Mapping guide

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Espon Cartographic Language

Mapping guide

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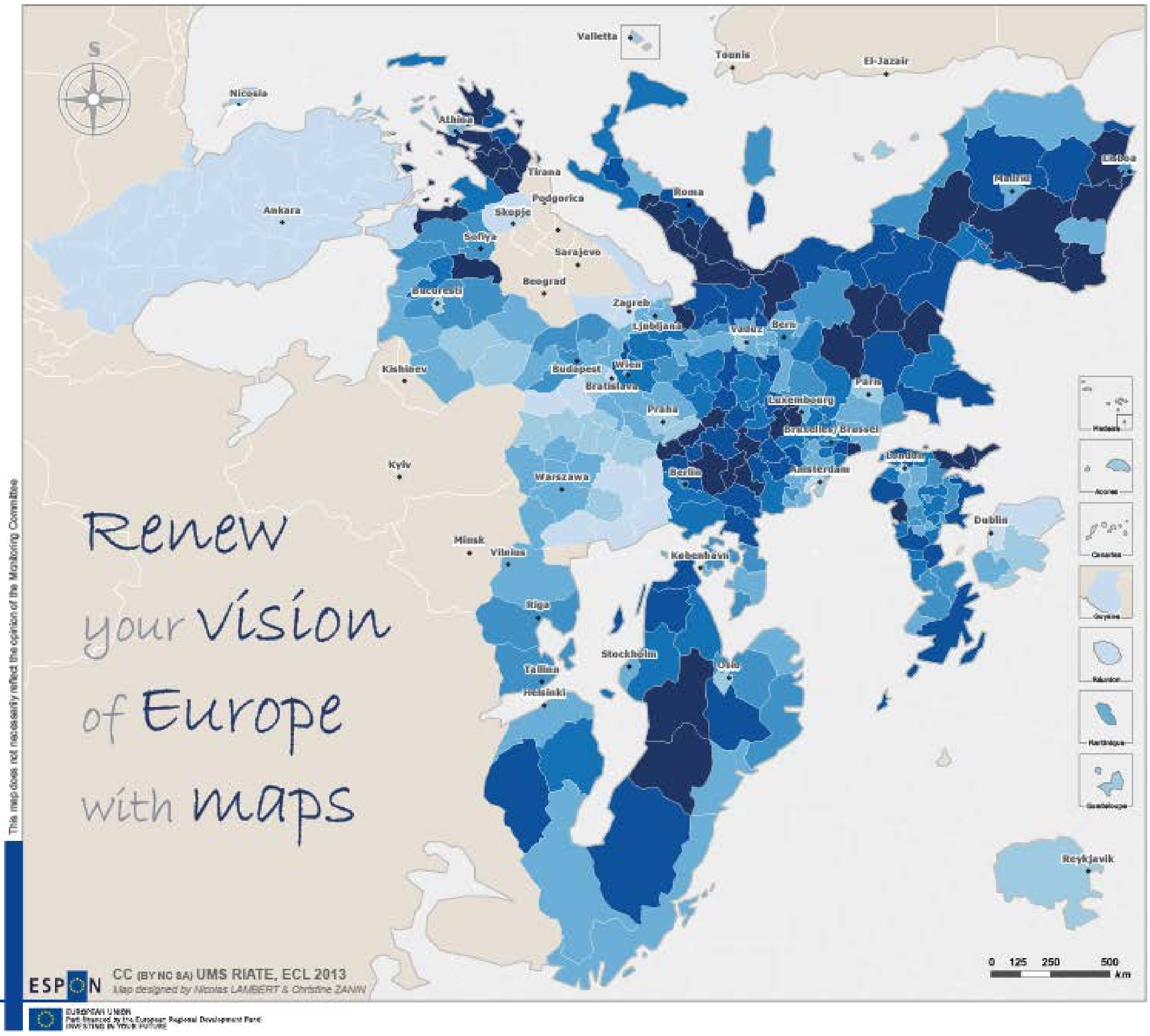

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"A drawing is worth a thousand words"
(Napoléon Bonaparte)

Different maps for different purposes

It is theoretically quite easy to look at a map, generally much more so than it is to read a text. But is it as easy to understand? Localising the place where you are standing, finding your bearings, seeing places on a paper map or a map on a mobile phone or a tablet are now everyday activities. These are maps for finding your way, but if we consider scientific cartography seeking to demonstrate or explain a spatial organisation, using a map no longer seem so operational or so easy.

Cartographic expression uses graphic language, and is the main vehicle for geographical knowledge. From flat images to animated 3D images, the map exhibits and explains the diversity of the world and highlights similarities, balances and imbalances. It is therefore rather ambitious to draft a new manual of cartographic rules intended to be "read". Does this mean that the designing of thematic maps and the way they are produced *still* requires explaining? Are they so difficult to comprehend? No, they are not. What is complicated is that we often expect them to be able to answer a question that was not asked, or was not asked in the right way, at the time it was designed. This is why, despite the technological revolution that enables virtually anyone to draw a map, it is more than necessary to restate the choices that need to be made for optimal delivery of the final message, be it political or humoristic.

There are many types of map. Whether it is a scientific object or a means of communication, or even a popularisation tool, a map is merely one possible representation of reality, and not the direct translation of that reality. Producing a map is to provide an intelligible image of the world. A map will differ according to the purpose, the viewpoint or the hypotheses that it is intended to convey, and it will differ above all according to the target audience, and the mode of reception chosen. A working map will not have the same trappings nor the same "staging" as a demonstrative or communication map. Here again we can differentiate, for instance, journalistic communication maps and maps used for purposes of political communication. It is possible to represent a phenomenon in as many ways as there are to ask a question on the subject in hand. A map will only express what we intend it to express, show, demonstrate, or explain. In fact, what makes maps different but effective is the fact that they are designed and therefore seen according to a point of view chosen by the designer or the person who asked for the map. Combinations are infinite, from the exploratory map to the communication map.

The cube presented in Figure 1 shows how we can position ourselves in the world of cartographic design. An exploratory map should enable us to discover spatial organisation and patterns of interaction. It can show information (Le Fur, 2007), it can seek to give life to statistics (Brunet, 1987), it can set out to have geographical data speak for itself, and render it meaningful. Shifting from this exploration to communication, even if it is only a minor objective, entails the need to organise the geographical information in visual manner. There is a cartographic language, and elementary graphic signs that enables this information to be converted into an image.

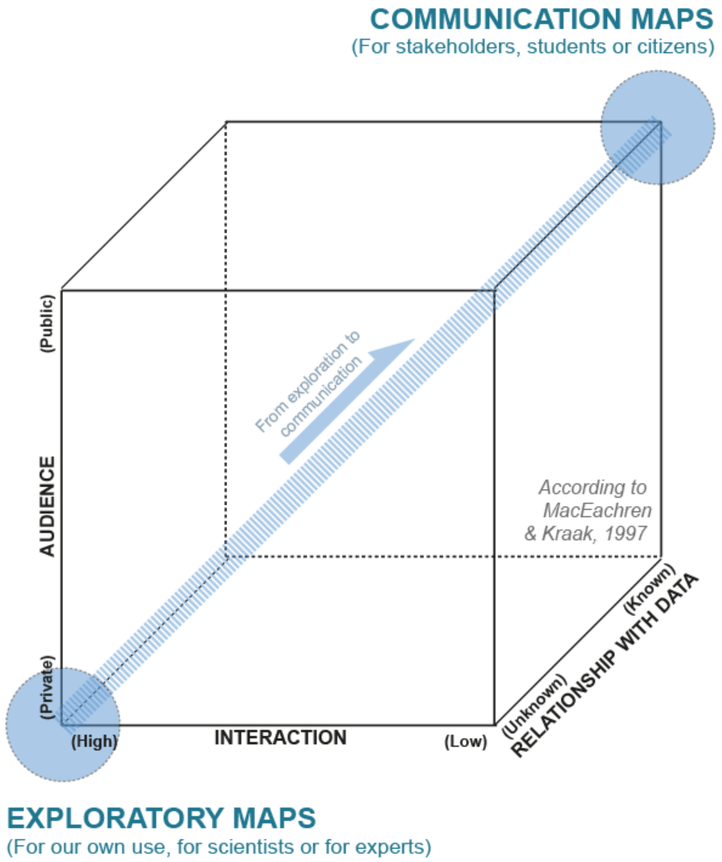


Figure 1: From exploratory to communication maps

From the question asked and confronted with the data to the actual delivery of a message, there are several phases and pathways: data processing, understanding the data, the emergence of hypotheses, conclusions, choice of a mode of representation, choice of one or several visual variables, consideration of the colours to use, choice of the graphic forms designed for the comprehension of the patterns of a spatial organisation, production of demonstration or decision-making tools.

The spirit of this guide

This guide sets out to present the choices open to designers for effective and attractive *cartographic* representations. Maps can deceive (Monmonier, 1993) or conversely come very close to reality. The message and its mode of representation need to be chosen. Thus to reproduce a complex reality in a three-dimensional world, the cartographer needs to be able to get the right balance by sorting, selection, hierarchisation, and modelling of the data to be represented or the message to deliver.

By carrying out this task of simplification, whether deliberately or unconsciously, the cartographer therefore always produces a graphic representation that is not a mirror image of reality, but an intellectual construction. In fact, a cartographer is a deceiver, lying at least by omission, and that is how it should be. It is his job to lie. If a map attempted to reproduce a spatial phenomenon in all its complexity on a flat surface, it would be a map with nothing to say. Information does indeed require simplification for it to be intelligible. This guide sets out to teach you how to "lie" in full awareness, and in a way that is graphically operational. It aims to present and explain "good practice" in the area of cartography. The basic rules are presented and analysed, showing how to move from data to the map in the most efficient manner in accordance with the audience and the objective

From data to map. The first part of this guide provides information on the general procedure in cartographic design: from data to map, what are the elements that require attention. What are the rules that always hold, and those allowing a certain leeway? How is the shift from the idea to its graphic transcription managed? Can all data be translated? What is the correct use of graphic semiology? What is the impact on understanding of a message of choosing a map using proportional symbols or a map using colours? Is the choice of colours important? How can the right balance be struck between the base map and the content?

Map "faces" of Europe. The second part of this guide seeks to provide more operational keys for the design and production of maps. It includes practical explanations on the different modes of cartographic representation. Detailed explanations are given on certain chosen topics.

The power of maps. The concluding section puts the issues involved in cartographic communication in perspective and reflects on the "power" of maps. Do we always need a map to back up discourse or demonstration? What message can we produce? What is the real power of maps? What are the possible pitfalls? What is the best way to stage communication using a map? What is the relative importance of standardisation and innovation?

Without claiming to be exhaustive, this guide thus attempts to confront a certain number of elements the purpose of which is to generate cartographic innovation for the ESPON 3 programme.

1

FROM DATA TO MAP

MAP «FACES» OF EUROPE

THE POWER OF MAPS

« Above all else, show the data »

(Tufte E., 1983)

Cartography is a serious scientific matter, and wars start and end for an incorrectly drawn border on a map. It is too serious a matter to be left to scientists alone. It has its place in the world of decision-makers and communicators, and this is particularly true because it is a very effective communication tool. Therefore it should be conceded that certain rules must be observed, or at least understood, so as to be fully aware of what is being expressed graphically, of the effectiveness of the message, and of the means available to achieve this. There are different stages, and decisions need to be made at each stage.

In cartography that is termed thematic (or statistical), from the exploratory map to the communication map mentioned in the introduction, two itineraries or design conceptions are generally distinguished (Figure 2).

Pathway 1 (in green) is governed by the data: its nature, its conversion, its processing, its graphic translation, and its arrangement on a spatial base. The stages are clearly identified: we have one or several pieces of geographical information ("spatialisable" data), we identify the nature of that information, we decide whether or not it requires processing (ranging from mere discretisation to classification), we identify the space represented (base map), we combine base map and data, we choose a graphic translation, (the graphic semiology which is itself determined by the target audience of the map), we obtain a cartographic image that we then "stage" by adding different elements (legend, title, contextualisation and scale, date, source, orientation) and determine a layout suiting the base-map used and the objective.

Pathway 2 (in blue) works in reverse order, entering directly via the mode of representation. We are acquainted with the message contained in the data, we know what we want to show and to whom, and we therefore choose a mode of representation directly, a type of map and a base-map to go with it. All we have to do then is adapt and position the elements one in relation to the other, paying attention to the staging of the message in relation to the base used.

Whichever pathway is chosen, in this first section we will use the three fundamental elements in map creation: the cartographic "**container**", or base-map, the graphic **content**, or how the geographical information is translated into a graphic representation, and finally the ordering of the ensemble or "**staging"** of these elements so as to produce an effective graphic communication.

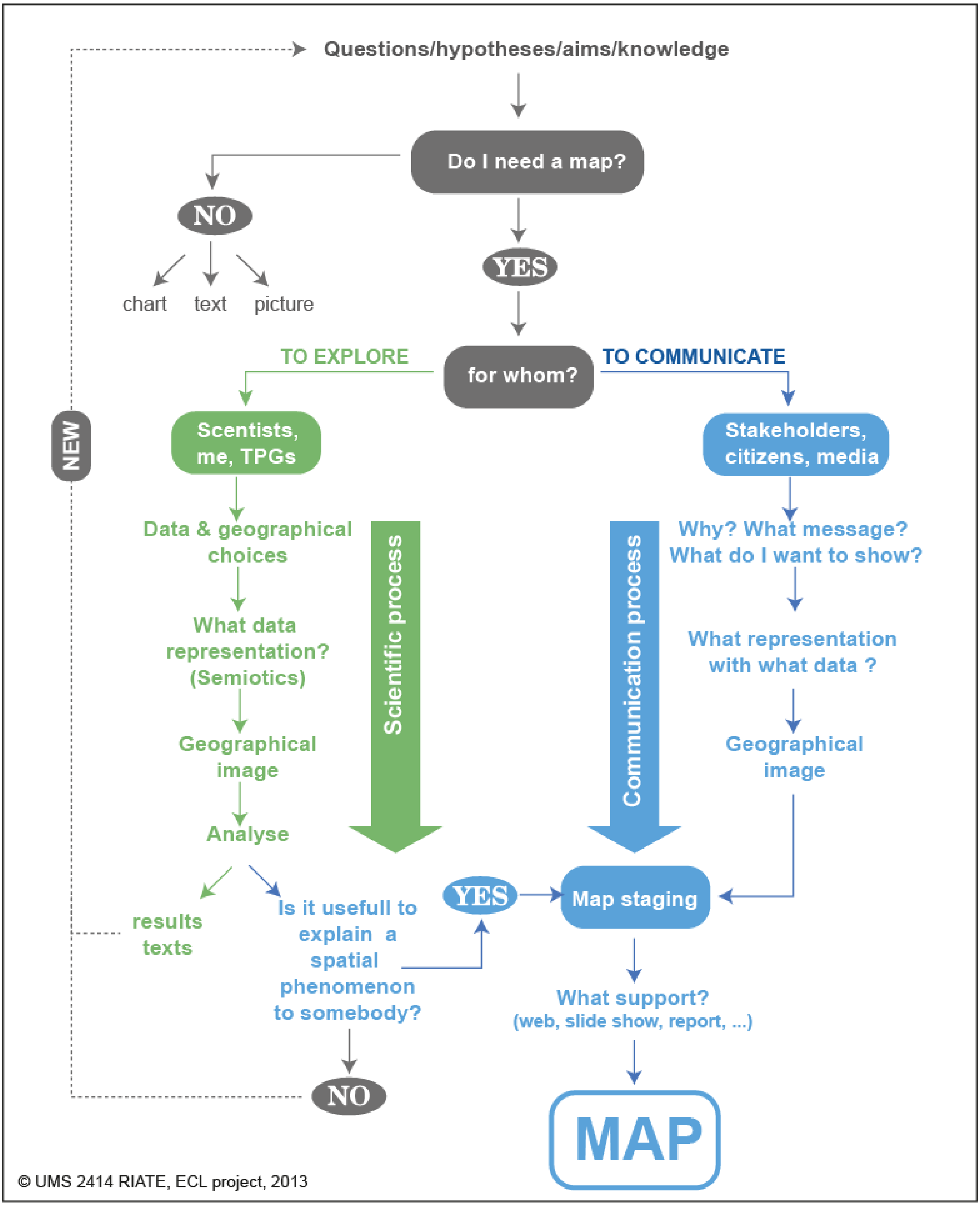


Figure 2: Pathways in the cartographic design process

The base map

Apart from providing a “container", a framework and a substrate for the geographical information, the base-map chosen is a meaningful element. The base-map provides information, and is also the vehicle for information. Plotting dividing lines or drawing borders has an impact, which is political, but also visual for the transmission of the message and hence its effectiveness. Choosing a system of territorial subdivision for the representation of information, and wondering if the subdivisions chosen are suited to the data and its representation, are the first questions that the map maker needs to ask, whether he is an amateur or experienced. Here are a few elements in the decisional process.

Generalisation

Any map is a reduced reproduction of a portion of space. It therefore requires a simplification in the lines traced. Indeed, the reduction in scale, combined with a minimum thickness for a line to be visible on the map, means that the cartographer must simplify contours, thus reducing the (probably unattainable) precision in favour of readability. The accuracy of the lines is certainly an essential element for a topographic map, but the same is not true for thematic maps which are our subject here. The base-map is merely treated as a base or substrate used to set out geographical information of a different nature. A map drawn with over-precise contours, far from adding accuracy, adds “noise” to the map that is counter-productive. "Generalization of a base map is necessary… to avoid the merging of features when they are reduced. Furthermore, it is most appropriate to generalize the base for a thematic map, because its purpose is to convey a distribution, not to serve as a reference for coastline and boundary details” (Cuff & Mattson, 1982).

Good practice in thematic cartography consists in simplifying the image so as to deliver the message more efficiently (Figure 3)

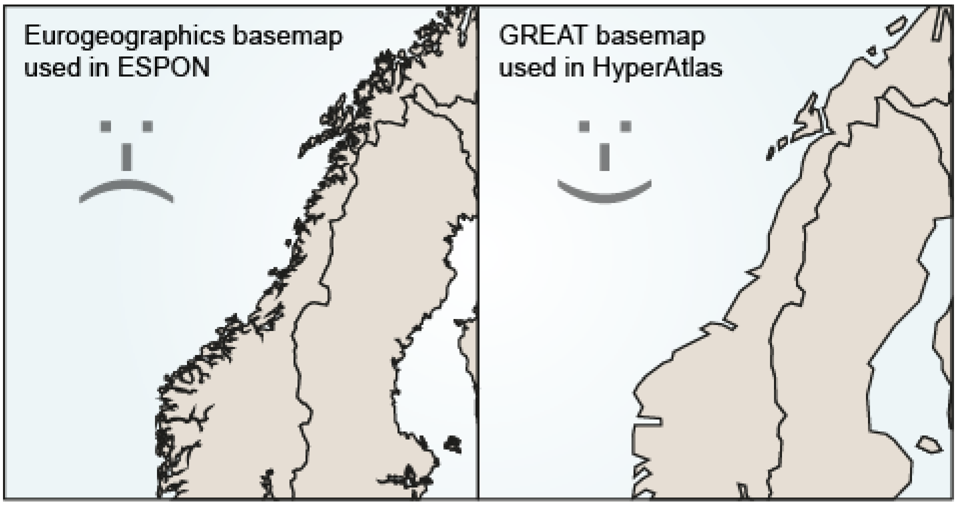


Figure 3: The base map, to generalize or not to generalize?

The process of cartographic generalisation, which is difficult to automate[1], can be broken down into three aspects: selection, diagramming and harmonisation

• Selection concerns the choice of graphic elements to include on the map. For instance it can involve deciding whether or not to include islands or enclaves the surface areas of which fall below a certain value.

• Diagramming is a geometrical operation to simplify lines (structural diagramming). It can also be conceptual diagramming when interpretive elements and manual choices are included.

• Harmonisation is the general homogenisation of the base-map so as to obtain a comparable level of generalisation at any point on the map.

Even if part of the generalisation process can be automated, (software such as ArcGis and PostGis offer an automatic generalisation function) to be adequately generalised a map needs to undergo a manual stage. This is a good thing. The base-map and its level of generalisation form one of the tools available to the cartographer to express his message effectively. Choosing the right level of generalisation is already a way of expressing part of the message.

Territorial divisions

From a geometric viewpoint, a grid is the strict subdivision of a geographical zone (without overlap or blur) into contiguous units. The shape and size of territorial subdivisions can be irregular. Here the elementary items are polygons, often of heterogeneous shape and surface area, fitting with each other like the pieces of a jig-saw puzzle[2]. But rather than a mere administrative subdivision, a system of subdivisions or a grid is also (and predominantly) an interpretation grid enabling a reality to be captured. It is template for understanding an analysis, based on a simplification and a generalisation of the information, and also a tool for the construction of knowledge. Grids are territorial "filters" (Figure 4) where each element provides new information for the understanding of a spatial phenomenon. The statistical, cartographic, and modelling results thus depend on the subdivisions used. The slightest change in size, shape or positioning of the units will have an impact on the results and on their visualisation.

[1] There is however on-going research worldwide for the automatic production of base-maps. On this issue, see the work in the International Cartographic Association (http://icaci.org/).
[2] John Spilsbury who invented the jig-saw puzzle was a geographer

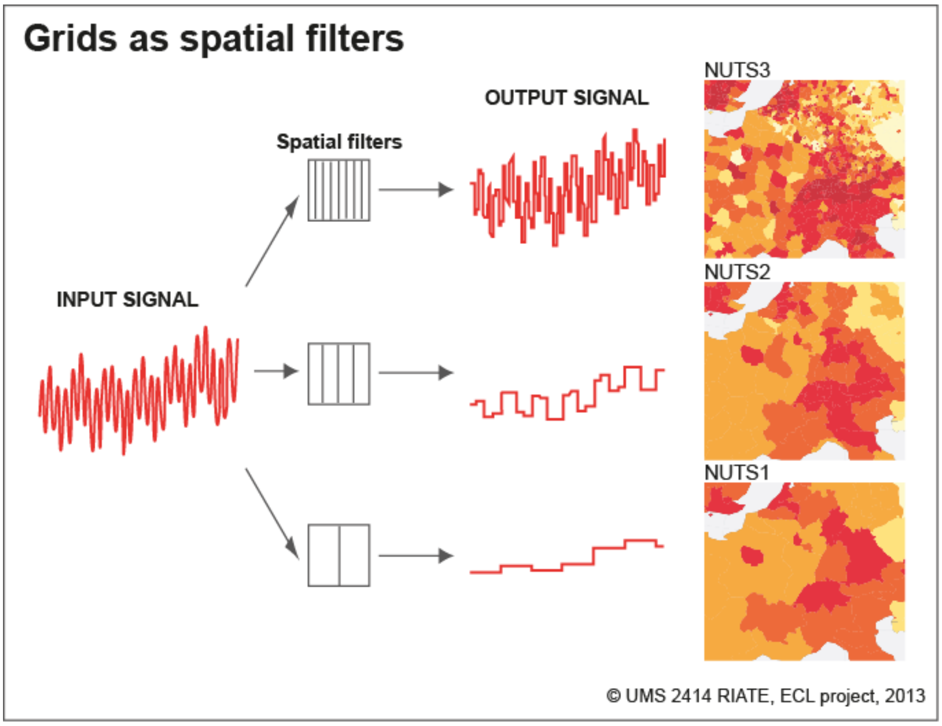


Figure 4: The grid is a filter enabling a spatial reading of geographical information.

The subdivisions therefore need to be as homogeneous as possible to enable relevant statistical analyses or a coherent cartographic representation. A heterogeneous subdivision made up of polygons of different shapes and surface areas, as is the case for instance in NUTS3, is a poor base. Any map produced on this base generates non-comparable spatial disparities on one and the same graphic representation (for instance a contrast between city and suburb on one part of the map and regional disparities in another part). In addition, correlations, statistical analyses or models based on a heterogeneous system of subdivision territory results that are always difficult to interpret.

However, territorial subdivisions are generally linked to established powers or the democratic management of space; they are in no way abstract filters. Thus the cartographer has the responsibility of the trade-off between the two constraints in territorial divisions: the social reality of the system and a need for maximum homogeneity.

Projection

To represent a spherical world in three dimensions on a sheet of paper or a screen, a system of cartographic projection is used. But this operation – a mathematical procedure aiming to match any point on the ellipsoid (which is a mathematical approximation of the surface of the Earth) with a point (x, y) on the plane used for the representation – cannot be achieved without a degree of distortion.

Thus cartographic projections can be classified according to the type of distortion that they generate:

• Conformal projections retain the angles, the meridians and the parallels intersect at right angles, but surface areas are altered the further they are away from the centre of the map.
• Equal-area projections preserve the relationships between surface areas, but shapes are markedly warped on the edges of the maps.

• Aphylactic projections retain neither the angles nor the proportionality of surface areas, but they are an attempt to compensate for these two sources of distortion via a compromise

Map projections can also be classified according to the way they are constructed:
• Azimuthal projections use a tangent plane at any point on the ellipsoid; here the positioning of the point of contact between the plane and the sphere (centre of the projection) will naturally have an effect on the image projected.
• Cylindrical projections are formed by projection of points on the sphere onto a cylinder that is tangent or secant. When the cylinder is opened out it forms a plane.
• Conical projections are constructed in similar manner by projection of points on the sphere onto a tangent or secant cone.

In the ESPON programme the map projection retained for the representation of Europe is the Lambert Azimuthal Equal Area projection. This is widely used in Europe. As its name indicates, the projection is azimuthal (constructed from a tangent plane) and equivalent (preserving ratios of surface areas). The centre of the projection is 50N 10E. The use of a common projection for Europe is a wise choice, since this facilitates interoperability between geographical objects (grids etc.).

The choice of a cartographic projection is also a means of expressing something. We can look at the example of the Gall-Peters projection.

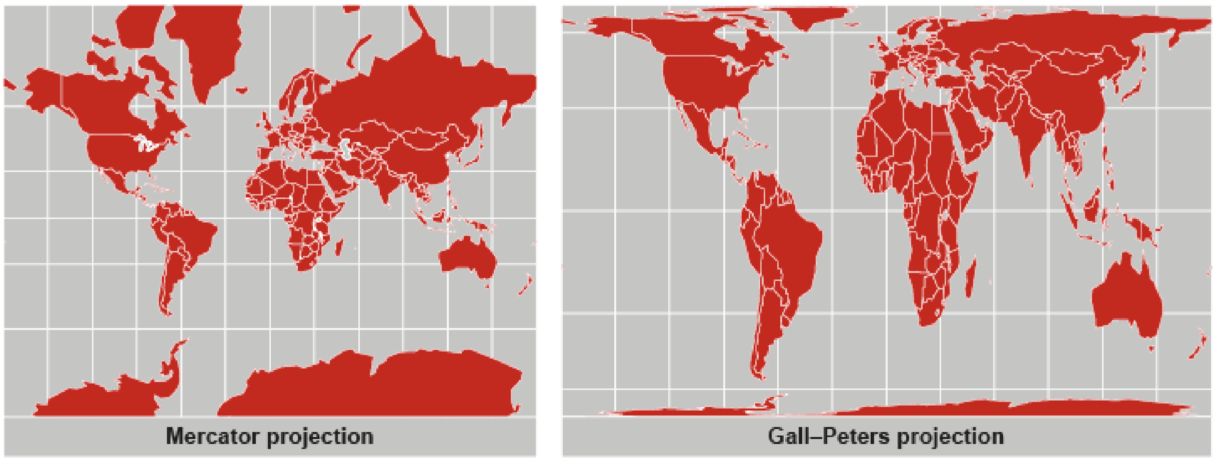


Figure 5: Mercator and Gall-Peters projections

The Gall-Peters projection was invented in 1973 by the German historian and cartographer Amo Peters. He was very critical of the Mercator projection, which has the disadvantage of over-representing the wealthy nations in the North, and the new cartographic representation he proposed raised considerable debate and controversy. Yet this projection has the advantage of preserving surface area proportions: the surface areas of the countries on the map are proportional to their actual surface areas (while this is not so for the Mercator projection). On this map, Africa and South America seem to be over-represented in relation to Europe or Greenland. However in reality, Africa is 5 times larger than Greenland (Figure 6). Europe appears minute, this being because it actually is very small: the European Union accounts for barely 3% of dry land on the planet overall.

