An Introduction to Geographical Information Systems (GIS)

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People, places and population change

Introduction

Geographical Information Systems (GIS) are computerised systems for the collection, storage, analysis and presentation of geographical information in digital form. At their simplest, they are used to display and to interact with digital maps. However, there is more to GIS than mapping. They are used to analyse and to extract meaning from geographical data, doing so by harnessing the power of location – knowing what happens and where.

Outline

This worksheet has four main aims:

1. To stress the importance of GIS in the geography curricula at GCSE, AS and A-level
2. To provide an introduction to GIS that can be used in a classroom context
3. To consider how population geographies and population change in the UK can be analysed and viewed using an online mapping tool
4. To provide a short tutorial on how to map crime data easily

1. GIS in the subject content for Geography

The GCSE subject criteria published by the Department for Education in 2014 state that geography should enable students to "develop and extend their competence in a range of skills including […] **using maps and Geographical Information Systems (GIS)** and in researching secondary evidence" (§3, p.3, emphasis added). It also states that students should develop and demonstrate a variety of skills, amongst which are "the use of a range of maps, atlases, Ordnance Survey maps, satellite imagery and other graphic and digital material including **the use of Geographical Information Systems (GIS), to obtain, illustrate, analyse and evaluate geographical information**" (§10, p.5, emphasis added).

The AS and A level subject criteria (DfE, 2014) also identify knowledge and use of GIS as part of the quantitative skillset required of each student. Specifically, and amongst other data analysis skills, students must "**understand what makes data geographical and the geospatial technologies (e.g. GIS) that are used to collect, analyse and present geographical data.**" Students must "**demonstrate an ability to collect and to use digital, geo-located data**, and to understand a range of approaches to the use and analysis of such data" (§23, p.13, emphasis added).

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Clearly use of GIS is stressed. The spirit of the GCSE and GCE A/AS level reforms is that quantitative skills should not be taught in isolation nor as an end in themselves but used to support the teaching of the core topic areas in geography – topics such as places and the geography of the UK, cities and urban society, and changing places, including the way places are represented digitally.

2. Introducing students to GIS

For a short introduction to GIS, suitable for GCSE and AS/A-level students, view the 'Story Map' at http://arcg.is/2czUFi8. It contains a collection of maps, videos, text, images and discussion questions covering the fundamentals of GIS, as well as links to follow-up material. Allow a minimum of 30 minutes as an in class or homework activity.
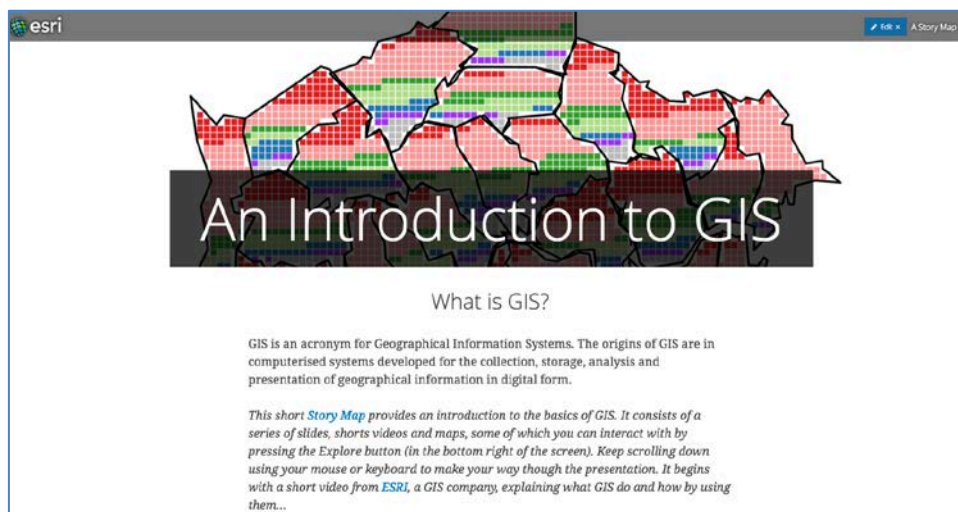

Figure 1. The start of the story map at http://arcg.is/2czUFi8.

Further resources:

There is an introduction to GIS available at http://giscommons.org. Chapter 8 of Quantitative Geography: the basics is also an introduction to GIS (for a draft copy of this chapter, contact rich.harris@bris.ac.uk). Both, however, are more about teaching the theories and science of GIS (how they work) rather than applying them to a particular part of geography.

