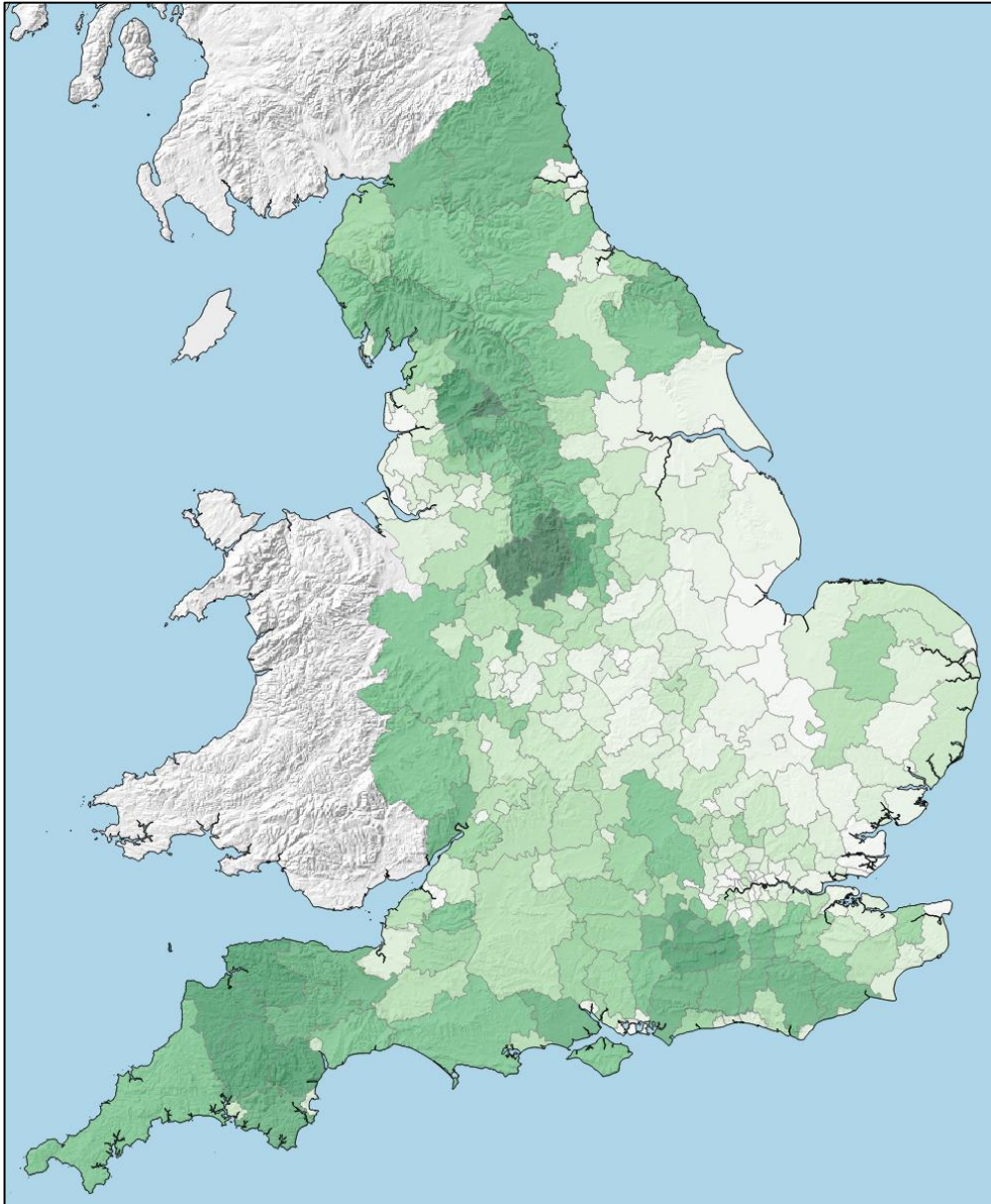


Opportunity Woodland Mapping in England



Report to Friends of the Earth

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Acronyms

ALC	Agricultural Land Classification
BMV	Best Most Versatile (agricultural land)
CROME	Crop Map of England
DEFRA	Department for Environment, Food & Rural Affairs
FC	Forestry Commission
FoE	Friends of the Earth
IPCC	Intergovernmental Panel on Climate Change
MAFF	(Former) Ministry of Agriculture Fisheries and Food
NFI	National Forest Inventory
RPA	Rural Payments Agency
TSR	Terra Sulis Research CIC

Acknowledgements

The author would like to thank his counterparts and Friends of the Earth; also colleagues in the Friends of the Earth Experiments Team who initiated the work on the Chew Valley. Thanks also to all of the members of Chew Valley Plants Trees and everybody at Terra Sulis.

Frontispiece

The frontispiece shows existing and opportunity woodland aggregated by administrative area for England. The colour scale uses natural breaks in area distribution and is purely for illustrative purposes.

Disclaimer

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Executive Summary

In 2019 Friends of the Earth (FoE) made an assessment of whether it is possible to double woodland cover in England. In early 2020 FoE commissioned Terra Sulis Research to undertake a more detailed local study in the Chew Valley. The Chew Valley study enhanced the methodology for opportunity woodland identification by generating an Agricultural Land Classification (ALC) Grade-3b category and by using Sentinel-2 satellite imagery to create a detailed local land cover layer. There is currently no publicly available version of the ALC map for England that differentiates between 3a (good quality) and 3b (moderate quality) land and it is not possible to regenerate the ALC map from first principles because of data license restrictions. However, differentiating between 3a and 3b is possible using open terrain data and applying the gradient criteria specified in the ALC Guidelines, MAFF (1988). A more detailed knowledge of the location of both marginal agricultural land and grassland cover enabled a more nuanced map to be generated. A local community group, *Chew Valley Plants Trees*, is now using this information to help galvanise tree planting in the valley.

The enhanced methodology has now been adapted to England and the results are described in this report. This has been achieved by extending the Grade-3b layer to the entire country using the latest version of Ordnance Survey's Terrain-50 digital terrain model and by utilising the temporal nature of the DEFRA Crop Map of England over the period 2016 to 2019.

A much more detailed knowledge of the distribution of arable and semi-permanent pasture (that has remained pasture for at least four years) means that as well as identifying marginal grasslands for opportunity woodland creation it is now also possible to more specifically model the scale of opportunity for agroforestry in both arable and grassland settings.

Superficially the FoE methodology and the Forestry Commission's (FC) approach to generating their 'Low-Risk Woodland Potential' maps sound very similar, but the results are very different. This difference has not been well understood given the apparently similar sounding methods.

The result of this mapping and analysis show that it is indeed possible to double woodland cover in England in a way that does not encroach on high-value arable farmland, Priority Habitats or protected sites. The distribution of opportunity woodland is closely associated with landscape morphology and perhaps a starting point for nature recovery networks that may necessitate inter-linkages across arable land, but this analysis is beyond the scope of this report. Insofar as possible efforts have been made to avoid biodiverse grassland but this criterion remains an area for improvement, as it is clear Natural England's Priority Habitats Inventory fails to record all remaining fragments of species-rich grassland and is not up to date. For all woodland creation, site specific surveys remain vital.

In England the area of opportunity woodland identified is 97% of the total of National Forest Inventory (NFI) woodland and would almost exactly double woodland area, and together with agroforestry would take this proportion to more than double current levels.

Opportunity Woodland Mapping – England

Table 1 Opportunity Woodland Area Results

	Existing Woodland Area (ha)	Opportunity Woodland Area (ha)	Opportunity + Silvoarable/ Silvopasture Woodland Area (ha)	Combined Area (ha)
England Woodland	1,322,751	1,283,572	1,283,572	3,889,895
England Potential Silvoarable			85,517	85,517
England Potential Silvopasture			162,188	162,188
England Total		1,283,572	1,531,277	4,137,600

Introduction

Finding solutions to the dual climate and ecological emergencies is the pressing issue of our time, both nationally and in Local Authorities and Parishes across the country. Planting trees and creating new woodlands is a rational response to reverse the trend of habitat and carbon loss through land use change which contributes more than one fifth of greenhouse gas emissions, IPCC (2020)¹.

The data used are openly available and the methodology is based on a straightforward set of assumptions. The results are intended to say something useful about the potential for woodland creation at the national levels in England and also at the level of Local Authorities. The task of actually creating woodland has to be a local activity that should fit into the bigger national picture without compromising arable food production or important habitats and biodiversity. Ideally this should also take into account the balance between the creation of woodlands (as defined by the National Forest Inventory (NFI)) and more extensive Agroforestry within both arable and pastoral settings. This balance changes from landscape to landscape and between local authorities. It is hoped that the results provide a reasonable view of what that balance is at the national scales and at the local authority level. The results are aggregated by local authority area to give a perspective onto the mix of woodland and potential woodland in each administrative unit.

¹ Agriculture, Forestry and Other Land Use are estimated by IPCC to contribute 23% of total anthropogenic greenhouse gas emissions (2007-2016)

Assumptions

The analysis in this report builds upon two previous studies, namely:

- Friends of the Earth, 2019, Finding the land to double tree cover and
- Terra Sulis Research, 2020, Identifying areas suitable for tree planting in the Chew Valley

The methodologies of these two studies are based on similar sets of straightforward assumptions and input data. The FoE study uses the FC's NFI and Natural England's ALC maps as the primary inputs; whilst Terra Sulis uses the NFI data, augments the ALC with grade 3b land and also utilises a satellite-derived land cover map to identify grassland. Various layers are used to exclude protected habitats and other features from the analysis.

Both approaches seek to find areas for woodland creation by:

- 1 Selecting marginal land on Grades 3b, 4 and (where appropriate) Grade 5
- 2 Avoiding arable land and temporary grassland
- 3 Selecting improved grassland that is not biodiverse
- 4 Avoiding protected areas
- 5 Avoiding priority habitats including upland peat bogs

The method should also avoid nonsensical land covers such as urban and open water areas. The area of each ALC Grade is shown in Figure 1.

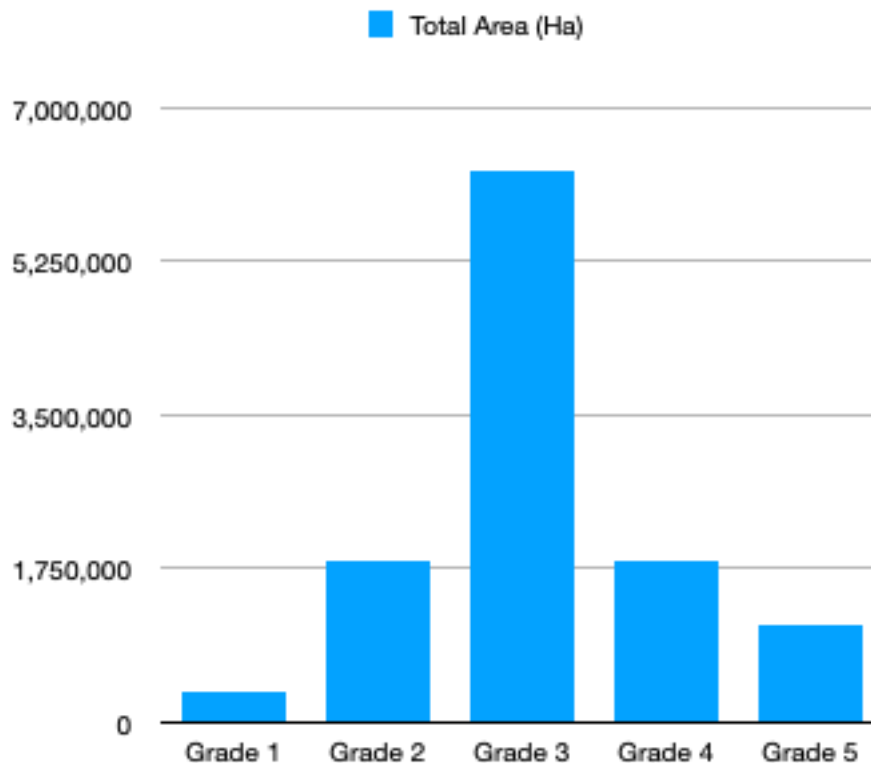


Figure 1 Areas of Agricultural Land Classification Grades

Opportunity Woodland Mapping in England

Using the Defra RPA CROME data for the years 2016 - 2019 it is now possible to test whether the assumptions made in the original Friends of the Earth study hold true. The following figures use the un-enhanced ALC map and the CROME crop statistics to test the original assumptions.

