

Historic Land-use Assessment

Data in GIS



Royal
Commission on the
Ancient and
Historical
Monuments of
Scotland



HISTORIC SCOTLAND
ALBA AOSMHOR

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Further Information

Information about Scotland's archaeological, architectural and maritime heritage can be found in Canmore (see above) and PastMap, at pastmap.org.uk. Archive items can be inspected in the RCAHMS Public Search Room, which is open Tuesday to Friday from 9.30am to 5.00pm (6.00pm on Thursdays), at the following address:

Royal Commission on the Ancient
and Historical Monuments of Scotland
John Sinclair House
16 Bernard Terrace
Edinburgh EH8 9NX

Tel: 0131 662 1456

Fax: 0131 662 1477

Email: info@rcahms.gov.uk

Revised October 2012

Cover Page Image: Oblique aerial view, looking across Loch Lomond towards Ben Lomond and the Grampian Mountains. SC506616

1. INTRODUCTION

HLA (Historic Land-use Assessment) provides a systematic and rigorous means of 'reading' and recording features that survive from past activities that can be identified in patterns of current land use. It employs an archaeological approach to understanding the development and history of Scotland's landscape. This Technical Paper provides details relating to the development of the GIS HLA data and how it may be interrogated.

2. THE PROCESS OF HLA DATA CREATION

The process of HLA data creation begins with the interpretative stage, which includes the creation of paper overlays of OS 1:25,000 maps. Once interpretation and the outlining of the land use types has been completed, digitisation, polygonisation and tagging of the polygons is then carried out. This completes the basic process of data creation, but is followed by an editing stage which incorporates the results of field work.

2.1 Interpretation

Interpretation is carried out on a basis of 10 kilometre square blocks. This practice was adopted by the project from the outset, primarily to make use of the format of the OS 1:25,000 scale Pathfinder maps which were for the most part published in a letterbox style covering an area of 20 by 10 kilometres. For wholly practical reasons this has remained the procedure, since it involves a manageable size for consulting the paper maps, as well as allowing for the continuation of the method for organising the digital files that are produced.

The OS has discontinued the production of their Pathfinder maps, replacing them with the Explorer series, also at a scale of 1:25,000, and it is these maps that HLA uses as the base mapping for the project. Where necessary an area covering two adjacent 10 kilometre square blocks is compiled from the Explorer maps and transparent drafting film is attached to the paper map. This allows for the areas assigned to each land use type to be drawn onto the film in outline while the 1:25,000 map remains visible underneath and the index number designated to each type can be written inside the area. Where only an historic (current) land use type is identified a single number will be applied, but where there is evidence for a previous land use, or land uses, the number for that relict (past) type, or types, will also be written on the film overlay. As HLA is designed to record up to three relict types, there can be four numbers assigned to an area (see HLA Glossary and HLA Type Definitions for details of each type).

2.2 Digitisation Polygonisation and Tagging

When the interpretation of each 10 kilometre square block is complete, the outlines marked on the film overlay are drawn digitally onscreen in a GIS package. Digital OS maps, also displayed onscreen, act as a background for the drawing. Since the drawing is done in a GIS package, each 10 kilometre square block is automatically spatially referenced to its correct geographical location according to the British National Grid. These outlines are then converted into areas, or polygons and the type numbers are entered for each of these polygons in an attribute table (see Figure 1). These HLA map tiles are each saved as a separate digital file identified by the map grid square (eg NT10).

FID	Shape *	ID	TAG	HIS_CODE	REL1_CODE	REL2_CODE	REL3_CODE
0	Polygon	0	12	12	777	777	777
1	Polygon	0	11/104	11	104	777	777
2	Polygon	0	14/119/123	14	119	123	777
3	Polygon	0	5/135/101/100	5	135	101	100

Figure 1: An extract from the HLA attribute table showing the four fields (HIS_CODE, REL1CODE, REL2CODE and REL3_CODE) with the Type index numbers entered. Note the default value 777 has been added where there is no HLA type index number to enter.

