Danny Dorling

Mapping change and changing mapping

Maps contribute to our geographical imaginations. Danny is well known for drawing 'strange' maps. In this article he shows how maps have changed with the development of cartographic techniques and also how what is being mapped has changed.

Accompanying online materials

Geographers sometimes like to talk of the 'geographical imagination', a particular view of the world and way of thinking that geographers imagine they have. In practice there may be as many geographical imaginations as there are people who think of themselves as geographers. Everyone has a geographical imagination. It is how we see our place in the world and how we see the world to be arranged around us. Some people's imagined world is very small and tightly wrapped around them; others have a less self-centred view. As you age your view changes.

You were not born with your geographical imagination ready formed. It has grown as you have grown, as you have seen more of the world and been taught about more of it. In the distant

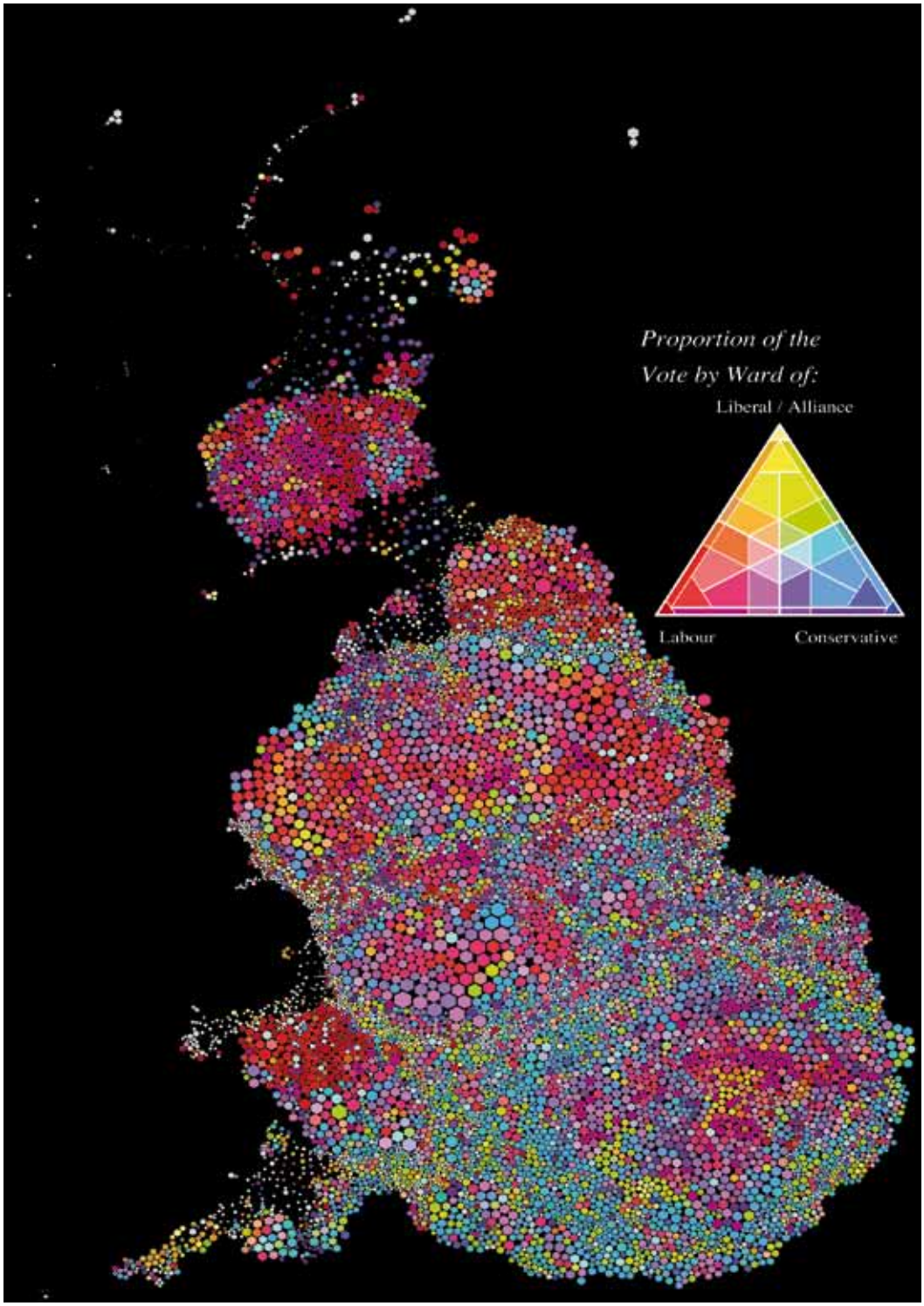

Figure 1: Local election results in Great Britain by ward 1987-1990, on a population cartogram base. **Source:** Dorling (2012), Figure 4.21.

past students were taught that the world was centred on particular places, for example Beijing, Rome, Jerusalem or Mecca; that the earth was flat; and that it was circled by the sun. What we are taught about the world now may in future appear as odd as some of those views do now.

Over time the way we draw maps, and what we draw them of, changes. I have been drawing strangely shaped maps for quarter of a century. To me they no longer appear so strange. When I began only a few people drew such strange maps. I copied some of those people. Today more and more cartographers are drawing maps that appear twisted in odd ways, maps which make cities large and the countryside small. Meanwhile millions have migrated so that now over half the population of the planet lives in cities. The world is changing and how we view it is changing too.

These no-longer-so-strange maps are called population cartograms. Figure 1 shows a British cartogram of local government wards in which each ward is represented by a hexagon drawn in proportion to the number of people who lived there. The wards in the cartogram are shaded to show how people voted in local elections some 25 years ago. Then, many wards in the industrial belt of Scotland were so solidly Labour that they are shaded dark red. Nowadays the Scottish Nationalist Party receives so many votes that a different key would be needed on the map: a vote on Scottish independence could fundamentally change the shape of future maps of the United Kingdom by cutting the top off.

