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Learning from outside the Goldfish bowl

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Preface: How you see the world determines what you think of the world. Conventional world and local maps present a distorted view of the human geography of people. That is because conventional maps are designed to preserve compass directions or to show places drawn in proportion to their land areas. Looking at human beings through such lenses is rather like looking out at the world through the curved glass of a goldfish bowl. The goldfish moved to a cuboid tank does not suddenly see the world clearly. To them their new vision of the world will appear as if it is curved. They will have become acclimatised to looking at a distorted view. But, given a little time, they will see their new image straighten out. They will see the world through flat glass as normal. So too will the maps in this article appear strange to you at first. You have been looking at human geography though a goldfish bowl all your life. Welcome to the real world.

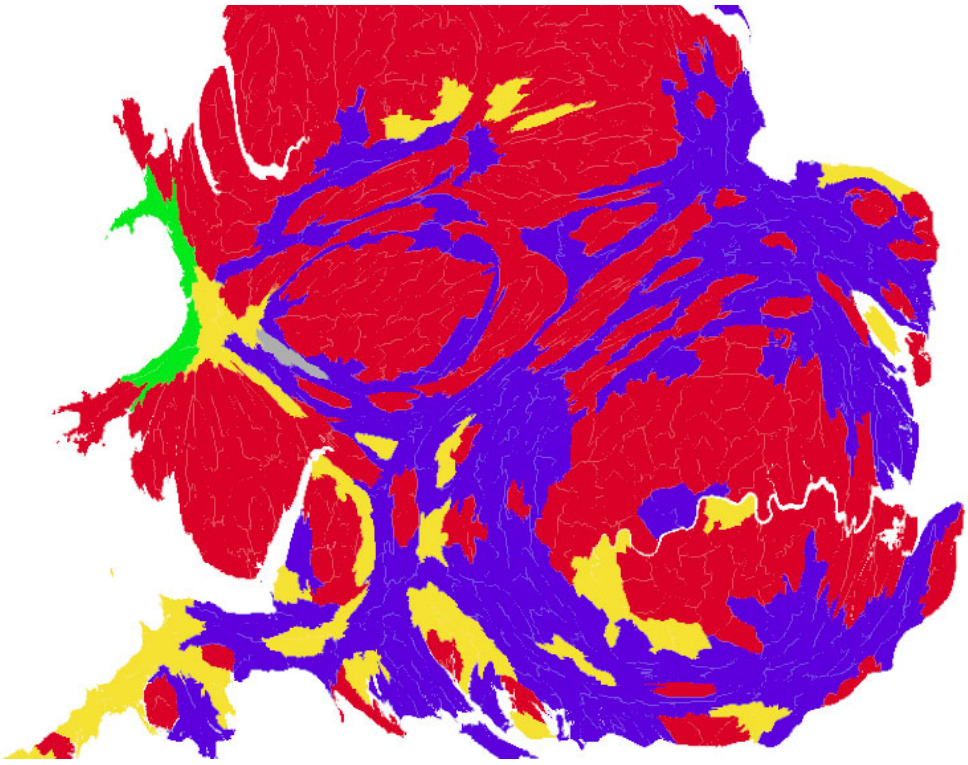


Figure 1: The Political Geography of England and Wales. Constituencies shaded by political party winning each area in 2001. Red I Labour, Blue Conservative, Yellow Liberal, Green Plaid Cymru, Grey: a constituency won

by an independent member of parliament. All constituencies are drawn to be the same size

"What use are Mercator's North Poles and Equators,
Tropics, Zones and Meridian Lines?"
So the Bellman would cry: and the crew would reply,
"They are merely conventional signs!"

From the Hunting of the Snark by Lewis Carroll, (Truss, 2003, pp.200-201)

Just as in literacy there are grammarians; in cartography there are traditionalists. The traditionalists would have us retain our conventional signs and structures. However, there comes a time and occasion when conventions need breaking. A time when we see other human beings as more equal is the right time to start mapping with more equality. The mapping of social statistics is one of those occasions when the conventions need breaking.

If you want to map the results of a general election, only a fool would use a conventional equal land area map. Figure 1 shows part of an equal population cartogram draw to depict the results of just one general election. Each constituency in Figure 1 has its area drawn in proportion to the size of its electorate. This is achieved in such a way that the resulting map remains 'conformal'. Conformal means angles are preserved locally as the projection minimally distorts. A small circle on the cartogram would be a small circle on the ground. The projection method is very new. It was first published in May 2004, in the Proceedings of the (American) National Academy of Sciences, by a Swiss doctorial student and his supervisor, an English physicist (Gastner and Newman, 2004). That a solution should exists was proven over a quarter of a century earlier (Sen, 1975), but it took many attempts before this particular one was found (Dorling, 2006).