Assumption 1: That arable crops are mainly on ALC Grades 1 - 3.

“Grade 1-3 are high-quality land well suited to crop growing, so while they may contain many areas available for tree planting, we’ve excluded them from consideration”.

This assumption is generally correct. Both persistent and non-persistent arable land are mainly on ALC Grades 1 to 3, although a greater proportion is on Grade 4 than Grade 1. The occurrence of crops on Grade 4 land reduces the areas previously assumed available for opportunity woodland.

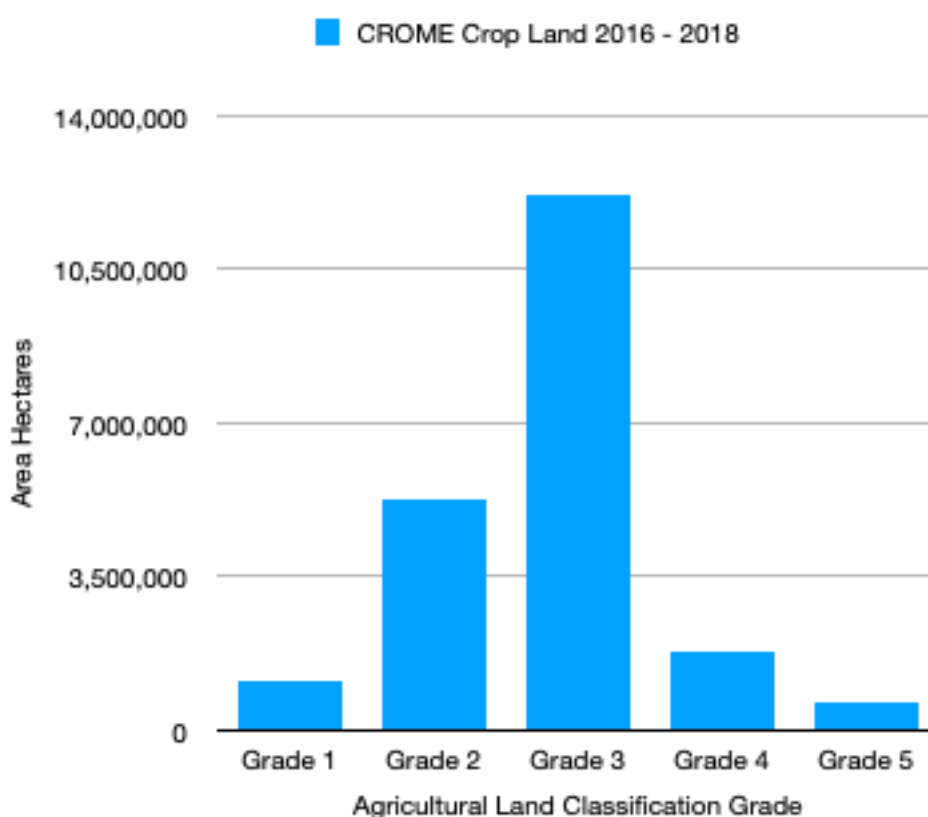


Figure 2 Area of CROME arable crop land by agricultural grade, the majority of crop land is on Grade 3 land.

Assumption 2: That Grade 5 land is a good proxy for upland peat bogs.

“We’ve also excluded Grade 5 land, as this is a good proxy for upland peat bogs”

In England this assumption is generally true in relation to upland areas of peat although there are some areas that are Grade 5 but not peat. This may relate to the definition of ‘upland’. There are some extensive areas of peat soils in the lowlands that are now exploited (mined) for arable

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agriculture, notably in East Anglia, however these are excluded from the analysis as they are Grade 1 agricultural land.

This assumption is generally true although there are some differences at the margins and some Grade 5 land is available for tree planting. This has been established by comparison with unpublished peat data from Natural England, although it is not used directly in the analysis, which uses the Moorland Line data set as an alternative proxy.

Assumption 3: That Grade 4 land is mostly used for pasture.

“Grade 4 poor-quality farmland, mostly used for pasture currently”

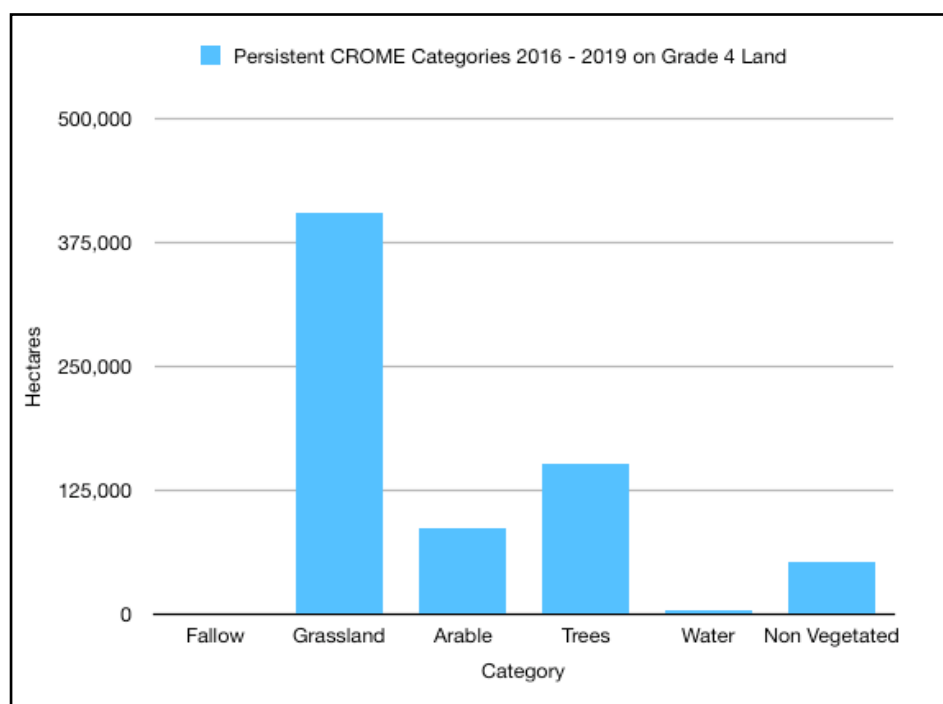


Figure 3 Areas of persistent CROME classes on Grade 4 land, indicating that a portion of Grade 4 land is used for arable agriculture

This assumption is generally correct, Grade 4 land is mostly used for pasture, followed by trees and arable. However, whilst trees were removed from Grade 4 in the previous assessment, arable was not and this is land on Grade 4 that is not available for tree planting. One might question how appropriate it is for arable cultivation to be on some Grade 4 land.

With the benefit of the CROME and other data the assumptions of the previous assessment are shown to be generally true. There is room for improvement, however, for example by separating out the arable and grassland on both Grade 3 and Grade 4 land.

Methodology

The DEFRA CROME data indicate that the underlying assumptions behind the methodology, as described by Friends of the Earth (2019) and Terra Sulis (2020) are fundamentally but not strictly valid. The methodology has been improved with the inclusion of additional data sets to exclude more protected areas and to better differentiate between arable and pastoral agriculture and the occurrence of temporary grassland as part of the arable crop cycle.

According to the methodology, opportunities for woodland creation exist on land that comply with the following criteria:

- Marginal agricultural land of very-poor-quality (Grade 5), poor-quality (Grade 4) and moderate-quality (Grade 3b) including land on steep slopes
- Short-term temporary grassland is considered part of arable
- Marginal grassland is included
- The priority habitat *good quality semi-improved grassland* that may be biodiverse, where known, is excluded
- All other priority habitats are also excluded
- Upland peat bogs are excluded because of their carbon storage potential and biodiversity
- Protected areas designated for the conservation of habitats and species are excluded
- Land already managed as woodland is excluded
- Urban areas, non-agricultural land and water bodies are excluded

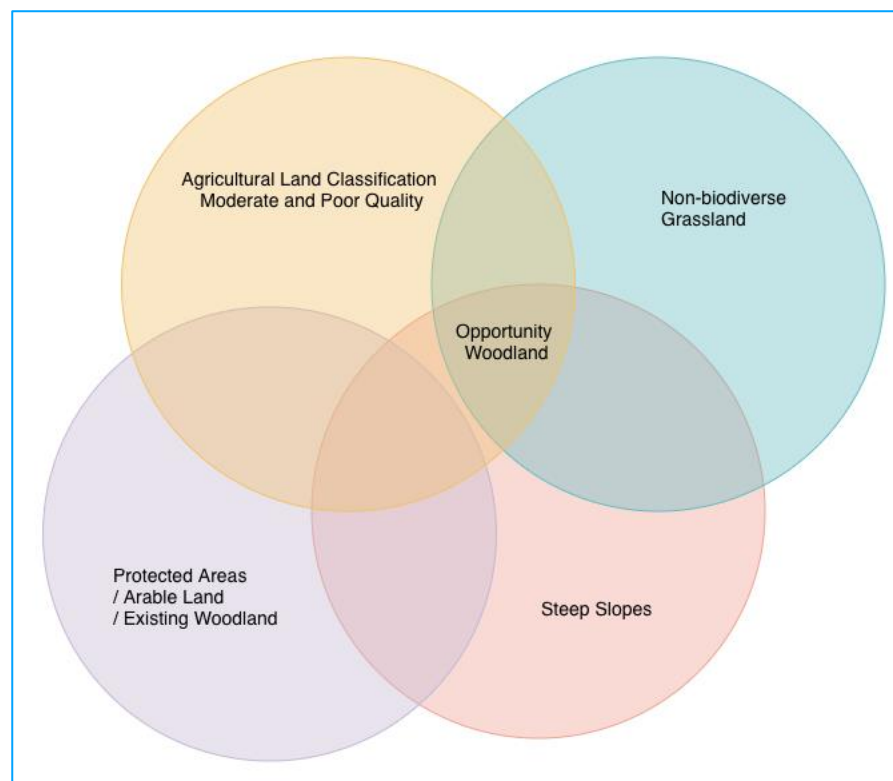


Figure 4 Venn Diagram of the niche identified by the methodology for opportunity woodland

These criteria identify a marginal niche where woodland creation may be considered, and which has no impact on arable food production and which may have limited impact on pastoral production by identifying less productive grassland.

Additionally, estimates are made for silvoarable and silvopastoral trees.

Data Inputs

Agricultural Land Classification (ALC)

The ALC is described in a set of revised guidelines dated October 1988 by the Ministry of Agriculture Fisheries and Food, MAFF (1988). The ALC framework is not discussed in depth here other than to give a summary of the land grades taken from the MAFF report, see Annex I.

The published ALC for England does not differentiate between Grade 3a and Grade 3b. It is not possible to regenerate this dataset from first principles because the soils data remains a proprietary dataset belonging to Cranfield University, with restrictive licensing. Enhancing the ACL with the gradient (slope) criteria for Grade 3b is the only procedure that can easily be performed to improve the data. Other enhancements would mean reconstructing the entire dataset and access to soils data that are currently unavailable.

It is important to also understand how the ALC maps relate to the Best and Most Versatile Agricultural Land (BMV) in use by the Forestry Commission. For its Low Risk Areas for Woodland Creation map the Forestry Commission uses a logical definition of High, Medium and Low sensitivity for woodland creation as described in their summary methodology (FC, 2020).

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The low risk areas identify opportunities for woodland creation. Their method uses land cover data from The Land Cover Map 2015 and the National Forest Inventory and defines:

- High-Sensitivity areas as protected areas such as SPAs, SACs, etc
- Medium-Sensitivity areas as protected landscapes and ALC 1, 2 and 3a
- Low-Sensitivity areas are essentially the remainder

On the face of it this sounds like a very similar methodology to FoE's. However, the Forestry Commission is not directly using the ALC map data but rather a derived product known as 'Likelihood of Best and Most Versatile' land (BMV) that splits Grade 3 into 'a' and 'b' sub-grades. The BMV product is a generalisation based on "*predicting the likelihood of 'best and most versatile' agricultural land (ALC Grades 1, 2 and 3a) when surveyed at the local level*" (Natural England, 2017). The map is a combination of data, including ALC, to predict the likelihood of encountering BMV land and "*use soil associations as the main basis of the assessment*".