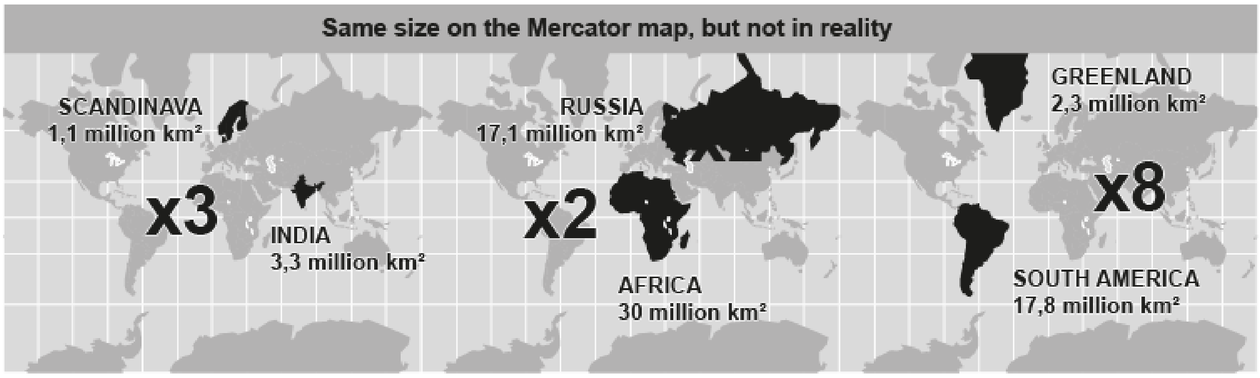


Figure 6: Surface areas and projections

The main asset of the Peters projection, a favourite with proponents of alternative globalisation, is that is gives greater importance to countries in the South compared to the more classic representations. In addition, it escapes the Euro-centric vision of the world that we are used to, where Europe is systematically in the centre of the map. Thus the choice of projection is indeed a means of cartographic expression, yet it is rarely used intentionally for this purpose.

From data to map

From data to the map the process is complex, but there are also numerous variants. A few precise rules need to be followed to avoid going astray.

Geographical data

"There are three kinds of lies: lies, damned lies and statistics" (Mark Twain)

One fundamental step in producing a map is the collection and selection of the data that it is useful to display in the form of a map. Today, with the development of computing technologies, geographical information has become available to the masses, and is easy to access and to use. It is very easy for a non-expert to gather data, transfer it to a map and integrate the map into a research report. It is enough to have reasonable command over the cartographic production chain.

The operation of selection, collection and conversion of geographical information is however far from trivial or insignificant. This stage implies choices that are often subjective. These choices mainly concern the relevance of sources and the conversion methods implemented (creation of indices, typologies etc.) which enable the complexity of the geographical information to be summed up in the form of a map delivering the desired message. Our task here, without aiming to be exhaustive, is to make the reader aware of the need for a reasoned approach to the data he or she is using and representing in graphic or cartographic form.

A number of geographical data is used because it is exhaustively available across the space and the theme targeted (for instance, it enables a straightforward question to be answered, such as "can you provide me with the latest trends in unemployment in the European regions?"). In this context it might appears that the methods used to collect and collate the data are of little importance. Yet it is essential to know how to handle the data in order to avoid any error in interpretation or any mistaken conclusion. This necessarily means that prior critical consideration needs to be given to the **intrinsic quality** of the data used (accuracy, credibility, objectivity), to the **setting** in which the data used was produced (survey, census, GIS process, estimates etc.), and to **comprehensibility** (complex indicators, typologies etc.). No-one wants to use and interpret data if its reliability and accuracy are not known, or if its finalities or even merely its organisation are not known.

The choice of the "right" visual variable, suited to the cartographic representation, entirely depends on the statistical nature of the data (qualitative, quantitative) and on the type of geographical object it is to describe (Figure 7). Generally, three types of geographical object are distinguished:
- a point is defined by precise coordinates (localisation of a place by X and Y).
- a line connects two points (a road, flows, between places)
- an area or zone is enclosed by several connected points (a territory).

Qualitative data

Qualitative properties are not measurable; they can be names, acronyms or codes. Qualitative attributes cannot be summed or averaged. There are two families of qualitative-type data:

- **ordinal qualitative characteristics**, which can be classified according to a logical order. This order can result from a given hierarchy (metropolitan regions, peri-urban or rural areas for instance) or from a classification. Their cartographic representation should reflect this notion of ordering and hierarchy. Here visual variables associating colour and colour value or texturing will be preferred to represent differences between the various indicators. For point locations (cities or towns for instance) or lines (roads) it is also possible to use size to differentiate and order the geographical objects.

- **nominal qualitative characteristics** cannot be ordered (official language of European countries for instance). The cartographic representation should in this case give precedence to a differentiation between the various elements making up this type of indicator. Thus the visual variables suited to this type of phenomenon are shape (for point or line locations) or colour differentiation. Texturing can also be considered (for zone locations).

Quantitative data

Data of quantitative nature is always numerical. By definition data of this type is ordered, and averages have meaning. Here too two families of quantitative data can be distinguished:

- **quantitative characteristics** expressed as "**count data**" – these are concrete quantities and their sum has a meaning (for instance numbers of unemployed, total population). The representation of this type of data should take account of the mode of expression of these quantities, and differences in proportionality among the different resulting elements. The visual variable suited to this type of data is size. For zone locations point densities can be used (where one point corresponds to a given number of inhabitants).

- **quantitative characteristics** expressed as "**ratio data**" describe a relationship or ratio between two quantities, but their sum has no meaning. By extension, it is possible to associate composite numerical indices with them. This is the type of indicator most often used in ESPON. The cartographic representation should be suited to the ordered progression of the values, from the lowest to the highest. Thus an association of values with colours is the preferred option, whatever the type of localisation. For zone locations, it is also possible to use texturing.

Data types in the ESPON database

To help to identify and understand the types of data used in the ESPON database, a specific field "NAT Type" has been created in the "indices" section of the metadata. It enables the description of the type of statistic in the data included in the database, and facilitates the choice of the mode of representation to suit each type of indicator. Further applications (web mapping tools for instance) also facilitate choice.

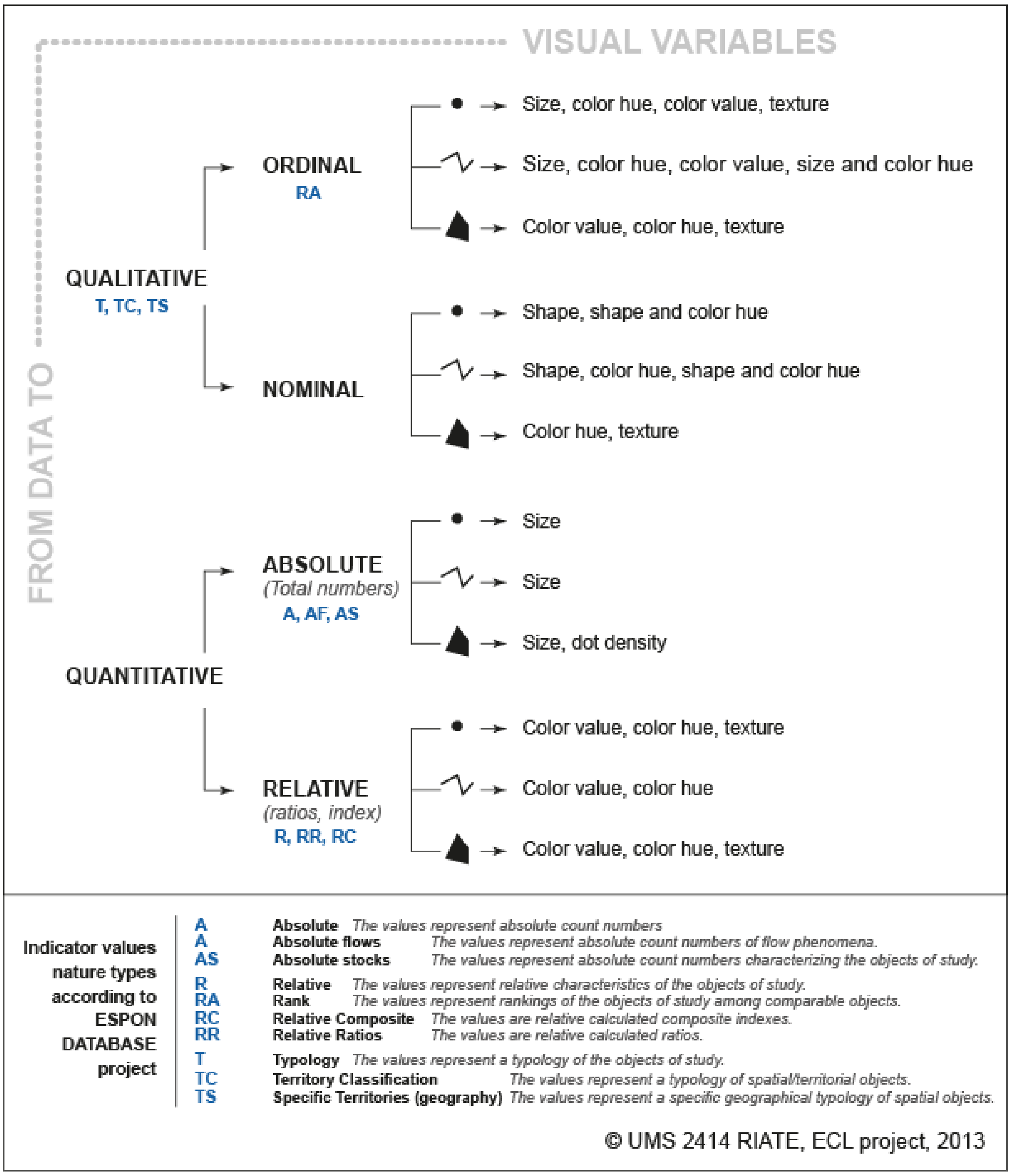


Figure 7: Nature of the data and visual variables

Discretisation

"Discretisation is an operation that makes it possible to divide series of qualitative or quantitative data into classes. This operation simplifies information by grouping the geographical objects that present the same characteristics into distinct classes" (Zanin, Trémélo, 2002)

This data reduction process is required to render the geographical information intelligible. Numerous discretisation methods can be used. The choice depends on both the properties of the statistical series (magnitude[3], dispersion[4], shape[5]) and those of the desired cartographic message (single map, comparative maps, audience). The four most commonly used methods are presented here.

- The **natural break method** consists in choosing the natural divisions in the statistical distribution as the class boundaries
- The **equal range method** consists in dividing the statistical series into classes of equal statistical range. To do this the whole statistical series (from minimum to maximum values) can be divided by the number of classes required. It is also possible to use the mean and standard deviation of the statistical series to define the class boundaries.
- The **equal frequency data method**, also known as the *quantiles* method, is based on the division of the total number in the distribution by the number of classes required. The number per class is thus obtained. The class boundaries are then determined by counting the geographical objects in the ordered series.
- The **geometric progression method** consists in multiplying the minimum value in the statistical distribution by the common ratio *r*[6] as many time *k* as there are classes to form to reach the maximum value in the series.

Whatever the method used, several elements need to be taken into account for effective mapping of the statistical series:

• The optimum number of classes depends on the number of geographical objects to be represented. As an indication, the Huntsberger index enables the determination of the ideal number of classes for a distribution. It is defined as follows:

N(cl) = 1 + 3,3 log10(N)

where N = number of observations and N(cl) = number of classes.

• It is important to remember that discretisation leads to a simplification – and thus a reduction – of the heterogeneity of a statistical series

• The minimum and maximum values in a statistical series should always be referenced in the map legend (always avoid noting "more than" and "less than" in the legend)

• The figures in the legend should be rounded off (1000 rather than 996) so that the reader can more efficiently memorise the anchors of the statistical series.

[3] measured via the central values of the statistical distribution: mode, mean, median
[4] measured via the standard deviation, the interquartile interval or the variation coefficient
[5] normal, symmetrical or dissymmetrical distribution
[6] $\text{Log } r = (\log(max)-\log(min))/k$ or $r=10^{\log r}$

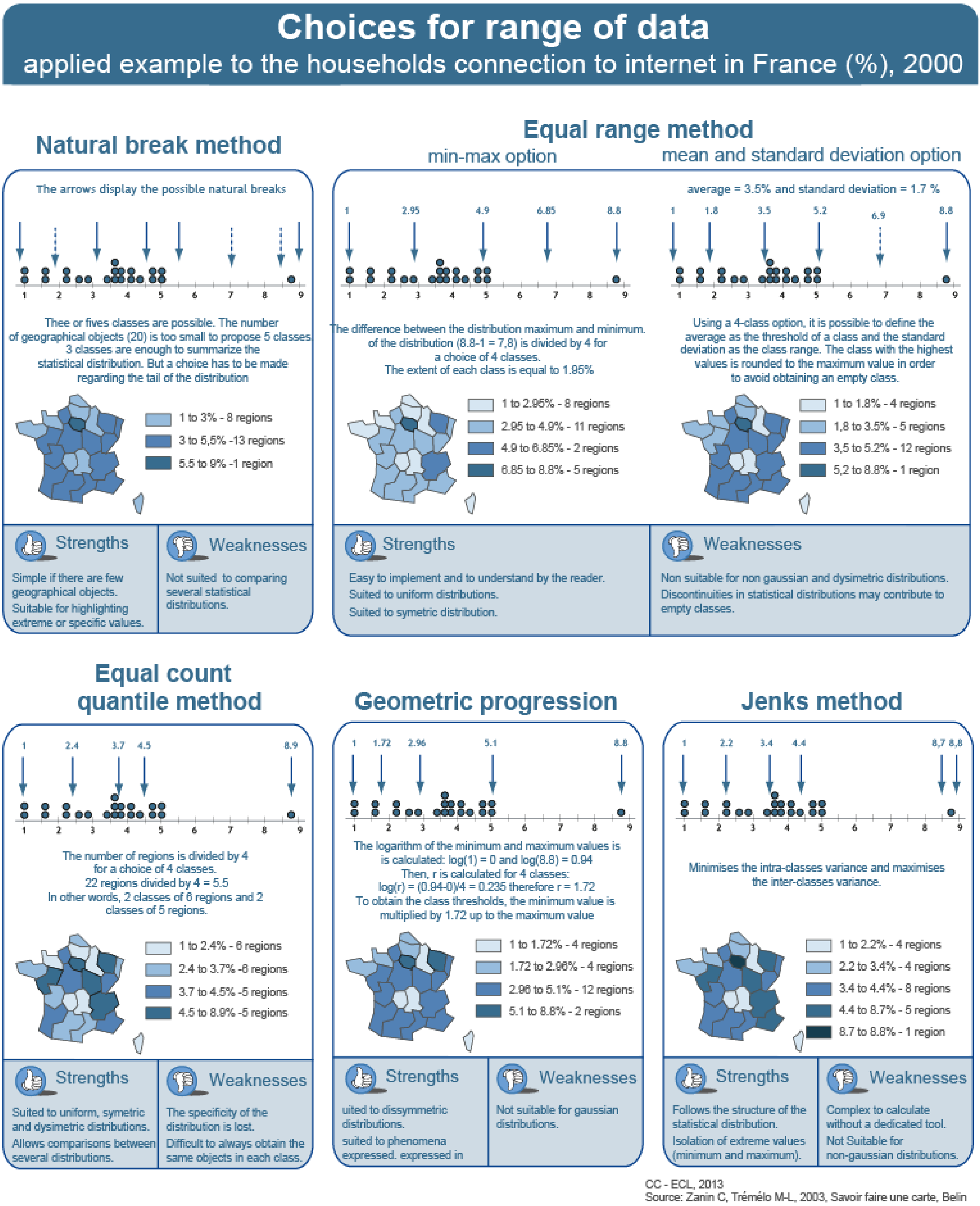


Figure 8: Choices for range of data example applied to connections to the internet among households in France

The graphic language

If geographical information is to be effectively delivered in visual form, certain fairly strict rules need to be applied, and the graphic signs need to be suited to the type of data represented and to the geographical object concerned. These rules enabling the transcription of geographical information in the form of graphic signs are what is known as the **graphic semiology**. When applied to elementary spatial objects (points, lines, polygons), these graphic signs form the cartographic "language". Thus, in the same way as a text can be described in terms of the words it uses, the syntax and the grammar, a map can be described by way of its cartographic language, which is made up of visual variables and rules of graphic perception that make up its "syntax" and "grammar" (Zanin & Trémélo, 2003). This language is purely visual. The following sections detail the elements.

Shape

The visual variable *shape* concerns the process consisting in varying the geometric contours of a graphic representation. It is a solely differential variable and enables the translation of qualitative information. In point localisation it enables the production of inventory maps, and it is widely used for topographical maps. In linear localisations it enables the characterisation of a line or course (road, river), and the differentiation of networks of differing nature. In zone localisation, the shape variable involves differential texturing.

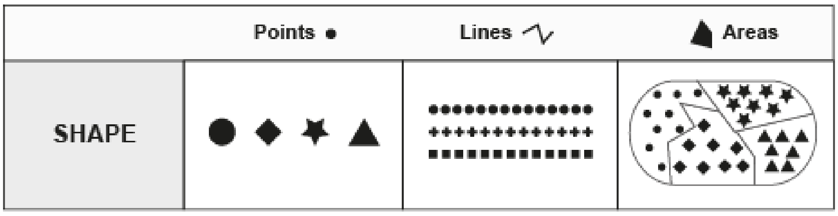


Figure 9: The visual variable shape according to three types of geographical object

Size

The visual variable size is used in the process whereby the surface area, the length, the height or the volume of a graphic figure is made to vary. This variable enables the representation of proportional relationships and it is the only visual variable that enables quantities to be transcribed directly. In point localisations, the figure most commonly used is the circle, and this enables the design of proportional circle maps (see p.33 and p.55). Bars can also be effective, but to be clear it may require the base map to be put in perspective (see p. 57). In linear localisations, size (in this case taking the form of the thickness of the line) enables flow maps (see p.59) or discontinuity maps (see p.49). Finally for zone localisations, the use of the size variable consists in distorting the base map so as to adapt the surface area of each territorial unit to the quantitative variable under study. This is known as cartograms (see p45).

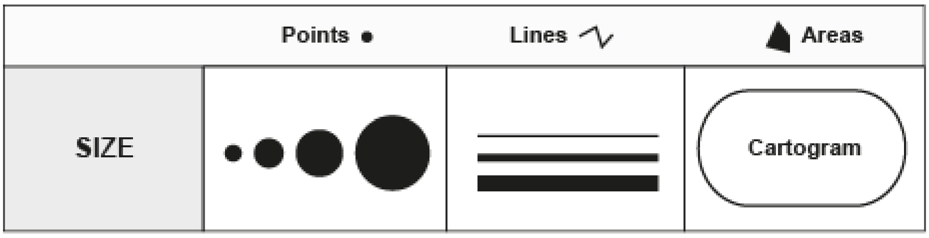


Figure 10: The visual variable size according to the three types of geographical object

Colour (hue)

The visual variable *colour* is widely used in cartography, for two reasons. The first is that it enables easy differentiation of objects one from another. The second reason is that good harmony in the colours used makes the map attractive and aesthetic. However we need to know how to choose colours wisely. In point, line or zone localisations colour enables differential qualitative relationships to be represented, and it also enables typologies. It is important not to introduce an order among the different types represented, and the intensity of the colour (see below) should be the same for all the colours used. Conversely, the intensity of the colour can be combined with the hue to suggest proximities between certain classes (see the HyperAtlas typology).

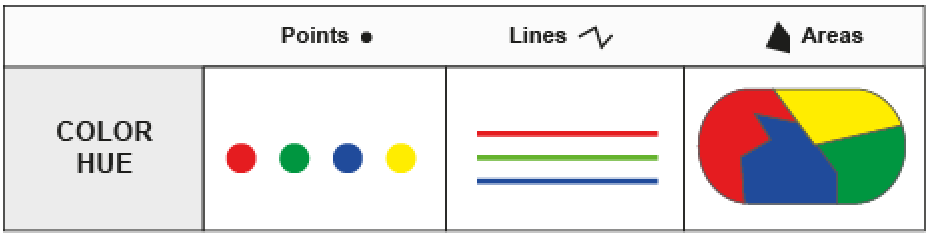


Figure 11: The visual variable colour (hue) according to the three types of geographical object

Colour (value)

The visual variable colour intensity or value is the relationship between the total quantities of black and white perceived over a given surface area. This procedure is also applicable to a colour that is gradually darkened by addition of black (colour intensity). As the human eye is able to rapidly classify light and dark elements in an image, this visual variable enables an order or a spatial structure to be represented. It is therefore applied to ordinal qualitative or relative quantitative data. When used in zone localisations, this visual variable produces what are known as choropleth maps (see p.37). However caution is required because the number of shades that are distinguishable to the eye is limited. Thus to convert a series of statistical data into a visual representation in classes, only a small number of colours should be used. This process is known as discretisation (see inset)

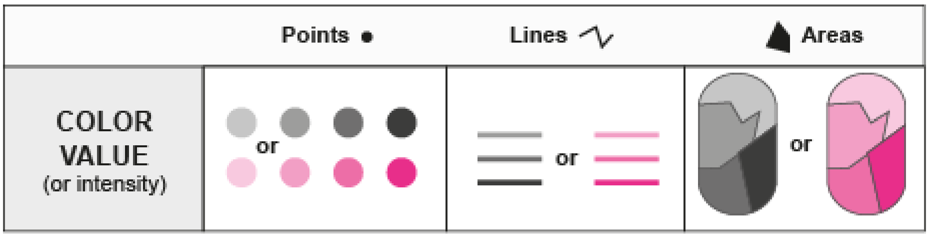


Figure 12: The visual variable colour (value) according to the three types of geographical object

Texturing and structuring

The visual variable *texturing/structuring* involves the combination of graphic elements to "construct" a surface area. It translates differential, equivalence or ranking relationships (quantitative and/or qualitative). It is not very effective for point or line localisations, and is above all used for zone localisations.

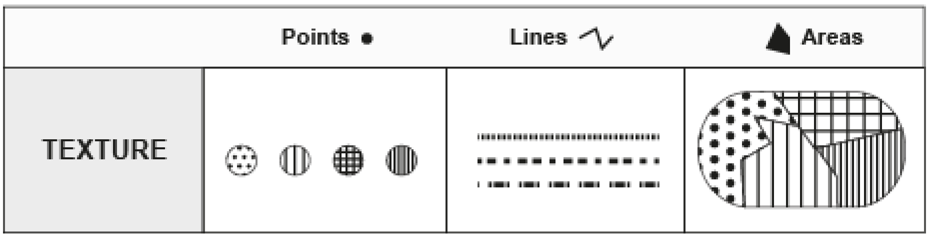


Figure 13: The visual variable texture/structure according to the three types of geographical object

Orientation

The visual variable *orientation* is a procedure consisting in varying the angle of a graphic element in relation to the vertical. This enables a graphic representation of qualitative differences. This visual variable is not very effective and is mainly used for zone localisations.

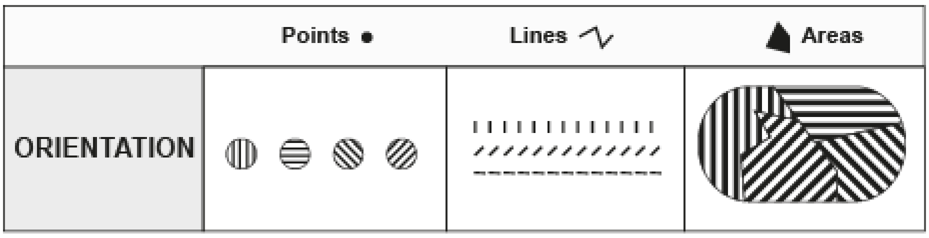


Figure 14: The visual variable orientation according to the three types of geographical object

The effectiveness of a map

The different visual variables presented above can be combined to simultaneously represent several types of information (for instance a count + ratio data map). As shown in the first part of this project[7], 21% of the maps produced in the ESPON programme use combinations of at least two visual variables, the preferred association being size and colour. Combining visual variables can indeed be a good way to incorporate complex information into a map.

Nevertheless it is clear that a map that superimposes numerous different layers of data would in fact be unlikely to deliver a clear message that is comprehensible in less than 10 seconds. This applies even more to maps that are to be "read", where the aim is not to provide an immediate visual message. Maps that need to be read or deciphered enable precise information to be delivered on a place, or comparisons between places, but they do not readily display a global spatial structure. In other words, the information is not perceived visually, but has to be deciphered point by point (Le Fur, 2007).

When faced with complex information, there are several options. First of all there is the option of dividing a complex map into two simpler maps. Positioning one map beside another then enables the reader to understand the phenomenon overall and the relationship between the two phenomena represented on the two maps. It can also sometimes be effective to combine a map and a non-cartographic geographical element (histogram, graph, and diagram). And finally the simplification of complex data does not involve solely the use of effective graphic elements on the map. It can be performed upstream of this stage via statistical processing and classification procedures involving one or several variables. This operation is highly recommended, but falls outside the scope of this manual, which is mainly focused on graphic representation aspects.

In all events, to be effective a map needs to be clear and well-organised, so that the message is understood readily and without risk of misinterpretation. This is the whole aim of the "staging" process in map production. There is one basic rule: the message has priority. It is thus the message that is made prominent, rather than the accompanying elements of the graphic configuration. The scale for instance is less important than the title, and therefore should be less prominent; its presence should be discreet so as not to hamper the interpretation of the phenomenon represented. Layout and "staging" contribute to this.

"Staging" the map

When a map is published in a book or a report, or presented on slides at a conference, the layout has to be planned and designed. The layout enables the cartographer to hierarchize the various elements that will turn the cartographic image into a map. Each particular layout is a sort of "staging" (in the theatrical sense) of the information, since each cartographer can choose to emphasise one or other element, so as to foster the perception of this or that spatial organisation. This staging procedure,

[7] ECL project Interim Report, May 2013

amounting to moving from the initial cartographic image to the geographical map, is one of the key elements in map development, since it is what makes the map intelligible.

The different elements to make maps appealing

There are several essential elements in a cartographic image.

The **title**, most often positioned at the top, is an important point of entry for the cartographic document. It should be written in sufficiently legible script (but there is no need for underlining, which belongs to written text). It should catch the eye quickly and deliver its message. The title of the map is not intended to describe the indicator represented; it should express the message to be delivered by the map, and should therefore be clear and brief.

The **legend**, which should preferably be positioned inside the map rather than besides or below it, is the element that enables the map to be understood in detail. It describes all the visual elements used for representation on the map. Titles of legends can therefore be quite long and technical, and need to be precise. To facilitate reading and comprehension, it must be organised and hierarchized.

The **data source** is another essential element. It should be noted as accurately as possible. It enables precise identification of the data used to develop the map, and means that another person could reproduce the map, possibly altering a few parameters, so that scientific exchange is rendered possible. Nevertheless, as the source is a technical component that does not contribute to the cartographic message, it needs to be presented unobtrusively, generally in small characters and never in bold.

On a theme map, there are three different **dates**, each of which should be present: the date when the map was created (e.g. 2013), the date of the indicator represented (e.g. total population, 2010) and the date of the source (e.g. Eurostat, 2012). Depending on the type of data used, the date can be more or less precise (e.g. on January 1st 2012).

Finally, to provide information on the relationship between surface area on the map and surface area in reality, the **scale** is also essential. It should be unobtrusive, and as far as possible should be in graphic form. A numerical scale (e.g. 1:200 000) would be incorrect if the document is reduced or enlarged, so this type of indication should be avoided. Finally, while the scale is essential in most instances, it sometimes has no meaning if distances at two points on the map are not at all comparable (e.g. polar projection, cartogram).

Other elements can also be used in the layout of the map, but they are optional: orientation (indication of the north), place-names, an inset showing a zoom-in or zoom-out, an inset providing technical data on the design and production of the map, or an outline frame for the map.

Layout or "staging" of the map

Beyond the mere inclusion of the above elements on the map, the "staging" of the map is the real means to make the map into a genuinely informative tool, the main aim of which is to deliver a message that is clear and intelligible. Unfortunately, all too often this step is performed in semi-automatic manner by using predefined layouts (mapkits) or standard colour palettes on offer in cartographic software or GIS. Thus in ESPON, whatever the themes broached, capital cities must be represented even if they have nothing to do with the subject considered (for instance, an environmental map showing drainage basins). The layout or staging is then "neutral", and implemented whatever the content of the map. This is damaging for the effective representation of the phenomenon considered. It is therefore preferable to perform the layout step with the aim of making the message more explicit, which is why we refer to "staging" rather than mere "layout".

Staging the map is an operation that is largely manual, and is performed using graphics software. The aim is to organise the different elements making up the map, and to add elements that help interpretation, so that the map's main message is apprehended in under 10 seconds. This involves naming the important places, and the drafting an explicit, relevant title that does not only describe the indicator represented, but also give keys to interpretation, to guide the reader as soon as possible towards what is important. This operation will differ according to the target audience (stakeholders, citizens, scientists, students etc.) and also according to the type of medium used, so as to enhance readability and effectiveness. To transfer from a paper medium to the screen, for instance for a PowerPoint projection, the organisation of the map needs to be reappraised.

