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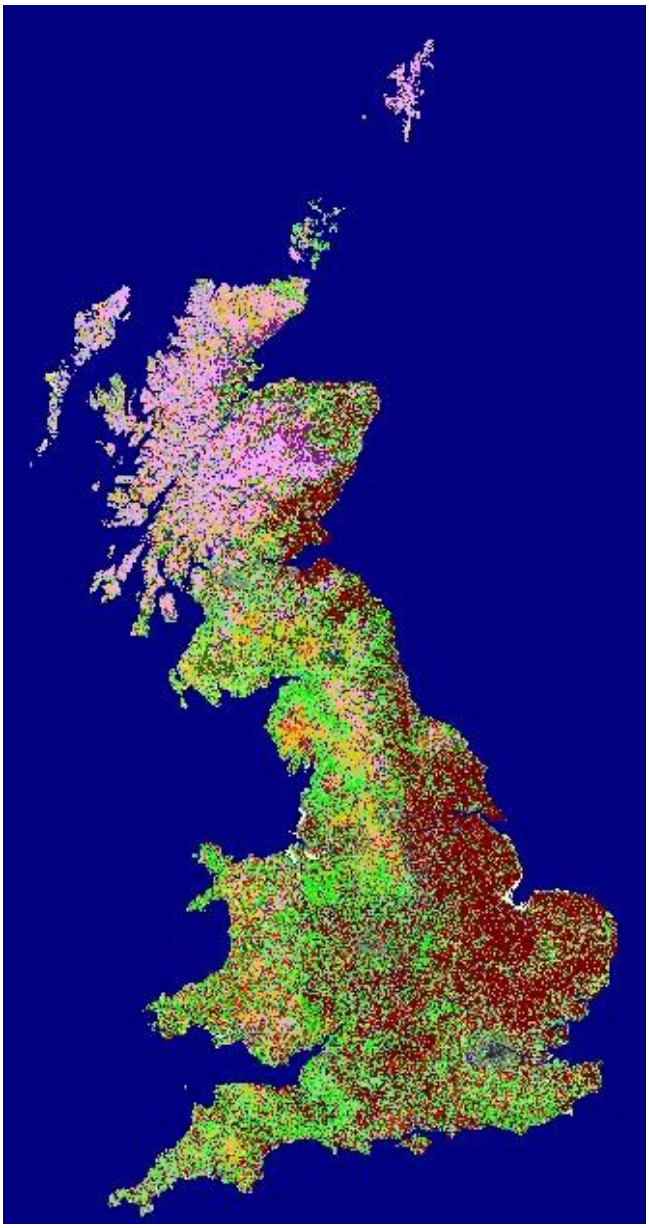

Land Cover Map of Great Britain (1990)

Dataset Information

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Land Cover Map of Great Britain

The Land Cover Map of Great Britain (1990) is a digital dataset, providing classification of land cover types into 25 classes, at a 25m (or greater) resolution. The data was derived from satellite data collected by the Landsat 5 Thematic Mapper. Data can be provided for any area of the country, under Licence, and is used for a wide variety of applications by business, government and researchers. Data from the map provides:

- the first complete map of the land cover of Great Britain since the 1960s
- the first time the land cover of Great Britain has been comprehensively mapped from satellite information
- the first digital map of national land cover
- accuracy to the field scale, checked against ground survey

The Land Cover Map comprises 25 classes, including sea and inland waters, bare, suburban and urban areas, arable farmland, pastures and meadows, rough grass, grass heaths and moors, bracken, dwarf shrub heaths and moorland, scrub, deciduous and evergreen woodland, and upland and lowland bogs. It can be used to plan, manage or monitor agriculture, ecology, conservation, forestry, environmental assessment, water supplies, urban spread, transport, telecommunications, recreation and mineral extraction. Current examples of the application of the Land Cover Map include detection of changing land cover, landscape management, mapping bracken in the context of health studies (bracken supports ticks carrying human disease), environmental assessments of motorway extensions, and planning of telecommunication lines.

Introduction

The Land Cover Map of Great Britain (LCMGB) was produced using supervised maximum likelihood classifications of Landsat Thematic Mapper data (Fuller et al. 1994a). The map, based on a 25m grid, records 25 cover types, consisting of sea and inland water, beaches and bare ground, developed and arable land, and 18 types of semi-natural vegetation - these are described more fully below. By combining summer and winter data, classification accuracies were substantially improved over single-date analyses (Fuller et al. 1994b). In all, 88% of Britain was classified from combined summer-winter images, and 12% from single-date, mostly summer, data. Just 0.4% of Britain was obscured by cloud cover on both summer and winter images. The missing areas of offshore islands represent just 0.1% of Britain. This document aims to give details about the map classes, the map's resolution and the way in which classes are depicted. Further details, which relate the map and its cover types to the results of other surveys, are given by Wyatt et al. (1994).