Figure 1 has no north arrow because the direction of north changes as you move around the map. Lines of longitude and latitude wiggle around, wide apart in cities and squeezed together in the countryside. The figure has no linear scale bar because the length of a kilometre varies depending where you are on the map. However everywhere on the map the same unit of area is always proportional to the same number of people. That ratio does not vary wildly as it does on a conventional equal land area map. The key on the map shows how the three colours can be combined to show the mix of votes in each place for what were then the three main political parties. When I was first taught geography such triangular graphs were used to classify soils by how much clay, silt and sand they contained.

Exactly how you draw an image, and what you say about it, can have a great effect upon the imagination of the person who is viewing it. Figure 2 shows one way of representing how many people commute to work. It uses exactly the same base map as for Figure 1 except that Scotland is not included. A line is drawn between every pair of wards where more than one in twenty-five-thousand of the product of the populations of the areas they move between travels. That means, on average, where more than 1 in 158 people are either arriving to work or leaving for work to or from each place. This is because the square root of 25,000 is 158.1 and that was chosen to ensure that a great many lines were included, but not all possible flow lines. Where more than 1000 people make a particular commute between a pair of wards a thicker line is drawn.

Figure 2 shows commuting patterns as they were over thirty years ago; many hundreds of thousands more people commute into London today. The prominent north-western 'spider' is Manchester, which now has far more commuters than in 1981 (precisely how many we will only find out when the 2011 census commuting matrices are released next year). The north-eastern 'spider' is Hull; with no flow from the south as back then the bridge over the Humber had yet to be opened. Between the two and a little south is Sheffield, where back in 1981 thousands of people travelled into the Don Valley every day to work in the steel mills.

The census for England and Wales is taken every ten years. What is most interesting about censuses is what they tell us about how the population is changing. The last census was in 2011, and the resulting statistical data are being released in stages. Go to www.ons.gov.uk/ons/census2011 for the latest releases.

As times changed, new weird and wonderful ways of drawing maps were invented. Before we had digital census data there was no need to worry about how to map flows between one set of ten thousand places and another set. All that is being mapped here are the changes in human location in a day, and then only by workplace. It is a far more complex task again to begin to map how those daily commuting flows are themselves changing, strengthening or shrinking. Harder again, though, would be mapping the changes in migration patterns, as the ways in which we tend to move around the UK and into and out of the UK also slowly change over time.

