SLS-DSU

Scottish Longitudinal Study Development & Support Unit

Technical working paper 5

Geographies and ecological variables in the Scottish Longitudinal Study (SLS)

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Contents

Introduction

The Scottish Longitudinal Study (SLS) is a large scale linkage study created from the linkage of data from routine administrative and statistical sources. These include Census data, vital events data (births, deaths, marriages), National Health Service Central Register (NHSCR) data (migration in or out of Scotland), NHS data (cancer registrations and hospital discharges), and education data (Hattersley & Boyle 2007; Boyle et al. 2009).

Geographical data are an integrated part of the SLS. All SLS data are coded onto a number of different geographies, including census, health and other administrative areas, at a range of spatial scales. These geographies relate to the geography existing at the time of the census, or the occurrence of a demographic event (e.g. birth). Geographies and ecological variables are essential not only for research on migration, but also for research on impacts of environmental and socio-economic contexts on individuals' well-being. This working paper will introduce geographical data including geographical identifiers and ecological variables in the SLS.

The structure of this paper is as follows: firstly a brief introduction on administrative geographies in Scotland; secondly, a summary of geographies in the SLS; thirdly, geographical identifiers in the SLS; fourthly ecological variables and last the use of geographical data.

A brief history of administrative geographies in Scotland

Administrative geographies in Scotland are largely hierarchical whereby sets of smaller areas nest into a larger area. Government, electoral, and census geographies tend to be closely related, the same as in the rest of the UK. This complexity is compounded by revisions to administrative geographies over time, with the last few decades of the 20th century experiencing widespread changes in administrative geographies (Walford, 2005; Norman et al., 2008; Walford & Hayles, 2011).

Prior to 1929, based on the Local Government (Scotland) Act 1889, local government consisted of largely of royal burghs, small towns and villages that organised primary services for communities. Scottish local government was re-organised in 1929, following the Local Government (Scotland) Act 1929, when a complex structure comprising of five types of local government area was established.

The system remained unchanged until 1975. The local government areas of Scotland were then redefined by the Local Government (Scotland) Act 1973. The 1973 Act created a two-tier system of 56 districts under nine regions and three islands areas. The new regions were generally very different from the counties and subdivisions of counties, also called districts, which had been in use since 1929.

The current local government structure was the result of the Local Government (Scotland) Act 1994. Council Areas were created on 1st April 1996 following a

review of the local government structure in Scotland. Council Areas provide a single tier of local government covering the whole of Scotland. There are 32 Council Areas in Scotland. They are groupings of contiguous electoral wards that are contained within a boundary defined by statute of Council. These 32 councils are responsible for delivering services such as education, leisure and recreation, planning and building standards, social services, housing, street cleaning, and refuse collection in their respective administrative areas.

Summary of administrative geographies

Census Geographies

1991 For the 1991 census in Scotland, the lowest level "Output Areas" (OAs) were created by the General Register Office Scotland (GROs) as aggregations of postcodes which had been previously digitized. The 38,254 OAs were mostly created by subdividing 1981 "Enumeration Districts" (EDs) which had themselves been constructed from the aggregation of postcode units, allowing a high degree of geographical comparability between 1981 and 1991 census results. The minimum threshold for publication of census data was 50 persons and 25 households and no OAs were created to be smaller than this.
1991 OAs nest within pseudo postcode sectors, which are the equivalent of the ward level in England. A postcode sector is the set of unit postcodes that are the same apart from the last two characters and has been used in the Census output in Scotland since 1981. Special postcode sectors (called pseudo postcode sectors) are created for Census output to ensure that sectors conform to a minimum threshold and do not cross local government boundaries. Pseudo postcode sectors vary widely in population size.

Higher level census geographies included districts and regions. There are also electoral wards in Scotland but these do not nest exactly within the census geography hierarchy.

