

WORLDMAPPER: the world as you've never seen it before

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Abstract—This paper describes the Worldmapper Project, which makes use of novel visualization techniques to represent a broad variety of social and economic data about the countries of the world. The goal of the project is to use the map projections known as cartograms to depict comparisons and relations between different territories, and its execution raises many interesting design challenges that were not all apparent at the outset. We discuss the approaches taken towards these challenges, some of which may have considerably broad application. We conclude by commenting on the positive initial response to the worldmapper images published on the web, which we believe is due, at least in part, to the particular effectiveness of the cartogram as a tool for communicating quantitative geographic data.

Index Terms—Geographic Visualization, Computer Graphics, Worldmapper, Data Visualization, Social Visualization, Cartogram.

1 INTRODUCTION

This paper describes the Worldmapper Project, whose aim is to communicate to the widest possible audience, but particularly to school and university students, how parts of the world relate to each other and the implications of these relationships for society. This is achieved by mapping quantitative geographic data using an unusual cartographic projection, with the resulting maps being made freely available on the Internet.

The Worldmapper Project has been made possible by the recent development of a new algorithm to create area cartograms, maps in which the sizes of territories (or other regions) are scaled in proportion to some variable of interest, such as population, income, or energy consumption. This algorithm's development is complemented by the recent release by several United Nations agencies of international data of a much higher quality than has previously been made available, as well as recent geographical theories that suggest places can better be understood globally in relation to one another than when studied separately.

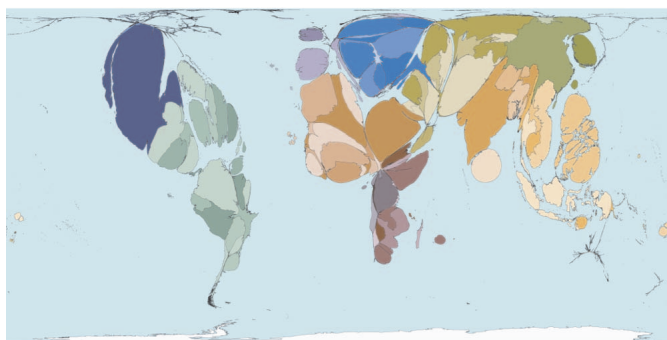


Fig. 1. *Worldmapper* net emigration map.

Figure 1 shows an example of the type of maps produced for the project. One can think of the maps as being akin to a 200-sectored pie chart, but with each sector morphed to roughly be at the same position as, and of a similar shape to, the relevant territory on a conventional world map: the bigger the area of a territory, the larger

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the proportion of the world total of the quantity of interest that belongs to that territory. Thus Figure 1 above, for example, shows the territories of the world with sizes proportional to net emigration from those territories, i.e., to the numbers of people who have left less the numbers who have entered in the fifty years prior to the year 2000. Territories with positive net immigration, such as the United States of America, receive a negative score by this measure, but since it is not possible to give a territory negative area on a map, such territories are given area zero in this case (see 2.1 below for an alternative approach to this issue). The map of net emigration shows from where more people have left than entered in recent years. Simultaneously it also shows proportionally how many more people are involved in the subject being mapped in each place. For example, the large blue territory dominating the top left hand corner of Figure 1 is Mexico, which has the largest net emigration of any territory represented in the map.

1.1 Rationale

World population statistics can be difficult to understand and are usually presented in the form of statistical tables (when they are presented at all). The idea of a “net emigrant” is not a simple idea to grasp. There are internationally agreed definitions as to who constitutes an immigrant and an emigrant. There are many sources of data, almost all of which are incomplete and there is no obvious way to depict such data. A conventional map allows areas to be shaded by a proportion or rate, but cannot easily be used to compare quantities. In the following sections of this paper we: (1) outline the background to this work; (2) present our approach to the problem of estimating missing information; (3) describe the algorithm that makes the new mapping shown here possible; (4) explain the subjects we have chosen to map, and the design, order and arrangement of the posters; and (5) give details of the website created and ancillary material.

1.2 Statistics

Many people have a justifiable suspicion of statistics. The recording of statistics for categories of people or geographic territories does more than just count; it defines populations through the categories used. Governments, often the source of territory-level statistics, are selective in what they choose to measure and report. On the other hand, statistics provide many opportunities to improve our understanding of the world. Territory-level data, though rarely complete or entirely accurate, allow us to draw pictures of many aspects of how the world works. We hope that by creating pictorial representations of these numbers we will help our readers to consider further what the numbers might show.