Figure 3 shows what the pattern of migration looked like between wards on the population cartogram as measured three decades ago. Huge numbers moved around London. Within cities the 'bundles' of moves were largely made up of local authority tenants within the district that housed them. Most of that kind of housing has been privatised in the intervening thirty years.

Over the course of the last few decades many different techniques have been developed, adopted or (more often) abandoned as to how to draw these once strange but now just novel kinds of maps. Figure 4 shows an early population cartogram. First the country was divided into some 255 areas, and each given a different colour. Next the map was stretched, east to west and north to south, so that within each row and column of the map an equal number of people lived. Then the fun began. Bits of the map began to eat other bits.

This is how it worked. You write a computer programme which looks at every cell of the map in turn. If that cell has a neighbouring cell from another area where people are living at a higher density then the cell can turn its allegiance to that area. In effect the areas with more people eat the areas with fewer people until everywhere

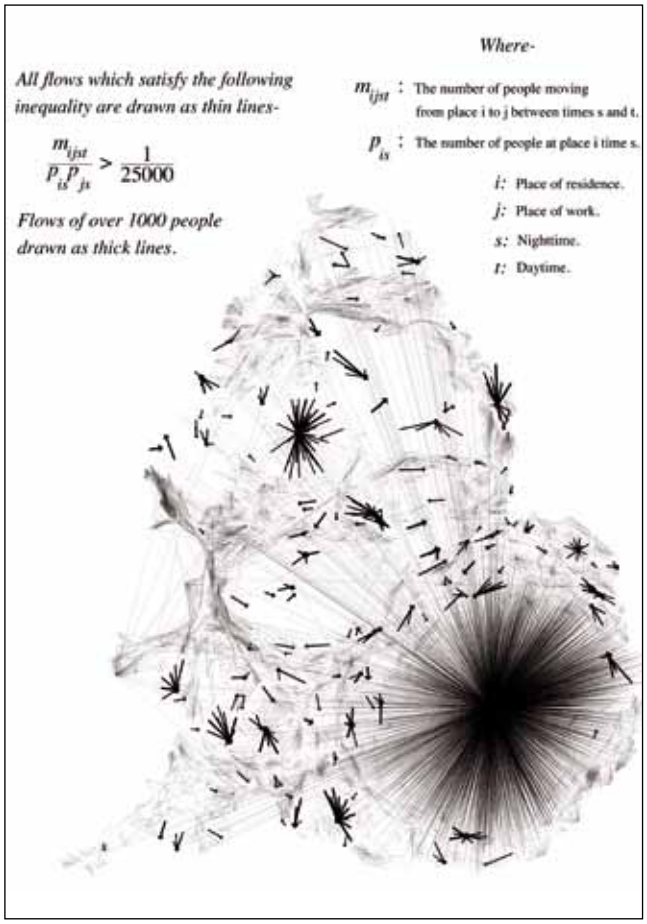

Figure 2: Commuting flows between England and Welsh wards in 1981.
Source: Dorling (2012a), Figure 6.14.

