The information that

can be extracted from this huge dataset is vast and here only a cursory examination is made. More extensive analysis of the data will be presented in a subsequent report.

2. LAND USE MAPS OF THE UK

The following comprises a selection of maps that best illustrate the major land use categories in the UK. The maps were produced in QGIS as described in Appendix 1 and are in the LAEA / EPSG: 3035 coordinate reference system. No attempt was made to catalogue or discuss all land use types as there are 36 that apply to the UK portion of the dataset, some that cover only very small areas of land. Instead, the following maps primarily deal with agriculture, forestry and urbanisation with a cursory look at the distribution and areas of the other land use classes. Some comparisons are made with other data sources in order to illustrate how different methodologies may result in somewhat different values for the coverage of a given land use type.

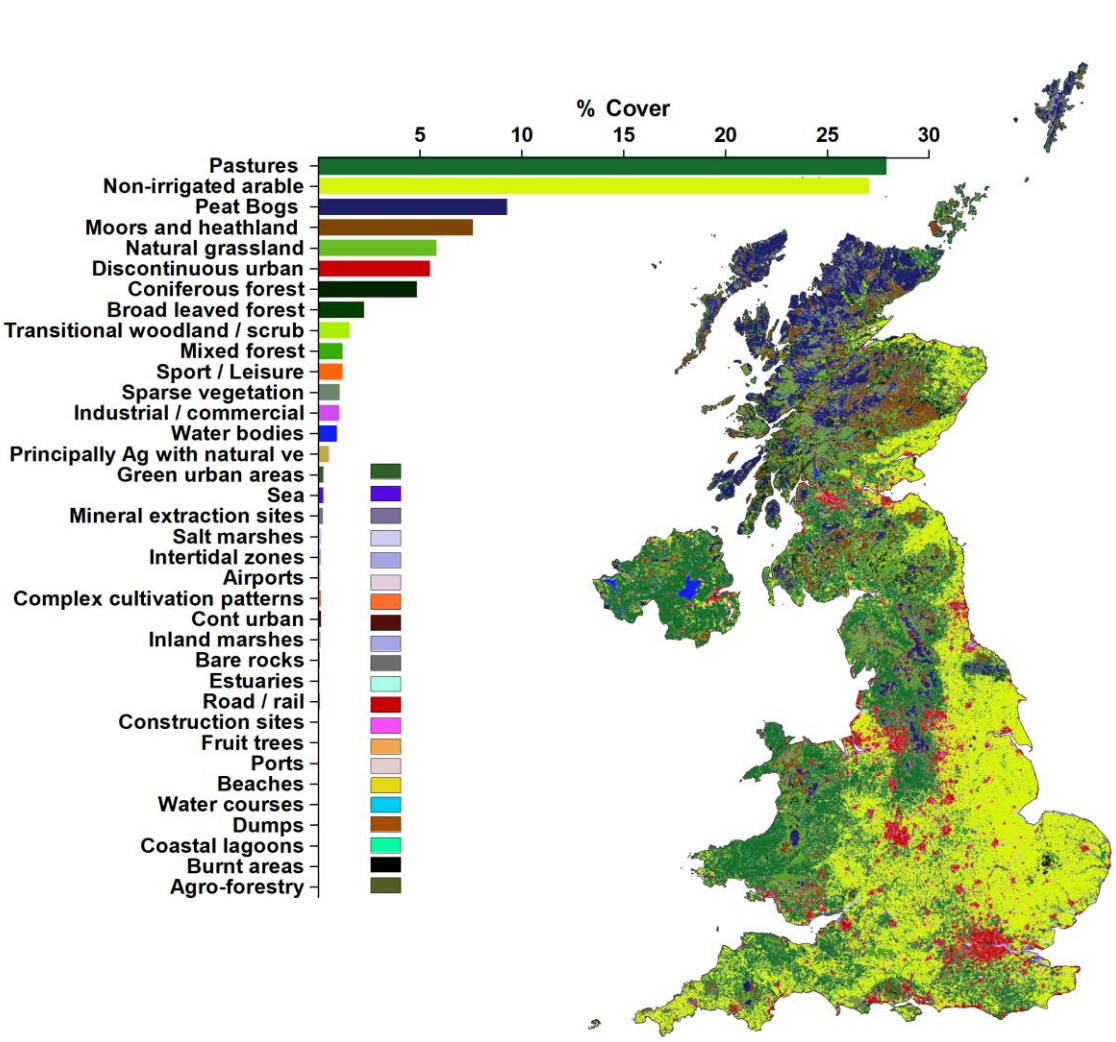

Figure 1. Land use in the UK.

The above map represents all land use classes included in the CORINE dataset for the UK. The overall picture of one of predominantly arable farming to the east of the country (pale green areas), with pastures / grassland, woodland and forestry (darker greens) concentrated in the west and north of the UK. Urban areas(continuous and discontinuous) are plotted in red and predominate in the South East, Midlands and North West, and the Central Lowlands of Scotland.