Zoom into figure 1 at any location and you will see what looks like a 'normal' map. Zoom out from a dense city and the rest of southern England will wrap tightly around you. Zoom out from a point in the countryside and a nation of people explodes around you visually, your original location quickly becoming a spec. It is, at first, disconcerting. But look at how the river Thames still flows and twists and turns through London, much as it did before. Zoom out further and the whole world is revealed to have a very different shape to that you have been shown to date.

Imagine that you had spent your life, until today, swimming round and around inside a spherical glass bowl. When you looked out on the world the world would not appear to you as strangely distorted. You would think it normal that people rapidly changed shape as they stooped, occasionally, to look at you. Looking from inside the goldfish bowl, people appear huge when close up and then rapidly shrink, if they move just a little further away. What's strange about that? That's just the way things look to you. All that really matters are those close by your bowl. Every other human rapidly moves into the background of your consciousness as they shrink to minuscule size the moment they take a step back from you. That is just how you see them to be. These are the sizes, the importance, you ascribe them.

How would you imagine the world to be if you were forced to live in such conditions? Just a few weeks after the mathematical solution to the conformal re-projection of human geography was published, in a story swept the internet of a modern urban folk tale. We learnt in July 2004 that Italian council official Giampietro Mosca of the city of Monza was about to become very famous. He told the press that local laws had been changed to outlaw the keeping goldfish in curved bowls in Monza.

This is what he said "A fish kept in a bowl has a distorted view of reality...and suffers because of this," (Mosca, 2004; Gilbert, 2006, p.171). Giampietro explains: “"This story about the goldfish, which has gone around Italy, seems a little irrelevant and people have mocked it a bit, but it has a very specific educational sense, especially for the little ones.". It's the little ones who bother me most too. What views of the world are we giving them? We tell them that the world looks as we see it, but what if we are wrong?

Concerns over the view of the world we give our children lead the international bodies UNESCO, UNICEF, and the charities OXFAM and Action Aid, amid other, to adopt the Peters Projection world map in the late 1970s and early 1980s. They did this in place of that produced more than four centuries earlier by Gerardus Mercator (Flemish).

Arno Peters, who designed the particular version of that map that is now so well known was born in Berlin, was awarded his doctoral dissertation on political propaganda at the University of Berlin in 1942. He lived until his death in 2002 in Bremen. He was a remarkable man and his map was a work of beauty. It was the map that those who taught me geography put upon my school classroom wall. His was the map I saw as I grew up.

However, there is little else that can get the ire of cartographers up, so much as praising this map (Pye, 1989). It is worth thinking about what it was in the mindset of 1980s cartographers that so annoyed them about the Peters' projection. They became annoyed about a map which does not even slightly curve any of the conventional lines and which, unlike Mercator's, actually had

a place for the poles. It was based on one produced by a man with the surname Gall, but that was not what most annoyed. Peters made what was then called the USSR shrink from the monster it normally appeared to be one world maps. That was more probably what most annoyed.

The Peters Projection was thought of initially a radical world map because it showed so many school children how much land there was in each part of the world, an aspect that more conventional projections had severely distorted. Suppose, though, that you were more interested in people than deserts, fields and mountains? Then your world map would then look like that shown in Figure 2:

Figure 2: The world drawn in proportion to population, 2002 (by Mark Newman's using a version of the algorithm that works on the surface of the sphere). Antarctica, the Seas and the Oceans are given 'neutral buoyancy', to avoid recreating Pangea.

Figure 2 is a conformal equal population world projection which approximates very closely to the theoretical single solution proved to exist by Sen (1975). That perfect projection will require population data more disaggregated within nation-state than was available here, but it will look little different to this map. The map in Figure 2 may seem strange to you. This may not be how you view the world. For me this is the map of the world. For several years now it has been the screensaver on my computer.

When I now see a conventional map I am taken aback by how small China and India are drawn, by how much space is given to Russia and the United States. For me Figure 2 is now how the world is. When I fly, it is across this

space that I am moving. When I take a train, it though, and from and to people as arrange in this Figure. When I drive in Britain Figure 1 is my map. I am not at all surprised how long it takes to drive across London. In my mind, on my map, the car travel great distances in a relatively short time in London, given how many people we pass. The train into London moves at supersonic speeds when distance is measured in units of people passed per second, as on this map.

