

MORPHING ROMANIA AND MOLDOVA PROVINCE

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Abstract. *Morphing Romania and the Moldova Province* gives a short insight of cartograms. Digital cartograms provide potential to move away from classical visualization of geographical data and benefit of new understanding of our world. They introduce a human vision instead of a planimetric one. By applying the Gastner-Newman algorithm for generating density-equalising cartograms to Romania and its Moldova province we can discuss the making of cartograms in general.

Keywords: *Map, area cartogram, cartogram, anamorphic cartogram, cartographic transformation, thematic cartography, isodemographic map, Romania, Moldova.*

Maps and other forms of geographical data visualization are not only an enlightening way of making geographical phenomena understandable by simulating our visual imagination, but also a way to explore the underlying data, to gain new knowledge, and to raise new questions about the emerging pictures. K. Börner (2010)

1. Introduction

After some 500 years of Gerardus Mercator's birthday, maybe we could benefit of new ways to look at our World. We need to rediscover our territories. *We need maps for the new era* (Henning, 2011). The question of finding new representations of the geographical space may be address globally by the term Paul Crutzen (2000) and Crutzen & Stoermer (2002) used to describe the human impact on the global environment: the *anthropocene*. It stands for a return to traditional virtues of geography as an interdisciplinary domain, claiming that the effects of humans on the global environment is so significant that with the industrialisation they have become a major driving force in environmental change. The sphere of the anthropocene is proclaimed to be a new geologic era, in which the effects of human population and economic development are also a part of globalisation and influence the natural environment as much as the natural environment previously determined the existence of human life across the globe. The debate about the complex relations and the diverse natures of the spheres in which globalisation and global environmental changes take place have an impact on how space is perceived in geography (Henning, 2011: 10-15). The understanding of such an issue could benefit of “*testable propositions and probable explanations derived from sensing of the world*” (Amin & Thrift, 2005: 223) and one solution might be to look at

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problems and phenomena occurring in the world in the form of mapping (Ballas & Dorling, 2011), a form of empirical focus and a visual manifestation of space. Thus the changing role of space in geographic practice and theory related to globalisation can be reflected in the underlying principles of cartographic techniques to construct the base projections of maps and include more specifically the human space(s) in maps.

2.Geographical space and projections

In the description of the different spheres of human and physical geography maps are key elements, helping us to illustrate phenomena that concern the environments we are living in. The appropriate map projection is crucial in the process of mapping because it modifies our perception of the geographical space and thus it has largely contributed to changes in the history of cartographic practice. *“Therefore, map projections are of pivotal interest to cartographic research from a conceptual as much as from a methodological perspective. The right map projection can solve a technical problem in the same way as it can provide a thought-provoking new perspective of an already known topic – or completely distort the view they give. Maps are never neutral...”* (Henning, 2011: 16). Maps, as visual manifestations of space, shape our imagination of space, they create mental images of a space thus they have large impacts on our understanding of the world.

A map projection is indeed first needed if we want to reconstruct any geographical space. The right choice for the appropriate projection has to be made before constructing a map for a specific purpose. In every map projection we follow a certain mathematical procedure that aims to preserve some geometric qualities of the physical space or to reconstruct this space to provide better solutions for a specific purpose. We know the classical approaches: the transformation of angles, the transformation of areas, the transformation of distances and the transformation of directions. For a map, there is no best map projection to give an accurate picture of the world or capable of serving all purposes. *“Basically a cartogram also applies certain mathematical principles to transform a map or a map-like representation in the cartographic result, just like a conventional map projection”* (Henning, 2011: 22).

