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An introduction to 2021 Census geography datasets

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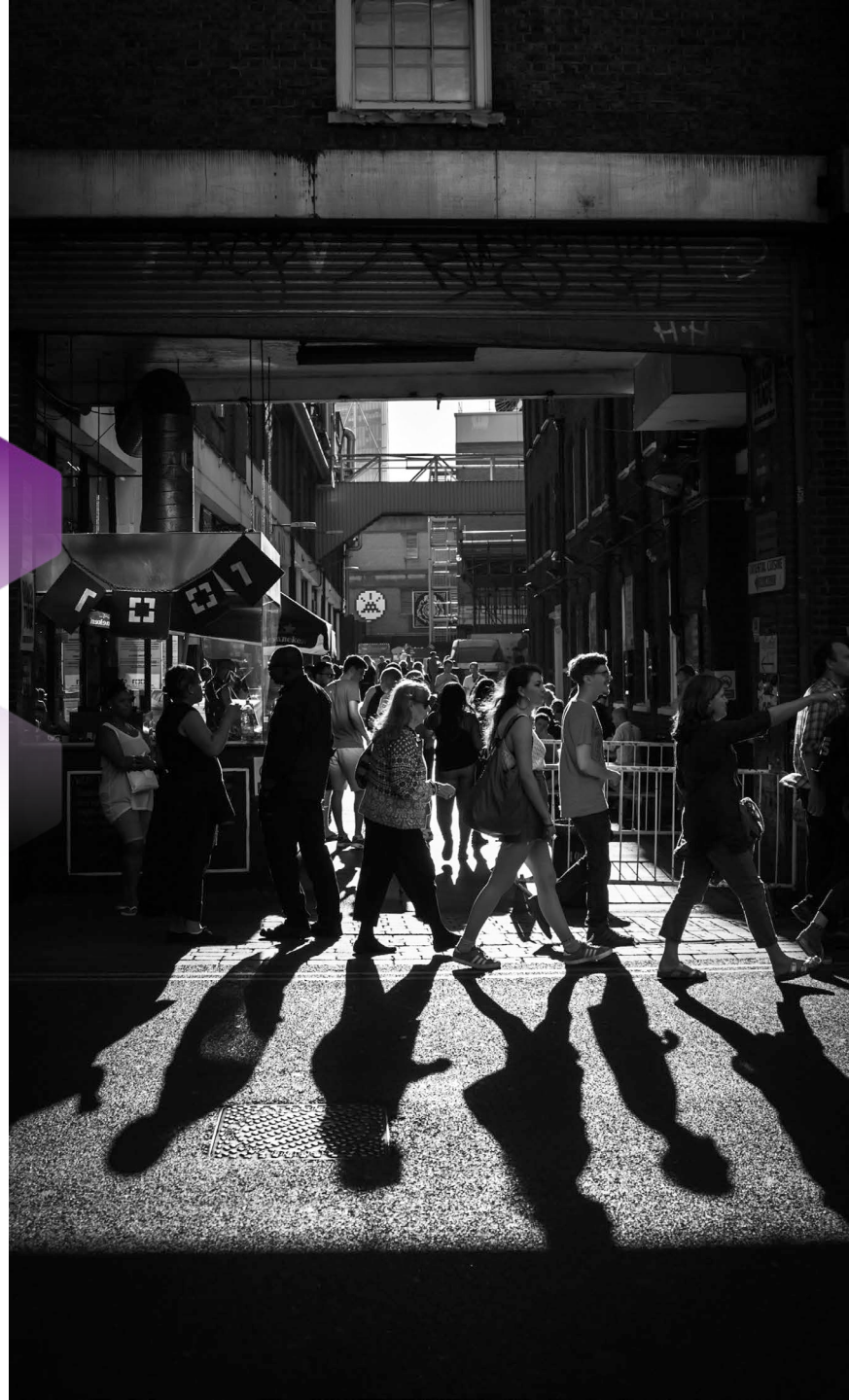
EDINA



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The UK Census

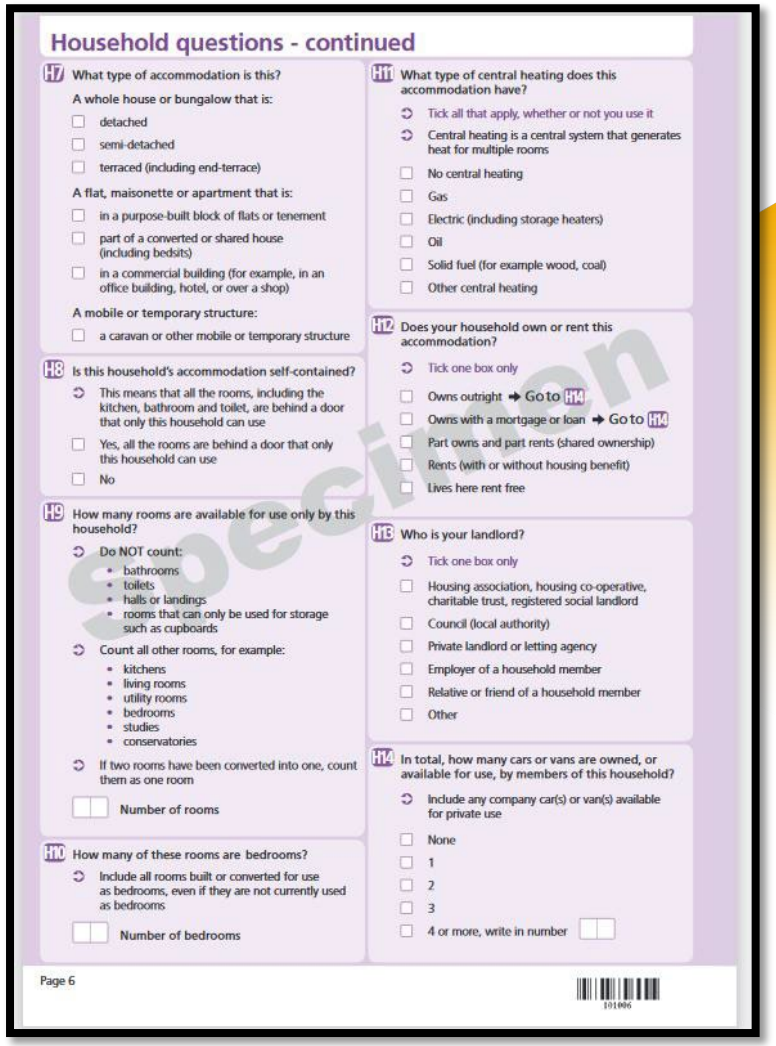
A population census is held every 10 years by the devolved UK statistical agencies.

Ask questions of the whole country.

A mix of Household and Individual Questions.