As an aid to maintaining consistency in the interpretation of the land-use types, each 10 kilometre square block is edited by a colleague, and any changes or refinements to the original interpretation are made to the polygon data. Similarly, after field checking there may also be changes to the interpretation that require the data to be edited.

It is beneficial to work on a geographical area, however defined, since there will be common factors that typify that area. When all the digital data has been created for an area, the edges of the individual 10 kilometre square blocks are checked to be sure that the types match from one to another and the data edited for consistency. To produce a single dataset of all the accumulated information, a GIS package allows for the individual files to be joined together and for the outlines of the 10 kilometre squares to be dissolved. In this way a seamless map is created. Finally a routine process is run to join the index numbers applied to each polygon to the attributes.

The Arran experiment

An experiment to confirm the efficiency of this methodology was carried out in 1999 by trying out an alternative process. The digital drawing of the HLA interpretation for the island of Arran was carried out by a consultancy firm. In place of the onscreen method, digitising tablets were used to draw the outlines having fixed the geographical position of the overlays in the GIS. In this case the lines drawn on the film overlay were drawn digitally without the use of any background mapping.

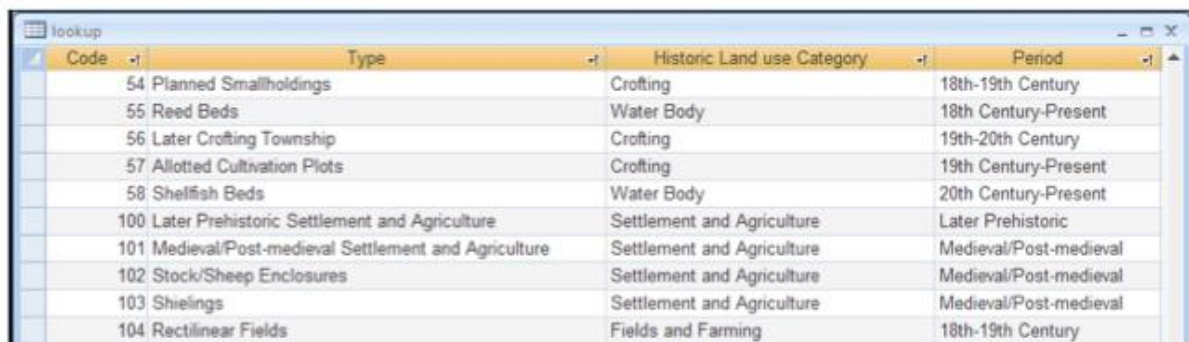
It was found that the data was not as accurately located using this method, edge matching was poor, and the edges did not always meet the tolerances of the scale. In addition, there were mistakes made in the tagging of the type numbers to the polygons. All these factors militated against pursuing this method as so much corrective work had to be done on the data when it was returned. However, it was considered useful to have tested this alternative approach, and it confirmed the original methodology as the most efficient and accurate method of creating HLA's digital data.

3. Attaching HLA attributes in GIS

All GIS data is comprised of spatially defined features which may be points, lines or areas and each of these features is attached to a table of attributes, using an identifier or tag. For HLA the features are all areas or polygons and each area has an attribute field called 'TAG' in which the index numbers that refer to individual land use types are applied. The relict types are separated from the historic (current) land use type by a forward slash and up to three may be recorded in this way (a list of the land use types with their index numbers is available in HLA Type Definitions).

In order to attach the type names and create accessible GIS data from the tagged file an electronic joining process is followed. This is a routine process that is designed to take the contents of the TAG field, which has up to four index numbers, and generates four new columns of data that are populated with these numbers – variously HIS_CODE; REL1_CODE; REL2_CODE and REL3_CODE in the attribute table (see Figure 1 above).

The numbers can be queried in the 'TAG' field. Although the interpretation process can record up to three levels of relict land use in any given area, there are very few instances of this; indeed many of the polygons will have only an historic (current) land use.