Spatial resolution & registration

It has been suggested (Townshend, 1983) that the minimum accurately map-able unit from TM data would be of the order of 3 to 5ha. In practice, in the LCMGB, most features of 1ha show clearly, giving a map which records patterns at a field by field scale. Superimposed on this 'minimum accurately map-able area' is a finer pattern of those smaller features with strong enough spectral signatures to discriminate them from the background cover: for example, roads, farms, shelter belts, water bodies and grass tracks are evident throughout the cover maps. After removal of isolated pixels, these are shown in units as small as 2 pixels (0.125 ha) (Fuller et al. 1994a).

Registration of the Landsat-derived raster maps to 143 vector field-maps of 1km squares showed average displacement to be 0.8 pixels (20m): 75 out of 143 squares needed no shift to achieve correspondence with vector overlays; 43 squares needed a one pixel shift; 15 squares needed 2 pixels movement and only 10 squares needed more than 2 pixels

movement relative to the vectors (Fuller et al. 1994a). This positional error is fully acceptable for most applications of the data.

Classification accuracy

Quality checks require access to 'ground truth data', but the accuracy of such data is rarely known (Congalton, 1991). Conventional maps are most commonly used, but their division of a continuum of landscape patterns into discrete classes, with hard boundaries is not 'truth' but an artificial generalization, which achieves different results according to the rules and methods employed. A recent study has revealed the wide variations in definitions of land cover (Wyatt et al., 1994). In assessing the LCMGB, it is important to note that the reference surveys also set out with different methods, different objectives and also differing potential in terms of the details they could record. Comparisons can only give indications as to LCMGB accuracy but they help point to sources of error and highlight the impacts of generalization and class definition.

Comparisons with independent ground reference data, for 508 1km squares, showed correspondences which varied depending on the level of detail at which comparisons were made. Many of the apparent discrepancies are due to significant differences in class definitions. Whereas the Landsat classification, like the Ordnance Survey, used a hydrological definition of bogs (see later), the field survey used a botanical definition which, in contrast, included wet moorlands. There were also differences in how the two surveys divided the continuum from grass, through heather-grass mixtures, to dense shrub heaths. There were differences, too, in dividing the continuum from rough grasslands to managed swards. There are no fixed conventions in such divisions and variations can arise between individual surveyors within a survey: a quality assurance exercise, which re-examined the 1km field data, showed an average 84% correspondence when the original surveyors' coding of land cover was compared with a quality standard. Allowing for different definitions, the overall correspondence between field and LCMGB samples is 67%.

The biggest component of map error is likely to be the misclassification of mixed boundary pixels. Some 40% of all pixels adjoin or cross a vector boundary and were thus made up of mixed cover types and additional boundary features. Correspondence was raised to 71% when boundary pixels were excluded. There are minor discrepancies due to geometry, where a feature was correctly classified but slightly displaced. In dissected landscapes this would have had a major impact. It is desirable, though not easy, to distinguish between misclassification and mis-registration. The satellite-derived map might be an accurate measure of cover, pattern and relative distribution, but with minor spatial differences relative to equivalent products.

Other differences reflect changes in cover between surveys, sometimes 2 years apart. For example, a pasture on one date, ploughed on the other. If we allow for likely time-based changes, overall correspondence is measured at 76% including boundary pixels, or 82% excluding boundaries.

Users of the data should be aware that these observations represent average error-rates. As with any average, the value represents a combination of lower and higher figures. Local discrepancies may be observed which seem to suggest higher or lower accuracy rates: this is only to be expected.

As previously noted, no survey could have delivered the 'ground truth' needed for exact validation; but it is possible to assess the probable meaning of results summarised here. If, as seems likely, the original CS90 field survey was close to the quality assurance survey and each 'correctly' recorded 90-95% of the landscape, they would have overlapped by around the measured 84%. If the Landsat survey achieved 80-85% success (a figure regularly achieved in pilot studies (Fuller et al., 1989a; b, Parsell, 1990)), then

the correspondence with the field survey would have been around 67-71%. These are the range of figures obtained if we allow for the obvious interpretation differences, with an element of temporal change. In conclusion, a realistic assessment of Land Cover Map accuracy is probably 80-85%.

For more details on accuracies see Fuller et al. (1994a) and Wyatt et al. (1994). Note too that a publication is in preparation which evaluates the correspondences between ground and satellite surveys in far greater detail.

Stand-alone datasets

Data orders for specific geographical areas can be provided according to customer requirements if appropriate area coordinates or vector shapefiles are provided. Data is available at 25m resolution; or 1km resolution in either a percentage or dominant value dataset.

Charges. Data charges are in three bands, according to end use, in accordance with the NERC Data Policy. These bands are commercial (highest rate), non-commercial, and research use (lowest). UK academics may be entitled to further reductions, subject to NERC arrangements.