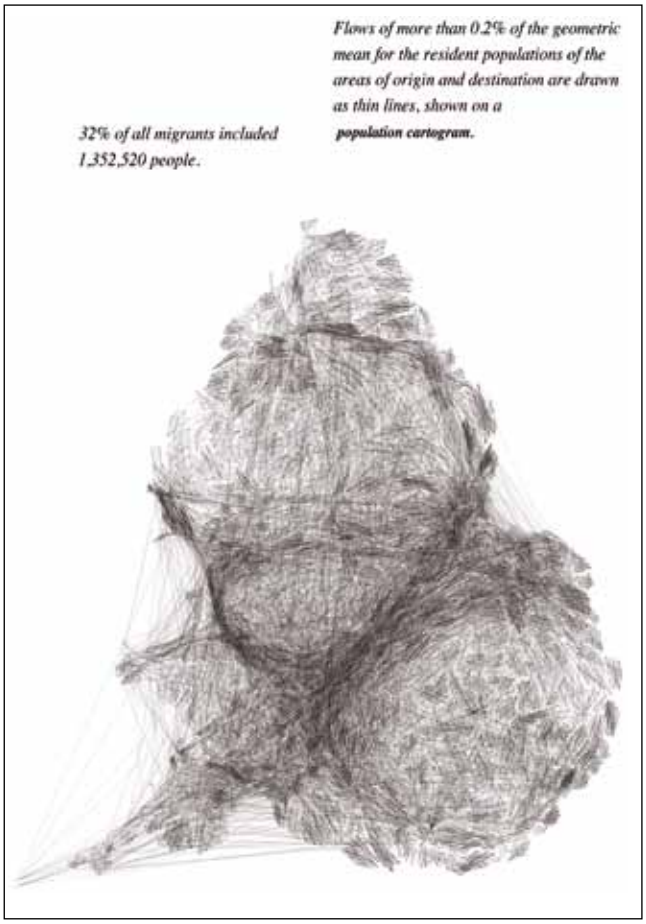

Figure 3: Migration flows between England and Welsh wards, 1980 to 1981.
Source: Dorling (2012a), Figure P.4.

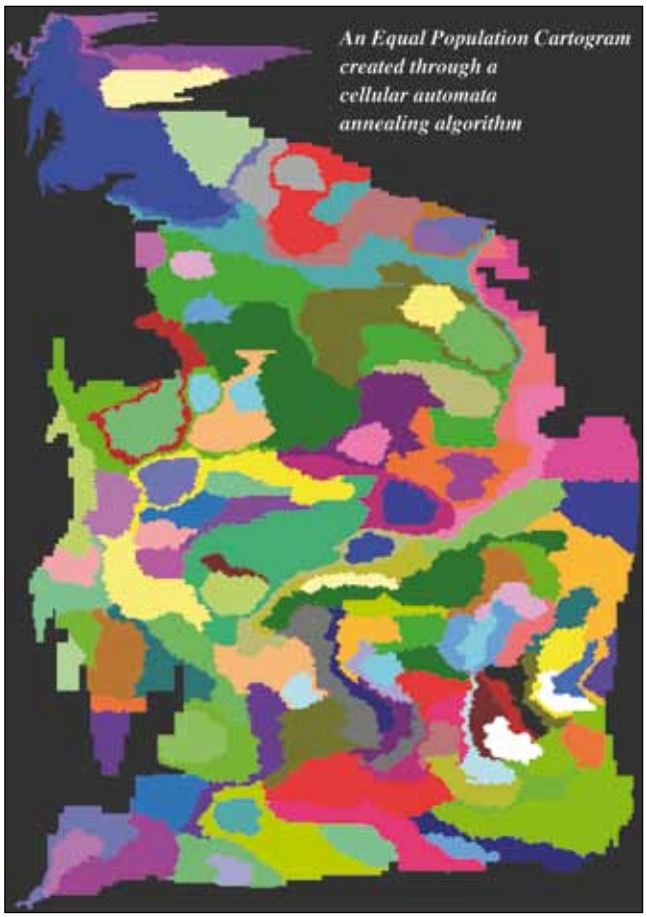

Figure 4: An early topologically correct population cartogram of Britain, major cities and counties. **Source:** Dorling (2012a), Figure I.6.

