A LAND CHARACTERISTIC DATA BANK FOR GREAT BRITAIN

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This Bangor Occasional Paper describes a land and land use data set at the 10 x 10 km grid square scale, that forms the basis of ITE Project 534, 'National Land Characteristics and Classification'.

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ABSTRACT

Land and land use attributes have been quantitatively recorded from existing map and statistic sources for the 2858 10 x 10 km grid squares (cells) of the Ordnance Survey National Grid which contain land in Great Britain. 126 attributes are grouped in categories of physiography; climate; geology; soils; topography; land use; agricultural land classification; and conservation status. They provide the initial major component of a computer-stored land data set appropriate to national and regional scales of ecological assessment and resource evaluation.

Standard statistics outputs supply complete or partial data for individual cells, or total and average values of required attributes for any group of cells. Map outputs display, list, and summarise data for cells which meet specifications of individual or combined attributes, for Great Britain as a whole, or for required regions.

Recording of the initial data, their computer input and editing, and the availability of analysis and retrieval programmes, have completed the first phase of this data bank.. Intended developments that are outlined include land classifications based on the data, correlations of land characteristics or classes with biological distributions already available at this scale, and extension and upgrading of the initial data set.

Information from the data set can be supplied at agreed charges.

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1. INTRODUCTION

The Institute of Terrestrial Ecology (ITE) "studies the factors determining the structure, composition and processes of land and freshwater systems ... (and) is developing a sounder scientific basis for predicting and modelling environmental trends arising from natural or man-made change. The results of this research are available to those responsible for the protection, management and wise use of our natural resources" (ITE 1981). With these aims, and a natural emphasis on the resources of Britain, the availability of a data set covering the major land characteristics of the country is a desirable tool for the basic and commissioned research of ITE. The importance to environmental research and resource evaluation of having accessible computer-based information stores of frequently needed data as expandable facilities with which research workers can interact is becoming widely recognised, as emphasised recently, for example, by Giles (1981).

In Britain, land data are available from a large number of primary map and statistic sources. In the absence of co-ordinated data sets, although many research and resource evaluation studies demand, or would benefit from, extensive searches and interpretation of the primary sources, the labour required is at best tedious and repetitive, and at worst involves impractical effort to obtain full coverage. As a result, such studies may rely only on partial personal knowledge of the land characteristics of Great Britain or of a region of interest, rather than on the possibility of a comprehensive rapid assessment of land factors that could

affect the study or its interpretation. The land characteristic data bank described here provides an edited, integrated, secondary source of land data that is available for comparative assessment and analysis of a range of land factors at national and regional scales. Because of its scale, format and content, it cannot provide answers to all conceivable questions, but it is appropriate for many purposes.

In principle it would be preferable for such a data bank to be of the highest possible accuracy (relative to the quality of the source data) and have the most versatile possible analysis and output options. Such requirements call for measurement of the location of particular features or the boundaries of defined areas by digitised co-ordinates, followed by storage of the digitised information in a way that allows exact retrieval of point and area locations and thus the plotting on maps of sites at which different land characteristics coincide. Large digitised data sets like that which could be built on the present foundation of the 'Ecobase' project of the Thematic Information Services Section (formerly the Experimental Cartography Unit (ECU)) of NERC could ultimately provide both precision and versatility, but at high costs in money and time. For some categories of land information, such methods would inevitably be being applied to data which as yet are not of sufficient quality, or sufficiently accurately localised on appropriate scale maps, to justify the calibre of the data extraction and retrieval methods.

Our philosophy is that a wide-ranging data set put together

reasonably quickly and relatively inexpensively, without needing the most advanced methods and facilities, is of sufficient medium term advantage to justify the effort spent in preparing it. Practical decisions that arose from this view were that data would be recorded by purely manual methods and that the recording units would be individual grid cells, giving what are called 'raster' data. An alternative would have been to digitise line segments off map sources and store these, in 'vector' format, as a series of coordinates and feature codes. The respective merits of vector and raster data bases have been reviewed recently by Schneider and Amanullah (1979) and by Lynch (1981). In outline, the raster approach, recording data for cells, allows simpler recording methods and data base structure and requires fewer facilities for data retrieval than does a vector data base. On the other hand, data in such a cell system are generalised to the cell area rather than being specifically locatable, and the initial choice of cell size prevents examination of the same data at alternative larger scales.

The cell size used for this land characteristic data set is that provided by the 10 x 10 km grid squares of the Ordnance Survey National Grid. This scale is appropriate for regional and national data, and has been used, among others, by the Biological Records Centre of ITE (formerly of the Nature Conservancy) in recording British distributions of plant and animal species. Land is present in 2858 10 x 10 km squares in Great Britain, defined here as England, Scotland and Wales, including the Isle of Man, but excluding other parts of the United Kingdom (Northern

Ireland and the Channel Islands). The index numbers for the squares in the data set, with their Ordnance Survey grid references, are given in Appendix 1.

2. DATA INPUT

2.1 Attributes in the data set

Quantitative recording of 126 land characteristics (attributes*) has been carried out for the great majority of the 2858 10 x 10 km cells containing land in England, Scotland and Wales.

The attributes are grouped in categories: physiography (taken to cover natural landform characteristics); climate; geology; soils; topography (taken to cover landscape features directly due to man, in contrast to natural landform physiographic characteristics); land use; agricultural land classification; and conservation status. These categories are summarised in Table 1 (from Ball, Radford and Williams 1983, with the addition of the Conservation Status category). Appendix 2 gives a detailed list of the included attributes, with their sources, and some problems arising in defining and measuring them. The majority were determined from maps, either from the only possible source, or, where alternatives were available, the most convenient scale that balanced data quality against recording effort. Population figures, and most land use data, come from national statistics, supplied directly or re-

* attribute is used here in its wider sense, to include discrete presence/absence records ('attributes' sensu stricto) and continuous variables.

calculated for the 10 x 10 km grid cells.

The arrangement of categories of land characteristics in Table 1 follows a sequence from natural environment factors (physiography, climate, and geology) through soils, which are largely the result of the interaction of the first three factors with time, vegetation and land use, to aspects directly concerned with man's modification of the natural landscape and his use of the land as a resource (topography, land use, agricultural land class and conservation status). This is purely a matter of presentation as, for data analysis and retrieval, individual attributes are accessible in any required order or combination.

2.2 Recording methods

When recording attributes from maps, the appropriate measurements are initially tabulated on pro-forma sheets. It is convenient for 2 operators to work together, one working off the map, assisted by the use of an angle-arm illuminated desk magnifier, and the other entering data on the forms. The measurements, either directly as recorded, or after any necessary transformation, are transferred from the tables to the computer via paper tape. Two methods have been most often used for measurements of map-derived characteristics: a point count procedure for area estimation; and a relative frequency score for linear features.

In the point count area measurements, a transparent overlay marked with 10 x 10 km cell boundary lines at the scale of the map being

TABLE 1

ATTRIBUTE CATEGORIES RECORDED FOR EACH 10 X 10 KM CELL

Physiography:	Extent* of sea
	Extent of altitude classes
	Altitude range
	Relative relief
	River frequency*
	Extent of freshwater
	Length of coastline
Climate:	Extent of annual rainfall classes
	Short-term seasonal rainfall (from 3-year averages)
	Short-term seasonal air temperature (from 3-year averages)
	Short-term seasonal sunshine (from 3-year averages)
	Short-term seasonal windspeed (from 3-year averages)
Geology:	Extent of stratigraphic units
	Extent of bedrock lithology categories
	Extent of surface geology categories
Soils:	Extent dominated by 8 major soil group categories
Topography:	Settlement frequency
	Road frequency
	Railway frequency
	Total population
Land Use:	Extent of farmland
	Extent of forest and woodland
	Extent of urban land
	Extent of individual crops
	Numbers of different farm livestock
	Farm labour input
Agricultural Land Classification:	Extent in Agricultural Land Classification categories
Conservation Status:	Presence and extent of individual National Parks
	Presence and extent of individual Areas of Outstanding Natural Beauty.
	Presence of Heritage Coast (England and Wales)
	Presence of Scenic Area (Scotland)

* 'Extent' is used to indicate that the category is held as an area measurement (% of cell)
'Frequency' indicates that data are held as a relative score, not an absolute measure.

used carries a systematic spot grid, of 10, 20, 25 or 100 points according to the map scale, using a 100 point grid for the most frequent map scales of 1:250 000 or 1:50 000. A count of the number of points which fall in the area of each attribute in a cell consequently gives a measure of the extent of that attribute in either 10, 5, 4 or 1% units. The principle of point counts for area measurement has been explored and accepted for many years (e.g. Chayes 1956; Frolov and Maling 1969). In the present project, a small test, comparing forest areas assessed by point count at the 1% level against digitised areas determined with a Reichert-Jung MOP-2 (MOP) digitising tablet for 28 sample cells, gave a correlation coefficient of 0.98. The point count method of area assessment was approximately twice as fast as using MOP on the sample squares, while the divergence between replicate measures by the same or different operators was at least as great with MOP as with point counts.

The frequency of linear features (rivers, roads, railways) has been assessed by a relative measure. This again employs a transparent overlay of the appropriate 10 x 10 km cell size, but sub-divided into 25 squares. Counts are made of how many of these sub-squares contain any occurrence of the particular linear feature. Thus, major road frequency, for example, is assessed on a scale of 0-25 by recording how many of the 25 sub-squares of each cell overlay include a mapped major road or roads. The correlation of these scores with measured lengths of the appropriate attribute has been tested using digitised length measurements of roads and rivers kindly made available by the Thematic Information

Services Section of NERC (formerly the Experimental Cartography Unit) for a sample of 70 10 x 10 km cells. Considering rivers and roads together, the regression of length in km (L) against frequency score (F) was L = 3.11F - 5.3, with a correlation coefficient of 0.90 and a standard error of 0.125. Considering roads and rivers separately, the regressions differ, probably because of the different nature of river and road courses on the source maps and perhaps also in their perception by a recorder. Higher frequency scores assess mapped lengths less accurately, because a sub-square is only counted once, whatever the length of feature in it. For frequency scores of 15-25 the correlation coefficient for rivers and roads in the 70 sample squares was 0.73, whereas for scores of 14 or less it was 0.95. However, the pattern of rivers and roads on the OS 1:250 000 scale maps is, for unavoidable cartographic reasons, usually only a selection of what is actually present, with their courses smoothed. In view of this, even an accurate measure from the source map does not directly relate to what actually may be present on the ground. Because the frequency score method effectively distinguishes ranges, such as 'low', 'moderate, 'high', or 'very high' road or river frequency, and because such ranges, rather than absolute length measures, are most appropriate to assessments of these attributes at this scale of study, the frequency scores have been retained.

With different attribute categories inevitably recorded off different scale source maps, the total extent of 'land', as measured in coastal squares, differed from one category to another for a single cell. This is in part because in point count area measurement, at one scale 5% units were used, and at

another scale, 1% units. Additionally, no matter how accurately attribute areas on these different source maps had been measured, there would remain differences in the extent of 'land' determined off different maps as a result of the progressive stylisation of the true coastline at smaller scales and the deviation of grid lines on some source maps from their true position.

Two choices were available. The first would record in the data set the apparent total area of land in coastal squares as it was actually measured in each data category. This would leave statistical outputs differing in the extents recorded for 'land' of an individual cell so far as physiographic categories and other categories such as geology, rainfall or agricultural land classes were concerned. The alternative was to adjust the area sums of different measured categories to conform to some standard value for the extent of land present in a coastal square. In this data set the most appropriate standard now available is the land area assessed from 1:250 000 Ordnance Survey maps by 1% point-counts of altitude classes in the physiography data group. Although adjustment, in coastal squares, of the measured areas of other data categories to conform to this standard land area can imply more accurate measurements than were usually made, the overall advantage of reducing discrepancies in statistical outputs has been considered to outweigh this consideration. Consequently map-derived area values for different attribute categories in coastal squares have mainly been adjusted to conform to the standard set for the land area of each square by the physiography data group.

The methods adopted depended on how far the attribute category area deviated from the standard. For deviations >10%, an initial check was made of the source maps to eliminate any gross measurement or data transfer errors. Remaining differences of >5% were dealt with by proportional adjustment of individual attributes in the category. Differences of <5% were treated by addition to, or subtraction from, the most frequent attribute in the category being adjusted. Exceptions to such adjustments affect the soil data and there are wider considerations which prevent reasonable adjustments for the land use data. These are considered in the appropriate sections of Appendix 2.

Turning to another issue, all measures in the data set, including area determinations, relate to the 10 x 10 km cells as units. In area measurements, the land area of an inland cell (including freshwater bodies as part of the land area) is 100 km^2, so a 1% measure, equal to 1 km^2, is both 1% of the square and 1% of the land in the square. This is not the case for coastal cells. If such a cell consists of 10% land and 90% sea, then a 10% value for a particular area attribute refers to 10% of the cell, or 10 km^2, but this would be 100% of the actual land in the cell. In data retrieval through map outputs, options provide either for treating coastal squares in the same way as inland squares, by treating their data as values for the entire square, or by treating analysis and output of data from the square relative to its actual land area.

A further consideration arising from the recording procedure, in

relation to data retrieval, is that because data have been recorded for cells, and because the 10 x 10 km cell boundaries do not coincide with those of administrative or natural geographic regions, statistic and map retrievals for such regions have to be for those cells which most closely conform to the actual regional administrative or other boundaries. Data outputs, as statistics or maps for say, Scotland, Devon, or the Peak District National Park, are for those 10 x 10 km grid squares which most closely parallel the true extent of such areas, usually by allocating a cell to an area if its mid-point falls within the area. At the scale of the study involved, such differences between approximate and actual areas are considered to be generally acceptable, when more than a few cells are involved.

A final point in considering general aspects of map data recording is that a zero value means just that. When no data are available for an attribute, this is identified in the computer store by allocating a value of -127. Retrieval programs omit such squares in statistic outputs and identify them on map outputs.

The recording methods applied to individual categories of attributes, and notes on particular points, are included in the attribute lists given in Appendix 2.

3. DATA RETRIEVAL

All data processing has been carried out at ITE Bangor using a Digital Equipment PDP 11/34 mini-computer under the RSX-11M operating system. Visual display units and a line printer provide standard output from the data base, but the more sophisticated facilities available via a fast link with mainframe computers may be made use of as necessary.