Some difference in the questions asked by the nations, reflecting local preferences.

Submission of paper form or online completion.



Household questions - continued

H7 What type of accommodation is this?

A whole house or bungalow that is:

- detached
- semi-detached
- terraced (including end-terrace)

A flat, maisonette or apartment that is:

- in a purpose-built block of flats or tenement
- part of a converted or shared house (including bedsits)
- in a commercial building (for example, in an office building, hotel, or over a shop)

A mobile or temporary structure:

- a caravan or other mobile or temporary structure

H8 Is this household's accommodation self-contained?

This means that all the rooms, including the kitchen, bathroom and toilet, are behind a door that only this household can use

- Yes, all the rooms are behind a door that only this household can use
- No

H9 How many rooms are available for use only by this household?

Do NOT count:

- bathrooms
- toilets
- halls or landings
- rooms that can only be used for storage such as cupboards

Count all other rooms, for example:

- kitchens
- living rooms
- utility rooms
- bedrooms
- studies
- conservatories

If two rooms have been converted into one, count them as one room

Number of rooms

H10 How many of these rooms are bedrooms?

Include all rooms built or converted for use as bedrooms, even if they are not currently used as bedrooms

Number of bedrooms

H11 What type of central heating does this accommodation have?

Tick all that apply, whether or not you use it

Central heating is a central system that generates heat for multiple rooms

- No central heating
- Gas
- Electric (including storage heaters)
- Oil
- Solid fuel (for example wood, coal)
- Other central heating

H12 Does your household own or rent this accommodation?

Tick one box only

- Owns outright → Go to H14
- Owns with a mortgage or loan → Go to H14
- Part owns and part rents (shared ownership)
- Rents (with or without housing benefit)
- Lives here rent free

H13 Who is your landlord?

Tick one box only

- Housing association, housing co-operative, charitable trust, registered social landlord
- Council (local authority)
- Private landlord or letting agency
- Employer of a household member
- Relative or friend of a household member
- Other

H14 In total, how many cars or vans are owned, or available for use, by members of this household?

Include any company car(s) or van(s) available for private use

- None
- 1
- 2
- 3
- 4 or more, write in number

Specimen

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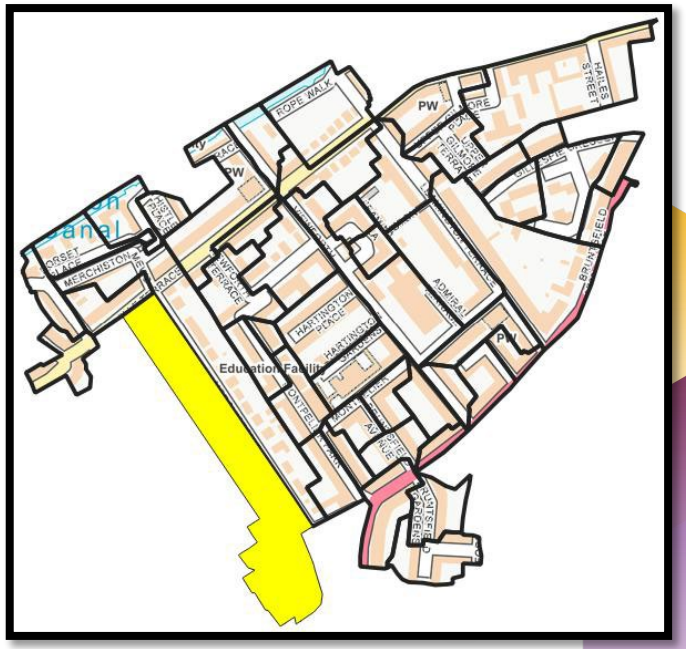
Processed Output Census Data

- Information submitted by census form on census night is processed into aggregate output tables by the national statistics agencies
- Producing Univariate and Multivariate tables of census statistics
- Census Statistics tables are output as counts of people or counts of households
- Data output at different levels of small area output geography
- The Smallest level of output geography across the UK is the **Census Output Area**
- Output Areas are a synthetic geography especially created for the publication (output) of census statistics



	fid	oacode	totpop	hhdspace	male	female	detached	flatpur
21	31	S00104890	138	66	63	75	0	64
22	24	S00106918	110	69	60	50	0	67
23	25	S00104904	73	54	29	44	0	53
24	26	S00104922	113	41	53	60	9	6
25	27	S00104908	153	53	75	78	3	39
26	4	S00104910	87	57	38	49	0	56

Census Output Areas

Each OA has a minimum of 40 households and 100 residents to a maximum of 250 households and 625 residents.

OAs are constructed using an automated zone building system

A design goal when buildings OAs is that each OA should contain a homogenous population

To ease comparisons with the previous 2011 census, a further goal is to minimise change between 2011 and 2021.

Changes to Output Areas

In the 10 years since the 2011 census there has been both an increase in the size of the UK population and changes to population distribution and population density as where people live has changed.

So that Census Output Areas continue to meet their design criteria in terms of the numbers of residents / households and the homogeneity of population characteristics there needs to be adjustment to the Output Areas.