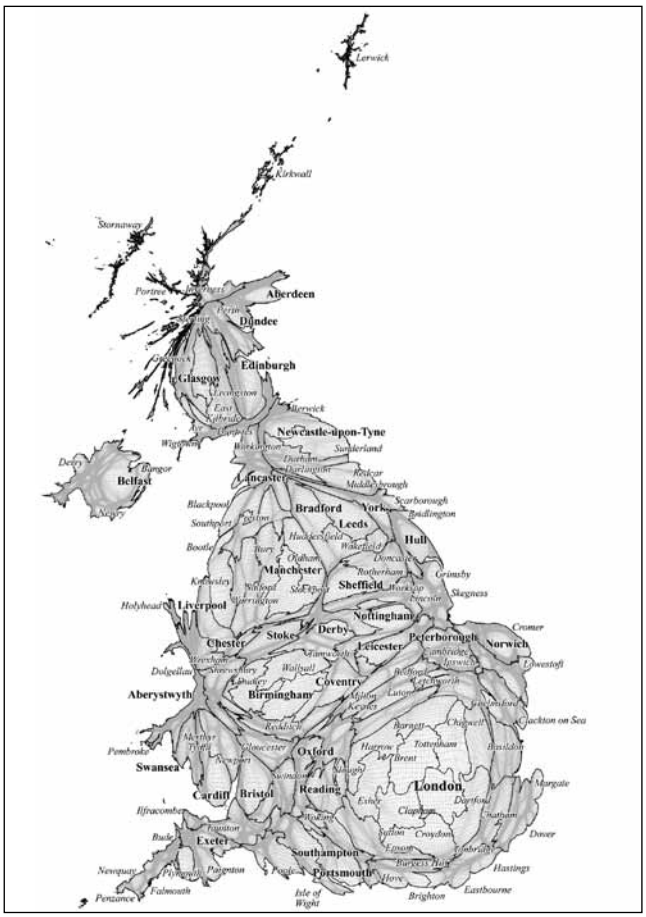

Figure 5: A modern topologically correct population cartogram of the UK: major cities and suburbs by Ben Hennig. **Source:** Dorling (2012b), fold out key map.

population density is equalised. A couple of caveats have to be added. Cells can't be eaten if their demise would break the topology of the map. There is also a built-in preference for eating peninsular cells, so the final boundaries are far smoother (annealed). This feasting on space continues until everywhere population density is equalised. The visual effect is quite pleasing, but it never really caught on as a technique.

For several years in the 1990s cartographic advances stalled. Help came finally from outside the world of geography. People other than geographers can have even great geographical imaginations. In 2004 Mark Newman and Michael Gastner of the Department of Physics and Center for the Study of Complex Systems, University of Michigan invented a new algorithm for drawing cartograms which (to put it simply) rather than solve the problem in two dimensions, moved it all to another dimension, solved it there and brought it back again. You need a little more imagination to imagine their imaginations. This new look at international geography resulted in the Worldmapper maps that you may have seen, drawn by Mark, Anna Barford (then a PhD student) and myself. The new way of looking at the United Kingdom is shown in Figure 5, a map drawn by Ben Hennig (2011) shortly after he completed his PhD in geography. On Ben's map everywhere is connected as it should be, everywhere is the size it should be, and all the lines of longitude and latitude still meet at right angles (despite no longer being straight lines).

On the modern population cartogram some very old population statistical measures can be shown and seen in a new light. Figure 6 reveals which people in Britain in 2001 were closest to the most people. It uses an old technique. For each place in the country 'population potential' is calculated as the sum of the number of people living in every other place where those numbers are first each divided by the distance to the place you are working the statistic out for. Unsurprisingly, population potential is highest in London. Once the 2011 population potential census results are released we will be able to update this map.

Figure 7 shows where the population potential was falling and rising within Britain between the censuses of 1991 and 2001. In areas where population has declined population potential