The data are held in a single file which is accessed by a number of retrieval programs, giving a range of output products. The main program, designed to provide access for analytical purposes, enables the user to address search specifications to all or geographically limited parts of the data. There is a choice of types of output, to identify and characterise the 10 x 10 km squares which meet these specifications, in the form of statistics and maps. Ancillary programs provide listings of the data in various forms, normally on the basis of simple, non-analytical criteria such as the grid square index numbers, while others give statistical summaries of selected attributes usually for predefined geographical or administrative areas. These different products of data retrieval are described and illustrated below in sufficient detail for the reader to appreciate the present capabilities of the data base, but this section is not intended to fill the role of an operations handbook.

3.1 Analytical enquiry

The principle of this method of accessing the data is that a search specification is matched against the corresponding data values for each grid cell 'relevant' to the search. 'Relevant' cells are those

included in the selected area of study (e.g. Great Britain, England, Scotland or Wales). Those cells meeting the specification ('valid squares') can be identified in the chosen type of output. For each execution of the analytical enquiry program, the user is required to select from a series of options which constrain the retrieval and output. The program will process up to 6 specifications, applying the same constraints to each. The following paragraphs describe the principal options for retrieval.

The search may be limited geographically by reference to one of the available base maps for displaying results. Those currently available are for: Great Britain, England, Scotland, Wales,and England and Wales together. Base maps for smaller regions may be added as necessary. Limiting the search reduces processing time, and therefore is helpful even if no mapped output is required.

Certain administrative divisions have been incorporated into the data file as extra attributes, and may be referred to in search specifications, for example each square has been assigned to a county via reference numbers. It is possible by this means to limit a search to required counties, while printing the result on an appropriate base map.

In addition to these standard divisions there is also the option of limiting a search to squares identified by their grid references. This is useful for making a series of enquiries about a relatively small region without the necessity either of creating a separate

base map, or of disentangling the relevant information from output lists and maps covering a larger area than that required. Grid references are accepted either with fully numeric codes or with letter codes for the 100 x 100 km square. In the former case the northings for the Shetlands and most of the Orkneys must include the 1000 km number to avoid repetition of references for the south of England. Appendix 1 gives the index numbers and numeric grid references for the 10 x 10 km squares in this data set.

As well as the main data file, two other types of file may be accessed. The first type includes 'external' files which can contain information for grid squares complementary to that in the main set. An example is the file containing species distribution data referred to in Chapter 4 (4.2). The second type of file is used to store the results of a search temporarily which may then be incorporated into a further search, or may be accessed by statistical programs as discussed in section 3.2. The results of up to 10 searches may be put into store and will remain there until explicitly overwritten. This feature allows temporary stores to be created and used as part of a series of enquiries. For example the user might wish to examine various characteristics of squares which are specified as 'undeveloped' on the basis of low values for population and for road and dwelling frequency. The 'undeveloped land' store can be generated first, and then used as part of further search specifications.

Because the data relate to grid cells rather than to the land they contain, for coastal squares there is a pronounced edge effect when using untransformed values. (See Chapter 2 (2.2)). Requests for

squares with more than 50% of land over 61 m high, for example, will mean that coastal squares with 50% land or less will automatically be disqualified. One of the retrieval options will systematically transform data values, for all appropriate attributes used in the specifications, as a function of the amount of land in the square. This enables the identification of all squares within which a specified proportion of the land has a particular characteristic.

The search specifications are processed consecutively, each subjected to the same selection of retrieval options, outlined above, and output options, described below. Each specification contains up to 8 separate parameters (individual criteria) linked by logical operators. The operators are: AND, NOT, OR (inclusive or), and XOR (exclusive or). Each parameter is enclosed in parentheses and is composed of 4 items. The first is the name of the attribute group and the second is the number of the attributes within the group (see Appendix 2). There can be up to 5 individual attribute numbers comprising the second item, the corresponding data values in the main file being summed. The third item in the search parameter is a relational operator selected from the following: 'less than', 'greater than', 'equal to', or 'not equal to'. The characters used are: <, >, = and # respectively. For example the parameter (ALC,1,2,3,<20) defines an interest in squares for which the total amount of land in the 3 highest grades of agricultural quality is less than 20% of the square. Figures for the quartile and decile ranges for each attribute are available for guidance in selecting suitable values for use in each parameter. The following are examples of possible specifications with accompanying descriptions, which may be used to annotate the results:

(CLIM,6,7,8,>60)AND(USE,5,>0)

Occurrence of woodland in squares predominantly receiving more than 1600 mm annual rainfall.

(USE,17,18,>6000)XOR(USE,19,>1500)

Squares characterised by high numbers of either cattle or sheep, but not both. (Note that sheep numbers are held in the data set as x 10^{-1}, see Appendix Table 2.6).

(SOIL,5,6,7,>0)OR(GEOL,29,>0)AND(PHYS,16,17,=0)

Gently sloping squares with some 'peaty' ground surfaces as identified from soil or geological data.

A range of outputs is available from the analytical enquiry program, examples of which are given for a deliberately limited land characteristic in Figure 1. Further examples of maps are given in Figures 2-4. For each search specification, the program generates a statement of the options used and a summary of the result. The latter records the number of relevant squares (i.e. the total number of squares searched), the number of valid squares (i.e. the number of squares within the search area that meet the specification), and the total land area for each of these. For each separate search parameter the summary also gives the attribute totals for relevant and for valid squares, and the amount of land in valid squares. The contribution to the overall outcome of the search made by each parameter is a useful guide to any subsequent 'tuning' that might improve a specification. It should be noted, however, that the figures for attribute totals are always computed from values relating to the whole grid square, whether or not transformation to land area has been selected as the basis for retrieval. For those attributes

recorded as percentage points (see Appendix 2), the total will be in units of square kilometres. See Figure 1a for an example of this type of output.

In addition to the automatically generated statement and summary, the following optional types of output are currently available:

i A map showing the distribution of grid cells meeting the specification, on the chosen base map. The map symbols are selected by the user to show: valid squares, those relevant squares which do not meet the specification, and those with no data for the specified attributes. Figures 1b and 2-4, taken from different attribute groups, show standard line printer maps. The scale distortion of this format can be rectified via alternative outputs if required.

ii A list of squares meeting the specification, giving their index number and grid references (see Figure 1c).

iii A data list for each square meeting the specification. This would normally be selected only in cases where relatively few cells are involved, because values for all attributes are printed. An example for a single square is given in Figure 1d.

iv An output file in a format suitable for submission to plotting programs capable of driving more sophisticated output hardware.

v A list of attribute totals for squares meeting the specification (see Figure 1e)*. For each of the 8 attribute groups the totals

* Though all attribute totals are printed, some (for example PHYS, 10, 11, 12) are not meaningful as totals but can be calculated as average values per grid square.

FIGURE 1a ANALYTICAL ENQUIRY PROGRAM - OPTION AND RESULT SUMMARY

NATIONAL LAND CHARACTERISATION PROJECT 534 27-JAN-83 17:11:58 JOB SIX 1 OF 1

SPECIFICATION (PHYS,9,>0)

DESCRIPTION SQUARES WITH ANY LAND OVER 914 M (3000 FEET)

RETRIEVAL OPTIONS Principal search area GREAT BRITAIN

OUTPUT OPTIONS / Map/ Grid reference list/ Data list/ Attribute totals

MAP SYMBOLS Valid squares * Relevant squares - Missing data :

RESULT STATISTICS

A. FULL SPECIFICATION	Number of relevant squares	2858	Land area of relevant squares	231435.00
	Number of valid squares	73	Land area of valid squares	7242.00
	Number with missing data	0		

B. FOR EACH SEPARATE SPECIFICATION FIELD	Total for relevant squares	Number of valid squares	Total for valid squares	Land in valid squares
FIELD 1	402.00	73	402.00	7242.00

FIGURE 1c ANALYTICAL ENQUIRY PROGRAM - LIST OF VALID SQUARES

Square numbers and grid references

No.	E	N	No.	E	N	No.	E	N	No.	E	N	No.	E	N	No.	E	N	No.	E	N
266	20	88	268	22	88	287	21	87	288	22	87	315	24	86	377	20	84	378	21	84
379	22	84	411	21	83	435	14	82	441	20	82	442	21	82	471	19	81	472	20	81
502	18	80	503	19	80	504	20	80	512	28	80	513	29	80	514	30	80	515	31	80
534	19	79	539	24	79	543	28	79	544	29	79	545	30	79	546	31	79	566	23	78
567	24	78	568	25	78	569	26	78	572	29	78	573	30	78	574	31	78	575	32	78
591	21	77	592	22	77	593	23	77	596	24	77	595	25	77	596	26	77	598	28	77
599	29	77	600	30	77	601	31	77	602	32	77	618	21	76	619	22	76	620	23	76
647	21	75	648	22	75	652	26	75	653	27	75	676	21	74	677	22	74	678	23	74
681	26	74	702	20	73	703	21	73	705	23	73	706	24	73	707	25	73	730	22	72
731	23	72	732	24	72	755	22	71	756	23	71	759	26	71	778	22	70	1231	32	52
1251	33	51	1615	26	36	1647	26	35												

FIGURE 1b ANALYTICAL ENQUIRY PROGRAM - MAP OUTPUT

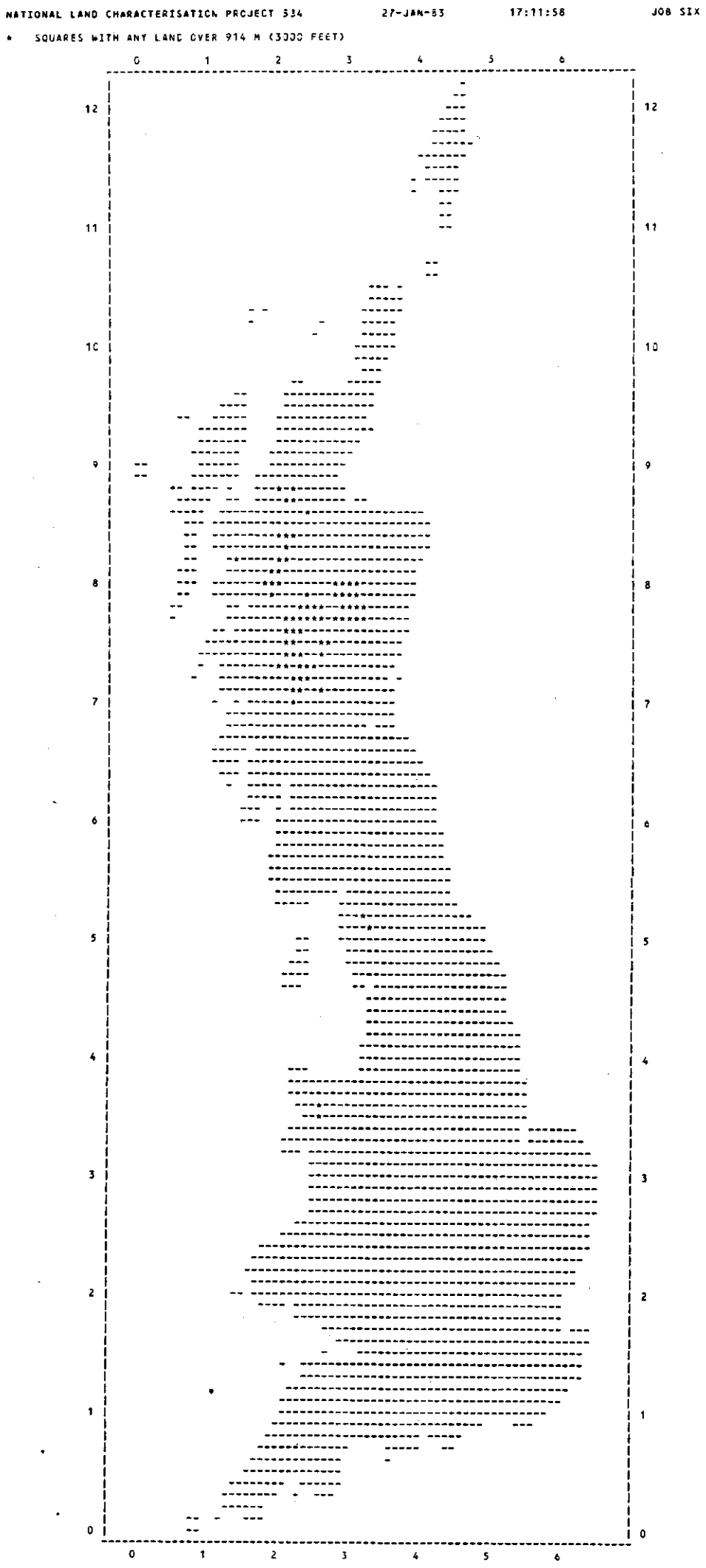


FIGURE 1d ANALYTICAL ENQUIRY PROGRAM - DATA FOR SOME INDIVIDUAL VALID SQUARES

Square number: 567 Grid reference: Easting 24 Northing 78

PHYSIOGR	0	0	0	0	0	50	19	21	10	252	1130	878	5	0	13	19	68	23	13	0				
CLIM ONE	0	0	0	0	45	50	5	0	503	338	601	730	2172	0	7	10	4	5	2	4	3	1	3	10
CLIM TWO	6	7	10	8																				
GEOL ONE	100	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	64	24
GEOL TWO	4	0	0	0	8																			
SOIL	0	0	0	20	50	0	20	10																
TOPOGR.	0	0	2	5	0	0	1																	
L. USE	0	1	72	73	12	0	0	0	0	0	0	0	0	0	0	0	0	141	309	0	1	4		
A.L.C.	0	0	0	0	100	0																		
CONS	0	0	0	0	0	0																		

Square number: 568 Grid reference: Easting 25 Northing 78

PHYSIOGR	0	0	0	0	0	39	32	27	2	260	1049	789	4	0	4	60	30	24	4	0			
CLIM ONE	0	0	0	10	65	25	0	0	503	338	601	730	2172	0	7	10	4	5	2	4	3	1	3	10
CLIM TWO	6	7	10	8																				
GEOL ONE	84	0	0	0	0	0	0	0	16	16	84	0	0	0	0	0	0	0	0	0	0	0	24	72
GEOL TWO	0	0	0	0	4																			
SOIL	0	0	0	0	80	0	20	0																
TOPOGR.	0	0	2	3	2	0	1																	
L. USE	0	1	72	73	16	0	0	0	0	0	0	0	0	0	0	0	0	112	283	0	1	3		
A.L.C.	0	0	0	0	100	0																		
CONS	0	0	0	0	0	0																		

