A photograph of a paved path winding through a lush forest. The path is dark grey and curves from the bottom left towards the center. The forest is dense with tall, thin evergreen trees and thick green ferns and undergrowth. The sky is overcast and grey.

# **Current Woodland Distribution and Afforestation Potential in Cumbria**

Highfield Biological Consulting  
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## Table of Contents

Summary.....	3
1. Introduction.....	3
2. Methods.....	4
3. Results.....	5
3.1 Tree cover in England, the UK and Cumbria.....	5
3.2 Land types and use in Cumbria.....	8
3.2 Current woodland extent with respect to land class and elevation.....	10
3.3 Opportunity for woodland expansion.....	11
3.3 Further areas for woodland expansion.....	15
4. Discussion.....	17
5. References.....	19
Appendix I.....	20
Appendix II.....	22
Appendix III.....	23

# Current Woodland Distribution and Afforestation Potential in Cumbria

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## Summary

An examination of existing tree cover and the potential for new woodland areas to be established was undertaken for the northern English county of Cumbria. Multiple data sources were mapped in order to arrive at a reliable value for existing woodland of just over 10%. The areas with potential for afforestation were mapped using the “woodland opportunity” dataset generated by Friends of The Earth. This data indicated that around 18.3% of the county’s land is suitable for planting with trees or for allowing natural regrowth to occur. The vast majority of proposed future woodland sites were situated on grade 4 land, generally at an elevation of between 200 m and 400 m. Most notably, if implemented, such establishment of trees would increase woodland area in the Westmorland Dales National Park portion of Cumbria from <4% to 28.4%.

The woodland opportunity map for England, when examined for Cumbria, uses criteria that have identified areas where agricultural productivity is likely to be low whilst, at the same time, it indicates potential woodland sites in parts of the county where growth will be, at the very worst, adequate for a range of tree species. Furthermore, sites of high ecological value are generally avoided. The utility and implications of the woodland opportunity map are discussed.

## 1. Introduction

The UK is legally bound by the Climate Change Act (2008) to achieve net-zero status with respect to greenhouse gas (GHG) emissions by 2050.<sup>1</sup> This, in effect, means that GHGs released into the atmosphere by that time will need to be balanced by removal of the gases from the atmosphere. Currently, per-capita carbon dioxide (CO<sub>2</sub>) emissions in the UK stand at around 5.2 tonnes (2019 figures)<sup>2</sup>, a value that must be reduced markedly if the country is to achieve its stated goal. This requires that not only are emissions reduced from all emitting sectors but, at the same time, an environment is created that has a much greater capacity to serve as a sink for GHGs, CO<sub>2</sub> in particular.

Among the various suggested pathways/processes for removing CO<sub>2</sub> from the atmosphere, increasing in the area of woodland currently present in the UK is probably the most often discussed, reported upon and readily achievable. The UK as a whole has low levels of woodland

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cover when compared with most European countries (Fig. 1), standing at around 13% of the total land area (Forest Commission data). However, in England this value falls to just 10%, rendering it one of the least forested nations in Europe. To address this poor coverage, governmental initiatives have set out a roadmap that seeks to increase woodland by 30,000 ha (300 km<sup>2</sup>) annually in order to achieve an overall UK forest cover of 17% by 2050.<sup>3</sup>

In England, the area available for expanded woodland is limited and, as such, the identification of areas that are most appropriate for afforestation is a prerequisite. With ongoing requirements for land to be given over to biodiversity (“rewilding”)<sup>4</sup>, energy generation (solar farms etc.)<sup>5</sup>, and new housing stock, amongst others, there are multiple pressures coming to bear with respect to England’s land resources. In order to maintain agricultural productivity it is necessary that a well thought-out approach is adopted that uses land for purposes that are most appropriate. Therefore, expanding woodlands into areas where carbon storage and biodiversity are maximised whilst, at the same time, food production is minimally impacted upon, would seem the most logical and least controversial course of action. Thus, the identification of such areas where these ends could be met is a necessary starting point on the road to meeting England’s (and the UK’s) forestry, biodiversity, and climate change goals.

The present study used a Geographic Information Systems (GIS) approach to analyse current woodland cover and distribution in northern England (the county of Cumbria) and, using freely available datasets, to identify areas where tree planting may be most appropriate. In particular, the woodland opportunity map produced by Friends of the Earth (FoE) is widely used in the present work as it provides an excellent and detailed map of land within England that it identifies as suitable for future woodland establishment.<sup>†</sup> The FoE’s approach to the generation of the woodland opportunity map is freely available, as are many of the outputs. Here, the dataset has been evaluated to examine how it maps onto the Cumbrian landscape, which land type it targets for woodland expansion and which areas are excluded, in order to produce an assessment of its usefulness as a resource to guide future afforestation efforts.

## 2. Methods

A full description of the methods used can be found in Appendix I. Briefly, the Geographic Information Systems package QGIS was used to map and analyse a range of publicly available datasets. These datasets were:

- CORINE EU Land classification (Copernicus Land Monitoring Service).
- Forestry Commission Woodland Inventory.
- OS OpenZoomstack woodland cover layer.

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<sup>†</sup> This is an online resource. Details of all web-based data sources are provided in Appendix I.

- Friend of the Earth Woodland Opportunities map (England).
- UK Provisional Land Classification map.
- European Digital Elevation Model (DEM).
- Natural England Environmentally Sensitive Areas (England): Deep peat, heathland, calcareous grasslands, purple moor.

Further details and the location of these datasets are described in Appendix I.

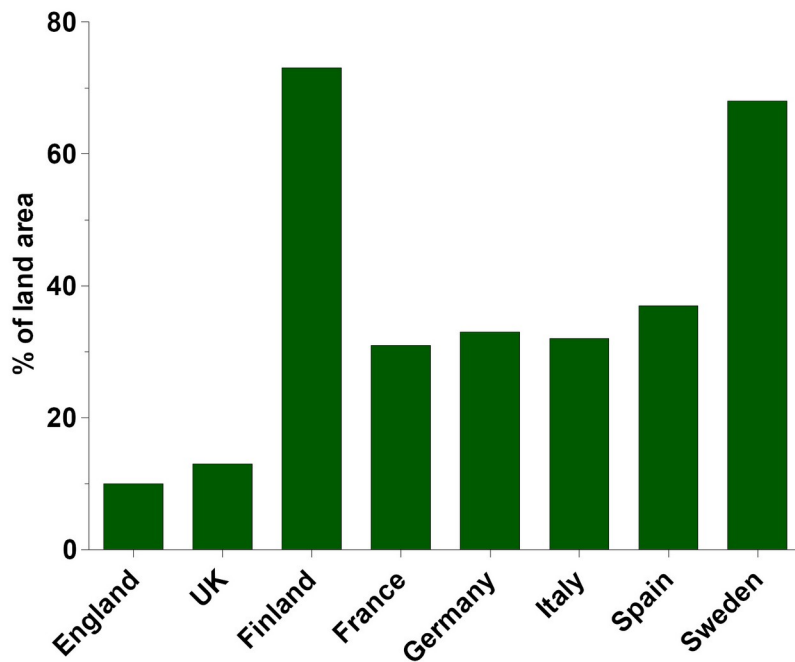
The original datasets were in a number of coordinate reference systems (CRSs) and were all reprojected into the WGS 84 CRS before any calculations were made. Clipping of datasets to the required geographic areas (England, Cumbria, Local Authority areas etc.) were made using standard UK shapefiles.

