The University Of Sheffield.

Department of Geography

Social and Spatial Inequalities Group

Gridded Population Cartograms: Drawing the Human Shape of the Planet

Creating an equal area projection of the United Kingdom

The basic principle of the equal population projection

Introduction

This poster introduces a technique to create grid-based population cartograms that are suitable to be used as a new map projection (Hennig et al 2010). Rather than preserving area or distances, the resulting maps draw an accurate picture of the population distribution based on an equally distributed grid. Thus this projection can be seen as an equal-population projection that puts the human being in the main focus of the map, while still preserving the geographical reference.

The main steps needed to create these maps are outlined in the following sections, accompanied by explaining illustrations: Figures 1a-d (left) show the main processing steps applied to the United Kingdom, using 2010 population data from SEDAC (CIESIN/CIAT 2005). This is complemented by some detailed depictions of the underlying data structure (Figures 2a-c). A simplified depiction of the basic principles for this method is given in Figures 3a-c (right).

Figure 1a: Starting point is the original shape of the United Kingdom. Additional information such as the topography can be used to add further detail to the map (small map above).

Figure 1b: An equally distributed grid is generated with each grid cell containing information on the number of people living in that area (see Figure 2a).

Figure 1c: The reprojection of the map is performed by applying a density equalising algorithm. The transformation resizes the grid cells proportinal to their population values. The additional map layers are transformed accordingly (such as the topography shown in the small map above).

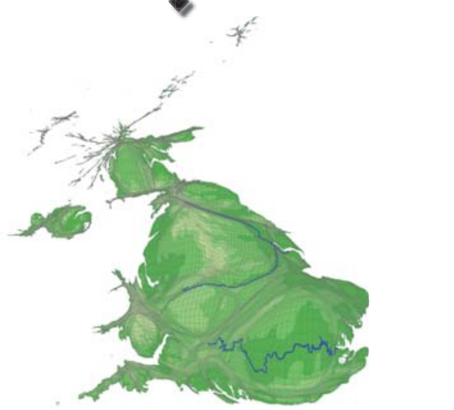


Figure 1d: The final map shows an equal population projection of the United Kingdom that preserves its geographical reference with each grid cell representing an equal geographical area.

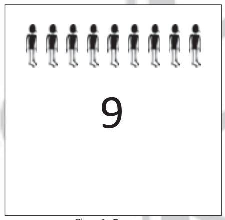


Figure 3a: **Base map**
Original shape of the feature containing the total population living in the whole area

Data preparation

The grid is the key element of the reprojection. Therefore a grid has to be created over the whole land area, with the size of each cell being determined by the population data. The population data is applied to the grid cells, so that the resulting grid is a representation of the population distribution: Each grid cell contains the value for the number of people living in that area. Figure 2a shows this for the Greater London region of the United Kindom. Figure 3b explains the basic principle for a simplified 2x2 raster with a different number of people living in the four same-sized grid cells.

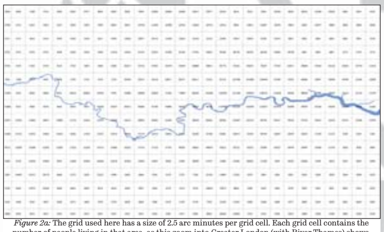


Figure 2a: The grid used here has a size of 2.5 arc minutes per grid cell. Each grid cell contains the number of people living in that area, as this zoom into Greater London (with River Thames) shows.

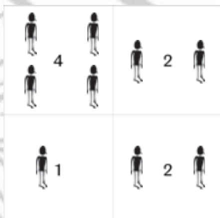


Figure 3b: **Grid map**
Equally distributed grid each containing the number of people living in that area

Reprojection

The reprojection is based on a diffusion cartogram algorithm developed by Gastner & Newman (2004) generating a density equalizing map. The grid cells are transformed to be proportional to their population, so that population density is equal throughout the map. Additional features are transformed equally and retain their location in relation to the underlying grid (Figures 1c/d). Sparsely populated areas diminish, but become visible when zooming in (Figures 2b/c). The algorithm deploys linear diffusion process of elementary physics, so that the original shapes remain recognisable (Figure 3c).

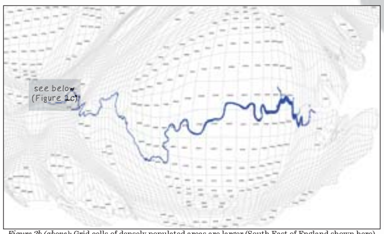
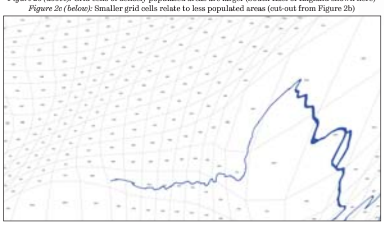


Figure 2b (above): Grid cells of densely populated areas are larger (South-East of England shown here)
Figure 2c (below): Smaller grid cells relate to less populated areas (cut-out from Figure 2b)



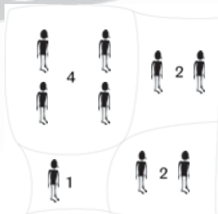


Figure 3c: **Gridded cartogram**
Grid cells resized according to the population living in there

Results

The resulting map shows an equally distributed population, giving space to the densely populated areas and reducing sparsely populated areas accordingly. By using an equally distributed grid as a base for the density-equalising transformation the geographical reference is preserved, so that down to the size of each grid cell all additional features can be accurately mapped onto the reprojected map. This provides an advantage over conventional cartograms which are usually based on administrative or other artificial units and shapes that can not retain the full geographical reference when being transformed. The new gridded cartograms draw a new picture of the human shape of the world, but the potential for the new technique is even greater, reaching far beyond the simple reprojection of topography or other map features as exemplified in Figure 1d: These maps provide a new basemap for revealing the real impact of humanity.

References
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Hennig, B.D., Pritchard, J., Ramsden, M., Dorling, D. (2010) Remapping the world's population. ArcUser. pp. 66-69. ESRI, Redlands, CA.
Michael T. Gastner and M. E. J. Newman (2004) Diffusion-based method for producing density equalizing maps. Proc. Natl. Acad. Sci. USA 101, 7499-7504.

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Department of Geography, University of Sheffield, Sheffield S10 2TN, United Kingdom - http://www.sheffield.ac.uk/geography/
Contact: Benjamin D Hennig, b.hennig@sheffield.ac.uk, http://benhennig.postgrad.shef.ac.uk/