Code	Type	Historic Land use Category	Period
54	Planned Smallholdings	Crofting	18th-19th Century
55	Reed Beds	Water Body	18th Century-Present
56	Later Crofting Township	Crofting	19th-20th Century
57	Allotted Cultivation Plots	Crofting	19th Century-Present
58	Shellfish Beds	Water Body	20th Century-Present
100	Later Prehistoric Settlement and Agriculture	Settlement and Agriculture	Later Prehistoric
101	Medieval/Post-medieval Settlement and Agriculture	Settlement and Agriculture	Medieval/Post-medieval
102	Stock/Sheep Enclosures	Settlement and Agriculture	Medieval/Post-medieval
103	Shielings	Settlement and Agriculture	Medieval/Post-medieval
104	Rectilinear Fields	Fields and Farming	18th-19th Century

Figure 2: There are four Microsoft Access™ tables that hold the text information relating to each of the land use Types.

The tables are brought into the GIS and their information is added to the basic attribute table by means of a joining process. All of the tables contain the land use type index numbers and it is these numbers that act as the link for the joining process (as shown in Figure 3 below). This tabular information can be made use of when querying the HLA data. Once the extended attribute table has been created, the dataset is complete, containing all the information – the polygons and their attributes – for the most up-to-date HLA coverage of Scotland.

4. HLA GIS Attribute Table

Each row in the attribute table corresponds to one of HLA's land use polygons. Each polygon has its own unique entry in the attribute table that contains all the information, or attributes, relating to it held in several fields, or columns.

OBJECTID *	Shape *	TAG	HIS_CODE	REL1_CODE	REL2_CODE	REL3_CODE	HISTORIC_L	PERIOD	TYPE
498	Polygon	5/153/119	5	153	119	777	Moorland and Rough Grazing	Late 20th Century-Present	Rough Grazing
499	Polygon	5/153/135	5	153	135	777	Moorland and Rough Grazing	Late 20th Century-Present	Rough Grazing
500	Polygon	5/154/146	5	154	146	777	Moorland and Rough Grazing	Late 20th Century-Present	Rough Grazing
501	Polygon	5/156	5	156	777	777	Moorland and Rough Grazing	Late 20th Century-Present	Rough Grazing
502	Polygon	5/158/101	5	158	101	777	Moorland and Rough Grazing	Late 20th Century-Present	Rough Grazing
503	Polygon	5/208	5	208	777	777	Moorland and Rough Grazing	Late 20th Century-Present	Rough Grazing
504	Polygon	5/209	5	209	777	777	Moorland and Rough Grazing	Late 20th Century-Present	Rough Grazing
505	Polygon	51/101	51	101	777	777	Rural Settlement	Medieval	Medieval Village
506	Polygon	51/104	51	104	777	777	Rural Settlement	Medieval	Medieval Village

Figure 3: The Category (HISTORIC_L), Period and Type information linked to each current (HIS_CODE) polygonised area is shown here. The same range of information is also attached to each of the relict (REL1, 2, or 3_CODE) areas.

Each entry will have its historic (current) land use type index number (HIS_CODE) followed by its relict (past) land use type index number if applicable (REL1_CODE, REL2_CODE, REL3_CODE). Where there is no relict land use type the default value 777 appears. These columns are followed by the corresponding Category, Period and Type for the historic (current) type and then the Category, Period and Type for the relict1 (past) type, followed by those for relict2 and relict3 if appropriate. Where there is no relict land use type the phrase 'Not Applicable' will appear.

When querying the HLA data using the attribute table, any number of the columns of data can be used as the basis of a query. That is, the user can ask for all the instances of a particular value in a particular column. So, for example, from 'TYPE' all the entries containing 'Managed Woodland' can be identified, or from 'REL1_PERIOD' all the entries containing 'Post-medieval' can be viewed.

For all queries, the results will show the information held in all the columns in the attribute table for those records that contain the requested value. The user may add any number of columns to the attribute table in order to input their own information or comments or perform statistics on the data such as calculating area.