Analysis of data was conducted in LibreOffice Calc and data graphed using GraphPad Prism. All GIS operations were conducted using QGIS 3.10 / 3.16. Unless accompanied by a citation, all figures mentioned in the following report have been generated *de novo* by the author.

## **3. Results**

### **3.1 Tree cover in England, the UK and Cumbria**

The comparatively poor forest cover of England and the UK as a whole is illustrated by the values graphed in Figure 1. The data indicates that, at 13%, the UK has less than half of the coverage of the major West-European economies, nations that typically have around 30% cover.

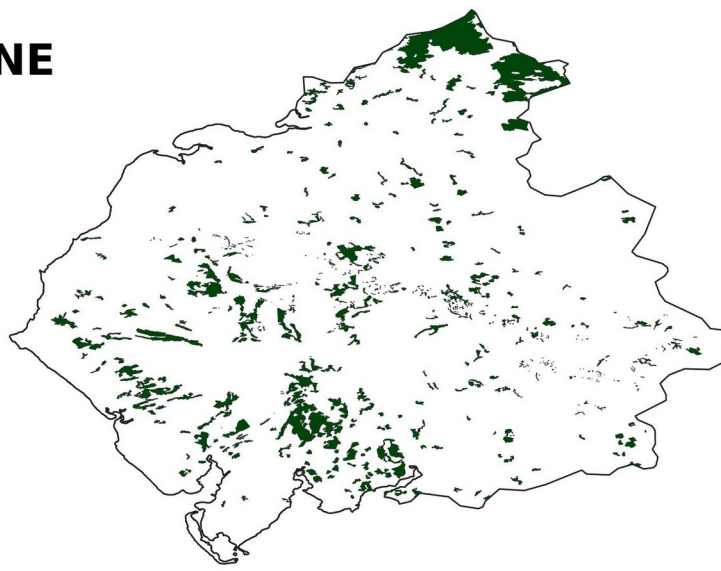


**Figure 1. Forest area as a percentage of land area. Data from the Forestry Commission citing the FAO Global Forest Resources Assessment Assessment (FRA) (2015).<sup>6</sup>**

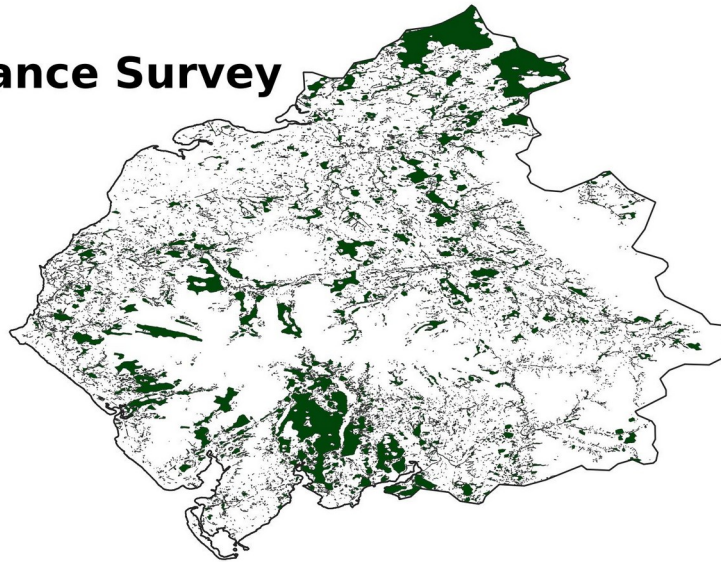
Values for current tree cover in Cumbria were determined using three different datasets (Fig. 2). Although not clearly apparent from the maps due to the highly fragmented nature of woodland in the county, the areas of woodland differ markedly for the different sources.

The most reliable figure for woodland cover in Cumbria is likely to be the Forestry Commission data (10.3% cover) as it is derived through methods that go beyond the machine analysis of imagery used to compile the CORINE dataset. The latter's data (7.0%) fails to include numerous (often small) areas of woodland that are clearly present when aerial imagery is examined. In contrast, the Ordnance Survey data generates an overestimate (12.8%) through including areas of very low tree cover as well as large numbers of thin strips of trees of the type found alongside roads, rivers and field margins. Throughout the remainder of this report, the Forestry Commission data set will be used as the baseline value for woodland cover in Cumbria. The full output of the CORINE dataset is mapped and tabulated Appendix 2 to provide reasonably accurate picture of current land use in Cumbria.

**A. CORINE**  
**6.8%**



**B. Ordnance Survey**  
**12.8%**



**C. Forestry Commission**  
**10.3%**

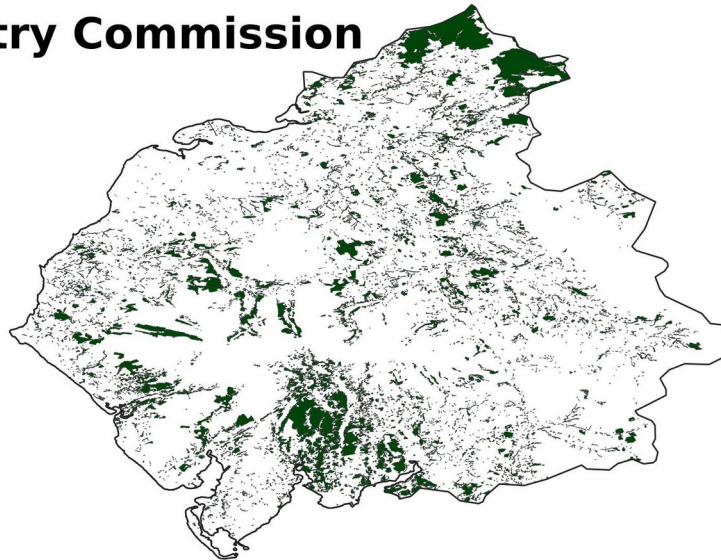


Figure 2. Forest cover representations produced from the (A )CORINE, (B) Ordnance Survey and (C) Forest Commission datasets .