2001 Following the tradition since 1981 all 2001 census geographies are based on the set of postcodes and their boundaries, which were frozen in January 2001. Output Areas (OAs) for 2001 are created as groups of postcodes nesting as well as possible into the following areas: Council Area, 2001 locality, 1991 OA, postcode sector and 2001 electoral ward in descending order of preference. The main aim governing this order of areas is to keep continuity with the 1991 OA while ensuring, as far as possible, that 2001 OAs fit into the locality or urban area which is seen as an increasingly important area type. GROS creates only one set of OAs and allocates all other output geographies using the OA as the basic unit. Each OA is assigned to an area in a 'higher' geography by first selecting one of the postcodes in the OA as a 'master' postcode. The OA inherits all of the characteristics of the master postcode including its assignments to higher areas and its centroid grid reference. There is a need to point out that OAs were based on postcodes as at December 2000.

The Council Area is the main area for 2001 outputs. As mentioned above there are 32 Council Areas in Scotland. They are groupings of contiguous electoral wards that are contained within a boundary defined by statute of Council.

Similar to the 1991 census special postcode sectors are created for Census output to ensure that sectors conform to a minimum threshold and do not cross Council Area boundaries. Because the confidentiality thresholds differ for Census Area Statistics (CAS) and Standard Tables (ST), there are two types of postcode sectors in Census output: Standard Table (ST) and Census Area Statistic (CAS).

Census Area Statistics (CAS) - The resulting 1,010 aggregations meet the minimum threshold for CAS (20 households and 50 persons). CAS sector names that include '(part)' indicate that the original sector had to be split.

Standard Table (ST) - ST Sectors that are mergers of CAS sectors. Where a CAS sector fails to meet the minimum threshold for Standard tables (400 households and 1,000 persons) it is merged with one or more neighbouring CAS sectors within the same council area so that these thresholds are met.

Census data are not available for true postcode sectors because they cross council area boundaries.

Census data are also released for census Wards (two types: CAS ward and ST wards), Settlement and Locality, Parliamentary Constituencies, Health Board areas, Civil Parish, Inhabited Islands (Figure 1).

Postal geographies

Royal Mail maintains a UK-wide system of postcodes to identify postal delivery areas. The system has been used by the Post Office since the late 1960s to facilitate the mechanised sorting of mail. The system covers every address in the country to which mail is delivered. On average, each unit postcode covers around 15 postal delivery points, unless it is assigned to a single large user such as a business address. A postcode represents a group of addresses on the postal delivery person's walk, instead of an area with defined boundaries. Postcodes are generally very stable over time though can be redefined at any time to reflect changes in local postal delivery. The decision to use postcodes as a base for census geography has been influenced by the fact that postcodes are widely known by the public and so can be easily entered on the census schedule. In addition, the use of postcodes for other statistical data within government departments and the National Health Service has becoming increasingly common. The main advantage of using postcodes is that they facilitate comparisons with other non-census statistics for the same area and with future census data.

There are four levels of postal geography:

Postal geography	Code example
Postcode Area	EH
Postcode district	EH12
Postcode sector	EH12 7
Unit postcode	EH12 7TF

In Scotland there are approximately 170, 000 unit postcodes. The postcode system is maintained on a continuous basis: some are created, changed or

discontinued. Scotland is the first country within the UK in the use of postcode geography in the definition of census geographies.

Consistent areas through time (CATTs)

As mentioned above the census geography has undergone changes between 1991 and 2001 (between 1981 and 1991 as well). At the local authority district level, re-organisation of local governments in 1996 brought marked changes to the boundaries of local government. The number of local governments has changed from 56 to 32 and therefore it is not possible to simply compare changes at local government level between 1991 and 2001. Although output areas are aggregates of postcodes and the method has been fairly consistent from 1991 to 2001, a number of output areas have to be revised to accommodate changes in population at the small area level. As a result, 1991 output areas and 2001 output areas are not comparable either.
To solve this problem, Daniel Exeter developed a set of geography, known as Consistent Areas Through Time (CATTs), that enables reliable comparisons of social data from 1981, 1991 and 2001 census data. Rather than using an areal interpolation technique to create a consistent geography, a merging strategy was used, which meant that whenever a source zone (e.g. 1991 OAs) overlapped more than one target zone (e.g. 2001 OAs), the affected target zones were merged. The merging process linked the 17,767 1981 EDs, 38,254 1991 OAs and the 42,604 2001 OAs onto one common boundary file containing 10,058 CATTs. More information regarding the construction of the CATTs can be found in Exeter et al. (2005).