The predictive BMV categories are:

- Areas where more than 60% of land is likely BMV (High likelihood)
- Areas where 20-60% of land is likely BMV (Moderate likelihood)
- Areas where less than 20% of land is likely BMV (Low likelihood)

Natural England suggest that these maps are part of an evolving set of maps, that they should be used as a "companion" to the ALC maps and they should only be used as strategic maps at scales of 1:250,000 for use at national and regional levels.

Whilst these maps are partly derived from the ALC maps they are not the same and appear to be much more dependent on soil series than the original ALC maps.

The FoE map is based entirely on ALC data because the soils data are unavailable in the public domain. The augmentation by Terra Sulis of the ALC map with Grade 3b is based on adding in the fine spatial detail of slope (i.e. the gradient) limitations as defined by MAFF (1988) to indicate areas that should belong in Grade 3b.

Therefore, whilst the FoE/TSR and the FC methods sound very similar - and are based on ALC Grades, with a differentiation between 3a and 3b - they are actually quite different. Inspection of the FC Low-Risk map shows large contiguous areas of opportunity woodland that it is thought would be difficult to implement in practice.

Agricultural Land Classification, England

In England the Agricultural Land Classification (MAFF 1988) is used to identify Grade 3b, Grade 4 and Grade 5 land. Grade 3b does not actually occur in Natural England's digital data set so a version of it, taking into consideration gradient limitations, has been created using the Ordnance Survey's Terrain-50 data. The 50-metre raster grid of Terrain 50 is used as the data-frame for all data sets in the analysis.

The gradients used to augment the map with Grade 3b are given in the table below, taken from the 1988 MAFF report:

Table 1 Grade according to gradient	
Grade/ Subgrade	Gradient limits (degrees)
1 }	7
2 }	
3a }	
3b	11
4	18
5	>18

Table 2 Agricultural Land Classification Gradient Limits

Any areas within these gradient limits that are in Grades 1 to 3 are also allocated to Grade 3b.

This augments the ALC categories with additional site limitations.

CROME Land Cover of England

The DEFRA/RPA Crop Map of England (CROME) is currently available for the years 2016, 2017, 2018 and 2019. The main focus of the CROME dataset is on differentiation of arable crops, of which up to 70 are identified by the RPA. In the current study each year of CROME data classes was generalised from the total of 80 classes into seven general classes: Arable, Grassland, Fallow, Trees, Water, Heathland and Non-vegetated.

The use of CROME data in this study is to differentiate between arable land and persistent/permanent grassland, allocating temporary-grassland to arable. This is achieved by analysis of the temporal dimension from one year to the next. The likelihood of a parcel of land being either arable or grassland is high if it is always observed as arable or grassland.

The four years of generalised data were used to make persistence maps of each class:

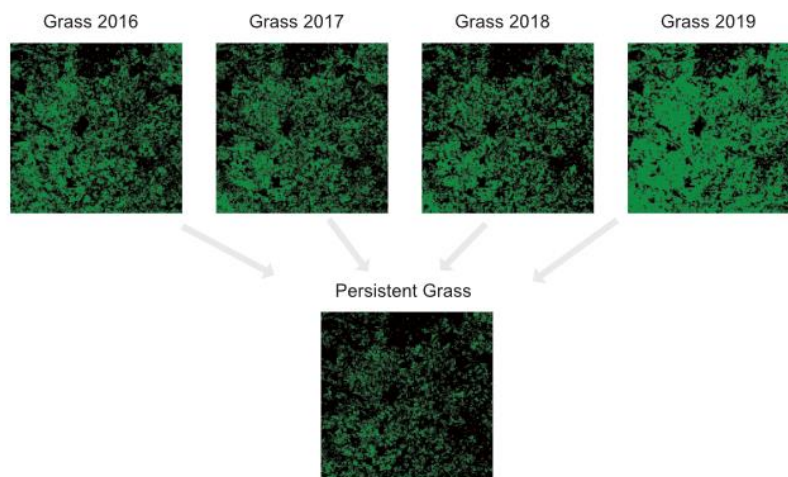


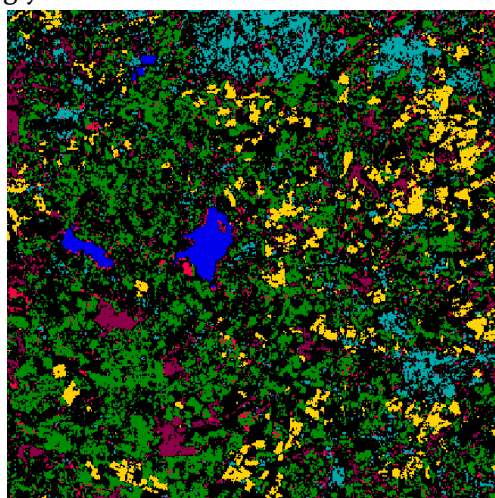
Figure 5 Identification of 'persistent' grassland from CROME data for 2016, 2017, 2018 and 2019

These show the persistence of Arable, persistence of Grassland, etc.

In this way a persistence map can be constructed of all of the classes with a high confidence in the accuracy of each class.

Areas that are always (4 years out of 4) a given class are unambiguous within the time frame. However, temporally mixed land covers remain where different classes occur from one year to the next (the black areas above). The meaning of these mixtures may be clear and understandable whilst others are hard to understand and may represent mixed pixels or noise. For example, Arable/Grass/Arable/Arable is obviously part of the arable rotation, whereas the nature of Fallow/Fallow/Grass/Fallow is less clear.

A coding system was defined to combine the vegetated classes into an explicit set of possible temporal mixtures. A set of temporal-land-cover classes was defined from these combinations and they were allocated accordingly. This makes for a more aesthetic and less noisy map but the



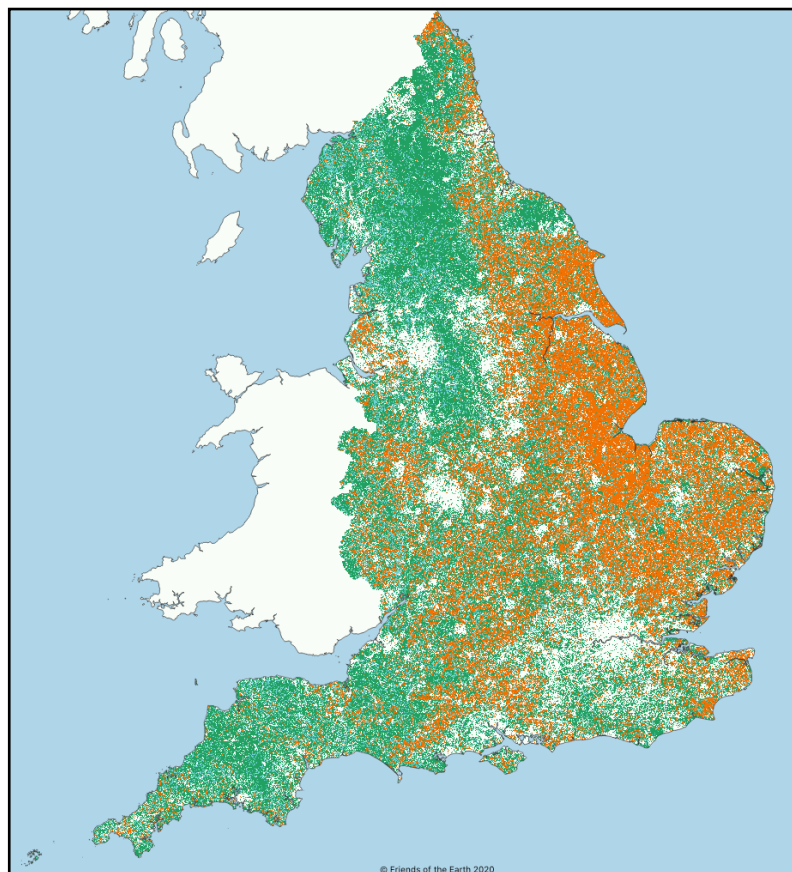
Green = persistent-grass, Yellow = persistent-arable, Blue - persistent-water, Cyan = persistent-non-vegetated,

Figure 6 Persistent CROME land covers separated by a fuzzy non-persistent space in black

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allocation of mixed temporal classes is somewhat subjective. See Annex IV for the allocations. If there is a hint of Arable in the mixed temporal profile, then the pixel is allocated to Arable. Unclear mixtures are allocated to the 'Other' class. These pixels tend to be at the edge or interface of Arable and Pasture and are treated permissively and included in the Pasture - i.e. they are considered for opportunity woodland so long as they satisfy all of the other criteria.

This may seem like a complicated procedure but it adds a powerful temporal dimension to the analysis that separates out certainty and fuzziness within the data. Conversely the Land Cover Map 2015 used by the Forestry Commission is a snapshot in time that identifies arable areas less successfully, although with spatially sharper boundaries.



General differentiation between arable (orange) and persistent pasture (green) in England. This information can be used to calculate estimates of the number of trees that could be planted in agroforestry and sylvo-pastoral systems.

Figure 7 CROME allows arable land and persistent grasslands to be separated out.

This temporal dimension of the CROME data is useful to identify the detail of temporary grasslands and also the general differential between arable and pasture in England.

Protected Areas

A variety of data sets were used to exclude protected areas from the analysis in order to prevent opportunity woodland occurring in inappropriate places.

To exclude protected habitats the following areas are excluded:

- Priority Habitats
- Special Protection Areas (Birds)
- Special Areas of Conservation (Habitats)
- Ramsar Sites (Wetlands)
- Sites of Special Scientific Interest
- National Nature Reserves
- Local Nature Reserves
- Moorland Line (England)

To exclude existing woodland and other inappropriate land covers the following are excluded:

- Artificial areas (from CROME / CORINE)
- Water bodies (from CROME / CORINE)
- National Forest Inventory Woodland
- OS Green Space, including:
 - Allotments or Community Growing Spaces
 - Bowling Green
 - Cemetery
 - Golf Course
 - Other Sport Facility
 - Play Space
 - Playing Field
 - Public Park or Garden
 - Religious Grounds
 - Tennis Court

Clearly some of the green spaces listed could benefit from additional tree cover without being fully converted. In this case some of these classes could be included in land considered for silvoarable and/or silvopasture, together with urban areas for urban forestry.

A visual inspection of data from Historic England indicates that Battlefields and Parks and Gardens are not significantly encroached upon by the opportunity woodland identified. The same is generally true for World Heritage Sites, with the exceptions of the Lake District and the Frontiers of the Roman Empire sites along Hadrian's Wall. The latter is a broad area up to 7 km in width and is not excluded, but its central core along the wall is excluded with a buffer of 500 m on either side. There will be areas identified as woodland opportunities where tree planting is inappropriate because of their archaeological significance, for example the Priddy Circles on Mendip. It has not yet been possible to identify such sites which will have to be dealt with on an individual basis.

Land in National Parks and Areas of Outstanding Natural Beauty is included. There is clearly potential for more woodland and trees in National Parks and AONBs given their generally low

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tree cover. The government's Glover Review identified that National Parks and AONBs should do more to help address the climate emergency. Some National Parks, such as Dartmoor, have started to consult on setting tree cover targets for their jurisdictions.