1.3 Mapping

The creation of flat, two-dimensional representations of our spherical, contoured planet has been a topic of research and invention for millennia. The sixteenth century Mercator projection is perhaps the most widely recognized cartographic projection of the Earth's surface. Mercator's map preserved angles on the globe, facilitating navigation for sea-based trade. (His creation of the map coincided roughly with the beginnings of large scale worldwide mercantile trade.) The Mercator worldview went largely unchallenged for four hundred years and was still in wide use well into the latter half of the twentieth century. Since 1974 the Gall or Peters' Projection has gained popularity (despite the dislike to it expressed by some cartographers). This projection sacrifices accuracy in the representation of the shapes of territories in order to represent them instead with areas proportional to their true areas on the ground (something the Mercator projection fails miserably to achieve). Equal-distance or geographic projections are also now in common use, in which the scale of representation of north-south distances on the map is constant everywhere.

1.4 Cartograms

Cartograms are maps in which the projection of geographic space onto the page is deliberately distorted to give regions or territories sizes that are proportional to some quantity of interest. Thirty years ago the proof was published that for each distribution a perfect cartogram exists [1]. That is: a cartogram in which every area is the correct size (of which there are any infinity for any distribution) and which is conformal – angles are preserved correctly locally – very small circles on the surface of the globe are also shown as circles on the cartogram (at the limit). There is a long history to the study of cartograms, dominated during the twentieth century by the work of Waldo Tobler who produced the first computer-aided, mathematically defined cartograms [2]. The cartograms of the Worldmapper project are produced using a new method based on an analogy to the physical process of diffusion, which is found empirically to generate attractive and readable maps. For more information on cartograms it is best to search the web as this field of enquiry is rapidly growing and new work is constantly appearing [3].

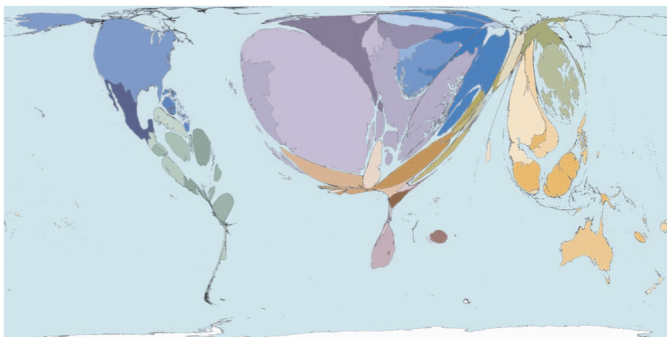


Fig. 2. *Worldmapper* map of profits from tourism.

These unconventional maps challenge viewers by distorting a familiar image prompting them to ask why is something the wrong size? “What is that blue country?” (see Figure 1). “Look how much tourists spend in Spain” (see Figure 2). It would be hard to provoke such reactions when presenting mere tables of figures – white squares filled with black numbers. Many people are uninterested in numerical data. Yet that same data can be made exciting by presenting it as a distortion of the world map. How many of our readers will previously have known who profits most from tourism, or even had any interest in finding out?

Our maps could be made more interactive, certainly, and there are probably many other features that could be added. But even in their present form they seem to make very effective tools for communication, and to the extent that this is true, it is because they

present an elegant approximation to the solution of the old computational problem, but are also being used to address new social issues, and are moreover visually appealing.

1.5 Posters

To explain and support these maps we have embedded them in colourful, simple posters designed for classroom walls. In our experience, the maps do not need much explanation, but we have given brief comments and some statistics on each poster to help orientate the viewer (see Appendix II for an example). Anyone with Internet access can freely view and download the maps and posters from our website (www.worldmapper.org). Future plans include possible translation of the posters into languages other than English.

The posters reveal much about the world but a persistent theme is inequality. There is already a heightened public awareness of worldwide inequalities, at least within some affluent countries and amongst people with ready access to news reports or the Internet. Our maps add an impartial, empirical overview that can assist the viewer in understanding more about their place in the world and their relationship to the people of other territories. For instance, our maps reveal that United Kingdom has lower immigration than the United States, India and Russia, slightly more profit is made from tourism that involves the crossing of international borders in Europe than in the rest of the world combined (see Figure 2 above) and more displaced persons seek asylum in Africa than in Europe (see poster in Appendix II).

2 CREATION OF THE DATA SETS

There are, within our data sets, many missing data, many territories for which we do not have figures for one or more of the quantities studied. We cannot simply assign zeros to these territories, because the resulting cartogram would then give the territory zero area, meaning it would vanish from the map altogether, which would be somewhat misleading. Instead, therefore, we are obliged to find some method for estimating the values of the missing data. In this section we discuss this and other issues involved in the creation of the data sets for the Worldmapper Project.