FIGURE 1e ANALYTICAL ENQUIRY PROGRAM - ATTRIBUTE TOTALS FOR THE VALID SQUARES

Group 1 PHYSICGRAPHY

(1. 1)-	58.0	(1. 2)-	10.0	(1. 3)-	156.0	(1. 4)-	176.0	(1. 5)-	524.0	(1. 6)-	1967.0
(1. 7)-	1795.0	(1. 8)-	2222.0	(1. 9)-	402.0	(1.10)-	12619.0	(1.11)-	77806.0	(1.12)-	65187.0
(1.13)-	425.0	(1.15)-	279.0	(1.16)-	943.0	(1.17)-	6020.0	(1.18)-	1625.0	(1.19)-	227.0
(1.20)-	118.0										

Group 2 CLIMATE

(2. 3)-	75.0	(2. 4)-	465.0	(2. 5)-	1285.0	(2. 6)-	2045.0	(2. 7)-	2605.0	(2. 8)-	767.0
(2. 9)-	34196.0	(2.10)-	22299.0	(2.11)-	42133.0	(2.12)-	51700.0	(2.13)-	150331.0	(2.14)-	77.0
(2.15)-	535.0	(2.16)-	791.0	(2.17)-	338.0	(2.18)-	437.0	(2.19)-	146.0	(2.20)-	339.0
(2.21)-	231.0	(2.22)-	79.0	(2.23)-	220.0	(2.24)-	974.0	(2.25)-	739.0	(2.26)-	798.0
(2.27)-	1061.0	(2.28)-	891.0								

Group 3 GEOLOGY

(3. 1)-	5260.0	(3. 2)-	356.0	(3. 3)-	88.0	(3. 8)-	39.0	(3. 9)-	1491.0	(3.10)-	1379.0
(3.11)-	3763.0	(3.12)-	240.0	(3.13)-	196.0	(3.14)-	44.0	(3.15)-	374.0	(3.16)-	308.0
(3.17)-	106.0	(3.19)-	836.0	(3.23)-	3695.0	(3.24)-	2915.0	(3.25)-	66.0	(3.27)-	196.0
(3.29)-	368.0										

Group 4 SOILS

(4. 1)-	131.0	(4. 3)-	134.0	(4. 4)-	298.0	(4. 5)-	1311.0	(4. 6)-	66.0	(4. 7)-	2842.0
(4. 8)-	2441.0										

Group 5 TOPOGRAPHY

(5. 1)-	2.0	(5. 2)-	17.0	(5. 3)-	106.0	(5. 4)-	219.0	(5. 5)-	157.0	(5. 6)-	77.0
(5. 7)-	339.0											

Group 6 LAND USE

(6. 1)-	21.0	(6. 2)-	166.0	(6. 3)-	5257.0	(6. 4)-	5444.0	(6. 5)-	477.0	(6. 6)-	23.0
(6. 9)-	0.0	(6.10)-	3.0	(6.13)-	2.0	(6.16)-	11.0	(6.17)-	3525.0	(6.18)-	28781.0
(6.19)-	45449.0	(6.20)-	269.0	(6.21)-	284.0	(6.22)-	1036.0				

Group 7 AGRIC. LAND QUALITY

(7. 3)-	59.0	(7. 4)-	408.0	(7. 5)-	6712.0	(7. 6)-	63.0

Group 8 CONSERVATION STATLS

(8. 2)-	381.0

FIGURE 2 GRID SQUARES CONTAINING ROCKS OF DEVONIAN AGE (GREAT BRITAIN)

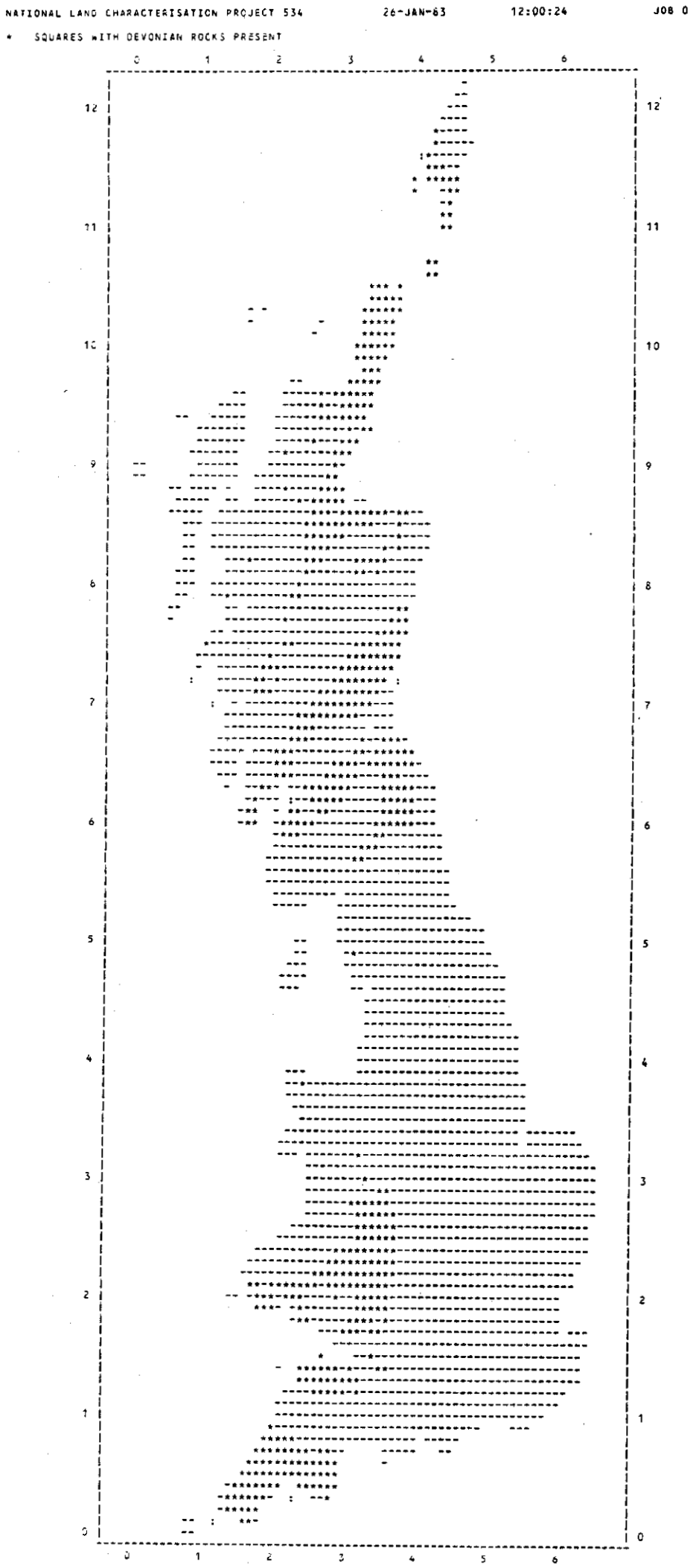


FIGURE 3 GRID SQUARES WITH HIGH ANNUAL AVERAGE TEMPERATURES 1978 - 1981 (ENGLAND AND WALES)

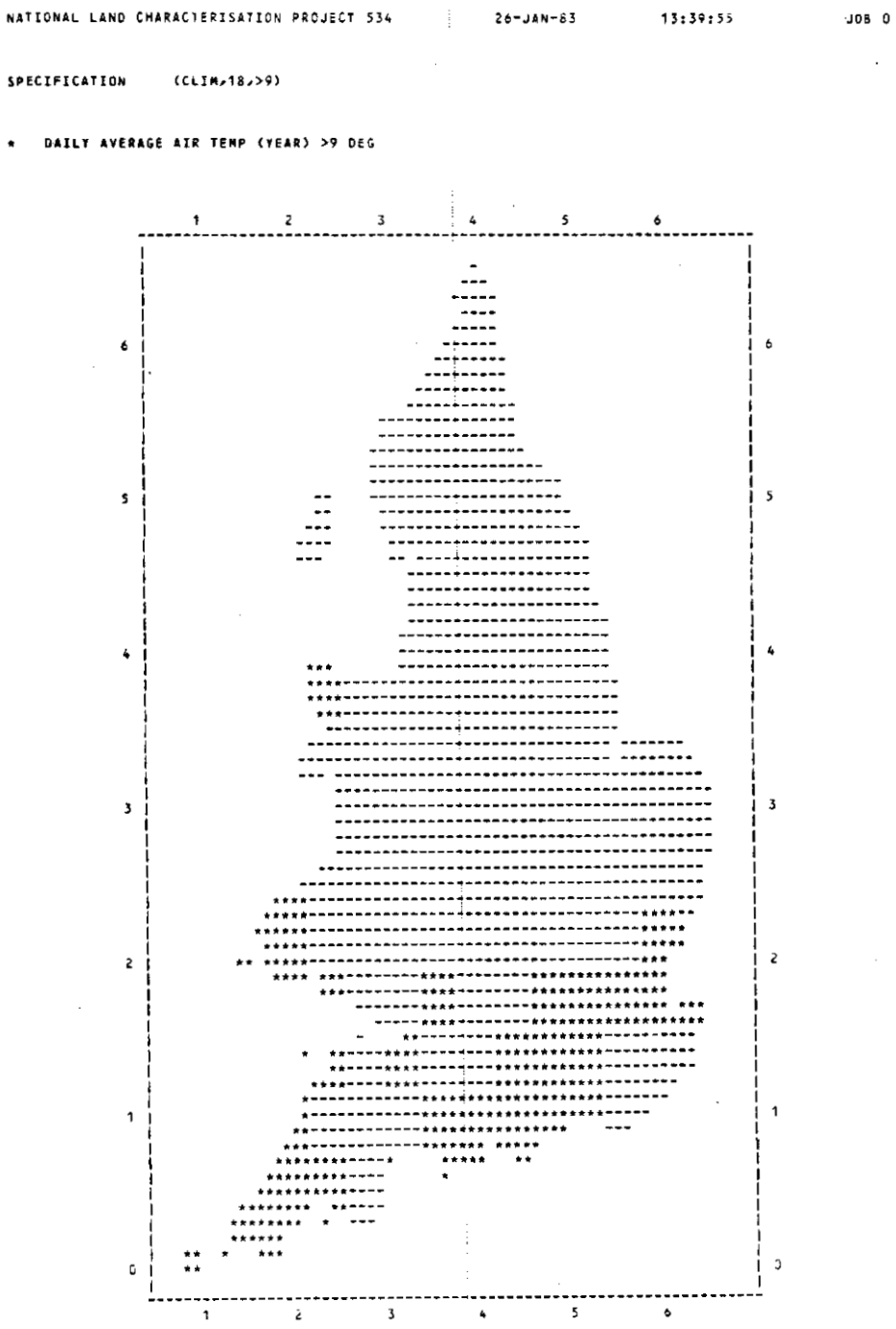
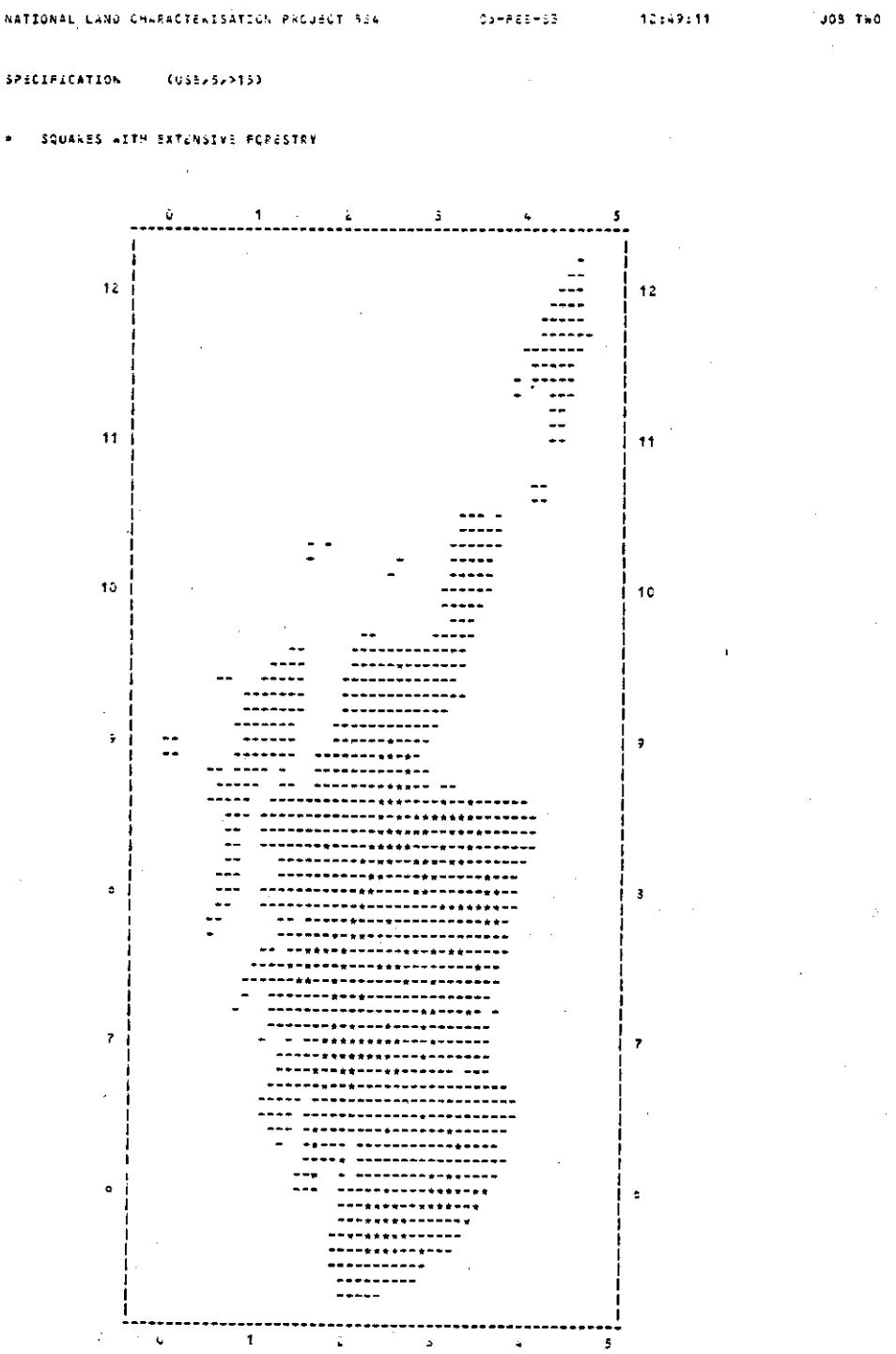


FIGURE 4 GRID SQUARES WITH FORESTRY >15% (SCOTLAND)



of the individual attributes for valid squares are printed where these are non-zero. The values are labelled to correspond with the numbering used in Appendix 2. This option allows the user to examine the outcome of a search in relation to attributes not made use of in the original specification. For example, the numbers of different types of stock, and the areas of different agricultural crops, could be examined in relation to specifications based upon altitudinal zones, soil types or rainfall.