3.Cartograms: human vision of our world

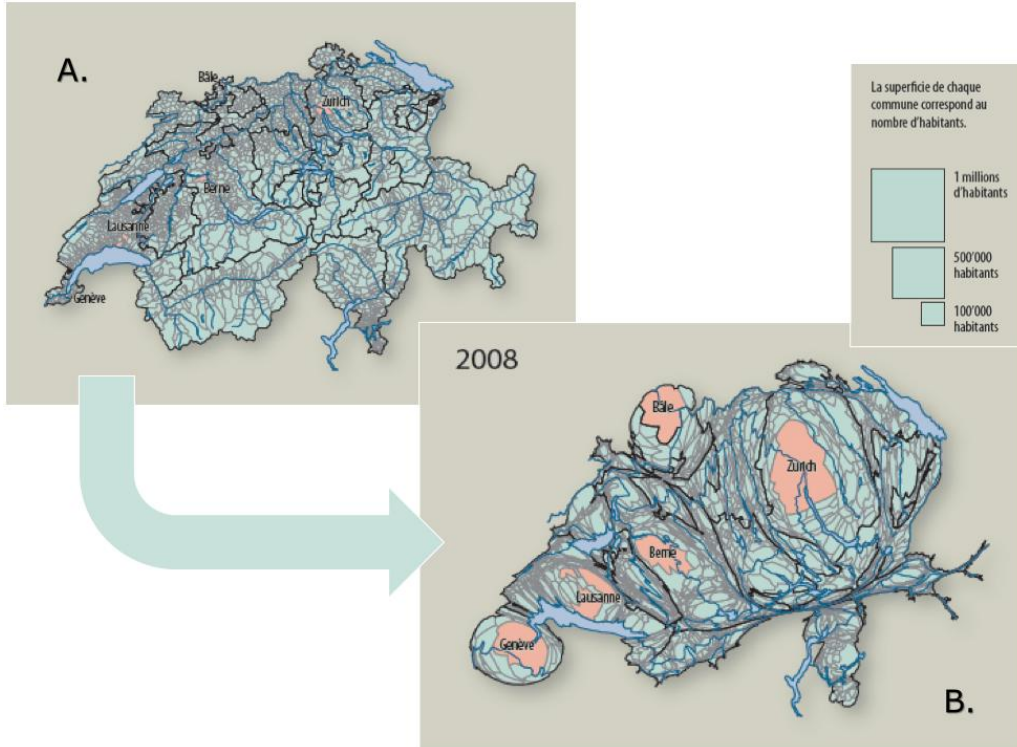
Cartograms are thematic maps in which the shape of the surface polygons is no more referenced to land area or the physical space. A spatially extensive variable, like for example population size or number of votes, is substituted to the land area so the geometry of the map – the projection of space – is then transformed (or distorted) in order to convey the information of the alternate variable (Figure 1). In the end, the shape of each geographic entity does not correspond to the planimetric form we are used to see but becomes proportional to a quantitative variable other than the topographic surface. The end result is another kind of thematic map in which the density of the variable under consideration is uniform throughout the map; the variations in values are represented by variations in the size of mapped entities, preserving the shape of the total area to the extent possible.

If we follow Waldo Tobler (2004), we can reference the term “cartogram” in the mid-1850. As the production of cartograms calls for a geometrical transformation of the surface polygons of a map, it represents a technical challenge that only the use of computers was able to cope with efficiently. Thus we can see from the 1960’s many researchers proposing a

variety of methods, algorithms and software implementations where approaches and results vary in many ways. It is Daniel Dorling who re-energised the deployment of the cartogram as a design in the early 1990s (Dorling: 2011). Here we will focus only on the popular Gastner-Newman algorithm (2004) for generating density-equalising cartograms.

Figure 1: Morphing the Swiss population (Kaiser, 2008 & 2010)

A. Switzerland in a topographic projection, B. Switzerland in a population projection



4. Technical aspects

Cartograms have always been a difficult undertaking, however with the development of the Gastner-Newman's approach in 2004, they have moved into the realm of practice. The Gastner-Newman algorithm for the construction of cartograms is based on a physical modelling of the diffusion of gas in an empty space: in a true cartogram, the attribute has to be uniform; once the areas of the region have been scaled to be proportional to their attribute, then, by definition, the attribute density is the same everywhere. Thus one way to create a cartogram, given a particular attribute density, is to allow the attribute somehow to "flow away" from the high-density areas into the low-density ones, until density is equalized everywhere. This is realized by the linear diffusion process of elementary physics by the Gastner & Newman algorithm. *"It commences with the source map with its varying "population" density and conceptually allows the individual members of this population to diffuse from higher density zones to lower density zones until such time as density is uniform. Zone boundaries are progressively moved during the diffusion process such that the net flow through them is zero, until they reach a stable position. It is important to note that here, as*