Opportunity Woodland Identification Results

Opportunity Woodland

The analysis boils down to the simple relationship that opportunity woodland equals:

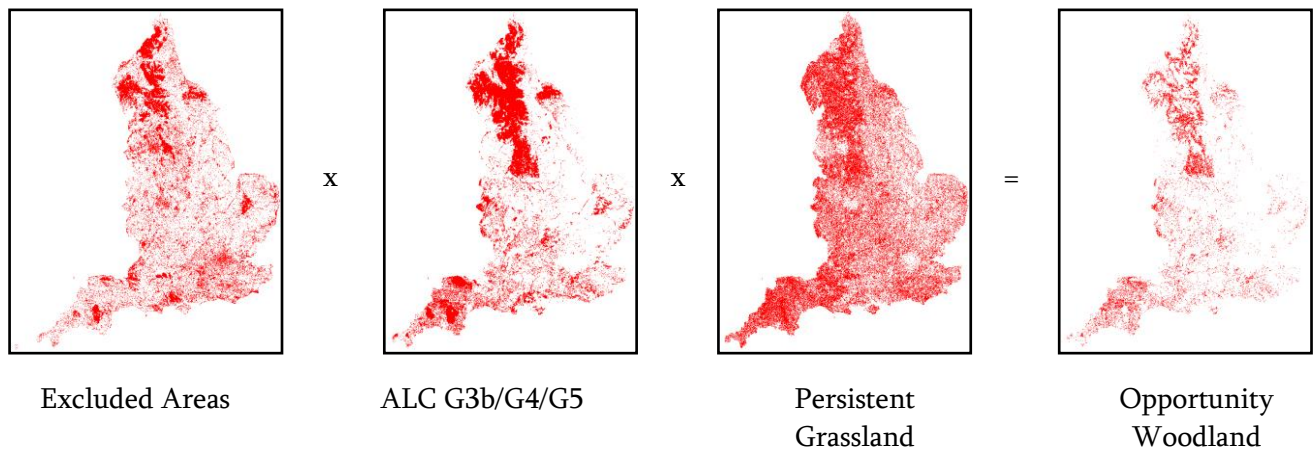


Figure 8 Methodology schematic

This simple relationship results in a complex spatial pattern of landscape dependent niches that nestle into the existing landscape, its land cover and morphology.

Table 3 Areas of woodland opportunity potential in England

	Existing Woodland Area (ha)	Opportunity Woodland Area (ha)	Combined Area (ha)
England Woodland	1,322,751	1,283,572	2,606,323
England Potential Silvoarable		85,517	85,517
England Potential Silvopasture		162,188	162,188
England Urban Trees			0
England Total		1,531,277	2,854,028

The figure for England is less than the previous (FoE 2019) estimate of 1,841,457 ha for Grade 4 land. The reason for this is thought to be not just additional exclusions but also the fact that Grade 4 does include some arable land which has now been excluded.

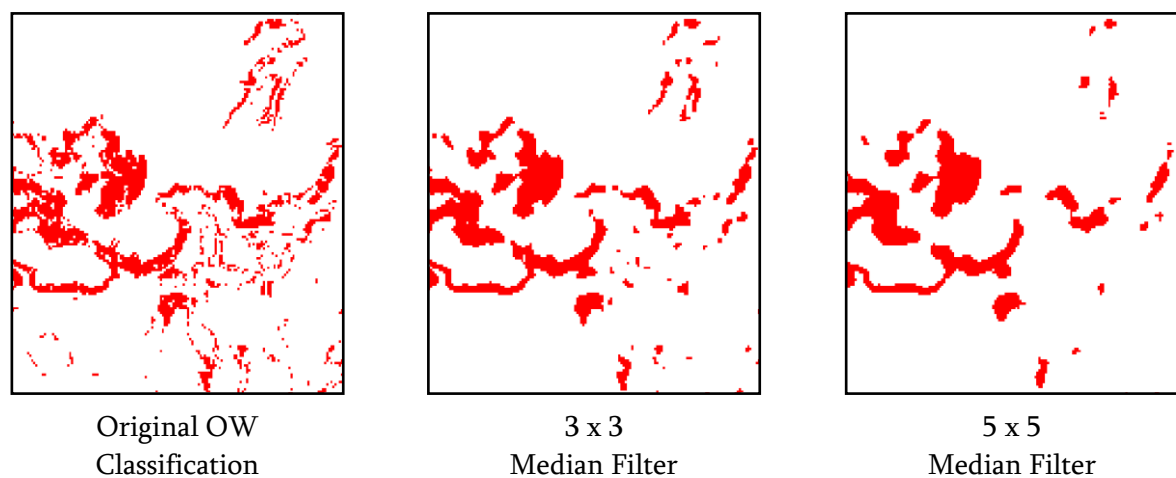
Note that, as defined here, Grade 3b is on moderate to steep slopes whereas Grade 4 and Grade 5 land may be on slopes of any gradient. So it is the case that opportunity woodland may occur on slopes with any gradient depending on the Grade.

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This analysis generates an output that contains numerous small and possibly isolated patches that are cartographically 'untidy'. These grains may be valid artefacts² or noise in the data. The binary classification can be filtered to remove some of the 'salt and pepper' effect. This can remove small but valid areas suitable for woodland creation, or conversely, create invalid areas by filling in isolated holes.

Filtering out many small features obviously effects the area statistics. It has been found that each level of generalisation reduces the area by about 5%.

The 'salt and pepper' in the Somerset Levels looks like an error but is actually an artefact of the rasterisation process with the drainage channels not resolving into recognisable features. It might be possible to remove such apparent inconsistencies but it is an additional complication.



Effect of the generalisation process with a 3x3 and a 5x5 median filter.

Figure 9 Generalisation of woodland opportunity 'salt and pepper'

Agroforestry, Silvoarable & Silvopasture

FoE (2019) assumes that 10% of Grade 1-3 land (i.e. assumed Arable) is to be converted to agroforestry which typically has one third tree cover of woodland. In England this would equate to 283,280 ha of agroforestry tree cover.

The CROME data enables a more informed estimate of the areal extent of arable land on Grades 1-3 and also on Grade 4. CROME also provides an estimate of the area of permanent grassland. This provides the opportunity to estimate Agroforestry on arable land and Silvopasture on grassland.

Here, the same approach is used but using tree densities per hectare of 75 trees for Agroforestry and 250 trees for Silvopasture, as per the following table.

Compared to a mature woodland tree density of 400 trees per hectare, 75 trees/ha represents 19% cover and 250 trees/ha represents 63% cover.

² For example drainage channels in the Somerset Levels

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With the CROME information we have the opportunity to hone this estimate.

The estimate of Arable land area from the CROME analysis is 4,500,895 hectares. This is considered to be entirely arable and none of it is allocated for opportunity woodland.

The potential for Silvopasture is on land identified as Pasture and Other, minus exclusions and minus the land identified for opportunity woodland. This area is 2,574,416 hectares.

Estimate for England based on CROME areas of arable and pasture outside of opportunity woodland and exclusion areas:

Table 4 Agroforestry area estimate for England

ENGLAND	Area Available of Arable and Pasture (ha)	Trees / ha	Density Factor (relative to 400/ha)	Area for 10% of Area by Factor
Silvoarable	4,500,895	75	0.19	85,517
Silvopasture	2,574,416	250	0.63	162,188
Urban Area	846,704			
Total:				247,705

Opportunity Woodland by Administrative Area

The resultant woodland opportunity map forms a continuous raster surface that can be cut up to generate aggregate statistics. Aggregate statistics by local authority administrative area have been extracted using the OS District, Borough and Unitary Region layer. Attributes for the area in hectares of opportunity woodland, NFI woodland, arable and pasture have been appended to the administrative data. In addition, the percentage area of these measures has been calculated for each administrative unit, together with the sum of the two. The administrative unit areas have been adjusted to exclude foreshore areas and persistent inland water bodies.

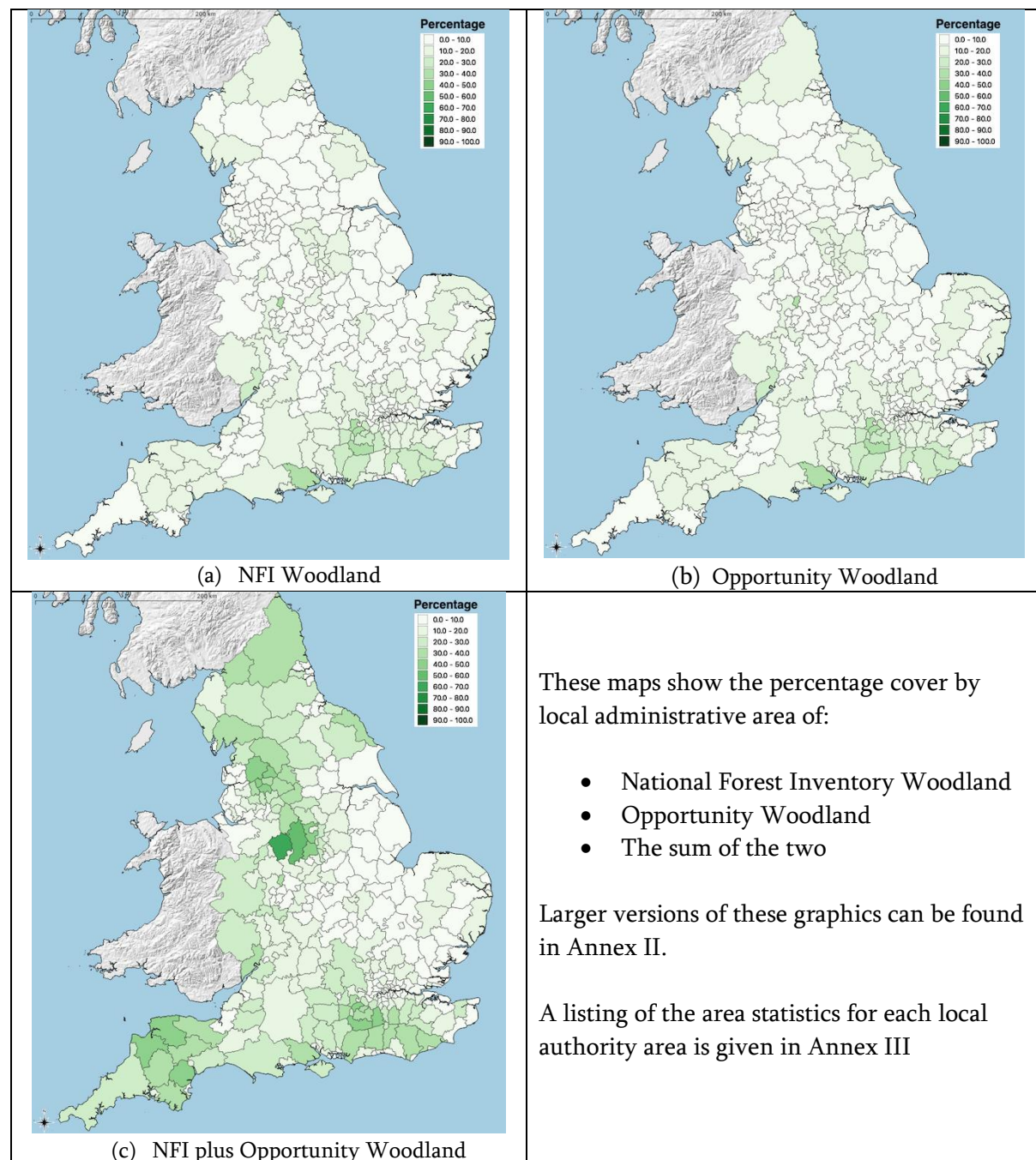


Figure 10 Administrative area-based estimates of woodland potential (relative scales)

Conclusions

The following conclusions are drawn from the results:

- The headline conclusion is that there is indeed space to almost exactly double woodland in England, without impacting on Priority Habitats, protected nature sites, or arable valuable farmland. This study builds on previous analyses and improves upon them by applying fresh constraints and a more granular, detailed analysis of the data.
- Using the assumption that 10% of agricultural land can be converted to Agroforestry brings the total up to an additional 116% of existing woodland.
- Small woods, individual trees, gardens and hedgerows are in addition again but we currently have not got an independent estimate for these that could be spatialised.

With regard to data sources:

- The Government's official ALC dataset is a central pillar in the analysis and can be effectively augmented by differentiating between Grade 3a and 3b using the site-specific gradient criteria of the original MAFF methodology. This augmentation also adds granularity because the gradient data is on a 50m grid.
- The ALC dataset is fundamental to the analysis and is freely available as Open Data. However, despite its (rather complicated) published methodology it cannot be re-derived from first principles because of its reliance on proprietary soils information. This matters greatly because the dataset embodies out-of-date climate data and cannot be adapted to accommodate future climate scenarios. Given that woodland creation is something with long-term requirements and impacts, the failure to take climate scenarios into consideration is a major failing that is dependent on no more than a data policy. Given that the ALC maps provide an important public benefit and that they are actually very generalised and given there is no modern equivalent it seems unreasonable for the Government and data owners to keep this important dataset closed.
- The Native Woodland layer on the LandIS website is a derived dataset set from the ALC maps is also both general and closed data but could be usefully employed in the public domain.
- The Forestry Commission also uses the BMV maps as the basis of their 'Low Risk' woodland categorisation and this produces very different results to the current study because of its apparent over-reliance on soils data.
- The South West Nature Partnership's Nature Recovery Network maps implement yet another methodology based on species dispersion using least-cost-distance modelling. These maps are also very different to the current study because they are not specifically mapping opportunity woodland. It is suggested that the opportunity woodland maps of the current study should be a starting point for a Nature Recovery Network model as this would more readily take existing land use into account, efficiently make use of marginal landscape niches and provide a starting framework for the recovery networks.
- Friends of the Earth are well placed to broker a conversation between the main actors on methodology.
- The use and exclusion of Priority Habitats in the methodology is an important step in the right direction to protect both important habitats and biodiversity. However, the data are probably both incomplete and out-of-date. This works both ways in that the data may include areas that are not biodiverse and omit areas that are. It is, however, a starting point.