2.1 Territories

The first decision which has to be made in creating maps such as ours is which areas to include. Our maps are each composed of 200 territories, of which most are member states of the United Nations. A few territories are states that are not members but which are signatories to various United Nations conventions, and the remainder are mostly disputed areas that contain a large number of people, or a large land area. Because not all states recognize all other states and because not all the areas we map are states we use the neutral word “territory” to describe our areas. Territories comprise a number of areas including many islands. Some of those islands areas are found a long way from the main land mass of the territory and have complicated relationships of sovereignty with the rest of the territory. Full details are given on the website, but in essence our decision has been to rescale the entire area of the territory by whatever variable is being mapped including over exclaves (i.e. Alaska and French Guiana) and remote islands (i.e. Islas Malvinas / Falkland islands).

2.2 Population

The territories on our maps are home to at least 99.95% of the world's population. But even as simple a number as total population for each territory is not easy to come by. To use population as an example of how we derive our statistics, most population data is derived from Table 5 of the United Nations Development Programme's (UNDP) Human Development Report 2004. The medium variant projection for the population in 2002 is used. Population estimates for territories not included in the UNDP series were derived from the United Nations Environment Programme (UNEP) figures and the Central Intelligence Agency's (CIA) “The World Factbook”.

2.3 Land area and data sources

Not all the subjects mapped in the Worldmapper project involve people. As another example, consider a measure as simple as land area (Figure 3). We define land area as total territorial area, excluding area under inland water bodies, national claims to continental shelf, and exclusive economic zones. 'Inland water bodies' usually means major rivers and lakes. Exclusive economic zones are areas of sea between 22km and 392km from the shore of a coastal territory within which the territory has jurisdiction over exploration and exploitation of marine resources. (The first 22km from shore is the territorial sea.) Land area data will vary over time because of water management projects, such as the damming of rivers or draining of submerged land, and changes in the level of the sea, lakes and rivers.

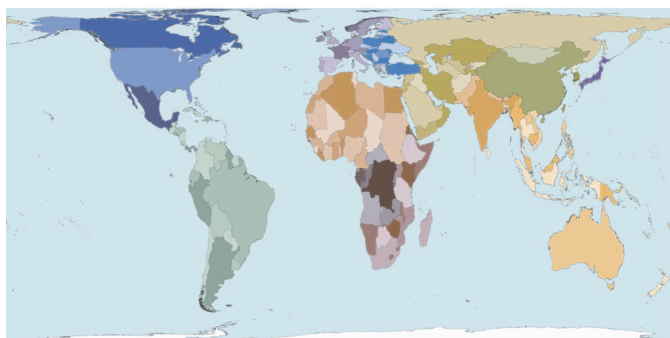


Fig. 3. *Worldmapper* land area map.

Most of our land area data comes from the United Nations Environment Programme. UNEP in turn took the data from the Food and Agriculture Organization's Production Yearbook and data files. Data for Hong Kong and Timor-Leste were included within the UNEP land area totals for China and Indonesia respectively – the land area of these smaller territories was subtracted from the land area of their larger neighbours. The data used are from 2002. The World Bank's 2005 World Development Indicators (WDI) provided land area data for Luxembourg, Hong Kong, Timor-Leste and Monaco. The World Bank also took these data from the Food and Agriculture Organization's Production Yearbook and data files. We have attempted to minimize the number of sources we use and so used the World Bank's version of this data.

2.4 Missing data

We have data for land area and population for all territories, but in many other cases data are missing for some territories. In these cases the missing numbers are assumed to be such that when expressed as a rate they are equal to the regional average for the region containing the territory in question. In most cases these are as rate of either population or land area; whichever is appropriate. For instance, when estimating the number of births in the world we draw birth data from the World Health Organization's 2005 World Health Report, Table 8. From this data we calculate a rate for each of the twelve regions. For those territories where figures are not available we assign a value equal to the regional crude birth rate per capita multiplied by the population of the territory. Because births have been imputed in this way to territories that previously had no data, an additional half million births are added to the worldwide total. The crude birth rate we use in this case is measured per person, not per woman or per woman in a particular age range. We do this for consistency with other estimated data and to ensure that we are not basing too many estimates upon other figures that are themselves only estimates (for instance of the number of women of particular ages living in each place).