### 3.2 Land types and use in Cumbria

The locations where trees could be established in Cumbria, and elsewhere, is influenced by a number of factors such as elevation, rainfall, topography and land type, amongst others. Cumbria is one of the more mountainous areas of England, as demonstrated by Figure 3. Here the county's land area is divided into four areas: below 200 m, 200-400 m, 400-600 m, and above 600m. These zones were chosen as the land above 200 m is largely marginal for farming beyond extensive sheep grazing whilst the 600 m boundary equates to the approximate tree line in the UK.<sup>7</sup> Given the likely need for biodiversity and afforestation efforts to minimize any reductions in agricultural productivity, this zone may constitute the most likely area for future tree planting or for allowing natural growth to develop.

The distribution of land classes in Cumbria is mapped in Figure 3A. The predominant land class in Cumbria is Grade 5<sup>‡</sup>, accounting for around 41% of the county with Grade 4 land making up a further 22% of the land present. These values exclude areas that are already planted with trees that predominantly fall within the Non-Agricultural class. The distribution of enclosed land (CORINE data), where the more productive agriculture resides, is shown overlying the areas of grade 4-5 land, indicating that most of the more intensive agriculture is confined to areas of grade 3 land or better. (Fig 3B) although some areas of the poorer grade land include enclosed pastures and meadows.

The quality of the land as an agricultural resource closely tracks elevation (Fig. 3C) with the vast majority of grade 2-3 land found below 200 m. Approximately 45% of Cumbria lies at an elevation of above 200 m (Fig. 3C). The treeline in the UK lies at around 600 m<sup>7</sup>, above which only around 4% of the county's land falls. These maps strongly indicate that new woodlands in Cumbria may best be located at elevations of 200 m and above, areas where agricultural productivity will be least impinged upon.

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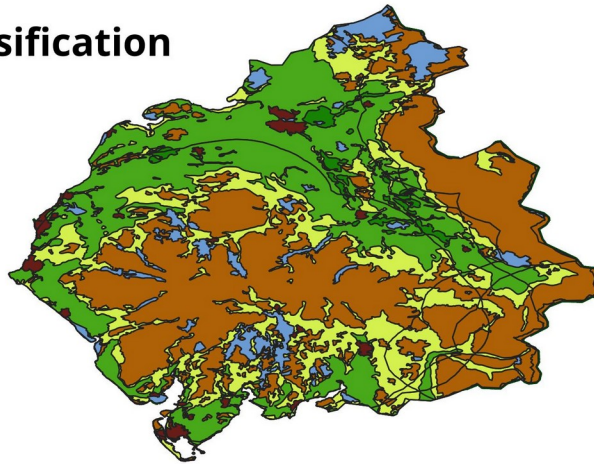
<sup>‡</sup> Land in England and Wales is classified according to its agricultural productivity and ranges from Grade 1 (highly productive agricultural land) to Grade 5 (very low productivity, typically found at higher elevations). Further details can be found here: <http://www.lra.co.uk/services/agricultural-land-classification>



### A. Land classification in Cumbria

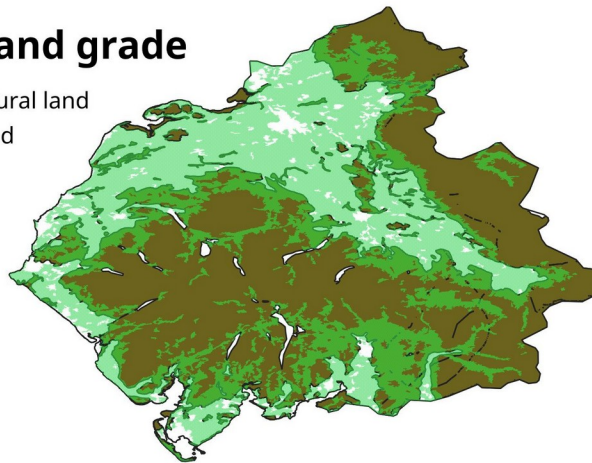
#### Class

- Grade 2
- Grade 3
- Grade 4
- Grade 5
- Non Ag.
- Urban



### B. Land use and grade

- Enclosed agricultural land
- Grade 4 and 5 land



### C. Elevation in Cumbria

- Above 600 m
- 400 - 600 m
- 200 - 400 m
- Below 200 m

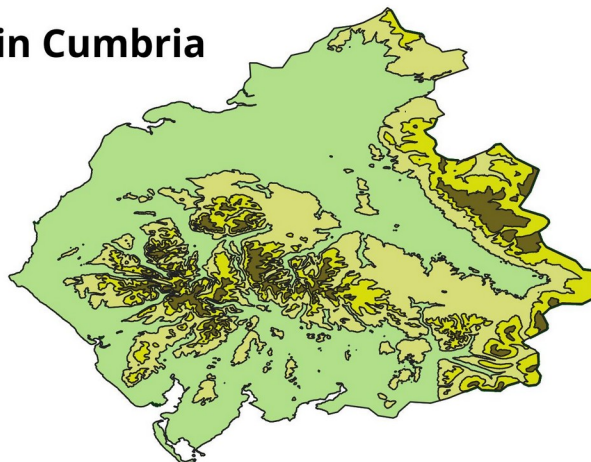


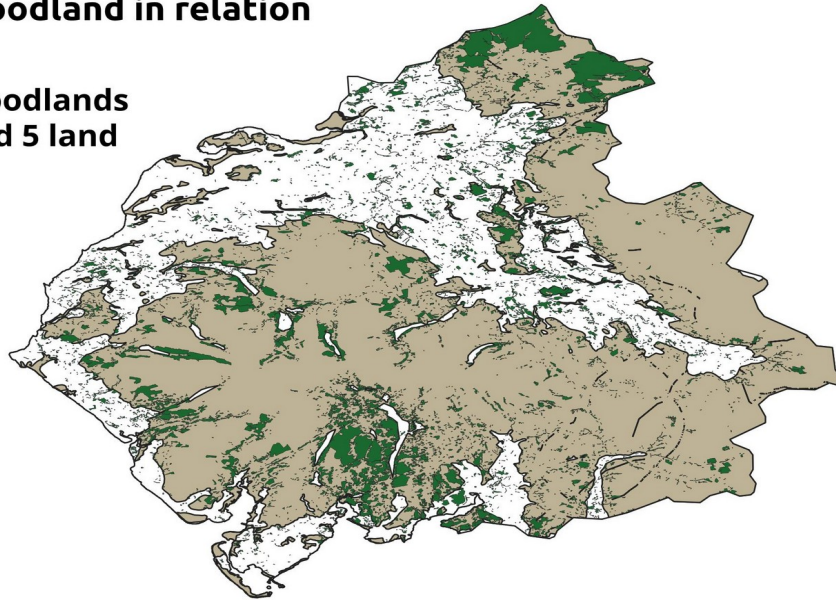
Figure 3. (A) Land classification, (B) enclosed agricultural land (pasture / meadow) / grade 4-5 land and (C) simplified elevation map.