Licensing. Data is supplied under Licence, to be signed by a responsible person within your organisation, students will need a signature from their supervisor. A wide variety of licences can be provided, from single user research licence to a corporate multi-user, multi-site licence. We are happy to develop new forms of licensing, to make access as easy as possible. Telephone enquiries are welcome, please ring +44 (0)1491 692315.

LCM 1990 classes

Introduction

The following descriptions outline the ITE Landsat-derived cover types used in the Land Cover Map of Great Britain. The choice of classes represents a compromise between what would be ideal for wide-ranging users, and what was feasible to map, at this scale, from remote sensing datasets. The classes chosen represent an aggregation of many subclasses: for example, wheat, barley and oilseed rape are subclasses of the 'arable' class. These subclasses have been reduced to a short-list of target 'classes' which are considered ecologically meaningful, consistently recognisable from the selected imagery, and realistic in terms of their likely accuracy. It would be possible to recombine subclasses differently, for example a map of 'graminoids' might be produced by aggregating all grass subclasses, including natural grasslands, agricultural pastures and arable cereals. Very likely, specialist users will require a 'tailor-made' aggregation to meet specific objectives, and this could be done digitally, by reference to the original maps of subclasses. Such users would have to accept that subclasses might not be distinguished consistently (*e.g.* not all images were of appropriate date to separate, for example, wheat from barley within the arable class).

The descriptions aim to record any limitations which would prevent further subdivisions to consistent standards. All classes are subject to the provision that they are only mapped if they are above the minimum map-able size, namely two pixels, i.e. 0.125ha, though in practice it cannot be said that all 0.125 ha features are shown - this will depend on how strong the spectral signature of a feature is and how pixels fall with respect to that feature. Minimum consistently map-able area could be 5 ha (Townshend 1983). In practice, the real value is probably between these two extremes, and perhaps nearer to 1ha.

At present, the list distinguishes lowland and upland categories which are similar, for example lowland heather and upland dwarf shrub. These classes have spectral characteristics which allow their separation, but not with the same level of accuracy as would be available in separating classes with entirely different characteristic species. Regional upland and lowland masks have been created from the cover-classes and coarsely filtered in order to generalise the classification into lowland and upland types. Some users may feel that other measures of context (*e.g.* altitude) are better criteria for separation, in which case such separations are best made in a geographical information system (GIS).

Agricultural grassland subdivisions have been taken further than spectral signatures may justify, because of the importance and extent of agricultural swards (see later). The situation with grasslands is complex: in addition to the interplay of species and altitude, there are extra difficulties imposed by soil-acidity, wetness and, more especially, by complex and ever-changing patterns of grassland-management. In the continua from lowland to upland, from wet to dry, from basic to acid soils and from natural to intensively managed, many classes might be identified. Agriculturalists and conservationists may not necessarily define the same classes, nor would a class be consistent from one agricultural region to another - a rough pasture in SE England might be considered to be good in montane Scotland for example. It is also true that discrete classes may not be spectrally separable, especially where management (e.g. mowing) obscures the characteristic appearance of the various components. Those classes which are defined here are thought to be ecologically meaningful and separable with good reliability. They are, most importantly, intended to be consistent throughout Britain.

How to use this class description

This class description document is structured in terms of the two levels of classification at which the Land Cover Map of Great Britain is being made available as a standard digital product: as either the full set of 25 'target' cover-types, or as an aggregation of these into 17 'key' cover-types.

The 25 classes are those provided as standard in the 25m spatial resolution data; the 17 classes are those provided as standard in the 1km summary data. In the former, there is just one layer of data, with values or 'labels' between 0 and 25 representing the designated cover type of each 25 x 25 m grid cell. In the 1 km summary data there are 17 layers, one for each 'key' class. Each layer records the cover for one 'key' class. The values for each 1 km grid cell represent the proportion of that cell that has been designated as being of a particular key cover-type. So, layer 1 holds the cover per 1 km cell for 'key' class A, layer 2 the summary cover data for 'key' class B, etc. This proportion is expressed as an integer percentage value, e.g. if 320 of the original 1600 25m cells within a particular 1 km cell were of key cover-type G (marsh/rough grass) then the layer for this class would have a value of 20 (%) for this 1 km cell in the 1 km summary data. (As indicated in the Introduction it is also possible to provide non-standard 'customised' data, e.g. the 25m data could be provided as the 17 key cover-types, rather than as the 25 target cover- types.)

In the 1 km summary data the integer percentage values are presented class by class and these may be thought of as distinct sets or 'bands' of data. The second column of Table 1 shows that in the full 17 class data set the order of these bands follows that of the letters A - Q. If a subset of the 17 key cover-types was requested then the corresponding band numbers would change, e.g. if data for only classes B, G, M and Q were requested then these would be bands 1, 2, 3 ∓ 4 respectively.