2.5 Refugees

There are some datasets for which the general estimation approach described above does not work. When it does not work a world cartogram cannot be produced unless other estimates are made. This process of estimation is thus crucial for visualization. One example is the number of refugees originating from and entering territories. We map both refugees and internally displaced persons combined (see Appendix II). The difference between these groups is that members of the former are outside their territory of origin, whilst members of the latter have stayed within national borders. Internally displaced persons may be extended protection or assistance from the United Nations High Commissioner for Refugees (UNHCR), generally pursuant to a special request by a competent organ of the United Nations. The movement of both groups is based on their "fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion" (UNHCR, 1951 [4]).

Our data for information about displaced persons come from the United Nations Development Programme's 2005 Human Development Report, table 22. The numbers in this report refer mainly to the latter part of 2003, though some are from 2002. The reported total of internally displaced persons (displaced within their country of origin) was 5,081,000 people, but only 4,108,000 of these were allocated to particular territories; the remainder includes estimates for territories for which there were no data available. Similarly, the total number of refugees was given as 9,970,000, of whom 9,465,000 were allocated to particular territories. To draw a world cartogram, however, all data have to be allocated to territories.

To produce the totals for all 200 territories used in this map shown in Appendix 2 we have assumed that in all of the main 177 territories for which the United Nations Development Programme reported data, but for which it did not report a figure for refugees, 1 in every ten thousand people is a refugee, adding 354,000 to the total. The United Nations Development Programme was unable to collate other more basic figures for 23 territories¹, so these territories do not appear in the datasets. The data may not have been collated because they were not recorded or were missing, this may be due to wars (which can displace people). Because of these special circumstances unusual estimation methods are required for these 23 territories in order to produce refugee and internally displaced persons estimates.

By calculating the estimates for refugees by destination for the 23 territories without data to be exactly 31% of the maximum country in their region, a world total is achieved identical to the figure of 15,296,000 (when recorded by territory of origin) given by the United Nations Development Programme. It thus appears possible that UNHCR followed similar procedures in arriving at their global estimate. The figure of 31% was found by trial and error. (Note that many refugees and displaced people live within territories at war; in some cases assuming a figure as high as 31% will produce numbers that are unlikely to be true of peaceful territories, unless they are found in generally peaceful regions.)

To produce the estimates for numbers of refugees by destination territory, a similar set of assumptions were made. For the main territories for which the United Nations Development Programme generally reports data, but for which it did not report a figure for refugees, it was assumed (as for refugees by origin) that one in every ten thousand people is a refugee. For the 23 remaining countries it was again assumed that numbers of refugees as a proportion of the population were a fixed fraction of the numbers for the territory with the highest proportion of refugees in the region. This results in the

¹ The 23 territories with no United Nations Development Programme data are Afghanistan, Andorra, Cook Islands, Democratic People's Republic of Korea, Greenland, Holy See, Iraq, Kiribati, Liberia, Liechtenstein, Marshall Islands, Federated States of Micronesia, Monaco, Nauru, Niue, Palau, Puerto Rico, San Marino, Serbia & Montenegro (possibly about to split into two states), Somalia, Taiwan, Tuvalu, and Western Sahara.

addition of 6,256,000 refugees worldwide, bringing the total to 15,296,000 for all refugees and displaced people in the world.

2.6 Historical and future population estimates

Our maps showing past and future population figures, are based on Maddison's population estimates (2003 version), which are derived from his series of historical statistics on the world economy which have been used in numerous studies [5].

Maddison estimated that the world population in the first year of the Common Era was 231 million people, 191 million of which he assigned to specific territories. The remaining 40 million we must assign ourselves, which we do on the basis of a variety of assumptions. In most cases we estimate missing population figures for a particular era by using regional estimates and matching the fraction of the regional population falling in the given territory in a later era. In some cases a better strategy is to allocate a constant proportion of the population of a nearby more populous territory. This strategy is adopted particularly for territories that were later partitioned into two or more territories, such that a earlier single population figure is inadequate to determine the historical populations of both later territories. Examples are the United Kingdom, Ethiopia, and India, each of whose population is reduced and a fraction allocated to Ireland, Eritrea, or Pakistan and Bangladesh respectively, to represent the distribution of their inhabitants in the periods before they were partitioned.

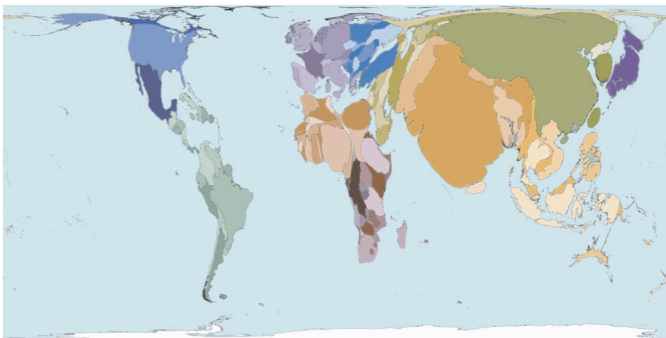


Fig. 4. *Worldmapper* population map (2002).