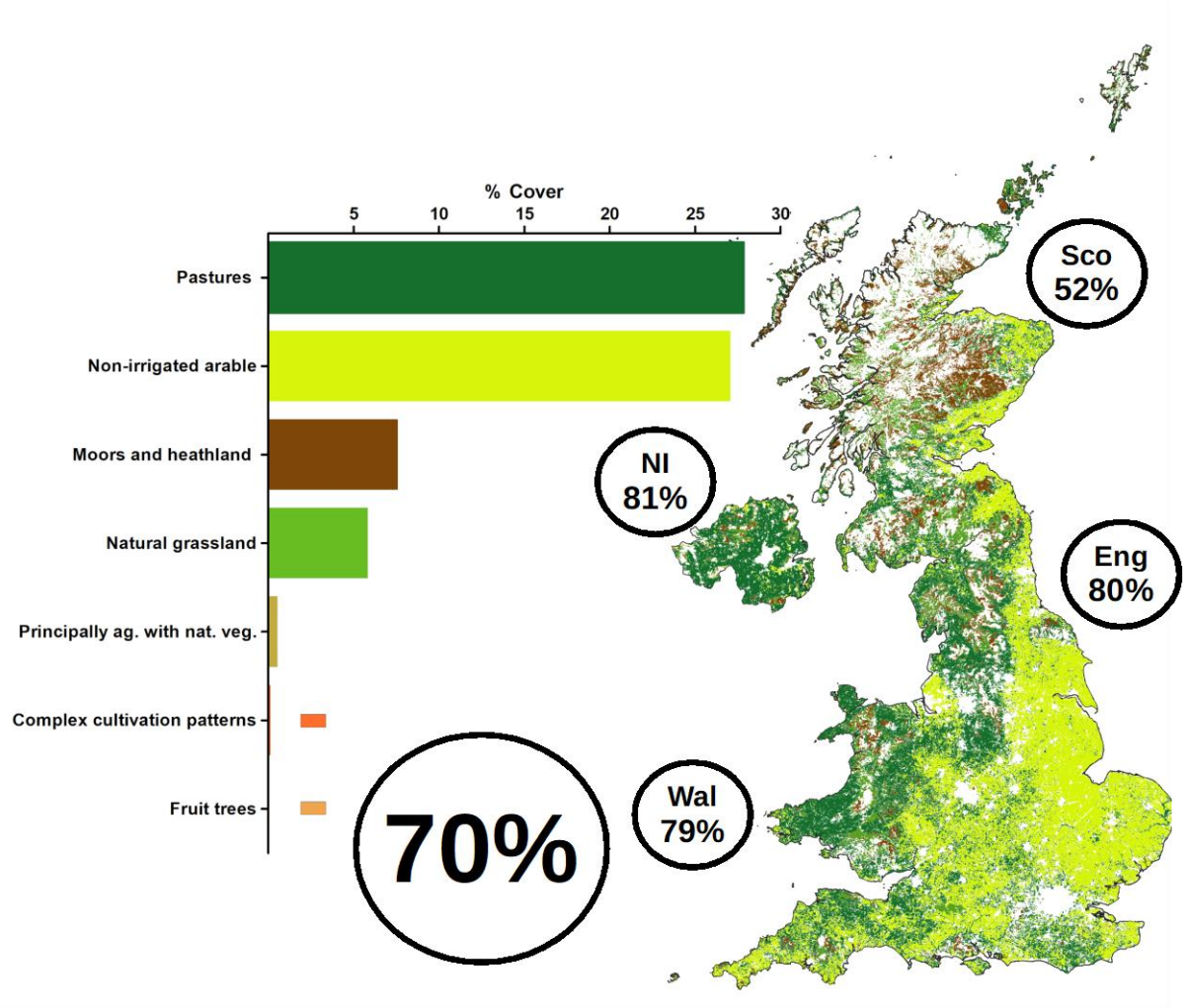

Figure 2a. Land used for agriculture.

The above map includes arable farming, pasture and grasslands as well as some more minor agricultural land-use categories. Heathland is included here as much of this predominantly upland land type is grazed by sheep. Peat bog is excluded from this chart despite the fact that several areas of peat bog occur within areas of moors grazed by sheep (e.g. Lake District, Pennines). The above map, therefore, constitutes a conservative view of the extent to which agricultural activity dominates the UK landscape.

