Re-Drawing the World:
An Approach towards a gridded World Population Cartogram

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1. Introduction

This work builds upon the worldmapper project which utilises cartograms that preserve the shapes of countries while distorting the area according to a specific variable. These maps are open to potential criticism when it comes to their informative value. One such criticism is the variation of the depicted topic within the territorial borders is not taken into consideration. A possible solution to this problem is presented here with a redrawn edition of worldmapper's world population cartogram calculated with grid-based data rather than using a single population figure for each country.

1.1 Worldmapper and its World Population Cartogram

In the first stage of the worldmapper project, a wide range of maps depicting various human dimension of the world have been published (http://www.worldmapper.org). Since the publication of the first new world population cartogram in 2006 (Webb 2006) nearly 600 maps have been produced, covering topics such as education, poverty, and pollution (Dorling, Barford & Newman 2006).
The worldmapper cartograms show the data for 200 territories, thus making this new view on the world to some extent an arbitrary view: territorial borders are artificial. The world population cartogram was used to test different ways to calculate new more detailed grid-based cartograms beyond the territorial borders.

2. Data and Cartogram Calculation

Data used in this work were derived from the Socioeconomic Data and Applications Center (SEDAC) of Columbia University, New York. The Gridded Population of the World (GPW) database contains the distribution of world's population on a gridded base (http://sedac.ciesin.columbia.edu/gpw/), including population data and estimates from 1990 to 2015. These data are available in resolutions of up to 2.5 arc minutes leading to a population grid of 8640x3432 pixels. Data from the year 2000 have been used to make results comparable to the original worldmapper population cartogram.
These raster format data were imported to ESRI's ArcGIS, converted to polygons and combined with further metadata (e.g. country labels) to match gridcells for further visualisation tasks. The cartogram script (see below) uses a 4096x2048 pixel-sized lattice for its map results.
The cartogram itself is calculated by using the ArcScript *Cartogram Geoprocessing Tool* by Tom Gross (http://arcscripts.esri.com/details.asp?dbid=15384) which uses Newman and Gastner's density-equalizing method methodology (Gastner & Newman 2004). Unlike the worldmapper cartograms that distort an initial projection of the boundaries of the territories, each population grid is treated as a separate part for the calculation, not taking any territorial information of borders into account. Thus each grid cell marks a border so that distinct shapes of countries are intentionally of no interest in the

calculation.
Changes in the distortion of the resulting cartogram thus are only possible by adjusting the factor to smooth the original density. In addition, data from the United Kingdom have been extracted from the 2.4 arc minutes population grid and are calculated separately in the same way to produce a more detailed view of the resulting grid and its interval variation.

3. Results

The resulting cartograms require some final visualisation steps to adapt them to appear similar to the original worldmapper cartograms. The polygons of the calculated world population cartogram are dissolved according to their affiliation to the worldmapper territories and coloured according to the distinctive worldmapper colour scheme. The gridlines in the UK cartogram are conserved to show the degree of distortion within the grid.

3.1 A redrawn World Population Cartogram

Compared to its predecessor (Figure 1), the redrawn World Population Cartogram (Figure 2) shows considerable differences. For example, in China the sparely populated Himalayan regions can be distinguished from the densely populated eastern coastal regions. Internal variation within the United States and Mexico can also be recognized. Somewhat harder to identify but still evident are North-South differences in Great Britain and West-East differences in Germany. Hence, our goal to take the varying distribution of population on a sub-national level and make them visible on a global view has been achieved. However, sub-national variation can be difficult to analyze in more detail because the gridcells are eliminated to sustain the view on the global scale. In addition, more distinctive national shapes are far more distorted than in the original cartogram, which for some users might appear odd when interpreting such maps.

3.2 Down to Earth: A Population Cartogram of the United Kingdom

To counter the loss of familiar national boundary shapes a separate population cartogram is produced for the United Kingdom (Figure 3). The shape of the cartogram has more detail compared to the shape of the UK on the world population cartogram. This is because more gridcells are used in the calculation of the cartogram and no other polygons (e.g. from the European continent) influence the calculation. The different scale also allows the visualisation of each gridcell so that sub-national variation can be recognized. An “original” map of Britain with its familiar shape is shaded-in underneath the grid to aid interpretation.
This visualisation on a different scale is an improvement in the visualisation that goes far beyond the current capabilities of the worldmapper project by using gridded base data to allow not only a different view on population distribution worldwide but also within separate regions. By using cartogram techniques, a different view on the regional variations of the human geography is created which can hardly be achieved with traditional mapping techniques.