3 THE CALCULATION OF THE CARTOGRAMS

The cartograms themselves are calculated using the diffusion-based method described by Gastner and Newman, but the method is modified somewhat to allow the creation of maps of the entire globe. The maps are created on a rectangular grid by distorting an initial projection of the boundaries of the territories. The final sizes of the territories are guaranteed proportional to the quantity of interest for the particular map in question, but this does not mean that the initial positions of the boundaries is immaterial: the algorithm attempts to resize territories appropriately with minimal distortion of their initial shapes, meaning that the final shapes are typically similar to the initial ones. The maps are therefore substantially affected by the particular choice of initial projection for the world map. All projections of the globe onto a flat page necessarily involve distortions, but the most satisfactory for our purposes are the equal area cylindrical projections, which provide the rectangular shape needed by our cartogram algorithm and accurately represent initial land areas.

To create a cartogram the population or other density function of interest is treated as a diffusing fluid, which spreads out from the areas where it is initially most dense into areas of lower density. As a simple analogy, imagine a bottle of ink emptied into a swimming pool: the ink is initially densest at the point where it is added to the water but over time will spread out until ultimately it is distributed uniformly throughout the pool. This process can be modeled using the standard linear diffusion equation of elementary physics, allowing us to calculate the motion of the fluid at any time. In our

cartogram calculation we allow the features of the map to be carried along with the diffusing population or other density until it comes to rest at its final position, which defines the cartogram transformation. It is a simple mathematical exercise to demonstrate that this process does indeed produce a map in which the final areas of territories are proportional to their target population or other property of interest. In practice, the maps produced are also attractive and readable, with relatively minor distortion of territory shapes in most cases.

At a technical level, the solution of the diffusion equation is performed in Fourier space, where it takes a particularly simple form. The initial density function is calculated on a 4096×2048 lattice, transformed using a two-dimensional fast Fourier transform, convolved with a Gaussian kernel and then back-transformed to give the diffusion field at an arbitrary later time. This field is then used to calculate the diffusion velocity as a function of position and the velocity integrated to give the displacement of the map features. The integration is performed using a standard fourth-order Runge-Kutta integrator. Because of the heavy memory demands made by the large lattice sizes we employ, the normally attractive Richardson extrapolation methods like the Bulirsch-Stoer method are not possible. However, with careful control of integration errors we have been able to calculate cartograms in which vertex positions are accurate to about 1 part in 10,000 in very reasonable computation times, typically in the order of a few minutes on a standard desktop computer.

Unlike maps of small regions of the planet, world maps “wrap around” from left to right: if one travels off one side of the map, one reappears at the corresponding point on the other. This means that the cartogram algorithm has to be modified to have “periodic boundary conditions” along the horizontal axis, but still retains the closed boundaries at top and bottom used by Gastner and Newman. Technically, this requires that the two-dimensional Fourier transform that lies at the heart of the calculation be of mixed type, a complex transform in the horizontal direction and a cosine transform in the vertical direction. In addition, checks were put in place to take note of map features that passed off the sides of the map, so that they can be correctly rendered in the final images. More information and a version of the algorithm is available on-line [6].

4 CHOOSING THE SUBJECTS

4.1 Choosing and arranging the subjects

The subjects chosen for the maps were those for which data were available. Around the year 2005, when work on this project began, there were sufficiently few such datasets that it was possible to examine most of them. As the project received publicity, viewers began to make suggestions for new maps and the final set of maps will reflect that feedback.

Arranging and order for the maps is a somewhat arbitrary process but we have attempted to tell a story that begins with the basics, moves on to flows of people, then goods, before addressing environmental, social, economic and medical issues, reserving the more harrowing subjects such as war for towards the end, but then trying to finish on a note of optimism. Subjects are arranged so that pairs of consecutive maps tend to be logically paired. There is not space here to do much more than list the title of the 27 sections of maps currently under preparation (see below). Some 87 subjects are still to be decided at the time of writing:

Basic	maps 1 to 12
Movement	maps 13 to 26
Transport	maps 27 to 40
Food	maps 41 to 56
Goods	maps 57 to 76
Manufacturers	maps 77 to 92
Services	maps 93 to 100
Resources	maps 101 to 108
Fuel	maps 109 to 120