### 3.2 Current woodland extent with respect to land class and elevation

Woodlands currently present in Cumbria were mapped against land class and elevation (Fig. 4). Land classes 4 and 5 were aggregated (incorporating non-agricultural areas) and the woodland areas subsequently overlaid to produce a map that indicates that the majority of tree cover within the county occurs on land of this type (81%) (Fig. 4A).

#### A. Current woodland in relation to land class

- Current woodlands
- Grade 4 and 5 land



#### B. Current woodland in relation to elevation

- Current woodlands
- Above 600 m
- 400 - 600 m
- 200 - 400 m
- Below 200 m

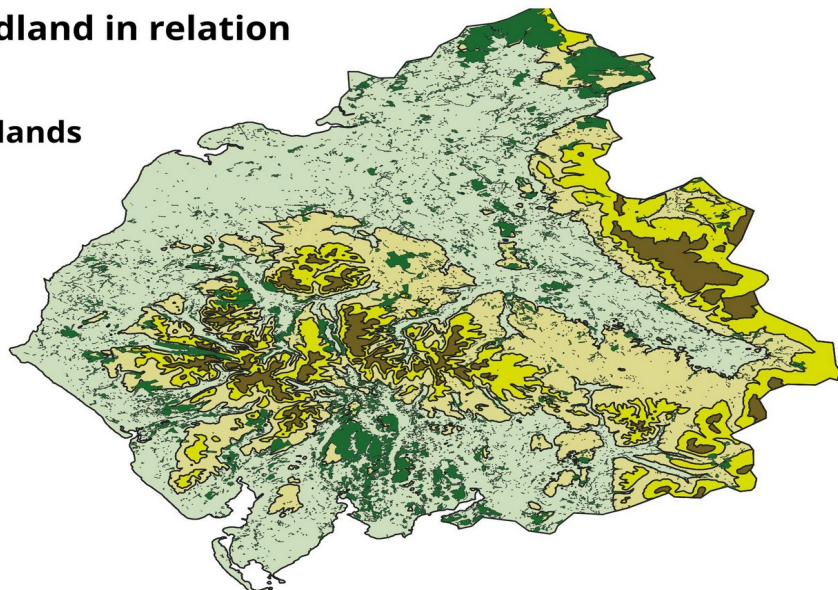
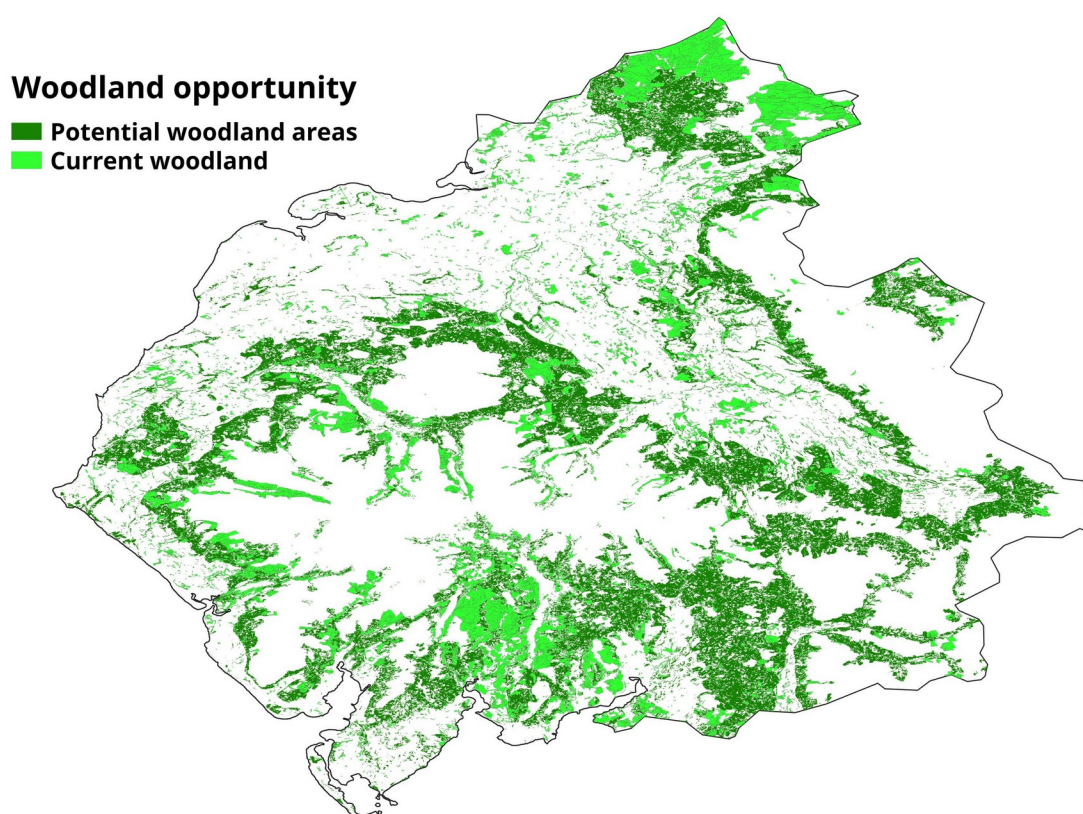


Figure 4. The current extent of woodland in Cumbria (Forestry Commission data) with respect to (A) land class and (B) elevation.

When woodland areas were examined in relation to elevation, it was apparent that around 40% of current woodlands occur above 200 m, primarily on land that can be considered marginal for agriculture.

### 3.3 Opportunity for woodland expansion

The areas that have been identified as suitable for the establishment of new woodlands (woodland opportunity) is shown in Figure 5. A variety of decision criteria were used to identify candidate areas for tree establishment (see Appendix III) and, as is apparent from Figure 6, placed potential woodland, for the most part, within areas of low value land whilst avoiding areas of high ecological value (peatland / bogs, long-standing meadows *etc.* ). As such, the mapped data closely adheres to the stated criteria that were used to identify woodland opportunity areas.