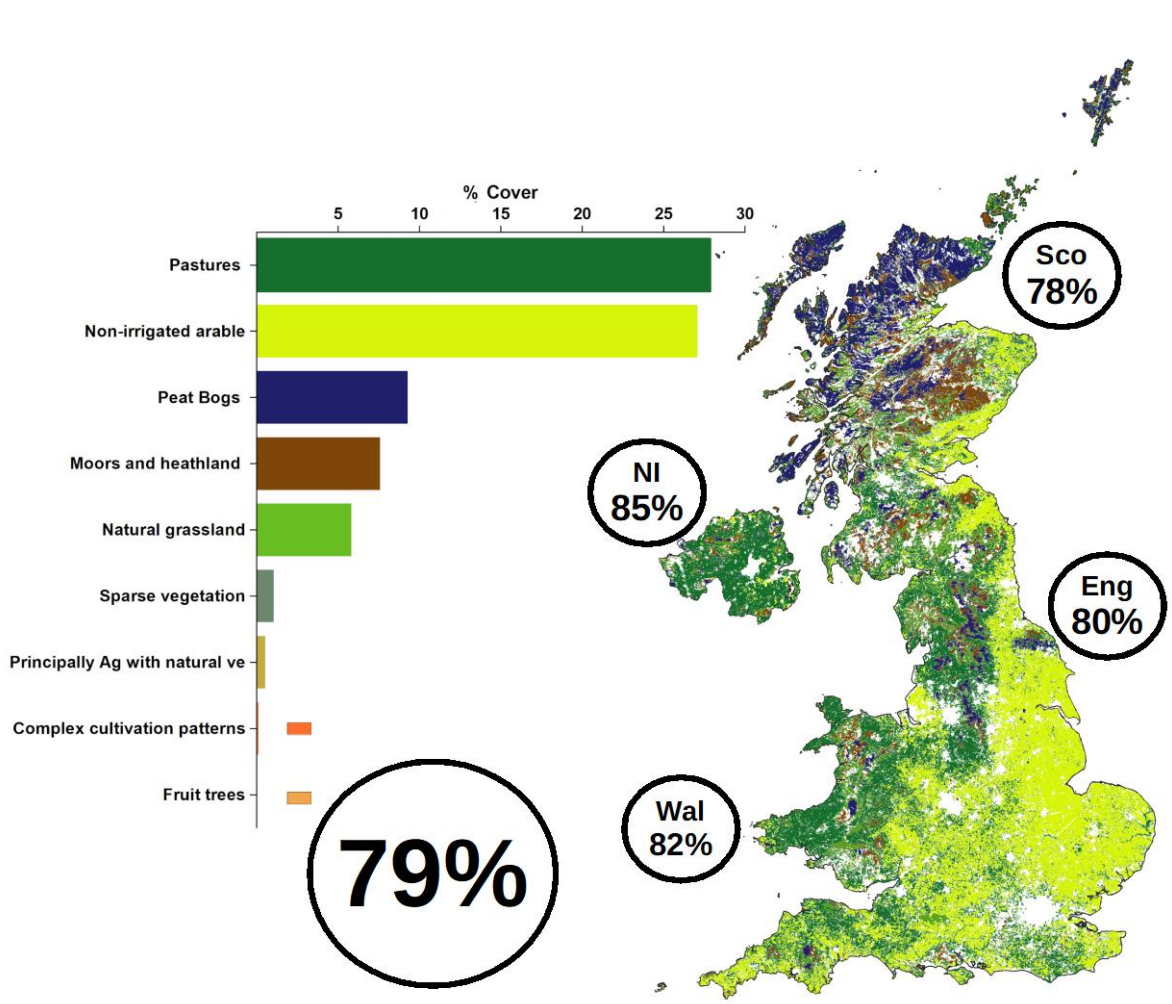

Figure 2b. All areas potentially under agriculture

The above map includes marginal land-types, such as peat bogs, that are often grazed by sheep and other areas that typically occur in upland regions, such as sparse vegetation zones. This map, therefore, constitutes the upper value for agricultural land use in the UK and will, almost certainly, encompass some areas where little or no agricultural activity occurs (e.g. some peat bog areas and fenced-off heathland).