In conclusion, to "stage" a map correctly, the desired interpretation of the phenomenon represented should be visible to the reader. The map is exhibited because it has something to say. The visual effectiveness of a map depends on attention to its clarity and its aesthetics - a map that is pleasant to look at is of course more attractive. To achieve this, the cartographer should take particular care in the choice of colours (see inset n°1 and part 3 p73).

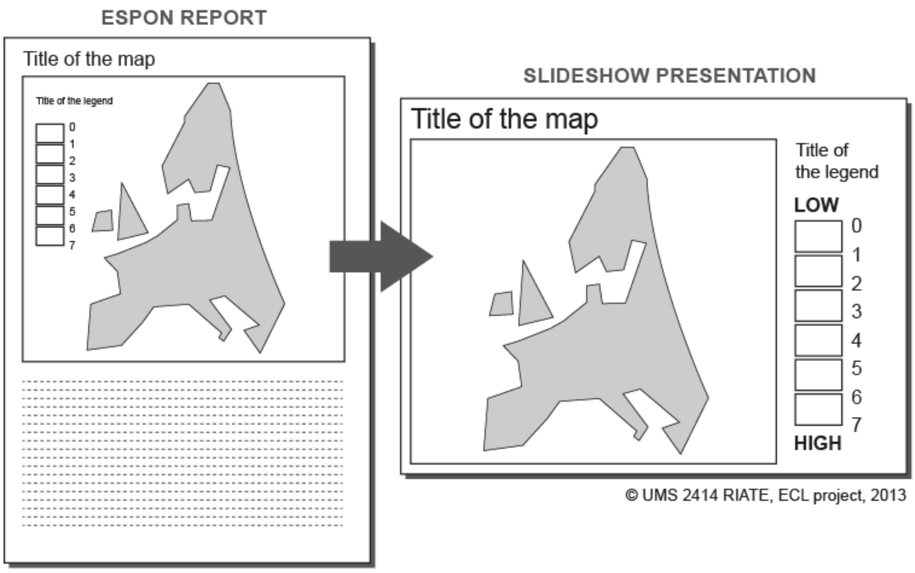


Figure 15: from ESPON report to a slideshow presentation: a different "staging" of the map

Inset 1: Colours

"When I have no blue, I use red" (Pablo Picasso)

The power of colours. In cartography colour is a major variable, immediately and intensely perceived, so that it has strong differentiation potential. Use of colour is widely appreciated, by both readers and cartographers. It enables a wide range of visual variations and enhances the aesthetic aspects. However, in visual communication, the use of colour is complex, and it cartography it is a very delicate matter. Colour possesses intrinsic properties, each colour corresponding to a specific wavelength. But colour also has psychological connotations that may be very strong and pervasive. Thus giving meaning to colours and using them appropriately is a relatively subtle task. Indeed, while there are objective criteria – for instance "warm" colours have longer wavelengths than "cold" colours – every human being learns to interpret colours during childhood. Thus for a Westerner, warm colours suggest sometimes heat, sometimes danger, while cold colours tend to suggest serenity and icy open spaces. A given colour will always call up contrasting notions. Perceptions can be individual, and each individual deciphers colours according to a system of reference connecting to memories or sensations that have been constructed over time.

Red and blue. Two or three generations of schoolchildren remember the cartographic colours of the Cold War: red for the baddies and blue for the goodies (Rekacewicz, 2006). Even today, blue is the colour of calm and serenity, it is consensual; it is the colour of Europeans and the Western world, whatever the social or professional environment. Blue is not a striking colour. Red is "fire, blood, love and hell" (Itten, 1961), it is a proud colour of ambition, it is insolent, violence, crime and sin are associated with it. Red draws the eye; it is the colour that stands out most in the natural world. With regard to Europe, red and blue are also the colours of the parties making up the Parliament. Thus these colours have meaning. Deciding to systematically use a given colour to express a phenomenon in positive manner and another colour to express the same phenomenon in negative manner is liable to upset a wide portion of the users.

Giving meaning to maps. The use of colour is an effective way to make maps even more meaningful, but we still need to know who is the target audience. It is all too easy to use a colour that will have a counter-productive effect. This is particularly true for maps developed in a supra-national context, as is the case in the ESPON programme. For instance, green does not have the same meaning in France (nature conservation), in North Africa (Islam) and in Ireland (national colour). The use of this colour in the European setting will therefore be perceived differently according to the nationality, cultural origin or religion of the reader.

Finally, used with discernment, colours contribute to giving meaning to maps, but we need to be aware of clichés. Are we certain that we should show boys in blue and girls in pink on geography maps? Nothing is less obvious*.

(*) Cf. The Pink & Blue Project (2005): http://www.jeongmeeyoon.com/aw_pinkblue.htm

FROM DATA
TO MAP

2

MAP «FACES» OF EUROPE

THE POWER OF MAPS

"Everything is related to everything else, but closer things are more closely related."
(Waldo Tobler)

"A map brings statistics to life"
(Brunet R., 1987)

Disclaimer

"Maps for the different faces of Europe" is the practical section in the ESPON cartographic language guide. Its purpose is to present a set of proven, effective methods for the production of maps. Different modes of cartographic presentation are proposed.

The figures are systematically set out across two pages. To make the presentation more instructive, a single layout has been used:
• a methodological explanation of the mode of representation
• the design and construction (the mapping process) of the particular mode of cartographic representation (explanations on the order of procedure and the organisation of the map development, with details on the types of tools to use
• a word about about the data (what data to use, and the data used in the example given)
• an example of a map and a particular layout
• advantages and drawbacks of the particular mode of representation
• the names of the tools used, and bibliographic references of interest for the cartographic technique used.

The examples of maps set out hereafter are based on elements discussed in the first part of this guide. They provide an opportunity to apply the rules set out. The generalised base-map GREAT and the NUTS 2/3 territorial level are used.

Since we have chosen to give prominence to reflection on cartographic innovation, certain cartographic elements that ESPON has been in the habit of using are not present here. For instance the visual identification, as defined in MapKit 2007, has not been used. The blue outlines of the ESPON maps, a sort of straightjacket defining the boundaries between what is "of interest" and what is not, have been removed. The aim was above all to escape from the over-normative aspects in the mapping process, clearly identified as a hindrance to creation[8]. Certain graphic elements recalling the visual identity of ESPON have nevertheless been retained, following reflection conducted in relation to the drafting of the ESPON Atlas[9].

Hence this second part in no way sets out to redefine the corporate identity of the ESPON programme, nor to offer suggestions for its evolution. Nor is it a *mapkit* defining different rules for layout, or defining semiological options. It is a practical guide explaining, in concrete and pragmatic manner, the choices open to researchers wanting to communicate their results by way of maps. The maps have been "staged" in as relevant a manner as possible, both scientifically and for their ability to communicate. These choices however belong solely to the authors. Nor is this a user manual for the cartographic software available.

[8] On this subject, see the results of the analysis of the cartographic corpus in the ESPON 2007-2013 programme (ECL Interim Report, May 2013).
[9] BBSR, S&W and VATI, 2013

Graduated symbol maps

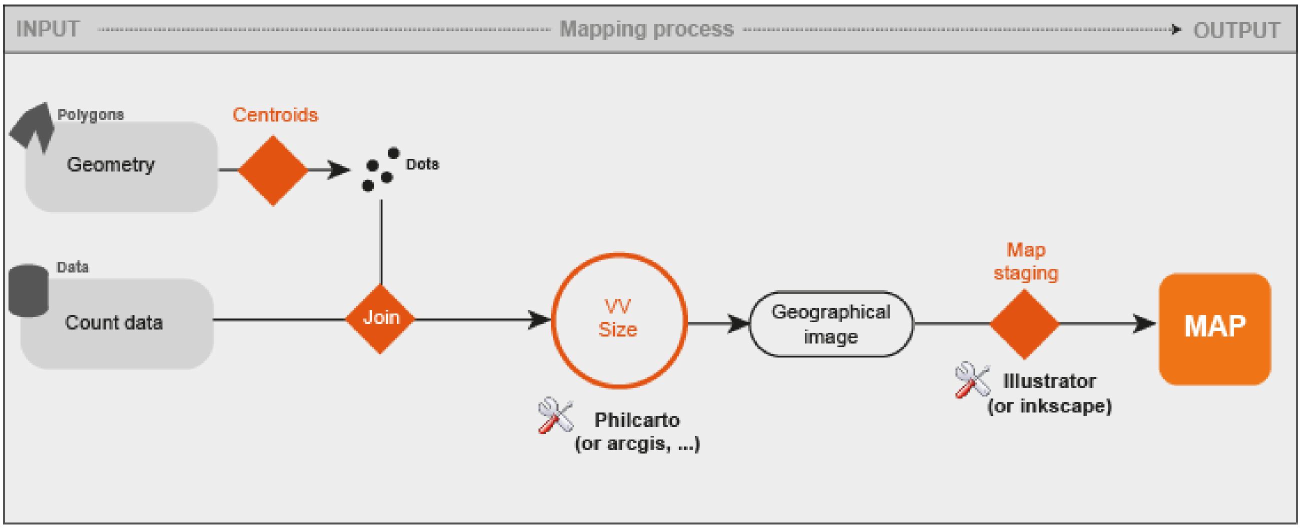
Representing stock data and giving weight to place

Explanation

Graduated symbol maps enable the representation of count data. This data is raw or absolute quantitative data. A piece of data is "quantitative" if its terms are expressed in numbers, and if the mean of these numbers has meaning (for instance populations are count data, because the sum of several populations has meaning). The cartographic representation of count data obeys very strict graphic semiology rules. Whatever the localisation (point, line, zone) the graphic variable used should translate the raw quantities in visual form and preserve variations in distance between elements in the data. Thus the only possible visual variable is size. Size involves variation in surface area, length, height or volume of a figurative element. It is the only graphic means to obtain a proportional relationship reflecting the weight of the element represented, and thus translate numerical quantities directly.

The difficulty when designing maps of this sort resides in the choice of proportional relationship between symbols. What should be the maximum or minimum size? How far is it possible to superimpose circles? What is the best way to outline circles to enhance readability? Part of the answer lies in the purpose of the map: if the aim is to associate a measure with each symbol, they need to be distinguishable, and thus the choice will be to only represent some of them. If the aim is a general view of the relative weight of places, the circles can be superimposed.

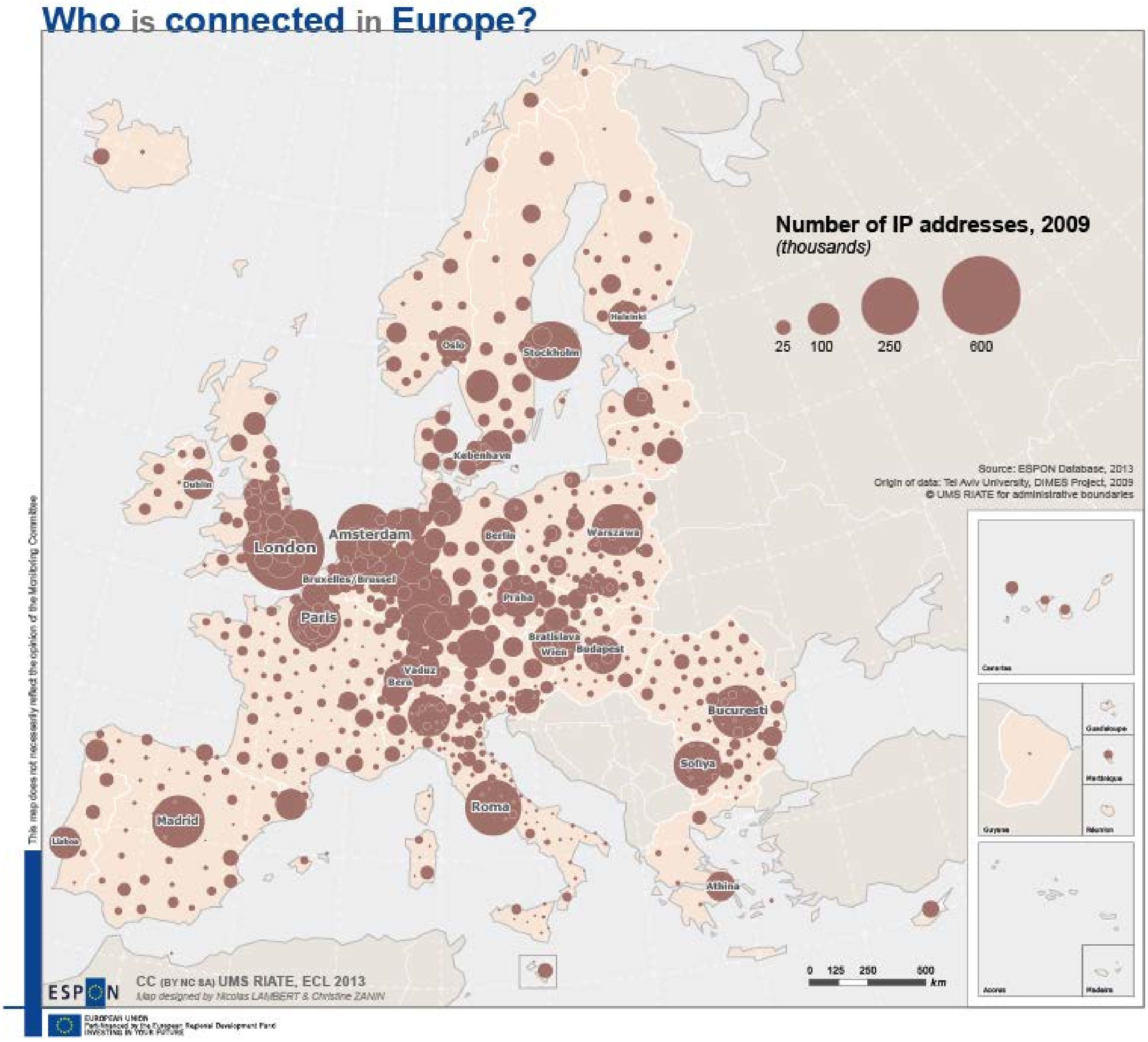
Mapping process



Appropriate Data : quantitative count data (absolute), totals

Data type

Map data : Number of IP addresses, 2009



This map highlights places of population concentration in Europe. Capital cities predominate, but places of demographic or economic power also stand out, and this contributes to discussion on territorial imbalances in the European Union.

Strengths	Weaknesses
Quantitative differences are easy to read	**Circles may be superimposed**
Quantities are clearly shown	**Displacement of circles leads to errors in localisation**
The information is hierarchized	**Administrative regions are difficult to identify**

Software: ArcGis, QGis, Philcarto, Illustrator, Inkscape
To go further: https://www.e-education.psu.edu/geog486/l5_p5.html#graduated

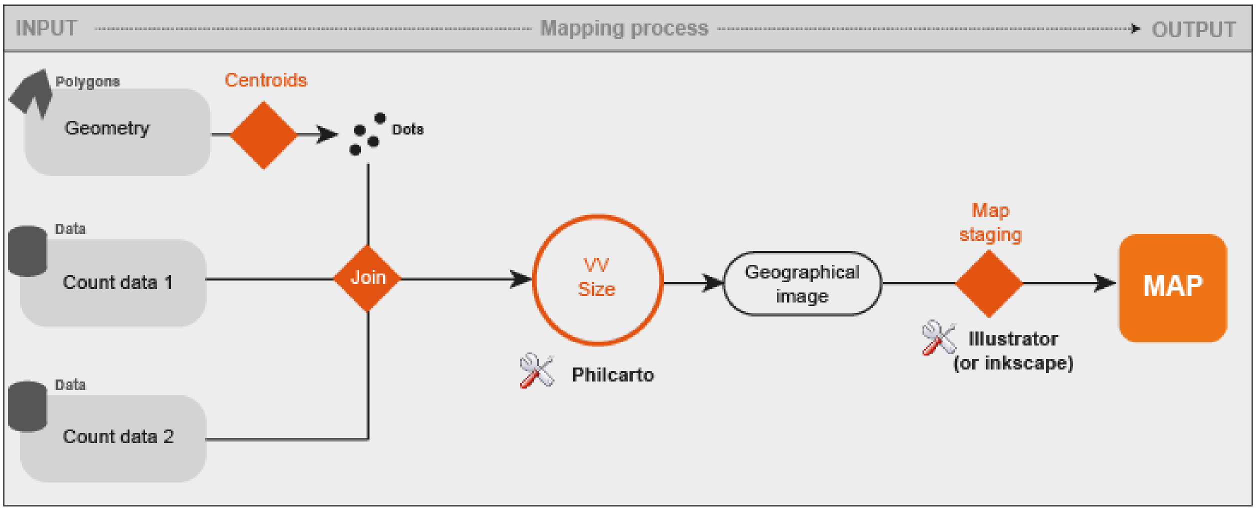
Segmented graduated symbol maps

Confronting two quantitative dimensions

Explanation

Segmented graduated symbol maps or semi-circles maps enable the comparison of two total populations or two quantities related to two categories in a given population. It is also possible to confront one and the same category at two different dates. The need to perceive differences requires circles of fairly large diameter, which restricts their number fairly drastically. The circles should be carefully calibrated from the diameter of the largest half-circle for the two variables represented. Indeed, the largest half-circle should not occupy too large a space so as not to mask the other half-circles, or obliterate the smallest half-circles.

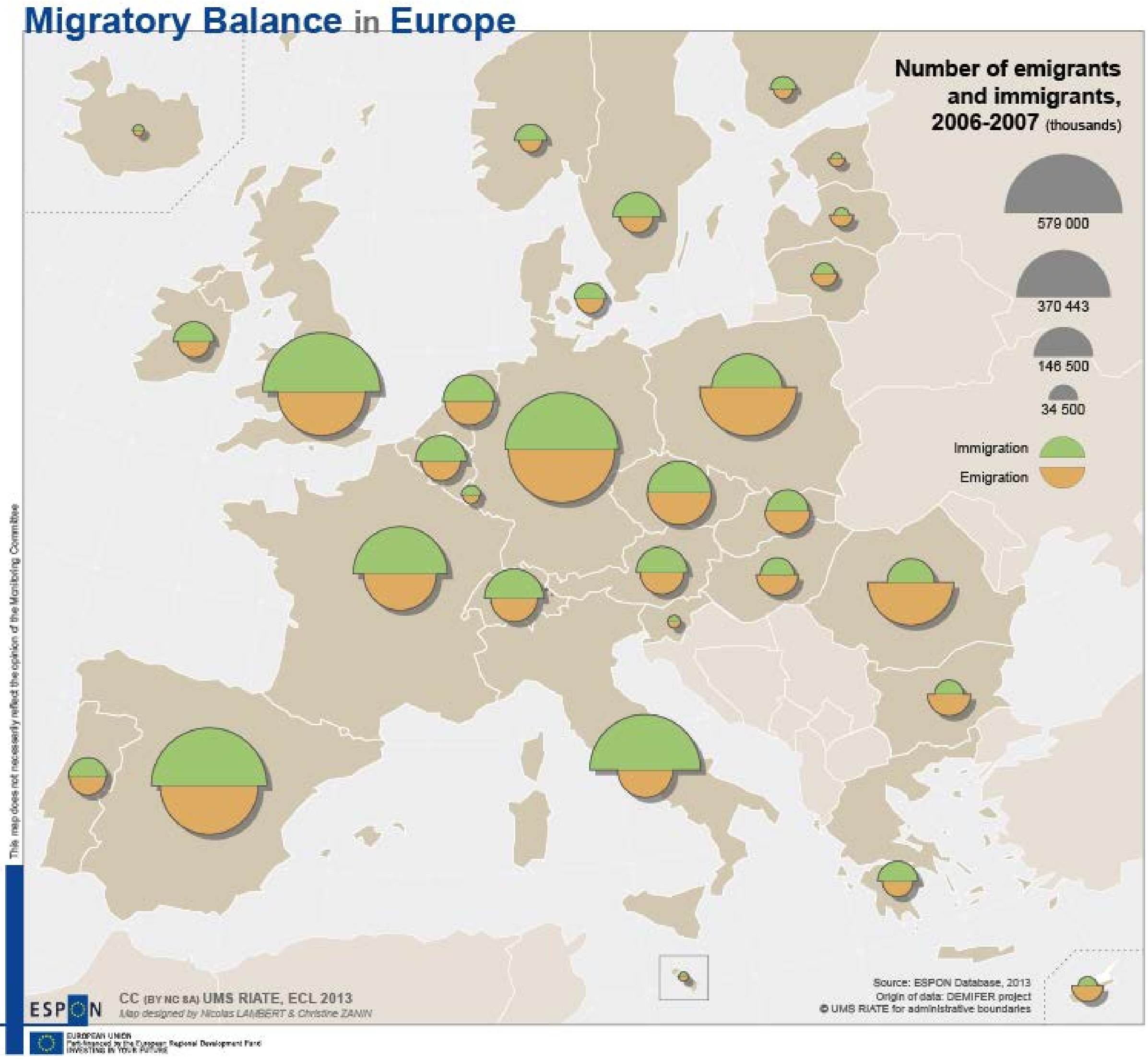
Mapping process



Data type

Appropriate Data: Absolute quantitative data

Data on the map : Numbers of immigrants and emigrants between 2006 and 2007



This map for the migratory balance in Europe simultaneously shows immigrants and emigrants for each European country. The mode of representation is well-suited to the theme, and enables differences in migratory policies across Europe to be highlighted. The emigration/immigration balance appears roughly equal in Germany, while in Italy immigration is clearly in excess, and in deficit for Poland.

Strengths	Weaknesses
Produces a simple image that is easy to understand	**Not suitable for large numbers of territorial units**
Enables rapid comparison of the respective weights of two phenomena	**Difficult to determine a suitable size for the circles**
	The comparison of the weights of the two phenomena is not feasible for small circles.

Software: Philcarto, Illustrator, Inkscape.
To go further: https://www.e-education.psu.edu/geog486/l5_p5.html#graduated

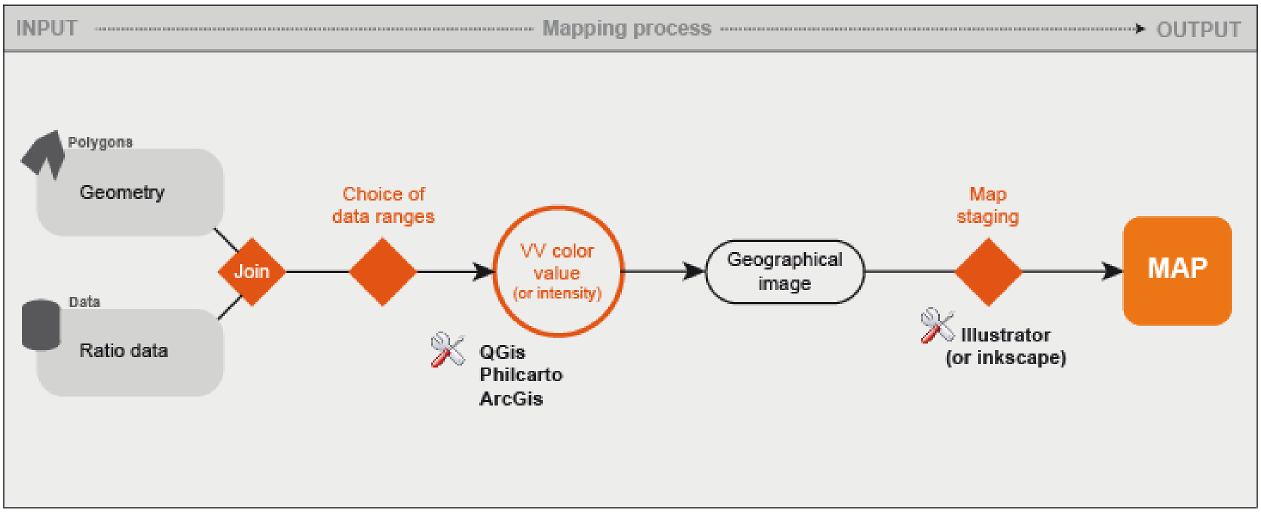
Choropleth maps

Representing order and degree

Explanation

Choropleth maps are statistical maps. The places or geographical zones (for instance regions) are coloured or filled in with a particular pattern. They enable the representation of data on the intensity or degree of a phenomenon. The magnitude of the phenomenon is not what is considered, but rather the ranking of the different elements. This mode of representation favours the observation of a phenomenon in relation to another, shows its variability, and thus produces an image that is specific to relationships between places. These maps are easy to execute, but they entail both mathematical and graphic problems. They require the choice of a subdivision of the data (discretisation) into classes or value intervals, and this needs to be suited to the distribution of the phenomenon being mapped, and assumes that the phenomenon is distributed evenly or homogenously across each geographical unit. Several graphic means can be used. The most common is to have values, or the colours associated with them, vary. The eye automatically classifies the fields from the palest to the darkest, and directly establishes an order and a selection among the spaces presenting a phenomenon ranging from weak to strong.

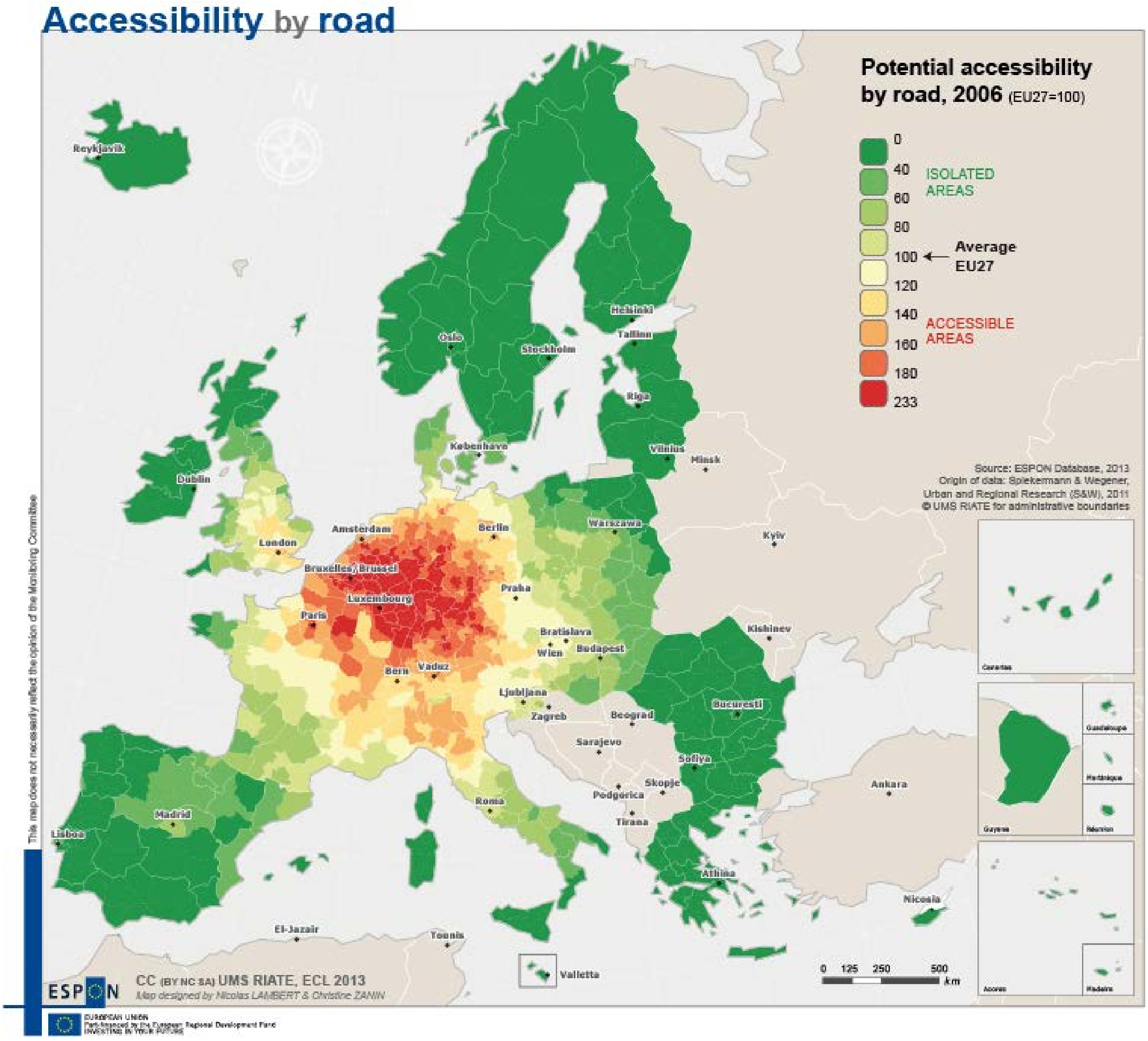
Mapping process



Data type

Appropriate Data: quantitative ratio data (absolute), index or ordinal qualitative data

Map data : Potential accessibility by road, UE base 100, 2006



This map classifies European regions (NUTS3) according to their degree of accessibility via the road network. The regions in red are the most easily accessible, and can be assimilated to the heart of the EU. The regions in green, more isolated, are markedly peripheral.