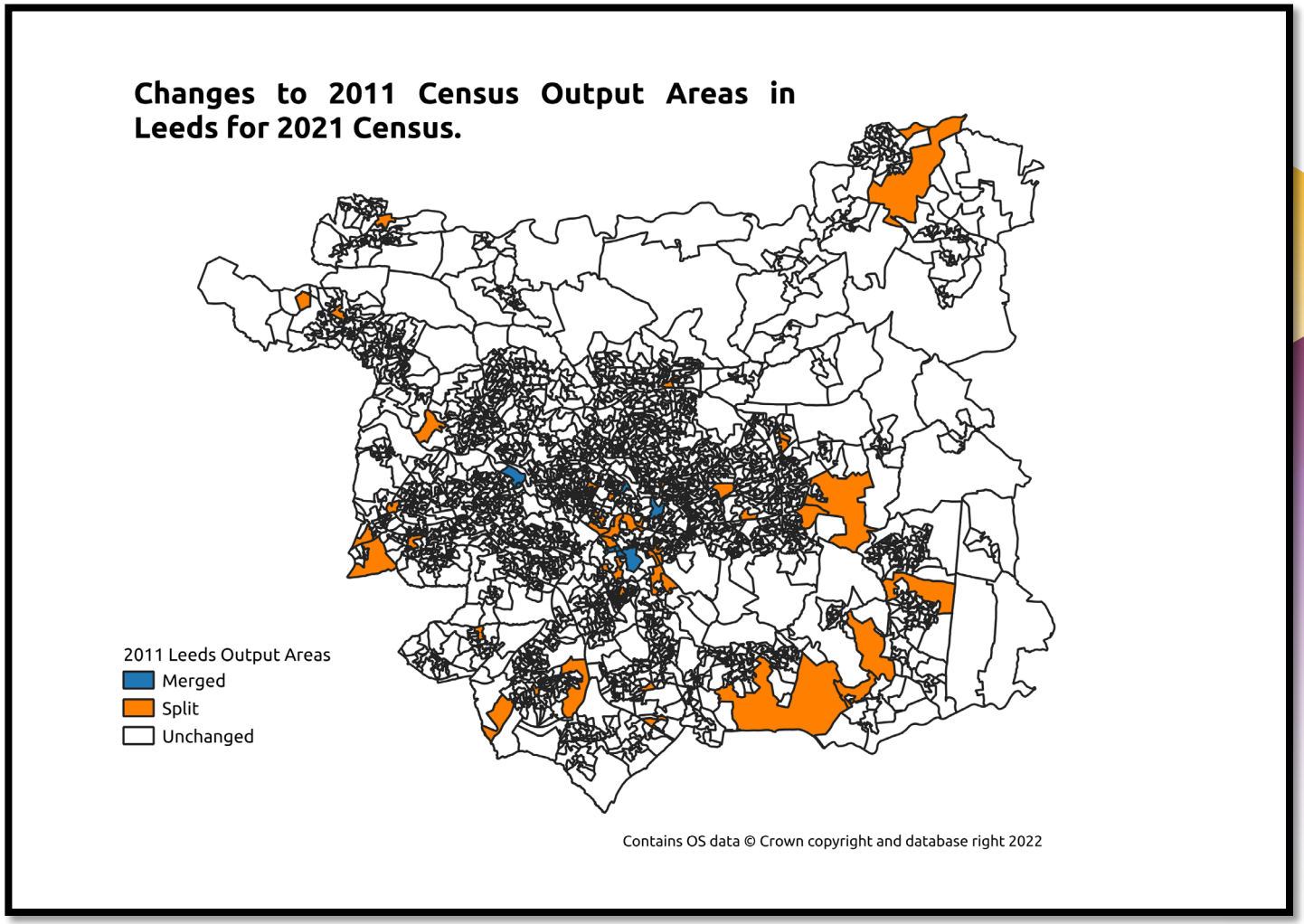
Minor adjustment to Output Areas

Across England and Wales as a whole ~ **95%** of 2011 OAs are the same in 2021. Of the rest:

Some 2011 OAs merged into 2021 OA.

Some 2011 OAs split into 2 or more 2021 OAs.

Other more complex types of change in a smaller number of cases.



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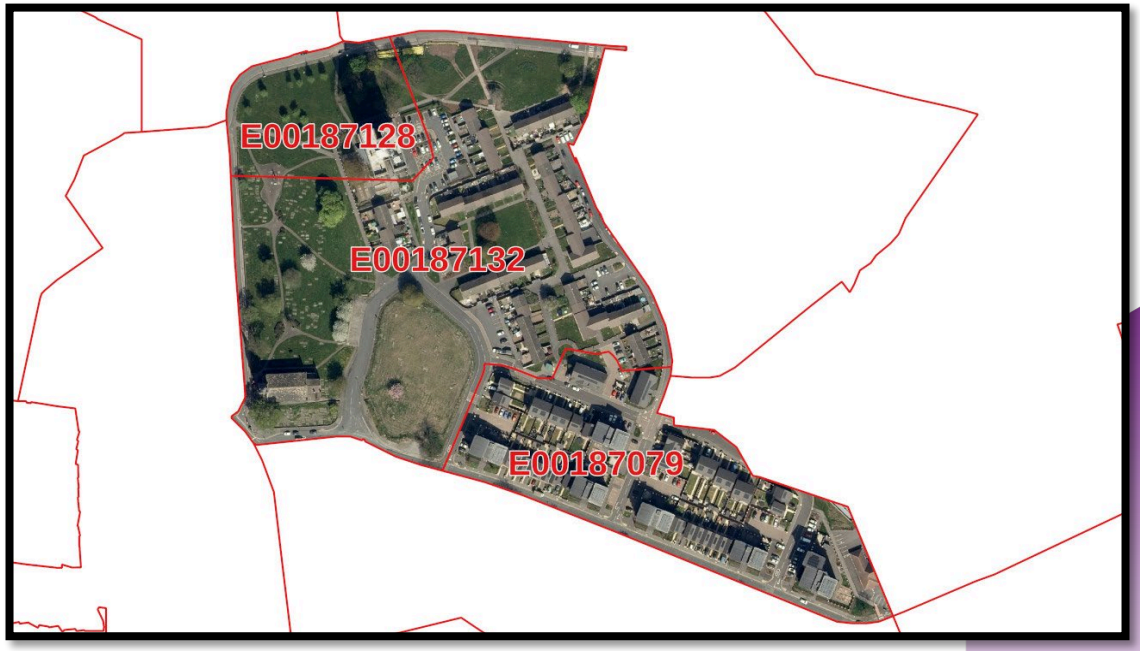
One 2011 Leeds OA becomes 3 in 2021



At the time of the 2011 census there is a single Census Output Area. At the time of the 2021 census a new housing development has been built on a former brownfield site so the 2011 OA has been split. In addition to meet the design goal of maximizing the homogeneity of the underlying population the region at the top left containing high-rise residential housing now forms an OA on it`s own.

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Super Output Areas

Statistical Disclosure Control is there to ensure that individuals cannot be identified from census statistics. In some cases, given the size of Output Areas and the small associated populations there is a risk of individuals being identifiable.

To prevent this, not all census statistics are released at the most detailed Output Area level but instead are released at much larger Super Output Area zones level.

2 levels of Super Output Areas:

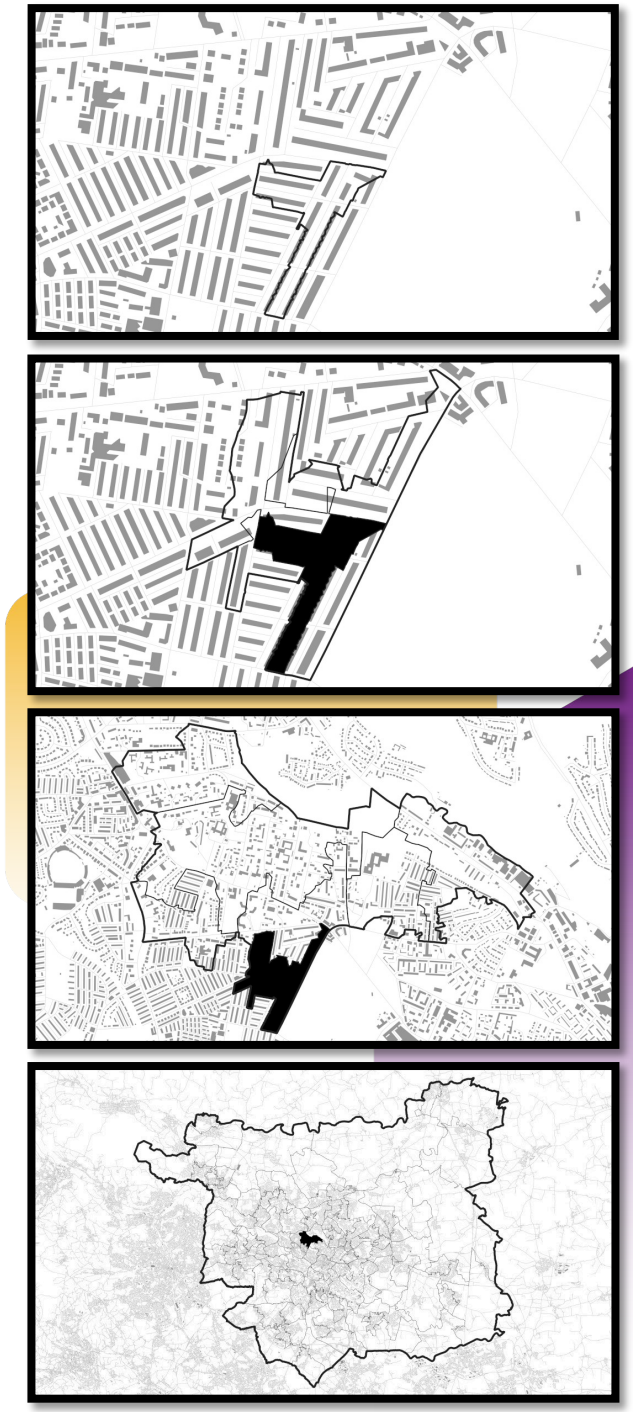
Lower Layer (LSOA): 400 – 1200 HHs / 1000 – 3000 people

Middle Layer (MSOA): 2000 – 6000 HHs / 5000 – 15000 people

LSOAs are created by merging OAs

MSOAs are created by merging LSOAs

OAs; LSOAs and MSOAs nest within Local Authorites.



Some national differences

Updated Output Areas in due time will be available for England, Wales and Scotland. In Northern Ireland Output Areas are known as Small Areas.

England and Wales have Lower and Middle Super Output Areas. Scotland has Lower and Middle Super Output Areas as well but in 2011 at least they are called Datazones and Intermediate Geographies.

Scottish Datazones are equivalent to LSOAs.

Scottish Intermediate Geographies are equivalent to MSOAs.

Northern Ireland only has 1 layer of Super Output Areas

Census Output Geographies

Statistical: Output Area; Lower / Middle SOA

Producing Census data at different geographies enables the census data to be compared with other non-census data which may be collected and output at different geographies:

Administrative: Local Authorities

Electoral: Electoral Ward; Parliamentary Constituencies

Health: NHS Regions; Integrated Care Boards

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Geospatial Data

Two forms of geospatial data – **Vector data** consisting of **Points**; Lines and **Polygons** and Raster data consisting of gridded data.

All geospatial data is referenced to a **Spatial Reference System**. British National Grid is an example of an SRS.

Geographic Identifiers are alphanumeric codes that unambiguously identify specific instances of a given output geography.

Geographic Look-up Tables relate one or more geographies to one another.

GSS Codes

Instances of UK Census Geography small areas are assigned a Geographic Identifier that uses the UK Government Statistical Service (GSS) system of codes.

GSS Codes are 9 digits in length. First 3 digits identify the **entity** (the type of geography). Remaining 6 digits identify the specific **instance** within that type.

The ONS maintain a Register of Geographic Codes which lists each of the entities.

So **E00***126679* has Entity Code of **E00**, this is instance *126679* of English Output Areas geography.

So **E07***000118* has Entity Code of **E07**, this is instance *000118* of English Non-Metro District geography.

GSS Codes were first used in the 2011 UK Census. Before 2011, in the 1991 and 2001 Census, Census codes were hierarchial in nature. GSS Codes are non-hierarchical – it`s not possible purely from the code itself to determine what LSOA; MSOA or LAD, an OA with code E00126679 falls within. Determining this requires the use of a geographic look-up table.

	A	B	C	D
1	**Entity code**	**Entity name**	**Entity abbreviation**	**Entity theme**
2				
3	**England**			
4	E92	Country	CTRY	Administrative
5	E00	Output Areas	OA	Statistical Building Block
6	E01	Super Output Areas, Lower Layer	LSOA	Statistical Building Block
7	E02	Super Output Areas, Middle Layer	MSOA	Statistical Building Block
8	E04	Civil Parishes	PAR	Administrative
9	E05	Electoral Wards/Divisions	WD	Administrative/Electoral
10	E06	Unitary Authorities	UA	Administrative
11	E07	Non-metropolitan Districts	NMD	Administrative
12	E08	Metropolitan Districts	MD	Administrative

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Census Boundary Datasets

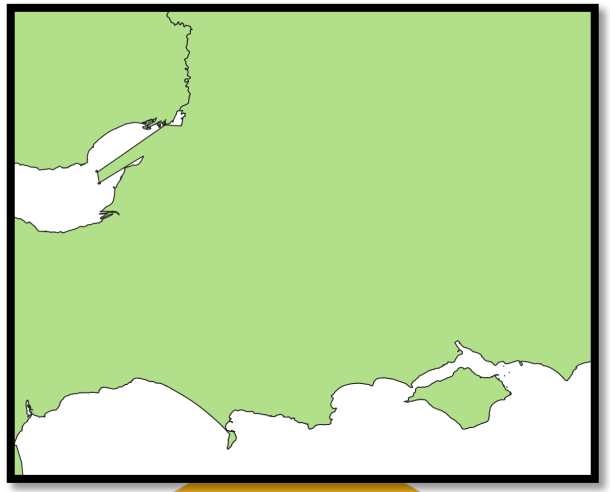
Census Boundaries describe the **spatial footprint** of an instance of a given geography and consist of **1 or more polygons** formed from a series of **geographic coordinates** located within a **spatial reference system**.

Census Boundaries are provided in different GIS Data Formats. Examples include Shapefiles and MapInfo TAB files. Shapefiles are ubiquitous.

Different flavors of polygonal geometry are available:

Boundaries may occupy the **Extent of the Realm** or be clipped to the **Mean High Water** mark. Boundaries clipped to the Mean High Water Mark provide a more familiar geography.

Generalized boundaries have polygons whose features are made up from fewer geographic coordinates resulting in smaller file sizes. Smaller file sizes mean that the data is quicker to load and display in mapping applications. However for carrying out (spatial) analysis un-generalized (full-resolution) boundaries should be used.