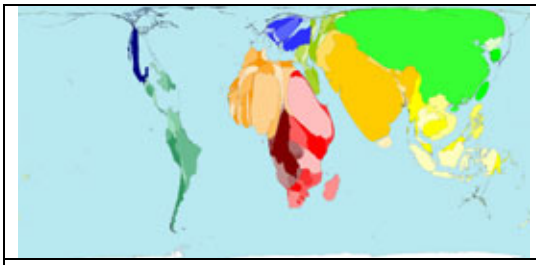
A world atlas based on a conformal equal population projection would have as many pages devoted to India as Africa. No insets would be needed for cities, but they could be provided for the more interesting wilderness areas. Otherwise there would be no map of Antarctica.

Conformal equal area cartograms have many uses other than as alternative national or world projections. They present an alternative metric for carrying out cluster analysis. If you want to know whether a particular phenomenon is clustered in the population, but the population is itself clustered, smoothing out the population helps greatly. Just smoothing the pattern of dots produces something that looks quite like figure 3 if the points are quite randomly arranged, as the incident of childhood leukaemia was in the late 1960s, 1970 and early 1980s.

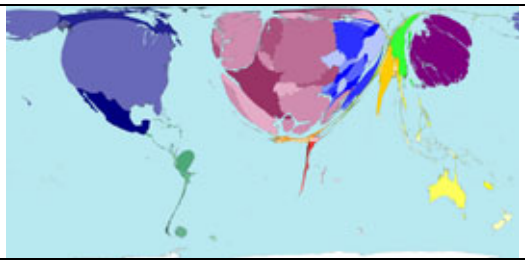
Figure 3: Source: http://www.sasi.group.shef.ac.uk/thesis/print_display.php?print=159

Note that a very different algorithm was used to produce this not quite so conformal cartogram back in 1990, and the child population of Britain was a little more located in the north between the years being mapped here, hence the shape of the country changes.

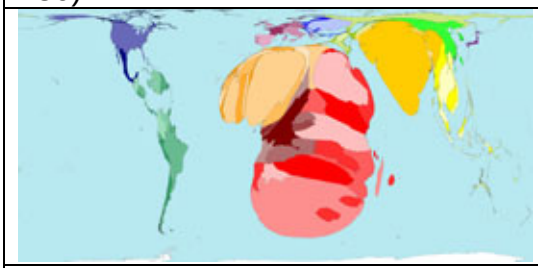
It is, however, when looking at the world, that different map projections, different ways of graphing and scaling, have most effect (Dorling 2007). Figure 4 shows the world alternatively shaped with area in proportion to: a) the 1.1 billion people who had access only to poor drinking water around the turn of the millennium; b), the 0.8 billion whose homes were connected to sewage systems; c) the 29 million people aged 15-49 estimated to be infected with HIV in 2003; and d) the 265 thousand thought to have died in 2002 with leukaemia given or estimated to be the underlying cause of death. All these maps and 580 more can be found at www.worldmapper.org where a group of us we have been trying to map world distributions in this way.



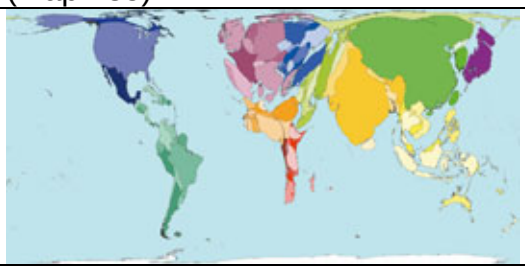
4a) People with poor water (Map 186)



4b) People with sewerage sanitation (Map 185)



4c) People Infected with HIV (Map 227)



4d) Deaths from Leukaemia (Map 434)

Figure 4: Source www.worldmapper.org (SASI group and Mark Newman)

The same colours are used to shade the same country in every map in Figure 4. If you can locate India on one map, you can find it on the others. These worldmapper cartograms can be thought of geographical pie charts. They tell you both where most of something is and how it is shared up around the world. That is not possible with a conventional map. On a conventional map only the proportions can be mapped, not the absolute amount. To interpret a conventional map requires having knowledge of world population density in your head and being able to integrate that with the rates