3.2 Statistical summary

Independently of the analytical enquiry process, listings of the values for all attributes, or for attributes within specified data groups, may be obtained for individual 10 x 10 km grid squares, identified by their data set index numbers or by grid references. These listings give the values for each attribute, labelled to correspond with Appendix 2. Additionally, statistical summaries can be provided for land characteristic totals, or for the mean values of land characteristics, for grid squares which make up a defined geographic or administrative region. The ranges, standard errors and standard deviations of these means can also be provided. Table 2 gives statistics for physiographic characteristics, as held in this data set, for Great Britain, England, Scotland and Wales. Ball, Radford and Williams (in press, 1983) show, by comparison of some totals from the data set with 'official' statistics for the same attributes, that the former conform closely to the official values. Due to recent data editing, the land areas now given in Table 2 differ slightly from figures in the earlier paper.

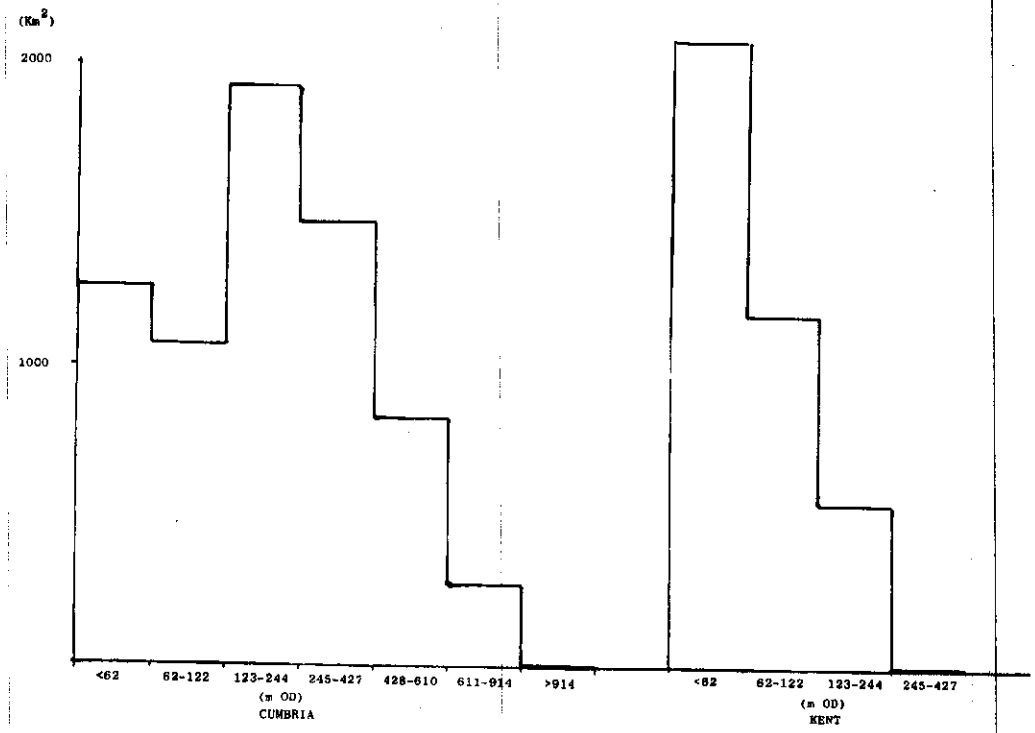
Examples of statistics comparing two very different English counties, Kent and Cumbria, are given in Figure 5 and Table 3. There are 50

TABLE 2 STATISTICS FOR PHYSIOGRAPHIC ATTRIBUTES IN THE DATA SET

	Great Britain	England	Scotland	Wales
Number of 10 x 10 km squares	2858	1478	1117	263
Area of land (km^2)	231433	131261	79346	20826
Area of land under 62 m	68278	50218	14442	3618
Area of land 62-122 m	55821	39415	12861	3545
Area of land 123-244 m	54354	28869	19974	5511
Area of land 245-427 m	34904	9705	19121	6078
Area of land 428-610 m	12411	2658	7909	1844
Area of land 611-914 m	5263	394	4645	224
Area of land over 914 m	402	2	394	6
Area of land with less than 5^o slope	157798	110969	36216	10613
Area of land with 5 - 11^o slope	53931	19157	25861	8913
Area of land with more than 11^o slope	19704	1135	17269	1300
Area of freshwater	2026	412	1527	87
Area of foreshore	3407	1802	1210	395
Length of coastline (km)	13410	3624	8654	1132

and 79 10 x 10 km squares respectively allocated to the two counties, of which 27 and 58 fall entirely within the administrative boundaries. The histograms in Figure 5 are based upon totals for attributes in all squares allocated to the counties. Those for land in each altitude class quantify the wider height range in Cumbria (7 classes, against 4 in Kent) and the difference in the modal altitude class (123-244 m in Cumbria, 0-61 m in Kent). In the case of land use, the histograms show the high preponderance of improved grassland in Cumbria compared with a more equal balance between improved grassland and arable crops in Kent. There is about the same amount of rough, unimproved grazing in Cumbria as there

FIGURE 5 ALTITUDE CLASSES AND LAND USES, CUMBRIA AND KENT



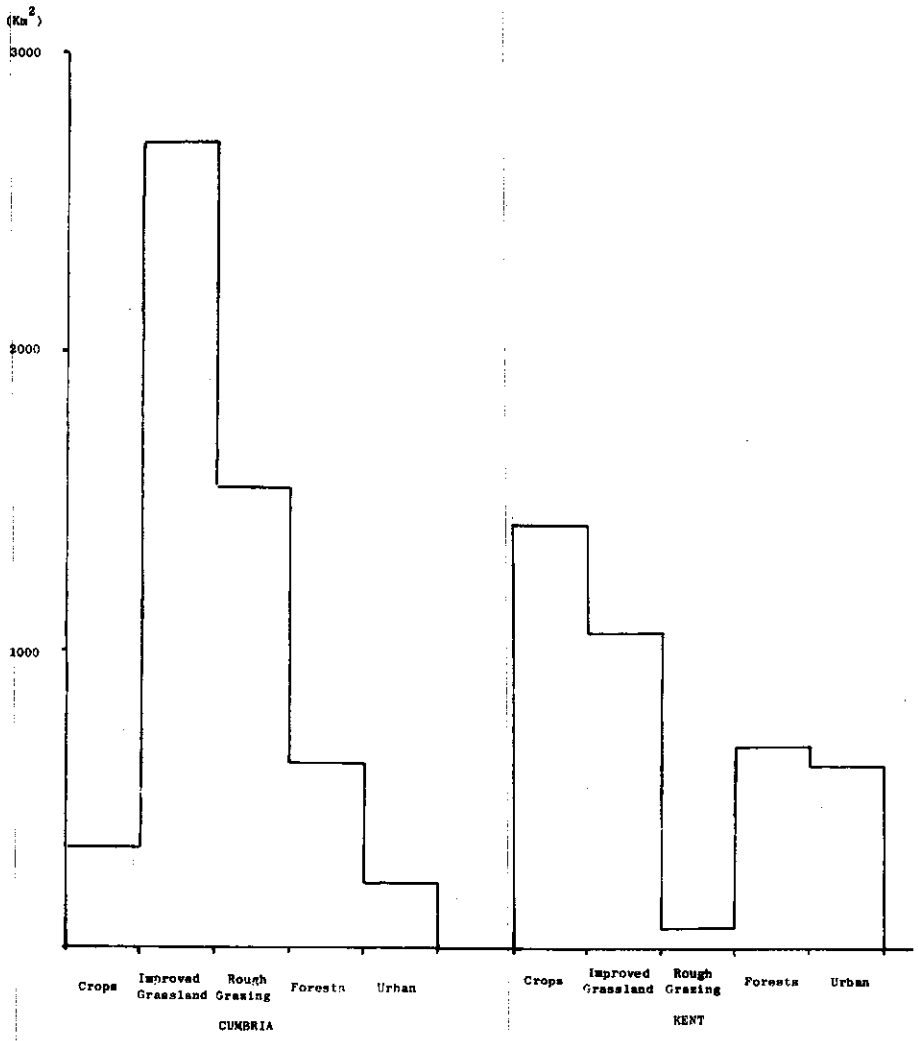


TABLE 3 POPULATION AND LIVESTOCK STATISTICS (AS MEAN AND STANDARD ERRORS PER 100 KM^2)

	Population	Beef Cattle	Dairy cattle	Sheep	Pigs
Cumbria	4500 ± 1100	3700 ± 260	4000 ± 410	22300 ± 1100	700 ± 110
Kent	26300 ± 5800	2100 ± 160	2000 ± 220	16200 ± 3000	4100 ± 340

is arable crop land in Kent, which emphasises the considerable extent of upland grassland in the former, in addition to the extensive improved grassland at lower altitudes. The total amounts of woodland and urban land are somewhat less for Cumbria than for Kent. Whereas, however, there is a considerably greater area of woodland than urban land in Cumbria, in Kent these uses are of comparable extent.

The Figures in Table 3 are means, and, in order to derive estimates of variance between squares, are based upon the 27 and 58 squares which fall entirely in Kent and Cumbria respectively. The means for population and livestock attributes presented in Table 3 show that the average population density (and the number of pigs) are about 6 times higher in Kent. Although average sheep numbers are of the same order in both counties, those for both beef and dairy cattle are roughly twice as high in Cumbria.

TABLE 4 A COMPARISON OF LAND CHARACTERISTICS FOR NORTH YORK MOORS AND EXMOOR NATIONAL PARKS

	North York Moors		Exmoor	
	Total (Km^2)	Mean (%)	Total (Km^2)	Mean (%)
Total number of squares	27		13	
Number of squares with > 49% NP	15		7	
Soils:				
Brown earths	220	14.7	518	74.0
Gley soils	582	38.8	0	0.0
Peaty podzols	5	0.3	0	0.0
Peaty gleys	590	39.3	112	16.0
Deep peats	0	0.0	20	2.9
Agricultural land classes:				
Grade 1	0	0.0	1	0.1
Grade 2	11	0.7	6	0.9
Grade 3	381	25.4	77	11.0
Grade 4	339	22.6	274	39.1
Grade 5	544	36.3	257	36.7
Grade 6	122	8.1	35	5.0

Table 4 compares characteristics of the North York Moors and Exmoor National Parks. Of the 27 grid squares within which the North York Moors Park falls, 15 have at least 50% of their land within the park boundary, and it is these squares that have been used for calculating the values in the table. Similarly for the Exmoor National Park, 7 of the 13 squares have 50% or more of their land within the park. The table shows that whereas the North York Moors have a preponderance of gleys and peaty gleys, Exmoor is dominated by brown earths, with relatively few gley soils, although there are some deep peats, which are absent from the northern park.

The figures for agricultural land classes show that both parks lack any significant amount of land with high potential for

arable use (grades 1 and 2), and that both have relatively little land primarily in non-agricultural use (grade 6). Both parks also have a closely similar proportion of land classed as having very severe limitations to arable agricultural use, (grade 5). The major difference between the parks in terms of agricultural land quality lies in the proportion of the 2 middle grades. The North York Moors have twice as much land with moderate limitations to arable use (grade 3) as Exmoor, whereas the reverse is true for land with severe limitations (grade 4).

As noted in the Introduction, cell recording of data makes it unavoidable that grid squares which are the closest match to actual administrative or geographic boundaries have to be used for statistical and map outputs. The North York Moors National Park has an officially quoted area of 1432 km^2, which compares with an area as measured from 1:250 000 maps for this data set of 1448 km^2 (1.1% error). Measured on the 'closest grid cell' basis, the land area of the 15 major cells is 1397 km^2. This would appear to be a 2.4% error, but these 15 cells include 178 km^2 (12.7%) which in fact fall outside the park boundary, and exclude 213 km^2 (15.2%) which lie within the park, but fall outside the pattern of 'best fitting' cells. In the case of the much smaller Exmoor National Park, of which the official area is 686 km^2, the data set gives a total area of 703 km^2 (2.5% error). On a 'closest grid cell' basis, the area considered is 650 km^2 (5.2% apparent error), but this includes 55 km^2 (8.5%) which lie outside the park boundary, and excludes 90 km^2 (13.8%) which lie within the park, but outside the 7 closest fitting grid cells. Differences between

accurately measured areas and those derived from a closest fit of grid cells tend to decrease as the area under consideration increases. However this relationship is not a simple inverse function, because of the effects of boundary shape, and the location of boundaries in relation to grid lines.

The types of output and statistical summary presented in this chapter illustrate the present capabilities of the retrieval system. They have been designed partly in anticipation of the most frequent type of enquiry, and partly in response to feedback from early exploratory uses made of the data set. The needs of users, both within ITE, and from external enquiries already received, can generally be satisfactorily met by this format. However, there is considerable scope for development, particularly in the field of statistical analysis; plans for such development are outlined in the following chapter.

4. PLANNED DEVELOPMENTS

To recapitulate, an initial set of land attributes for Great Britain has been quantitatively recorded for the 10 x 10 km cells of the Ordnance Survey National Grid. This data set has been computer stored, edited, and now provides a range of retrieval options.

Developments planned over the next 2 years, as discussed later in this chapter, include:

i Stratifications (classifications) of the land of Britain into definable classes, based on analyses of selected parts of the stored data.

ii Consideration of the relationships between land characteristics or classes and the biological distributions already recorded elsewhere at the same scale.

iii Associations between land characteristics and classes at this scale and the results of other work at different scales in ITE.

iv Expansion of the initial data set through additional quantitative data, and supplementary qualitative feature lists.

v Improvement of the quality of information now held in the main data set, as opportunity offers when new source material or more accurate measurements of currently included data become available.