3. Online maps of population and change

Mapping social and demographic change is not at all easy, especially if we are interested in looking at the geography of neighbourhoods in detail. Census data provide a snapshot of a nation, at ten-year intervals in the UK, which have taken place every year since 1841 (with the exception of 1941). But using these to evaluate change is made difficult by the changing geography of the Census and by differences in the questions asked from one census to the next (the questions change because society does). For example, the main difference in the 2011 Census questionnaire over the 2001 version was in the topics covered. There were eight new topics: Bedrooms, type of central heating, second address, month and year of arrival in the UK, intended length of stay in the UK, national identity, passports held, and main language (ONS).

(a) Looking at the 2011 Census data

For the moment, let's not worry about looking at change but instead consider the characteristics of the Census population in 2011. An easy way to do so is to use the mapping interface at http://datashine.org.uk. This allows you to select a census variable from the Data Chooser (top right of the map), to zoom in and out, to centre the map on a postcode of your choosing (bottom of map), to change the way the data are classified and presented and, very usefully, to download the data for the current map view (press the Data button, underneath where a postcode is entered). A minor irritation at the time of writing is that the information highlighted in the key (bottom left of the map) relates to where the mouse pointer is positioned on the map, not necessarily to any postcode entered.

Class Exercise: use the map interface to collect data for the areas around your school (centre the map on your school, zoom in a little and download the data for various variables). What seem to be the distinctive characteristics of your local area? Is there evidence of differences between places locally or are all the neighbourhoods broadly similar? Are you aware of any changes since the Census was conduced in 2011?

You might also use the maps (and how they are shaded) to compare your local area with other places nationally.

(b) Representations of place using Census data

Census data are used to create what are called geodemographic profiles, sometimes described as 'the classification of people by where they live'. There are a number of commercial classifications but a free and open source classification can be viewed at http://oac.datashine.org.uk/, which categories and then maps the UK's population into the following eight categories:
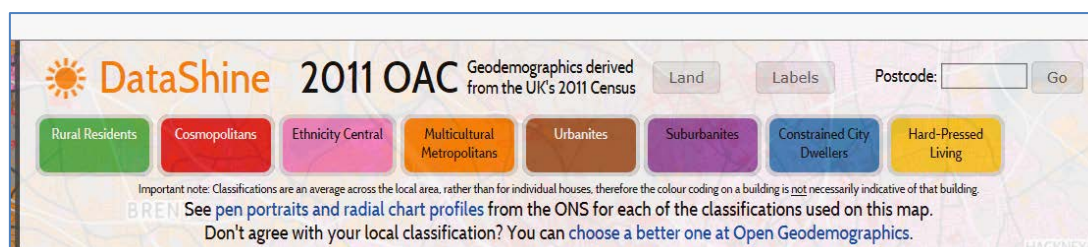
Class Exercise: enter the postcode of the school to centre the map on your local area, and then move your mouse across the map to see the names that have been assigned by the classification to describe your local neighbourhoods. Do they provide a fair representation of those areas? Why or why not?

It is interesting to compare the classification above (OAC) with a commercial classification such as that at http://acorn.caci.co.uk/ (you can register to try it for free). Have a look at the user guide and how it represents places and the people that live in them. An alternative is http://www.p2peopleandplaces.co.uk/P2Explore.htm. The videos at https://www.youtube.com/watch?v=7UCxzYpXhpI and https://www.youtube.com/watch?v=K8Hte8KXuf4 give an idea about how these classifications are used in business and service planning. You might discuss to what extent they are portraying fact or fiction – they are based on real data but some people have accused these kinds of tool as stereotyping (especially poorer communities). What could be the advantages and disadvantages of these sorts of representations of people and places?