Extent of the Realm

Clipped to MHW

Census Centroid Datasets

A Centroid simplifies the spatial footprint of a census geography feature from a polygon to a simple vector point geometry or simply an x/y coordinate. There are 2 forms of centroid:

Geometrically Weighted Centroid (GWC): the location of the point is defined based on the spatial average of the coordinates that define the polygon

Population Weighted Centroid (PWC): the location of the point is defined based on the underlying population distribution within the polygon.

Within Census data, Population Weighted Centroids are the norm.

Centroids can be used for simple analysis, for example as a proxy for a spatial footprint within travel time or network analysis.

Mostly though Centroids are used for georeferencing purposes to relate a given geography to 1 or more other geographies where the nature of the polygonal boundaries is such that there would be an imperfect nesting and cases of overlap etc.

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Census Look-Up Table Datasets

Census Look-Up Tables relate one or more Census geographies to one another. Enabling census data to be shown at those geographies:

Some examples:

2021 OA : 2021 LSOA : 2021 MSOA : 2022 LAD

2021 OA : Care Board : NHS Region

2011 OA : 2021 OA

Postcode Directories are a special form of geographic Look-Up Table relating postcodes to other geographies, including Census Geographies

Postcode Oct 2022 : 2021 OA : 2021 LSOA : Country

OA21CD	LSOA21CD	LSOA21NM	MSOA21CD	MSOA21NM	LEP21CD	LEP21NM	LAD22CD	LAD22NM
E00060255	E01011950	Hartlepool 008A	E02002490	Hartlepool 008			E06000001	Hartlepool
E00060256	E01011949	Hartlepool 009A	E02002491	Hartlepool 009			E06000001	Hartlepool
E00060257	E01011949	Hartlepool 009A	E02002491	Hartlepool 009			E06000001	Hartlepool
E00060258	E01011951	Hartlepool 007A	E02002489	Hartlepool 007			E06000001	Hartlepool
E00060259	E01011951	Hartlepool 007A	E02002489	Hartlepool 007			E06000001	Hartlepool
E00060260	E01011951	Hartlepool 007A	E02002489	Hartlepool 007			E06000001	Hartlepool
E00060261	E01011951	Hartlepool 007A	E02002489	Hartlepool 007			E06000001	Hartlepool
E00060262	E01011951	Hartlepool 007A	E02002489	Hartlepool 007			E06000001	Hartlepool
E00060263	E01011951	Hartlepool 007A	E02002489	Hartlepool 007			E06000001	Hartlepool
E00060264	E01011949	Hartlepool 009A	E02002491	Hartlepool 009			E06000001	Hartlepool

Access to Census datasets through the UK Data Service

The UK Data Service:

- brings together current and historic census datasets from the different UK national statistic agencies
- adds value to those datasets with the specific needs of the UKDS user community in mind
- provides alternative access mechanisms to those provided by the national statistic agencies themselves
- supports the use of census data through online training materials; webinars and hands-on user workshops

Plans for release of 2021 census geography datasets through online UK Data Service applications

- The Boundary Data Selector allows one to make sub-selections from any boundary dataset held within the UKDS boundary database and the download of those boundaries in different geospatial data formats.
- Easy Download provides simple access to downloads of full boundary datasets without any sub-selecting; centroids and geographic look-up tables.
- The Postcode Data Selector allows one to make sub-selections from current and historic ONS postcode directories held by UKDS. Postcode directories include lookups to many standard UK geographes.
- The UKDS team at EDINA are in the process of adding the new census geography datasets to UKDS applications.
- New census geography datasets: boundaries; centroids and LUTs expected to be added to applications in the next few months following the building of derived products; database/application updates and UI tweeks.
- Following user feedback we plan to add dataset preview functionality to the Boundary Data Selector and enable boundaries to be output in additional geospatial data formats like GeoPackage.

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Use of boundaries for the visualization and analysis of census data.

	GEOID	GEONAME	M	Manuf_M	manuf_m_pcnt
374	S12000036	Edinburgh, City of	121562	6407	5.270561524
375	S12000038	Renfrewshire	41219	5691	13.80673961
376	S12000039	West Dunbartonshire	20402	2644	12.95951377
377	S12000040	West Lothian	44709	6677	14.93435326
378	S12000041	Angus	28723	4446	15.47888452

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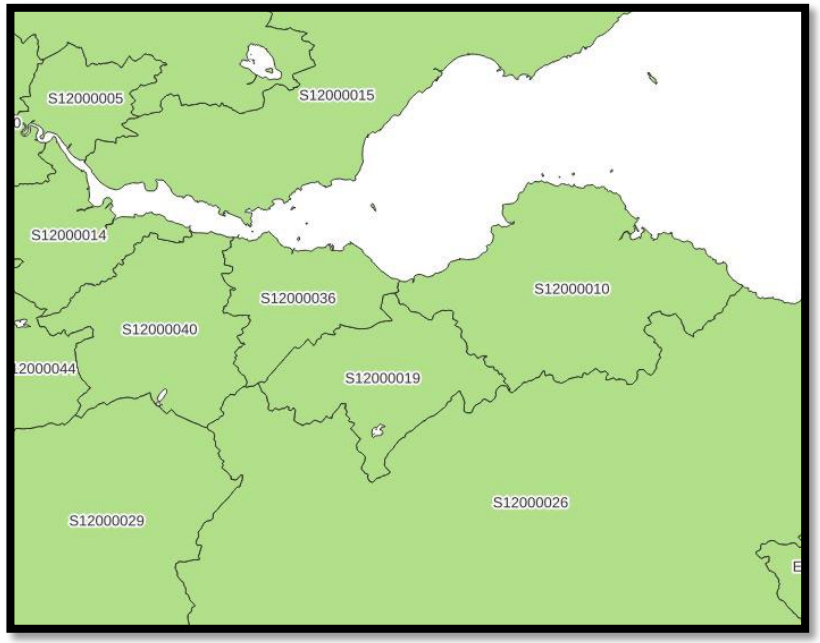