Production	maps 121 to 132
Work	maps 133 to 146
Income	maps 147 to 158
Wealth	maps 159 to 172
Poverty	maps 173 to 182
Housing	maps 183 to 194
Education	maps 195 to 212
Health	maps 213 to 226
Disease	maps 227 to 244
Disaster	maps 245 to 254
Death	maps 255 to 266
Destruction	maps 267 to 278
Violence	maps 279...
Pollution	...
Depletion	...
Communication	...
Exploitation	...
Action to 365

4.2 Layout of the posters

The posters were designed with older school children and younger university students in mind as the target audience (see appendix II). All are in English so far, but we have attempted to design them so that they can be read and understood anywhere. We attempted to minimize clutter and make them bright and colourful enough to stand out when pinned to a wall. On the web only certain parts of each poster are normally shown on screen at one time to reduce visual confusion.

4.3 The selection of quotations

Quotations were included on the posters to help younger viewers in particular realize that there are many stories that each poster can tell and many issues that they raise. The quotations aim to remind the viewer that the maps show real lives by personalizing the topic. In selecting the quotations we have tried to avoid too much bias towards the familiar and mundane. One way in which we have done this is to only allow ourselves to use any source once. We give the real names of the authors of the quotations without titles whenever possible (Tony Blair rather than Prime Minister Blair) to reduce the distance between the writer and the reader. At times we have had to cut quotations or correct minor typographical areas in them. Any changes we have made are indicated if major or detailed in the technical notes if minor.

4.4 The design of the graphs and tables

The graphs and tables are intended to be simple. Graphs could potentially be off-putting to some members of our target audience. All the graphs allow comparison to be made between the twelve main regions. We try to use the same style of graph within each section of the website. Occasionally the graphs show information that cannot be depicted on the cartogram such as per capita figures. This is also what almost all the tables do, and so they allow the reader to see where the rate is most and least as well as the absolute amount. The background in the tables is coloured according to region to allow readers to see at a glance if the areas listed are in the same region.

4.5 Style of text and technical notes

Both the text on the posters and that in the further technical notes is designed to be understandable when read quickly by an able older school child. We try to explain succinctly what is being mapped and to point out interesting features. We try to avoid making statements that might be read as one-sided, but our most important goal is to be clear. We avoid any use of technical terms (such as per capita) when at all possible and we try to be as transparent as we can about the usually simple arithmetic used to derive the statistics. The technical

notes are also designed to allow anyone with access to the internet to be able to replicate our work.

4.6 The use of colour

A consistent colour scheme is used throughout all the maps, tables and spreadsheets in worldmapper (see Figure 5). The twelve regions of the world we use are ordered from poorest to richest by the Human Development Index published in 2004. Shades of dark red are used to demarcate the poorest territories – moving through the rainbow scale to a shade violet for the best-off: Japan. The regions were chosen to be geographically contiguous groups of territories which divided the world into roughly symmetrically balanced population groups with no region containing fewer than one hundred million people.

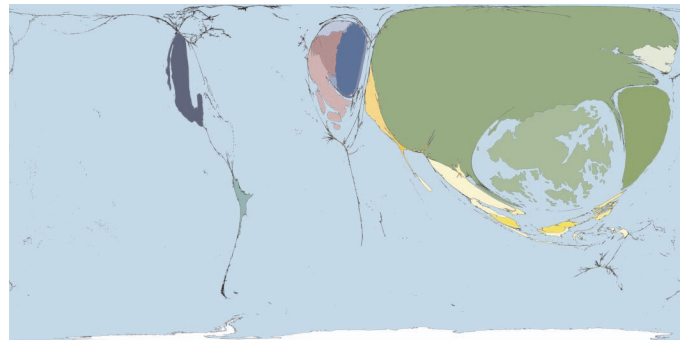


Fig. 5. *Worldmapper* net toy exports map. Note – this map appears lop-sided because world trade is so lop-sided.

5 NUMBERING AND NAMING

In creating the worldmapper website we realized that everything needs to be defined. For instance: Population is the number of people alive in the world, at one moment in time. A birth is the moment of delivery of a baby. Definitions usually appear obvious after you have read them but for the maps we are producing here to be widely understood we have to define everything that we are mapping. We also have to be consistent in how we number and name places. The ISO 3 code, or ISO ALPHA-3 code is a three letter code devised by the International Organization for Standardization. Codes are used as a short way of identifying a territory; their shortened form makes it easier to match data. We have included these codes in all the datasets we map.