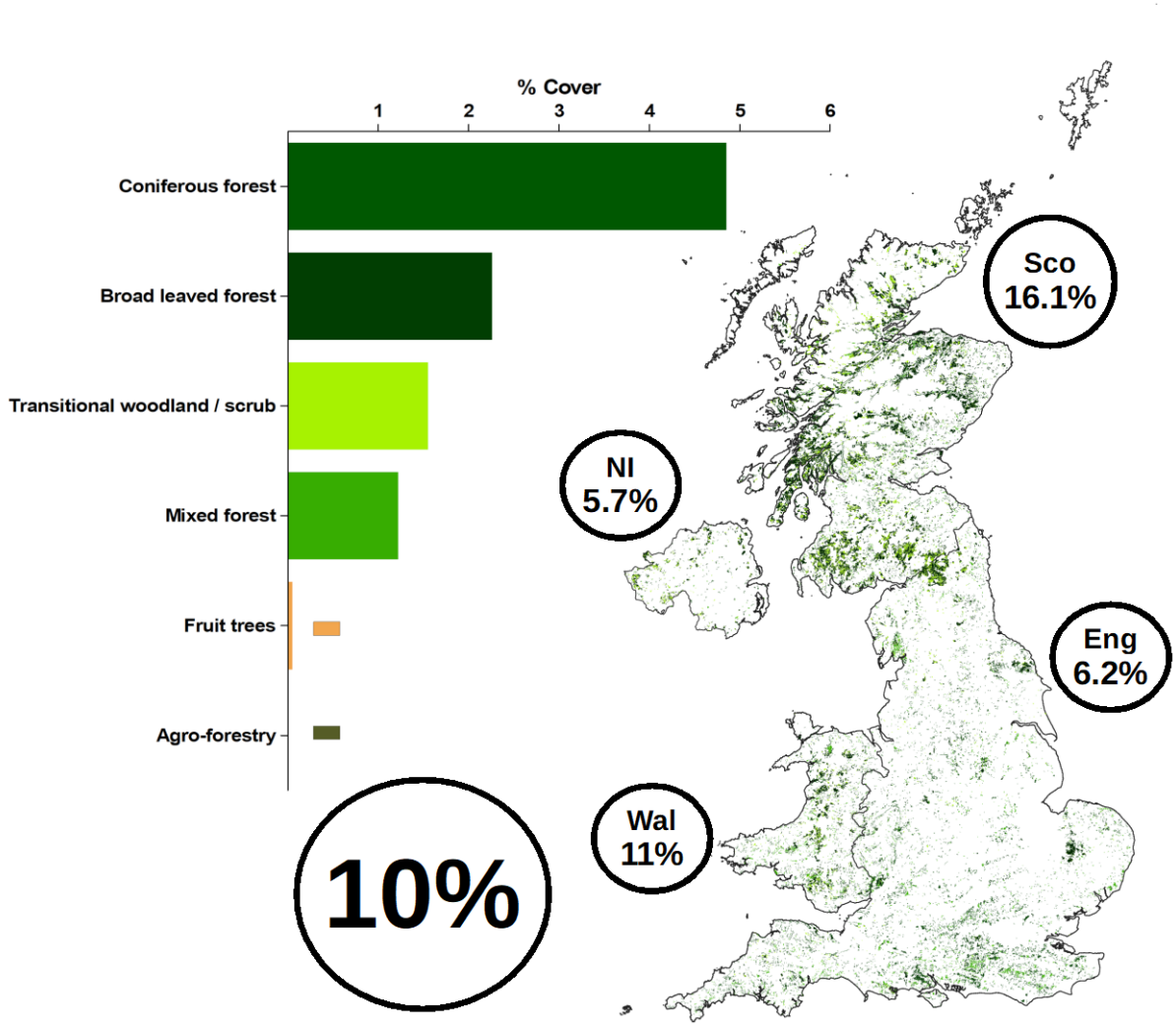

Figure 3. Forest and woodland in the UK

Woodland and forestry in the UK, as recognized by the CORINE data, amounts to around 10% of the total land area. This value effectively includes all land categories that could be defined as potentially containing trees (broad leaved, mixed, coniferous and transitional woodland). The value generated here is somewhat lower than the official value for the UK produced by the Forestry Commission, which is around 13% [6]. The potential reasons for this discrepancy are discussed later.

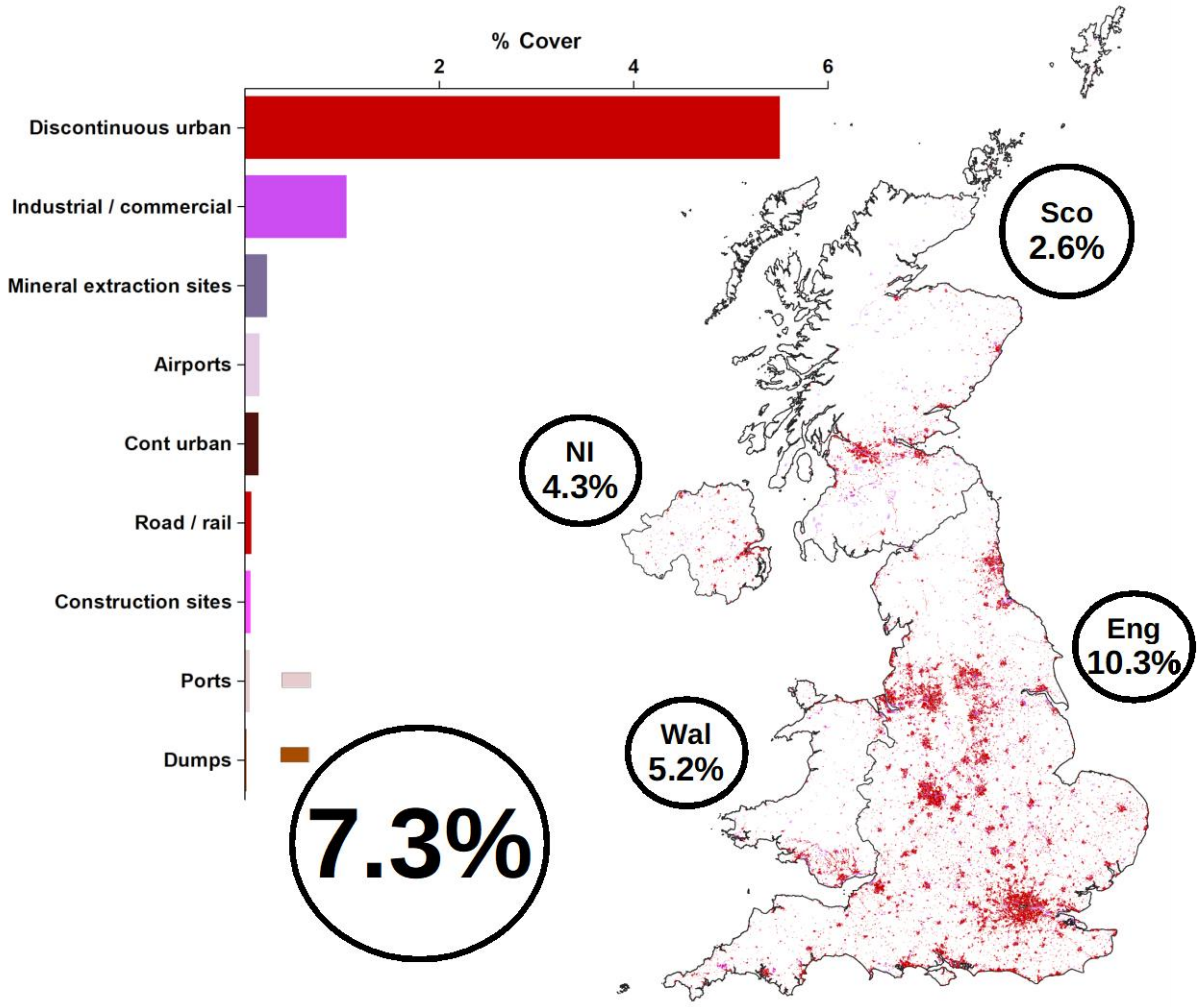

Figure 4. Urban and built-upon areas

The above map covers areas of land that are predominantly built upon, such as urban and industrial areas, ports and airports, dumps etc. Smaller roads and paved areas are not always identified in the CORINE data and, as such, the value presented here may be slightly lower than the actual value. As is clear from the data, the built environment in the UK is highly concentrated in England.