A - SEA/ESTUARY

This category includes all open sea and coastal waters, including estuaries, normally inland to the point where the waterway is constricted to 1 pixel or its continuity is broken by a bridging point. An exception is where waterways open up again into major estuarine features, such as Breydon water near Great Yarmouth or many of the sea lochs on the north-west Scottish coast. The division will be immediately evident by reference to classmaps. It is not intended to accurately show the limit of saline or tidal waters, which may extend much further inland.

Fuller key-name: Sea, coastal waters and estuaries, inland to the first bridging point or barrier.

This category carries the label '1' in the 25 'target' class dataset.

B - INLAND WATER

Inland water includes all map-able fresh waters and any estuarine waters which are excluded in the above category. The maps record only those areas which are water-covered on both the winter and summer images. Thus, reservoirs with summer draw-down, or winter-flooded meadows are classified to the summer class (i.e. bare or grassland in these examples).

Fuller key-name: inland fresh waters and estuarine waters above the first bridging point or barrier.

This category carries the label '2' in the 25 'target' class dataset.

C - COASTAL BARE GROUND (BEACH / MUDFLATS / CLIFFS)

The coastal bare ground category includes intertidal mud, silt, sand, shingle and rocks. It also includes bare maritime habitats above the tide-line, such as shingle beaches, mobile sand dunes and bare rocks or soil of coastal cliffs. A covering of sparse vegetation, such as pioneer salt marsh, dune or shingle species will not put the beach into a vegetated class unless the majority of the substratum is covered.

Distinction of this cover type is dependent on the level of the tide on the days of imaging (the lower tide being used to define the lower limit of the beach). Thus discrepancies can arise where high tides prevailed on imaging.

Fuller key-name: bare coastal mud, silt, sand, shingle and rock, including coastal accretion and erosion features above high water.

This category carries the label '3' in the 25 'target' cover-type digital data set.

D - SALTMARSH

Areas of seaweeds are sometimes sufficiently extensive to show as vegetated intertidal plant communities. The may comprise the green alga *Enteromorpha intestinalis* or the brown wracks *(Pelvetia caniliculata, Fucus* spp. and *Ascophyllum nodosum)* growing on rocks, boulders and sometimes gravels, sands and muds. Saltmarshes are intertidal sand-, silt- or mud-based habitats, colonised by halophytic grasses such as *Puccinellia* spp, and herbs such as *Limonium* spp., *Aster tripolium* and *Triglochin maritima*. They remain mostly green in winter. For the purposes of this classmap, only those marshes up to normal high water spring tides (i.e. those flooded monthly) are included. The upper saltmarsh, inundated only on extreme high-water spring tides, is dominated by coarse grasses such as *Agropyron* spp.. These are classified accordingly as marsh / rough grass (see below).

Distinction of this cover type is dependent on the level of the tide on the days of imaging (the lower tide being used to define the lower limit of the seaweed beds or saltmarshes). Thus discrepancies can arise where high tides prevailed on imaging.

Fuller key name: intertidal seaweed beds and saltmarshes up to normal levels of high water spring tides.

This category carries the label '4' in the 25 'target' class dataset.

E - ROUGH PASTURE / DUNE GRASS / GRASS MOOR

There are potential problems of confusion between lowland grass heaths and upland grass moors, largely because the species complements are similar. However, there are sufficient differences that spectral separation may be reliable. It has also proved possible to separate the two using a digital mask to correct regional misclassifications (see introduction). Some users of the maps and data may choose to aggregate the two classes, for later separation in a GIS, but using their own contextual definition based on altitude, climate, latitude and longitude or combinations of any such variables.

Grass Heath

This class includes coastal dunes and inland grasslands typically growing on sandy soils, usually acid in character. The species might include, on coastal dunes, *Ammophila arenaria, Festuca rubra* and *Carex arenaria* and a wide variety of herbaceous species, often winter annuals. Inland, and on mature 'grey' dunes, all but *Ammophila* might be present, but acid-loving species are typical, including *Festuca ovina, Agrostis* spp. and *Deschampsia flexuosa* set in a carpet of lichens and mosses (Duffey et al. 1974). The latter species are also characteristic of marginal hill-grasslands and a zone of semi-natural acid grassland may lie between the agricultural grasslands of lower hill-slopes and moorland communities on the hill tops. These swards are characteristic of north-western Britain, mostly on land between 100-200 m, but right down to sea level in north-west Scotland.

In winter, the lowland grass heaths have substantial quantities of dead plant litter, distinguishing the lowland grass heaths from agricultural swards, but the litter content is less than is typical of coarse rough grasslands, offering a spectral distinction from these.

Fuller key-name: semi-natural, mostly acid, grasslands of dunes, heaths and lowland-upland margins **This category carries the label '5' in the 25 'target' class dataset.**

Moorland Grass

This class includes upland swards, mostly of deciduous grasslands, often referred to as grass moorland or upland grassy heath. They are typically dominated by *Nardus stricta* and/or *Molinia caerulea,* with *Festuca ovina, Deschampsia caespitosa, Juncus* spp. often including sparse cover of upland dwarf shrubs. These swards form large tracts of mostly unenclosed hill-grasslands, lightly grazed often by sheep.