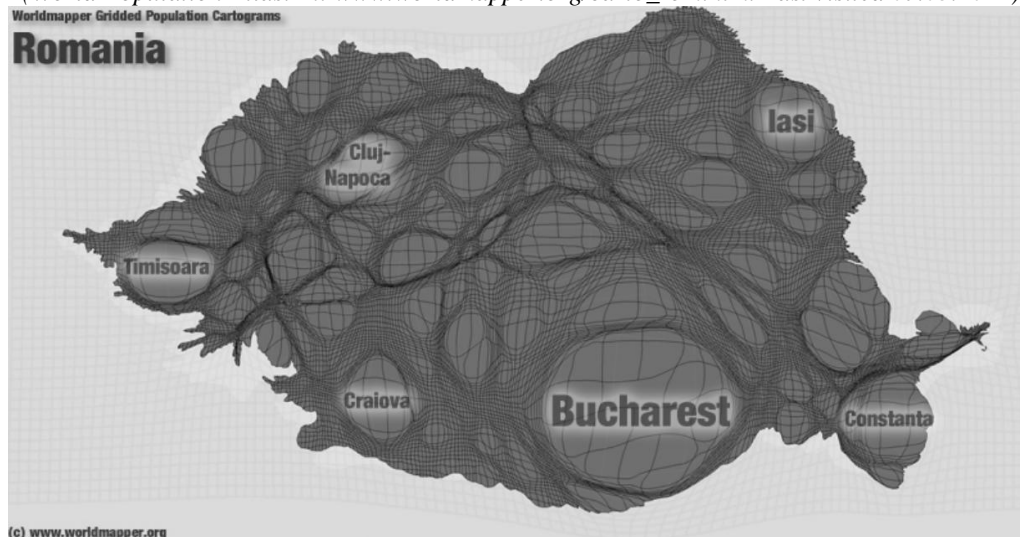
with many software implementations of geospatial algorithms, the final cartograms may differ depending upon the software package used to generate them and the parameters used or selected” (Geospatial Analysis, 2006-2011).

Someone interested in visualizing multiple variables transformed in cartograms at the world level should look at the Worldmapper web site (<http://www.worldmapper.org/>). The Worldmapper project provides a mapping of the diverse geography of the world using the diffusion-based method for density equalising cartograms. The technical solution puts population on the map in its true proportions. It is a limited solution because it cannot serve as a basemap for other geographic dimensions. The population cartogram is somehow weakened by the limited amount of population data – one population value per country– and by the highly variable physical extent of the geometries –the countries– that constitute the base of the map transformation. To improve those inaccuracies there should be increase in the data values used for the transformation and standardization for the basic geometry that is transformed. In that sense, more efficient but linked to the Worldmapper project, the thesis research of Benjamin D. Henning (2011) on gridded cartograms of human and physical space shows an alternative technique builds on these limitations. Before in the ScapeToad Project (Andrieu, Kaiser, Ourednik & Lévy, 2007) the Gastner-Newman algorithm for generating density-equalising cartograms has been applied. The basic hypothesis still being that the diffusion-based algorithm can be adjusted for a more accurate visual representation of geospatial information in cartogram form. Technically the Henning solution uses various components of ArcGIS and external extensions like XTools Pro and a Cartogram Geoprocessing Tool as the main script for the cartogram transformations. Thus the Cartogram Geoprocessing Tool is an alternative to ScapeToad. ScapeToad being a Java-based application, has limited capability to process data and would be less powerful in working with very large amount of data like the world’s population grid (more than 375,000 administrative units with a heterogeneous resolution, for example); however ScapeToad works pretty well for most datasets for a country (for example for the 10,000 communes of France, the nearly 3,000 communes of Switzerland or Romania). The two technical approaches (ScapeToad and Cartogram Geoprocessing Tool) show no overall differences in their capabilities (Henning, 2011: 57-59). For Romania, the grid map produce with Cartogram Geoprocessing Tool (Figure 2) uses the gridded population cartogram method showing land area distorted to the extent that every person living within the surface of a square are is given the same amount of space on the transformed map. In the resulting map every areal unit for which the total population is counted is transformed accordingly. Consequently the grid cell as the smallest areal unit in a gridded cartogram is the smallest geographical reference from the physical space. The area that is covered in the original raster is the same area in the resulting gridded cartogram, hence the new maps show the number of people living in the same geographical space. ScapeToad (Figure 3) uses a different method, the plain Gastner-Newman algorithm. The ScapeToad cartogram, as a final map, has been calculated on the basis of the population in 2007 on a calculated grid for all of the communes. We can notice also that the overall distortion is less in the second view and the design of the map can be done after the calculation in an Adobe Illustrator environment for example, allowing a more realistic mapping of the results, providing back the original source boundaries instead of the calculated grid. Thus the procedure provides a continuous mapping of the source data, as close as possible to the overall form of the original map with no lost reference to the familiar country shapes from a conventional map projection.