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- DEFRA's RPA CROME crop maps should provide an important and continually improving land use data resource going forward, in particular in relation to understanding the dynamics of grasslands. Their quality is more variable than suggested by their published quality indicators.
- Knowing where biodiverse meadows are in relation to improved grasslands remains uncertain. Biodiverse meadows are managed differently to 'improved' grasslands and this difference in management and timing of mowing may provide a way using remote sensing to better understand and differentiate between the two. The stumbling block to exploring this possibility is the very large data processing task at the national scale. DEFRA's new Sentinel processing service might provide a viable way to address this issue. This needs to be explored.
- Before commencing a tree planting programme, it is vital to undertake an ecological survey.
- Important archaeological sites need to be excluded where this is feasible; this may need to be done on a case by case basis.

References

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Erratum

A previous version of this report contained the conclusion that including agroforestry the potential for woodland is 124% of existing woodland area, however this is the figure for England and Wales. This version has the correct figure of 116% for England alone.

Annex I - Agricultural Land Classification

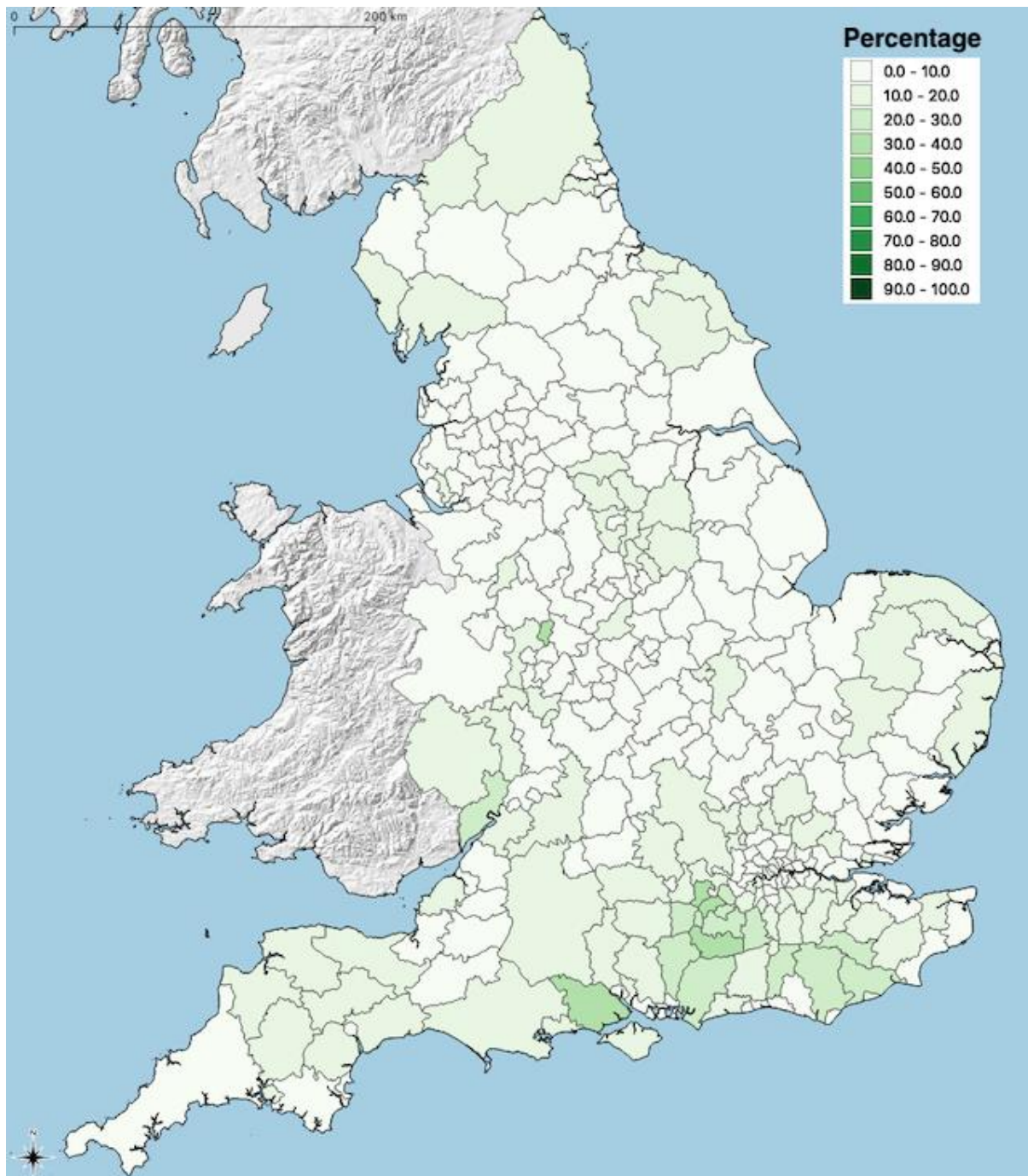
- **Grade 1** - excellent quality agricultural land
 - Land with no or very minor limitations to agricultural use. A very wide range of agricultural and horticultural crops can be grown and commonly includes top fruit, soft fruit, salad crops and winter harvested vegetables. Yields are high and less variable than on land of lower quality.
- **Grade 2** - very good quality agricultural land
 - Land with minor limitations which affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown but on some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than Grade 1.
- **Grade 3** - good to moderate quality agricultural land
 - Land with moderate limitation which affect the choice of crops, timing and type of cultivation harvesting or the level of yield. Where more demanding crops are grown yields are generally lower or more variable than on land in Grades 1 and 2.
 - **Subgrade 3a** - good quality agricultural land
 - Land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of a wide range of crops including cereals, grass, oilseed rape, potatoes, sugar beet and the less demanding horticultural crops.
 - **Subgrade 3b** - moderate quality agricultural land
 - Land capable of producing moderate yields of a narrow range of crops, principally cereals and grass or lower yields of a wider range of crops or high yields of grass which can be grazed or harvested over most of the year.
- **Grade 4** - poor quality agricultural land
 - Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land.
- **Grade 5** - very poor quality agricultural land
 - Land with very severe limitation which restrict use to permanent pasture or rough grazing, except for occasional pioneer forage crops.
- **Non Agricultural Land** - 'Soft Uses'
 - 'Soft' uses where most of the land could be returned relatively easily to agriculture, including: golf courses, private parkland, public open spaces, sports fields, allotments and soft-surfaced areas on airports / airfields. Also active mineral workings and refuse tips where restoration conditions to 'soft' after-uses may apply.
- **Urban Land** - 'Hard Uses'
 - Built up or 'hard' uses with relatively little potential for a return to agriculture.

Source: MAFF (1988)

Annex II

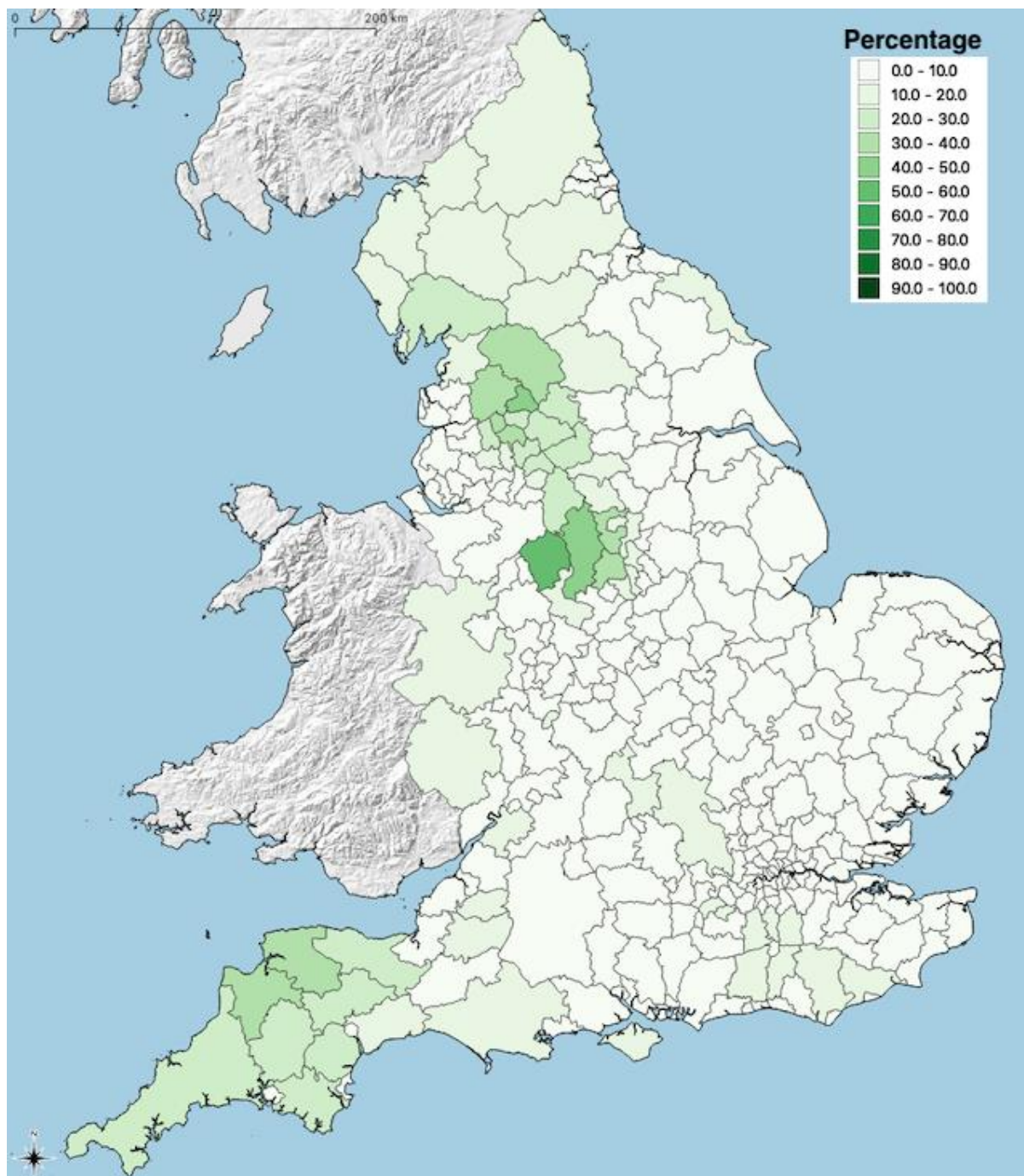
The following maps show percentage woodland by administrative area. The colour scales are directly comparable one map to the next.