**Figure 5. Woodland opportunity in Cumbria and existing woodlands.**

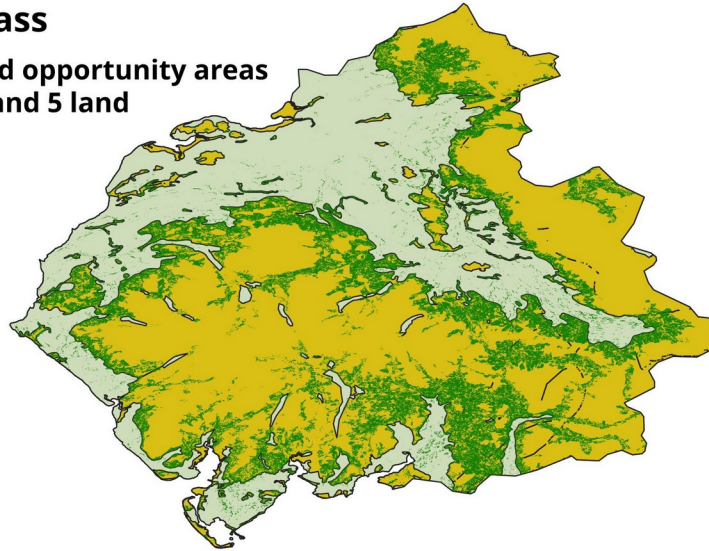
The expanded area of woodland indicated by this map is in the region of 1256 km<sup>2</sup>, a value that equates to *circa.* 18% of the land area of Cumbria. This would take the area of woodland in the county up to a value of around 28%, effectively increasing coverage 2.8 fold. Much of the existing woodland and forestry lies adjacent to the candidate areas for afforestation, indicative of the fact that the woodland opportunity project appears to have identified sites using a logical set of decision criteria (see Appendix III).



The proposed new woodlands chiefly fall in areas of grade 4-5 land (Fig. 6A) at elevations of between 200 and 400 m (Fig. 6B). Relatively small areas of proposed woodland lie at above 400 m, particularly in the east of the county whilst suggested afforestation at lower elevations is most prevalent in the north east of the county and in the south.

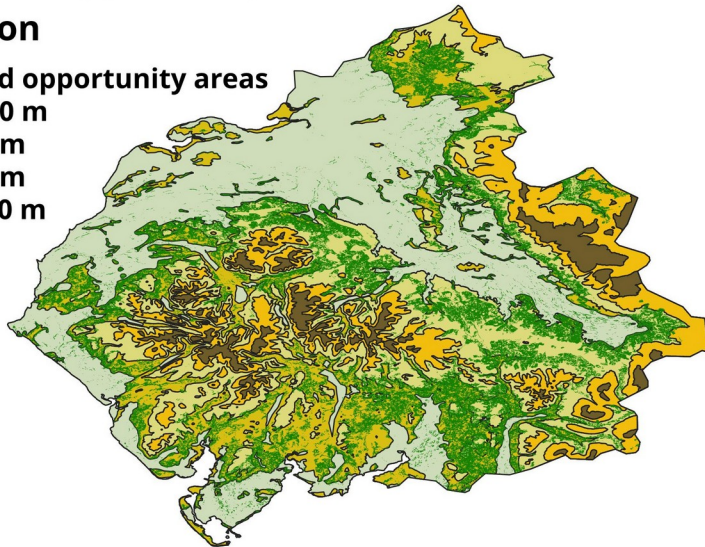
### Woodland opportunity in relation to land class

- Woodland opportunity areas
- Grade 4 and 5 land



### B. Woodland opportunity in relation to elevation

- Woodland opportunity areas
- Above 600 m
- 400 - 600 m
- 200 - 400 m
- Below 200 m



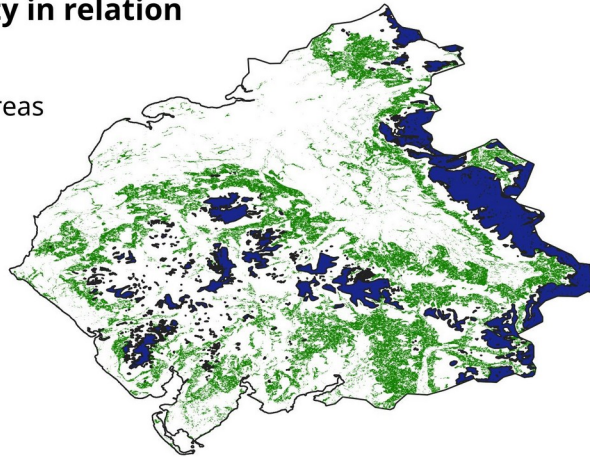
**Figure 6. Candidate areas for afforestation in relation to (A) Grade 4-5 land and (B) elevation .**

To assess the value of the woodland opportunity map further, the proposed woodland areas were mapped in relation to selected environmentally important areas: Deep peat lands, calcareous grasslands and purple moorlands. Cumbria contains just under 24% of the deep peat land present

in England and, as an important carbon store, tree planting could negatively affect these areas. As can be seen in Figure 6A, the proposed woodlands avoid such areas almost entirely.

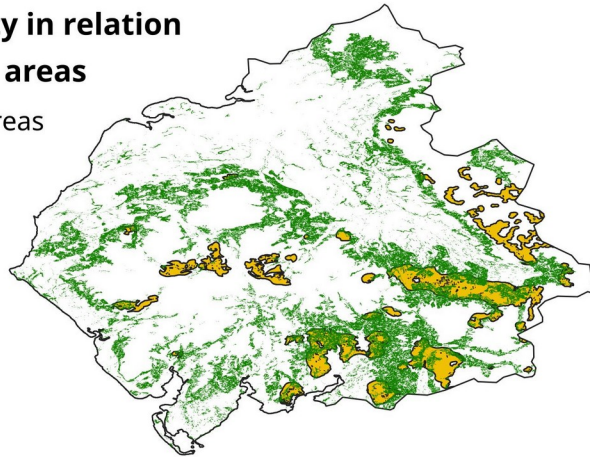
**A. Woodland opportunity in relation to deep peat areas**

- Woodland opportunity areas
- Deep peat



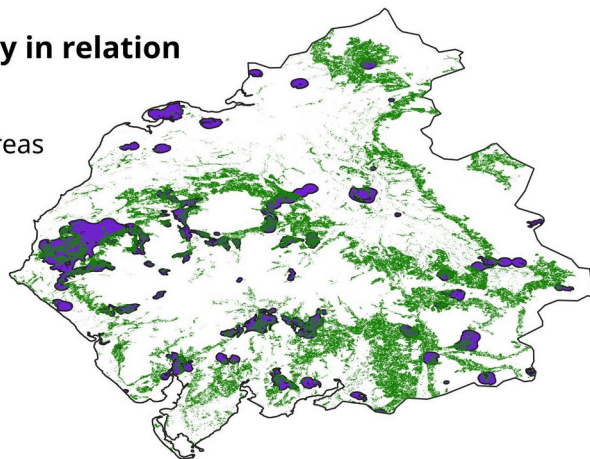
**B. Woodland opportunity in relation to calcareous grassland areas**

- Woodland opportunity areas
- Calcareous grassland



**C. Woodland opportunity in relation to purple moor areas**

- Woodland opportunity areas
- Purple moor



**Figure 7. Woodland opportunity areas in relation to (A) deep peat areas, (B) calcareous grasslands and (C) purple moorlands.**

Calcareous grasslands are of particular importance for maintaining biodiversity in upland areas of England due to the diverse range of wild flowers and grasses that occur in such zones. As a consequence, it is preferable for future tree planting to avoid such areas. Around 38% of England's upland calcareous grasslands occur in Cumbria but, in contrast to the near total avoidance of deep peat areas, the woodland opportunity map places around 26% of the total potential woodland areas on calcareous grasslands (Fig 7B). In the case of purple heath, areas typically comprised of heather, grass and rush, we again see an ingress of woodland opportunity areas into the habitat. Cumbria contains around 7% of England's total for this land type and around a third of the area within the county is co-located with proposed woodland areas (Fig. 7C).