4.1 Land classification

A wide range of statistical methods are available to stratify, dissect, or, in the general sense, 'classify', individual cells in the population of grid cells comprising Great Britain in this data set into classes which are definable quantitatively and descriptively. Such classes, to be useful, must be interpretable in terms of land character and geography in ways that assist understanding and evaluation of the ecological and resource diversity of the country and, applied to other studies, must simplify or improve sampling programmes by providing a basis of meaningful defined land strata.

Within ITE, different classification methods have been applied to geographic cell-based data, but the method most often used has been Indicator Species Analysis (ISA) (Hill, Bunce & Shaw 1975). Among applications of this method to different scales of data have been a provisional classification of the uplands of England and Wales (Ball & Williams 1977, summarised in ITE 1978); work by Bunce & Smith (1978) in a sample-based study of Cumbria; by Bunce, Barr and Whittaker (1981a, b) in a major sample-based study, an ecological survey of Britain; and a district land classification of a range of upland parishes (Ball et al 1981).

ISA has been criticised (Howard and Howard 1981), from a reworking of the Ball and Williams upland data, as not the most effective method for dissecting multivariate geographic data. A variant of the method they prefer, 'k-means cluster analysis', has been used by

Satchell, Mountford and Brown (1981) in a land classification of the United Arab Emirates. A further comparison of alternative classifications, using a sample of grid square data from the national land characteristic data set, is being carried out by Dr D Moss. The results of this study will guide the choice of methods for application to comprehensive classifications at the 10 x 10 km level.

There is no single best classification method likely to be unequivocally applicable to all collections of geographic data, and few totally wrong ones. The aim is to select one which approaches providing the least variability in most characteristics within classes, and the most distinction between classes, while producing a reasonable number of categories for the purpose in hand. It is convenient if these categories also are of relatively uniform size, and have geographically interpretable distributions, as an aid to their presentation and discussion.

From the results of the comparative study of classification methods, alternatives will be explored, with different selections of land data, for Great Britain as a whole, and for political and geographic sub-divisions. It is hoped that results from the chosen methods will be applicable in a consideration of the geography of major land and land use resources of Britain.

4.2 Correlation with species distributions

Species distributions of plants and animals, at the 10 x 10 km scale, have been collated for many years by the Biological Records Centre (BRC),

formerly of the Nature Conservancy, and later part of ITE at Monks Wood Experimental Station. The work of BRC has been described by Heath and Perring (1979), and examples of species distribution atlases based on its work are the publications on non-marine mollusca (Kerney 1976), ferns (Jermy et al 1978) and mammals (Arnold 1978).

The availability now of land characteristic data recorded at this cell size, and the planned development of land classifications from these data, will allow relationships between land character of 10 x 10 km cells, and the occurrence of species or associations of species in these cells, to be explored and presented through combined retrieval from different data sets. Positive associations, and the absence of particular expected associations in some cells, should provide a useful broad view of some ecological aspects in resource assessment studies.

Of course, it must again be emphasised that the stored data refer only to the presence of particular land attributes or particular species somewhere in a 10 x 10 km cell, and thus cannot directly demonstrate any coincidence between environment and species in a habitat/ecosystem relationship. Additionally, species records typically do not show the frequency of a species in a cell, simply that there has been a recorded presence of the species there. The whole question of how one might move on from broad associations using cell data, such as will be possible between this land data set and the available species records, to definitive, quantitative, habitat/species recording and correlation in a comprehensive data

set, as distinct from having detailed knowledge only at specific, limited, sites, is of considerable importan ce to resource and development impact evaluations. Advances here will depend on the availability of appropriate standardised field data on habitats and species, which will involve large scale information collection and handling methods, including data from remote sensing as well as ground sources.

4.3 Comparison of data at different scales

Two aspects of correlation between this land data set and other types and scales of ITE data will be explored. One question is whether the 10 x 10 km cell data, or derived land classes, can be related, with mutual benefit, to classes obtained from the sample-based 1 x 1 km Ecological Survey of Britain (Bunce *et al* 1981 b, 1983). A second, more limited, approach could use the land classification carried out at the 0.5 x 0.5 km 'district' scale for 12 study areas totalling c. 750 km^2 in the uplands of England and Wales (Ball *et al* 1981). By extending this district scale data collection and classification to give complete coverage of the 10 x 10 km squares in which the study areas fall, a small sample will be available to consider the association of upland land types classified at two very different scales. If encouraging, further sample data might enable inferences to be made about the detailed composition of a wider range of 10 x 10 km land classes.

4.4 Additional data

As well as the primary quantitative data now held, and secondary

classifications from these data which may usefully be retained, it is planned to add subsidiary qualitative information for each cell. Such information will, for example, list the presence in cells of features likely to be sources of valuable information, such as Forestry Commission census plots; public and private research and experimental farms; Climatological Stations; National Nature Reserves and other designated conservation areas; the locations of past and current major ITE research studies; and the presence of major industrial enterprises such as power stations, smelters, brickworks and refineries. This type of information will provide a useful supplement to the quantitative data, in resource evaluations or study area selection.

4.5 Improved data

A 'housekeeping' programme to sustain and upgrade the quality of the present data set will continue. It is clear, from some notes in Appendix 2, that some attribute measurements could certainly be improved by the substitution of data recorded off larger-scale source maps, and the advantage from the effort required to make these improvements will be assessed. Measures of some of the characteristics that have been obtained by relatively rapid methods as described here may be replaceable, and desirably replaced, by more accurately measured material from other sources. Liaison with the Experimental Cartography Unit of NERC, as its 'Ecobase' project is developed, provides one possibility here. Additionally, new sources of data should become available that will supersede present less satisfactory material. The current mapping programmes of the Soil Surveys are one obvious source for such improvement. Finally, in cases where land or land use data are changing with time, retention of compatible data for

more than one period would be desirable, and may be possible, to give the opportunity for comparative historical analysis.

5. DATA AVAILABILITY

Statistics, maps and interpretations of land and land use information held in this data set can generally be provided. Charges may be involved. These will depend on the quantity of information required, on the time involved in preparing it, and on whether it can be supplied through standard outputs, or requires individual programs. Requests should initially be directed to:

The Secretary

Institute of Terrestrial Ecology
Bangor Research Station
Penrhos Road
Bangor
Gwynedd
LL57 2LQ
NORTH WALES

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To enable us to have national cover of some land attributes, unpublished maps, referred to in Appendix 2, were made available by Mr Campbell Clark, Department of Agriculture and Fisheries for Scotland (DAFS), and Mr R Grant, Soil Survey Department, Macaulay Institute for Soil Research. The land use statistics were supplied by Professor J T Coppock, University of Edinburgh, and the Edinburgh Regional Computing Centre, permission for the provision and inclusion of these statistics being given by the Ministry of Agriculture, Fisheries and Food, and by DAFS. The Office of Population Censuses and Surveys supplied population statistics.

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APPENDIX 1

INDEX NUMBERS AND GRID REFERENCES OF THE 10 X 10 KM GRID SQUARES CONTAINING LAND IN GREAT BRITAIN

The index numbers 1-2858 run in rows from west to east, starting with 1, in a 1-square row, in the north (a square containing Out Stack, off Muckle Flugga, Unst, Shetland), and ending with 2858 as the eastern end of the most southerly row (part of St Mary's, Scilly).

Grid references are given in numeric form. For most of Britain, 4-figure grid references are sufficient, but 5 figures are needed for squares north of a line through southern Orkney, to avoid repetition of references for southern English squares.

The criteria for 'land', and thus for the inclusion of a grid square in the data set, are discussed in Appendix 2.1.

No.	E	N	No.	E	N	No.	E	N	No.	E	N	No.	E	N	No.	E	N	No.	E	N
1	46	122	2	45	121	3	46	121	4	44	120	5	45	120	6	46	120	7	43	119
8	44	119	9	45	119	10	46	119	11	42	118	12	43	118	13	44	118	14	45	118
15	46	118	16	42	117	17	43	117	18	44	117	19	45	117	20	46	117	21	47	117
22	40	116	23	41	116	24	42	116	25	43	116	26	44	116	27	45	116	28	46	116
29	41	115	30	42	115	31	43	115	32	44	115	33	45	115	34	39	114	35	41	114
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43	45	113	44	43	112	45	44	112	46	43	111	47	44	111	48	43	110	49	44	110
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134	31	95	135	32	95	136	33	95	137	6	94	138	7	94	139	11	94	140	12	94
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2542	53	14	2543	54	14	2544	55	14	2545	56	14	2546	57	14	2547	58	14	2548	59	14
2549	60	14	2550	61	14	2551	62	14	2552	63	14	2553	24	13	2554	25	13	2555	26	13
2556	27	13	2557	28	13	2558	29	13	2559	30	13	2560	31	13	2561	32	13	2562	33	13
2563	34	13	2564	35	13	2565	36	13	2566	37	13	2567	38	13	2568	39	13	2569	40	13
2570	41	13	2571	42	13	2572	43	13	2573	44	13	2574	45	13	2575	46	13	2576	47	13
2577	48	13	2578	49	13	2579	50	13	2580	51	13	2581	52	13	2582	53	13	2583	54	13
2584	55	13	2585	56	13	2586	57	13	2587	58	13	2588	59	13	2589	60	13	2590	61	13
2591	62	13	2592	63	13	2593	22	12	2594	23	12	2595	24	12	2596	25	12	2597	26	12
2598	27	12	2599	28	12	2600	29	12	2601	30	12	2602	31	12	2603	32	12	2604	33	12
2605	34	12	2606	35	12	2607	36	12	2608	37	12	2609	38	12	2610	39	12	2611	40	12
2612	41	12	2613	42	12	2614	43	12	2615	44	12	2616	45	12	2617	46	12	2618	47	12
2619	48	12	2620	49	12	2621	50	12	2622	51	12	2623	52	12	2624	53	12	2625	54	12
2626	55	12	2627	56	12	2628	57	12	2629	58	12	2630	59	12	2631	60	12	2632	61	12
2633	21	11	2634	22	11	2635	23	11	2636	24	11	2637	25	11	2638	26	11	2639	27	11
2640	28	11	2641	29	11	2642	30	11	2643	31	11	2644	32	11	2645	33	11	2646	34	11
2647	35	11	2648	36	11	2649	37	11	2650	38	11	2651	39	11	2652	40	11	2653	41	11

2654	42	11	2655	43	11	2656	44	11	2657	45	11	2658	46	11	2659	47	11	2660	48	11
2661	49	11	2662	50	11	2663	51	11	2664	52	11	2665	53	11	2666	54	11	2667	55	11
2668	56	11	2669	57	11	2670	58	11	2671	59	11	2672	60	11	2673	21	10	2674	22	10
2675	23	10	2676	24	10	2677	25	10	2678	26	10	2679	27	10	2680	28	10	2681	29	10
2682	30	10	2683	31	10	2684	32	10	2685	33	10	2686	34	10	2687	35	10	2688	36	10
2689	37	10	2690	38	10	2691	39	10	2692	40	10	2693	41	10	2694	42	10	2695	43	10
2696	44	10	2697	45	10	2698	46	10	2699	47	10	2700	48	10	2701	49	10	2702	50	10
2703	51	10	2704	52	10	2705	53	10	2706	54	10	2707	55	10	2708	56	10	2709	57	10
2710	58	10	2711	20	09	2712	21	09	2713	22	09	2714	23	09	2715	24	09	2716	25	09
2717	26	09	2718	27	09	2719	28	09	2720	29	09	2721	30	09	2722	31	09	2723	32	09
2724	33	09	2725	34	09	2726	35	09	2727	36	09	2728	37	09	2729	38	09	2730	39	09
2731	40	09	2732	41	09	2733	42	09	2734	43	09	2735	44	09	2736	45	09	2737	46	09
2738	47	09	2739	48	09	2740	49	09	2741	54	09	2742	55	09	2743	56	09	2744	19	08
2745	20	08	274e	21	08	2747	22	08	2748	23	08	2749	24	08	2750	25	08	2751	26	08
2752	27	08	2753	28	08	2754	29	08	2755	30	08	2756	31	08	2757	32	08	2758	33	08
2759	34	08	2760	35	08	2701	36	08	2762	37	08	2763	38	08	2764	39	08	2765	40	08
2766	42	08	2767	43	08	2768	44	08	2769	45	08	2770	46	08	2771	18	07	2772	19	07
2773	20	07	2774	21	07	2775	22	07	2776	23	07	2777	24	07	2778	25	07	2779	26	07
2780	27	07	2781	28	07	2782	29	07	2783	30	07	2784	36	07	2785	37	07	2786	38	07
2787	39	07	2788	40	07	2789	44	07	2790	45	07	2791	17	06	2792	18	06	2793	19	06
2794	20	06	2795	21	06	279e	22	06	2797	23	06	2798	24	06	2799	25	06	2800	26	06
2801	27	06	2802	28	06	2803	29	06	2804	36	06	2805	16	05	2806	17	05	2807	18	05
2808	19	05	2809	20	05	2810	21	05	2811	22	05	2812	23	05	2813	24	05	2814	25	05
2815	26	05	281e	27	05	2817	28	05	2818	29	05	2819	14	04	2820	15	04	2821	16	04
2822	17	04	2823	18	04	2824	19	04	2825	20	04	2826	21	04	2827	24	04	2828	25	04
2829	26	04	2830	27	04	2831	28	04	2832	29	04	2833	13	03	2834	14	03	2835	15	03
283e	16	03	2837	17	03	2838	18	03	2839	19	03	2340	20	03	2841	23	03	2842	26	03
2843	27	03	2844	28	03	2845	13	02	2846	14	02	2847	15	02	2848	16	02	2849	17	02
2850	18	02	2851	08	01	2852	09	01	2353	12	01	2854	16	01	2855	17	01	2856	18	01
2857	0e	00	2858	09	00															

APPENDIX 2

DETAILS OF ATTRIBUTES IN THE LAND CHARACTERISTIC DATA SET

For each data group, an introduction summarises the sources and some general points about the information used. Tables then list the attributes, identified by group reference and attribute number (e.g. PHYS, 1), with specific points covered in footnotes.

2.1 Physiographic attributes

20 physiographic attributes are listed in Table 2.1. Their source is principally the 1:250 000 series of Ordnance Survey (OS) maps, of which sheets 1-17 cover Great Britain. In the longer term, complete substitution of more accurate data off the 1:50 000 OS series could be desirable, but an adequate initial regional and national picture of the country's physiographic diversity is provided from the much more rapidly recorded data off the 1:250 000 series. Height range attributes (PHYS, 10-12) have however been taken at this stage from 1:50 000 maps, because only inadequate figures are possible for many grid squares from the fewer contours and limited spot heights of the 1:250 000 series. PHYS, 1-9, 15-17 and 19 were measured using a 100-point grid; other measurement methods are given in notes to Table 2.1.