Percentage National Forest Inventory Woodland by Administrative Area



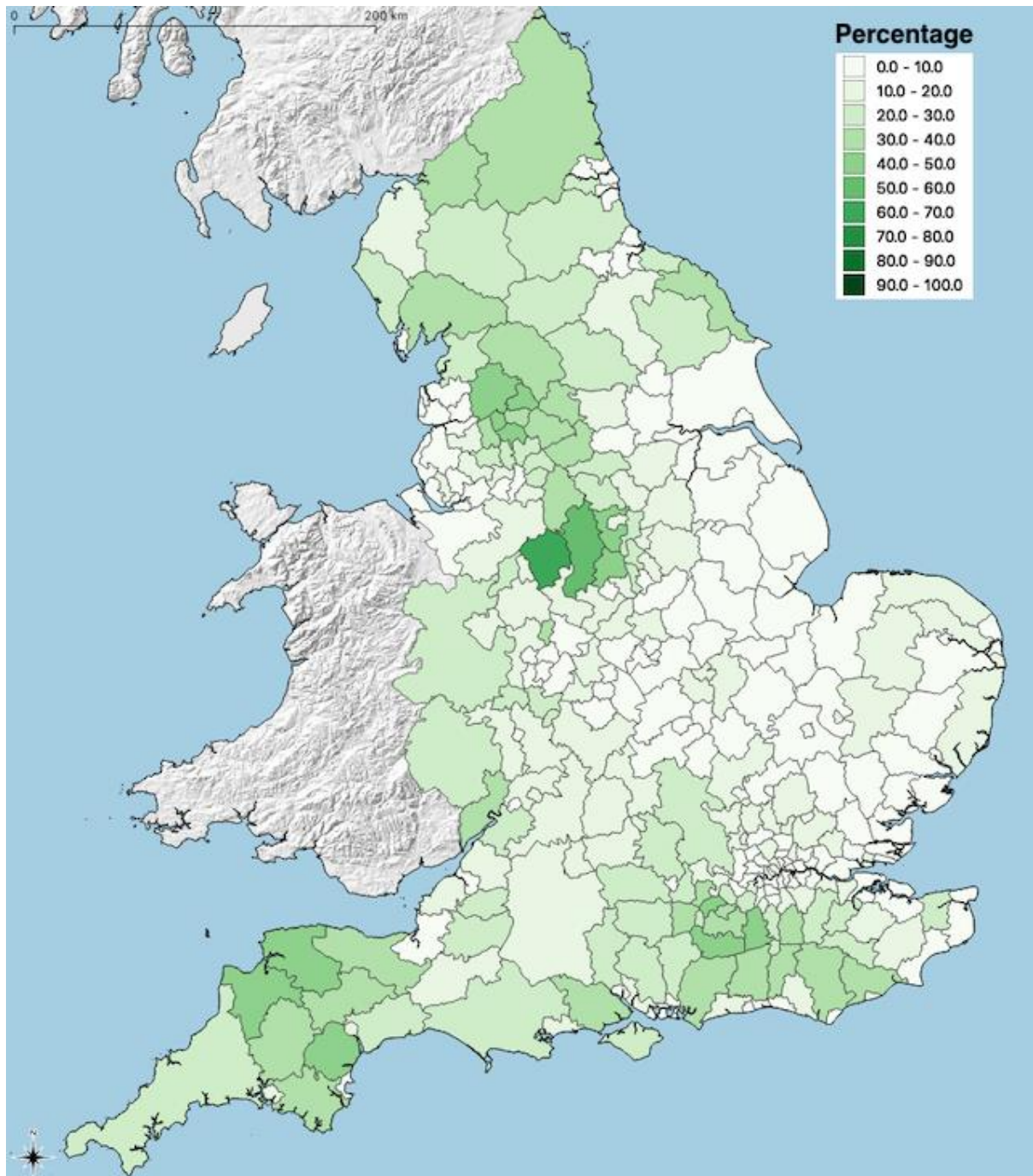
Opportunity Woodland Mapping in England

Percentage Opportunity Woodland by Administrative Area



Opportunity Woodland Mapping in England

Percentage National Forest Inventory Woodland plus Opportunity Woodland by Administrative Area



Annex III - Opportunity Woodland by Administrative Areas

The following table lists each local authority area in England and gives a summary of the area and percentage of potential Opportunity Woodland (ow), existing National Forest Inventory (NFI) woodland, arable and pasture (plus mixed). Space limitations mean that the full table can't be reproduced here but the hectareage can be worked out from the unit's area (adjusted_area_ha) and the percentages. The 'mix' are those pixels that exist in the fuzzy space between arable and pasture and can't be clearly identified as one or the other. They have been allocated to the pasture category.

The unit's area is 'adjusted' to exclude both foreshore areas and persistent water bodies, where trees cannot grow, as evidenced by the multi-temporal CROME maps.

Name	Area code	Code	Adjusted area Ha	%_ow	%_nfi	%_arable	%_pasture_mix
Adur District	DIS	E07000223	4179.50	5.56	3.45	24.03	13.30
Allerdale District (B)	DIS	E07000026	124239.50	14.32	6.86	12.89	23.87
Amber Valley District (B)	DIS	E07000032	26538.50	37.97	8.87	14.80	15.37
Arun District	DIS	E07000224	22057.50	3.19	16.06	32.71	18.46
Ashfield District	DIS	E07000170	10951.25	12.96	15.27	21.43	11.74
Ashford District (B)	DIS	E07000105	58044.25	2.33	14.55	36.54	31.61
Babergh District	DIS	E07000200	59420.25	1.08	7.61	62.19	16.93
Barking and Dagenham London Boro	LBO	E09000002	3607.25	0.00	1.27	4.57	6.11
Barnet London Boro	LBO	E09000003	8674.50	2.90	9.80	2.52	11.92
Barnsley District (B)	MTD	E08000016	32797.25	17.23	11.02	21.84	14.79
Barrow-in-Furness District (B)	DIS	E07000027	7696.75	13.42	3.28	13.60	22.64
Basildon District (B)	DIS	E07000066	10999.25	0.75	8.00	23.53	19.75
Basingstoke and Deane District (B)	DIS	E07000084	63381.50	3.12	16.93	44.87	18.86
Bassetlaw District	DIS	E07000171	63665.00	0.82	10.60	60.66	16.33
Bath and North East Somerset	UTA	E06000022	34673.00	15.45	8.46	21.96	30.82
Bedford (B)	UTA	E06000055	47458.25	0.31	6.37	60.06	19.28
Bexley London Boro	LBO	E09000004	6051.00	0.07	7.76	2.23	11.01
Birmingham District (B)	MTD	E08000025	26715.00	0.09	5.95	4.11	5.45
Blaby District	DIS	E07000129	13039.25	4.84	3.03	35.78	28.49
Blackburn with Darwen (B)	UTA	E06000008	13607.25	22.59	9.90	7.17	4.34
Blackpool (B)	UTA	E06000009	3492.75	0.00	1.87	5.31	11.83
Bolsover District	DIS	E07000033	16023.50	13.71	10.38	44.24	9.51
Bolton District (B)	MTD	E08000001	13954.75	10.90	9.49	7.99	14.48
Boston District (B)	DIS	E07000136	36136.00	0.06	0.55	79.64	7.67
Bournemouth, Christchurch and Poole	UTA	E06000058	16113.75	4.97	11.94	4.56	9.18
Bracknell Forest (B)	UTA	E06000036	10933.25	2.06	34.34	7.09	20.04
Bradford District (B)	MTD	E08000032	36589.00	28.55	6.25	5.51	10.93
Braintree District	DIS	E07000067	61151.00	0.46	6.73	65.69	15.92
Breckland District	DIS	E07000143	130432.00	3.14	16.75	52.11	10.48

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Brent London Boro	LBO	E09000005	4321.25	0.00	3.35	0.64	3.34
Brentwood District (B)	DIS	E07000068	15316.50	0.40	11.14	41.09	22.98
Broadland District	DIS	E07000144	55127.75	0.38	12.11	52.92	14.07
Bromley London Boro	LBO	E09000006	15012.75	1.99	14.79	10.64	16.76
Bromsgrove District	DIS	E07000234	21691.00	9.91	10.38	20.86	36.82
Broxbourne District (B)	DIS	E07000095	5126.25	3.50	14.45	10.36	22.31
Broxtowe District (B)	DIS	E07000172	7988.00	18.72	7.51	20.74	7.89
Buckinghamshire	UTA	E06000060	156352.00	12.40	12.53	30.88	26.66
Burnley District (B)	DIS	E07000117	11038.25	26.92	8.81	9.19	4.30
Bury District (B)	MTD	E08000002	9919.00	19.93	8.96	6.97	7.14
Calderdale District (B)	MTD	E08000033	36208.75	28.84	7.02	6.01	4.35
Cambridge District (B)	DIS	E07000008	4067.00	0.06	4.51	12.16	13.46
Camden London Boro	LBO	E09000007	2178.25	0.00	14.28	0.02	0.22
Cannock Chase District	DIS	E07000192	7886.75	6.12	33.24	9.49	11.42
Canterbury District (B)	DIS	E07000106	30819.75	2.77	18.58	36.20	19.56
Carlisle District (B)	DIS	E07000028	103806.50	13.11	18.32	13.30	25.85
Castle Point District (B)	DIS	E07000069	4508.50	3.08	11.26	7.13	11.58
Central Bedfordshire	UTA	E06000056	71324.00	1.67	9.84	51.37	20.98
Charnwood District (B)	DIS	E07000130	27784.00	4.86	8.11	34.60	25.50
Chelmsford District (B)	DIS	E07000070	33905.75	1.19	7.19	49.94	21.00
Cheltenham District (B)	DIS	E07000078	4660.25	8.79	5.49	6.66	17.54
Cherwell District	DIS	E07000177	58831.75	12.95	5.19	44.94	20.11
Cheshire East (B)	UTA	E06000049	116382.50	9.23	6.50	22.94	40.90
Cheshire West and Chester (B)	UTA	E06000050	91458.00	2.71	6.31	26.94	40.79
Chesterfield District (B)	DIS	E07000034	6603.50	10.21	8.03	21.51	9.21
Chichester District	DIS	E07000225	78573.00	4.84	27.33	30.31	21.32
Chorley District (B)	DIS	E07000118	20158.75	7.17	8.53	17.97	29.91
City and County of the City of London	LBO	E09000001	290.00	0.00	0.95	0.00	0.00
City of Bristol (B)	UTA	E06000023	10964.00	0.45	6.12	2.05	8.62
City of Derby (B)	UTA	E06000015	7799.25	1.49	3.55	5.32	10.05
City of Kingston upon Hull (B)	UTA	E06000010	7146.25	0.34	1.72	7.43	12.65
City of Leicester (B)	UTA	E06000016	7338.00	0.20	3.34	3.08	7.84
City of Nottingham (B)	UTA	E06000018	7444.75	0.06	5.30	2.30	8.32
City of Peterborough (B)	UTA	E06000031	34190.50	0.37	5.60	60.48	10.98
City of Plymouth (B)	UTA	E06000026	7968.75	2.48	10.47	3.49	13.83
City of Portsmouth (B)	UTA	E06000044	4041.75	0.24	2.00	3.58	9.15
City of Southampton (B)	UTA	E06000045	4987.00	0.42	7.60	0.42	2.05
City of Stoke-on-Trent (B)	UTA	E06000021	9336.00	7.30	4.88	3.65	12.38
City of Westminster London Boro	LBO	E09000033	2152.00	0.00	12.44	0.07	0.45
City of Wolverhampton District (B)	MTD	E08000031	6941.00	0.52	3.84	1.76	9.00
Colchester District (B)	DIS	E07000071	32755.00	1.03	8.33	45.45	19.84
Copeland District (B)	DIS	E07000029	73074.50	15.23	10.54	6.13	14.60