Fuller key-name: montane/hill grasslands, mostly unenclosed Nardus/Molinia moorland. **This category carries the label '9' in the 25 'target' class dataset.**

F - PASTURE / MEADOW / AMENITY GRASS

Agricultural grasslands comprise many types, from newly sown leys, of single species, to largely unimproved swards of indigenous species. This range is subdivided in many different ways by the many different surveys of grasslands (see Fuller 1987). Here we must be constrained by what is possible, with acceptable accuracy, using satellite imaging. Certainly, the class 'pasture/meadow/amenity grass' can be identified with good consistency. It characteristically forms a cropped sward, comprising finer grass species (eg *Festuca, Agrostis, Lolium* and *Poa* spp.) often with many other grasses and herbs. The sward is maintained by mowing and/or grazing, such that coarser species of grass, herbs and scrub cannot become dominant.

In agricultural and conservation terms, there is an important distinction between 'improved' and 'unimproved' swards. Improvement may involve reseeding, herbicide treatments, and/or fertiliser applications which promote the growth of 'preferred' species, especially *Lolium perenne*. Swards which are essentially 'unimproved', or which have reverted, contain a dominant proportion of indigenous species (Fuller 1987).

Improved pastures or close-mown amenity swards are mostly distinguishable on satellite imagery: they remain green in both summer and winter. Unimproved swards are generally used at a low intensity and are typically unenclosed. They are also likely to be discernible from intensive pastures because of their rougher texture, their weed content and the quantity of plant litter they carry in winter (all factors which affect overall reflectance). The problem is that hay meadows, of both the lowlands and the partially improved lower

slopes of upland areas, could be confused with either improved or unimproved swards, depending on the stage of management in the particular year of imaging *e.g.* growing hay, standing hay, cut hay, aftermath- grazed. This obviously depends on the date of the image available for classification (and only days may separate the four types).
The 25 class classification identifies two types of pasture/meadow/amenity grass, which are be retained as separate class numbers in the database, but could be aggregated to a single colour- class for map and data outputs, depending on the measured accuracy and user requirements. It should be realised that the classes are readily inter-changeable by changing management practices, and such changes may take place on a cyclical basis (*e.g.* where swards are mown one year grazed another). The two pasture/meadow/amenity grass subclasses are described below.

Mown / Grazed Turf
Mown/grazed turf grasslands are managed either as agriculturally productive swards or mown as amenity grasslands. They are mostly agriculturally 'improved' by reseeding and/or fertiliser use and would normally contain high quantities of *Lolium perenne* and/or other preferred species. Their key characteristic is that they did not, at either date of imaging (summer or winter), have any detectable quantity of dead plant material, nor a substantial uncropped stand of living material. This implies that the swards were grazed or cut and thus maintained as a turf throughout the growing period. This management prevented the sward from reaching flowering height in summer and ensured that there was little or no standing crop of plant litter to influence the winter-reflectance of the sward.
Fuller key-name: pastures and amenity swards, mown or grazed, to form a turf throughout the growing season.
This category carries the label '6' in the 25 'target' class dataset.

Meadow / Verge / Semi-natural swards
Meadows and verges include grasslands which are managed, but mostly at a lesser intensity than the 'mown/grazed turf' class. Partial improvement favours productive species such as *Lolium perenne,* and herbicide treatment may reduce the content of broadleaved 'weeds' but some of the swards in this category represent the traditional hay meadows which have escaped improvement. The swards may be mown for hay and perhaps aftermath- grazed.
Semi-natural swards may have much the same appearance. *Festuca/Agrostis* swards are typical of the indigenous, essentially unimproved grasslands, of neutral to acid soils, mostly enclosed, formerly covering much of Britain's grazing land, but now restricted to upland margins and odd pockets of lowlands, usually on floodplains. The swards are characterised by *Festuca rubra* and *ovina, Agrostis stolonifera, A. tenuis* and/or *A. canina,* often with substantial quantities of rushes *(Juncus* spp.), sedges *(Carex* spp.) and broadleaved plants. Alternatively, the semi-natural grasslands may be agriculturally non-productive swards which are managed by occasional cutting to prevent excessive weed or scrub growth, *e.g.* roadside verges, country parks, golf course semi-rough areas.
The key characteristic of this class is that the swards were not a short-cropped turf throughout the year - either they were grazed at low intensity such that patches of unpalatable species became sufficiently dominant to produce a higher standing crop than on pastures. Or the swards were used for hay and appeared as a long grass sward awaiting mowing or grazing: or, perhaps, they had recently been mown for hay. The important characteristic is that they were cropped by the time of winter imaging, to remove much of the standing crop of grass. Thus, by winter they were mostly green rather than a straw- coloured stand of plant-litter as would be typical of natural swards of coarse grasses. This class forms a transition, often in appearance, perhaps in species contents and productivity, often in terms of time (*i.e.* improving or reverting) and especially space (a transition zone), between improved pastures and the 'natural' grasslands of heaths and moors.
Fuller key-name: Meadows, verges, low intensity amenity grasslands and semi-natural cropped swards, not maintained as a short turf.
This category carries the label '7' in the 25 'target' class dataset.