ScapeToad has been developed in Switzerland for the Laboratoire Chôros of the Ecole Polytechnique Fédérale de Lausanne, in the context of the project PNR 54 “Our Inhabited

Space” (Andrieu, Kaiser, Ourednik & Lévy, 2007). The Java implementation was done by Christian Kaiser between 2006 and 2008, for a ScapeToad version 1.1 ready in mid-2008. It uses the GIS Library of JUMP and the Java Topology Suite Library. The ScapeToad application can be download at <http://scapetoad.choros.ch>, and, as the web site explains, : *it is a cross-platform, open-source application written in Java, design as an independent application using the ESRI Shapefile format for input and output. It also exports maps in SVG format and has a user-friendly interface, which guides the user throughout the map creation process.*

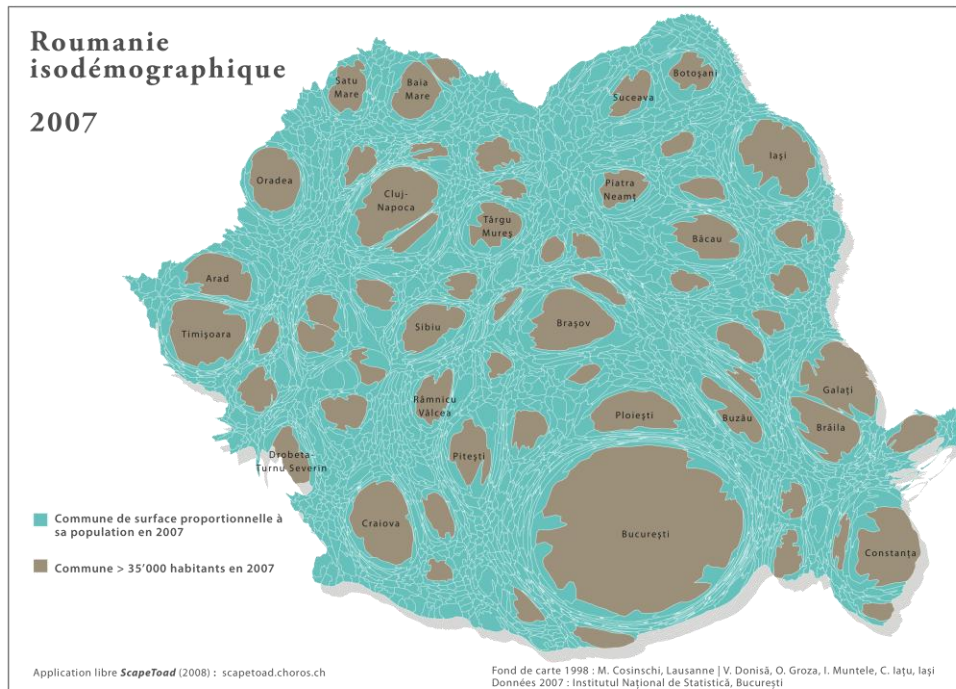
Figure 2: Morphing the Romanian population with the Gastner-Newman technique with the Cartogram Geoprocessing Tool : the gridded population cartogram (World Population Atlas. In: www.worldmapper.org/carto_rom.htm. Last visited 07.03.2012)



The general objective in a cartogram is to modify the original areas using an attribute value associated to each area. In this process it is necessary to minimize the size error in limiting the deformations so to be able to recognize the original topology. This problem has no unique solution. The ScapeToad project added to this the possibility of deformation of many layers in the same process, the deformation of polygons and lines as well, both in respect of the topology (no tearing nor superposition of polygons). All this is established in a user-friendly environment for rapid work and with the use of standard GIS data.