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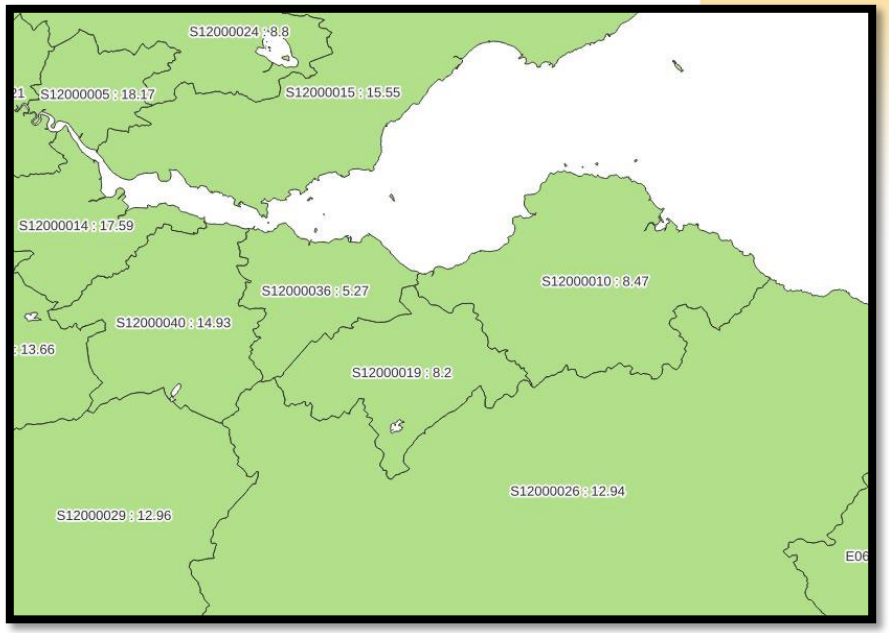

Join a table of aggregate census statistics to digital boundaries for the same geography

Boundaries now have associated with them all of census statistics

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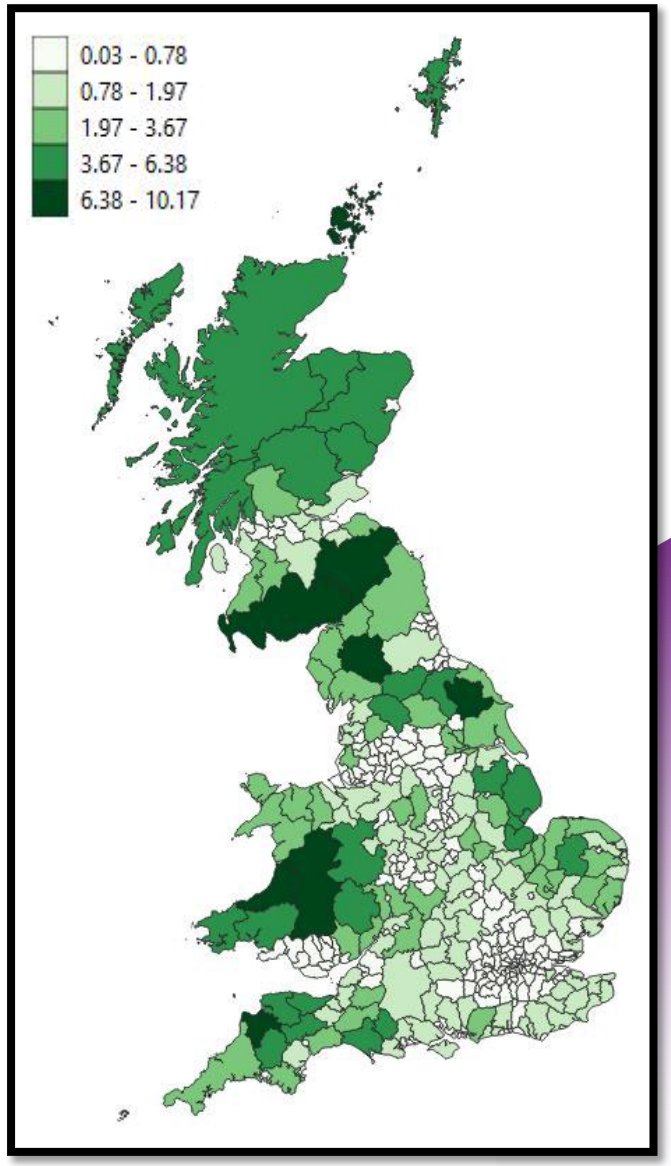
Choropleth Maps

Polygons are shaded in proportion to the measurement of the statistical variable being displayed on the map.

Choropleth maps provide an easy way to visualize how a measurement varies across a geographic area or to show the level of variability within a region.

% of people employed in Agriculture; Forestry and Fishery



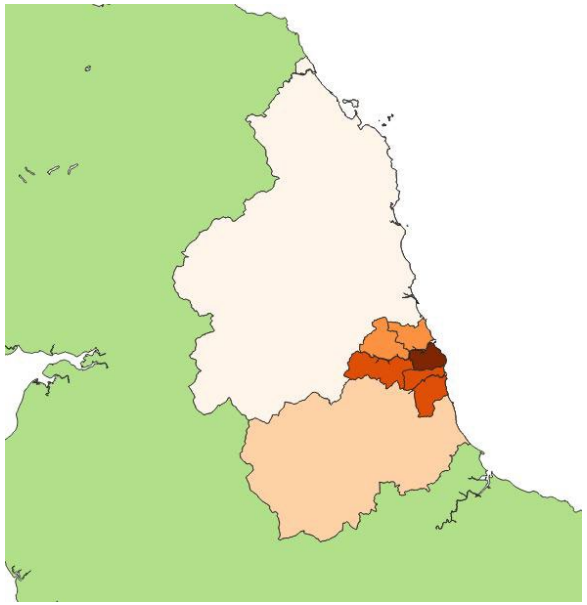
Choropleth mapping of census variables at different levels

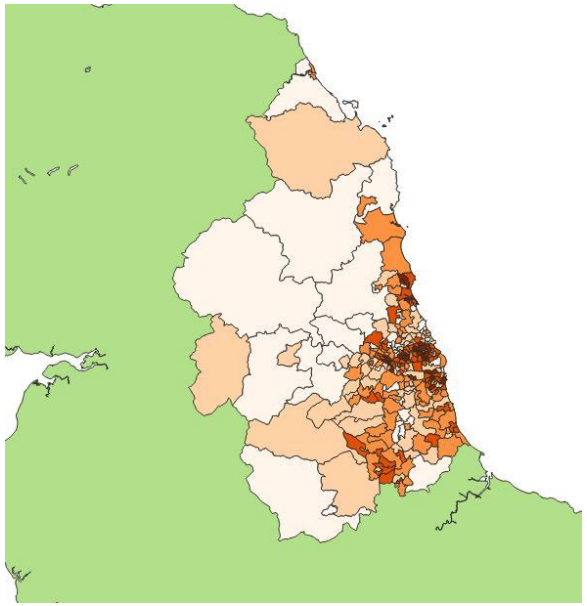
Disclosure control might mean that a given aggregate census statistic is not available at all levels of geography – therefore it may not be possible to map the statistic at most detailed OA level.