G - MARSH / ROUGH GRASS

In the 25 class data the marsh/rough grass category comprises three types, separated to distinguish established rough swards from new colonisation. In the 17 class list these are amalgamated.

Ruderal weed

The ruderal weed cover-type is generally bare ground being colonised by annual and short- lived perennial plants, usually with a considerable remnant of bare ground, especially in winter. The ground may be naturally bare, *e.g.* shingle beaches, or abandoned arable land, *e.g.* set-aside, or derelict industrial works such as demolished factories, gravel pits etc. This category is rarely extensive enough to map, was chosen to classify what might have been extensive areas of set-aside, and is aggregated with the rough grass class for maps and most data summaries.

Fuller key-name: ruderal weeds colonising natural and man-made bare ground.

This category carries the label '19' in the 25 'target' class dataset.

Felled Forest

Recently felled forest, usually with large quantities of brush-wood etc, comprise this class. As they re-vegetate, felled areas re-colonise with ruderal weeds, and then become rough grassland. Although originally selected in the anticipation that they would be relatively commonplace, felled areas are rare. They will be aggregated with 'marsh / rough grass' class for most display purposes and data-summaries.

Fuller key-name: felled forest, with ruderal weeds and rough grass.

This category carries the label '23' in the 25 'target' class dataset.

Rough / Marsh Grass

This class includes lowland herbaceous vegetation of fens, marshes, upper saltmarshes, and rough or derelict ground. The characteristic feature of this category is that the swards are not significantly cropped by mowing or grazed by stock. In fact most are unenclosed grasslands, abandoned from economic use. The result is that they have a high standing crop of vegetation, most of which dies back in winter, leaving a dense plant litter.

Fuller key-name: lowland marsh/rough grasslands, mostly uncropped and unmanaged, forming grass and herbaceous communities, of mostly perennial species, with high winter-litter content.

This category carries the label '8' in the 25 'target' class dataset.

H - GRASS / SHRUB HEATH

In the 25 class dataset open shrub heath and open shrub moor are kept separate. In the 17 class data they are aggregated into one class.

Open Shrub Heath

This category complements the above moorland variety of grass /shrub heath. However, because intensive grazing of lowland heaths is no longer practised, the incidence of this class is rare. It will be found where knowledge-correction has identified an area of the grass / shrub heath mixture as being in a lowland zone.

Fuller key-name: lowland, dwarf shrub/grass heathland.

This category carries the label '25' in the 25 'target' class dataset.

Open Shrub Moor

This cover type is fairly commonplace on some marginal hill grazing land, especially in northern and western parts of Britain, where grazing prevents the dominance of dwarf shrub species. It is also extensive in *Calluna* moorland, as a result of moor-burning to maintain young heather regrowth to promote grouse populations. Initial regrowth produces grassy swards, which over a period of years revert to heather-cover. As the heather senesces, so moorland is re-burnt, with a repeat cycle of perhaps 10 years. Whereas other transient cover-features of management (e.g. haycutting, arable crop-type) are not defined because of their short-lived nature, the 10-year cycle is judged long

enough to justify the distinction between currently managed and unmanaged areas. The proportionate cover of *Calluna* which is required to alter the classification from 'burnt' back to 'dwarf shrub' is not yet clear: this will become evident on comparison of classmaps with corresponding 1km field squares of Countryside 1990.
Fuller key-name: upland, dwarf shrub/grass moorland.
This category carries the label '10' in the 25 'target' class dataset.

I - SHRUB HEATH

In the 25 class dataset dense shrub heath and dense shrub moor are kept separate. In the 17 class data they are aggregated into one class.

Dense Shrub Heath
Dense shrub heath refers to communities with high contents of heather *(Calluna),* ling *(Erica* spp.) but perhaps mixed with broom *(Cytisus scoparius),* gorse *(Ulex* spp.). It is mostly evergreen, hence different from other scrub communities. Almost invariably, it represents vegetation on sandy soils, in characteristic sites like the Brecklands, and the Dorset and Surrey Heaths, or on extensive coastal dune systems.
Fuller key-name: lowland evergreen shrub-dominated heathland.
This category carries the label '13' in the 25 'target' class dataset.

Dense Shrub Moor
The dense shrub moor communities include heather *(Calluna vulgaris),* ling *(Erica* spp.) and bilberry *(Vaccinium* spp.) moorlands. Though dominated by woody shrubs, these may be mixed with herbaceous species, especially those of the moorland grass. The dense shrub moors may be managed by moor-burning, in which case they may be bare, for most of the first year after burning; then the grass / shrub heath mixture is found until dense shrub growth again dominates the cover.
Fuller key-name: upland evergreen dwarf shrub-dominated moorland.
This category carries the label '11' in the 25 'target' class dataset.