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Corby District (B)	DIS	E07000150	8028.25	4.37	13.30	34.54	16.44
Cornwall	UTA	E06000052	354237.50	20.59	9.31	21.42	28.65
Cotswold District	DIS	E07000079	116124.25	5.95	11.45	46.54	24.77
County Durham	UTA	E06000047	222559.25	17.27	8.60	19.11	14.79
County of Herefordshire	UTA	E06000019	217947.75	12.13	11.69	36.50	26.06
Coventry District (B)	MTD	E08000026	9865.75	0.04	5.04	7.82	15.57
Craven District	DIS	E07000163	117660.00	32.83	4.67	6.42	3.57
Crawley District (B)	DIS	E07000226	4499.50	6.71	13.90	4.43	16.09
Croydon London Boro	LBO	E09000008	8650.25	0.28	12.92	1.49	6.25
Dacorum District (B)	DIS	E07000096	21218.25	3.75	12.63	33.94	26.57
Darlington (B)	UTA	E06000005	19739.25	0.75	3.92	48.82	30.28
Dartford District (B)	DIS	E07000107	7260.50	1.23	10.77	25.76	19.23
Daventry District	DIS	E07000151	66250.25	2.38	4.19	50.81	32.87
Derbyshire Dales District	DIS	E07000035	79296.25	42.12	9.60	11.39	16.17
Doncaster District (B)	MTD	E08000017	56745.50	3.67	8.80	44.07	12.75
Dorset	UTA	E06000059	248989.00	13.92	12.28	30.28	25.36
Dover District	DIS	E07000108	31464.00	2.72	6.88	48.76	19.10
Dudley District (B)	MTD	E08000027	9792.00	0.63	6.64	5.18	9.94
Ealing London Boro	LBO	E09000009	5556.75	0.00	3.88	0.95	6.37
East Cambridgeshire District	DIS	E07000009	65058.75	0.61	2.90	67.63	16.35
East Devon District	DIS	E07000040	81443.75	15.48	11.70	22.68	30.38
East Hampshire District	DIS	E07000085	51437.00	6.65	22.10	33.95	18.65
East Hertfordshire District	DIS	E07000242	47547.75	0.63	10.02	53.89	20.54
East Lindsey District	DIS	E07000137	175902.00	0.53	3.97	73.52	12.85
East Northamptonshire District	DIS	E07000152	50795.50	0.94	10.60	57.25	20.00
East Riding of Yorkshire	UTA	E06000011	240643.00	1.61	3.79	73.05	11.38
East Staffordshire District (B)	DIS	E07000193	38678.75	11.61	8.39	21.82	36.95
East Suffolk District	DIS	E07000244	125993.75	3.23	10.23	54.53	12.06
Eastbourne District (B)	DIS	E07000061	4411.00	2.64	5.36	3.00	14.85
Eastleigh District (B)	DIS	E07000086	7973.50	8.99	11.99	5.20	13.85
Eden District	DIS	E07000030	214339.50	19.95	5.93	10.24	16.04
Elmbridge District (B)	DIS	E07000207	9445.50	2.53	18.27	4.89	23.69
Enfield London Boro	LBO	E09000010	7981.25	0.02	8.20	10.19	11.96
Epping Forest District	DIS	E07000072	33810.00	1.07	10.73	49.39	20.07
Epsom and Ewell District (B)	DIS	E07000208	3406.50	0.00	12.83	3.14	21.41
Erewash District (B)	DIS	E07000036	10883.00	13.47	5.58	21.12	22.34
Exeter District (B)	DIS	E07000041	4706.25	5.77	8.31	4.03	10.26
Fareham District (B)	DIS	E07000087	7418.75	2.24	8.84	20.91	13.72
Fenland District	DIS	E07000010	54593.25	0.05	0.55	79.60	7.45
Folkestone and Hythe District	DIS	E07000112	35506.25	3.15	6.32	46.77	16.57
Forest of Dean District	DIS	E07000080	52667.25	7.81	26.07	22.16	28.09
Fylde District (B)	DIS	E07000119	16559.50	0.19	2.84	32.16	33.01

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Gateshead District (B)	MTD	E08000037	14235.25	5.11	15.47	18.96	16.90
Gedling District (B)	DIS	E07000173	11985.50	1.42	14.85	32.88	19.09
Gloucester District (B)	DIS	E07000081	4051.75	1.24	4.45	3.57	11.01
Gosport District (B)	DIS	E07000088	2533.50	0.00	6.38	2.16	11.51
Gravesham District (B)	DIS	E07000109	9892.00	2.09	14.53	28.31	15.54
Great Yarmouth District (B)	DIS	E07000145	17288.75	0.15	6.11	47.33	12.73
Greenwich London Boro	LBO	E09000011	4730.25	0.00	9.50	1.14	5.09
Guildford District (B)	DIS	E07000209	27080.25	9.20	29.98	11.18	21.24
Hackney London Boro	LBO	E09000012	1897.00	0.00	4.55	0.18	1.37
Halton (B)	UTA	E06000006	7887.50	0.39	6.97	19.20	14.18
Hambleton District	DIS	E07000164	131075.75	5.06	7.31	51.16	24.65
Hammersmith and Fulham London Boro	LBO	E09000013	1637.00	0.00	2.86	0.05	1.13
Harborough District	DIS	E07000131	59172.00	3.15	4.04	43.45	40.32
Haringey London Boro	LBO	E09000014	2960.00	0.00	9.42	0.13	1.69
Harlow District	DIS	E07000073	3054.50	0.01	8.64	9.02	14.63
Harrogate District (B)	DIS	E07000165	130558.25	19.10	7.24	27.32	18.70
Harrow London Boro	LBO	E09000015	5048.00	0.26	8.70	1.19	11.46
Hart District	DIS	E07000089	21516.50	6.58	28.22	21.91	17.22
Hartlepool (B)	UTA	E06000001	9381.50	0.96	4.67	39.56	25.35
Hastings District (B)	DIS	E07000062	2972.50	2.09	12.93	2.10	4.11
Havant District (B)	DIS	E07000090	5539.00	1.60	8.46	10.87	11.80
Havering London Boro	LBO	E09000016	11223.00	0.18	8.65	14.64	18.70
Hertsmere District (B)	DIS	E07000098	10066.50	0.22	8.76	25.92	31.04
High Peak District (B)	DIS	E07000037	53681.50	27.22	8.27	5.14	1.39
Hillingdon London Boro	LBO	E09000017	11506.25	0.20	9.14	4.66	26.81
Hinckley and Bosworth District (B)	DIS	E07000132	29711.00	0.71	6.08	45.90	31.91
Horsham District	DIS	E07000227	53028.25	15.20	17.28	17.44	29.61
Hounslow London Boro	LBO	E09000018	5588.50	0.00	5.82	3.72	11.13
Huntingdonshire District	DIS	E07000011	90307.75	0.39	4.20	69.32	13.89
Hyndburn District (B)	DIS	E07000120	7278.00	38.14	8.45	10.45	3.92
Ipswich District (B)	DIS	E07000202	3944.75	0.93	4.41	8.87	9.01
Isle of Wight	UTA	E06000046	38012.75	12.75	13.51	24.63	21.62
Isles of Scilly	UTA	E06000053	1627.25	0.00	3.33	3.55	34.91
Islington London Boro	LBO	E09000019	1486.75	0.00	3.21	0.07	0.12
Kensington and Chelsea London Boro	LBO	E09000020	1211.75	0.00	5.18	0.31	0.95
Kettering District (B)	DIS	E07000153	23336.25	2.83	7.98	51.40	23.22
King's Lynn and West Norfolk District (B)	DIS	E07000146	142655.25	1.76	6.95	67.67	10.72
Kingston upon Thames London Boro	LBO	E09000021	3727.25	0.90	5.30	4.92	10.97
Kirklees District (B)	MTD	E08000034	40729.75	27.51	8.44	9.23	11.46
Knowsley District (B)	MTD	E08000011	8637.50	0.12	10.17	26.89	15.03
Lambeth London Boro	LBO	E09000022	2678.25	0.00	2.51	0.09	0.86
Lancaster District (B)	DIS	E07000121	57530.25	19.05	7.08	10.69	18.37

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Leeds District (B)	MTD	E08000035	54997.00	6.24	9.92	23.00	21.56
Lewes District	DIS	E07000063	29195.25	8.34	9.93	27.45	25.56
Lewisham London Boro	LBO	E09000023	3512.75	0.00	5.13	0.22	1.46
Lichfield District	DIS	E07000194	32973.00	2.92	6.19	47.23	24.37
Lincoln District (B)	DIS	E07000138	3560.25	0.06	6.81	9.89	13.85
Liverpool District (B)	MTD	E08000012	11178.75	0.00	4.77	2.78	7.44
Luton (B)	UTA	E06000032	4331.75	0.29	2.95	5.33	17.54
Maidstone District (B)	DIS	E07000110	39326.25	1.85	11.94	33.11	29.67
Maldon District (B)	DIS	E07000074	35831.75	0.66	3.96	58.97	15.27
Malvern Hills District	DIS	E07000235	57672.75	6.79	10.84	35.32	32.99
Manchester District (B)	MTD	E08000003	11558.00	0.22	7.64	0.89	6.13
Mansfield District	DIS	E07000174	7665.00	0.51	13.47	30.09	14.13
Medway (B)	UTA	E06000035	19049.75	2.02	7.98	22.35	12.85
Melton District (B)	DIS	E07000133	48121.25	4.21	4.75	51.68	30.96
Mendip District	DIS	E07000187	73909.75	13.36	7.54	19.30	36.89
Merton London Boro	LBO	E09000024	3757.25	0.00	9.97	0.31	3.17
Mid Devon District	DIS	E07000042	91280.50	23.60	10.20	22.92	31.88
Mid Suffolk District	DIS	E07000203	87081.25	0.85	4.29	72.21	14.17
Mid Sussex District	DIS	E07000228	33364.25	10.32	25.72	12.63	29.09
Middlesbrough (B)	UTA	E06000002	5382.75	0.11	5.38	14.17	23.56
Milton Keynes (B)	UTA	E06000042	30771.00	2.45	7.33	39.71	20.91
Mole Valley District	DIS	E07000210	25823.50	16.49	29.70	14.12	20.85
New Forest District	DIS	E07000091	75148.25	7.34	31.07	12.37	10.02
Newark and Sherwood District	DIS	E07000175	64864.75	0.89	11.17	56.25	20.50
Newcastle upon Tyne District (B)	MTD	E08000021	11339.00	0.33	5.76	16.96	15.27
Newcastle-under-Lyme District (B)	DIS	E07000195	21094.75	9.00	11.11	17.16	36.11
Newham London Boro	LBO	E09000025	3601.00	0.00	1.93	1.78	5.10
North Devon District	DIS	E07000043	108583.50	32.00	10.49	16.05	23.46
North East Derbyshire District	DIS	E07000038	27516.75	33.54	11.00	20.16	10.58
North East Lincolnshire (B)	UTA	E06000012	19178.00	0.23	3.54	56.27	13.18
North Hertfordshire District	DIS	E07000099	37541.25	0.73	7.23	60.46	18.78
North Kesteven District	DIS	E07000139	92087.50	0.46	3.95	76.92	11.72
North Lincolnshire (B)	UTA	E06000013	84492.50	0.62	5.09	68.95	12.01
North Norfolk District	DIS	E07000147	96203.00	0.69	10.42	60.12	13.09
North Somerset	UTA	E06000024	37353.50	7.39	11.12	9.13	27.76
North Tyneside District (B)	MTD	E08000022	8230.00	0.08	3.35	19.02	16.87
North Warwickshire District (B)	DIS	E07000218	28353.00	3.01	7.89	45.97	24.30
North West Leicestershire District	DIS	E07000134	27900.00	5.75	12.43	36.20	25.89
Northampton District (B)	DIS	E07000154	8033.50	1.98	5.21	5.57	13.88
Northumberland	UTA	E06000057	500921.00	15.35	17.74	21.51	13.44
Norwich District (B)	DIS	E07000148	3940.00	0.60	7.97	1.97	12.63
Nuneaton and Bedworth District (B)	DIS	E07000219	7892.25	2.72	5.41	28.62	19.03