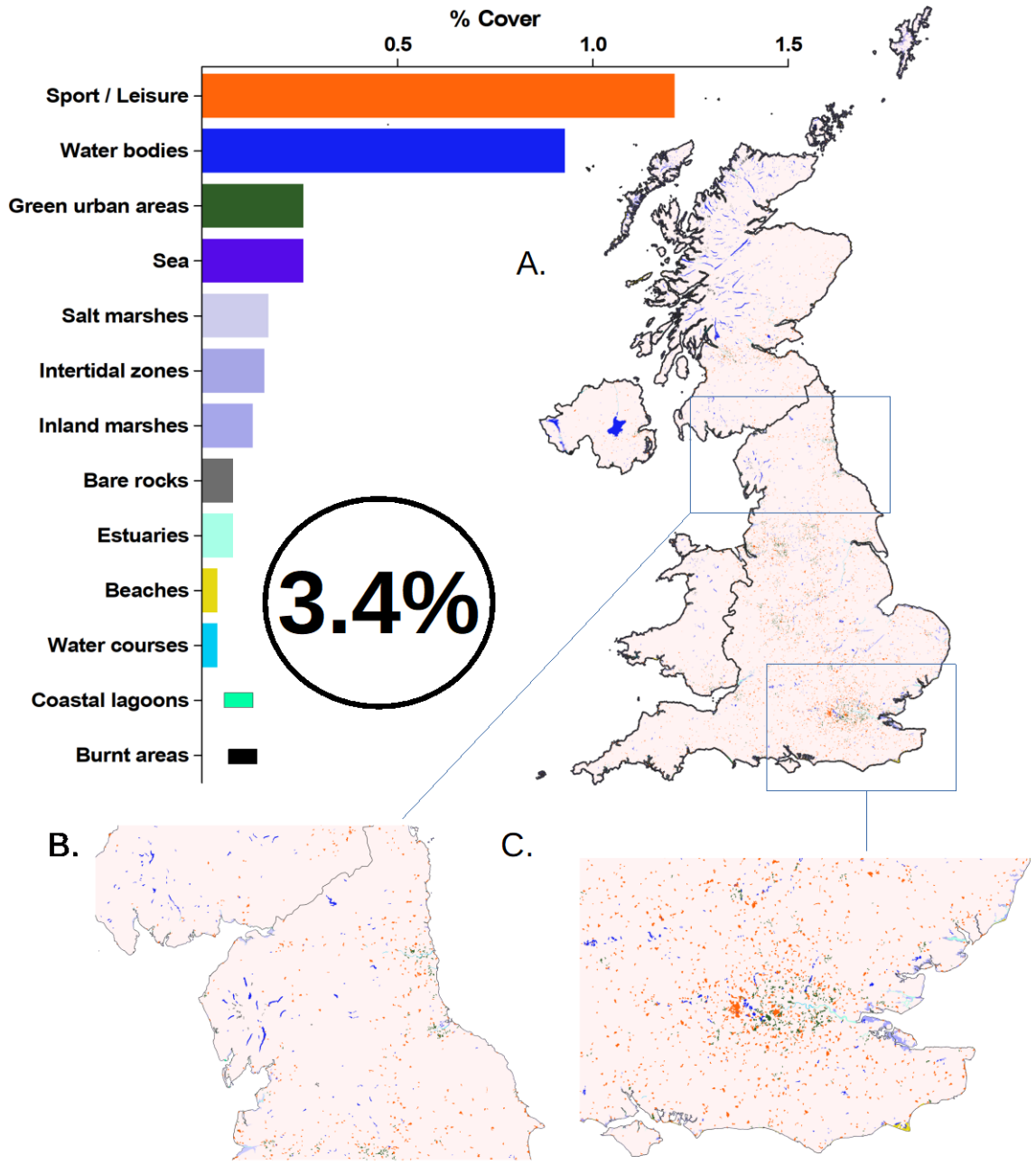

Figure 5. Other Uses.

As can be discerned from the indistinct nature of these maps, the areas of land use outside the agricultural, woodland/forestry and built environment categories are very small in the UK and highly diffuse. The most obvious category here is sports/leisure areas. The North of England / Scottish Borders (B) and the South East of England (C) illustrate the differences in abundance of these "other" categories across the country.