Although the structure of local government is currently under revision in Cumbria, the existing local authority boundaries provide useful demarcation lines to examine how woodland opportunity is distributed around the county. The resource made available from FoE contains data similar to that presented here (Table 1).<sup>§</sup>

**Table 1. The distribution of current tree cover and woodland opportunity areas across Cumbria by Local Authority and National Park area.**

LA / NP	Current Cover (%)	Woodland Opportunity (%)	Potential Future Woodlands (%)
Allerdale	6.8	14.1	20.9
Barrow	3.2	13.2	16.4
Carlisle	18.4	13.0	31.4
Copeland	10.6	15.0	25.6
Eden	5.9	19.6	25.5
South Lakes	13.5	25.2	38.7
Lakes Nat. Park	13.0	17.9	30.9
Dales Nat Park	3.4	26.2	29.6
Cumbria total	10.1	18.3	28.4

The FoE's woodland opportunity project identified the Eden Valley region of Cumbria (Eden District Council local authority) as one of the top 10 areas in England with respect to potential woodland expansion. The data here confirms this and indicates that there are potentially 42,300 ha of land suitable for new woodlands, almost 20% of the area of the region. This additional woodland would take tree cover within the Eden District Local Authority from the presently low value of under 6% to around 28%. The South Lakes area, which currently has coverage close to the UK average (13.5%), has proportionately the greatest area suitable for future planting that, if implemented, would raise woodland coverage in the area to nearly 39%.

<sup>§</sup> The summed areas for the LAs of Cumbria exceeded the total area of Cumbria for the FoE data, indicating that some (minor) errors were present. Despite this, the numbers presented here never vary by much more than 0.5% from those already available from the FoE website.



Cumbria contains two national parks (the Lake District and the Westmorland Dales)<sup>\*\*</sup>, areas under a measure of conservation that occupy approximately 35% of the county. In the case of the the Lake District, current woodland cover (13%) is slightly higher than that of Cumbria as a whole (10%) whereas the Westmorland Dales has just 3.4% of its area occupied by trees.

### **3.3 Further areas for woodland expansion**

The woodland opportunity data presented here give what can be considered an effective and rational plan for future woodlands in the County of Cumbria. However, there is value in examining briefly whether the areas indicated fully exploit suitable land and, secondly, whether they co-occur with areas recently planted with trees.

Firstly, it is notable that the proposed woodland areas are rarely sited on upland heath (open moorland / fell). This is illustrated in Figure 8. Although this is an area where a number of sensitive habitats occur (peat bogs etc.), only a modest proportion of the woodland opportunity (21%) area fall within this land type despite the it being extremely marginal for agriculture.

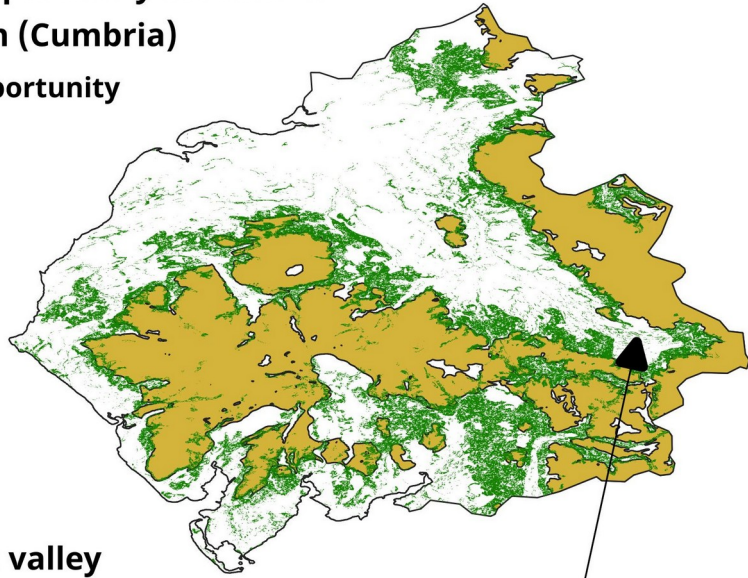
Although no explicit investigation was made into recent woodland establishment, it is very obvious (from personal observation and the evaluation of aerial imagery) that many recently established woodlands in the county fall in areas outside of those indicated by the woodland opportunity map and, instead, are sited in areas of newly enclosed moorland.

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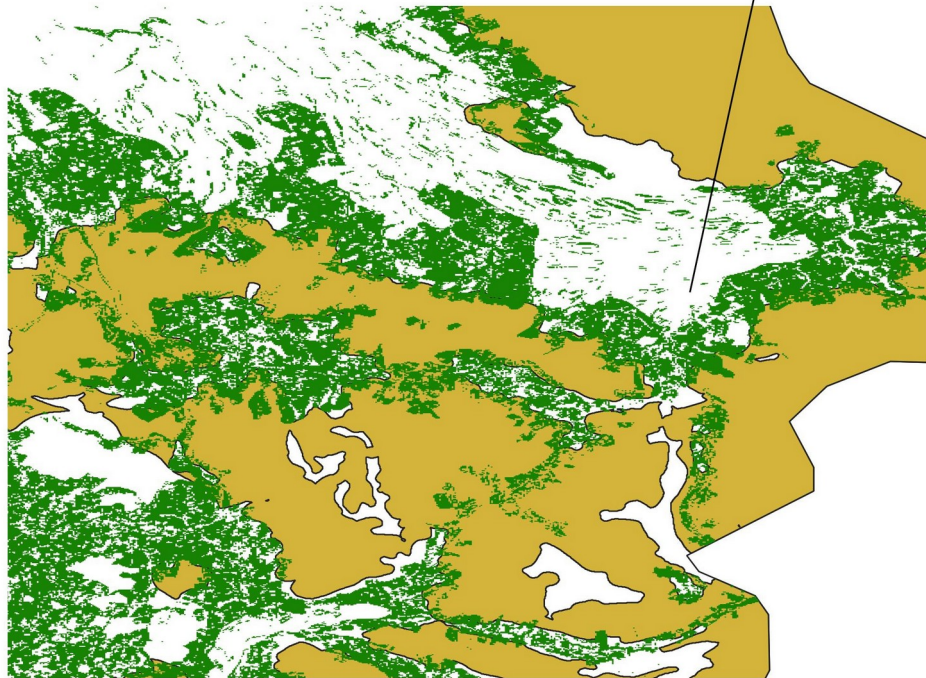
<sup>\*\*</sup> This is the relatively recently established portion of the Yorkshire Dales National Park that was created to make the latter contiguous with the Lake District.