J - BRACKEN

The bracken class is herbaceous vegetation dominated by *Pteridium aquilinum.* It may be upland or lowland, mixed with grass and other species. The obvious characteristic is that the distinctive colour of winter bracken dominates the reflectance of the community.
Fuller key-name: bracken-dominated herbaceous communities. **This category carries the label '12' in the 25 'target' class dataset.**

K - DECIDUOUS / MIXED WOOD

This category comprises all deciduous broadleaved trees, broadleaved and includes mixed stands, where they cannot be separated spatially. The 25 class data identifies two cover types.

Scrub / Orchard
Scrub and orchard areas are deciduous, often with substantial herbaceous vegetation. Typical species include sallow (*Salix* spp.) in wetlands, or hawthorn *(Crataegus monogyna),* brambles (*Rubus fruticosus* agg.) and saplings or small trees: these include, of course, fruit trees. Although commonplace, the scrub category is rarely extensive enough to record more than just a few pixels. The exceptions are in areas of orchards (though these are only found in a few areas), and in semi-natural vegetation, for example, the sallow-carr woodlands of the Broads or hawthorn scrub on chalk downland. For map-production purposes and in most data summaries the scrub and deciduous woodland classes will be amalgamated.
Fuller key-name: deciduous scrub and orchards.
This category carries the label '14' in the 25 'target' class dataset.

Deciduous Woodland

The deciduous characteristic separates it from evergreen species, as it appears bare in winter. However, deciduous woodland has a unique spectral signature which separates it from other deciduous vegetation and from arable land. Mixed woodland may be included with this category, though continuous evergreen stands, where greater than the minimum map-able area, will be separated.

Fuller key-name: Deciduous broadleaved and mixed woodlands.

This category carries the label '15' in the 25 'target' class dataset.

L - CONIFEROUS / EVERGREEN WOODLAND

Coniferous/evergreen woodland comprises coniferous species (including the deciduous larch (Larix spp.), plus other evergreens such as holly *(Ilex aquifolium),* Rhododendron *(R. ponticum),* yew *(Taxus baccata)* or Holm oaks *(Quercus ilex).* As well as remaining in leaf all year round, the species generally have very dark leaves or needles, giving them unique signatures in both summer and winter.

Fuller key-name: Conifer and broadleaved evergreen trees.

This category carries the label '16' in the 25 'target' class dataset.

M - BOG (HERBACEOUS)

Bogs are widespread in upland areas especially to the north and west of Britain. They are also found locally in lowland areas. They are characterised by permanent water-logging, resulting in depositions of acidic peat. The 'bogs' of this classification are mostly herbaceous communities of wetlands with permanent or temporary standing water (Ordnance Survey maps show the same areas using 'marsh' symbols). Wet heather moorlands, which botanists may refer to as 'bogs', are not generally mapped as such on topographic maps (OS maps show them as 'heaths'), and are mapped by this survey as dwarf shrub categories. As with other heathland and moorland classes in the 25 class data, a distinction is made between upland and lowland variants of this class.

Lowland bog

Lowland bogs are rare in much of Britain, due to drainage and peat extraction. However, local large areas of bog are to be found on the west coast of Scotland. They carry most of the species of upland bogs, but in an obviously lowland context, with Myrica gale and Eriophorum spp. being highly characteristic.

Fuller key-name: lowland herbaceous wetlands with permanent or temporary standing water.

This category carries the label '24' in the 25 'target' class dataset.

Upland bog

Upland bogs have many of the species of grass and dwarf shrub heaths and moors, but are characterised by water-logging, perhaps with surface water, especially in winter. The water- logging promotes species such as bog myrtle *(Myrica gale)* and cotton grass (*Eriophorum* spp.) in addition to the species of grass and dwarf shrub moorlands.

Fuller key-name: lowland herbaceous wetlands with permanent or temporary standing water.

This category carries the label '17' in the 25 'target' class dataset.

N - TILLED LAND (ARABLE CROPS)

Tilled land includes all land under annual tillage, especially for cereals, horticulture etc. It also includes leys in their first year, ie if they were bare at the time of the winter imagery. Other land, vegetated at the time of summer imagery but bare soil during the winter, is also included in this land cover type: hence any temporarily bare ground (e.g. from scrub-clearance, development, mining or soil tipping) would be classified in this category.

Fuller key-name: arable and other seasonally or temporarily bare ground.

This category carries the label '18' in the 25 'target' class dataset.

O - SUBURBAN / RURAL DEVELOPMENT

The suburban/rural development category includes all land where the pixels of the Landsat image have recorded a mixture of built-up land and permanent vegetation. Most suburban and rural developments, where the buildings and associated car-parks etc. remain small enough that they do not fill all of each pixel, are included in this cover-type. Small rural industrial estates, glasshouses, railway stations, larger rural roads, villages, small retail sites are all included in this class.