Strengths

Produces a simple, familiar and easily comprehensible image

Territorial units are identifiable by their shape and localisation

Weaknesses

Representation not suited to heterogeneous administrative divisions of the territory

The magnitude of the phenomenon is not taken into account

Data handling requires the choice of a mode of discretisation

Software: ArcGis, QGis, Philcarto,
To go further: http://my.ilstu.edu/~jrcarter/Geo204/Choro/Tom/ and http://my.ilstu.edu/~jrcarter/Geo204/Choro/

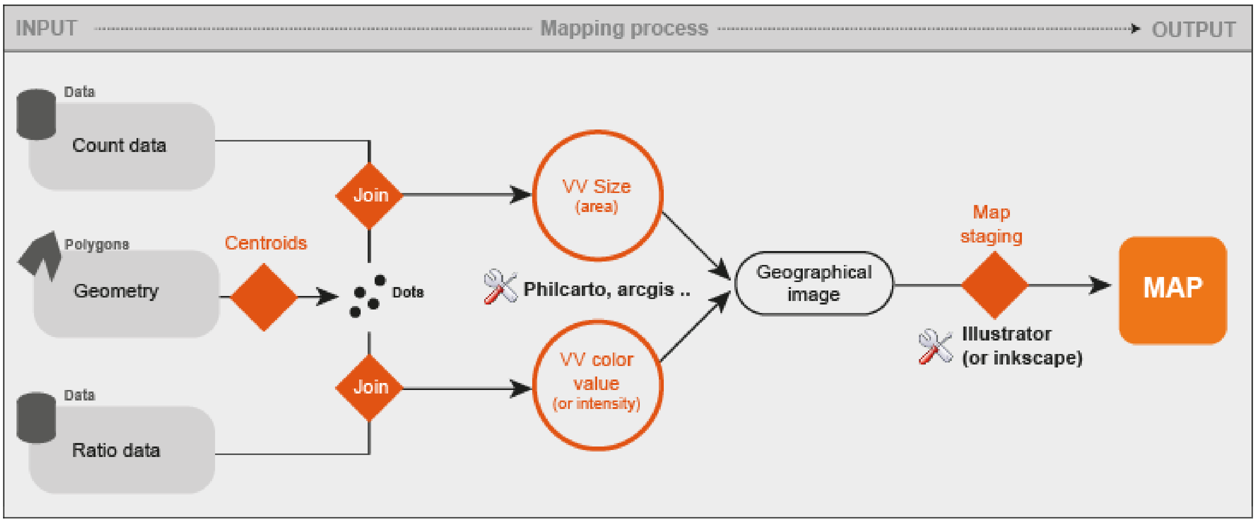
Count and ratio data maps

Putting discretised information into perspective by attaching a weight

Explanation

Combined count and ratio data maps enable the simultaneous representation of quantitative data and relationship or ratio data. The observer does not need to navigate between two maps, and "at a single glance" can apprehend a phenomenon in the light of two the different types of information. The count variable expresses its weight and shows the general scale of the phenomenon observed. These maps are also referred to as proportional coloured circle maps. The surface areas of the circles are proportional to the values of a first variable expressing quantities or numbers. The colours for their part correspond to the values of the second variable, which can be continuous (percentages, rates, indices) and hence already discretised, or else discrete (numerical or nominal categories). The calibration of the circles should be performed carefully, as for the proportional (quantitative) maps, paying particular attention to the overlaps, which should not hinder interpretation of the colours. The use of pale colours needs to be cautious, as the circles may not be sufficiently visible (this problem can be partly solved by using a dark-coloured background).

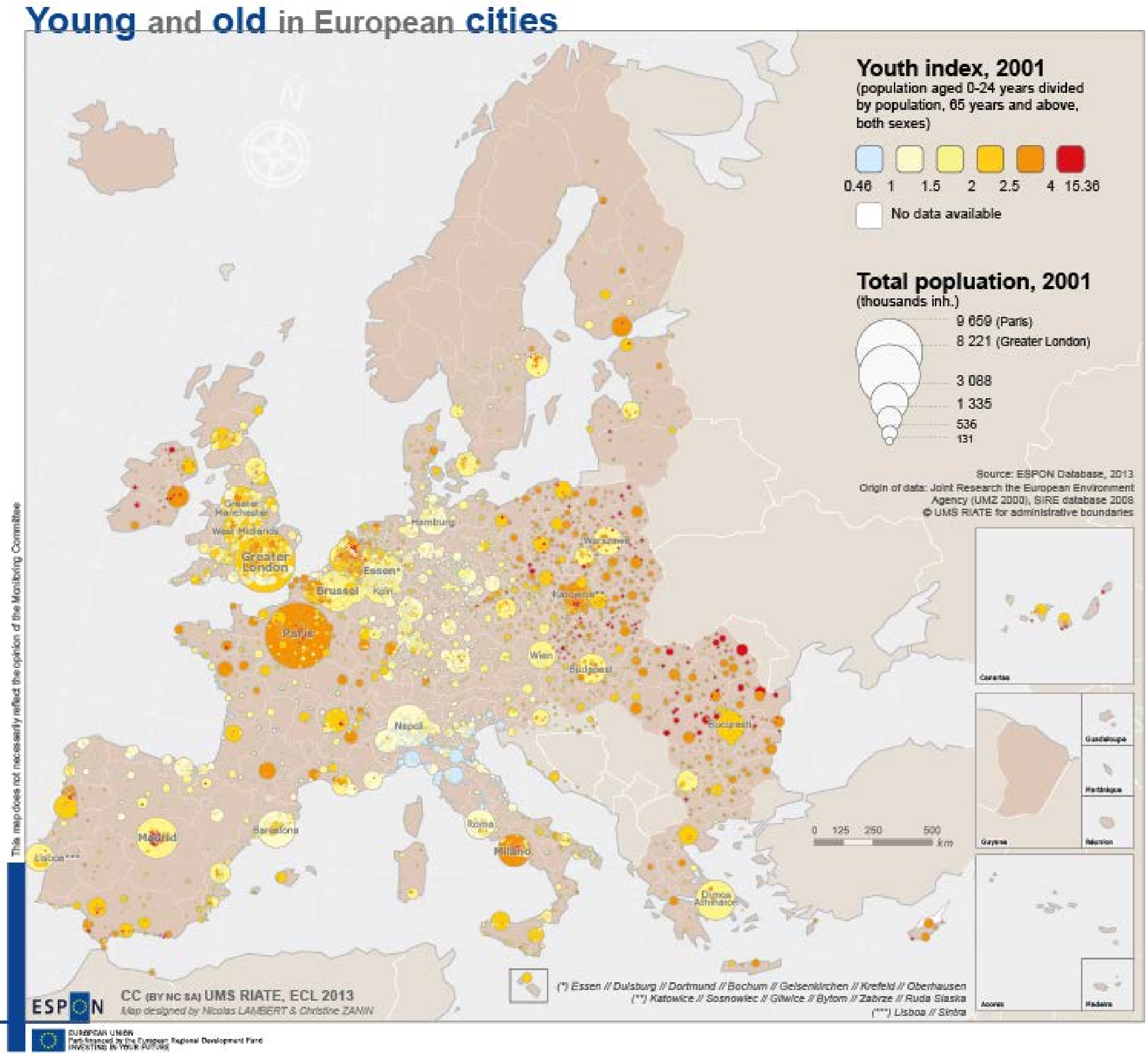
Mapping process



Data type

Appropriate Data: absolute quantitative data (count data) and quantitative ratio or qualitative nominal data

Map data: 2001 total population and ratio of population aged 0-24 yrs. to population over 65 yrs. 2001. Territorial division: LAU



This **Youth index map** for European cities establishes a relationship between the youth index and the total population. This confrontation of variables enables the magnitude of this indicator to be put in perspective in relation to the weight of the total population. The higher the value of the index, the younger is the population (and the lower it is, the older the population). It can thus be seen that a middle band in the European Union is occupied by a series of small cities where the population is on average older than elsewhere. To the east, the index shows a very young population in cities that are even smaller.

Strengths

Produces an image that is easy to understand

Enables confrontation of two types of variable

Weaknesses

Overlap of circles

Illegibility of certain colour variations

Software: ArcGis, QGis, Philcarto, Illustrator or Inkscape

To go further: Krygier J.; D. Wood. 2011. Making Maps: A Visual Guide to Map Design for GIS. New York: The Guilford Press.

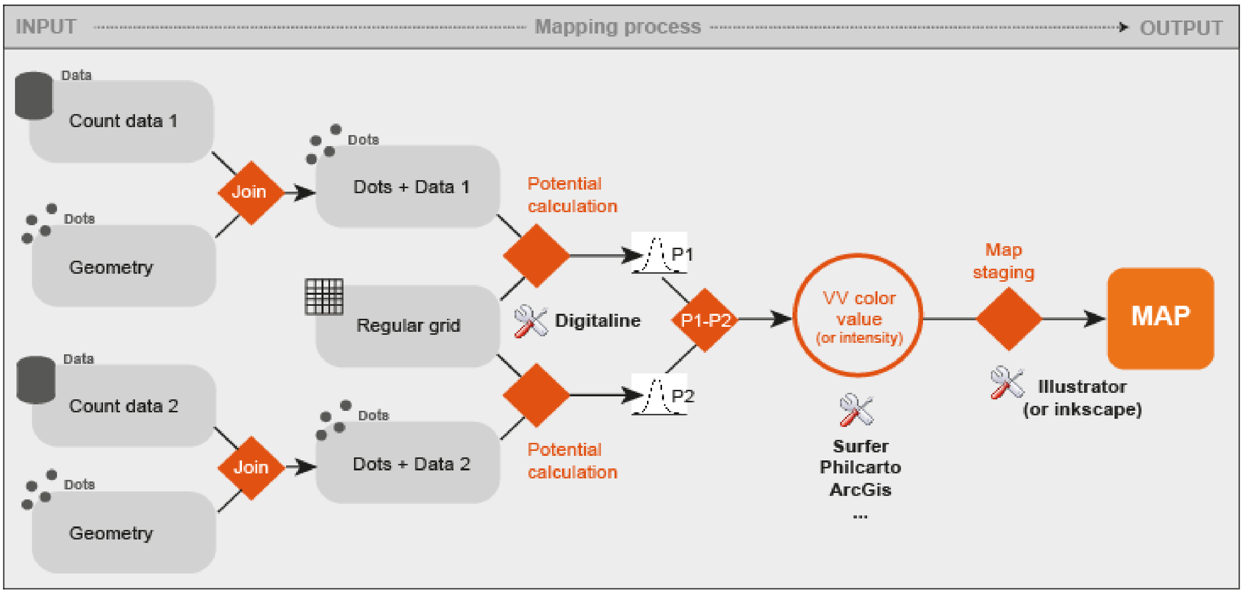
Isopleth maps

For the continuous representation of spatial phenomena

Explanation

Isopleth maps enable the representation of a phenomenon in continuous manner. Indeed, numerous socio-economic phenomena are spatially distributed according to logics of continuity, with no major breaks at boundaries, which appear as artificial discontinuities. If the phenomenon observed has a distribution that is overall continuous, that is to say if the phenomenon studied has values that differ in progressive manner as we move through space in relation to a given point, the aim of this "smoothed" map is to visualise the main phenomena, preserving their organisation as far as possible. Although these maps are said to be "smoothed", what this in fact refers to is a calculation of potentials. This method of spatial analysis enables observation of the spatial distribution of the phenomenon studied, whatever the heterogeneity of the spatial subdivisions present. The calculation of this potential requires two parameters: a spatial interaction function (here a Gaussian function – what is "close" counts for more in the calculation than what is "distant"), and a range, which determines the level of generalisation of the phenomenon. From a cartographic viewpoint, this type of representation helps the eye to read the map. Just as a trend more readily sums up a series of values measured over time, a smoothed map enables the most prominent phenomena to be highlighted.

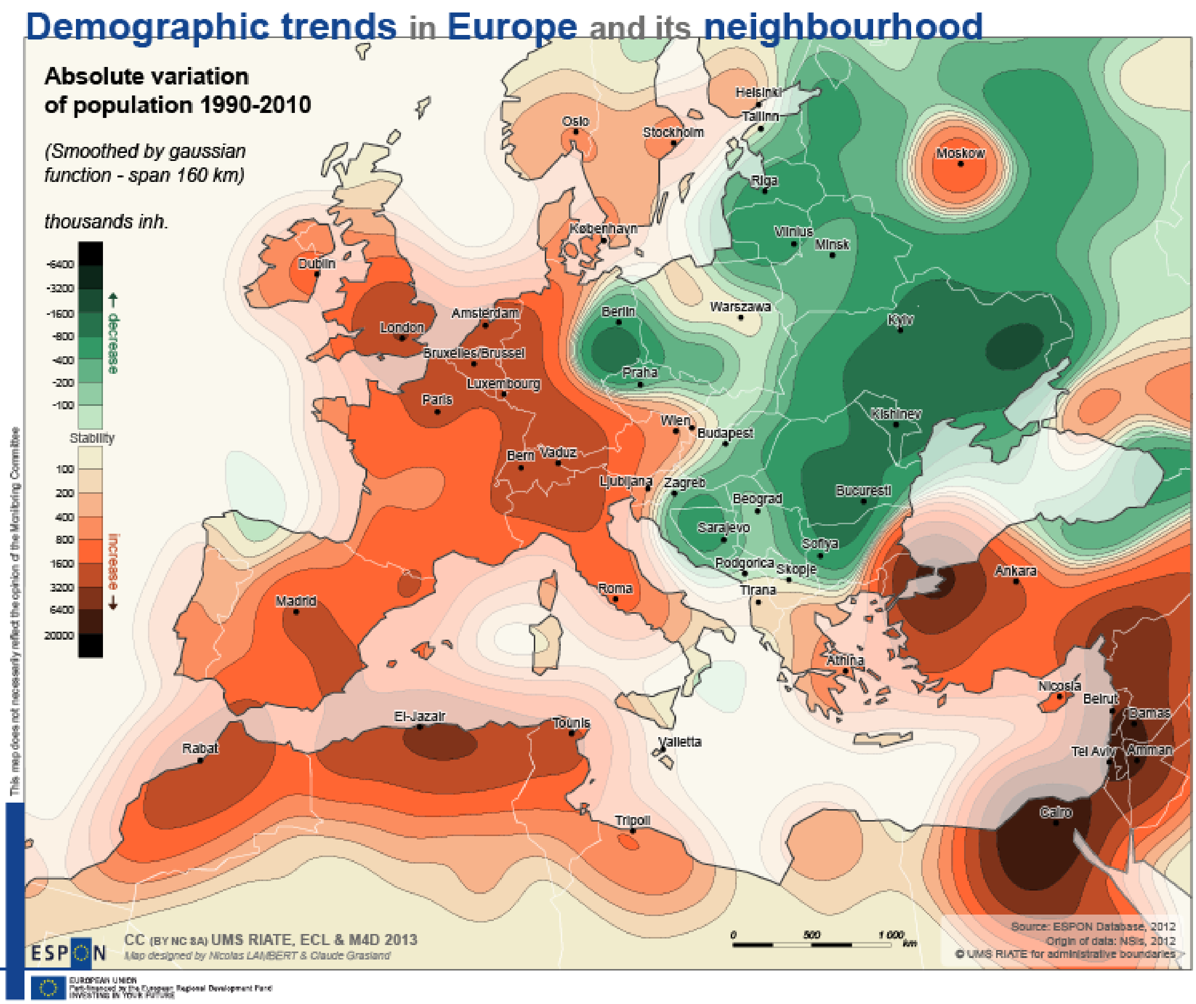
Mapping process



Data type

Appropriate Data: quantitative stock data or relative, ratio data

Map data : Absolute variation of population, 1990-2010



Mapping demographic variation potentials over a range of 160 km enables enhanced visualisation of local demographic concentrations in Europe, since it uses one and the same rule (potential within a rage of 160 km) for any point within the space to show the magnitude of population variation in the surrounding area. Thus it is easy to distinguish the European backbone from London to Milan via Benelux and the Rhine. The demographic weight of Paris can also be seen, as well as that of the other main metropolises (Madrid, London, Berlin etc.), and in particular the cities to the south of the Mediterranean basin. It is of course possible to vary the range of the smoothing procedure to detect more local concentrations (e.g. by using a range of 50 km) or conversely more global (300 km).

Strengths	Weaknesses
Escapes from administrative subdivisions	**Administrative units can no longer be distinguished**
Highlights concentrations	**Difficult to interpret**
Synthetic representation of space	**Mapping process fairly complicated**
Aesthetically pleasing	

Software: Digitaline, ArcGis, Surfer

To go further: http://thesocietypages.org/graphicsociology/2011/11/21/map-smoothing-technique-from-david-sparks/

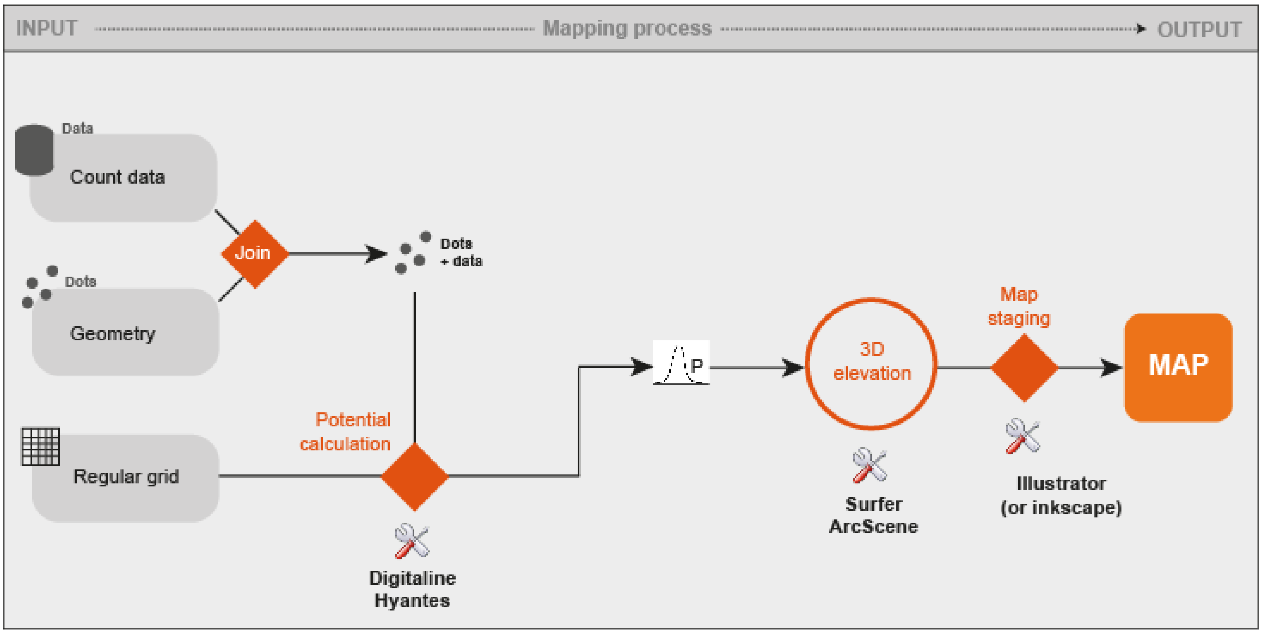
3D isopleth maps

A map in relief avoiding MAUP

Explanation

3-dimensional isopleth maps provide a visualisation in relief of potential maps (see p. XXX). This method of analysis enables the spatial distribution of the phenomenon to be observed whatever the heterogeneity of the spatial subdivisions, highlighting solely the main structures via a continuous representation of space. The three-dimensional representation of this information, generalised by the calculation of potentials, has several advantages. The method enables gradients to be shown clearly in the form of steep or shallow slopes. The "relief" produced makes it possible to quickly apprehend the quantities represented on the map, since the size of the peaks can be recognised at a glance, and compared one with another. Finally, it produces a cartographic image that is undoubtedly aesthetic and attractive.

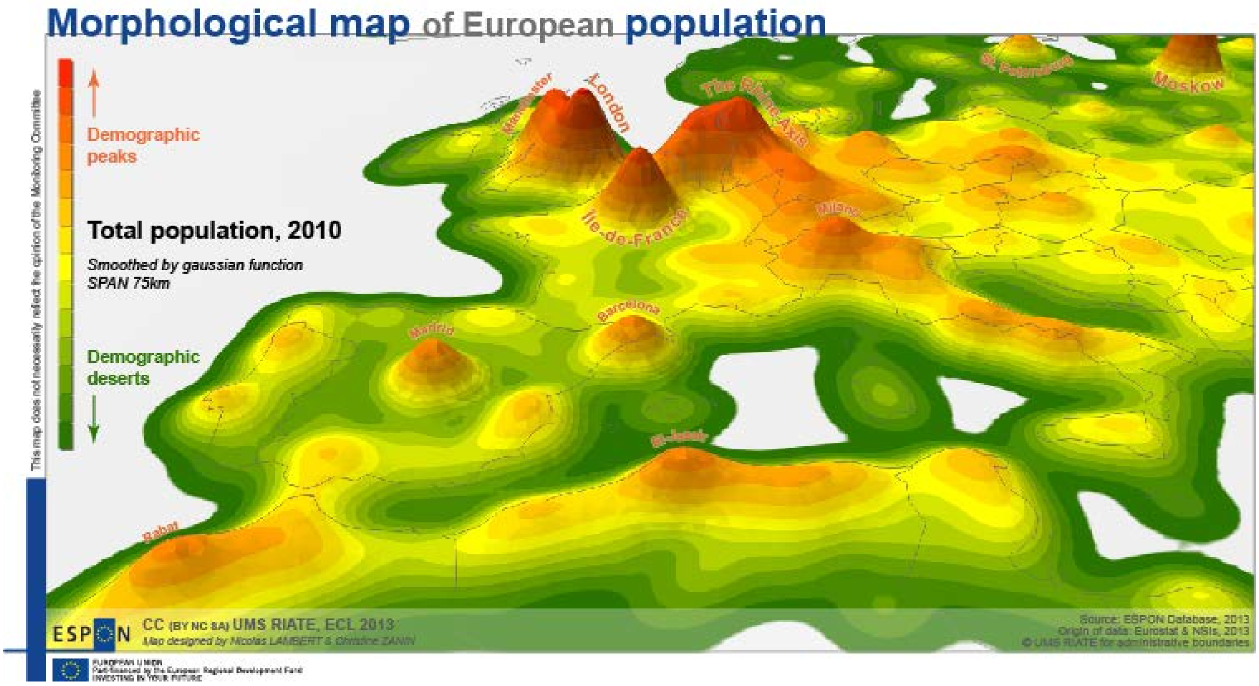
Mapping process



Data type

Appropriate Data: absolute quantitative data (count data)

Map data: Total population, 2010. Nuts 3 & SNUTS



This three-dimensional map represents the total population in Europe in 2010. It is constructed from NUTS3 data (SNUTS for the neighbourhood regions), and the cartographic generalisation provided by the smoothing process enables concentrations of population (red "peaks") and depopulated zones (green "plains") to be shown. On this map a "mountain range" forming the backbone of Europe can be clearly seen, the densely populated areas corresponding to Manchester, London, the Paris basin and the Rhine corridor. In contrast, the least densely populated areas are also immediately identifiable, for instance the empty diagonal across France.

Strengths	Weaknesses
Escapes from the administrative subdivisions	**Administrative units can no longer be identified**
Highlights concentrations and gradients	**Difficult to interpret**
Quantities easy to perceive	**Mapping process quite complicated**
Aesthetically pleasing	

Software: Digitaline, ArcGis, Surfer, Arcscene
To go further: Wolf-dieter Rase , 2009, "Visualization of three-dimensional GIS objects using rapid prototyping technology", Geovizz

Cartogram maps

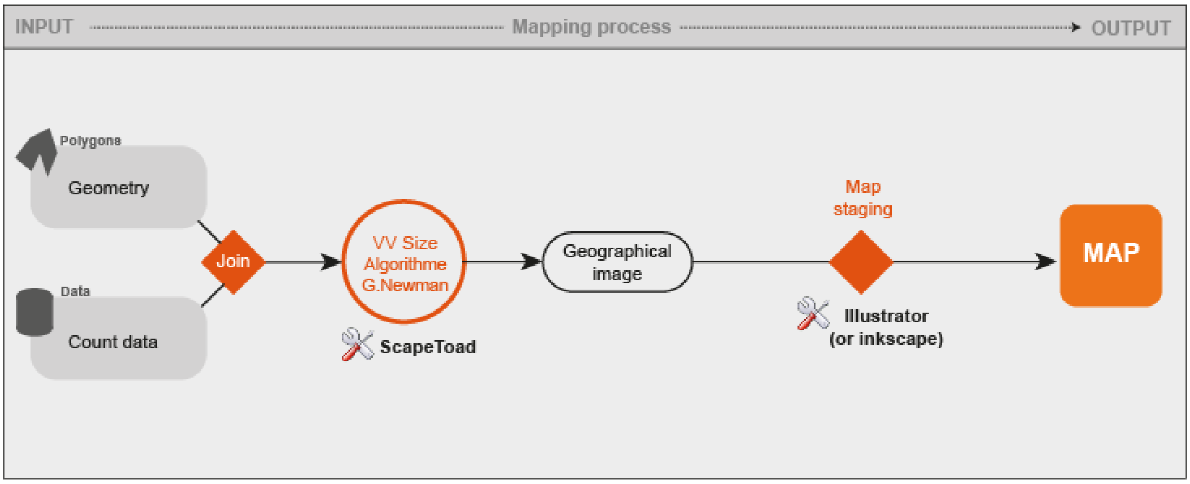
Apprehending differences in the weight of a phenomenon by changing the perspective

Explanation

Anamorphosis maps or **cartograms** alter the surface areas of spatial units so as to make them proportional to a given quantitative variable. This cartographic option is often envisaged when the aim is to establish links across territorial units of very different size, which often hinders the understanding of the link between the territory and the phenomenon represented. Several conversion algorithms can be used, but the general principle consists in exerting forces starting from the centre of the polygon (centroid) and extending towards the points defining its edge. These forces represent the difference between the initial surface area of the polygon and the surface area it would have if all the areas were proportional to the quantity to be represented. Thus it can be noted that if the original surface area is too small in relation to the quantity to be represented, the spatial entity will be enlarged, and if the original surface area is too large in relation to the quantity to be represented, the spatial entity will be reduced. The conversion also preserves contiguities between spatial entities.

This representation leads to a distortion of the base-map making it possible to show the magnitude of a given phenomenon. Thus the map no longer represents a geographical reality, but the reality of a phenomenon. Cartograms does not change the message, but it can enhance its legibility.