Throughout our project we also use a consistent numbering system for areas. The numerical territory code has been used to order territories in a consistent manner. The number is decided by the 2004 Human Development Index rank of the 177 territories included in the main United Nations Development Programme tables (1 being Norway with the highest Human Development Index in 2004). The other 23 territories are numbered in alphabetical order, starting at number 178.

Region and territory names can be contentious. Regions consist of geographically contiguous territories and nearby territories. Region names are intended to be descriptions of the location of the region. The region names try to avoid describing regions as being far away places because this implies a location for the author (and the authors of these maps work on two continents). The 'far East' is only far away for some and thus we use 'Asia Pacific'. In our naming of regions we also tried to avoid subsuming smaller territories in the name of a larger territory in the region, such as using 'Greater India' for what we have termed 'Southern Asia'. In attempt to avoid confusion with other regional definitions we use 'Southern' rather than 'South' where we hope it is appropriate.

The territory names used are what appeared to be the most common spellings used by multiple United Nations agencies and on

the Internet, using the Roman alphabet, in January 2006. Note, we have avoided using accents on characters because there is inconsistent use of accents for territory names by United Nations agencies. Examples of the various spellings and wordings for territory names are below; the name we use is first, followed by examples of alternative spellings:

Albania, Republika e Shqiperise
 Bahrain, Mamlakat al Bahrain
 Burundi, Republika y'u Burundi
 Cape Verde, Cabo Verde, Republica de Cabo Verde,
 Cote d'Ivoire, Côte d'Ivoire
 Democratic People's Republic of Korea, Choson-minjujuui-inmin-konghwaguk
 Kyrgyzstan, Kyrgyz Respublikasy
 Timor Leste, Timor Lorosa'e, East Timor
 Mexico, Estados Unidos Mexicanos
 Morocco, Al Mamlakah al Maghribiyah
 Mozambique, Republica de Mocambique
 Sao Tome & Principe, São Tomé e Príncipe, Sao Tomé et Príncipe
 Uruguay, Republica Oriental del Uruguay
 Viet Nam, Vietnam, Cong Hoa Xa Hoi Chu Nghia Viet Nam
 Yemen, Al Jumhuriyah al Yamaniyah, Al Yaman

Lastly, in some cases it was necessary to abbreviate country names in order that they would fit into certain sections of the poster. In order to maintain some consistency, the following abbreviations were made, when necessary, to reduce the length of the name:

- a) If a well-used abbreviation already existed, it was adopted, this was done for the following:
 - 'Former Yugoslav Republic of Macedonia' was abbreviated to 'Macedonia FYR'
 - 'Democratic People's Republic of Korea' was abbreviated to 'DPR Korea'
- b) 'Saint' was changed to 'St'
- c) 'Democratic' was changed to 'Dem'
- d) 'Federated' was changed to 'Fed'

6 CONCLUSION

We conclude by commenting on the apparent early enthusiasm for the worldmapper images on the web and by speculating as to why this might be partly due to the visual advantages of the particular kinds of cartogram this project has had access to and then turn to issues of interactivity. In the first half of 2006 the worldmapper website received 470,000 unique visitors, mostly since April of that year. No announcement was made that the site was being created but it quickly attracted the attention of commentators on the web and the maps were featured in many magazine articles, in *New Scientist* and on the Discovery Channel on television. We have included a couple of new images yet to appear on the web in Appendix I below to illustrate why these images appear to be somewhat addictive to view, and how when contrast as pairs they can leave a lasting impression.

As yet the maps are not interactive. In the future we hope to be able to add interactivity to the maps such that the user will be able to select territories and find out more about them. Applications could be created to allow users to 'brush' over the cartograms and see the names of territories change under their eyes. We could think about dynamically linking the graphs in the spreadsheets of world data that we also make available to the maps to allow users to see how altering values alters the image. We have not yet added any animations to the website. We are currently looking at the possibility of making available animated cartogram globes that you can spin and zoom into, in the style of 'google earth'. We have also not yet thought how we could morph from one projection to another to better illustrate just how unevenly peoples, goods and livelihoods are distributed

over the surface of this planet. Worldmapper is still a work in progress. See www.worldmapper.org for more information.