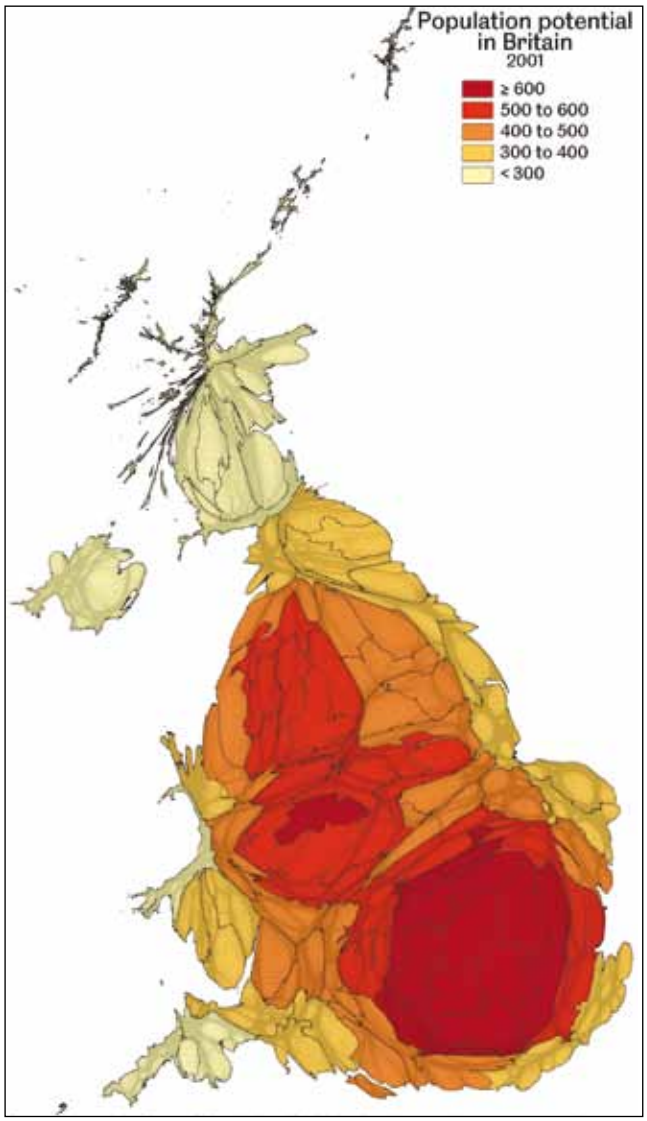

Figure 6: Population potential on a modern topologically correct population cartogram of the UK, 2001. **Source:** Dorling (2012b), Figure 9.2.

Figure 7: Change in population potential on the population cartogram of the UK, 1991 to 2001. **Source:** Dorling (2012b), Figure 9.3.