5. HLA GIS Legend Files

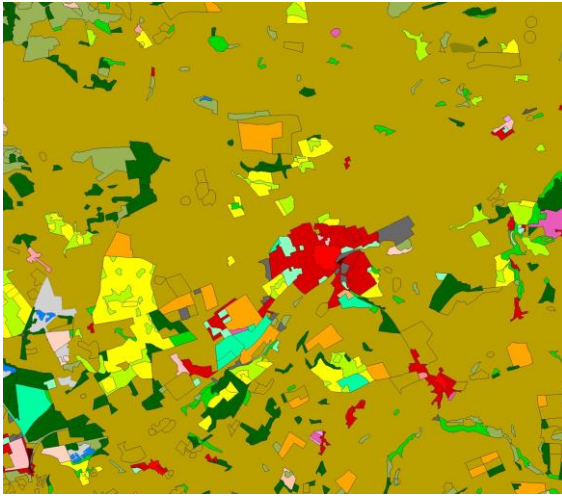
To accompany the digital dataset, there are four legend files, designed to provide users with a coloured view of the data. The legend files are supplied with the data in HSV format (.avl or .lyr files in ArcGIS), and for users who have a GIS that cannot import these legends the colour values, RGB, can also be provided.

When attached to the data these legends change how it is displayed by colouring the individual polygons according to their Type, Category or Period (Figure 5 below). When applied to the data each type or period is shown in a separate colour in order to highlight the different land uses or period. The category, being a grouping of related land use types, will colour several types the same.

To meet any user's individual needs these files can be manipulated – colours can be changed or fills changed to outlines. These legends can be applied to all the HLA data, whether the types are historic (current) or relict (past).

Figure 5: Here the HLA data for Cupar and its environs is displayed using each of the four standard legend files.

Historic (current) Types:



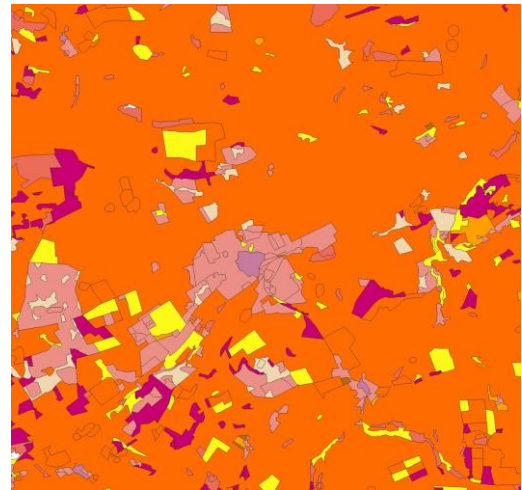
Relict (past)Types:



Categories of land-use:



Periods of land-use Types:



6. Data analysis

It is most effective to view HLA data against an OS or an aerial survey background with the legend semi-transparent, a function that many GIS have. Looking at the landscape with the different legends switched on and off can be most effective. This should help the user to understand what the different types describe on the ground, as well as the chronological development of the landscape.

Data analysis enables the selection of an individual type to view just those particular aspects of the landscape. This may well require the searching of the historic (current) and relict (past) data to make sure that all examples are returned.

6.1 Interrogating the data

There are two types of query:

- location based, that is 'what are the historic (current) land uses in this area?' and
- type specific, such as 'where are there occurrences of this particular type, category or period?'

6.1.1 Location-based query

In the location-based query, all the land-use information within a given area defined by the user is displayed, up to national coverage. Alternatively a boundary might be selected from another dataset to choose the extent of the HLA data that is queried, or the user might define the area of interest themselves by using a box to select an area, or using a cursor to compose the area of interest.

6.1.2 Type-specific query

In type-specific queries, the user can construct a query that will result in seeing only those types that are of interest to them, for instance from just the historic (current) land use types. This is not limited to a single query, several queries can be included in one Boolean statement (ie 'and', 'or' and other such parameters), or a series of iterative queries can be made, developing from the results of a previous query. Searches can be aided by extracting data so that those particular types or periods that a user has an interest in are separated from the whole dataset. This can be a benefit to the user in speeding up the display of data and subsequent querying.