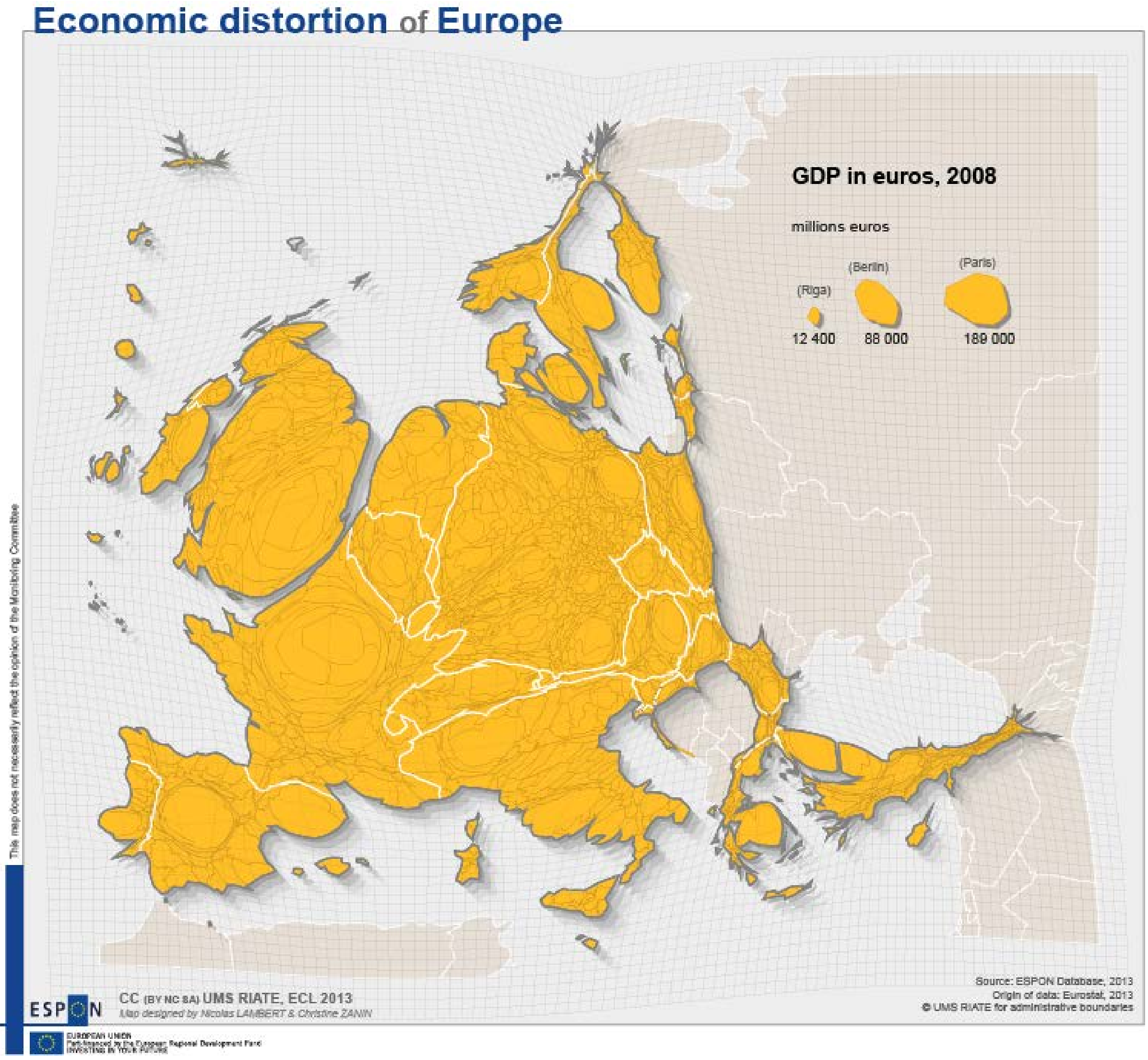
Mapping process



Data type

Appropriate Data: Absolute quantitative data (count data)

Map data: GDP in millions of euros, 2008. NUTS3



The cartogram showing GDP in Europe distorts the surface areas of the different regions to make them proportional to their wealth. It is thus easy to see the wealthy areas like the Paris basin or London, and poorer areas like southern Italy of eastern Europe.

Strengths	Weaknesses
An original mode of representation	**Administrative units are distorted and not easy to identify**
Global, synthetic image	**It is not easy to locate points on the map**
Quantities easy to perceive	

Software: ArcGis, QGis, Scape Toad, Illustrator or Inkscape
To go further: http://www.ncgia.ucsb.edu/projects/Cartogram_Central/types.html
http://www.geog.ucsb.edu/~tobler/publications/reprints.html#cartograms

Dorling Cartogram maps

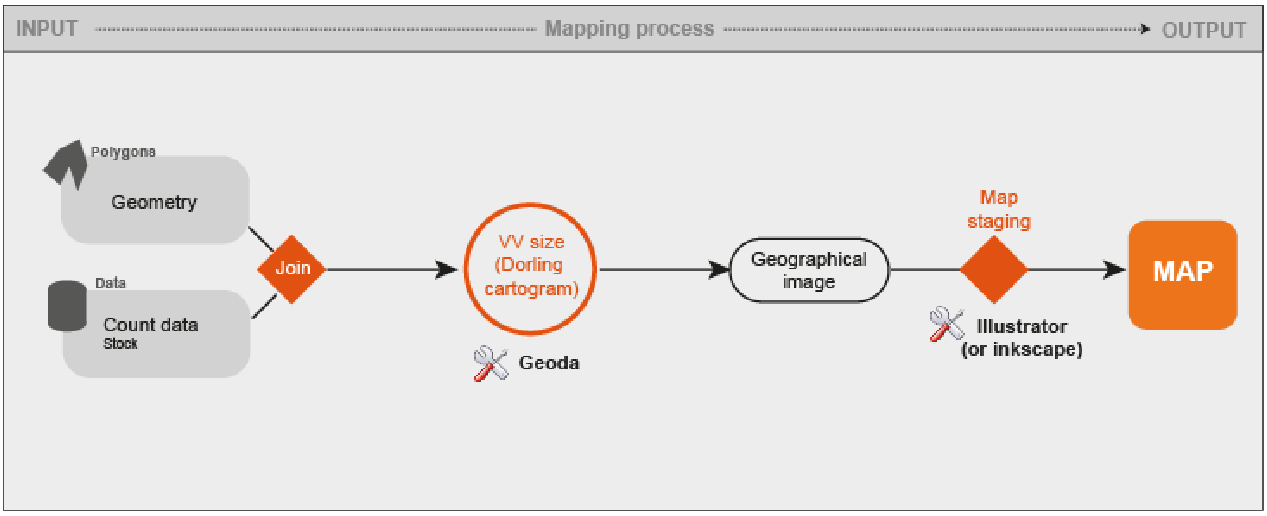
Concentrating on the relative weight of a phenomenon

"The fundamental tool for geographical analysis is undoubtedly the map or, perhaps more correctly, the cartogram." Sir Dudley Stamp (President of the Royal Geographical Society, 1962: 135)

Explanation

A Dorling Cartogram Map is a particular type of cartogram map named after its inventor, Danny Dorling, from the University of Leeds (UK). This method, known as the circular cartogram, preserves neither the shape, nor the topology, nor the centroid of the objects represented. It neither enlarges nor reduces the spatial units, but replaces objects by a uniform shape, generally a circle, of the appropriate size. The aim is then to avoid overlap of the forms, which can be displaced so that the whole surface of each form can be seen. The forms are shifted to a position that is as close as possible to the original localisation of the geographical object.

Mapping process

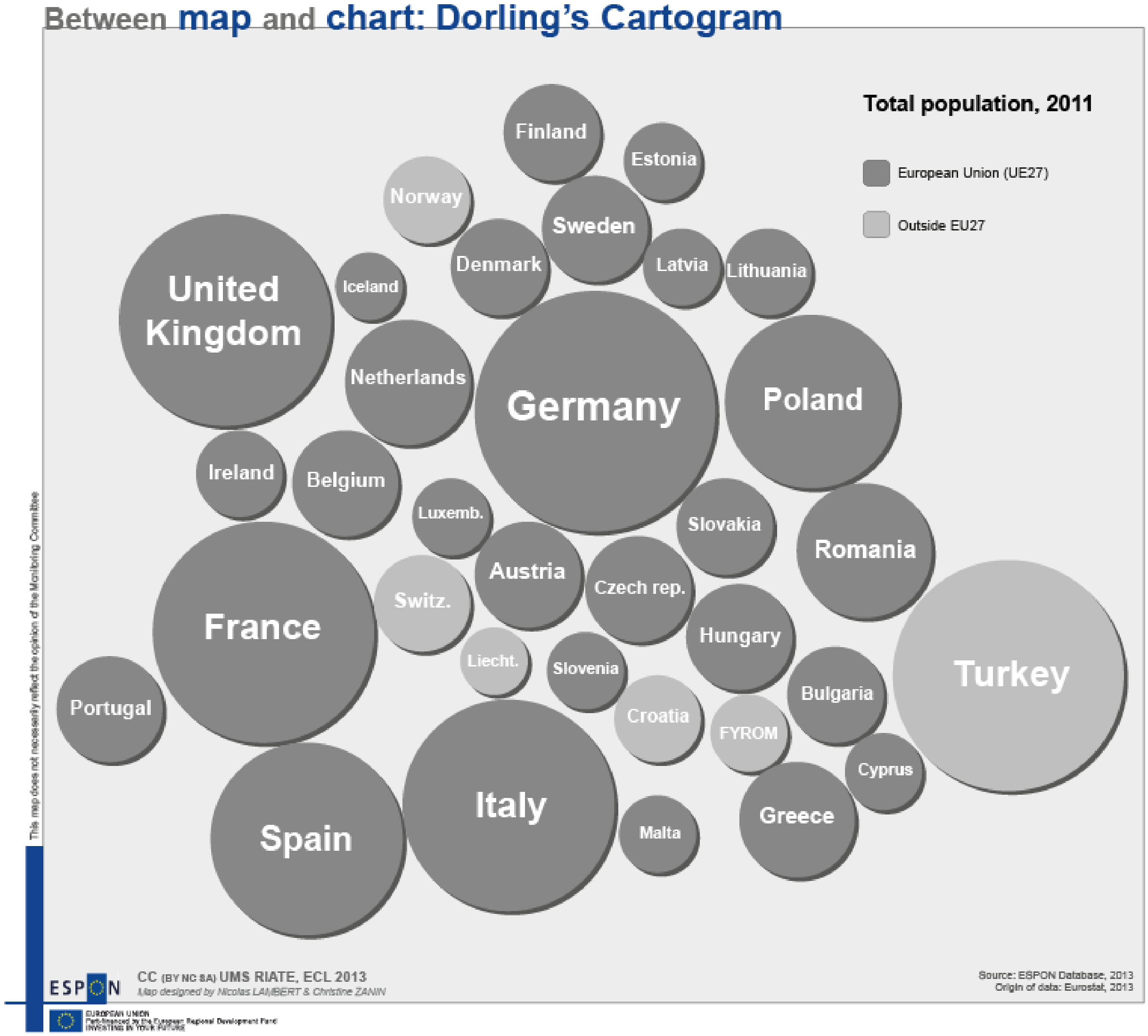


Appropriate Data: absolute quantitative data (count data) or ratio data if the aim is to include another variable via variation of value or colour

Data type

Map data: Total population in 2001 for European countries.

Between map and chart: Dorling's Cartogram



The total population of the countries in Europe is represented here using a Dorling cartogram. Each country is replaced by a circle that is proportional in size to the size of its population. The positioning of the circles attempts to approximate with their actual geographical localisation. This representation is very effective in animations, because it enables the main trends to be apprehended very quickly. A small qualitative distinction is made here by way of the use of the two shades of grey distinguishing countries belonging to the EU from the outside.

Strengths	Weaknesses
Produces a simple, easily understandable image	**Not suited to large numbers of territorial units.**
No superimposing of circles	**The topology is lost**

Software: Geoda, MAPresso, Illustrator or Inkscape
To go further: http://www.csiss.org/streaming_video/csiss/dorling_cartograms.htm
http://www.dannydorling.org/?page_id=1448
http://www.dannydorling.org/books/visualisation/Homepage.html

Discontinuity maps

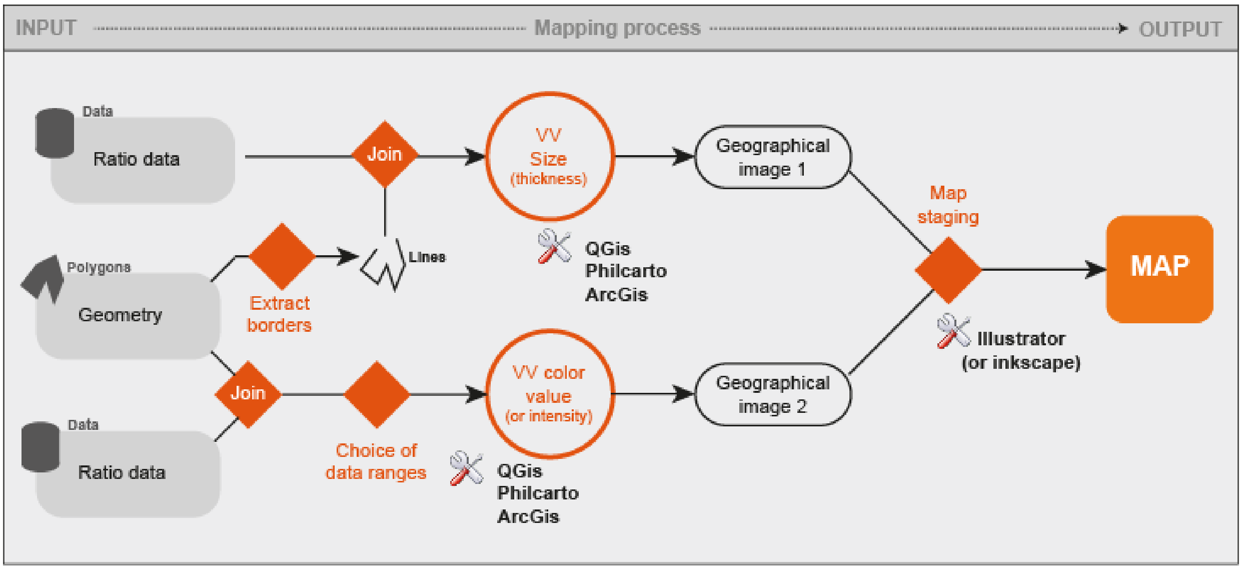
Highlighting breaks in spatial organisation

Explanation

Discontinuity maps enable the representation of the spatial breaks or discontinuities in socio-economic phenomena, bearing out the notion that geographical space is fundamentally discontinuous. When combined with the choropleth technique (use of colours) this cartographic representation is particularly useful. The discontinuity values are calculated by assessing the relationship (relative discontinuities = [max (ratio1, ratio2) / min (ratio1, Ratio2)]) or the differences (absolute discontinuities = [max (ratio1,R-ratio2) – min (ratio1,ratio2)]) between the values attached to the phenomenon on either side of a territorial division. Only the minimum and maximum values are considered. To represent the degree of discontinuity in visual form, the size visual variable is used, whereby the thickness of the boundary varies in proportion to the degree of discontinuity.

This type of representation draws the reader's eye, not to large homogeneous zones, but to the borders where marked disparities in the phenomenon studied are observed on either side.

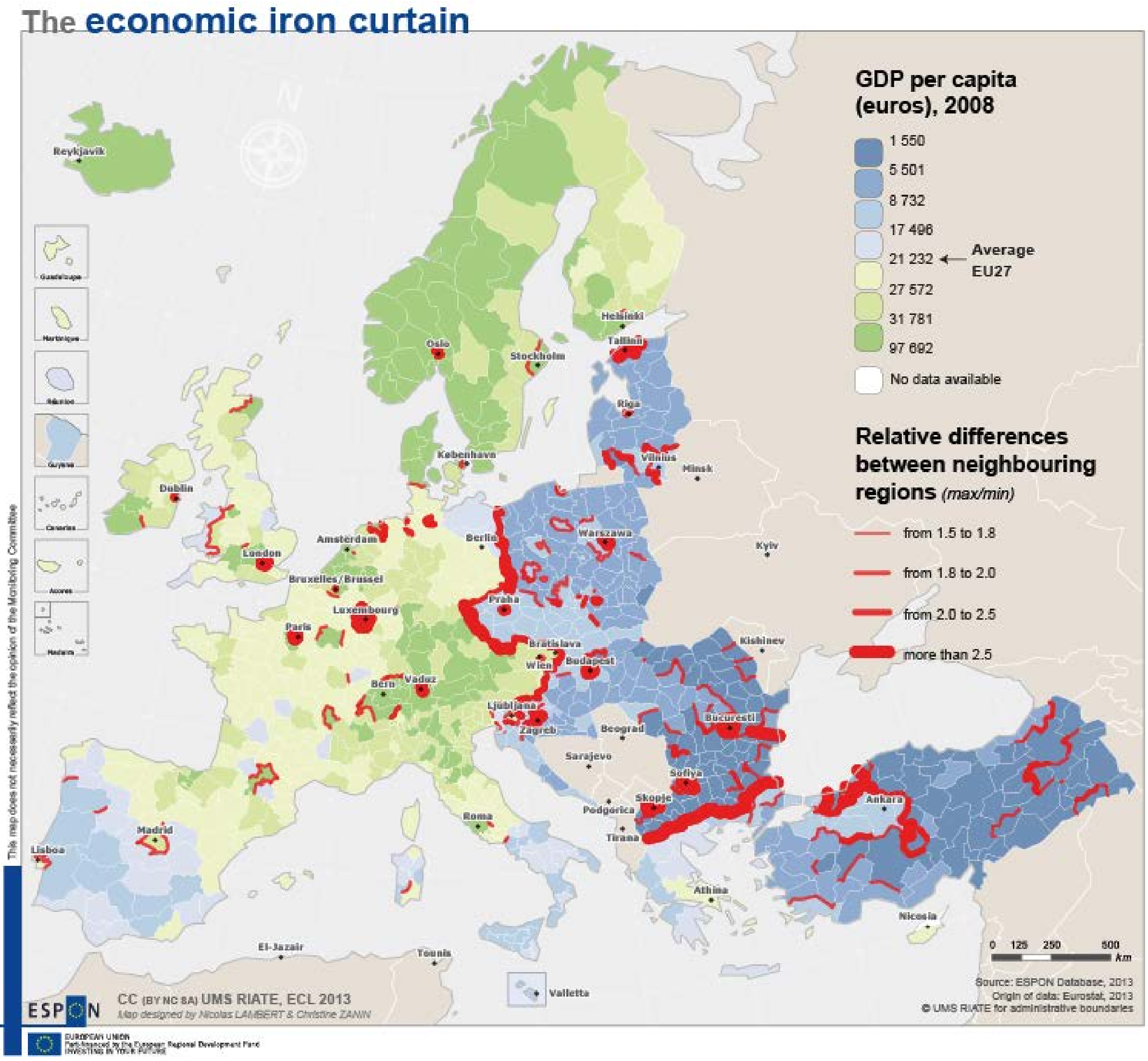
Mapping process



Appropriate data: relative, ratio or index quantitative data, qualitative ordinal data

Data type

Map data: Per capita GDP in 2008, NUTS3 and calculation of relative differences



This map shows economic discontinuities from one economic region in Europe to another. The issue is wealth differentials between neighbouring regions – is there a gradual shift from very wealthy regions to very poor regions via a series of intermediate regions? Or are there genuine discontinuities, with very wealthy regions coming into direct contact with very poor areas on the two sides of the border? At national level, there are sharp contrasts between Germany and Poland, Austria and Slovakia, or Greece and Bulgaria. Likewise, between NUTS3 regions the discontinuities underline the differences between long-standing and new members of the EU. But there are also marked discontinuities within certain countries, where the region around the capital city is far more wealthy than the surrounding regions (Paris, London, Bucharest, Prague).

Strengths	Weaknesses
The image produced is simple	**Calculations can be lengthy**
Spatial breaks are clearly identified	**The discontinuities vary considerably with the territorial divisions used.**

Software: ArcGis or QGis, Philcarto, Illustrator or Inkscape
To go further: Sack R. D., 1983, "Human territoriality: a theory", Annals of the Association of American Geographers, n°73-1 and http://www.hypergeo.eu/spip.php?article454

Prism maps

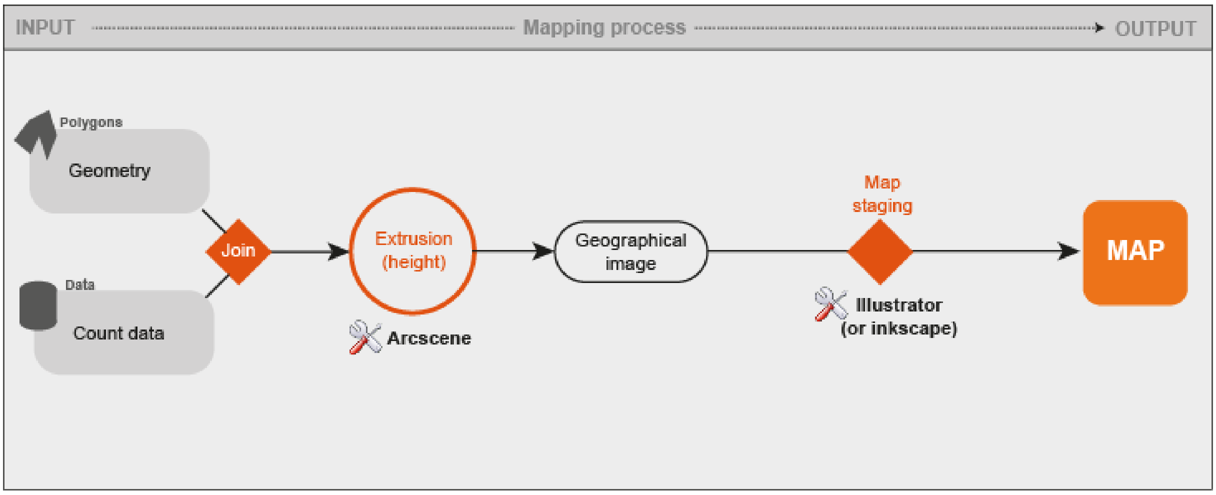
Symbolizing data with extruded polygons

Explanation

Prism maps enable the representation of count data. As described earlier for count data maps (p. XXX), this data is quantitative in nature, whether raw or absolute. Their cartographic representation therefore uses the size visual variable. In the case of a prism map, size is expressed by the height of the territorial units displayed in three dimensions. It is via an extrusion of the polygons that the variable is transcribed: the taller the polygon, the higher the value represented, and the smaller the polygon, the smaller is the value represented. Negative values are possible.

When there are large numbers of territorial units this representation is not very effective, but it has the advantage in certain cases of producing a synthesis that enables the approximate magnitude of a spatial phenomenon to be captured in a few seconds. The method should however be used fairly sparingly.

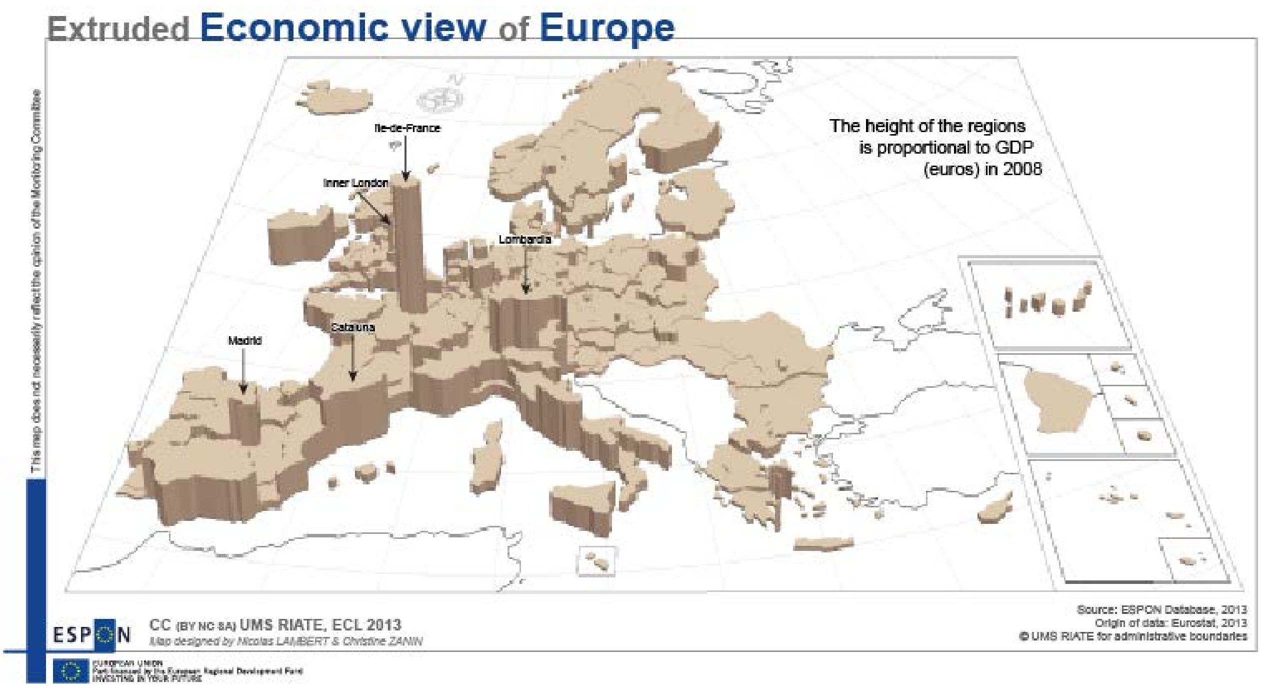
Mapping process



Appropriate Data: quantitative count data (absolute)

Data type

Map data : GDP(euros) in 2008, NUTS2



This map shows GDP in euros in European regions (NUTS2) in 2008. This three-dimensional representation clearly shows the most wealthy regions (Paris basin (Ile de France), Inner London, Madrid, Lombardy) while the poorer regions of Eastern Europe appear flat.

Strengths	Weaknesses
The representation is original	**Illegible if there are too many territorial units**
High values stand out clearly	**Representation depends very much on the territorial units used**
	Certain elements are masked by others

Software: ArcScene, mapviewer
To go further: Creating 3D Prism Maps using Google Earth:
http://www.beginningspatial.com/creating_3d_prism_maps_using_google_earth

Dot density maps

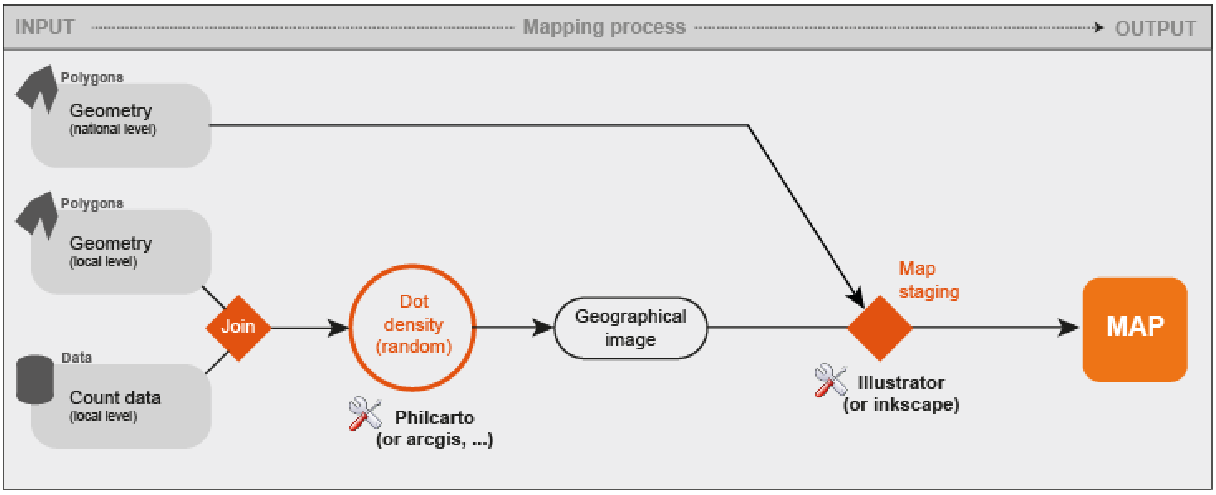
An easily understandable map to visualize spatial patterns

Explanation

Dot density maps (or dot distribution maps) are thematic maps in which each dot represents an equal value, or at least an equal amount of information. These maps are constructed from quantitative count data (i.e. the sum has meaning) using the finest possible geometric grid. Indeed, since the dots are distributed randomly in each grid cell, the finer the grid the more precise is the localisation of the dots.

These maps are often used in world atlases to show population distribution. They are maps that attempt to produces images "approaching reality" that are easy to understand by the reader with no knowledge of statistics or geography. Although they are easy to read, they are quite complicated to produce, with the main challenge being obtaining maximum precision in the localisation of the dots (near coasts, near roads etc.) to render the image relevant and intelligible.