Neighbourhood statistics geography

From 2006 Scottish Neighbourhood Statistics (SNS) has introduced two new, small-area statistical geographies to complete the Scottish statistical geography hierarchy. The data zones and intermediate zones build on the well-established postcode and census geographies, and are now the key geographies for disseminating government statistics and for supporting policy making.
Data Zones The data zone is the key small-area statistical geography in Scotland. The data zone geography covers the whole of Scotland and nests within local authority boundaries. Data zones are groups of 2001 Census output areas and have populations of between 500 and 1,000 household residents. Where possible, they have been made to respect physical boundaries and natural communities. They have a regular shape and, as far as possible, contain households with similar social characteristics.
Intermediate Geography Not all statistics are suitable for release at the data zone level because of the sensitive nature of the statistics, or for reasons of reliability. Therefore a statistical geography between data zones and local authorities was required. The intermediate zones were thus created as aggregations of data zones within local authorities and contain between 2,500 and 6,000 people. Details on data zones and intermediate geography can be found in Flowerdew et al. (2007).

Health geographies

Scotland has 14 Health Boards (HBs) which form the upper tier of the Scottish health care system and report directly to the Scottish Government. The 36

Community Health Partnerships (CHP) form the lower tier of the Scottish health administration. The HBs were introduced in 1974 and were constituted from groups of the local government districts that existed in Scotland between 1975 and 1996. There were originally 15 HBs but in April 2006 the Argyll & Clyde HB was abolished and the area was absorbed by two existing HBs (Highland, Greater Glasgow and Clyde).

Nomenclature of Units for Territorial Statistics (NUTS)

NUTS was created by the European Office for Statistics (Eurostat) as a single hierarchical classification of spatial units used for statistical production across the European Union. At the top of the hierarchy are the individual member states of the EU: below that are levels 1 to 3, then LAU levels 1 and 2 (LAUs were only introduced in July 2003). Prior to 2003 there had been five different NUTS levels. Scotland is a NUTS level 1 region. NUTS level 2 refers to groups of local councils. NUTS level 3 refers to council areas. NUTS Level 4 boundaries (similar to LAU 1) correspond to combinations of council areas, Local Enterprise Companies (LECs) and parts thereof. NUTs level 5 are electoral wards.

Geographical identifiers in the SLS

Geographical location of SLS members was collected from the census form which a respondent filled in. Main time points for residential location include 1991 census day (21st April 1991), 2001 census day (29th April 2001), 1990 from address 1 year ago, 2000 from address 1 year ago. In the 2001 census, the address of workplace or study at the time of the census was also collected (Table 1).

Availability of postcode unit level information allows users to link to any higher level geographies and to map 2001 SLS members to 1991 geographies or vice versa. The postcode, grid references and output area of enumeration are integrated within the SLS tables while other geographies are usually available through lookup tables. Other geographic identifiers include geographies for Neighbourhood Statistics, NHS Boards, and Nomenclature of Units for Territorial Statistics (NUTs).

The SLS links to vital registrations including birth registrations, death registrations, and marriage registrations. The postcode, grid references and output area of residence when the event occurred are also available. Furthermore, a selected number of statutory and administrative geographies are also available in the vital event records (Table 2).

The SLS links to educational data such as school census and educational attainments. The pupils' addresses in the format of postcodes or council areas are available for the time the pupils were at the school.

Table 1 Geographical identifiers in the census records

Geography	1991 census	
	1990	1991
Residential		
Grid references		Easting, northing
Postal geography	Full Postcode	Full Postcode
Output area	Output Areas	Output Areas

Geography	2001 census	
	2000	2001
Residential		
Grid references		Easting, northing
Postal geography	Full Postcode	Full Postcode
Output area	Output Areas	Output Areas
Work or study		
Postal geography		Full postcode

Note: higher levels of geographies are also available through look-up tables

Table 2 Geographical identifiers in the vital registrations

Vital events (births, stillbirths)	Description
Output areas	Mother's residence
Postcode	Mother's usual residence or father's usual residence if different from mother's
Postcode	Place of birth
Grid references	Mother's residence
Council	Council area of mother's residence
Electoral ward	Electoral ward of mother's residence
Health board	Health Board of mother's residence
Local government district	Local government district 1991, mother's residence
NUTS4	NUTs level 4 of mother's residence