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Oadby and Wigston District (B)	DIS	E07000135	2352.25	1.36	2.43	18.60	15.03
Oldham District (B)	MTD	E08000004	14186.75	20.06	5.48	7.15	1.51
Oxford District (B)	DIS	E07000178	4561.00	4.42	5.70	2.35	5.51
Pendle District (B)	DIS	E07000122	16879.50	46.06	3.99	10.78	3.36
Preston District (B)	DIS	E07000123	14212.75	2.17	5.32	9.85	49.55
Reading (B)	UTA	E06000038	4041.00	3.67	4.96	1.87	5.90
Redbridge London Boro	LBO	E09000026	5636.00	0.02	6.73	6.30	6.41
Redcar and Cleveland (B)	UTA	E06000003	24449.50	9.29	12.97	27.60	16.84
Redditch District (B)	DIS	E07000236	5426.75	15.75	10.73	10.06	15.75
Reigate and Banstead District (B)	DIS	E07000211	12909.75	10.82	16.71	12.76	19.68
Ribble Valley District (B)	DIS	E07000124	58356.00	33.97	9.53	9.15	16.74
Richmond upon Thames London Boro	LBO	E09000027	5728.25	0.00	16.88	0.73	5.82
Richmondshire District	DIS	E07000166	131768.25	19.00	5.05	17.34	9.45
Rochdale District (B)	MTD	E08000005	15685.75	20.65	5.24	7.18	6.43
Rochford District	DIS	E07000075	16913.75	0.44	3.67	49.29	15.31
Rossendale District (B)	DIS	E07000125	13741.75	33.93	6.65	14.17	0.02
Rother District	DIS	E07000064	50904.00	10.79	21.71	14.52	24.52
Rotherham District (B)	MTD	E08000018	28581.00	1.55	10.26	39.88	15.91
Rugby District (B)	DIS	E07000220	35132.00	3.72	4.51	45.87	30.92
Runnymede District (B)	DIS	E07000212	7762.00	5.80	23.88	3.44	20.53
Rushcliffe District (B)	DIS	E07000176	40846.25	1.68	4.90	56.16	24.19
Rushmoor District (B)	DIS	E07000092	3904.50	0.12	20.73	1.49	9.94
Rutland	UTA	E06000017	38251.00	2.27	6.62	57.65	24.75
Ryedale District	DIS	E07000167	150651.50	8.46	15.26	45.26	12.17
Salford District (B)	MTD	E08000006	9711.75	1.67	9.32	13.07	11.42
Sandwell District (B)	MTD	E08000028	8555.00	0.10	5.92	1.27	6.86
Scarborough District (B)	DIS	E07000168	81621.25	17.00	14.51	22.79	11.93
Sedgemoor District	DIS	E07000188	56321.75	4.58	5.63	17.04	18.06
Sefton District (B)	MTD	E08000014	15256.25	1.13	5.65	19.99	10.80
Selby District	DIS	E07000169	59885.00	0.40	5.98	65.06	16.91
Sevenoaks District	DIS	E07000111	36910.50	7.68	19.91	22.68	25.98
Sheffield District (B)	MTD	E08000019	36607.75	15.21	13.44	3.41	4.71
Shropshire	UTA	E06000051	319591.25	14.62	9.43	35.65	27.24
Slough (B)	UTA	E06000039	3250.00	0.00	3.98	3.86	14.31
Solihull District (B)	MTD	E08000029	17819.00	4.24	6.64	20.39	27.31
Somerset West and Taunton District	DIS	E07000246	118797.00	23.44	12.33	20.00	17.30
South Cambridgeshire District	DIS	E07000012	90044.25	0.60	4.45	68.48	14.36
South Derbyshire District	DIS	E07000039	33626.75	8.12	9.50	36.52	30.27
South Gloucestershire	UTA	E06000025	49668.50	6.07	6.18	22.25	37.94
South Hams District	DIS	E07000044	88564.75	22.48	9.49	23.16	20.26
South Holland District	DIS	E07000140	74226.00	0.00	0.41	85.53	5.88
South Kesteven District	DIS	E07000141	94121.50	0.80	5.92	71.38	13.81

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South Lakeland District	DIS	E07000031	153357.50	25.63	13.60	7.33	6.00
South Norfolk District	DIS	E07000149	90687.25	2.15	6.38	60.54	16.34
South Northamptonshire District	DIS	E07000155	63384.00	1.95	7.35	49.95	30.73
South Oxfordshire District	DIS	E07000179	67757.50	7.22	13.90	43.40	20.40
South Ribble District (B)	DIS	E07000126	11296.25	2.15	5.73	14.44	30.55
South Somerset District	DIS	E07000189	95866.75	9.41	5.60	27.74	37.94
South Staffordshire District	DIS	E07000196	40629.50	3.33	10.96	41.94	29.36
South Tyneside District (B)	MTD	E08000023	6438.25	0.28	3.44	21.82	23.73
Southend-on-Sea (B)	UTA	E06000033	4171.25	0.04	2.50	7.19	8.92
Southwark London Boro	LBO	E09000028	2886.00	0.00	6.23	0.20	2.30
Spelthorne District (B)	DIS	E07000213	4381.25	0.00	3.70	6.84	27.82
St. Albans District (B)	DIS	E07000240	16120.50	0.66	11.83	33.44	26.29
St. Helens District (B)	MTD	E08000013	13601.75	0.15	9.26	37.11	11.39
Stafford District (B)	DIS	E07000197	59756.00	7.02	9.02	31.25	36.65
Staffordshire Moorlands District	DIS	E07000198	57500.50	52.30	8.46	7.27	9.52
Stevenage District (B)	DIS	E07000243	2593.75	0.04	6.40	8.86	13.35
Stockport District (B)	MTD	E08000007	12604.00	8.76	9.69	6.22	10.84
Stockton-on-Tees (B)	UTA	E06000004	20349.25	2.18	6.39	33.69	23.02
Stratford-on-Avon District	DIS	E07000221	97774.75	6.75	7.12	46.10	29.46
Stroud District	DIS	E07000082	46059.25	12.00	11.96	20.63	28.15
Sunderland District (B)	MTD	E08000024	13732.75	0.76	7.75	20.51	23.61
Surrey Heath District (B)	DIS	E07000214	9493.00	11.30	32.35	1.02	8.80
Sutton London Boro	LBO	E09000029	4386.50	0.00	3.85	2.31	9.25
Swale District (B)	DIS	E07000113	37280.00	2.17	7.99	37.29	18.51
Swindon (B)	UTA	E06000030	22996.25	6.22	6.45	33.61	24.25
Tameside District (B)	MTD	E08000008	10251.50	12.73	8.86	5.98	5.47
Tamworth District (B)	DIS	E07000199	3067.50	3.14	3.36	12.14	11.20
Tandridge District	DIS	E07000215	24811.00	12.50	17.96	17.61	28.83
Teignbridge District	DIS	E07000045	67381.25	23.67	19.73	13.30	17.58
Telford and Wrekin (B)	UTA	E06000020	29017.75	3.33	9.30	46.96	14.65
Tendring District	DIS	E07000076	33730.50	1.56	4.38	53.86	16.43
Test Valley District	DIS	E07000093	62747.00	4.23	16.22	43.55	16.59
Tewkesbury District (B)	DIS	E07000083	41437.50	8.63	7.62	32.68	27.52
Thanet District	DIS	E07000114	10328.75	0.20	1.53	49.64	16.13
The City of Brighton and Hove (B)	UTA	E06000043	8268.75	4.44	5.86	11.61	9.79
Three Rivers District	DIS	E07000102	8838.25	1.53	15.04	15.97	30.49
Thurrock (B)	UTA	E06000034	16294.25	0.32	4.98	37.36	18.43
Tonbridge and Malling District (B)	DIS	E07000115	23935.75	2.89	19.01	25.63	23.58
Torbay (B)	UTA	E06000027	6298.25	7.49	8.86	7.15	12.23
Torridge District	DIS	E07000046	98401.75	32.10	14.00	13.73	29.15
Tower Hamlets London Boro	LBO	E09000030	1978.00	0.00	4.28	0.18	0.91
Trafford District (B)	MTD	E08000009	10595.00	0.71	5.40	14.83	11.92

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Tunbridge Wells District (B)	DIS	E07000116	33125.25	4.52	22.38	18.76	31.17
Uttlesford District	DIS	E07000077	64113.75	0.12	6.03	71.34	14.45
Vale of White Horse District	DIS	E07000180	57707.25	8.77	8.21	49.27	18.40
Wakefield District (B)	MTD	E08000036	33751.25	1.00	7.23	38.47	18.04
Walsall District (B)	MTD	E08000030	10390.00	1.54	6.72	8.93	15.27
Waltham Forest London Boro	LBO	E09000031	3792.00	0.01	10.65	0.63	3.76
Wandsworth London Boro	LBO	E09000032	3429.50	0.00	8.86	0.15	1.82
Warrington (B)	UTA	E06000007	18045.50	0.38	7.99	31.41	16.90
Warwick District	DIS	E07000222	28281.00	1.36	7.39	38.28	31.84
Watford District (B)	DIS	E07000103	2143.50	0.00	10.10	1.55	9.89
Waverley District (B)	DIS	E07000216	34491.50	7.76	34.67	6.48	27.12
Wealden District	DIS	E07000065	83323.50	11.20	23.30	13.04	26.73
Wellingborough District (B)	DIS	E07000156	16218.75	2.68	4.88	53.03	18.84
Welwyn Hatfield District (B)	DIS	E07000241	12949.50	0.59	18.72	25.28	25.81
West Berkshire	UTA	E06000037	70299.00	3.90	16.40	40.03	21.66
West Devon District (B)	DIS	E07000047	115948.00	28.05	10.93	7.14	19.00
West Lancashire District (B)	DIS	E07000127	34664.25	0.71	4.20	56.55	15.02
West Lindsey District	DIS	E07000142	115536.00	1.23	6.62	73.68	12.89
West Oxfordshire District	DIS	E07000181	71231.75	5.48	9.46	49.57	21.92
West Suffolk District	DIS	E07000245	103409.00	2.70	14.68	52.74	10.98
Wigan District (B)	MTD	E08000010	18729.25	1.00	9.65	16.41	21.37
Wiltshire	UTA	E06000054	325357.75	7.07	10.33	39.08	23.50
Winchester District (B)	DIS	E07000094	66093.25	5.72	14.83	45.52	17.27
Windsor and Maidenhead (B)	UTA	E06000040	19629.25	2.43	15.89	18.13	24.74
Wirral District (B)	MTD	E08000015	15695.25	0.63	6.55	11.56	20.33
Woking District (B)	DIS	E07000217	6357.25	10.37	22.31	2.57	12.43
Wokingham (B)	UTA	E06000041	17866.75	7.77	15.02	17.72	20.55
Worcester District (B)	DIS	E07000237	3327.75	0.17	4.63	6.24	15.00
Worthing District (B)	DIS	E07000229	3244.25	2.37	6.09	10.06	14.54
Wychavon District	DIS	E07000238	66319.75	4.68	6.88	41.46	32.53
Wyre District (B)	DIS	E07000128	28223.50	5.84	4.16	20.75	31.51
Wyre Forest District	DIS	E07000239	19531.25	9.36	18.39	27.73	23.38
York (B)	UTA	E06000014	27190.50	1.13	4.90	45.12	24.41

Annex IV - Allocation of Temporal Mixtures

The generalised classes of interest are coded according to the table below. For example, if a pixel is Arable in year-1 it is given a value of 1, in year-2 a value of 2, in year-3 a value of 4 and year-4 a value of 8. These values are added together to give 15. So, 15 means that the pixel was consistently Arable each year. Similarly, 240 indicates that the pixel was Grass each year. Such pure classes are unambiguous.

However, temporal mixtures may also occur. Arable in year-1 and year-2 followed by Grass in year-3 then Arable in year-4 results in 43. So 43 means that the Grass observed in year-3 is part of the arable crop cycle and is essentially temporary.

Class		Year 1	Year 2	Year 3	Year 4
Heathland	0	4096	8192	–	–
Grass	0	16	32	64	128

We are mainly concerned with pure-Arable (15) and pure-Grass (240) and the temporal mixtures of the two. Fallow and Heathland are also given a temporal codes, Trees, Water and Non-Vegetated are 'other'. The RPA changed the way in which it has used the Heathland class which is a complicating factor.

Based on the mixtures of classes that actually occur the temporal mixtures of Arable, Grass, Fallow and Heathland give the follow unique Codes. The Code 1 means a lone Arable pixel that is not mixed with Grass, Fallow or Heathland.

DN	Group	Code	Class		Confidence
30					
10	A	2	Arable x 2	2 Arable mixed with 2 'other'	Low
10					
10	A	8	Arable x 4	Persistent arable	High
30					

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10	A	17	Grass 1 / Arable 1	Temporary grass	Low
10					
10	A	20	Grass 1 / Arable 3	Temporary grass	High
20					
10	A	33	Grass 2 / Arable 1	Temporary grass	Medium
10					
20	G	64	Grass 3	Grass mixed with 'other'	Medium
20					
20	G	128	Grass 4	Persistent grass	High
30					
10	A	257	Fallow 1 / Arable 1	Arable Fallow	
10					
10	A	260	Fallow 1 / Arable 3	Arable Fallow	
30					
10	A	273	Fallow 1 / Grass 1 / Arable 1	Arable Fallow	
10					
20	O	288	Fallow 1 / Grass 2		
10					
20	G	320	Fallow 1 / Grass 3		
30					

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10	A	513	Fallow 2 / Arable 1	Arable Fallow	
10					
30	O	528	Fallow 2 / Grass 1		
10					
20	O	544	Fallow 2 / Grass 2		
30					
30	A	1025	Fallow 3 / Arable 1	Arable Fallow	
30					
30	F	2048	Fallow 4	Persistent Fallow	High
40					
	H..	4097	Heathland ...		