6.1.3 Querying across datasets

As with all GIS data, HLA can be queried in conjunction with other data using GIS functionality, such as proximity to, or intersection with another suite of data, for instance that held in Historic Environment Records. The data structure allows the enquirer to discover the present and past impacts on the land in any area and to analyse this by what it is and when it took place. A type-specific query may follow from an area definition to determine the patterns of past land use. It should be noted, however, that HLA data does not carry any indication of relative value; this comes through a separate process of analysis and judgement.

6.2 Querying and analysing the data

Querying the HLA data can be done in a number of different ways within a GIS package. The following outline of query instructions should be used for guidance only since the functionality of different GIS software programmes will vary and it is always advisable to consult a manual or help file.

6.2.1 Label

Labelling the onscreen data is an easy way to see any information relating to all the polygons. The user can choose which field in the attribute table will act as the source for the labelling (see Figure 6 below).

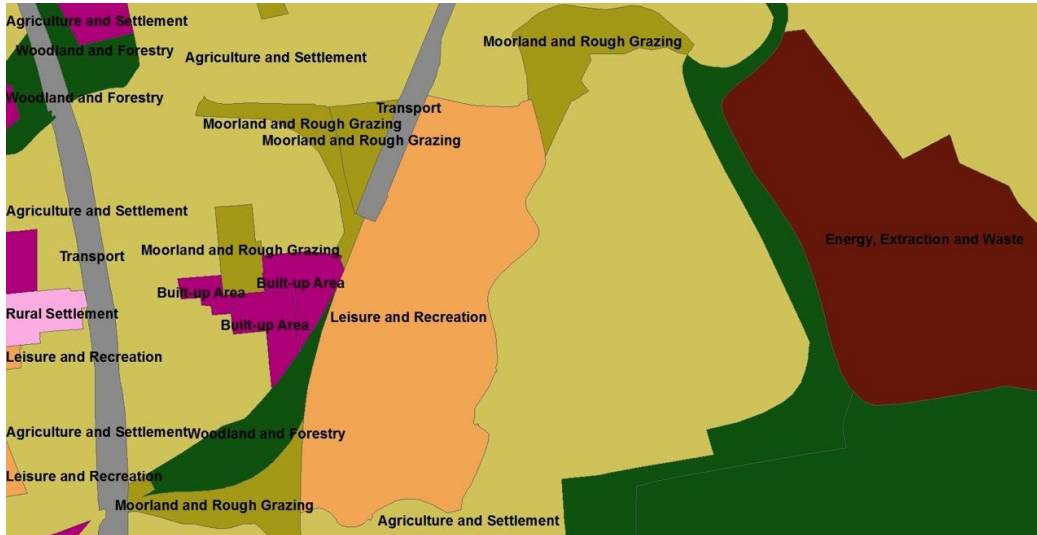


Figure 6: The HLA data in this example is shown coloured according to Category with attached labels

6.2.2 Identify

Another simple way to find out what land use has been interpreted for a particular polygon is to use the GIS ‘Identify’ tool. This tool allows the user to click on a polygon to produce a list of all the information held in the data’s attribute table for that polygon. In this way the user can see all the Type, Category and Period information that apply to that polygon.

6.2.3 Select by area on the map

If a user is interested in the HLA information relating to a specific area one of the GIS ‘Selection’ functions can be used. Drawing a box using the ‘Select’ tool will highlight all those polygons lying wholly or partly within that box. The highlighting might appear as a specifically coloured outline or fill, depending on the GIS package being used. The data for each of these polygons will also be highlighted in the corresponding attribute table.

6.2.4 Select using a single feature in the attribute table

Another ‘Selection’ function would be to interrogate the data by means of the attribute table. This makes it possible to select only those Types (or Categories or Periods) that are of interest. When the table is displayed on screen, the user can choose a specific value from a list that refers to a particular column, in order to select only those polygons containing that value. For instance, a user might want to select all those polygons that belong to the Agriculture and Settlement category currently in use.

Figure 7: After running a query the results are highlighted in the attribute table.