Vital events (deaths)	Description
Grid references	Grid references of residence
Postcode	Residential postcode
Output areas	Residence
Council	Council area of residence
Electoral ward	Electoral ward of residence
Health board	Health Board of residence
Local government district	Local government district 1991
NUTS4	NUTs level 4

Vital events (marriage)	Description
Postcode	Bride and groom's residential postcode
Output areas	Residence
Council	Council area of bride and groom's residence
Electoral ward	Electoral ward of bride and groom's residence
Local government district	Local government district 1991, bride and groom's residence
NUTS4	NUTs level 4 residence

Table 3 Geographical identifiers in the education data

School census	Description
Postcode	student's home postcode
Council	Student's home council

Ecological variables

Ecological variables are defined here as variables that provide information about the characteristics of a place, rather than the location of that place. One example would be a rural-urban identifier, which may have a number of classes, from the most urban metropolitan centres to the most remote rural areas. A number of commonly used ecological variables are available in the SLS. They cover areal deprivation, urban rural classifications, environmental pollution, green space and smoking prevalence estimates.

Deprivation

Three types of deprivation indices are included in the SLS. They are Carstairs deprivation index, Townsend deprivation index, and the Scottish Index of Multiple Deprivation (SIMD). Carstairs deprivation index is a census based deprivation indicator (Carstairs & Morris, 1989; 1991). The index is defined as the sum of four standardised percentage variables from the census: proportion of male residents in unemployment, proportion of residents in overcrowded households (more than one person per room), proportion of residents in households with no car, and proportion of residents in lower social classes (partly skilled and unskilled occupations).

Townsend deprivation index is also a census based deprivation indicator (Townsend, Phillimore, & Beattie, 1988). The four census variables used for calculation of Townsend scores are: proportion of residents in unemployment, households without cars, households who are not owner–occupiers, and households in overcrowded conditions (more than one person per room).

Scottish Index of Multiple Deprivation (SIMD) is based on six domains: income, employment, education, health, housing, and geographical access, with data

from the census and other administrative sources as well (Scottish Executive, 2004; 2006). There is a total score and separate score for each domain. SIMD has been updated three times since first constructed in 2004. SIMD is thus available for 2004, 2006, 2009, and 2012.

Urban rural types

Urban/rural indicators are available. These indicators were first developed by the Scottish Government in 2004, and have since been updated in 2005-2006 and 2007-2008. There are six-fold and eight-fold classifications.

Environmental indicators

Environmental data include air pollution data which are estimated by the AEA (Tsagatakis et al, 2010). The annual estimated concentrations of six pollutants: PM10, PM2.5, NO2, CO, SO2, O3 are available from 1994 to 2008. The data are in the grid format, with each grid covering 1 square kilometre (1*1 km). The pollution data can be linked to the SLS members (residence or work/study) via the grid references of their residence or work/study place.

Green space data is available. It is estimated as proportion of electoral ward being green space. Details of methodology of estimation can be found in Richardson et al. (2010).

Smoking prevalence is available at the OA level. The prevalence is estimated for total populations, males, and females. The methodology can be found in Twigg et al. (2000).

User-defined variables

Any variables describing characteristics common to an area can also be added upon request. An example is to create buffer zones around power lines. Then SLS members can be allocated to these buffer zones using national grid references. Another example is a mixed tenure variable which describes proportions of different housing tenures at say OA level can be attached to the SLS.

Use of geographies and ecological data in the SLS

There are some limitations that should be borne in mind when using SLS geographies. Residential locations of SLS members are unknown for time points between the two census dates. Also, if an SLS member moved to England or Wales, s/he was classified as embarkation and we don't know where the detailed destination is.

Although the SLS hold detailed geographical identifiers and small area level indicators, some of them are restricted in their access due to confidentiality concerns. Postcodes, grid references, output area codes, and datazone codes are not released to external users. Instead, for example, if a user would like to use postcode to link to a user-defined geography, the support officer will help the linking, adding the new geography, and remove the postcode codes before passing the data to the user.

Access to ecological variables at small area levels is also restricted. For example, Carstairs deprivation scores will not be released to the user in the original format. Instead the score will be rounded up to one decimal place and added to the file. Alternatively, Carstairs deprivation quintiles or deciles are readily available.