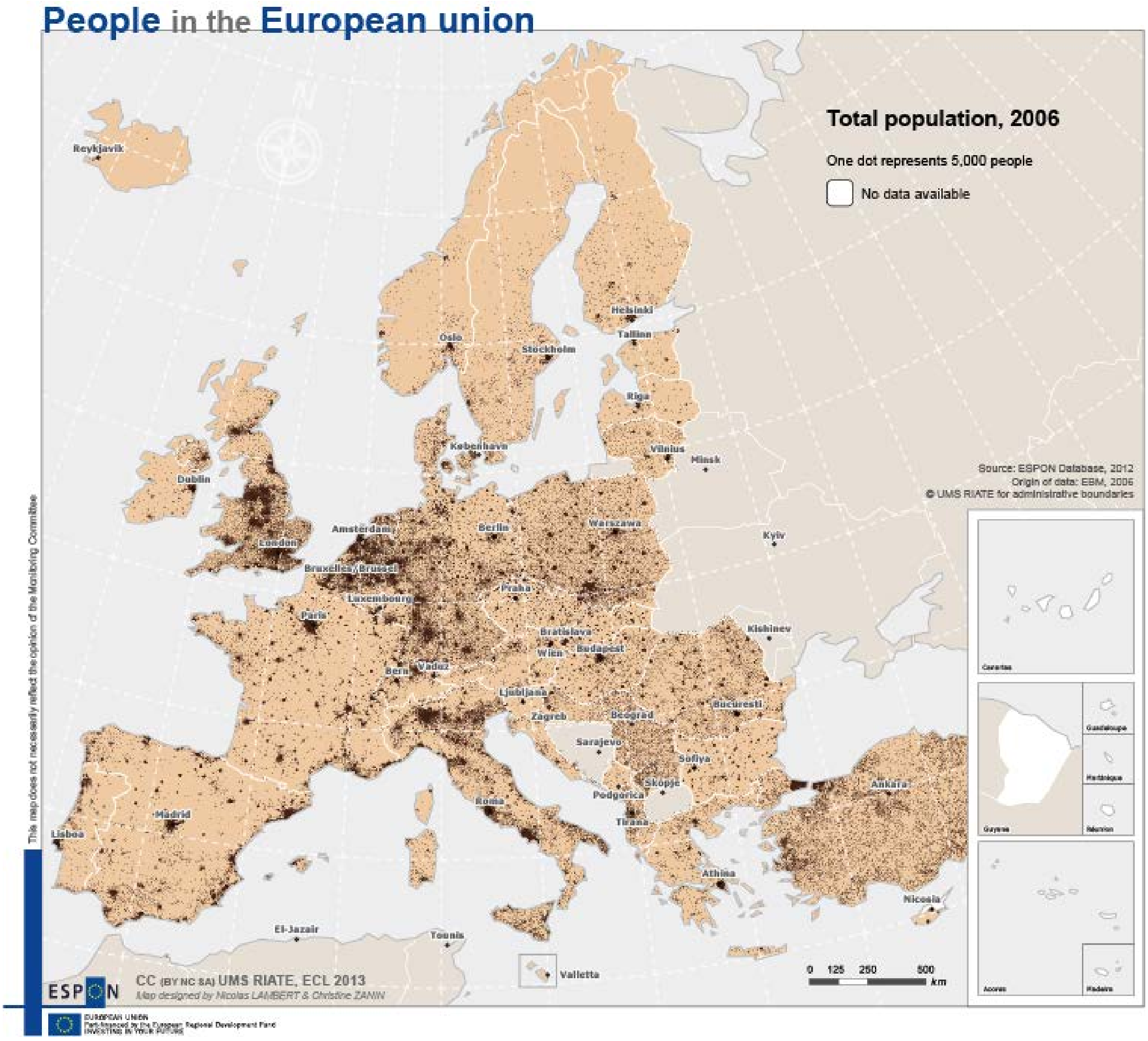
Mapping process



Data type

Appropriate Data: quantitative count data

Map data : Total population, 2006, LAU2



This map shows the distribution of population in Europe in 2006. Since each dot represents 5000 inhabitants, the maps shows up concentration zones with high densities, and other areas that are less densely populated, where the dots are more scattered. The map is constructed from population data in a LAU2 grid, but this calculation grid is obviously not shown in the final representation.

Strengths	Weaknesses
Simple and comprehensible	**Requires local data and grid**
Concentrations are easily perceived	**The positioning of the dots is random**

Software: ArcGis, Philcarto
To go further: 2010 Census: Children less than five years old: http://media.apps.chicagotribune.com/chicago-census/less-than-five.html

“Smart projected” maps

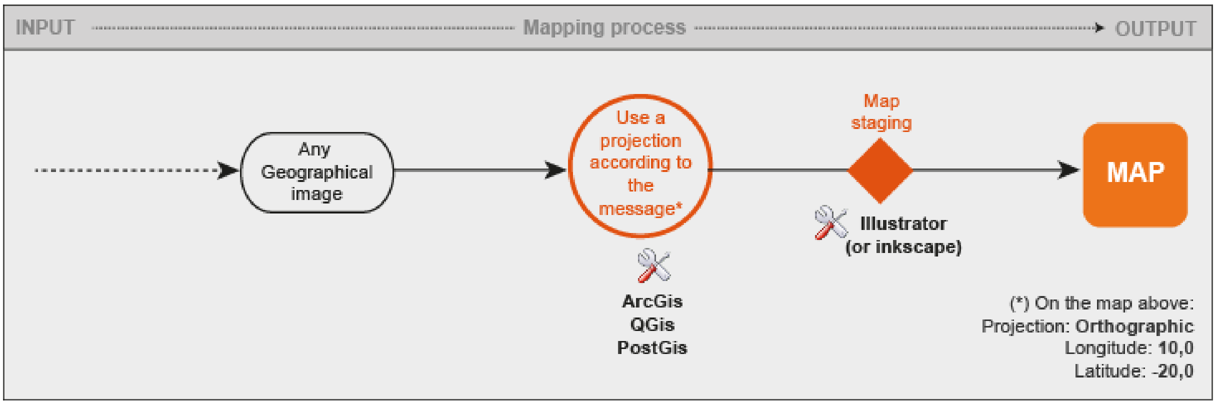
Using a map projection to enhance the message

Explanation

"Smart projected maps" are not really a type of representation. The procedure here does not consist in using this or that visual variable to represent a piece of geographical data efficiently. It consists in converting an already formed geographical image into a map for communication purposes by appropriate use of a cartographic projection. What we are dealing with here is cartographic "staging" in the full sense.

On this sort of map, the use of the orthographic projection can for instance enable the representation of Europe from the south. Instead of the usual Europe-centred projection (LAEA) the map-maker chooses to position himself on the other side of the Mediterranean, and to produce a view of Europe from elsewhere. A map is not a neutral object, it always expresses a viewpoint, and the following example is a demonstration.

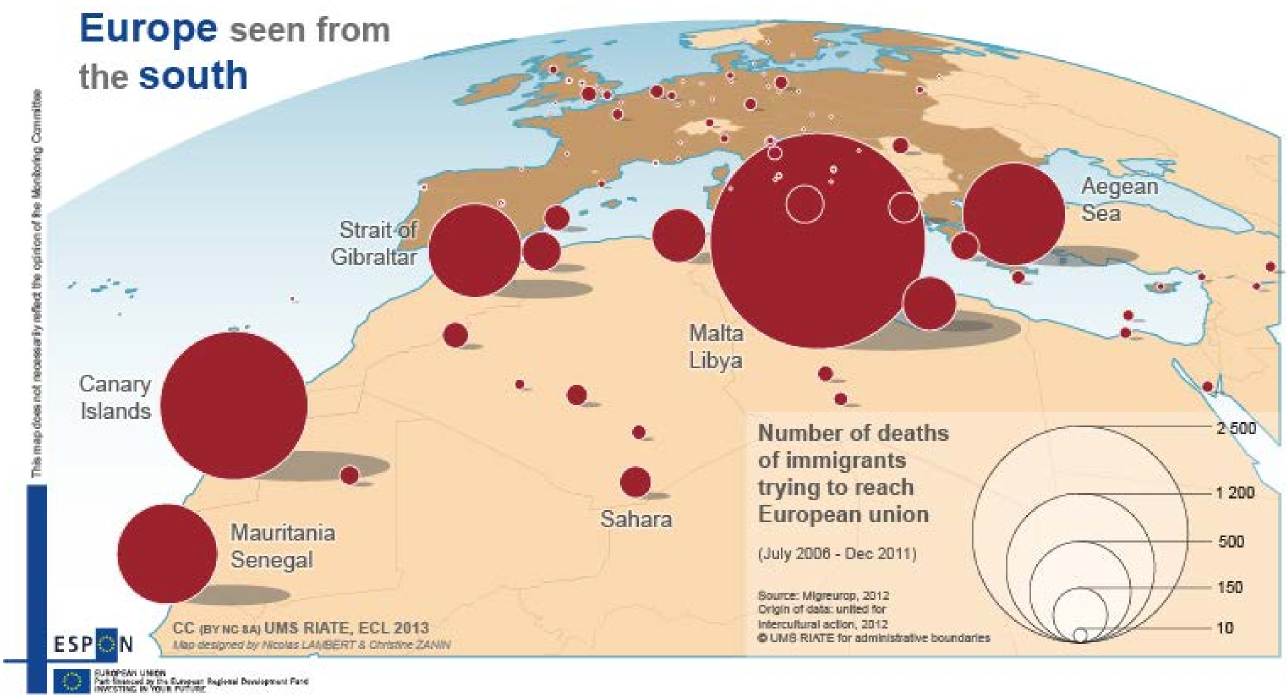
Mapping process



Appropriate Data: (not relevant)

Data type

Map data : Numbers of deaths of immigrants, 2008-2011



This map shows the numbers of migrants who died trying to reach Europe from July 2006 to December 2011. Seen from the south, that is to say from the viewpoint of the migrants, this map shows huge red circles, like so many insuperable obstacles placed in their way by the EU watching the migrants move in. The viewpoint is clearly on the side of the migrants trying to reach Europe.

Strengths	Weaknesses
The full communication power of the map is used	**Long and complicated to produce**
Informative but subjective	**Require particularly good skills and knowledge**

Software: ArcGis, Inkscape, Illustrator
To go further: http://nationalatlas.gov/articles/mapping/a_projections.html

Histo-maps

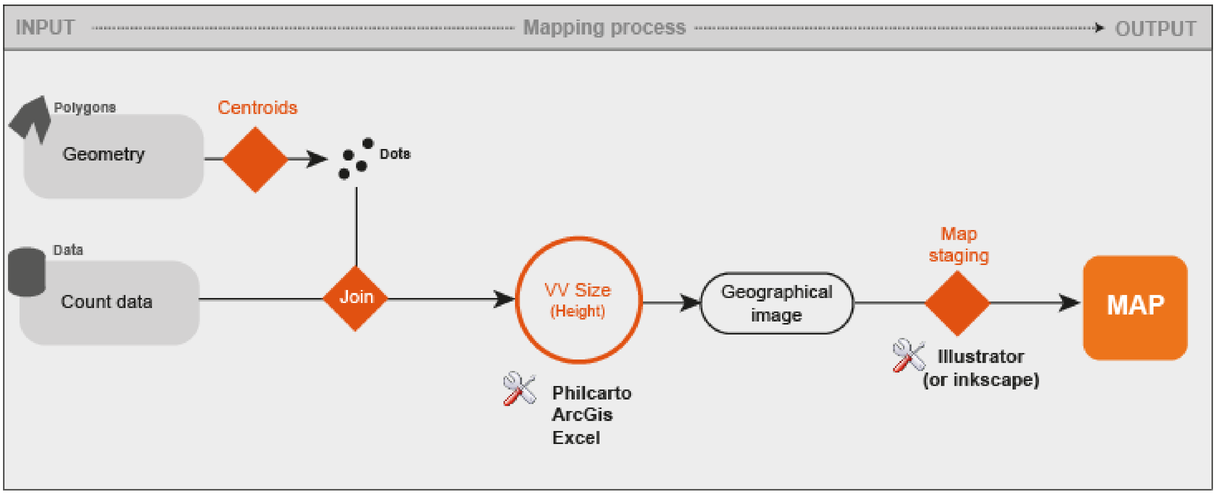
A way to visualize Geo-referenced diagrams

Explanation

Histo-maps belong to the family of maps to be "read" or decipher, the purpose of which is not to immediately deliver a clear, understandable message, but rather to represent in spatial manner information that requires time to interpret (see part 1 p.20). This type of map, which can be complex, also enables the representation of any type of diagram on the map (a histogram, a curve, a pie-chart) when they can be localised. Nevertheless, these maps are generally not very effective in terms of communication, and they generally have poor pedagogical value.

In the case of the histogram (see the example provided) the visual variable used is size. This enables raw quantities (count variables) to be transcribed. To enhance legibility, it can be useful to put the base map in perspective to signal graphically that the representation will vary in height perpendicular to the map.

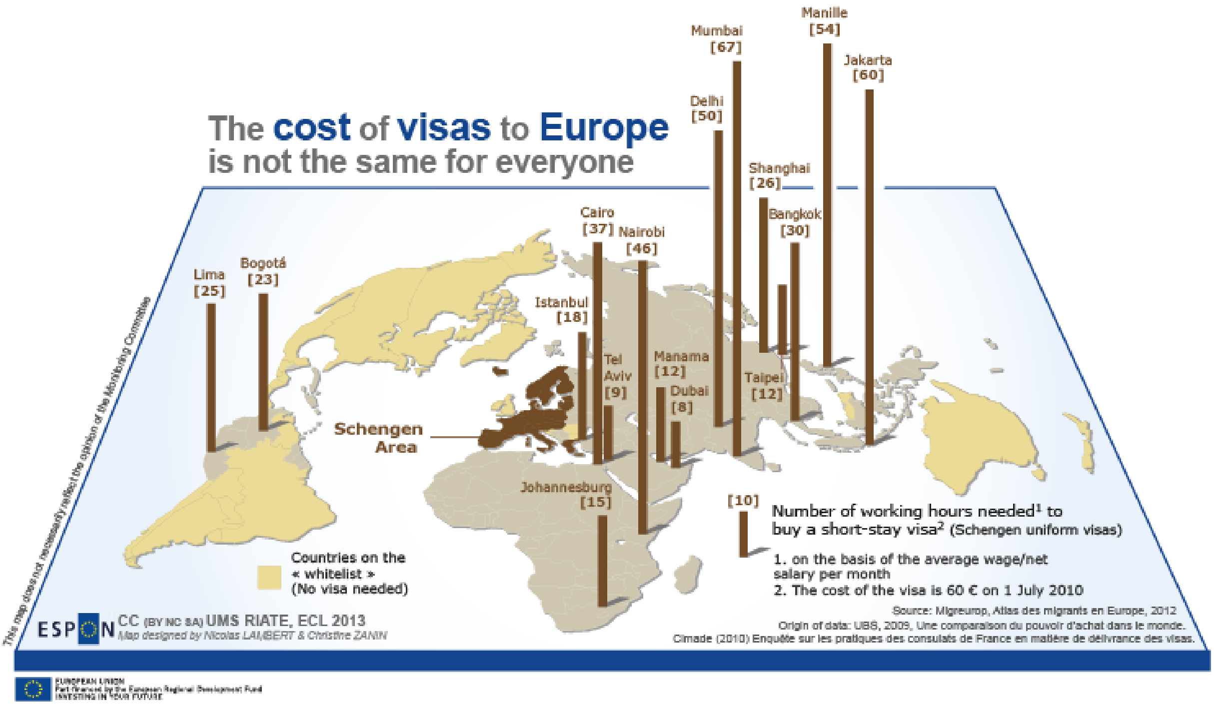
Mapping process



Appropriate Data: quantitative count data (absolute)

Map data : Monthly salaries & cost of visas to Schengen zone

Data type



This map shows the cost of a visa for the Schengen zone in different cities in the world. It is based on a cost of 60 euros for a short-stay visa. For some, paying for it amounts to 67 hours of labour (e.g. Mumbai) while for others the cost is equivalent to only 9 hours (i.e. seven times less, e.g. Tel Aviv). Finally, a certain number of countries on the "white list" are exempted from visas.

Strengths	Weaknesses
Enables several variables to be combined and compared	**Maps requiring reading** **Maps that do not communicate readily** **Not suited to large numbers of territorial units**

Software: ArcGis, Philcarto, ArcGis, Excel

Flow maps

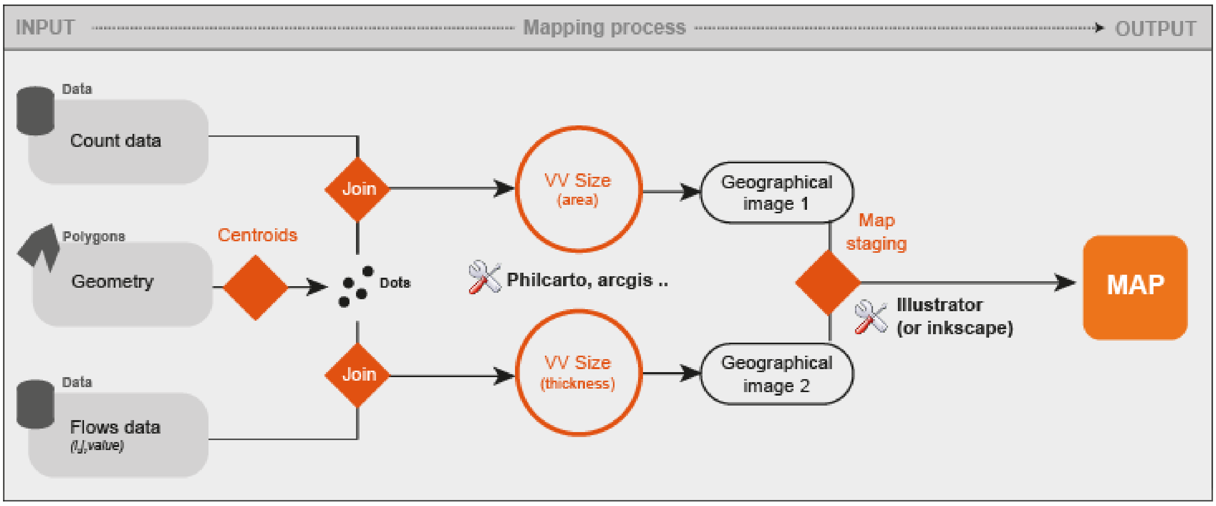
Showing movement on maps

Explanation

Flow maps, which generally use arrows and lines of variable thickness from one spatial unit to another, provide information on exchanges between places. The nature of these exchanges can be signalled by colours, and the scale of the exchanges by the thickness of the lines, while the direction of the flows are represented by the arrow heads. Thus flow maps can be developed from qualitative or quantitative data to express relationships between objects.

Representing flows between places is a recurrent need in cartography, and it is by no means simple. Indeed, while it is easy to draw lines between geographical objects that are calculated automatically to have a given thickness, the positioning of the flows in relation to each other or choosing the appropriate curve are not easy matters. Thus the cartographer requires great skill to reconcile the shape of the arrows and the organisational logic, at the same time minimising overlaps, to produce an intelligible, effective image. Here it is very important to suit the map projection to the nature of the flows under study.

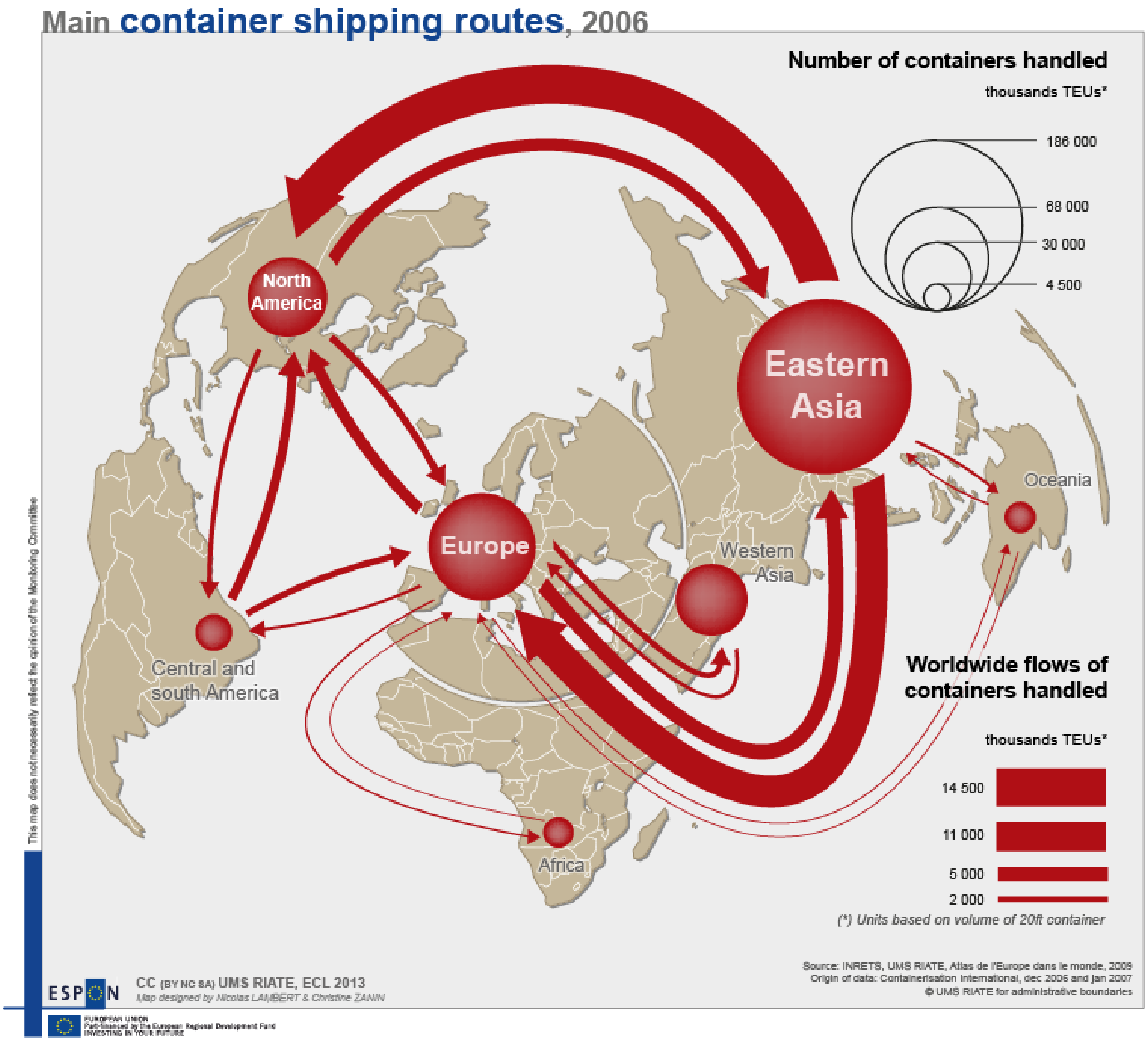
Mapping process



Appropriate Data: quantitative count data (absolute)

Data type

Map data: Container flows, 2006



This map, derived from the Atlas of Europe in the World, shows flows of containers handled across the world in 2006. The commercial routes, symbolised here by lines of varying thickness, show the intensity of exchanges while at the same time emphasising certain dissymmetries (the flows are directional). The lines followed by the various flows attempt to reflect actual container routes, but avoid any excessive precision that could hinder legibility.

Strengths	Weaknesses
Shows movements	**Can only show a small amount of flow data**
Aesthetic and effective	**Flows not easy to position**
	Labour-intensive (part of the task cannot be automated)

Software: ArcGis, Philcarto, Illustrator
To go further: Didelon C., Grasland C., Richard Y., (2008) : Atlas de l'Europe dans le monde, La documentation française. And Europe in the world (ESPON Project 3.4.1 Final Report December 2007)

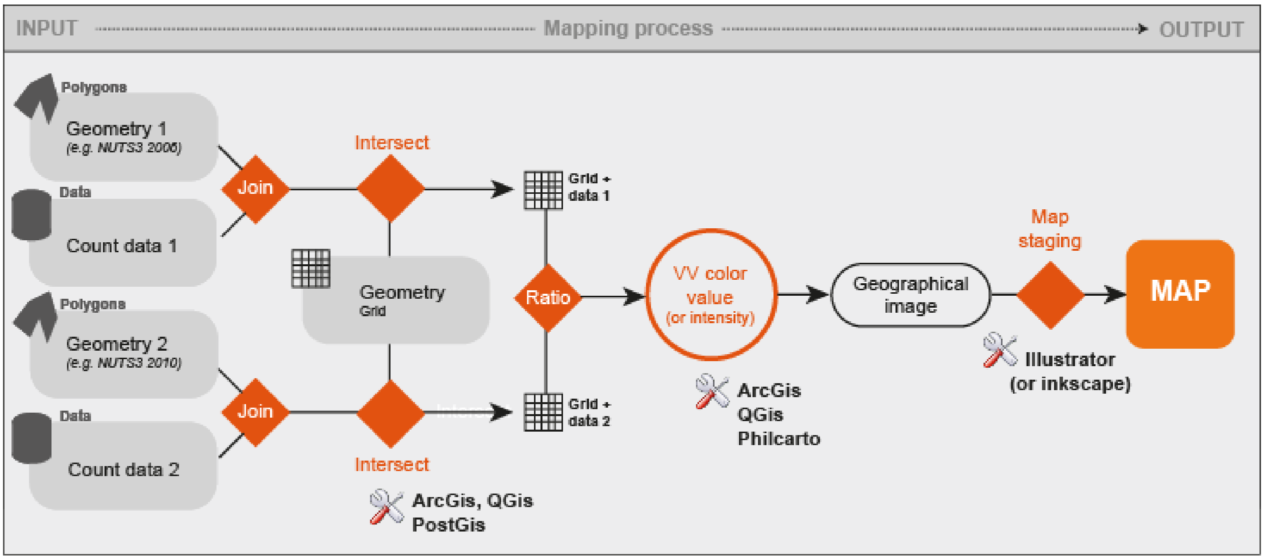
Grid maps

Removing administrative territorial divisions

Explanation

Grid maps are statistical maps that are developed on a neutral, regular grid. Most often a cartographic representation is based on an administrative system of subdivision which acts as a spatial filter for the geographical information (see Mapping Guide part 1). The more heterogeneous are the subdivisions, the more this "filter" will distort the message contained in the map. This is the case with Europe, where for instance at NUTS3 level the smallest administrative unit has a surface area of 13 km^2 while the largest has a surface are of 98249 km^2 (the overall average being 33000 km^2). The introduction of a regular grid is in this case one way of escaping from the administrative subdivisions that may not be relevant in the desired visual representation. The data is then spread across a regular square grid, within a particular projection, and placed on the map. The data obtained per square is discretised and then displayed as coloured areas across the grid. The principle used consists in allocating the count data associated with the administrative subdivisions to the squares in the regular grid according to the surface area covered by each. This method produces a map that combines territorial divisions possessing geometries that are not compatible (for instance regions and river basins). Nevertheless, the values of the data shown on the grid depend strongly on the underlying administrative subdivisions.

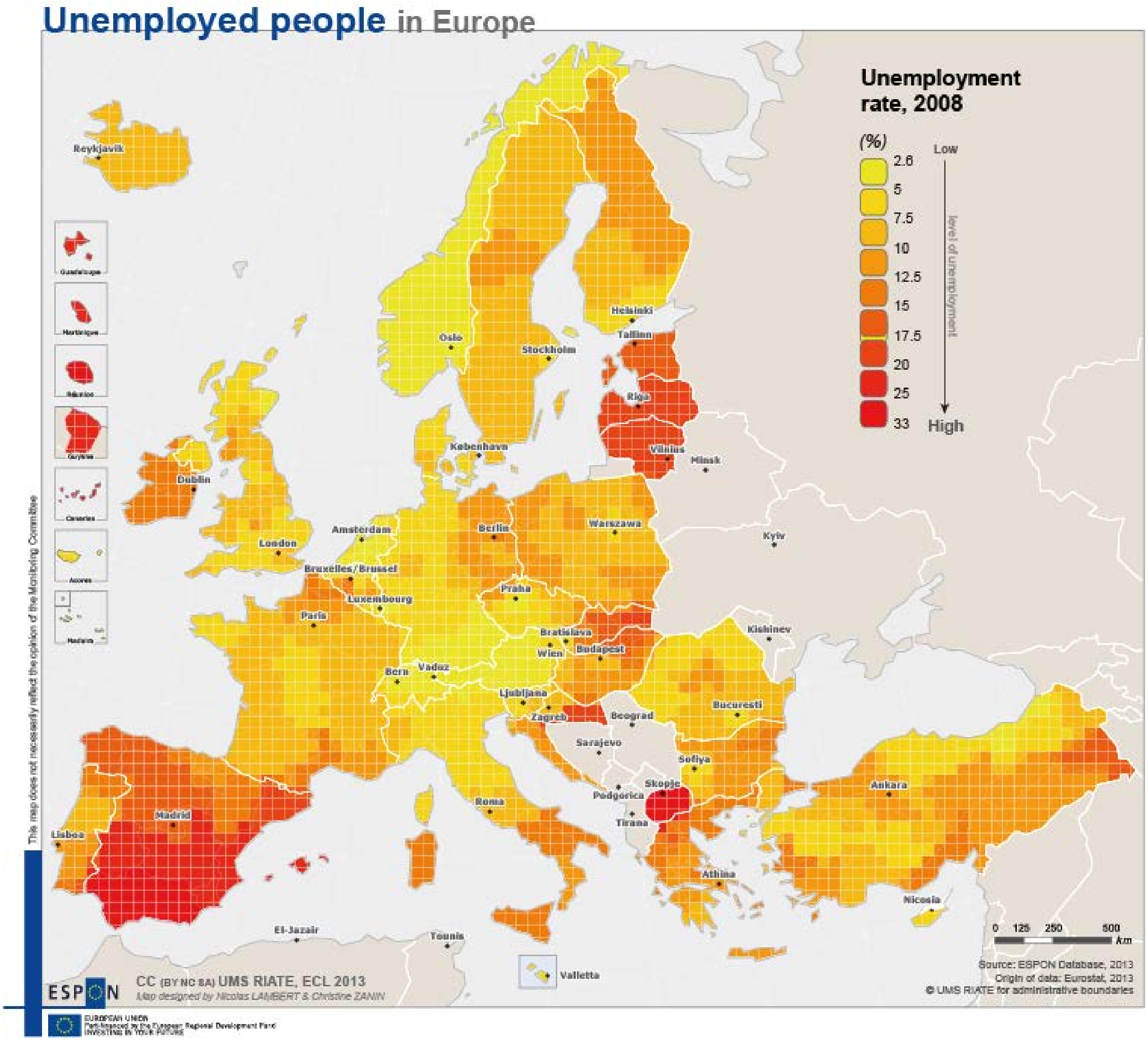
Mapping process



Appropriate Data: Quantitative stock data and calculation of relative or ratio values

Data type

Map data : Unemployment rate, 2008



This map showing unemployment rates in Europe has been developed using a regular grid. Each square is associated with an amount that is proportional to the surface area covered by the squares. It shows the main trends of the spatial distribution of an element of data, and enables its processing, because the territory is divided up into equal squares. Thus there is a shift from discontinuous representation to continuous representation of the information. It can be clearly seen that the peripheral and eastern areas are less privileged in terms of employment.