To create a cartogram one need a *polygon layer* (with a surface defined in *metric units* and a *clean topology*) and a *metric statistical variable* (a *mass* like a population, any quantitative variable allowing arithmetic operations) defined for each polygon; it will become the new metric unit of the cartogram surface. Then the computing may be characterized in five steps: the creation of the cartogram grid based on the cartogram polygon layer, usually defined according to topographic metrics; the calculation of the transformation using the diffusion algorithm, by computing the density for each grid point; the projection of all layers on this transformation respecting shape constraints; the production of the visual transformation grid layer reflecting the user-defined variables and finally the production a computation report. The creation process for ScapeToad is technically discuss and exemplified at <http://scapetoad.choros.ch/help/v11/a-cartogram-creation.php#cartogram-constitution>.

Figure 3: Morphing the Moldova population with the Gastner-Newman technique with ScapeToad : the final map. (M. Cosinschi & A. Ourednik)



5. Morphing the Moldova province: two examples

The use of cartograms is particularly common in distinct subject areas. The mapping of results of elections is probably one of the most obvious. How does the geography of a region change if the map projection is changed radically and shows us the basic geography of the region in relation to the people living there? The cartogram adds another dimension as a new basemap becomes an alternative map projection that bridges the gaps between the geography of the physical and the human space.

We have made a first example (Figure 4) to appraise the distribution of votes in the 2009 presidential election for Moldova. Mapping electoral results in the form of a cartogram gives an honest representation of the vote share in relation to people. Technically, we create the cartogram grid based on the polygon layer for the communes, taking into account the number of votes in favour of T. Băsescu, we then compute the transformation using the Gastner-Newman's diffusion algorithm, if we had added more layers (the roads, the districts limits for example), then we can project all layers on the former result, we produce the visual transformation grid layer and we map a complementary variable, the percentage of votes in favour of T. Băsescu so the cartogram shows a geometric structure for an electoral constituency and display the election result on it.

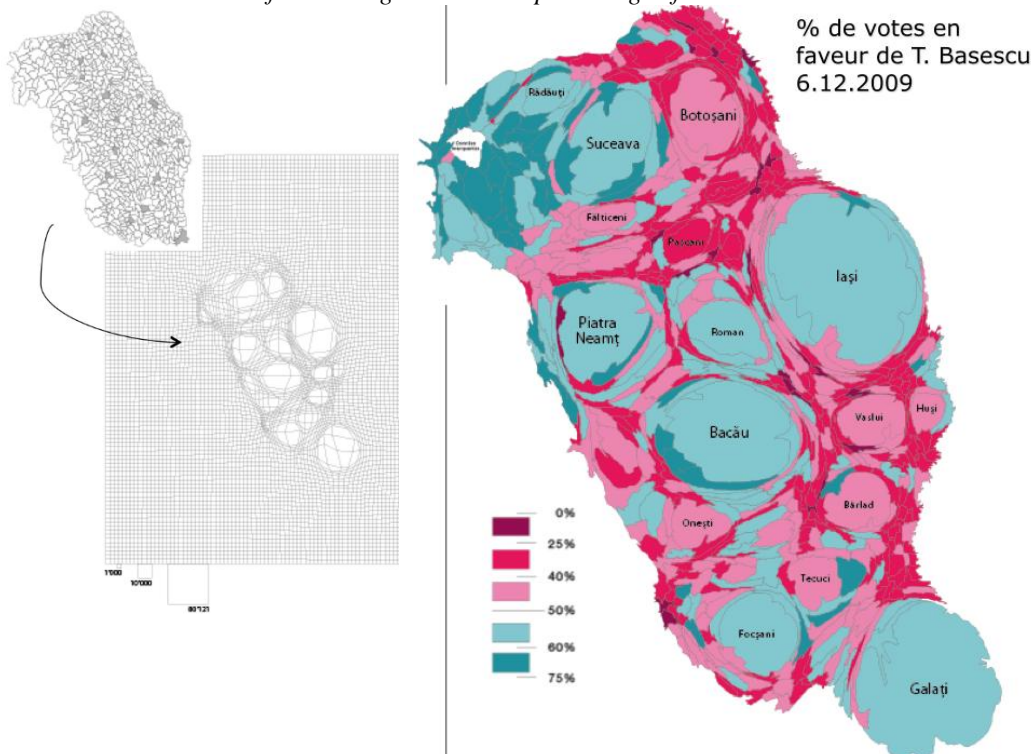
This basemap figures where the number of votes has been predominant – with no surprise mostly in large urban areas but not only if you notice the Bucovina region. If we look at the structure of the votes, in coloured percentage, the image is more complex: Iași, Bacău, Galați, Piatra Neamț and also Focșani, Roman and the Suceava region score between 50%-