Table 4 Ecological variables in the SLS

Type	1991	2001	Geographical level
Deprivation	Carstairs deprivation index	Carstairs deprivation index	OA, data zone, postcode sector, CATTs
	Townsend deprivation index	Townsend deprivation index	OA, data zone, postcode sector, CATTs
		Scottish Index of Multiple Deprivation (SIMD)	Data zone
Urban/rural indicators	population density	population density	OA, data zone, postcode sector, CATTs
		SHS 6-fold and 8-fold urban rural classification (2003-04)*	Postcode, OA, data zone
Green space		%green space	2001 CAS wards
Graham Moon's smoking estimates		%smokers by gender	2001 OAs
Air pollution	From 1994 to 2008, pollutant: PM10, PM2.5, NO2, CO, SO2, O3		1km*1km grid

* Urban rural classifications were updated in 2005-06 and 2007-08 as well.

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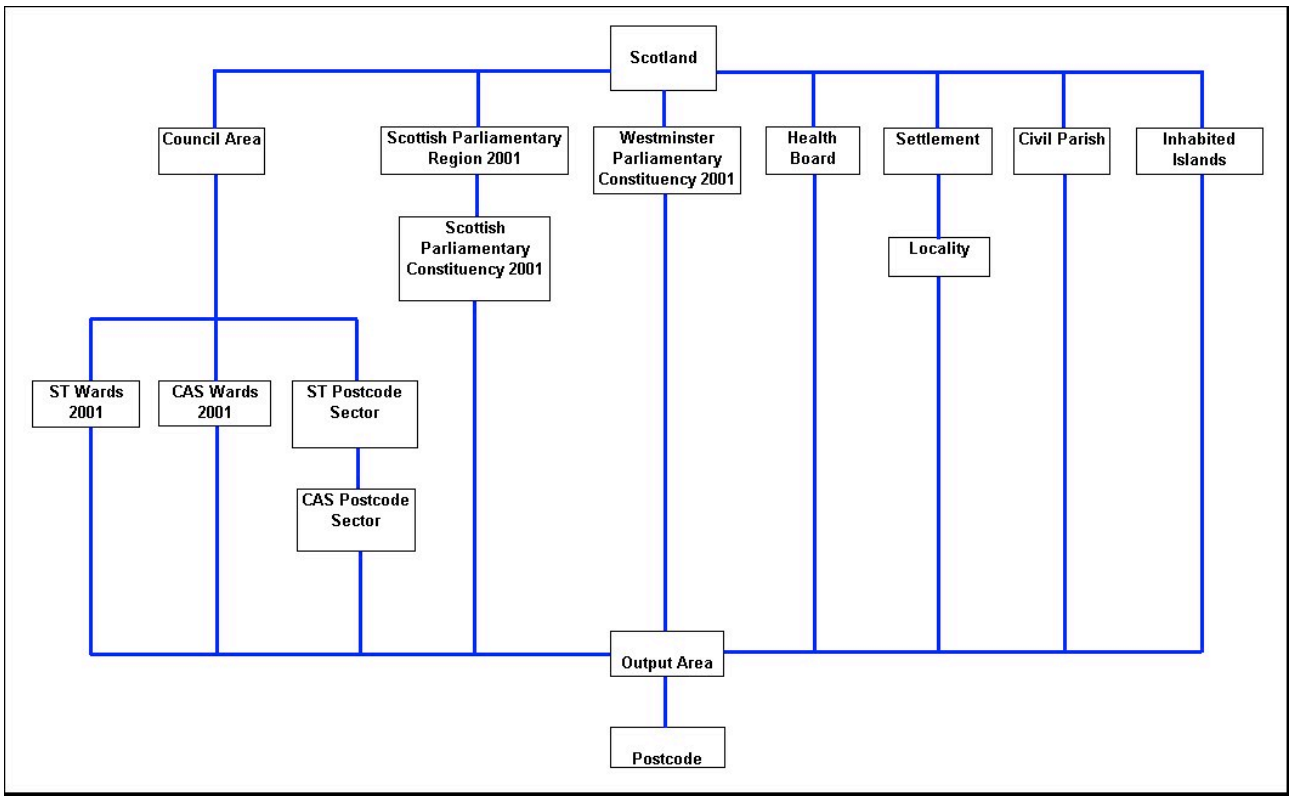
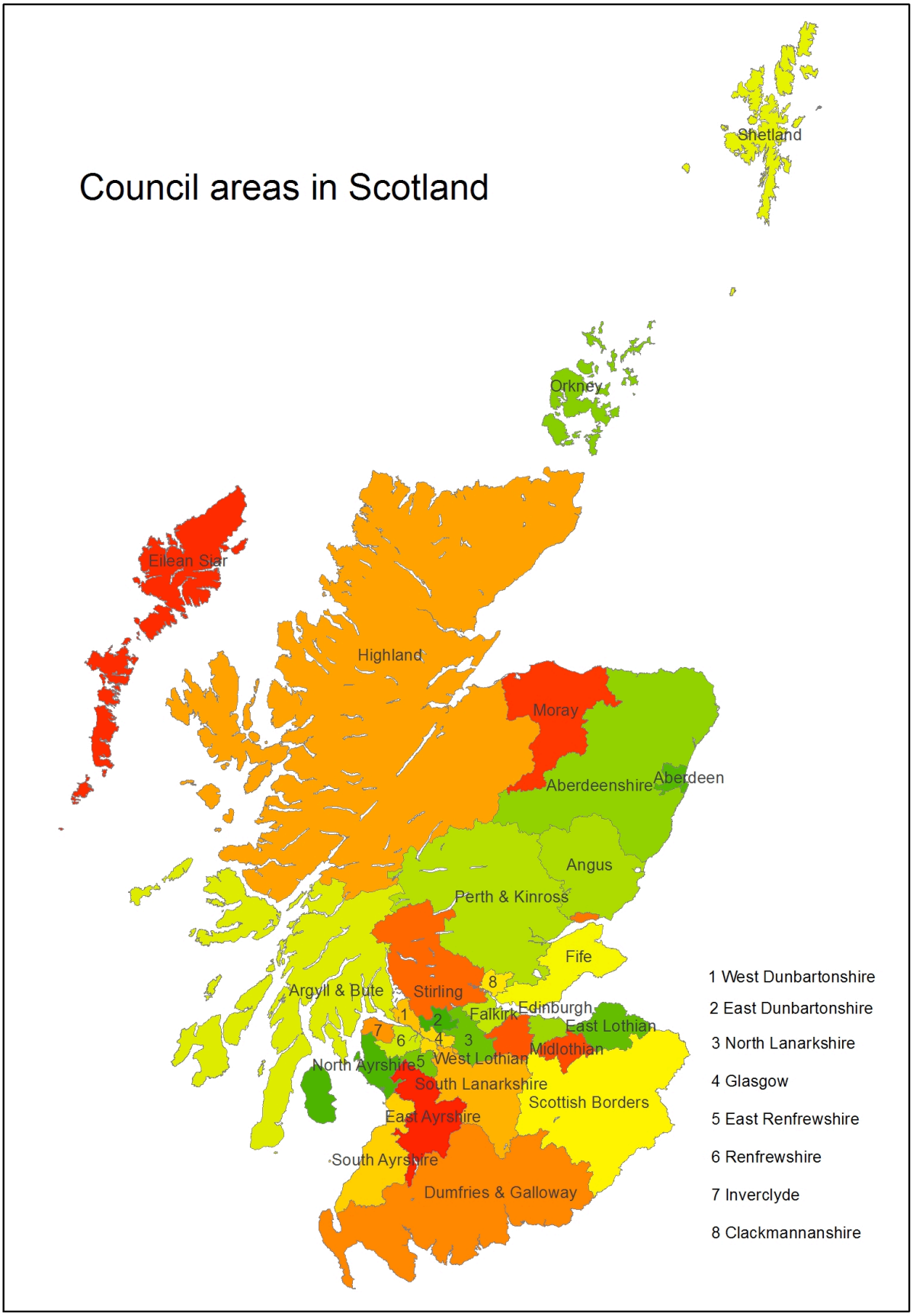
Annex

Relationships between selected geographies in Scotland, 2001



Map of Council areas in Scotland



Local government region, 1976-1996

Region ID	Region name
56	Borders
57	Central
58	Dumfries and Galloway
59	Fife
60	Grampian
61	Highland
62	Lothian
63	Strathclyde
64	Tayside
65	Orkney
66	Shetland
67	Western Isles