505	Polygon	51/101	51	101	777	777	Rural Settlement	Medieval	Medieval Village
506	Polygon	51/104	51	104	777	777	Rural Settlement	Medieval	Medieval Village
507	Polygon	52/110	52	110	777	777	Agriculture and Settlement	Medieval/Post-medieval	Medieval/Post-medieval Curvilinear-shap
508	Polygon	52/110/132	52	110	132	777	Agriculture and Settlement	Medieval/Post-medieval	Medieval/Post-medieval Curvilinear-shap
509	Polygon	52/117	52	117	777	777	Agriculture and Settlement	Medieval/Post-medieval	Medieval/Post-medieval Curvilinear-shap
510	Polygon	52/201	52	201	777	777	Agriculture and Settlement	Medieval/Post-medieval	Medieval/Post-medieval Curvilinear-shap
511	Polygon	54/119	54	119	777	777	Agriculture and Settlement	18th-19th Century	Planned Smallholdings
512	Polygon	56/113/101	56	113	101	777	Rural Settlement	20th Century	Recent Crofting Township
513	Polygon	56/123	56	123	777	777	Rural Settlement	20th Century	Recent Crofting Township
514	Polygon	56/124	56	124	777	777	Rural Settlement	20th Century	Recent Crofting Township
515	Polygon	58	58	777	777	777	Water Body	20th Century-Present	Shellfish Farm
516	Polygon	59/104	59	104	777	777	Agriculture and Settlement	18th Century-Present	Orchard
517	Polygon	6/109	6	109	777	777	Rural Settlement	18th-19th Century	Crofting Township
518	Polygon	6/117	6	117	777	777	Rural Settlement	18th-19th Century	Crofting Township

The polygons that are highlighted in the attribute table following a query are also highlighted on the map screen.

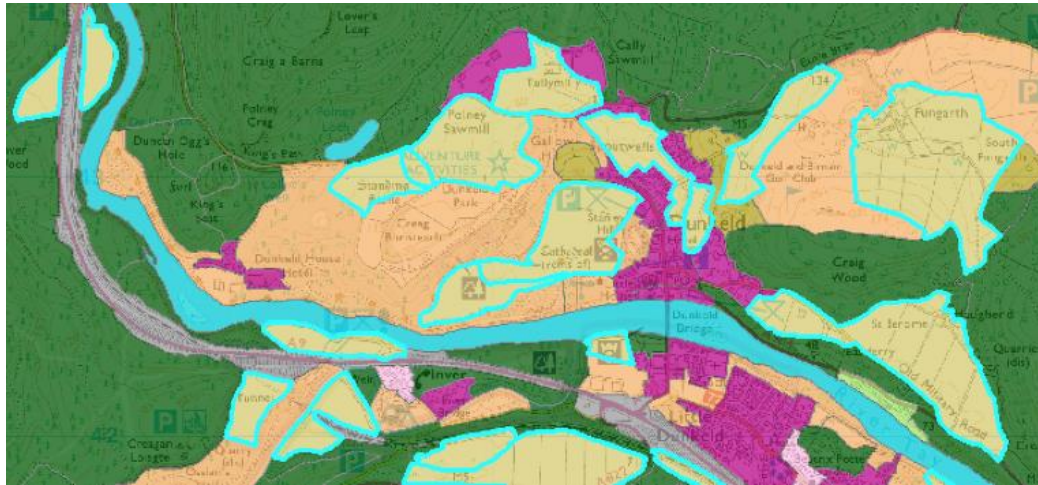


Figure 8: Agriculture and Settlement marked up on the map.

6.2.5 Select using multiple features in the attribute table

A more complicated selection would involve selecting more than one value from a single field, or using more than one field. In this way it is possible, for example, to make a selection of all the polygons that belong to the Agriculture and Settlement category and all the polygons that belong to the Rural Settlement category using a single query. Similarly, a selection could be made of those polygons that have been identified as land use type Rectilinear Fields and Farms and those identified as land use type Planned Rectilinear Fields and Farms.

However, it should be noted that most GIS packages will allow for the results of one selection to be added to the data assembled from a previous query, so providing a simpler incremental method for carrying out complex queries.

It is important to note that if users are querying the relict (past) types, categories or periods of the HLA data, the query could relate to types in any of the three layers of relict data. In order to obtain all the relevant information, a query should be carried out on all three of the relict columns in the attribute table.