Fuller key-name: suburban and rural developed land comprising buildings and/or roads but with some cover of permanent vegetation.

This category carries the label '20' in the 25 'target' class dataset.

P - URBAN DEVELOPMENT

The urban development category covers all developments which are large enough to completely fill individual pixels, to the exclusion of significant quantities of permanent vegetation. It includes cities, large town centres, major industrial and commercial sites, major areas of concrete and tarmac, plus permanent bare ground associated with these developments, such as car-parks and tips.

Fuller key-name: industrial, urban and any other developments, lacking permanent vegetation.

This category carries the label '21' in the 25 'target' class dataset.

Q - INLAND BARE GROUND

The inland bare ground category includes all 'natural' surfaces such as rock, sand, gravel or soil, though their origin has often not been natural: the exceptions are coastal features which classify as beach/mudflat/cliffs. Ground which has been bared by human activities, or by livestock would be included. Imported surfaces of sand or gravel (eg car parks) would also be classed as bare ground.

Fuller key-name: ground bare of vegetation, surfaced with 'natural' materials.

This category carries the label '22' in the 25 'target' class dataset.

UNCLASSIFIED

Within the 25m data about 2% of Great Britain remains unclassified, *i.e.* unallocated to any of the 25 'target' cover-types described above. These occurrences represent (i) some small areas within scenes that were either obscured by cloud upon both the summer and winter imagery used for the classification, (ii) some locations for which a single scene of cloud free imagery was not available to the mapping project (*e.g.* the island of Tiree), and (c) some areas of unusual cover types that were not defined by the classifier training exercise.

In the 25m grid cell data these cells are uniquely labelled, with the value '0', in the same manner as those cells designated to one of the 25 target cover-types. In the 1km summary data the proportion of each 1km cell that is unclassified is represented by default, by the difference between the sum of the values for the 17 key cover-types and 100.

Fuller key-name: cover-types which did not fit into the 25 'target' classes.

This category carries the label '0' in the 25 'target' class dataset.

Land Cover Map 2000 is now available. Further information on its creation and potential is available within the Countryside 2000 website, some sample data (1km resolution) can be seen here, and is available for download at the Countryside Information System data download site.

Contact: Land Cover Map Sales, CEH Wallingford, Wallingford. Oxon. OX10 8BB England. **tel:** +44 (0)1491 692315**email:** spatialdata@ceh.ac.uk

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Appendix 1: Advice, Recommendations, and Good Practice for users of LCMGB 1990.

Please read these notes BEFORE using the dataset

These notes ***summarise*** some aspects of the LCMGB1990 specification, provide guidance when interpreting the data and outline good practice recommended by the LCM production team.

LCMGB1990 maps land cover. This may be synonymous with land use (e.g. arable crop cover denotes arable land use) but often land use cannot be inferred (e.g. grass used for recreation is much like that which is grazed).

The ability to distinguish land cover will be dependent upon the dominant land cover at the time of imaging.

Accuracy or correspondence. Users should take care not to refer to inaccuracy if they mean differences due to data model, scale, resolution, interpretation, class-definition, target classes etc. LCMGB1990 incorporates inevitable inaccuracies, but they may not be the major cause where it fails to match user needs.

Data Assessment Report (DAR). To effectively manage feedback from users of LCMGB1990 data a DAR form is provided with the data. The DAR is not only a means for communicating problems which may be identified in LCMGB1990, but also more general comments on the dataset, helpful hints on analysis and applications, and queries about good practice.

Appendix 2: Colour recipe for LCM1990 mapping

LCM Subclass Number	LCM Subclass Description	Red	Green	Blue
0	Unclassified	13	0	129
1	Sea/Estuary	0	0	128
2	Inland Water	0	0	255
3	Beach and Coastal Bare	254	248	164
4	Saltmarsh	0	208	219
5	Grass Heath	230	204	0
6	Mown / Grazed Turf	0	255	0
7	Meadow / Verge Meadow / Verge / Semi-natural	128	230	128
8	Rough / Marsh Grass	255	255	0
9	Moorland Grass	219	205	0
10	Open Shrub Moor	246	164	254
11	Dense Shrub Moor	128	26	128
12	Bracken	255	77	0
13	Dense Shrub Heath	179	102	179
14	Scrub / Orchard	255	153	153
15	Deciduous Woodland	255	0	0
16	Coniferous Woodland	0	102	0
17	Upland Bog	124	166	152
18	Tilled Land	102	0	0
19	Ruderal Weed	255	255	0
20	Suburban / Rural Development	128	128	128
21	Continuous Urban	51	51	51
22	Inland Bare Ground	179	179	255
23	Felled Forest	255	0	0
24	Lowland Bog	20	164	171
25	Open Shrub Heath	246	164	254