Local government district, 1976-1996

district ID	district name	district ID	district name
5601	Berwickshire	6229	Edinburgh City
5602	Ettrick and Lauderdale	6230	Midlothian
5603	Roxburgh	6231	West Lothian
5604	Tweeddale	6332	Argyll and Bute
5705	Clackmannan	6333	Bearsden and Milngavie
5706	Falkirk	6334	Clydebank
5707	Stirling	6335	Cumbernauld and Kilsyth
5808	Annandale and Eskdale	6336	Cumnock and Doon Valley
5809	Nithsdale	6337	Cunninghame
5810	Stewarty	6338	Dumbarton
5811	Wigtown	6339	East Kilbride
5912	Dunfermline	6340	Eastwood
5913	Kirkcaldy	6341	Glasgow City
5914	North East Fife	6342	Hamilton
6015	Aberdeen City	6343	Inverclyde
6016	Banff and Buchan	6344	Kilmarnock and Loudon
6017	Gordon	6345	Kyle and Carrick
6018	Kincardine and Deeside	6346	Clydesdale
6019	Moray	6347	Monklands
6120	Badenoch and Strathspey	6348	Motherwell
6121	Caithness	6349	Renfrew
6122	Inverness	6350	Strathkelvin
6123	Lochaber	6451	Angus
6124	Nairn	6452	Dundee City
6125	Ross and Cromarty	6453	Perth and Kinross
6126	Skye and Lochalsh	6554	Orkney
6127	Sutherland	6655	Shetland
6228	East Lothian	6756	Western Isles

Councils in Scotland, 1996 onwards

Council code	Council name
60QA	Aberdeen City
60QB	Aberdeenshire
60QC	Angus
60QD	Argyll & Bute
60QE	Scottish Borders
60QF	Clackmannanshire
60QG	West Dunbartonshire
60QH	Dumfries & Galloway
60QJ	Dundee City
60QK	East Ayrshire
60QL	East Dunbartonshire
60QM	East Lothian
60QN	East Renfrewshire
60QP	Edinburgh, City of
60QQ	Falkirk
60QR	Fife
60QS	Glasgow City
60QT	Highland
60QU	Inverclyde
60QW	Midlothian
60QX	Moray
60QY	North Ayrshire
60QZ	North Lanarkshire
60RA	Orkney Islands
60RB	Perth & Kinross
60RC	Renfrewshire
60RD	Shetland Islands
60RE	South Ayrshire
60RF	South Lanarkshire
60RG	Stirling
60RH	West Lothian
60RJ	Eilean Siar

NHS Health Boards before 2006

Code	NHS Health Board
SA9	Ayrshire & Arran
SB9	Borders
SC9	Argyll & Clyde
SF9	Fife
SG9	Greater Glasgow
SH9	Highland
SL9	Lanarkshire
SN9	Grampian
SR9	Orkney
SS9	Lothian
ST9	Tayside
SV9	Forth Valley
SW9	Western Isles
SY9	Dumfries and Galloway
SZ9	Shetland

NHS Health Boards after 2006

Code	NHS Health Board
SA9	Ayrshire & Arran
SB9	Borders
SY9	Dumfries and Galloway
SF9	Fife
SV9	Forth Valley
SN9	Grampian
SJ9	Greater Glasgow & Clyde
SK9	Highland
SL9	Lanarkshire
SS9	Lothian
SR9	Orkney
SZ9	Shetland
ST9	Tayside
SW9	Western Isles

Number of zones for selected geographies

Geography	1991	2001
Region	12	-
District	56	-
Council area	-	32
Postcode sector	'pseudo' 1003	'CAS' 1010
Output Area	38254	42604
NUTS 2 / 3 / 4	4 / 23 / 41	4 / 23 / 41
Consistent Areas Through Time (CATT)	10058	10058
Scottish parliamentary regions	8	8
Scottish parliamentary constituencies	73	73
Parliamentary constituencies	72	72
NHS Health Board	15	15
Data zone	-	6505
Intermediate zone	-	1015

Note: There are 14 NHS Health Boards since 2006