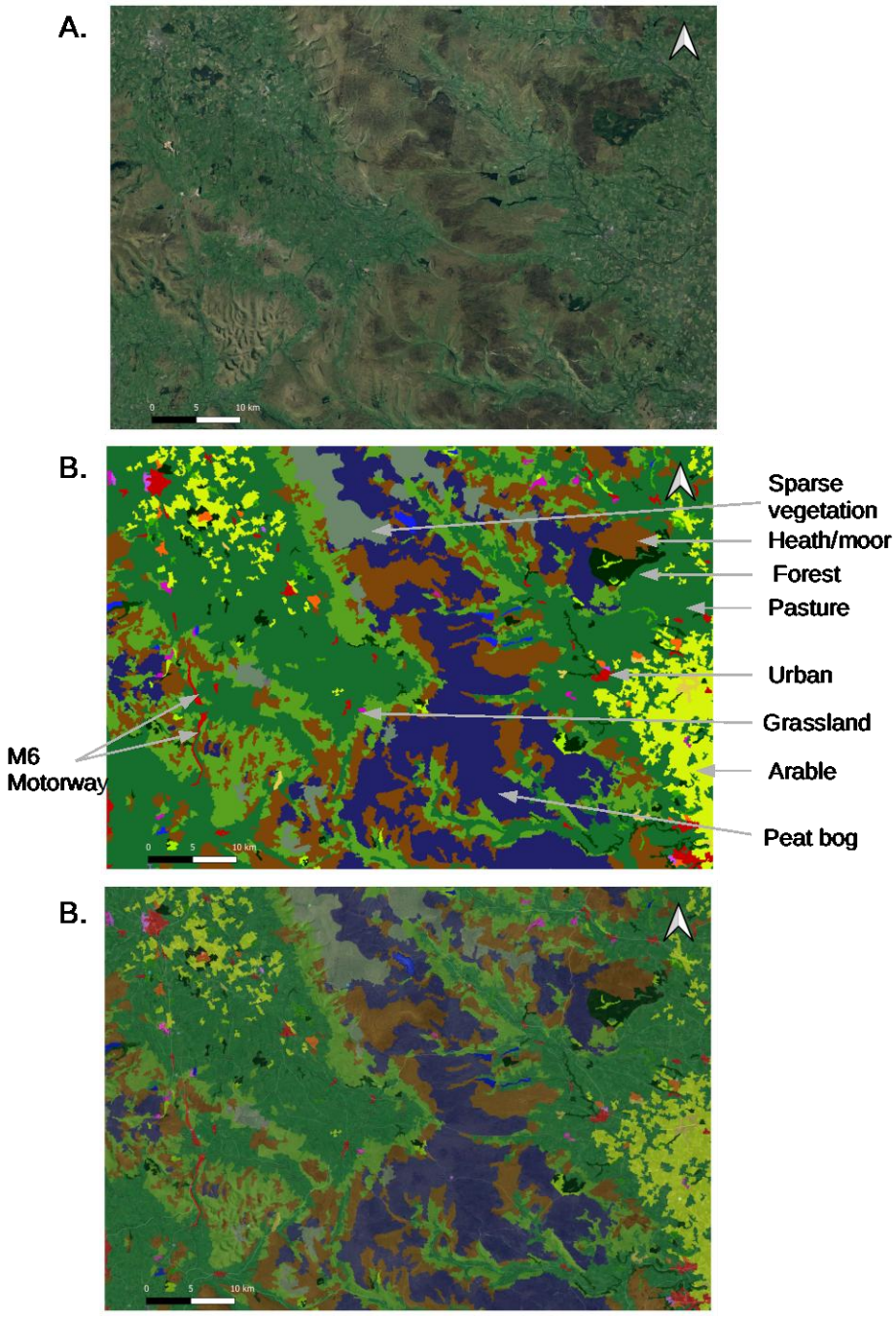

Figure 6. Upper Eden Valley / West County Durham area (North Pennines)

The above figure shows (A) the satellite, (B) mapped land use and (C) composite views of the Upper Eden Valley area (eastern Cumbria) and western Country Durham with the Pennine mountain range dividing the two. Most of the primary UK land-use categories are contained within these maps. The mapped data is largely in agreement with the use that can be determined from the examination of the satellite imagery. Some minor features such as small areas of woodland are, however, subsumed into neighbouring categories in a number of cases whilst identification of roads is patchy and inconsistent (note that the M6 motorway is not continuously present whilst other roads are completely absent).