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7 APPENDIX I : EXAMPLES OF MAPS CONTRASTING

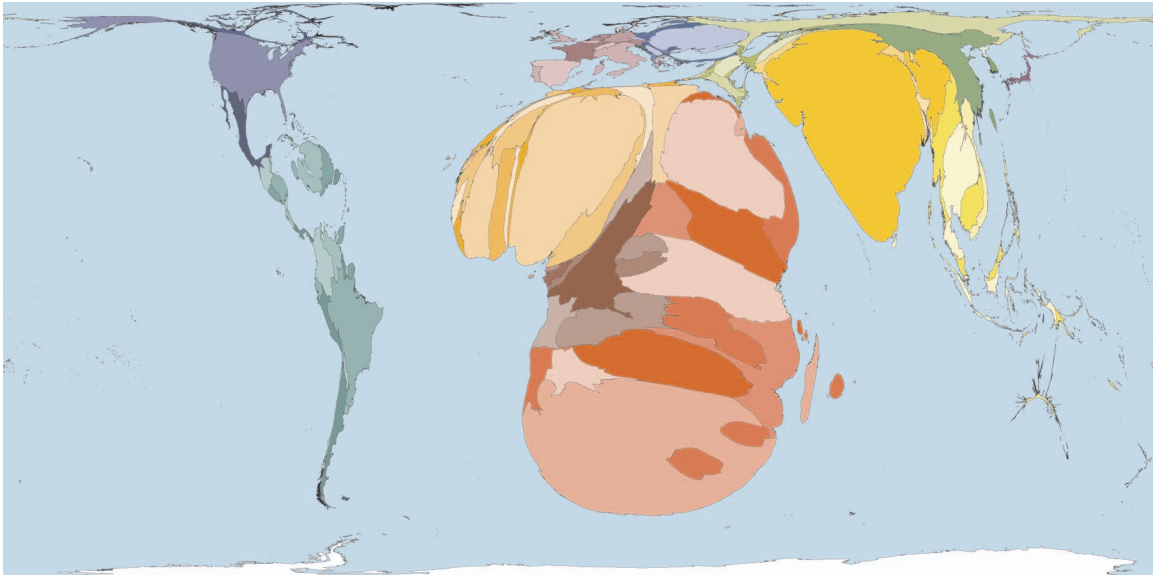


Fig. 6. *Worldmapper* map of people estimated to have HIV/AIDS. More than 25 million people have died of AIDS since it was first diagnosed in the early 1980s almost 3 million of these deaths occurred in 2005.

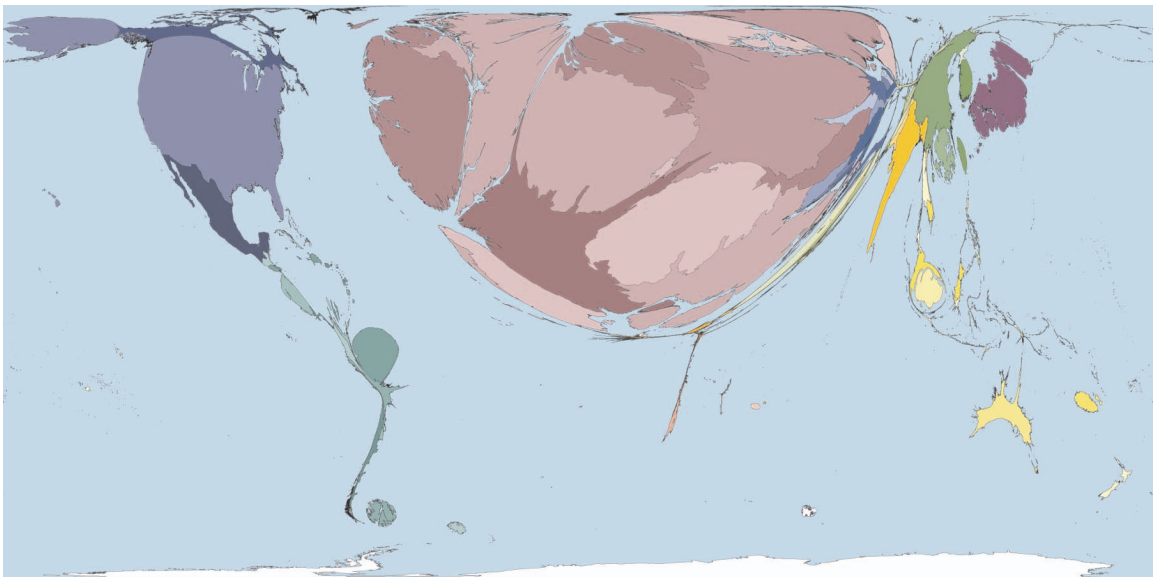


Fig. 7. *Worldmapper* map of the gross US dollar value of medicines exported in 2002 between the territories of the world. The total area of the map represents gross export earning of US\$46 billion in that year.

8 APPENDIX II: EXAMPLE POSTER