(c) Looking at change from one Census to the next

A team at the University of Liverpool has created an online tool for looking at population change in Great Britain. You can access it and register for free at https://popchange.liverpool.ac.uk/. What it has done is take the census data for various years and convert them into a raster grid. Grid values for one year can be compared with grid values for another to identify change. What can be compared depends on the years available. The system also gives a coloured warning as to how well the variables compare over time: green is a good comparison; red is weak. Figure 2 shows the increase or decrease in the number of the population aged 65 or above between 1971 and 2011. Despite an aging population nationally, London, for example, has seen a decrease in the number of older people who live there, whereas the surrounding counties have seen an increase (presumably because people have, at some stage in their life course, moved out of the city into more suburban and rural areas). The changes are more obvious when viewed online.
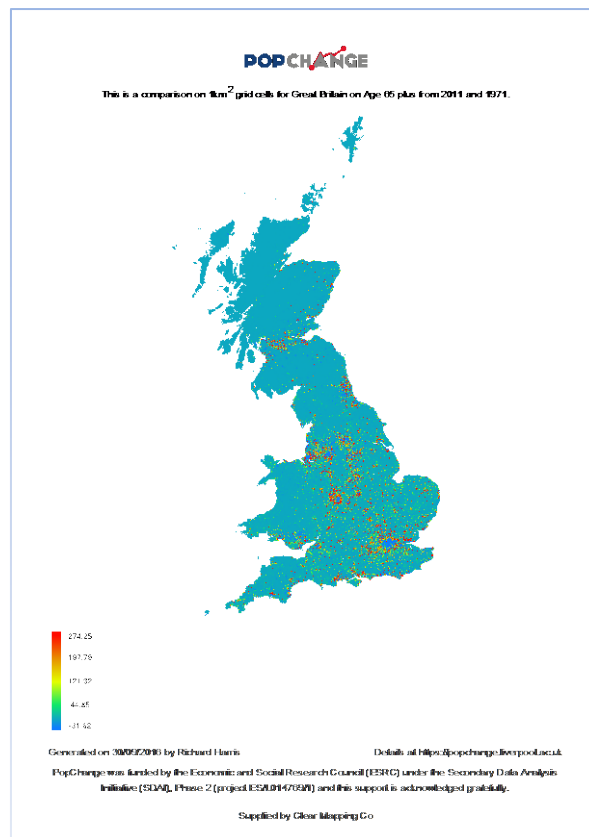
Figure 2. Looking at population change from 1971 to 2011 using
https://popchange.liverpool.ac.uk/.

*Class Exercise: use the system to explore how your local area has changed over time.
Alternatively, search nationally to identify places of greatest aging or of ethnic change, for
example.*

4. Mapping data

(a) Mapping crime data

A trend of recent times is the increase in the amount of data that are available to access
online, without charge. A good example is crime data, which is provided in a format that can
be mapped without needing anything more than a Google account. For example, Figure 3
shows a heat map of the location of public order offences in the West Midlands in July 2016.
It can be created in ten, straightforward stages, which consist of little more than downloading
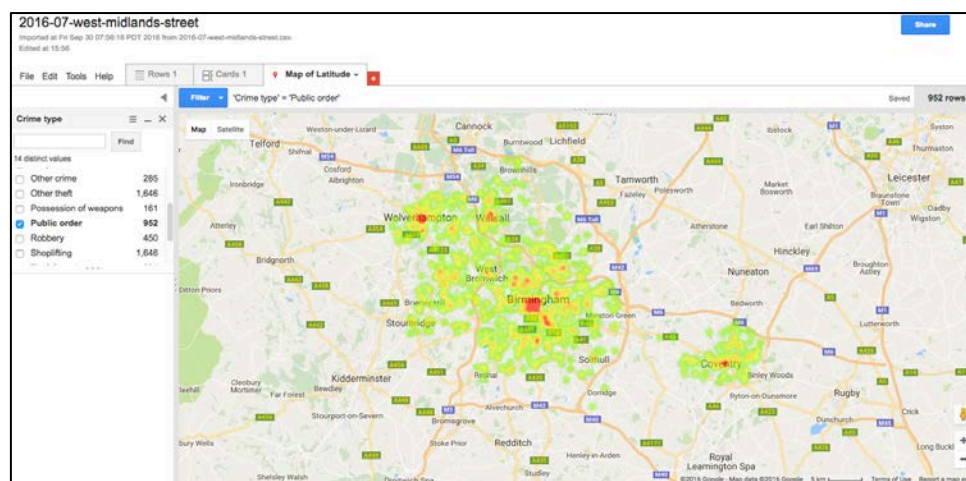the data from a website then uploading it to a Google app.

Figure 3. A heat map showing the concentration of public order offences in the West Midlands in 2016. The map makes use of freely available crime data and Google's Fusion Tables.