**A. Woodland opportunity in relation to upland heath (Cumbria)**

■ Woodland opportunity  
■ Upland heath



**B. Upper Eden valley**



**Figure 8. Woodland opportunity in relation to heathland (open moorland) in (A) Cumbria and (B) the Upper Eden Valley .**

## 4. Discussion

Over the last 20 years or so, the need to expand woodlands in the UK has met with significant research at both the local and national scale.<sup>6,7,8,11</sup> Whilst expanding woodland coverage has become increasingly central to efforts to increase UK carbon storage, the benefits are manifold and include positive impacts on biodiversity, temperature-regulation, hydrology and erosion, amongst others.<sup>12</sup> However, afforestation has to be undertaken carefully in order to prevent damage to sensitive land types, such as peatlands, that already provide valuable levels of carbon storage as well as valuable ecological services.<sup>13</sup> As such, the afforestation that is necessary across the UK over the coming years must be undertaken in a considered manner – it is as important to determine where trees should not be planted as where they should.<sup>11</sup>

The assessment of the current woodland cover in Cumbria revealed that the dataset evaluated has a strong influence on the value that is arrived at. Here, three estimates of woodland area for Cumbria were calculated using publicly available datasets. The lower value, derived from the CORINE data<sup>14</sup>, was clearly an underestimate whilst the higher value calculated from the Ordnance Survey data<sup>15</sup> included areas that can be only tenuously classified as woodland and, as a consequence, provides an inflated value for overall tree cover. The data that appeared most accurate, as might be expected, was derived from the UK woodland cover map produced by the Forestry Commission.<sup>3</sup> The value derived from this latter dataset gave a woodland coverage of about 10% in Cumbria, a value lower than the UK average of 13% and very close to the mean for England as a whole.

Cumbria is one of England's least populous counties and has about one third of its land area contained within two national parks. Given the very rural nature of the county, and the protected status that large areas of the county have been given, one might have expected it be more heavily wooded. However, the county is no higher than average for England, a fact that places in stark relief the UK's poor track record in maintaining and expanding woodland. The woodland opportunity data indicates that there is the potential to increase the area of woodland in Cumbria to encompass an additional 18% of the county's land area, taking the total to over 28%. In contrast, the potential new woodland areas for England as a whole comes to only around 9.8%. Notably, the proposed woodland areas largely avoided areas of high environmental value, such as deep peat moorland and ecologically valuable grasslands, which would indicate that the identification areas for tree planting was undertaken using methodologically sound principles.

The generally coherent nature of the woodland opportunity map notwithstanding, there is at least one issue that is worthy of further consideration. The vast majority of the proposed new woodland areas are sited on marginal farmland (enclosed pasture and meadow) and largely avoid ingress into open moorland (heathland / fell). This seems somewhat at odds with what is actually happening in, for example, the Upper Eden Valley, where several recently established areas of woodland have been planted on newly enclosed parcels of moorland that exist outside of the



opportunity areas (author's personal observations). Given that the woodland opportunity map has been generated using a series of rules as to where new woodlands could be established, it is interesting to see an avoidance of most of the lower reaches of moorland (areas adjacent to enclosed land). As these areas are maintained in their current treeless state almost exclusively by extensive sheep grazing, it would seem logical that such areas would have been utilized to a greater extent by the woodland opportunity map than they have. It is likely that the FoE's exclusion of grade 5 land from the woodland opportunity map is the reason for the avoidance of such heathland. The opportunity map was generated under the assumption that such land is almost completely dominated by peatland / peat bog (see Appendix III) and, as a consequence, should not be planted upon. This assumption is erroneous – less than 30% of upland heath is classified as deep peat in Cumbria - and has led the woodland opportunity map to be somewhat conservative in its use of low quality land resources currently exploited by highly extensive livestock farming.

The above point notwithstanding, the potential for additional woodlands in England is clearly large. The data from Cumbria indicates that much of this new woodland could be sited in areas of low agricultural production and, as a result, have minimal impact on food production. Similarly, the proposed areas largely avoid environmentally sensitive areas and, therefore, would probably have low to negligible impacts on existing biodiversity. It is, however, important to understand that the woodland opportunity map was produced to indicate where trees *could* be grown as opposed to where they *will* be grown. To establish even a fraction of the indicated woodland in Cumbria requires considerable resolve from, and engagement with, the various stakeholders. These include the owners and tenants of the land that, for the most part, currently derive their income from livestock farming. Furthermore, much of the area earmarked as suitable for tree establishment falls within parts of Cumbria classed as Severely Disadvantaged Areas, where agricultural incomes are reliant, at least in part, on governmental support<sup>17</sup>, a fact that would indicate that such support would have to be redirected towards afforestation efforts to render such activities financially attractive to farmers and landowners. Moreover, a relatively recent survey of stakeholders indicated that lack of interest in woodlands and their establishment by landowners may hinder any rapid take up of afforestation initiatives in the UK.<sup>18</sup>

In Cumbria it seems inevitable that at least some future woodland expansion would need to occur within national parks. The establishment of new woodlands within national parks has, however, proven to be controversial and a recent study concerning Dartmoor reported that, amongst several concerns, "common land" challenges were a source of worry for some stakeholders.<sup>10</sup> This refers to the common grazing rights that many upland farmers have on open moorland, rights that would be impinged upon should woodland be expanded into such areas. This fact may, in part, explain why the woodland opportunity map largely avoids open moorland as sites for new woodlands although other considerations clearly play a part.

A potential *modus operandi* that may serve as a starting point on the path towards greater woodland cover in Cumbria was proposed by Lee *et al.* (2002), where, using a GIS approach, the authors exploited existing, semi-natural, woodlands as nuclei for the creation of expanded wooded areas in the Chilterns.<sup>8</sup> The new woodlands were sited in such a way as to join unconnected areas (the nuclei) that lie in relatively close proximity and, as a result, render them contiguous, increasing their value as a resource. In essence, the suggested process starts with expanding existing woodlands to initiate a process of woodland defragmentation. Such an approach for Cumbria would necessitate identifying the most appropriate nuclei, an process that would add a new layer of detail onto the existing wood opportunity map. A larger scale woodland expansion evaluation, targeting South West Wales, provides a excellent example of how a modelling approach can be used to inform as to how best to implement an afforestation programme based on a series of flexible decision rules.<sup>7</sup> It is very likely that a similar approach, adapted to each locale, will have to be used for Cumbria and elsewhere in England, in order to meet the need for additional woodlands in an effective and ecologically sound way.