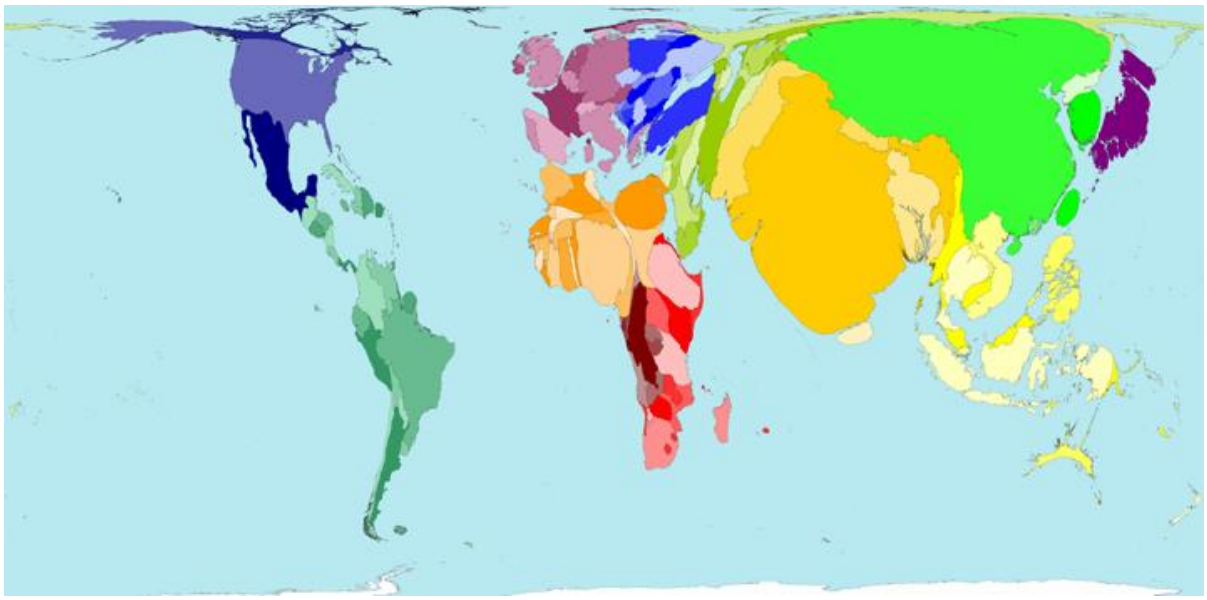

Figure 1. Worldmapper Population Cartogram
(Source: http://www.worldmapper.org/images/largepng/2.png)

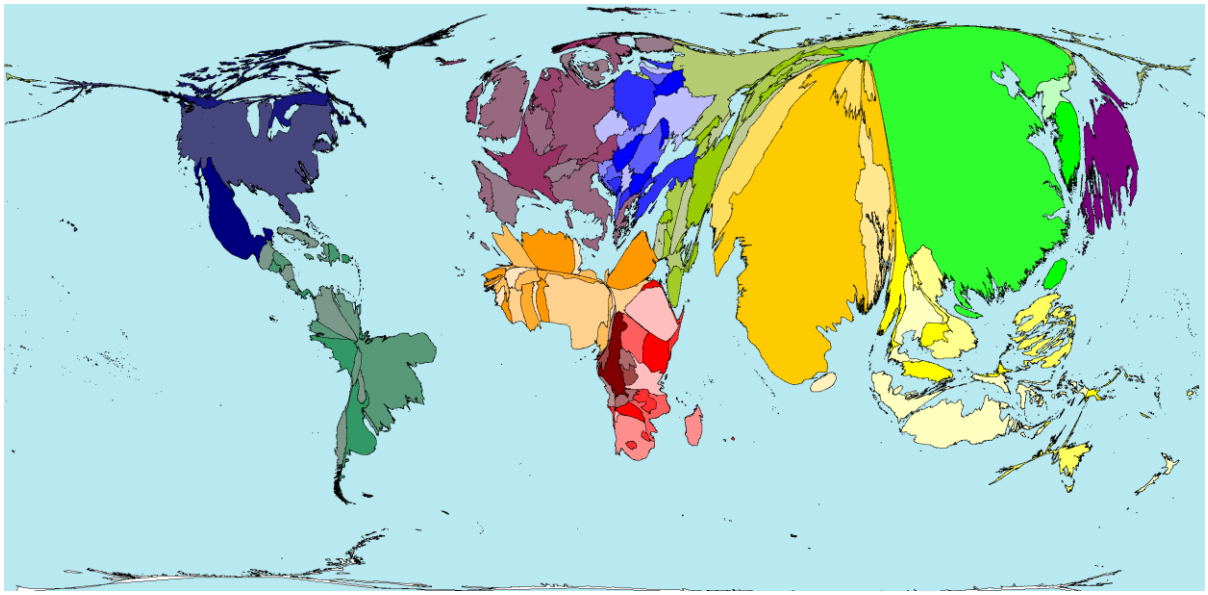

Figure 2. Grid-based World Population Cartogram (2000)

Figure 3. Grid-based Population Cartogram of the United Kingdom (2000)

4. Outlook

The most significant obstacle to the realisation of gridded depiction for worldmapper will be the vast quantity of the different topics covered and availability of data. Reliable gridded socio-economic data for the whole world are barely available and rarely of such good quality as the population data. The estimation of missing national data for some topics has already been a serious matter in the existing worldmapper cartograms (Dorling, Barford & Newman 2006; Dorling 2007). Such estimations will not meet the demands of gridded datasets, so new ways of data estimation are needed (e.g. Gaffin et al 2004; Hay, Graham & Rogers 2006).

Revised gridded cartograms offer great potential to enhance the variety of worldmapper's visualisation capabilities. A different view of the "real" location of the depicted topic can present a better understanding of the human geography of our planet. However, distortions associated with the gridded method can potentially undermine the purpose of the used algorithm to preserve country shapes. Therefore, the potential of the gridded approach and the desire to preserve familiar shapes must be carefully balanced. Nevertheless, much potential lies in adding more user-interactivity and detail to worldmapper. Grid-based cartograms have the advantage of allowing a user to zoom in to view national and regional details, within a global context. Finally, a transfer to popular digital globes can thus easily be realised, allowing viewers to identify the regional dimension of a subject. Separate regional editions of gridded population cartograms can be generated to visualise the regional variation of population distribution.

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Biographies

Benjamin Hennig completed his Master degree in 2005, working with remote sensing applications and geographical information systems. He joined the worldmapper team at Sheffield University in 2008 where he currently works on a PhD project to improve worldmapper's geo-visualisation capabilities.

Danny Dorling worked on children's play schemes in the late 1980s, but has been trapped in universities since then. He has worked with several colleagues on a number of books, papers and reports. He is currently professor of human geography at Sheffield University.

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