Two points of definition should be drawn attention to here. The first point concerns the lower limits of 'land area' and 'coastline'. By definition the cells recorded all contain land. In some 100 cells, however, the extent of land is very small, either because of the way 10 km grid lines fall with respect to the mainland or major island coasts, or because the cell includes only a minor offshore islet or islets. In such cases the point count measureing method is likely to fail to record its minimum of 1% land, and the length of coastline can be only a fraction of a kilometre. In all these cases minimum area measures of 1% land and a coastline length of 1 km have been assigned to the cell. The converse applies to about 10 predominantly land squares which just cross the coast. These are recorded as having 1% sea, and again 1 km coastline.

The second point concerns the definition of 'sea'. It has been taken here to include wide tidal bays connected to open water by narrow channels; all tidal channels between islands; and tidal estuaries and creeks >1 km wide. This arbitrary limit is preferred as it generally separates the sections of estuaries that have tidal shorelines, certainly 'coastal' in character, from river courses which, though still tidal, have banks of 'inland' character, but it unavoidably excludes a few narrow tidal inlets, such as occur in southwest England and south west Wales.

Northern Ireland and the Channel Islands are not covered. Otherwise, the only square with UK land that has been intentionally omitted is the islet of Rockall, because of its location some 300 km west of the otherwise furthest west islands of the St Kilda group. A couple of 10 x 10 km squares which only have reefs and rocks that are covered at high water have been omitted (e.g. one containing 'Seven Stones', off Scilly and another with some reefs just east of Faraid Head, north Scotland). A few other such squares have been included but only where they carry a lighthouse or light (Skerryvore, Bell Rock, The Smalls, Eddystone Rocks and Wolf Rock).

APPENDIX TABLE 2.1

PHYSIOGRAPHY DATA GROUP ATTRIBUTES

Identified in the data set as PHYS, 1-20. All data from 1:250 000 OS maps, except for PHYS, 10-12, taken from 1:50 000 OS maps.

ATTRIBUTES

Sea and areas offshore exposed at low tide - recorded as % of grid square, in 1% units.

PHYS, 1 Sea (including 'foreshore' PHYS, 2)
PHYS, 2 Foreshore

Altitude classes - recorded as % of grid square, in 1% units

PHYS, 3 Land of altitude 0-61 m (0-200 ft)
PHYS, 4 Land of altitude 62-122 m (201-400 ft)
PHYS, 5 Land of altitude 123-244 m (401-800 ft)
PHYS, 6 Land of altitude 245-427 m (801-1400 ft)
PHYS, 7 Land of altitude 428-610 m (1401-2000 ft)
PHYS, 8 Land of altitude 611-914 m (2001-3000 ft)
PHYS, 9 Land of altitude >914 m (3000 ft)

Altitude range - recorded as figures in m

PHYS, 10 Lowest contour or spot height recorded in grid square
PHYS, 11 Highest contour or spot height recorded in grid square
PHYS, 12 Height difference between highest and lowest mapped contour or spot height.

Major relief - recorded as the number of slope direction changes along 2 diagonal transects through the mid-point of the square

PHYS, 13 Number of changes of slope direction with >183 m (600 ft) height difference to next slope change
PHYS, 14 Number of changes of slope direction with 61-182 m (200-600 ft) height difference to next slope change (1.14 is recorded only when 1.13 is zero)

Slope classes - recorded as % of grid square, in 1% units, measured from classes drawn from contour spacings

PHYS, 15 Land of slope $<5^0$
PHYS, 16 Land of slope $5\text{-}11^0$
PHYS, 17 Land of slope $>11^0$

Relative river frequency - recorded as a frequency score (0-25) from the number of sub-cells in a 5 x 5 grid overlay on the 10 x 10 km cell which contain any mapped river.

PHYS, 18 River frequency score

Water bodies - recorded as % of grid square, in 1% units

PHYS, 19 Lakes and reservoirs

Coastline - recorded using a hand map-measuring wheel, as length in km

PHYS, 20 Coastline length

NOTES

a) The extent of land in coastal cells (as PHYS, 3-9) is taken as a standard measure, to which other data groups are adjusted, as discussed in Chapter 2 (2.2).

b) Sea (PHYS, 1) has been defined as all open marine areas including straits between islands and the mainland, as well as natural harbours and estuaries >1 km wide. An arbitrary junction between 'sea' and 'river' (considered as part of the land area) is thus made in estuaries like the Tay, Forth, Colne and Thames. The extent of sea includes any foreshore also recorded (PHYS, 2).

c) 'Foreshore' is the exposed intertidal zone shown on the 1:250 000 maps by symbols for soft deposits or rock platforms. Off-shore banks are not included.

d) Because the OS map set used had contours in feet, conversions to metric height ranges necessarily give apparently curious class limits.

e) The 1:250 000 maps give problems in accurate direct measurement of altitude class areas (PHYS, 3-9) and in overdrawing slope classes (PHYS, 15-17) on them in regions such as the Western Highlands of Scotland where relief is very strong and contours consequently closely spaced. Data for such areas would benefit by substitution of more accurately measured classes off the 1:50 000 scale maps. However 2nd series maps at this scale, with contours at 10 m intervals, will not be complete for some years, so that many areas will continue to have 1st series 1:50 000 maps with contours transformed to metric spacings. To what extent critical areas can be usefully re-recorded off existing 1:50 000 maps is being considered.

f) Water bodies (PHYS, 19) as recorded here include natural lakes and man-made reservoirs (inclusion of the latter being the only departure in this data group from natural environmental attributes). The omission of small bodies of water and some large recent reservoirs on the 1:250 00 edition used has been noted as a problem in providing accurate measurements of this attribute (Ball, Radford and Williams 1983). The present measurements will, when possible, be substituted by better data from the latest editions of 1:50 000 maps. A detailed study of

the representation of inland waters on the 1:250 000 OS maps by Smith and Lyle (1979) suggests that the water bodies on these are in general those of area greater than 4 ha. In number these are only about 14% of upland water bodies and only a few percent of those in lowland Britain, but they account in area, as measured in the present national data set, for 82% of the official figure of 2740^2 (COI 1981). The area determined by point count measurement (2026 km^2) is reasonably close to the figure of 1924 km^2 obtained by Smith and Lyle using a different method.

g) PHYS, 13-14 are an attempt to provide a relative assessment of surface relief as a supplement to the single figure for maximum height difference in a square given as PHYS, 12.

2.2 Climatic attributes

The 28 climatic attributes included are listed in Appendix Table 2.2. Apart from published 1:625 000 maps of average annual rainfall, only very small-scale maps of long-term averages of most other climatic variables are available, extrapolated from data from scattered climatological stations, which are less frequent in the more variable climates of upland Britain than they are in the less climatically variable but more populated lowlands.

Attributes CLIM, 1-8 are taken, as areas in rainfall ranges in each grid square, from the 1941-1970 Annual Average Rainfall maps, measured by a 20-point grid. Other attributes in this group have been calculated, as a single figure for each attribute applying to a grid square, from cell-plotted monthly data for 40 x 40 km cells providing during the 3 years April 1978 - March 1981 by the Meteorological Office under its "Rainfall and Evaporation Calculation System" (MORECS). From the monthly averages of each quantity for the 40 x 40 km cells, seasonal and annual 3-year averages have been calculated, and these values have then been applied uniformly to all 10 x 10 km cells within a 40 x 40 km cell. MORECS did not totally cover the coastal areas of Great Britain. Where an omitted 10 x 10 km cell is reasonably adjacent to a MORECS cell, the data from the latter have been extrapolated beyond its limits to the adjacent 10 x 10 km squares. In the case of Shetland and some remote western islands for which no MORECS data were provided, such extrapolation would have had to be stretched too far to be acceptable, so short-term climatic data are not available for these parts of the country. Clearly a 3-year average is not as stable, in relation to values from other periods of similar length, as are long-term

averages from periods of 30 years or so. The MORECS data however emphasise that variability in any month from one year to another in a single cell can be greater than variation between adjacent cells in the same year. Since any average disguises such annual variations, and the MORECS material provides the only convenient possibility of including in this data set seasonal data for important climatic variables, estimated recently across Britain, it has been drawn on here.

APPENDIX TABLE 2.2

CLIMATE DATA GROUP ATTRIBUTES

Identified in the data set as CLIM, 1-28. CLIM, 1-8 are from 1:625 000 Meteorological Office maps of Annual Average Rainfall, 1941-1970. CLIM, 9-28 are calculated from monthly 40 x 40 km cell-based maps provided from April 1978 to March 1981 by the Meteorological Office Rainfall and Evaporation Calculation System (MORECS).

ATTRIBUTES

Average Annual Rainfall classes 1941-1970 - recorded as % of grid square, in 5% units

CLIM, 1 Annual rainfall <600 mm (<24 in)
CLIM, 2 Annual rainfall 600-799 mm (24.31 in)
CLIM, 3 Annual rainfall 800-999 mm (32-39 in)
CLIM, 4 Annual rainfall 1000-1199 mm (40-47 in)
CLIM, 5 Annual rainfall 1200-1599 mm (48-63 in)
CLIM, 6 Annual rainfall 1600-2199 mm (64-86 in)
CLIM, 7 Annual rainfall 2200-3199 mm (87-126 in)
CLIM, 8 Annual rainfall >3200 mm (>126 in)

Short-term seasonal and annual climatic attributes 1978-1981 - recorded as average values for each grid square, rainfall in mm, air temperature in ^{0}C, sunshine in hrs/day, and windspeed in km/hr.

CLIM, 9 Rainfall, average total, January-March
CLIM, 10 Rainfall, average total, April-June
CLIM, 11 Rainfall, average total, July-September
CLIM, 12 Rainfall, average total, October-December
CLIM, 13 Rainfall, average total, year

CLIM, 14 Air temperature, daily average, January-March
CLIM, 15 Air temperature, daily average, April-June
CLIM, 16 Air temperature, daily average, July-September
CLIM, 17 Air temperature, daily average, October-December
CLIM, 18 Air temperature, daily average, year

CLIM, 19 Sunshine, daily average, January-March
CLIM, 20 Sunshine, daily average, April-June
CLIM, 21 Sunshine, daily average, July-September
CLIM, 22 Sunshine, daily average, October-December
CLIM, 23 Sunshine, daily average, year

CLIM, 24 Windspeed, daily average, January-March
CLIM, 25 Windspeed, daily average, April-June
CLIM, 26 Windspeed, daily average, July-September
CLIM, 27 Windspeed, daily average, October-December
CLIM 28 Windspeed, daily average, year

classes have been made regionally. The lithological classes used involve subjective judgements, for example which rocks are 'hard' and which 'soft'. GEOL, 18 is intended for loose sands and relatively friable and rapidly weathering consolidated sandstones, compared to the massive indurated sandstones characteristic of the older rock systems; GEOL, 20 is applied to strata with unconsolidated clays or friable shales compared to less readily weathered shales and slates. GEOL, 22 covers chalk and a few other calcareous rocks from younger strata, while GEOL, 21 is applied to older limestones.

In treating surface geology, as drawn from maps showing the nature of unconsolidated deposits which conceal solid rock outcrops, seven attributes have been used, derived from a slight condensation of the mapping units of the IGS drift sheets.

Appendix 3 shows the equivalence adopted between mapping units on the source maps and the derived attributes held in this data set.

APPENDIX TABLE 2.3

GEOLOGY DATA GROUP ATTRIBUTES

Identified in the data set as GEOL, 1-29, derived from mapping units of the 1:625 000 Institute of Geological Sciences, Great Britain (North and South) maps of solid and drift geology.

ATTRIBUTES

Bedrock Stratigraphy - recorded as % of grid square, in 4% units

GEOL,	1	Pre-Cambrian
GEOL,	2	Cambrian, Ordovician and Silurian
GEOL,	3	Devonian
GEOL,	4	Carboniferous
GEOL,	5	Permian and Triassic
GEOL,	6	Jurassic
GEOL,	7	Cretaceous
GEOL,	8	Tertiary
GEOL,	9	Igneous rocks of unspecified stratigraphic age

Bedrock lithology - recorded as % of grid square, in 4% units

GEOL,	10	Intrusive acid igneous rocks and lithologically similar metamorphic rocks (e.g. granite and gneiss)
GEOL,	11	Extrusive acid igneous rocks and lithologically similar metamorphic rocks (e.g. rhyolite and mica-schist)
GEOL,	12	Intrusive basic igneous rocks and lithologically similar metamorphic rocks (e.g. dolerite and hornblende-gneiss)
GEOL,	13	Extrusive basic igneous rocks and lithologically similar metamorphic rocks (e.g. basalt and hornblende-schist)
GEOL,	14	Igneous or metamorphic rocks of high ferro-magnesian composition (e.g. peridotite and serpentine)
GEOL,	15	Metamorphic quartzose rocks (quartzite)
GEOL,	16	Metamorphic calcareous rocks (metamorphosed limestone)
GEOL,	17	Hard sandy sedimentary rocks (hard sandstones, grits)
GEOL,	18	Soft sandy sedimentary rocks (soft sandstones and sands)
GEOL,	19	Hard clayey sedimentary rocks (slates, shales)
GEOL,	20	Soft clayey sedimentary rocks (clays)
GEOL,	21	Hard calcareous sedimentary rocks (limestone)
GEOL,	22	Soft calcareous sedimentary rocks (chalk)

Surface geology - recorded as % of grid square, in 4% units

GEOL,	23	Bedrock
GEOL,	24	Boulder clay or other drift cover with a medium- to fine-textured matrix
GEOL,	25	Sand and gravel drift cover
GEOL,	26	'Clay-with-flints' cover
GEOL,	27	Alluvial cover
GEOL,	28	Wind-blown cover
GEOL,	29	Peaty cover

classes have been made regionally. The lithological classes used involve subjective judgements, for example which rocks are 'hard' and which 'soft'. GEOL, 18 is intended for loose sands and relatively friable and rapidly weathering consolidated sandstones, compared to the massive indurated sandstones characteristic of the older rock systems; GEOL, 20 is applied to strata with unconsolidated clays or friable shales compared to less readily weathered shales and slates. GEOL, 22 covers chalk and a few other calcareous rocks from younger strata, while GEOL, 21 is applied to older limestones.