In conclusion, it is apparent that the potential for woodland expansion in Cumbria is comparatively large and, proportionally, far exceeds that of England as a whole. The woodland opportunity map is a useful tool for identifying sites suitable for the establishment of new woodlands but it is likely that a more granular and localised approach will be necessary for its outputs to be implemented in Cumbria and elsewhere in England. Not least will be the need to take into consideration the economic imperatives of landowners and farmers as well as the specific ecological and environmental issues particular to any given region.

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## Appendix I

### A. Data sources

- [CORINE Land Cover \(CLC\)](#) EU Land classification map from the [Copernicus Land Monitoring Service](#). A land use map of Europe, available in a number of formats.
- [Forest Research Woodland Inventory](#). From the Forestry Commission Open Data portal. Provides a variety of tree cover maps for the UK and constituent countries.
- [OS OpenZoomstack](#) Woodland cover layer. A digital OS map for the whole of the UK containing multiple layers.
- Friend of the Earth [Woodland Opportunities map](#) (England). Further details of this resource can be found at the [FoE website](#). The map is made available to users on request.
- [UK Provisional Land Classification \(ALC\)](#). Compiled by natural England and available from UK Government's Open Data portal.
- [European Digital Elevation Model \(DEM\)](#). Available from [Copernicus](#).
- [Environmentally Sensitive Areas \(England\)](#). Available from [Natural England Open Data](#)

### B. GIS procedures



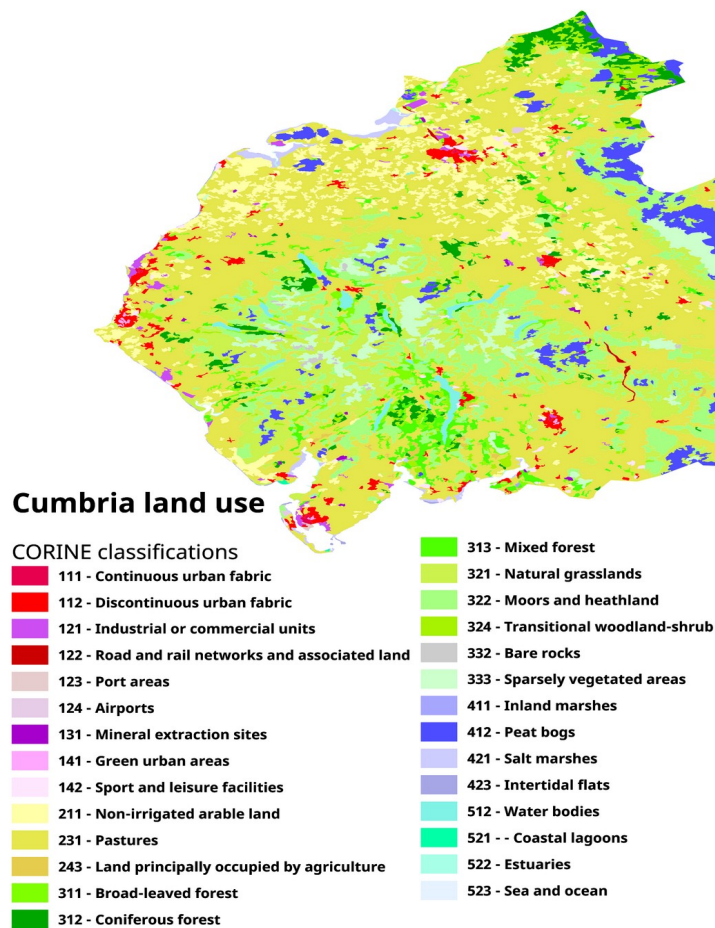
Freely available shapefiles of the UK, England and Cumbria were also used. These can be readily acquired from a variety of sources.

The terms and conditions of use are acknowledged for each of the data sources listed.

All data was mapped in QGIS 3.10/3.16. National datasets (England / UK) were clipped against a shapefile of Cumbria and areas recalculated using the “\$area” function. Where necessary, geometries were fixed and multi-polygon vector layers dissolved into a single feature. As and when required, datasets were exported as comma delimited text (CSV) files to LibreOffice Calc for further calculations and analysis. Maps were generated in the WGS 84 /EPSG: 4326 coordinate reference system (CRS). Some minor discrepancies in areas were generated over those of the original CRS (most frequently OSGB 1936 / EPSG: 27700) but in no instances were they considered significant. Similarly, some minor misalignments of vector layers were observed, probably due to oversimplifications of some geometries. Again, these were not a source of significant error.

Where data was gridded, a 5 km OS shapefile was used. The areas of woodland under the grid were determined through using the “intersection” function to cut the polygons along the grid-lines. The areas of the new polygons were calculated and these values subsequently joined to the grid using the “join by attribute” function.

## Appendix II



### Land Use in Cumbria – CORINE Data

Land Class	Area km <sup>2</sup>	%	Land Class	Area km <sup>2</sup>	%
Continuous urban	3.27	0.05%	Mixed forest	151.48	2.21%
Discontinuous urban	116.91	1.71%	Natural grasslands	1038.25	15.14%
Industrial / commercial	36.5	0.53%	Moors and heath	773	11.28%
Road / rail	6.23	0.09%	Transitional woodland scrub	114.38	1.67%
Ports	1.95	0.03%	Bare rocks	13.75	0.20%
Airports	2.98	0.04%	Sparse vegetation	240.89	3.51%
Mineral extraction	11.43	0.17%	Inland marshes	0.95	0.01%
Green urban	2.97	0.04%	Peat bogs	393.58	5.74%
Sport / leisure	34.34	0.50%	Salt marshes	39.99	0.58%
Non-irrigated arable	461.74	6.74%	Intertidal flats	9	0.13%
Pastures	2999.3	43.75%	Water bodies	64.92	0.95%
Principally agriculture	15.65	0.23%	Coastal lagoons	1.23	0.02%
Broad-leaved forest	128.99	1.88%	Estuaries	5.6	0.08%
Coniferous forest	185.57	2.71%	Sea / ocean	0.88	0.01%

## Appendix III

### FoE exclusion criteria

The woodland opportunities map specifically excluded:

- Water bodies and existing woodland.
- Designated wildlife sites (like Sites of Special Scientific Interest), priority habitats, and semi-improved grasslands.
- The highest quality agricultural land (known as Grade 1 and 2).
- The poorest quality agricultural land (Grade 5), almost all of which is carbon storing peat bogs.
- A portion of Grade 4 land (used for crops).
- Grade 3 is split into 3a and 3b, with 3a the better quality. Some of 3b is used for crop growing and some is used for pasture. All Grade 3a land was excluded along with some 3b areas that are used for crop growing.