60% for T. Basescu. On the other hand, Botosani, Vaslui, Barlad, Tecuci, Husi or Falticeni and Onesti score less than 50%, in fact between 40%-50%. We have noticed a positive regional effect in Bucovina and in large urban areas, a negative one in smaller cities, particularly in the Moldavian Plain, in the north, and along the Barlad River. The higher scores (60%-75%) are in some periurban areas and in Bucovina. The rural localities and smaller cities have in general voted against T. Basescu. There is also a regional effect. As we lack of sociological and political grounds, it is difficult for us to further interpret this electoral map.

Figure 4: Morphing electoral results in the Moldova province with the Gastner-Newman technique in ScapeToad (M. Cosinschi & A. Ourednik,)

A: The generation of the cartogram grid from the votes in each commune

B: The final cartogram with the percentage of votes added in colour.



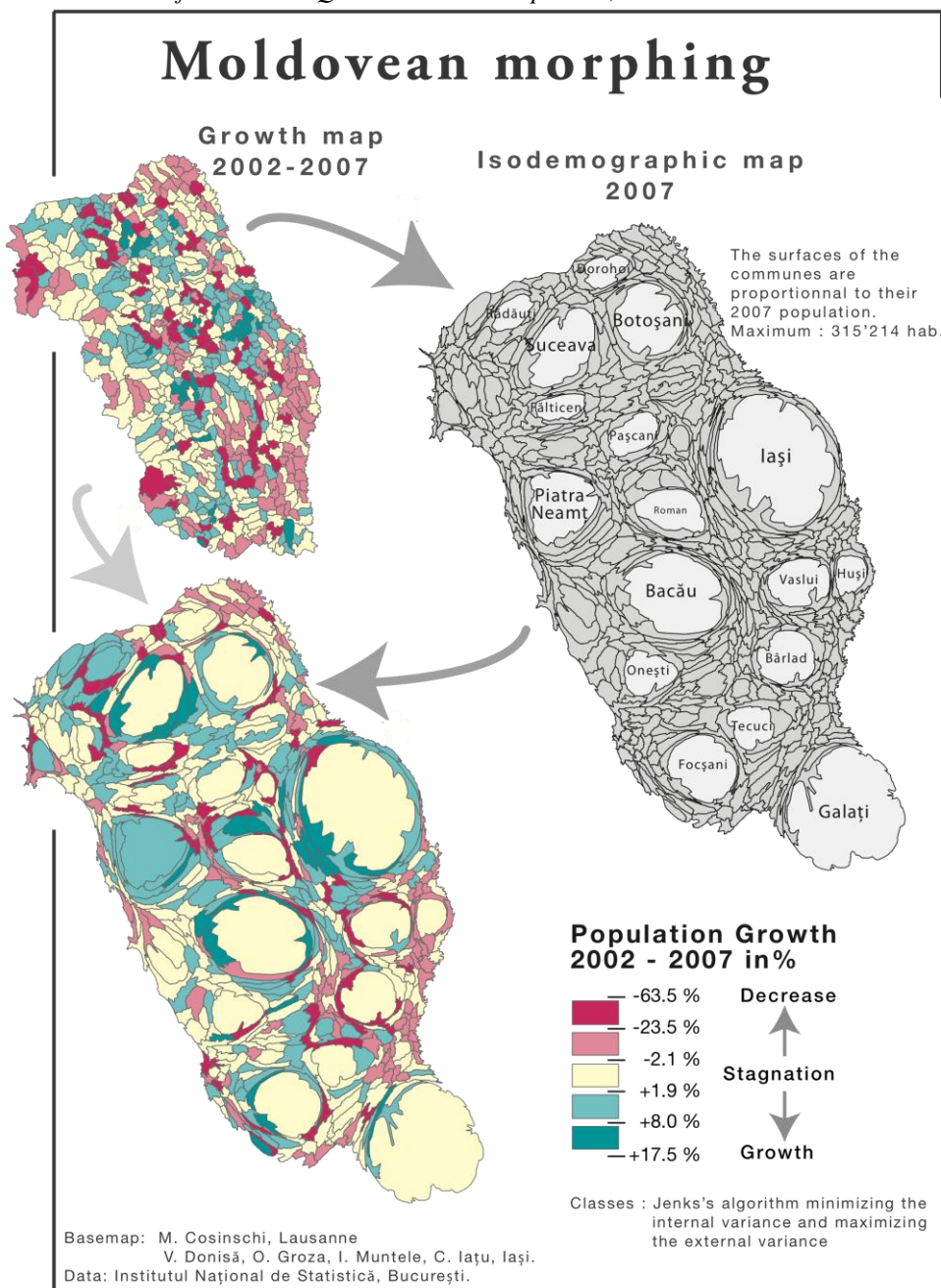
A. The surface of each commune is transform proportionally to the total number of legitimate vote the 6.12.2009 for the presidential election.