In treating surface geology, as drawn from maps showing the nature of unconsolidated deposits which conceal solid rock outcrops, seven attributes have been used, derived from a slight condensation of the mapping units of the IGS drift sheets.

Appendix 3 shows the equivalence adopted between mapping units on the source maps and the derived attributes held in this data set.

APPENDIX TABLE 2.3

GEOLOGY DATA GROUP ATTRIBUTES

Identified in the data set as GEOL, 1-29, derived from mapping units of the 1:625 000 Institute of Geological Sciences, Great Britain (North and South) maps of solid and drift geology.

ATTRIBUTES

Bedrock Stratigraphy - recorded as % of grid square, in 4% units

GEOL,	1	Pre-Cambrian
GEOL,	2	Cambrian, Ordovician and Silurian
GEOL,	3	Devonian
GEOL,	4	Carboniferous
GEOL,	5	Permian and Triassic
GEOL,	6	Jurassic
GEOL,	7	Cretaceous
GEOL,	8	Tertiary
GEOL,	9	Igneous rocks of unspecified stratigraphic age

Bedrock lithology - recorded as % of grid square, in 4% units

GEOL,	10	Intrusive acid igneous rocks and lithologically similar metamorphic rocks (e.g. granite and gneiss)
GEOL,	11	Extrusive acid igneous rocks and lithologically similar metamorphic rocks (e.g. rhyolite and mica-schist)
GEOL,	12	Intrusive basic igneous rocks and lithologically similar metamorphic rocks (e.g. dolerite and hornblende-gneiss)
GEOL,	13	Extrusive basic igneous rocks and lithologically similar metamorphic rocks (e.g. basalt and hornblende-schist)
GEOL,	14	Igneous or metamorphic rocks of high ferro-magnesian composition (e.g. peridotite and serpentine)
GEOL,	15	Metamorphic quartzose rocks (quartzite)
GEOL,	16	Metamorphic calcareous rocks (metamorphosed limestone)
GEOL,	17	Hard sandy sedimentary rocks (hard sandstones, grits)
GEOL,	18	Soft sandy sedimentary rocks (soft sandstones and sands)
GEOL,	19	Hard clayey sedimentary rocks (slates, shales)
GEOL,	20	Soft clayey sedimentary rocks (clays)
GEOL,	21	Hard calcareous sedimentary rocks (limestone)
GEOL,	22	Soft calcareous sedimentary rocks (chalk)

Surface geology - recorded as % of grid square, in 4% units

GEOL,	23	Bedrock
GEOL,	24	Boulder clay or other drift cover with a medium- to fine-textured matrix
GEOL,	25	Sand and gravel drift cover
GEOL,	26	'Clay-with-flints' cover
GEOL,	27	Alluvial cover
GEOL,	28	Wind-blown cover
GEOL,	29	Peaty cover

NOTES

a) In other data groups with maps at the 1:625 000 scale a 20-point grid overlay was used, giving area measurements in 5% units. Geology was a later data group recorded. It was found equally convenient and slightly more precise to use a 25 point grid giving 4% area units. Denser point overlays than this are too laborious to use at this map scale and would be inappropriate in relation to the simplification of map unit boundaries involved in preparing the source maps.

b) Of the surface geology attributes, clay-with-flints is a minor feature localised over Cretaceous (GEOL, 7) soft calcareous sedimentary rocks (GEOL, 22) but is of sufficient geological and ecological interest to justify retaining separately. 'Peat' as mapped by IGS is typically of greater purity and depth than is the case in some areas identified in the Soil data group as dominated by 'Deep Peaty Soils and Peats' (SOIL, 7) so that peaty cover as defined by the soil attribute is more extensive than as defined by the geology attribute.

c) IGS drift maps at this scale do not distinguish the mineralogical nature of the drift so that it is not possible to identify where drift composition differs substantially from that of the underlying solid rocks.

2.4 .Soil attributes

The 8 attributes listed in Appendix Table 2.4 have been simplified from the mapping units of the 1:1 000 000 Soil Map of England and Wales; from an unpublished draft map of soils in Scotland made available by Mr R Grant, Soil Survey Department, Macaulay Institute, Aberdeen; and from a soil map of the Isle of Man by Dr B S Kear.

On the source maps the mapping units are complexes dominated by a named major soil group occurring in association with other named soil groups. 71 mapping units occur on the England and Wales map and 23 on the unpublished Scottish map. To reduce these to a few classes clearly required very great further simplification of already simplified source data. The attributes used are classes dominated by a single major soil group, or several closely similar major soil groups, using traditional conventional terminology rather than the current but, as yet, less widely appreciated current survey nomenclature. As with the geological data, initial recording listed the proportion of each square occupied by the mapping units of the source maps, using a 20-point grid for the England and Wales map, and a 10-point grid for the Scottish map. The initial data lists were then edited to give the simplified classes. Appendix 4 gives the correlations applied between mapping units on the source maps and the recorded attributes.

The soil data group can be expected to be substantially improvable in the near future as a result of the current mapping programmes of the Soil Surveys of England and Wales and of Scotland. The two organisations are producing a new, co ordinated, 1:250 000 series of soil maps from comprehensive field work, which will give much more accurate source maps. From these a wider range of soil attribute categories could usefully be drawn to replace the present material.

APPENDIX TABLE 2.4

SOIL DATA GROUP ATTRIBUTES

Identified in the data set as SOIL, 1-8. Data are simplified from mapping units of the 1:1 000 000 Soil Map of England and Wales published by the Soil Survey of England and Wales, Rothamsted Experimental Station, Harpenden; of an unpublished draft soil map of Scotland made available by Mr R Grant, Soil Survey Department, Macaulay Institute, Aberdeen; and of a map of the soils of the Isle of Man at 1:63 360 by Dr B S Kear (published by North of England Soil Group 1982).

ATTRIBUTES

Dominant soils - recorded as % of grid square, in 5% units for England and Wales, and 10% units for Scotland

SOIL, 1 Brown Earth Variants
SOIL, 2 Rendzinas or Calcareous Soils
SOIL, 3 Gley Soils
SOIL, 4 Humus or Iron Podzols or Brown Podzolic Soils
SOIL, 5 Peaty Podzols
SOIL, 6 Peaty Gleys
SOIL, 7 Deep Peaty Soils and Peats
SOIL, 8 Immature or Skeletal Soils

NOTES

a) Attribute SOIL, 1 covers areas dominated by freely-drained mineral soils; SOIL, 2 areas dominated by shallow or deeper soils associated with lime-rich parent materials, including calcareous dune sands in Scotland; SOIL, 3 areas dominated by poorly drained non-peaty soils; SOIL, 4 areas dominated by freely drained upland marginal soils and lowland heath soils; SOIL, 5 and 6 areas dominated respectively by moderately and very poorly drained peaty-topped moorland and hill soils; SOIL, 7 areas dominated by organic soils; and SOIL, 8 covers areas dominated by shallow soils with rock outcrops (Ranker variants) in Scotland and siliceous coastal dune sands. Other soil groups occur as subordinate associates of the named dominant soils, and these latter may occur as subordinate members of other attribute classifications.

b) On the soil map of England and Wales, a mapping unit shows major urban areas. Because it is not reasonable to make assumptions about the nature of any soil cover in such areas, the procedure of equating the extent of SOIL, 1-8 with the standard area of land for a square has not been applied to soil data.

2.5 Topographic attributes

The 1:250 000 series Ordnance Survey maps provide six of the seven topographic attributes included in Appendix Table 2.5, the seventh being figures for the total population of each 10 x 10 km grid cell in 1970, supplied by the Office of Population Censuses and Surveys.

Attributes TOP, 1-3 give the number of settlements named on the 1:250 000 maps, in three broad size categories. 'Towns' records separately named areas blocked in grey; 'villages' are named settlements shown on the maps as having 5 or more individual 'building' symbols; 'hamlets' are named settlements with less than 5 'building' symbols. These attributes give a picture of the frequency of settlement centres, but the total population of a grid square (TOP, 7) and the measured area of urban land (in the land use data group, USE, 6) are alternative, preferable, indicators of settlement patterns.

Other attributes in this data group give relative density figures for the communication network within cells, with scores on scales of 0-25 for the frequency of major roads, minor roads and railways, assessed by a method discussed in Chapter 2 (2.2).

APPENDIX TABLE 2.5

TOPOGRAPHY DATA GROUP ATTRIBUTES

Identified in the data set as TOP, 1-7. Attributes are recorded from 1:250 000 OS maps, except for the population figures which were supplied by the Office of Population Censuses and Surveys (OPCS)

ATTRIBUTES

Settlements - recorded as number counts

TOP, 1 Towns
TOP, 2 Villages
TOP, 3 Hamlets

Communications - recorded as a relative frequency score, 0-25, from the number of sub-cells in a 5 x 5 grid overlay on the 10 x 10 km cell which contain the specified map feature

TOP, 4 Major roads (defined as motorways and roads coloured red or brown on the 1:250 000 OS map)
TOP, 5 Minor roads (defined as uncoloured roads on the 1:250 000 OS map)
TOP, 6 Railways (in use)

Population - recorded as the total figure for each cell at the 1970 census, as supplied by the OPCS

TOP, 7 Total population, 1970

NOTES

a) This scale of map records virtually the entire railway network, but inevitably, due to space contraints, only a selection of the actual road network, so that a higher proportion of actual roads is shown in less settled areas than in densely settled areas.

b) The population data (TOP, 7) are held as x 10^{-2} of the actual population figures, rounded up to the next higher 100. Thus a data entry of 1 means a population between 1 and 100; a data entry of 2 a population between 101 and 200, etc. This was desirable to reduce the range involved (1-897265). Sums of populations for groups of squares will thus be small over-estimates. Population data should not be quoted for publication without the approval of OPCS.

2.6 Land use attributes

Table 2.6 lists 22 attributes of this data group. Attributes USE, 5 (forest and woodland) and USE, 6 (urban) are taken from maps, the first of these from the 1:50 000 OS series. The second was also measured from this series for Scotland but, for England and Wales, from 1:250 000 'Developed Area' maps produced by the Department of the Environment in 1969 from an air photo survey.

All other land use attributes come from computations to the 10 x 10 km grid cell basis of this data set from the official agricultural statistics for 1972. Statistics collected annually from farmers are made available on a parish basis, in England and Wales by the Ministry of Agriculture, Fisheries and Food, and in Scotland by the Department of Agriculture and Fisheries for Scotland. The allocation of parish data to a grid square basis was carried out at the Edinburgh Regional Computing Centre, using statistics as previously employed for the agricultural atlases of Professor J T Coppock (Coppock 1976 a, b). ITE is grateful to Professor Coppock, the Edinburgh Computing Centre and the respective Ministries for permission to use these statistics and for their provision in a form suitable for this data set. Figures for 1972 were used because those for later years were not available at Edinburgh when the computing was carried out.

It must be made clear that there are considerable difficulties which prevent acceptance at face value of the quantitative detail of these statistics at individual cell level, as distinct from their regional sweep. This is especially the case in upland areas where parishes can contain particularly diverse land types and hence land uses. The problems run through from the original definitions of individual

statistics, their method of collection and checking, and their presentation on a parish basis, to the inevitable effects of transforming parish statistics to a cell basis.

The first difficulty with the source data for the purpose of this data set is that some categories used on the Scottish parish return forms filled in by individual farmers differ from those used in England and Wales, especially in the cattle section. Because the attributes used in this data set are a simplification and reduction of more numerous individual headings on the forms, decisions were initially required to ensure as close an equivalence as possible in such cases between the categories used for an attribute from the England and Wales returns, and from the Scottish data. It is believed that these decisions will have ensured acceptable compatibility between attributes north and south of the Scottish border.

Secondly there is no certainty that all farmers interpret the requirements of the forms uniformly. There is a particular problem with regard to uncertainties in definition and recording of 'farmland under rough grazing', which Coppock notes is "the least well-known statistically of all the major categories of land use in the country". Another aspect is that farmers generally record land on a single farm on one return, not distinguishing whether the farmland falls in more than one parish. All data for the farm are then treated as relating to the parish in which the farmhouse is situated.

In transforming parish data to a cell basis, other deviations from reality enter in areas with complex land uses. Parish data already

conceal internal variety in the case of parishes with widely differing types of land and land use. The only practical way of transforming parish to cell data, without in effect a national re-survey, is to allocate the values for a parish uniformly to all grid cells which fall entirely within the parish, and deal with grid cells which straddle parish boundaries by proportional allocations. For previous work in Edinburgh, data had already been prepared on a 1 x 1 km cell scale, and these were amalgamated to the 10 x 10 km scale for ITE.

The outcome is a picture which is broadly correct, but which deviates in local detail from the truth, particularly in complex upland areas. As a known example, the parish of the Small Isles off the west coast of mainland Scotland, south of Skye, includes smaller islands with significant agriculture, and a larger island (Rhum) owned and managed as a National Nature Reserve with minimal agricultural stock. Because parish data are distributed across all 1 x 1 km cells which make up a parish, the 10 x 10 km cells containing Rhum are recorded in this data set as having the greater part of sheep and cattle of the other islands in the parish, though no sheep and very few cattle are actually present on Rhum. In this case the 'error' is known to the compilers of the data set and could be edited out but it is impossible correctly to adjust all such transformation 'errors'.

The overall regional view of recent agricultural land use that is obtained from the recorded data however conforms reasonably to distributions plotted by Coppock (1976 a, b) and to total areas and stock numbers for England, Scotland and Wales. At present, and probably in the foreseeable future, there are unlikely to be alternative figures that, with any reasonable level of effort, can be made more accurately applicable to grid cells.

APPENDIX TABLE 2.6

LAND USE DATA GROUP ATTRIBUTES

Identified in the data set as USE, 1-22. USE, 5 is from 1:50 000 OS maps; USE, 6 is also from 1:50 000 maps for Scotland but from 1:250 000 'Developed Area' maps (1969) of the Department of the Environment for England and Wales. Other attributes are from statistics computed in the Edinburgh Regional Computing Centre from data reworked on behalf of Professor J T Coppock, Department of Geography, University of Edinburgh, from parish returns for 1972 supplied by the Ministry of Agriculture, Fisheries and Food, and the Department of Agriculture and Fisheries for Scotland.