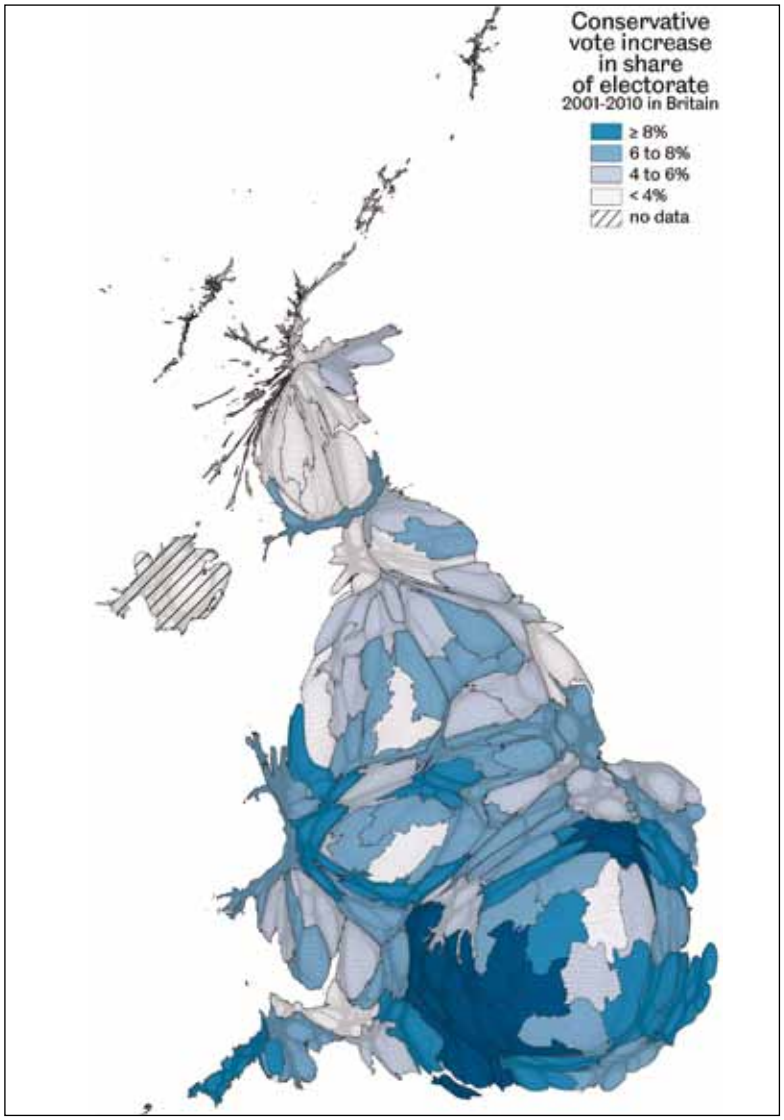

Figure 8: Change in share of the electorate voting Conservative in Britain, 2001 to 2010. **Source:** Dorling (2012b), Figure 5.3.

tends to fall, especially in those areas a long way from London. In the south east of England, and especially in London, as more people have moved in (and been born) than have moved out (or died) population potential has been growing. Around each person in the south east of England are crowded more and more others with every year that passes. This was not always the case, but you have to go back to the 1970s for the last time the population of Britain was not, on average, moving south and when the population of overcrowded London was still falling.

Finally, Figure 8 brings us up to date by looking at one aspect of voting change between the general elections of 2001 and 2010. This map brings us full circle, as Figure 1 showed voting too, but in a different way. In Figure 8 areas are shaded according to the increase in the share of the electorate voting for the Conservative Party. In some parts of London, Scotland and the North voters actually swung away from the Conservatives, even as the country as a whole moved towards them. The increase in Conservative support was greatest, as the figure shows, to the south west of London. However, these are places that have almost always voted Conservative (as Figure 1 showed). Because of that, the recent electoral swings did not help the Conservative Party much and they were unable to secure enough seats to win the election of 2010 outright. Instead they had to form a coalition with the Liberal Democrats.

It takes a little geographical imagination to understand how you can get so many more votes, but not win an election outright. It takes a little more imagination to see how this is partly the result of the north-south divide widening with each year that passes.

When I look at a 'normal' map today I see a strange map. I see a map about places where people almost always don't live. I see almost all human life squeezed into a tiny part of the paper or screen. I see the people living in cities forgotten and imaginations cluttered and confused by images that don't give everyone equal space and equal representation. We are unlikely to see things in much the same ways as our parents did; and the next generation will see things differently to us. On our screens, on our phones, in our textbooks and magazines, our images of the world are changing faster than the world is itself. This is because we are rapidly evolving to think, collectively, differently, to visualize better, and to accept conformity less meekly. | **TG**

References

Dorling, D. (2012a) *The Visualization of Social Spatial Structure*. Chichester: Wiley. (in press; available August 2012).
Dorling, D. (2012b) *Population of the UK*. London: Sage (in press; available November 2012).
Hennig, B. D. (2011) *'Rediscovering the world: Gridded cartograms of human and physical space'* (PhD thesis, University of Sheffield).

Further reading

Bunge, W. (2011) *Fitzgerald: Geography of a Revolution (Geographies of Justice and Social Transformation)*, (reprinted from 1971 original). Athens, GA: University of Georgia Press.
Champion, A. G. Coombes, M. Raybould, S.R, Wymer, C. (2007) *Migration and socioeconomic change: A 2001 Census analysis of Britain's larger cities*. Bristol: Policy Press.
Harvey, D. (2012) *Rebel Cities: From the Right to the City to the Urban Revolution*. London: Verso.
Johnston, R. J. and Pattie, C. J. (2006) *Putting Voters in their Place: Geography and Elections in Great Britain*. Oxford: Oxford University Press.
Tobler, W. R. (2004) 'Thirty Five Years of Computer Cartograms', *Annals of the Association of American Geographers*, 94, 58-73. Available online at *www.geog.ucsb.edu/~tobler/publications/pdf_docs/inprog/Thirtyfiveyears.pdf* (last accessed May 2012)
Wills, J., Datta, K., Evans, Y., Herbert, J., May, J. and McIlwaine, C. (2010) *Global Cities At Work: New Migrant Divisions of Labour*. London: Pluto.

Online resources
The maps used in this article are available to download. Go to *www.geography.org.uk/tg* and click 'Autumn 2012'.

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