Where a census statistic is available across multiple levels of geography:

Mapping the data at Local Authority level uncovers general patterns and smooths the data

Mapping the data at a more detailed LSOA / Output Area level provides more detail but also adds more noise

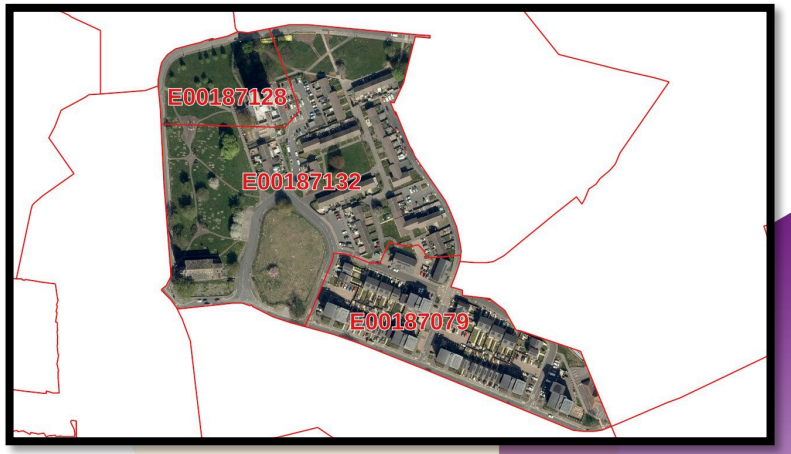




Problems of Choropleths

Choropleth maps imply that the population is distributed uniformly across the extent of the polygonal census zone.

Choropleth maps are also subject to the Modifiable Areal Unit Problem (MAUP) especially when making comparisons over time where the census boundaries may have changed between each census.



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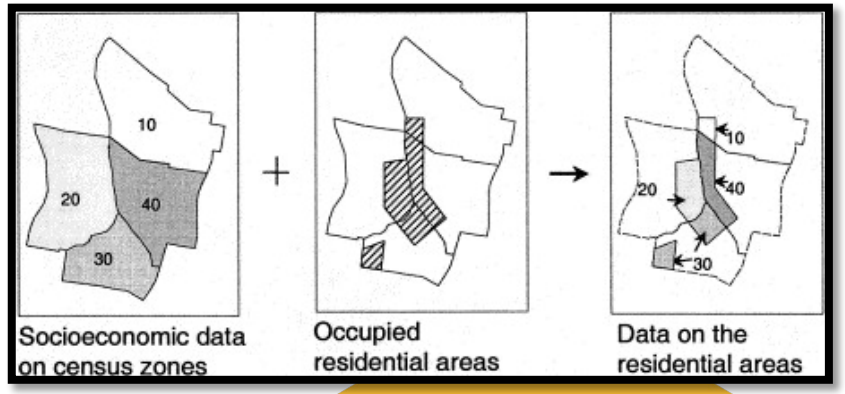
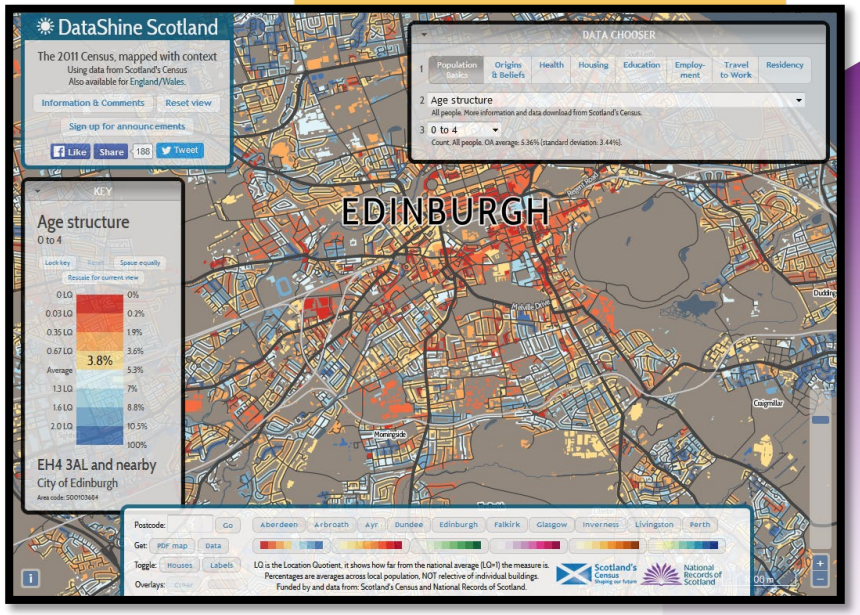
Masked Choropleth Maps

Masked Choropleth Maps modify traditional Choropleth maps using additional land use datasets to present a more realistic distribution of the variable.

DataShine is a form of this where a layer of Ordnance Survey buildings is used to mask the census areas

This helps with the problem of the choropleth implying that population is uniformly distributed across polygons





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Cartograms

A cartogram is a special form of map projection where polygon areas are drawn in proportion to the variable being mapped rather than the land area of the polygon

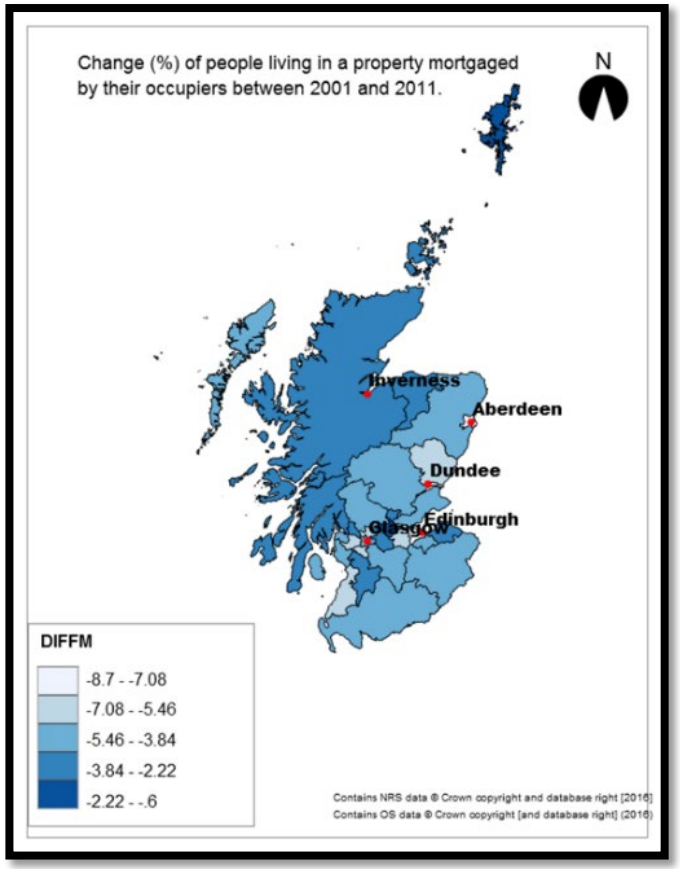
Different types of Cartogram:

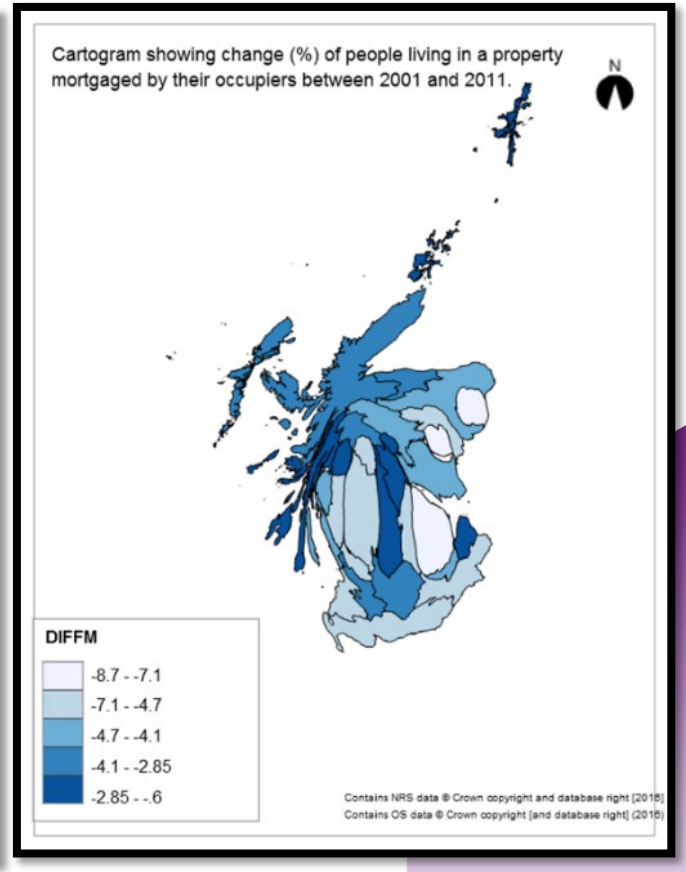
Non-contiguous Cartograms

Contiguous Cartograms

Dorling Cartograms

Cartograms help avoid the problems of census areas with large populations but covering a small area being hidden by census areas with small populations but covering much larger areas



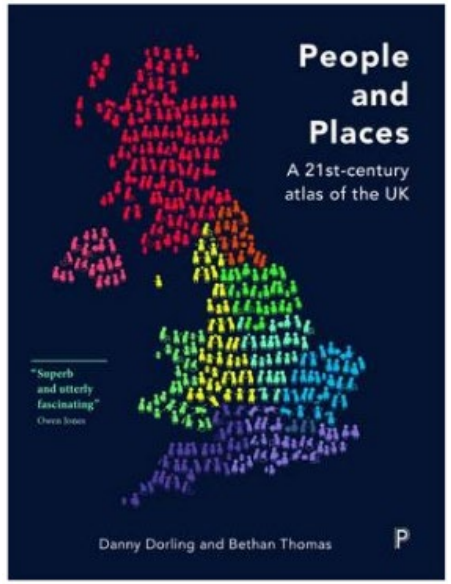


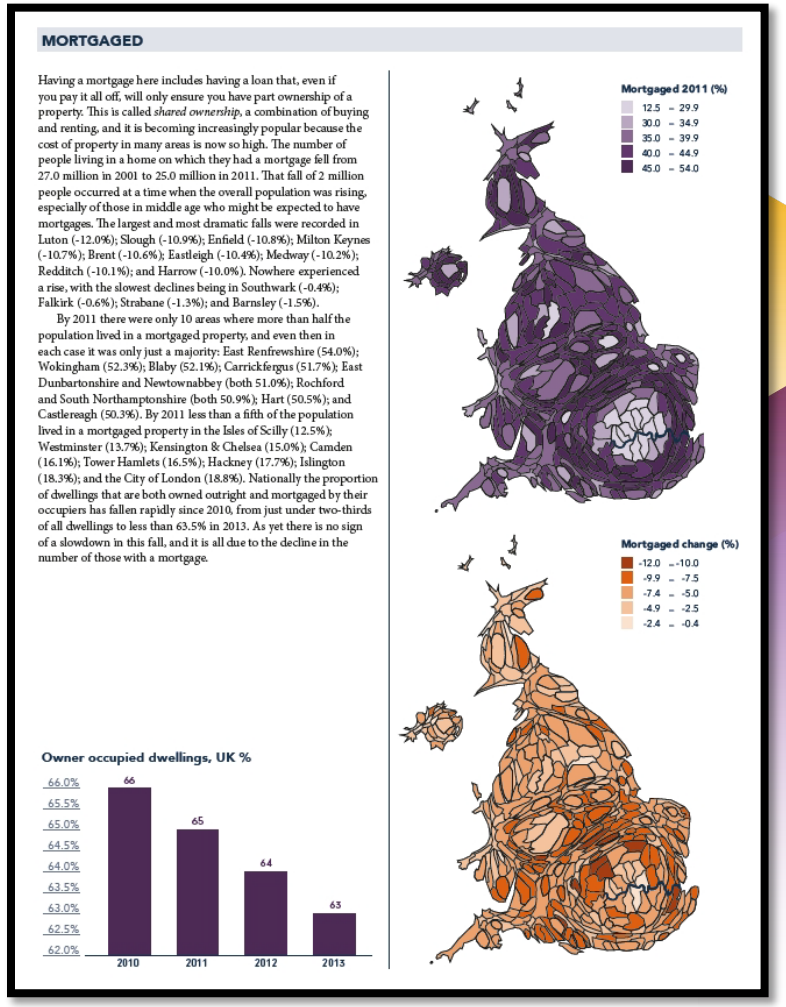
Census Cartograms in the wild

People and Places: A 21st-century atlas of the UK

Danny Dorling and Bethan Thomas

The QGIS Desktop GIS has a plugin which can be used to create these kind of Cartograms.





Further Information

UKDS Data Impact blog post written by Professor David Martin talking about the development of UK Census Output Geography:

https://blog.ukdataservice.ac.uk/david-martin-profile-1/

Videos and information about AZTool – the automated zone design tool used to build the Census OAs developed by Professor David Martin and colleagues at the University of Southampton:

http://aztool.geodata.soton.ac.uk/supporting_materials/

Online ONS Geography and Statistics Training course which provides awareness of geography and statistics (including census statistics) and use of data in QGIS; R and Python:

https://onsgeo.github.io/geospatial-training/

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Thank you.
James Crone

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Please fill in the evaluation form for this webinar.