1. Go to https://data.police.uk/ and select Downloads.
2. Choose the data range (here it is July 2016 to July 2016) and the Force Area (West Midlands). Then press Generate file.
3. Wait for the file to be generated and download it. You might want to change the name of the file to something more intuitive (but don't change the extension, .zip, which indicates the data have been compressed to reduce the file size).
4. Once downloaded, click on the file to extract the files.
5. Extracting the files will create a new folder (directory) in the same place as the downloaded data, in which will be a comma delimited (.csv) file.
6. Go to https://fusiontables.google.com/DataSource?dsrcid=implicit. If not already, you will be asked to log into (or create) a Google account.
7. You will next be asked to import a new table. This will be the .csv file extracted in Stage 5. Once you have chosen that file from your computer, press Next to upload it, Next again, and Finish.
8. You should now see a table of the crime data. At the top, one of the tabs is Map of Latitude. Click on it.
9. You should now have a map of the crime data. Clicking on the points will display their attributes – including the nature of the crime that took place.
10. Clicking on where it says Heatmap will generate a heatmap but it is limited to the first 1000 rows of the data set. To get around this, we can apply a filter – in this case, a filter by crime type, selecting Public Order. Done!

Class Exercise: generate heat maps for different types of crime. Which crimes are concentrated in particular areas and which are more spatially diffuse? Is there evidence of an association between types of place and types of crime? If so, can you explain the relationship (e.g. does the function of the place make it more or less susceptible to a particular type of crime?)

You may also find this storymap a useful resource with explores crime mapping through GIS http://www.rgs.org/OurWork/Schools/Teaching+resources/GIS+resources/Investigating+the+geography+of+crime.htm

(a) Mapping Census data

Mapping Census data yourself (instead of using an online tool) is not straightforward and is probably not recommended in a classroom setting. The challenge to creating the map is that you need to select the data, 'clean' the data (make it suitable for mapping) and then link the data to a digital map, which will require access to GIS software. There are free GIS software available, such as QGIS (http://www.qgis.org) but they do require some expertise to use.

The **Teaching the Census through GIS** project can help. The resource contains a full series of 10 lessons (complete with a scheme of work and downloadable resources) providing the opportunity for students to explore the 2011 UK Census whilst exploring a substantive problem – that of health inequalities – and learning a range of important quantitative and GIS skills through the use of the free GIS package, QGIS. The lessons contained in this scheme of work are designed for Key Stage 5 pupils studying Geography or related subjects at GCE Advanced Level (particularly the AQA specification, although key skills will be relevant for all examination boards) or taking the International Baccalaureate. It can be accessed at http://www.rgs.org/OurWork/Schools/Teaching+resources/GIS+resources/Teaching+the+Census+through+GIS.htm

Conclusion

The examples of using GIS described above have concentrated on describing places and their populations using socio-economic data for the UK. At the global scale, Canadian Geographic have developed an online atlas to 'compare countries, statistics, learn about the Human Development Index and explore our changing world'. It can be accessed at http://worldmap.canadiangeographic.ca

Google Earth, free from https://www.google.co.uk/earth/, can also be viewed to explore changes to the Earth's surface. In version 5 or later, select View → Historical Imagery to view 'historic' imagery for yours or other areas. For example, if you type Bristol Hippodrome into the search area you can view the changes to and the remodelling of the city centre over the period 1999 to 2013. The same principle can be used to monitor tree loss and deforestation – see http://www.globalforestwatch.org

The Global Risk Map at http://globalriskmap.nicta.com.au superimposes on to Google Earth a range of data about natural hazards, economic vulnerability, social vulnerability and resilience.

The message of this worksheet is that there is a lot of data 'out there' that have been combined with geospatial technologies to support the mapping and analysis of geographical information in ways that are relevant to the school geography curricula. To use these requires little expertise in GIS because the focus of the curricula is less about teaching GIS and more about using GIS and applying it to core themes and topics. Some initial ideas on how to do so have been presented here. Your feedback on these and on other ways of using GIS and geospatial technologies in the classroom is very much welcomed. It can be sent to in the first instance to Jack Narbed j.narbed@rgs.org.

Other resources for teaching data skills in geography are available at
http://www.rgs.org/OurWork/Schools/Data+skills+in+geography/Data+skills+in+geography.htm

About the author

Richard Harris is a Professor of Quantitative Social Geography at the School of Geographical Sciences, University of Bristol, where he is Director of the University of Bristol Q-Step Centre, part of a multimillion pound national initiative intended to provide a step change in the quality of quantitative training provided to social science students. He also is author of the books Quantitative Geography: the basics (published by Sage, 2016), and co-author of Statistics for Geography and Environmental Science (Routledge, 2011). He was the recipient, in 2014, of the Royal Geographical Society's (with IBG) Taylor & Francis Award for excellence in the promotion and practice of teaching quantitative methods.