Strengths	Weaknesses
Combines incompatible territorial divisions **Phenomenon is viewed on a regular grid** **By varying the resolution, more or less generalisation is obtained**	**The method depends on the underlying administrative subdivisions**

Software: ArcG is ou QGis, PostGis, Philcarto, Illustrator or Inkscape
To go further: http://resources.esri.com/help/9.3/arcgisengine/dotnet/0b2a721b-ca71-4cf1-bf19-b6a946dfbb5e.htm#Overview

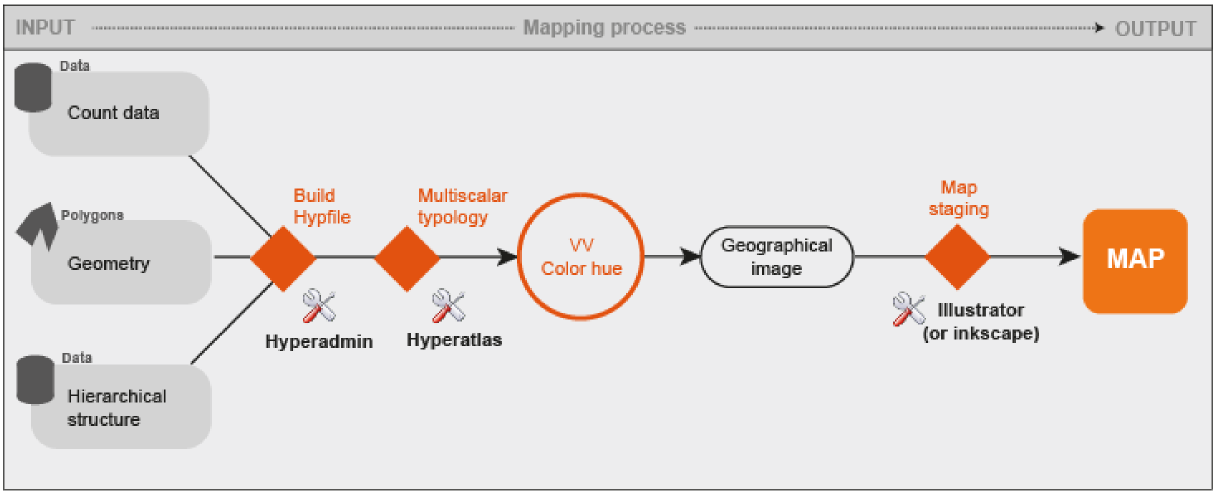
Typology maps

Organising geographical information into characteristic classes

Explanation

Typology maps enable the representation of a set of types so as to facilitate analysis, classification and study. They are often synthesis maps. Typologies are produced by data processing of varying complexity. Ranging from simple classifications according to a qualitative or quantitative dimension to results of specific statistical analyses, the typologies represented share the property of enabling the classification of spatial units into well-defined classes that are relevant in relation to the phenomenon under consideration.

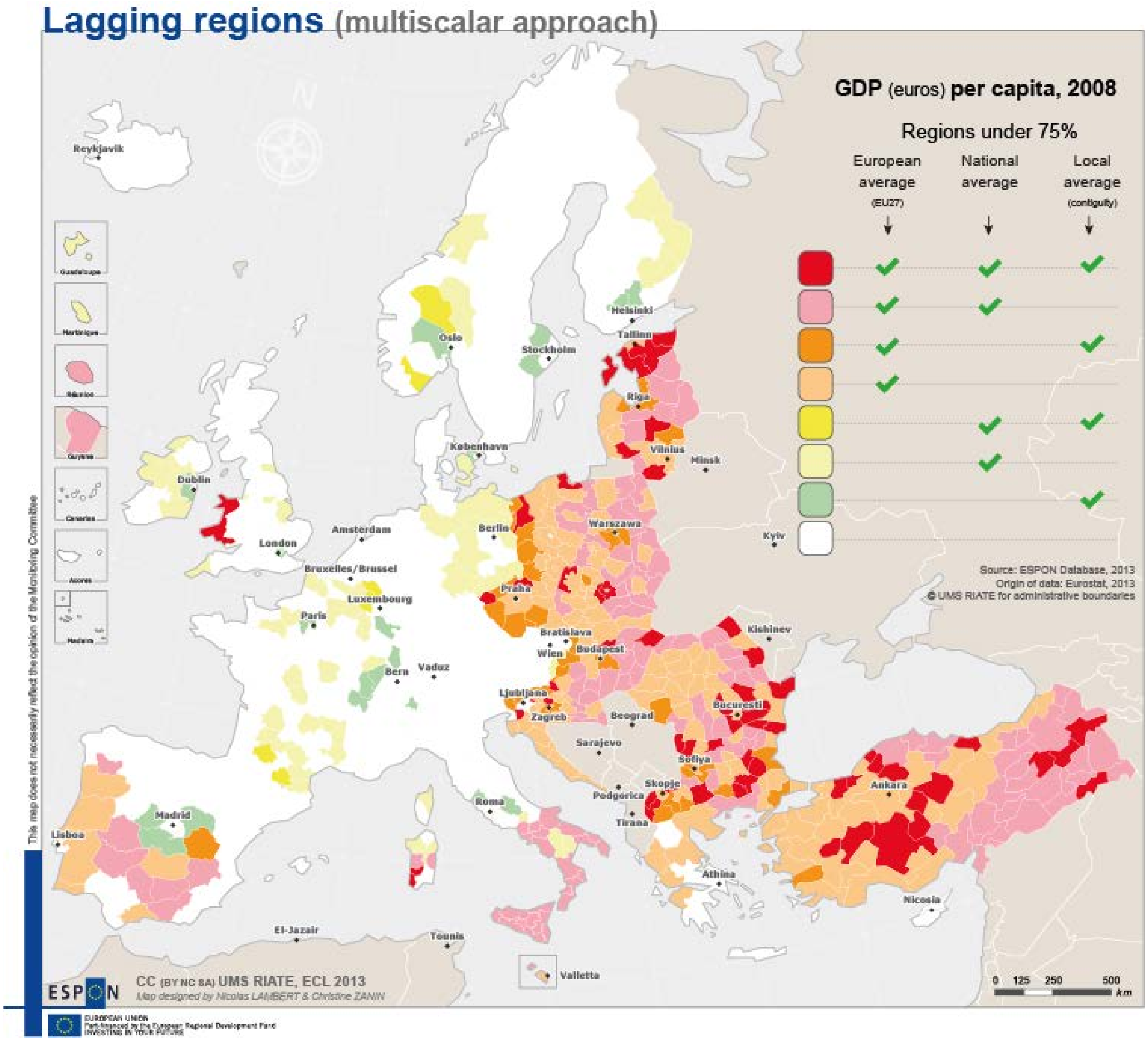
Mapping process



Appropriate Data: quantitative or qualitative data

Map data : Per capita GDP, 2008, NUTS 3

Data type



This typology, created using per capita GDP values for NUTS3 European regions, classifies the regions according to mean levels of wealth: the regions around the national mean, those round the European mean (EU27) and those around a mean calculated for adjacent regions. This map is derived from a multiscalar approach using the principles recommended by HyperAtlas.

Strengths	Weaknesses
Delivers a simple message	**Requires prior theoretical reflection**
Enables a synthesis	**Influenced by the method used**

Software: Hyperadmin , Hyperatlas, Illustrator
To go further: ESPON HyperAtlas:
http://www.espon.eu/main/Menu_ToolsandMaps/ESPONHyperAtlas/index.html

Mapping spatial scenarios

Some practical ideas to deal with spatial scenarios

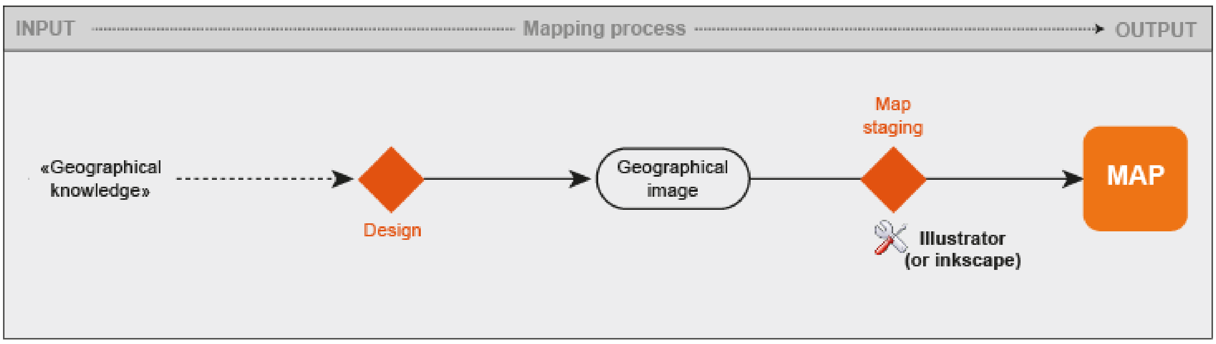
Explanation

Scenario maps. To understand a spatial phenomenon and to make it understandable, it needs to be simplified and "caricatured". This is especially true when the task is to map scenarios where well-defined hypotheses enable the representation of the different options. The representation of scenarios is a crucial issue for ESPON. Two solutions are set out below.

Diagrammatic maps and chorems. Chorematics, created in 1980 by Roger Brunet using the Greek word *chôra* meaning territory, is a discipline envisaged as an "alphabet of space" in which each element is an "elementary structure". It is a spatial grammar made up of 28 basic chorems, each of which represents a very precisely defined spatial configuration. Based on highly simplified geometrical shapes (a territory is often represented by a circle or a rectangle without any precise localisation), the combination of the different elements serves to make up what Brunet called a *carte-modèle*, i.e. a map in diagrammatic form. Rather than a straightforward map, a diagrammatic map is a genuine tool with elaborate rules for converting often complex geographical knowledge into an image. It has been widely developed in the French scientific journal "L'Espace Géographique", but this approach is still not widely recognised, in particular in English-speaking countries.

Synthesis diagram. This is simpler to implement than the chorem, and it can be a valuable tool for the synthetic representation of a geographical phenomenon. It is less stringent in its requirements, a sort of cartographic dissertation accompanied by a well-organised legend. Its aim is to respond in clear informative mode to a given question.

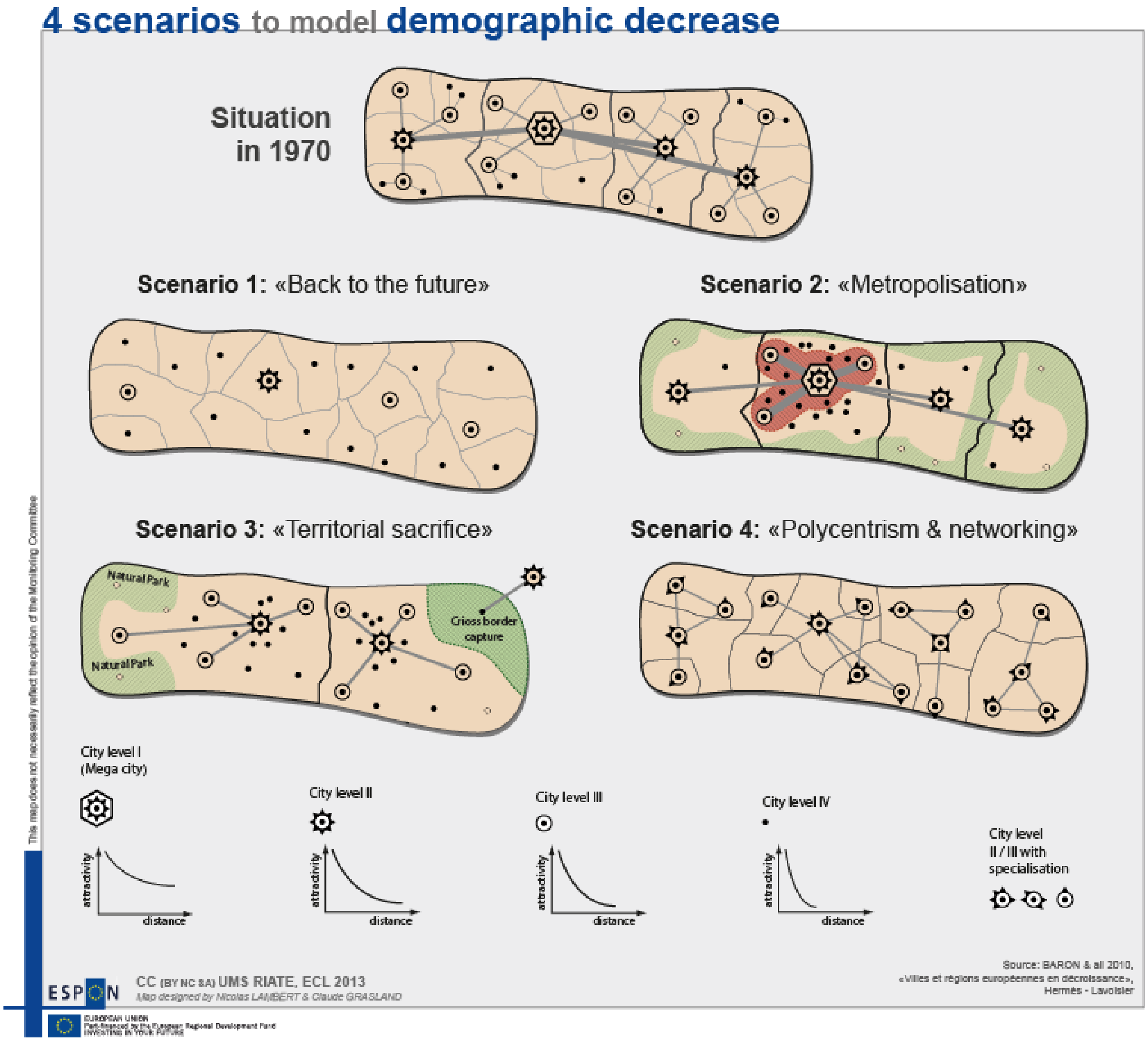
Mapping process



Appropriate Data: brainpower and geographical knowledge

Map data : A summary of the results of the study

Data type



This synthetic diagram developed for the book "*Villes et régions en décroissance*" (declining cities and regions) sets out four theoretical scenarios for the evolution of city systems and administrative subdivisions in the context of demographic decline. Although this diagram was derived from a study conducted on the EU, it was constructed in an abstract geographical space so as to give more emphasis to the content of the suggested scenarios. The situation at the outset is presented at the top and below four images show four possible evolutions. The cities are represented according to their size and level of specialisation; places are connected according to their levels of interaction.

Strengths	Weaknesses
Highly instructive	**The information represented is complex and interpretation takes time**
Enables the organisation and synthesis of complex knowledge	**Requires organisation and synthesis of complex information**

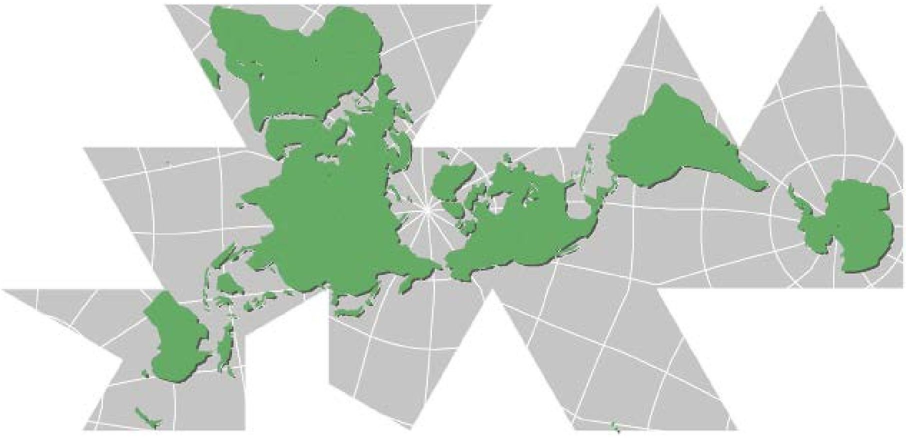
To go further: BARON M. & al, (2010), « Villes et régions européennes en décroissance », Hermès
BRUNET R., (1996), « La carte modèle et les chorèmes », Mappemonde n°4

FROM DATA
TO MAP

MAP «FACES»
OF EUROPE

3

THE POWER OF MAPS



« Mapping is ... an act of power »

(Jai Sen, 2008)

Foreword

A map is a diagrammatic representation of reality on a flat surface. It is "a flat, geometric, simplified, conventional representation of all or part of the Earth's surface, in a suitable relationship of similitude known as the scale" (F. Joly, 1976). There are two main types of maps: thematic maps and topographical maps. Theme maps, which are the subject of this manual, use precise rules to represent qualitative and quantitative phenomena (see parts 1 and 2). Topographical maps, sometimes known as base-maps, have the purpose of accurately localising places, borders and networks on a plane. These maps are not the subject of this manual, and would require a manual of their own.

« A map is not the territory » (Alfred Korzybski)

The third part of this guide opens the way towards more specific aspects of the design and implementation of maps, distinct from the "academic" rules presented in parts 1 and 2. It pinpoints certain specific issues that are essential for the reappraisal and enhancement of the modes of representation promoted and used by ESPON to date.

This third section can be used rather like a dictionary, dipping in here and there for the items that are relevant to one or other project. It can also be read as a narrative on elements that are usually mentioned in isolation, but which are those that give the map power, elements that enable the territory to be constructed or de-constructed, and enabling a particular approach, whether it is scientific research, popularisation, or policy-oriented and strategic. Indeed, even if the rules of "graphic semiology" are complied with to the letter, it is by no means certain that the perceived message will be the desired message. The context of publication, the cultural or religious setting, the age group and educational status are all factors that can bias understanding of the spatial information shown on a map. We therefore propose to cast more light on the small details that make a map an extremely valuable scientific object and/or a communication tool.

The map and the map-maker

"Maps are too important to be left to cartographers alone" (Brian Harley)

From the clay tablet dating from 600 BC discovered by Sippar in Iraq to the T and O maps and through to the digitisation of the world in three dimensions by Google, the way in which maps are designed has changed radically in the course of time. The cartographic epic, carried forward by scientific and technical progress, was long characterised by an aim for ever greater accuracy and precision in the localisation of the different places. Today, at a time when the whole world is being digitised in 3D by Google or the Open Street Map project, this target is gradually being reached. But this will not be the end of the cartographic adventure. Indeed, despite Google's claims that the "the future of the map isn't a map at all, it's information", tomorrow's mapmakers will more than ever need to place the issue of geographical knowledge and the usefulness of the map as a diagrammatic representation of space at the heart of their concerns. It is of course quite feasible to store increasingly precise digitised representations of the world in a computer, but this does not make the reality digitised in this manner any more intelligible. This is the real challenge for thematic mapping. Without questioning the usefulness of computer storage facilities, rather than aiming for levels of precision and accuracy that have little meaning, the real issue in cartography today is making geographical data intelligent and intelligible in an environment in which 80% of the information will be geo-referenced. This classic challenge may seem obvious, but it is an aspect that appears to be often forgotten by prospective users.

Thus the role of the cartographer is complex. At the crossroads of science, technology, ethics, politics and even art, the skills and knowledge required to develop a map are rarely all encountered in one individual. The cartographer is not a sole agent wielding all the power. Cartographers often find themselves at the meeting point between the different interacting skills that will enable a representation of space that has meaning and is as effective as possible. Thus the role of the cartographer is to convert the results of a scientific reasoning (whether or not he or she is behind it) into images via a visual transcription, using skills and knowledge that are specific to the trade. Technical and theoretical abilities of increasingly high levels are required. The cartographer needs to suggest analysis methods and techniques, and to implement a production process that requires a large number of different techniques. Choices need to be made at each stage, and they need to be reasoned and justified. The ultimate aim remains the processing of spatial information and its representation: a considerable agenda.

It is common to say that maps produced by cartographers are of two sorts. Either an exploratory tool or a communication tool: a map is at once the starting-point and the endpoint of geographical reflection. Thus a map is an intellectual construction that is based on the experience and knowledge of the cartographer, the data he or she has available, and the initial hypotheses. When it aims to teach or inform, a map is also *purposeful*, that is to say it is piloted by objectives, and seeks to deliver a message that is as clear as possible. Thus a map is necessarily a caricature, one way among others of casting light on a complex reality that it is impossible to apprehend as a whole. Michel Foucher[10] offers a synthetic definition of the map integrating these two aspects: a map is "a purposeful representation based on information relating to the world that we know at the moment when the map is created". Thus each map is the result of conscious or unconscious choices, and it is intrinsically subjective. It is not reality that we can see on the map, but a representation of reality. Creating a map is setting out geographical knowledge in such a way that it is intelligible from the image, it is a way of "narrating" the Earth. Of course, several different narratives are possible, and sometimes at odds with each other. The map is not a territory, but one representation among others of the territory.

The power of maps

"Refraining from choice is still choosing" (Jean-Paul Sartre)

Mapping is an act of power

The British geographer John Brian Harley was a precursor. Very early on he wondered whether the geographical map actually was an objective representation of reality, or whether it was not rather a social construction. He answers this question by describing the map as a tool for surveillance and power over a territory by a government. For Harley, the map is a representation that cannot be seen independently from the social setting in which it is developed. It therefore always exerts a form of power. Harley considers that a map intrinsically carries an ideological discourse. The "powers" wielded by maps are of four types:

- the map as an administrative tool. In France, it was Napoleon who created the *cadastre* or land registry in 1807 so as to levy tax. In Britain, this was established in 1862 with the Land Registry Act. Centralised and standardised mapping of land ownership is clearly a tool for authority and exercise of power.

- the map as a tool for economic power. Anyone able to produce detailed maps possesses a considerable asset in determining trade routes or developing geo-strategic plans. Likewise, producing statistical maps on a fine scale over a supra-national space enables the organisation and promotion of territorial development strategies.

- the map as a tool for war. The ability to produce detailed maps of battle fields has always been a decisive element for the military, and this is still true today, with the additional assistance of remote detection and 3D.

- the map as a tool for territorial sovereignty. At the present time, there are still disputed borders. Whether in Western Sahara, Kashmir or Palestine, producing maps showing these disputed territories and showing borders to the nearest metre is indeed a way of rooting territorial claims in reality.

[10] Foucher M. 2010, La Bataille des cartes, analyse critique des visions du monde, François Bourin Editeur, 176pp.

Thus one thing is clear: maps are hugely powerful. Drawing a map is seizing power, with the pen as sole weapon – deciding on the smallest line, selecting, exaggerating, or even deceiving (Ingrid Saumur[11]). The Green Line in Cyprus is a good example[12]. In theme mapping this power is even easier to exercise – it is possible to do away with certain administrative subdivisions, so that the base map is distorted. Or the message delivered by the map can be at the expense of a faithful representation of the geographical reality, rendered redundant. Creating a map is stating a viewpoint. Since many were aware of this danger, the production of maps and statistics was for a long time centralised in state departments and often "protected" by national security. Today, in the era of participative mapping and open data, this centralised model seems to have run its time. In the era of Geoweb 2.0, anyone can produce a map from their own data or data downloaded free of charge.

Maps are subjective

There are a thousand and one ways to map a geographical phenomenon. Yet maps, as products of scientific research, are almost considered to provide irrefutable proof. If it's on the map, then it's true, is the general feeling. This is however deceptive, since maps can indeed deceive. Since it is a graphic representation that to be legible does not enable all the elements of reality to be shown, (information is selected, aggregated, hierarchized, etc.) a map is nothing more than a subjective view of reality: "In order to reproduce in a meaningful manner on a flat piece of paper or a video screen the complex relationships of a three-dimensional world, a map must distort reality"[13]. Another cartographer reiterates this notion by adding that the art of cartography is to show what we want to show, the map "only gives an amputated, incomplete, partial or even adulterated image of reality"[14]. Thus maps lie, if only by omission. And this is how things should be. Producing a neutral image intended to be as close to reality as possible is in fact not particularly worthwhile. To narrate something, to present a hypothesis or to defend a viewpoint, a map is the result of choices, whether they are conscious or not. Choosing not to choose is still a choice, as Jean-Paul Sartre had it[15].

Behind the ESPON maps of Europe

We have just seen that maps are quite clearly political tools. Beyond this, a map can be analysed in three ways: what is shown on it, what is not shown, and the way in which information is hierarchized. Thus if we analyse a map, a lot can be learnt about the context in which it was produced, and what is concealed beneath the mere representation of the information, its hidden purposes, and so forth. This is even more true if we consider maps of Europe, a space in which the political issues are extremely pervasive, and which is evolving from one day to the next.

Can ESPON maps tell us the secrets of the European territorial development programme?

First of all, ESPON maps are markedly harmonised and provided with a clearly stated visual identity. Blue predominates – the colour of the European Union, but also a colour of consensus. The ESPON

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[11] http://strabic.fr/Cartographier-le-pouvoir-supreme.html

[12] In December 1963 a British army officer drew a line with a green crayon on a map of the capital city to mark the separation between the Greek and Turkish communities on the island. Since then it has been known as the Green Line.

[13] Mark Monmonier, 1993, *How to Lie with Maps*, The University of Chicago Press, 2nd ed. 222 p.

[14] Philippe Rekacewicz, février 2006, Le Monde Diplomatique.

[15] Jean-Paul Sartre, 1996, *L'existentialisme est un humanisme*, Gallimard, Folio essais n°284, 120 p.

maps are well-made, without semiological errors but with no frills. They use the Eurographics base-map, which is a guarantee of quality, but there is also a level of precision that can hinder easy reading of the information on the map, at least in the case of theme maps. They are maps that no-one takes a dislike to, too bad if they merely deliver a message that is run-of-the-garden or already known.

These cartographic representations rarely escape from MapKit, and rarely attempt to produce anything but straightforward maps with coloured fields or other simple representations that are on standard offer in GIS software. Thus although there are few semiological mishandlings, we hypothesise the few cartographers or geo-visualisation specialists hold major positions in the TPGs, which appear mainly to include thematic mappers.

Regarding the space represented on ESPON maps, Turkey appears less than 4 times out of 10, and sometimes with missing data, while the capital of Lichtenstein appears on every map. Is this not a highly political choice? Yet, ESPON protects itself, and assigns responsibility for content to the project in question: each map is to present a clearly visible central indication of the non-involvement of ESPON in the choices operated in the presentation. The disclaimer is included in a yellow rectangle and states: "This map does not necessarily reflect the opinion of the ESPON Monitoring Committee".

In synthesis publications by the ESPON programme, "cold" colours are used to represent high values, while warm colours are used to represent low values. This practice, found in the countries of northern Europe, is not unanimously welcomed, because in southern Europe it is often the warm colours that are used for high values. This could well reflect a power balance in the EU in favour of the northern countries.

Finally, over time, the harmonisation of cartographic procedures has been improved. This reflects greater integration in the EU, and convergent working practices. This convergence is also observed in other European bodies, since a common projection has been adopted to enable interoperability between geographical objects. However, this harmonisation is at the expense of map diversity, since it has been observed that in the same period the number of "original" maps has diminished. This effort to harmonise probably arises from the fact that the ESPON programme has not opted between being a study bureau with a flourishing map production (and too bad if the results are contradictory, so long as they provide food for thought to political decision-makers and practitioners) and being one of the Commission's official production bodies, in which each map produced needs to be checked to ensure that the message delivered is in line with a pre-established communication strategy.

In conclusion, is can be noted that ESPON maps are abundant on the Internet, they offer a view of Europe that has been collectively constructed by the various actors in the programme. The issue is not to know whether this view is coherent with reality, nor is it to determine whether it consciously serves a particular point of view. The aim here is to understand what is concealed behind the maps, and thus to know what needs to be changed to obtain more innovation in mapping techniques. It may well not be just a problem of technique or software...