B. The colours indicate the percentage of legitimate votes for T. Basescu : in red < 50%, in green > 50%. The surfaces of the communes are proportional to the total number of votes calculated in A.

The second example focuses the growth of population between 2002 and 2007 (Figure 5). The standard growth map can be seen up left. As usual, it is the coloured land areas of the communes that gives the first visual impression, the bigger communes in terms of surface are emphasized, for example in the extreme north-west part of Moldova. In the cartogram, it is easy to see that those communes are very small in terms of population. On the other hand, the communes in population growth at the periphery of larger cities are efficiently identified on the cartogram, compare to the standard map. The urban areas are in stagnation, with the exception of Piatra Neamt, in growth. Generally the growth is distributed in the surrounding

periphery of the urban areas, with the exception of Vaslui and Barlad where the periphery is decreasing. The small communes at the western part of the region, at the border of Moldova and Transylvania are decreasing or in stagnation. Decrease is also at the north region, up Botosani, and in the hills between Iasi and Galati.

*Figure 5: Morphing the growth of population between 2002-2007 with the Gastner-Newman technique in ScapeToad. (M. Cosinschi & A. Ourednik,)
Software used: Quantum GIS & ScapeToad, Adobe Illustrator.*



By looking at the spatial context of the quantifiable dimensions useful, here the votes or the people, we can understand the sometimes hard-to-grasp dimensions of numbers in a visual way, in which we perceive more efficiently information. It allows a more intuitive understanding of a topic. *Visual thinking* as in cartograms remains a powerful element to see things that we would have otherwise not noticed in the vast amount of data hidden in a classical map from a planimetric projection. The significance of the cartogram method lies in its possibility to break free from the limitations of physical space in the map and give other dimensions space. At the same time, space is not abandoned, as the spatial reference is preserved in the cartogram pattern. In conclusion, with a geographical relevance in a more practical and therefore also a more substantial way, cartograms used in their versatile range of concepts provide an alternative solution to visualise quantitative data in a new dimension.

6. Conclusion

For an intended message, there are only appropriate map projections. This choice of the right map projection depends on the verdict of the cartographer, and whether a certain phenomenon makes sense to be shown in that particular projection. Where a topic needs to be shown in relation to population and that information is made quickly accessible to the map reader, a cartogram projection may be an appropriate choice with an added value to the map.

Cartograms are an alternative way of *visualizing what we know* (Börner, 2010). But they are still used as unusual visualizations, so that this element of unconventional and sometimes provocative mapping remains in the focus of cartographic display. This may explain the reluctant use of cartograms as a basemap to show additional information. There is a need to liberate cartograms from their image as limited graphical representations of a single topic. Cartograms put a stronger emphasis on the geographic content of the maps in order to highlight their interpretational value for potential users, as in electoral mapping for example. Cartograms do not only provide a solution for a different understanding of humanity, but a new understanding of the different social and physical dimensions that determine our whole environment.

Digital technology has changed our common cartographic practices. There is a need to “*reclaim the map*” (Dodge & Perkins 2008) *in a very own geographic manner by rethinking cartographic practice in the light of a world that today is very different to the days when mapping became part of academic disciplines* (Henning, 2011: 187). The visualization capabilities of cartogram techniques offers new possibilities how cartography can be conducted to become part of the efforts to use visualization to make sense of the ever growing amounts of data that are also a result of the digital age.

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