ATTRIBUTES

Agricultural land use - recorded as % of grid square, from statistics for 1972

USE, 1 Farmland under cultivation for crops other than grass
USE, 2 Farmland under sown ("improved") grass
USE, 3 Farmland under rough grazing
USE, 4 Total farmland (as USE, 1-3)

Other major land uses - recorded as % of grid square, in 1% units

USE, 5 Forest and woodland
USE, 6 Urban development
USE, 7 Balance of land in uses other than agriculture, forest and woodland, or urban development (as 100 (or area of land) - USE, 4-6) recorded only where positive value (see note a)).

Individual agricultural crops - recorded as % of grid square, from statistics for 1972

USE, 8 Wheat
USE, 9 Barley
USE, 10 Oats
USE, 11 Potatoes
USE, 12 Sugar beet
USE, 13 Stockfeed crops
USE, 14 Horticultural crops - vegetables
USE, 15 Horticultural crops - fruit
USE, 16 Total extent of specified crops (as USE, 8-16)

Farmland Livestock - recorded as numbers in grid square, from statistic sources, 1972

USE, 17 Dairy cattle
USE, 18 Beef cattle
USE, 19 Sheep
USE, 20 Pigs
USE, 21 Poultry

Workers employed in agriculture - recorded as number in grid square, from statistics for 1972

USE, 22 Total regular and casual farm staff

NOTES

a) Problems in the initial statistics and their transformation, outlined above, create discrepancies between the actual land area of each cell and their agricultural uses. A grid cell would be expected to include agriculture (USE, 4), forest (USE, 5) and perhaps urban land (USE, 5) adding up to equal, or be less than, the total land of the square, any balance then being allocatable to miscellaneous 'other uses' (USE, 7). In practice, USE 4-6 (and often USE, 4 alone) exceed 100. It would be possible to round down the crop, improved grass and rough grazing figures proportionately to ensure that USE, 4-6 did not exceed 100. This, though cosmetically desirable, would stray even further from the real situation than these data already do, and the alternative has been adopted of leaving the figures as they are, and allowing a user to adjust individual deviations as he thinks best when he reads the outputs. This data group is thus an exception to the correlation of land totals measured from different source maps for different data groups in each square which has been widely applied to map-derived data (see Chapter 2, 2.2). It also means that USE, 7 is of low value, except in the clear cases of small areas known to have no agricultural use, and in which all the small extent of land has been allocated to USE, 7.

b) For England and Wales an alternative measure of land in non-agricultural use is given in the Agricultural Land Classification (ALC) data group as attribute ALC, 6. However this class includes some major forests and urban land areas but not all of these, as well as a few large nature reserves and airfields which may in fact have subordinate pastoral agricultural use. In Scotland, the draft ALC maps show only the major cities as non-agricultural land, so that there is no comparison possible between the figures for attribute ALC, 6 in Scotland and in the rest of Great Britain. At present no preferable figures for the overall balance of land uses have been located that could be applied to grid cells.

c) Livestock figures are held as x 10^{-1} for sheep (USE, 19) and pigs (USE, 20), and as x 10^{-2} for poultry (USE, 21); the print-out figures being rounded up to the next higher 10 or 100. A record of '3' for USE, 19 thus refers to 30 sheep (actually a value of between 21 and 30) and for USE, 21 refers to 300 poultry (actually a value of between 201 and 300).

2.7 Agricultural land classification attributes

This data group contains 6 attributes, listed in Appendix Table 2.7, determined off published and unpublished maps, using 100- and 20-point grids respectively. The source data for England and Wales are the 1:250 000 Agricultural Land Classification maps published by the Ministry of Agriculture, Fisheries and Food. Similar maps have not been published for Scotland, but a compatible draft map has been supplied for the purpose of this data set by Mr Campbell Clark of the Department of Agriculture and Fisheries for Scotland. These classifications take into account a combination of natural environment features, of climate, physiography and soil, that affect agricultural productive capacity and versatility, in gradings which cover decreasing versatility for arable use, from class 1 downwards.

Some modifications to the England and Wales system now under development are aimed at sub-dividing the most extensive classes (3 and 5) to counter the inference often made that class 3 is "third-class" agricultural land, and to distinguish different levels of actual and potential productivity within the wide variety of hill land in class 5. If maps including such modifications become comprehensively available then this data group can be revised and expanded.

APPENDIX TABLE 2.7

AGRICULTURAL LAND CLASSIFICATION DATA GROUP ATTRIBUTES

Identified in the data set as ALC, 1-6. From 1:250 000 published maps of the Ministry of Agriculture, Fisheries and Food for England and Wales, and from an unpublished draft map of the Department of Agriculture and Fisheries for Scotland.

ATTRIBUTES

Agricultural land classes - recorded as % of grid squares in 1% units for England and Wales, and 5% units for Scotland

ALC, 1 Land with very minor or no limitations to a wide range of arable agricultural use
ALC, 2 Land with some minor limitations to a wide range of arable agricultural use
ALC, 3 Land with moderate limitations to arable agricultural use
ALC, 4 Land with severe limitations to arable agricultural use
ALC, 5 Land with very severe limitations to arable agricultural use
ALC, 6 Land primarily in non-agricultural use

NOTES

a) The unpublished Scottish draft map uses categories identified as A+, A, B+ and B, B- and C, D. These can be equated broadly with ALC classes 1-5 in England and Wales, and this has been done in this data group.

b) On the Scottish map, the 'non-agricultural use' category only covers major cities. On the maps of England and Wales, some urban areas and large sectors of 'land in other uses' (such as major forests, airports and large conservation areas) are shown separately. They have been combined here as attribute ALC, 6 but this attribute does not represent the same thing in Scotland as in England and Wales. A separate measure of urban land for all grid squares is given as attribute USE, 6 in the land use data group.

2.8 Conservation status attributes

This data group at present includes 6 attributes, listed in Appendix Table 2.8. CONS, 1 and CONS, 3 record the presence within a square of specific National Parks (NP) or Areas of Outstanding Natural Beauty (AONB), designations in use in England and Wales. For these categories, the extent of the identified NP or AONB in a square is recorded as attributes CONS, 2 and CONS, 4 respectively. The remaining attributes are presence records of squares which contain any designated 'Heritage Coast' (England and Wales), or which include part of any 'Scenic Area' (Scotland) as proposed by the Countryside Commission for Scotland.

The presence, and possibly the extent, of National Nature Reserves, and perhaps also of Sites of Special Scientific Interest, as designated by the Nature Conservancy Council, will be added to this attribute group in the near future.

APPENDIX TABLE 2.8

CONSERVATION STATUS DATA GROUP ATTRIBUTES

Identified in the data set as CONS, 1-6, from maps for England and Wales supplied by the Countryside Commission (CONS, 1-5), and for Scotland (CONS, 6) from 'Scotland's Scenic Heritage' (Countryside Commission for Scotland 1978).

ATTRIBUTES

CONS, 1 and 3 are entered as the reference number of any NP or AONB that occurs in a square or as 0 if no NP or AONB is present. In the few cases where more than one such area falls in a square, only the most extensive is recorded. CONS, 2 and 4 give the extent of the identified NP or AONB, in 1% units. CONS, 5 and 6 note the presence of 'Heritage Coast' or 'Scenic Area' by the entry 1, and their absence by the entry 0.

CONS, 1 Presence of a National Park (by its reference number)
CONS, 2 Extent of the identified NP
CONS, 3 Presence of an Area of Outstanding Natural Beauty (by its reference number)
CONS, 4 Extent of the identified AONB
CONS, 5 Presence of declared Heritage Coast
CONS, 6 Presence of suggested Scottish Scenic Area

NOTE

Reference numbers for NP and AONB, as entered in CONS, 1 and CONS, 3

National Parks (CONS, 1)

1 Northumberland
2 Lake District
3 Yorkshire Dales
4 North York Moors
5 Peak District
6 Exmoor
7 Dartmoor
8 Snowdonia
9 Pembrokeshire Coast
10 Brecon Beacons

Areas of Outstanding Natural Beauty (CONS, 3)

1 Northumberland Coast
2 Solway Coast
3 Arnside and Silverdale
4 Forest of Bowland
5 Lincolnshire Wolds
6 Norfolk Coast
7 Cannock Chase
8 Shropshire Hills
9 Suffolk Coast and Heaths
10 Malvern Hills
11 Dedham Vale
12 Wye Valley
13 Cotswolds
14 Chilterns
15 Mendip Hills
16 North Wessex Downs
17 Quantock Hills
18 Surrey Hills
19 Kent Downs
20 East Hampshire
21 Sussex Downs
22 Chichester Harbour
23 South Hampshire Coast
24 Isle of Wight
25 Dorset
26 North Devon
27 East Devon
28 South Devon
29 Isles of Scilly
30 Cornwall
31 Anglesey
32 LLeyn
33 Gower

APPENDIX 3 CORRELATION OF GEOLOGY SOURCE MAP UNITS WITH GEOLOGICAL DATA GROUP ATTRIBUTES

a) Solid Geology - South Sheet

Map unit symbol	Attribute allocation in Geology Data Group	
	Stratigraphy	Lithology
Gothic D*	1	13
Gothic G*	1	11 (10)
U	) Symbols U-T recorded here) either as their given) stratigraphic age (1-8),) or as attribute 9 where no) age is given on the source) maps	14
E		12
D		12
H		12
F		10
G		10
B		13
S		13
A		13
R		11
T		11
Gothic X**	1	11
a, a1-2, a3	2	19 (17)
b, b1, b2, b3, b5, b6, b7	2	19
b5-7 limestone	2	21
c, c2, c3 ***	3	17
c1	3	17 (18)
c2 limestone	3	21
d2 conglomerate	4	17
d2	4	21
d4 ****, d5, d6	4	17, 19
e	5	17, 18
e', e2	5	21
e3, e5	5	18, 20
e4	5	21
f1-3, f1-5	5	18 (17)
f4-5	5	17
f6	5	20 (17)
g1, g5, g9, g14*****	6	21
g2, g6-8*****	6	20, 21
g3-4	6	18
g10, g12	6	20
g11	6	21 (18, 20)
g13	6	21 (17, 18)
h, h2	7	18 (20)
h1	7	20 (18)
h3-4	7	18, 20
h5	7	22
i1-2	8	18, 20
i3	8	20
i4-7	8	18
i8-12	8	18, 20, 22
k	8	18
k1	8	22
l	8	18, 20

b) Solid Geology - North Sheet

Map unit symbol	Attribute allocation in Geology Data Group	
	Stratigraphy	Lithology
1, 5	1	14
2, 6, 7	1	12
3, 3c, 8	1	10
4	1	10
9	9	14
10, 11, 13, 14	9	12
12, 15, 16	9	10
17, 22	2	13
18, 23, 24	3	13
19	4	13
20	5	13
21	8	13
25, 26	3	11
27	4	11
28	2	11
29, 31, 33, 34, 39, 41, 42	1	11
30, 35, 44	1	16
32, 37, 38	1	15
36	1	13
40, 43******	1	19
45	1	17
46	2	15
47	2	17
48	2	21
49, 50, 51, 52	2	19
53, 54, 55	3	17
56	4	19
57	4	17, 19, 21
58	4	17
59, 60	4	17, 19
61	5	17
62	5	21
63, 63'	5	18, 20
64	6	17, 21 (19)
65	6	17
66	6	19
68, 69	8	18

c) Drift Geology - North and South Sheets

Areas left white on map; Landslip ; Crag	23
Boulder clay and morainic drift	24
River terrace deposits (mainly sand and gravel; Raised beach and marine deposits; Glacial sand and gravel; Sand and gravel of uncertain age or origin	25
Clay-with-flints	26
Lacustrine clays, silts and sands; Alluvium	27
Blown sand; Brickearth, mainly loess	28
Peat	29

NOTES

a) Where lithology is shown as e.g. 17, 19, the area involved is divided equally between lithological categories 17 and 19. Where shown as 17 (19) the area involved has been allocated 75% to 17, 25% to 19.

b) * Gothic D and G in Devon have been recorded as stratigraphic age unknown (3)

** Gothic X on the Longmynd, Shropshire, has been recorded as stratigraphic age uncertain and lithology complex (3, 17, 19)

*** In Southwest England the Devonian has been recorded as the following lithological classes: c, c1 = 17, 19; c2 = 19; c3 = 19 (17)

**** In Southwest England the Carboniferous rocks d4 (Culm Measures) have been recorded as of lithology 17, 19)

***** In the North York Moors are, map units g, and g 5-8 have been allocated lithologies of 20 and 17, 20 respectively, rather than the general lithologies allocated to these stratigraphic units

****** Map unit 40 on the IGS 'North' solid geology sheet is identified as "slates, phyllites and mica-schists". On balance it was decided to record it lithologically in this data set with attribute 19 rather than 11.

APPENDIX 4 CORRELATION OF SOIL SOURCE-MAP UNITS WITH SOIL DATA GROUP ATTRIBUTES

Map Units a) on published soil map of England and Wales b) on manuscript soil map of Scotland		Soil attribute in data set
a	2, 3, 12, 13, 18-40, 60-63 (Brown Alluvial Soils, Brown Sands, Brown Earths or Argillic Brown Earths dominant)	1 Brown Earth Variants
b	2, 28, 29, 31, 32, 34, 40	
a	10, 11, 14-17, 45, 46, (Rendzinas, Brown Calcareous Earths or Calcareous Pelosols dominant)	2 Rendzinas and Calcareous Soils
b	21	
a	4-6, 47-59, 68, 69. (Alluvial Gley Soils, Sandy Gley Soils, Cambic Gley Soils, Argillic Gley Soils or Stagnogley Soils dominant)	3 Gley Soils
b	3, 10, 11, 15	
a	41-44, 64 (Podzols, Drier Lowland Gley-Podzols, Drier Lowland Stagno-Podzols or Brown Podzolic Soils dominant)	4 Humus or Iron Podzols and Brown Podzolic Soils
b	56, 57	
a	66, 67 (Upland Stagnopodzols dominant)	5 Peaty Podzols
b	60, 61, 62	
a	7, 8, 65, 70 (Humic-alluvial Gley Soils, Upland Gley-Podzols or Stagnohumic Gley Soils dominant)	6 Peaty Gleys
b	65, 68	

APPENDIX 4 (cont)

Map Units a) on published soil map of England and Wales b) on manuscript soil map of Scotland		Soil attribute in data set
a	9, 71 (Earthy Peat Soils or Raw Peat Soils dominant)	7 Peaty Soils
b	67, 69	
a	1 (Raw Sands dominant)	8 Skeletal Soils
b	20, 27	