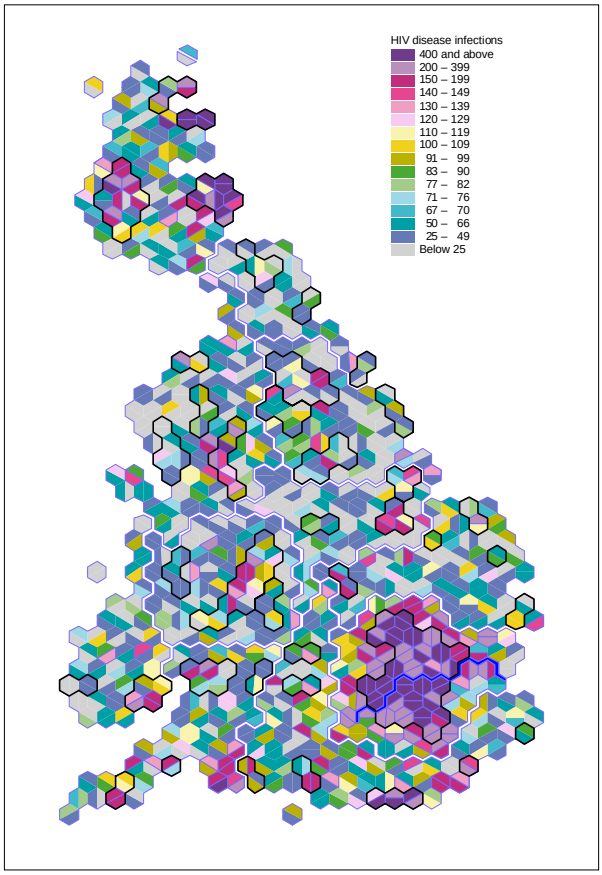
to work out the product. It is useful to know rates, but it is also useful to know absolutes too.

Some 366 of these world maps were published in the autumn of 2008 in a ‘Real World Atlas’ (Dorling et al. 2008). Unlike the maps shown in Figure 4, the maps in the atlas come complete with the Equators, Tropics, Meridian Lines, Mountains and even ocean trenches stretched and superimposed, all the conventional signs (as shown in Figure 2). They have been added to reassure that these are just map projections.

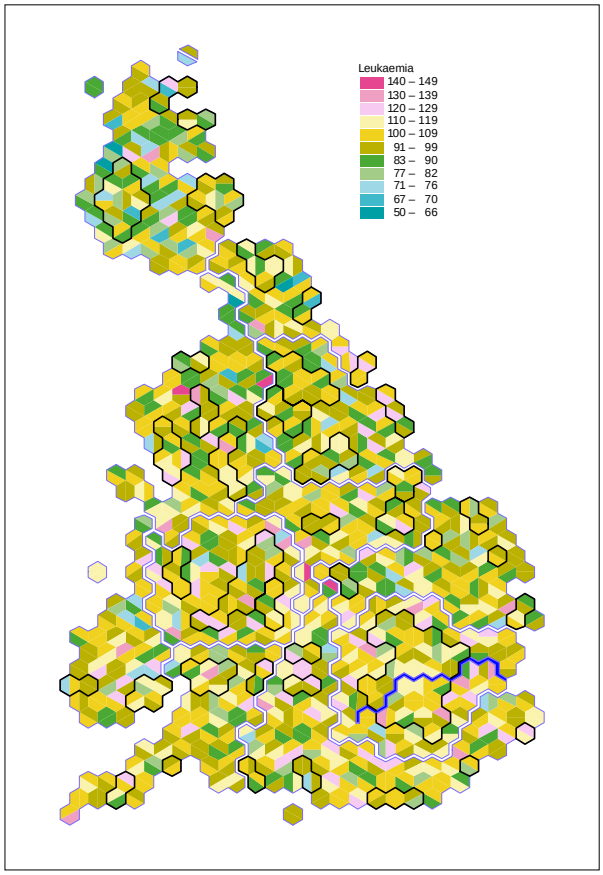
Finally, a single population cartogram can be used as a base map for an entire atlas. Another group of colleagues and I have started to use the same base map of the island we live on, Britain, to make learning the new map a little easier. We also simplify the image visually. On this map hexagons are used, every one being a parliamentary constituency. Each is then split in two so that two geographical areas can be shown. For instance, the Northern most hexagon in the maps below is the 2001 constituency of Orkney and Shetland; and its two halves are those two groups of Islands (south and north respectively). The Orkneys and Shetland are the northern most inhabited parts of the British Isles.