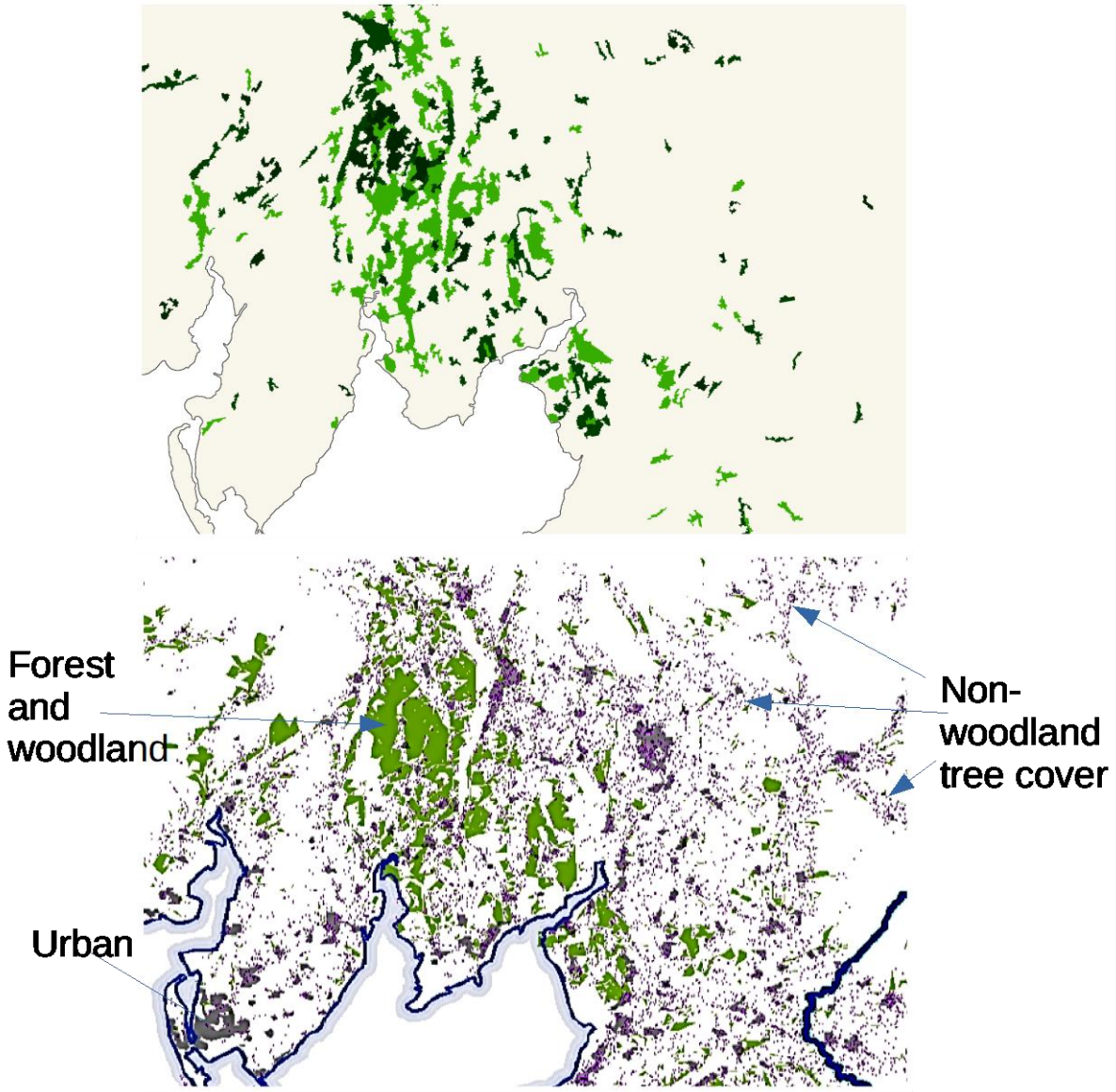

Figure 7. Mapped forest data versus Forestry Commission Statistics.

The maps of South Lakeland and the Morecambe Bay area show forestry mapped from the CORINE data (A) is in close accord with that of the official map produced by the Forestry Commission (B) [6]. However, areas mapped from the CORINE data tend to be smaller, more fragmented and with some small areas missing. The purple areas in the lower map are described as “tree cover outside woodland” by the Forestry Commission. These areas are generally, but not always, absent from the CORINE data and are subsumed into other classes.

Table 1 UK land cover by category

Cat.	Land use type	Area km^2	%
111	Continuous urban	331.57	**0.14%**
112	Discontinuous urban	13533.13	**5.51%**
121	Industrial / commercial	2588.69	**1.05%**
122	Road / rail	163.38	**0.07%**
123	Ports	122.91	**0.05%**
124	Airports	365.32	**0.15%**
131	Mineral extraction sites	574.96	**0.23%**
132	Dumps	51.95	**0.02%**
133	Construction sites	145.02	**0.06%**
141	Green urban areas	648.45	**0.26%**
142	Sport / Leisure	2964.38	**1.21%**
211	Non-irrigated arable	66464.35	**27.08%**
222	Fruit trees	124.07	**0.05%**
231	Pastures	68388.09	**27.86%**
242	Complex cultivation patterns	334.74	**0.14%**
243	Principally Ag. with natural vegetation	1329.06	**0.54%**
244	Agro-forestry	0.65	**0.00%**
311	Broad leaved forest	5545.94	**2.26%**
312	Coniferous forest	11920.05	**4.86%**
313	Mixed forest	3002.29	**1.22%**
321	Natural grassland	14319.32	**5.83%**
322	Moors and heathland	18669.43	**7.61%**
324	Transitional woodland / scrub	3814.51	**1.55%**
331	Beaches	94.99	**0.04%**
332	Bare rocks	204.81	**0.08%**
333	Sparse vegetation	2617.01	**1.07%**
334	Burnt Areas	1.61	**0.00%**
411	Inland marshes	310.78	**0.13%**
412	Peat Bogs	22817.85	**9.30%**
421	Salt marshes	419.85	**0.17%**
423	Intertidal zones	393.04	**0.16%**
511	Water courses	89.38	**0.04%**
512	Water bodies	2282.54	**0.93%**
521	Coastal lagoons	8.52	**0.00%**
522	Estuaries	196.61	**0.08%**
523	Sea	634.09	**0.26%**
	TOTAL	**245473.34**	

Table 2. Selected land-type comparisons across the nations of the UK.

Land Type	England	Northern Ireland	Wales	Scotland
Arable	43.41 (43.14)*	2.91 (2.75)	5.89 (5.69)	10.22 (10.13)
Pasture	27.84 (30.40)	62.89 (67.10)	52.08 (52.37)	15.38 (18.65)
Moors and Heathland	2.72 (2.52)	4.55 (4.52)	8.26 (7.97)	16.02 (15.59)
Peat bog	2.14 (2.08)	3.84 (4.43)	2.85 (2.80)	23.75 (23.62)
Broad leaved woodland	2.88 (2.67)	0.54 (0.51)	1.52 (2.24)	2.36 (1.48)
Coniferous woodland	1.64 (1.60)	3.23 (3.47)	5.10 (5.46)	10.38 (11.08)
Mixed woodlands	1.40 (1.24)	0.37 (0.20)	1.99 (1.82)	0.89 (0.47)
Continuous urban	0.20 (0.19)	0.22 (0.20)	0.06 (0.05)	0.04 (0.03)
Discontinuous urban	8.41 (7.85)	3.05 (2.91)	3.59 (3.53)	1.69 (1.61)

* The value in brackets refers to the percentage areas calculated by Rae (2017) using the CORINE 2012 datasets

3. RESULTS AND DISCUSSION

For the most part, the information presented here closely matches that of Rae (2017) [4] that was extracted from the 2012 CORINE dataset. Where differences occur, they are mostly slight and potentially result from the remote-sensing CORINE methodology (see Appendix 2) used to identify land-use type. For some classes, such as those associated with the built environment, where consistent increases are observed across the nations of the UK, the differences are likely to represent actual changes.

The data indicates that land use varies quite markedly across the nations that make up the UK. Notably, the aggregated value for the built environment (urban, roads, rail, industrial sites etc.) is much greater in England, at 10.3%, than, for example, Scotland where the value is just 2.6%. This value is dominated by discontinuous urban areas that cover a full 8.4% of England, as opposed to 3.1%, 3.6% and 1.7% in Northern Ireland, Wales and Scotland, respectively. Those that suggest urbanisation is not particularly extensive or problematic in the UK often fail to emphasise the fact that the built environment is very much concentrated in England and that this urbanisation is clearly eroding the quality of the environment over large swathes of that part of Britain. Importantly, it is likely that the regions of the UK already containing significant urban areas are the localities that will see the largest increases over the coming years.