6.2.6 Select using features from various datasets

For those users who wish to combine the HLA dataset with other datasets, there are several forms of queries that can be carried out. It is possible, for example, to select those HLA land use polygons that occur within a certain distance of the records held within another GIS dataset. These 'location' based queries require the user to set various parameters, such as distance.

6.2.7 Select and save a query

Any number of polygons, held within the HLA dataset, can be selected. These can be saved separately from the original data, whilst leaving the original data unchanged (Figure 9). This has the advantage of showing only the data that is of interest to a user, as well as reducing the size of the dataset. This can make displaying and then querying the data faster.

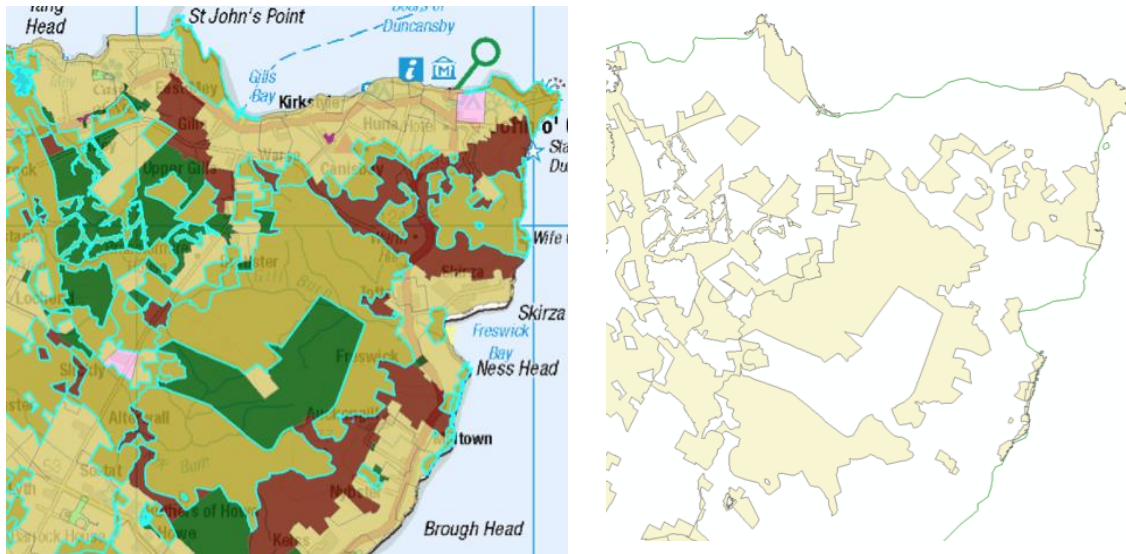


Figure 9: The left-hand image is the result of a query to show all the Moorland and Rough Grazing Category in the north-east corner of Scotland. These selected polygons have then been saved separately as shown on the right.

6. The strengths of HLA GIS data

There are numerous reasons for querying the data held in HLA. They may be quantitative, such as wanting to know the hectareage of reservoirs in a certain area. Or they may be qualitative, such as wanting to find out how rare a specific type might be in a council area and comparatively with the whole of Scotland.

- Types – particularly historic (current) land use types – are at the core of the HLA interpretation and in consequence, as each type is unique, many queries will be based upon them.
- Category is a useful grouping of similar types and so provides a convenient overview: for example, all means of transport are included in the Transport category.
- Period indicates the period of origin or use of each type, and is fundamental for addressing questions about the origins of the land use and changing patterns of land use through time.

HLA shows that the modern landscape is substantially a creation of the last 300 years due to agricultural improvements and industrialisation, and that those parts of the landscape that are of medieval or earlier origin are rare. The early date of origin of these surviving elements was not often recognised until HLA was carried out and their rarity enhances their importance. More recent landscapes, such as field patterns resulting from agricultural improvements, can also be important because they are so characteristic of the Scottish landscape, representing significant historical development. Period is consequently also a crucial aspect in data analysis.