In Figure 5a this population base map has been coloured to show the age-sex standardized rate of mortality, centred on 100 from two causes of death as measured over a 24 year period. Exactly the same shading scheme is used on both these maps and the more than 100 others that are included the atlas these two are drawn from (Shaw et al., 2008). This means that once you have learnt to read one of these maps, you should find reading the others easier. It’s the same memory trick as with the world maps except here we use the same colour scale throughout, not just colour all areas the same colour

In Figure 5, and throughout the atlas it is taken from: If a shorter length of scale is shown to the key of a map, it means that the extreme rates did not occur anywhere over this period of time. Over four times as many people died from HIV disease infections in some constituencies and parts of constituencies as you would expect were HIV risk evenly distributed amongst geographical groups. In contrast, rates of mortality from leukaemia have been, at most, a little over 40% elevated in a scattering of neighbourhoods, with no clear patterning, as shown in Figure 5b.



a) SMR: HIV disease infections 1981-2004



b) SMR: Leukaemia 1981-2004

Figure 5: Age and sex standardized mortality rates by cause: Source Mary Shaw et al., 2008.

Without a population cartogram it is very hard to draw an atlas of aspects of human geography which does not distort. Look at these patterns on a normal map and it is like looking at the world from the inside of a goldfish bowl. In Figure 5 some 24 years of deaths are combined, with denominator data drawn from three decennial censuses, so that the patterns shown are quite robust.

The deaths of men and women are both included here over all ages. We could have applied forms of statistical smoothing to the data, but those are far less needed when mapping on a population cartogram as your base map is not designed to emphasis the areas where the fewest people live. If you would like to see the smoothed data then squint a little when viewing figure 5.

There are some conventional signs missing from these maps: north arrows and distance scale. A north arrow could be included, but it would wiggle differently on each map, a scale bar could also be added, but the units would

be measured in something called the square root of a person. That is a hard concept to get your head around if these maps are new to you.

Once you begin to start stretching space it is hard to know where to stop. All the images shown here are simply re-projections of two dimensional surfaces (albeit including the surface of the sphere). If you want to include history as well as geography you may need more dimensions. The three dimensional version of the population cartogram is a solid in which every life is a line allotted equal volume (no matter how short). Such a space-time population cartogram can be flown through and zoomed in and out of. Potential clusters of disease can be differently colour coded in such a volume. Voting behaviour as recorded from surveys can be marked along the lines. A summery of human history can be drawn, where the length of the time lines is proportional to the collective number of life stories being told.

Arno Peters' other great work was a world history where equal pages were given to equal lengths of time. The world history yet to be written is one where equal pages are given to equal numbers of lives lived.

None of this is as complex when viewed as it sounds as when described. For instance, see http://www.sasi.group.shef.ac.uk/maps/index.htm for an animation of all British general election results from 1832 to 2001, and local elections from 1974-2007. In both cases these are drawn taking successive slices through such single space-time blocks. Watch these animations a little too long, or fly in and out of too many historic maps, and you too can begin to see what was in the mind of 1960s (American) physicists who experimented with, among of things, such visualization in the physical world where: "It certainly feels like time is passing; I'd be foolish to argue otherwise. But I want to show you that this feeling is a sort of illusion. Change is unreal. Nothing is happening. The feeling that time is passing is just that: a feeling that goes with being a certain sort of spacetime pattern." (Rucker, 1984, p.140).

Looking at the worlds of humans using different lenses and projections allows you to see things differently. It can be argued that there is a Copernican (Prussian) difference in moving from seeing people as spaced upon the land, to seeing the land as made up of the people. The land is not so important that its shape should remain sacrosanct while we squeeze the stories of our lives into the tiny specs of space the vast majority of us occupy.

You might think the way you currently view the world is fine. That the map of your country you have in your head is right, and if you happen to spend most of your time flying, it is. But if you take the train, want to know how people vote, are interested in what is happening in the world, or in how we are dying across this country, then there are other maps that can be drawn.

Incidentally, have you found the way I have tried to ascribe nationalities to the folk in this tale a bit irrelevant or perhaps annoying? It not as easy as you might think. People move between countries. Have links with more than one, and often countries are not the most important thing in their lives. Does it now matter much that Copernicus was a Prussian? I've included the national names to try to illustrate how odd it is that we should accept such labelling on all the maps shown here. Maps without borders but showing flows are sorely needed.

Some call the maps I have just shown you humanistic mapping. This is what the editor of the forthcoming history of cartography in the twentieth century had to say recently about such maps. How they are moving from rarity to mainstream, from objects of curiosity to a different way of looking at the world: "…humanistic mapping thrives in diverse niche markets, which are likely to grow in number if marketing theorists are right about 'the long tail' … a statistical phenomenon that describes the internet's prowess in creating a word-of-mouth buzz previously exclusive to the comparatively small number of bestsellers, blockbuster films, and similarly successful mass-marketed products." (Monmonier, 2007, page 376).

Welcome to the world.

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