Agriculture dominates the land area of England to a remarkable extent. Arable farming and pastures account for over 71% of the land area although this value is just 25.6% in Scotland. Certain areas of land, such as those classed as sparsely vegetated or peat bog, are frequently grazed and, as such, the land used for agriculture cannot be precisely determined from only examining the CORINE data. It is clear, however, that across the UK as a whole the land exploited for agricultural purposes falls between 70% and 80% of the entire area. This value largely falls within the generally accepted value for the UK [7].

Notably, the area of woodland / forest cover calculated here using the CORINE data (10%) is lower than that that published by the UK's Forestry commission (13%) [6]. The reason for this is probably due to small areas of woodland being misidentified by the CORINE methodology (Fig 7). The UK Forestry Commission classifies woodland as any given area with 20% canopy cover or the potential to reach that figure. The disparity between the CORINE and Forestry Commission datasets is, therefore, probably due to the absence of small and/or highly discontinuous woodland in the former's data. If this is indeed the case, it would suggest that a significant proportion of land accounted for in the UK woodland inventory exists as very small parcels of land, often isolated from other wooded areas and of limited ecological value. Moreover, recently planted areas of woodland, whilst likely to be included in the Forestry Commission data, are not visible to the CORINE methodology. Again, as with other land classes, England's value, at 6.2%, is markedly different to Scotland and Wales, which have 16.1% and 11% woodland cover, respectively. As such, the CORINE data indicates, somewhat depressingly, that England has a greater area of continuous and discontinuous urban areas (8.6%) than it does land covered by trees to any meaningful extent.

Of the numerous other land use categories, the most prevalent is categorised as sports and leisure in the CORINE dataset. Examination of areas in the north of England and south of Scotland (data not shown), where this land use type are relatively sparse, revealed that these areas predominantly belong to just three types: parkland (stately home gardens/parks etc.), holiday parks (camping, caravan sites etc.) and golf courses.

The Committee for Climate Change's report (2020) [1]) indicates that the UK should aim for a woodland cover at least 17%. The data presented here, although likely underestimating tree cover, illustrates the magnitude of this aspiration that requires the planting of 30,000 hectares of trees annually (300 km^2), a total area in excess of that of the county of North Yorkshire by 2050. England, most obviously, has very few large contiguous areas of forestry, as Figure 3 shows, with only distinct areas of coverage visible in the South Lakes, Northumberland, North Yorkshire, the west of Suffolk and Norfolk, and areas of the South East. Much of England, particularly the eastern half, is essentially devoid of significant areas of tree cover.

In summary, the UK, particularly England, is essentially an agricultural landscape with much of the remainder made up of built-up areas, transportation infrastructure and industrial zones. It is clear that moves to create a more sustainable landscape that includes a greater areas of tree cover and "natural" areas are presented with considerable challenges. To implement changes that have any meaningful and positive impact on the UK landscape will, inevitably, require marked changes in the extent and types of agriculture undertaken in many areas. A following iteration of this report will examine various aspects of land use in the UK, particularly England, in further detail and will also examine how use has changed over the last 30 years.

4. ACKNOWLEDGEMENTS

Work such as this is made possible due to the freely available CORINE data provided via the Copernicus portal of the European Union [2] and copyright statements associated with the data are available from their website. This data is used here for strictly non-profit purposes and this report can be disseminated freely without the permission of the author.

5. DISCLAIMER

This is the first iteration of this report and, although the data presented here is believed to be accurate, computational manipulations conducted within the GIS environment may have introduced some sources of error and, as a result, please contact the Author if inaccuracies are apparent. Interested parties are urged to download and examine the data for themselves should they seek to verify any of the data presented here. The QGIS program that was used to visualize and manipulate the data is freely available from https://www.qgis.org/en/site/.

6. THE AUTHOR

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7. REFERENCES

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APPENDIX 1 -METHODOLOGY

The 2018 CORINE land use data was downloaded from the Copernicus Land Monitoring Service website (https://land.copernicus.eu/pan-european/corine-land-cover) as a GeoPackage (CLC 2018). The GeoPackage was opened in QGIS and subjected to the FIX GEOMETRIES (*vector geometry>fix geometries>)* procedure. The United Kingdom was separated from the full European land use map via the CLIP vector function (*vector>geoprocessing tools>clip*) using the gadm36_GBR_0.shp shapefile (available from the Ordnance Survey). This shapefile was reprojected into the LAEA Europe / EPSG:3035 coordinate reference system (CRS) of the CORINE data before use. Clips of the constituent nations of the UK were made from shapefiles of England, Northern Ireland, Wales and Scotland that were, in turn, produced by creating individual shapefiles from the gadm_GBR_1.shp OS shapefile. As before, these were reprojected into the LAEA Europe / EPSG: 3035 CRS before being used for clipping purposes.

Areas of the polygons contained within the clips of the UK and constituent countries were calculated using the $Area function of the QGIS field calculator (accessed via the attributes table menu) which returns a m^2 value for each polygon. Calculations were implemented at the maximum precision setting (10). The values for each polygon were exported to a comma separated value (*.csv) file and imported into LibreOffice Calc for further manipulation. Calculation of the areas for each polygon type (i.e. aggregated value for each land use category) were made using pivot tables and expressed as km^2.

Graphs of data (used for the figure legends) were constructed in GraphPad Prism 5 and composite figures produced in GIMP 2.10 with additional annotation undertaken in LibreOffice Impress.

APPENDIX 2 – CORINE METHODOLOGY