The power of colours

"Handling colours and lines is not really a matter of diplomacy,
because the real difficulty is tuning them all*" (Raoul Dufy)*

Since geographical maps are increasingly intended for viewing on a screen, there is no reason to hesitate to use colour. The choice of the "right" colour is however a highly cultural issue. Understanding how colour works enables awareness of the impact of this choice. Here the aim is not to provide precise guidelines on the colours that must be chosen to get things right, it is rather to point out the main aspects of the power of colours in mapping. The dimension, the harmony, and the perception and meaning of colours are major issues.

The dimensions of colour

The human eye possesses three types of cone enabling the perception of the quantities of blue, green and red in white light. The total intensity of the light perceived and the proportions of these three primary colours enable the eye to see the different colours, according to three dimensions, known as HSL - Hue, Saturation and Lightness.

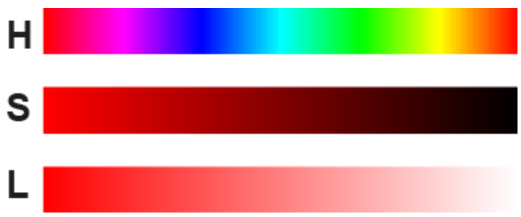

Figure 16: The dimensions of colour

Hue (such as red, green, or blue) can be used to categorize features that are qualitatively different, such as a river and a road.

Saturation (or intensity of hue, such as bright red as opposed to a dull, grey red) can be used for qualitative or quantitative data.

Lightness (or value) can be used to represent data quantitatively (either rank-ordered data or numerical values), such as population density. The value is typically light for small numbers (e.g. light green) and dark for large numbers (e.g. dark green).

Colour harmony and perception

In cartography as in matters of dress, not all colours go well together. Also, while some colours are best not combined, for aesthetic reasons, handling colours when designing a map above all requires consideration of the various types of information that the variable is to transcribe graphically. Indeed colours are perceived differently according to context, and they are not easy to use. Here are a few examples[16].

Below, two small grey squares are positioned in two larger rectangles, one light green and one dark green. The two grey squares are identical, yet the left-hand square appears darker than the right-hand square. Thus when the square is surrounded by a light-coloured ground, the eye will tend to "darken" the grey square to see it more efficiently, while when it is surrounded by a dark ground the eye will tend to lighten it.

Figure 17: Colour perception, example 1

The context can therefore be very misleading in the perception of colour. Below, the eye will tend to perceive the two small squares in the same manner, yet the colours are different.

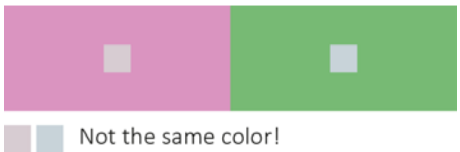

Figure 18: Colour perception, example 2

The combination of certain colours can also make perception difficult or impossible. In the figure below, the blue square is perfectly visible when on a light green ground, but it is barely visible on a dark green ground. It is however the same blue.

Figure 18: Colour perception, example 3

In a last striking example[17], belonging to the sphere of optical illusions, the impact of context on colours is clearly seen. In the figure below the two grey surfaces indicated by the arrows are equal.

[16] Examples after Kingsley and Wood (2011). They were designed to be seen on a screen. A paper version might not be ideal.
17 http://ngc-qa.nationalgeographic.com/channel/brain-games/galleries/brain-games-watch-this-pictures/at/optical-illusion-37418/

This is hard to believe. To be certain, conceal the central part with one finger of a piece of paper – surprising!

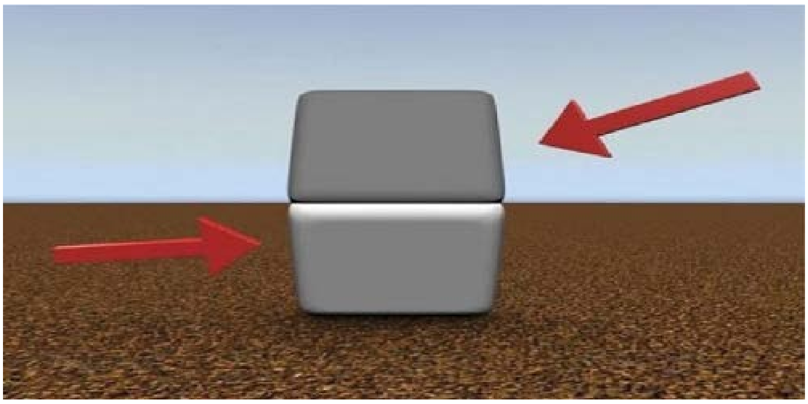

Figure 19: Colour perception, example 4

ColorBrewer: a web tool for selecting colours for maps

ColorBrewer is an online application offering a wide range of colour palettes for map-making that is free of charge. This tool, available at the following address: http://colorbrewer2.org/ is a useful function available to map-makers to choose and test different options.

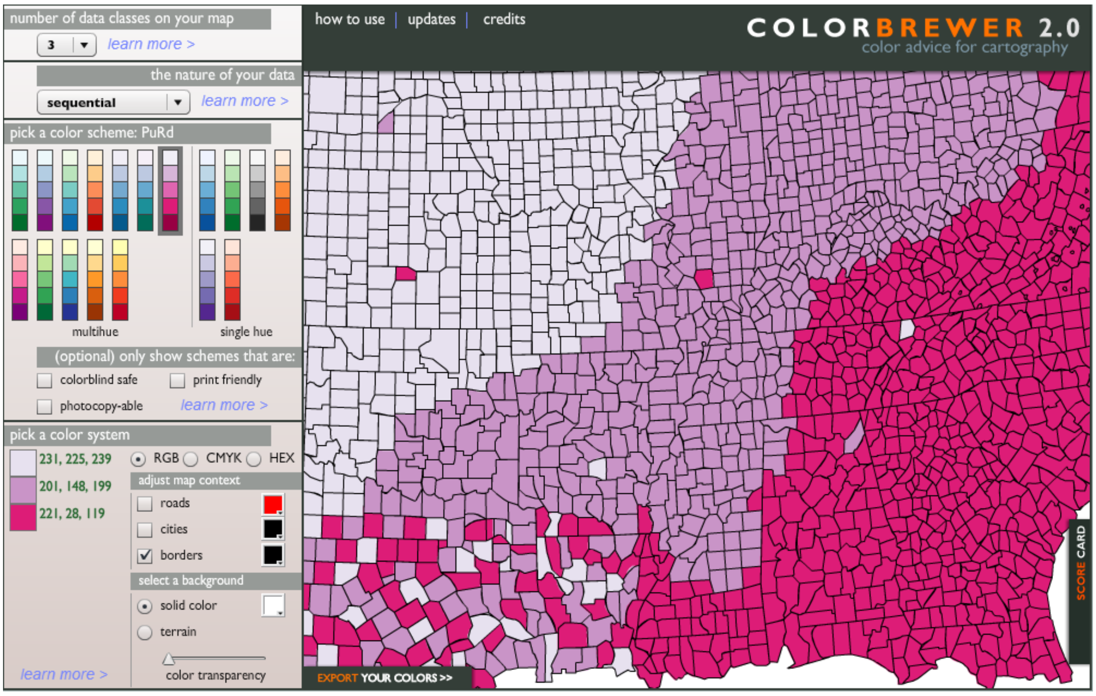

Figure 20: ColorBrewer online application

Under Flash[18], the application enables the user to determine the number of classes on the map (from 3 to 12)[19].The user then chooses among three types of data: sequential, diverging or quantitative. Following these two choices, numerous colour ranges are offered in single or multi-hue.

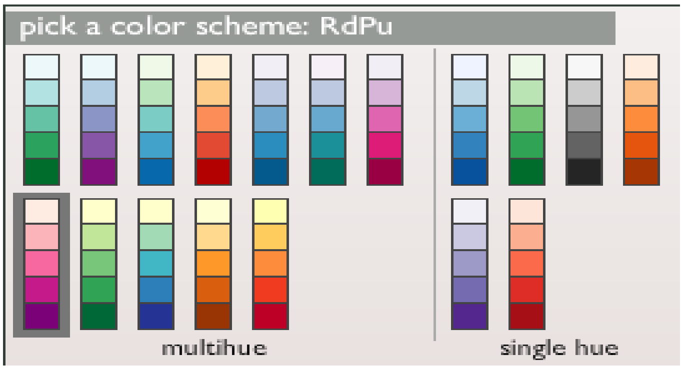

Figure 21: ColorBrewer palettes

Each of the palettes available can then be assessed according to various criteria: ability to be seen by colour-blind individuals, "printer-friendliness", use on LCD screen etc. Thus the user has at hand the various prerequisites for an efficient implementation of the different palettes according to the base-medium used for the map. The colour palettes are exportable in different formats and easy to use in graphics software. Despite evident qualities, it can be noted that the palettes are often not sufficiently contrasted, which can be detrimental to the clarity of the information shown.

Colours and themes

Numerous paper and online atlases have established links between colour palettes and the subject-matter. This is true for instance of the Interactive Atlas of European Regions[20] (AIRE), which uses 5 different palettes, each corresponding to a topic in the Atlas. This graphic procedure is effective in terms of communication, since it is a further element available to the user to gain rapid understanding of what the map is about. Thus the method can be recommended for synthesis documents in the ESPON programme. However attention should be paid to the fact that not all maps cover just a single theme. Finally, this technique is of course unsuited to TGP reports, often covering a single theme but requiring the use of several colours.

A proposal for colour palettes for each of the themes in the ESPON database can be made, and adapted to each objective.

[18] Adobe Flash® Professional
[19] It can be recalled that a large number of classes makes differences difficult to perceive between certain colours or shades. Choosing to present information in 12 classes is thus often not useful, or even counter-productive. It is strongly recommended (see part 1 of this guide) to divide up the data into 3 to 7 classes at most. There can be more classes in some cases where the spatial structure is regular and reflects a continuous organisation in space (e.g. potentials).
[20] http://aire.ums-riate.fr

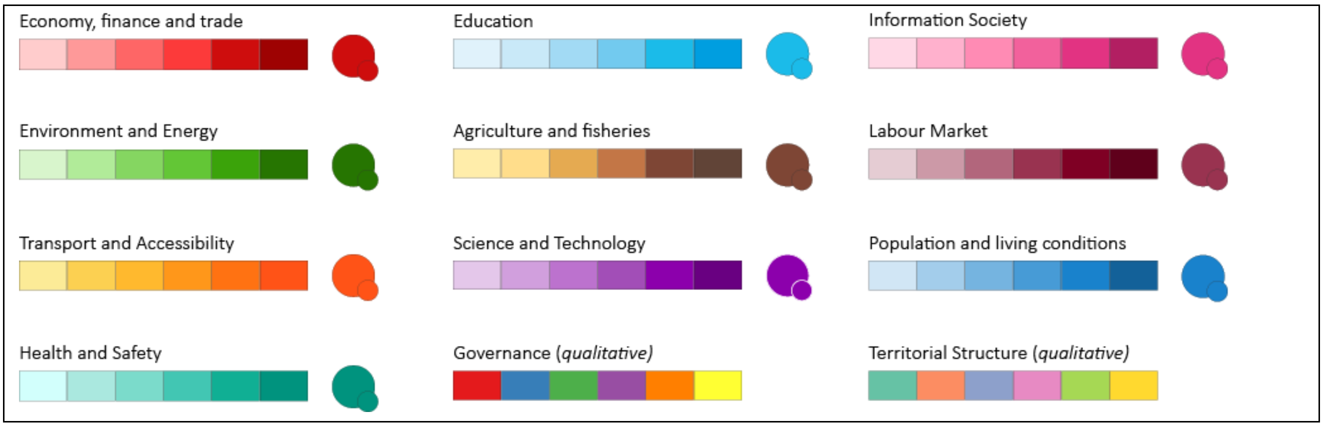

Figure 22: Proposal of colours schemes for ESPON

Meaning(s) of colours

Allocating a colour to a theme is nevertheless a delicate operation. Across the world each culture gives specific meanings to different colours. These meanings can be powerful, depending on the environment and the experience of each individual. Connotations are cultural or symbolic, they sometimes echo experience, sometimes emotion. Connotations give colours meanings that should, as far as possible, be taken into account in mapping procedures.

Blue is the trans-cultural colour, the colour of the sky wherever one is standing. It suggests consensus and wisdom. It was neglected in Antiquity because it was difficult to manufacture, it was the colour of the Barbarians, of foreigners. Today blue is not conspicuous, it has lost it symbolic strength and has become a discreet colour. It is also the colour of the Europeans.

Green expresses fertility and paganism in Europe. It stands for Islam for Moslems, and for grief and mourning in Asia. Green is considered as bringing evil in show business. It can stand for Nature and cleanliness, and alongside for dishonesty and hypocrisy.

Red is fire, blood, and love, but also hell and danger. Red draws the eye, it is the colour that contrasts with the rest of nature. Red is of course Communism, but it is also the colour of purity in India.

Yellow is infamy, the foreigner, the traitor, the one who cannot be trusted. Yellow was the colour of the robe worn by Judas. But in Antiquity the colour was much appreciated. In china, yellow suggests wealth and wisdom, and was for a long time reserved for the emperors. In the Philippines yellow represents peace and resistance.

Brown represents mourning in India, the Nazis in Europe, and it is a ceremonial colour for the Australian Aborigines.

Purple is dignity, royalty, elegance, and wealth. It is also often the expression of death and crucifixion (in particular in Europe) and of prostitution (in the Middle East).

White is purity and innocence, and divine light. But is represents mourning and sadness in India and the Moslem world!

Black suggests fascism, anarchy and other negatively connoted extremisms. Black also represents mourning, but not in Asia where is represents death (mourning being in white). Black is the opposite of white.

Grey, is between black and white, and suggests reserve and dullness. It expresses tranquillity, or even sophistication. It is however easy to use since it "goes" with all the other colours.

Beyond the cultural meanings of the different colours, cartography often uses colours for their likeness to those encountered in the natural world. Thus blue is widely used for lakes and oceans, and green for vegetation and natural environments. Brown is used for arable land or mountains, and red for danger (what is red in the natural world is often venomous). White signals absence of information.

In all events, beyond the culturally-bound meanings of colours, if there is one thing to recall for the use of colours in mapping, it is the very strong negative or positive impact that colours can have on perceptions AND understanding of spatial information. Colours enable varying weights to be allocated to the spatial forms shown. When they are well-used they considerably enhance the effectiveness of the map. When they are not, they reduce the effectiveness and even change the meaning.

The rules of the "mapping" game

"Cartography draws on the sort of ambiguity that arises at the confluence between exact science and art" (Jean-Claude Groshens)

The rules set out here enable a number of fundamental points to be highlighted in the design and production of a map. They take the form of 10 simple questions and 10 rules for map "staging".

10 questions to ask before designing a thematic map.

1- Do I really need a map? Would not a graph or a table be more relevant?
2- Do I need one or several maps for my purpose?
3- Whom is my map intended for? Who will be looking at it?
4- Will the map be published? If so, where and how? Will it use colours?
5- What is the message to be delivered by the map?
6- What is the space concerned in the chosen representation?
7- Are the data available? Do they require processing?
8- What are the semiological rules to suit the data to be represented?
9- How can the perception and legibility of the map be enhanced? How important is the aesthetic aspect?
10- What can contribute to the legibility of the message?

10 rules to apply when designing a thematic map.

1- It is not always a map that "meets the bill".
2- We need to accept the need to reduce the amount of information, and not to attempt to show everything on the map.
3- A map is designed for a specific "audience", and when the audience changes the representation will also change.
4- The context in which a map is published influences the way it is perceived. A paper map and a map on a screen are not read in the same manner, and they cannot therefore be designed in the same way.
5- A map has a particular message, which should be carefully defined before embarking upon the production process.
6- The choice of the base-map delivers a message. The base-map should be precise as to its extent, and unobtrusive (via generalisation).
7- The data processing should render the spatial information simple and comprehensible. It needs to be performed with accuracy, and the sources should be properly identified.
8- Each piece of data is transcribed using a precise graphic sign enabling the ranking, quality or quantity relationship to be represented. Information should be hierarchized, and non-useful information should be removed.
9- The aesthetic aspect should not be underestimated for successful mapping. For instance a black line should never be 100% black, it is better to choose 80% so as to avoid over-sharp contrasts.
10- The way a map is "staged" contributes to an effective map.

10 rules to apply for an effective "staging" of the map.

1- The layout (arrangement) and staging of the map are important factors in the understanding of the spatial phenomena represented on the map.
2- Staging is performed in accordance with the shape of the space represented.
3- The layout of the different elements should be organised as close as possible around the map without crowding it.
4- 4 elements in the layout are essential: the title, the legend, the date, and the data source.
5- Further elements can enhance certain representations: scale, orientation, latitude and longitude, place-names, insets (with changes in scale) and publisher's indications
6- The elements making up the map should be hierarchized.
7- The title should express what is on the map (and not the fact that it is a map).
8- The legend is the "dictionary" of the map. It should present exactly the same symbols as those used on the map. The title "Legend" should not be used
9- Text on the map should be legible, and place-names should be easy to localise. Text should never interfere with the data or the layout of the map. Different fonts and colours can be used to establish a clear association between text and the characteristics of the map.
10- Visual balance is always an important consideration in the design.

M. A. P. S. = Message + Artistic + Purpose + Scientific

Producing a map is delivering a **message** by way of an image. The message should be clear, intelligible and as simple as possible so as to facilitate memorisation. Cartographic images need to sum up geographical information in "immediately perceptible" form. To do this, J. Bertin considers that "the effectiveness of the message will be all the greater if the number of images (separate or superimposed) and their complexity are reduced, and the map can be read as a whole".

To be attractive and possess high communication potential, a map needs to be aesthetically pleasing, and the finishing touches require considerable attention. Thus the **artistic** aspect is very important. A good map will be one for which the cartographer is careful to process the various "trappings" of the map, and to use colours wisely. The communication power of the image created in this manner, pleasant to look at and set out in relevant manner, will inevitably be more powerful.

A map should be specifically designed for a single **purpose,** and suited to the **target audience**. Thus the cartographer needs to know for whom the map is intended, and to adapt the production procedures accordingly. A map should not be designed in the same way according to whether it is intended for scientists or for stake-holders, whether it has a genuine teaching function or is merely a working document.

Finally, we should not forget that a map is also and above all the central object of geographical reflection. It is a scientific object developed according to strict, precise rules. Indeed, although a map is subjective and constructed according to a communication objective, and also has a viewpoint, it is nevertheless not possible to completely warp reality. Thus the cartographer has the task of processing data carefully and transcribing it graphically according to strict rules established by the scientific community. Each map should be reproducible, and therefore is open to scientific controversy.

ANNEXES

Tools for designing the ECL Maps

This list does not provide a state-of-the-art detailing all software available in the area of geomatics. It merely describes the programmes used to produce the maps in this guide. The software concerned is wherever possible available free of charge. Only commercial software with a genuine comparative advantage over the open source equivalent is indicated.

GIS

ArcGIS is a proprietary GIS (geographical information system) developed by Environment Systems Research Institute Inc. (ESRI). It is efficient and user-friendly, and is in reality part of an office range that can be completed by adding specific modules
http://www.arcgis.com/

Quantum GIS (QGIS) **(FREE)** is open-source GIS software licensed by GNU General Public Licence. Qgis, which is an OSGeo official project (Open Source Geospatial Foundation), runs under Linux, Unix, Mac OSX, Windows and Android. This GIS is user-friendly and continuously evolving, and a good free-of-charge alternative to ArcGis.
http://hub.qgis.org/projects/quantum-gis/wiki/Download

CARTOGRAPHY

Philcarto **(FREE)** is free cartographic software for the production of thematic maps. It was developed by Philippe Waniez, geography professor in Bordeaux University. This tool enables the easy design and production of different types of theme map, using an instructive and intuitive approach.
http://philcarto.free.fr/

rCarto **(FREE)** is a thematic cartography package under R developed by Timothée Giraud, UMS RIATE. Available from CRAN, this package is still being developed, and enables users of R to produce thematic maps easily in a universe that was initially intended for statistical processing.
http://cran.r-project.org/web/packages/rCarto/index.html

DRAWING/INFOGRAPHY

Adobe Illustrator is proprietary software for vector graphics developed by Adobe Systems. It is very useful for the layout of maps, and an essential tool for finalising maps.
www.adobe.com

Inkscape **(FREE)** is an open-source tool for vector graphics. It is based on Scalable Vector Graphics (SVG) and is a free-of-charge alternative to Adobe Illustrator. Its scope is however much more restricted when large numbers of graphic objects have to be dealt with.
http://inkscape.org/

SMOOTHING

Digitaline **(FREE)** is a free-of-charge programme developed by Joël Boulier, a geographer in Paris 1 University. This tool enables in particular the calculation of potentials according to different interaction functions.

Hyantes **(FREE)** is a library under C enabling the calculation of potentials in a given neighbourhood. This tool was developed by the Mescal team in a Grenoble computing laboratory (LIG), a member of the HyperCarte research group.
http://hyantes.gforge.inria.fr/

CARTOGRAMS

ScapeToad **(FREE)** is a user-friendly tool for creating cartograms. It is based on the Gastner-Newman algorithm, and is an open-source that is free of charge and the best way available to perform these cartographic conversions with minimum error.
http://scapetoad.choros.ch/download.php

GeoDa **(FREE)** is a free programme for data analysis and geo-visualisation. In particular, it enables the creation of Dorling cartograms.
https://geodacenter.asu.edu/software/download

3D

ArcScene is a 3D viewer that is well-suited to generating scenes in perspective that enable navigation and interaction with 3D vector and raster data. When backed up by ArcGis, this tool enables in particular the production of prism maps.
http://www.arcgis.com/

Surfer is a 3D visualisation programme that runs under Windows. It was developed by the GoldenSoftware Company, and enables the export of 3D representations in vector format.
http://www.goldensoftware.com/products/surfer

Cartographic Glossary

This glossary is intended to enable the identification of technical terms in cartogapahy used in this guide. Numerous dictionaries and cartogaphy manuals have been used to find suitable definitions. The references used to draft these definitions are provided at the end of the glossary.

- A –

Animated map: Map displaying changes either over time, or through space, or both. Animated mapping is the application of animation, either computer or video, to add a temporal component to a map

Area: A roughly bounded part of the space on a surface, e.g. a region

Amount: The quantity associated with a feature.

Arrangement (layout) : The way things are placed on a map.

- B –

Base-map: A map showing essential outlines, where additional geographical or topographical data can be placed. It provides the "container" for a map and references that can provide different geospatial information frelevant to what the cartographer is trying to communicate. A map containing basicinformation, from which maps showing specialized information can be prepared.

- C –

Cartogram: a map showing statistical information in diagrammatic form. A cartogram map is a simplified or abstract diagrammatic representation of statistical data, usually on a base-map or a distorted base-map.

Choropleth maps: symbols or marked and bounded areas on a map denotie the distribution of different phenomena. Choropleth maps are thematic maps based on predefined areal units. They are intended to show only one specific set of data. Because each group of data is organized as a ratio value, (a zero value for comparison is present), we use a graded color ranges to show the least intensity to the greatest intensity (using light to dark colours). Each data collection area is assumed to be homogeneous. From the Greek terms choro meaning place, space, or land, and pleth meaning full.

Classification: Ordering, scaling, or grouping into classes that simplify features and their attributes.

Color (Hue): Colors that are qualitatively different. Hues are appropriate for showing qualitative data. “What we think of as the *color*, such as red, green, or blue”.

Color Value: Perceived lightness or darkness of a hue. Different colour values are used to show qualitative ordered data and quantiative density or ratio data.

Color Intensity: describes the amount of white in a hue. Intensity is useful to show qualitative ordered and quantitative density or ratio data.

Continuous phenomena: Geographic phenomena that have continuously changing values over space.

Continuous surface: A continuous surface map (or isopleth map or smoothing map) is a map representing a geographic phenomenon where numerical values alter smoothly across the area mapped.

Count data: numerical data that canb be counted, summed or averaged

Count value: the total number of point, line, or area features within a data collection unit

- D –

Density value: A value obtained by dividing the count value by the area of its data collection unit.

Derived data : A value obtained by calculation : densities, rates, and intervals are derived data.

Discrete feature: A point, line, or area (zone) feature, such as an individual house, tree, or parking lot.

Discontinuity: A break in the continuity of values

Discretization: Refers to the process of converting continuous features or variables into discretized or nominal features.

Dot Density: Used to show the distribution of phenomena where values and location are known. Dot maps create a visual impression of density by placing a dot or some other symbol in the approximate location of the variable being mapped. Dot maps should be used only for raw data, not for processed data or percentages.

Dot unit value: The amount that each dot represents on a dot density map (must be greater than one).

- E –

Equal area projection: has the property of preserving the relative size of regions everywhere on the map projection.

Equal number intervals: A procedure used to assign class intervals to a numerical distribution so that the numbers of items in each class are as close as possible to equal.

Equal range intervals: A procedure used to assign class intervals to a numerical distribution where the range of data values is divided by the desired number of classes to obtain intervals with the same range.

- F –

Feature: A geographical object in a representation system.

Flow line: a l line symbol used on flow maps to represent movements. Its thickness can be roportional to the intensity of the flow.

Flow map: A map that shows flows bay way of a line.. It can also show ratio data and changes in magnitude

- G –

Generalization: the process of reducing the amount of information on a map by changing the geometric representation of the features.

Geographical Information: Localized information. Information or data related to a location in space. By extension, it means spatial data on a set of places.

Geographic Information System (GIS): Automated, spatially referenced system for the capture, storage, retrieval, analysis, and display of data about the Earth.

Geometric symbol: A simple shape, such as a square, circle, or tringle, used to represent a feature.

Ratio data:

Grid cell counting: A counting method for estimation of numbers of units within an area using a grid of small, evenly spaced squares superimposed on the map.

Graduated or proportional symbol: A symbol that is scaled proportionately to a range of data values; each value is symbolized to show its position in the progression from smaller to larger data values. The graduated symbol map varies the size of a symbol placed within each geographic area. Proportional symbol maps are not dependent on the size of the area associated with the variable. In other words, on a proportional symbol map of Europe, tiny Liechtenstein would have the same visual importance as Spain if their unemployment values were the same. This would not be the case with a choropleth map.

Graphic mark: A point, line, area, or pixel on a map that is used to represent a geographic feature.

- H –

Histogram: A graphical display showing the proportion of features that fall into each data category; also called a frequency diagram.

Homogeneous: Uniform in structure or composition throughout.

- I –

Interactive map: A map that gives you control over such things as which images are shown on the screen, the sequencing of images, and movement from one viewpoint to another.

Interval data: measurement where the difference between two values is meaningful. Data consisting of regularly spaced numerical values on a magnitude scale that has an arbitrary zero point (such as temperatures in degrees Celsius or Fahrenheit).

Isoline: A line of equal values used to map continuous data surfaces by connecting points of a selected value.

Isopleth: a line drawn on a map through all points having the same numerical value, as in a population figure or geographic contours. Isopleth maps can take two forms: Lines of equal value are drawn such that all values on one side are higher than the "isoline" value and all values on the other side are lower. Ranges of similar value are filled with similar colours or patterns.

- L –

Line generalization: The smoothing of linear features and the edges of areal features on a map so that there is a desired loss of detail.

- M –

Map: a spatial representation of the environment that is presented graphically.

Map accuracy: the fidelity with which a map represents geographic phenomena at a given scale.

Measurement: The process of determining the quantity associated with different features; reported as an amount, intensity, or magnitude.

Measurement mode: A way to characterize the nature of numerical information about different features. There are four basic measurement modes: nominal, ordinal, interval, and ratio.

Metadata: data about data. Information about the type of information shown on a map, such as the different sets of data used to create the map.

Multivariable map: A map that shows more than one theme. It can integrate two or more related themes, or several attributes of a feature can be incorporated into the same symbol.

- N –

Natural breaks: Gaps in a distribution of data that can be used to define natural groupings for the purpose of class interval selection.

Nominaldata: Data that is presented in categories, also called categorical data..

- O –

Ordinal data: Data that are ranked according to a less-than/greater- than rule.

- P –

Percentage: A proportional measure obtained by dividing the number of features in a sub unit by the total number of features in the whole data collection unit, and then multiplying this value by 100.

Pixel: Picture element, a cell at the intersection of rows and columns in a digital image.

Population count: Data collected for every element of a theme.

Population density: Population per unit area, such as square kilometer or mile.

Prism map: A map made by dividing a region into a data collection areas and showing magnitudes by proportionally varying the heights of areas.

- Q –

Qualitative information: differences in kind. Also involves nominal and ordinal data

Quantitative information: differences in amount: includes count, interval, and ratio data.

- R –

Raster data : consist of a grid of cells, each with a particular value or values. Higher-resolution raster files have smaller cells. Data is collected by grid cells.

Ratio data : Data that consist of numerical values on a magnitude scale, ratio of two measurements. A ratio data has a clear definition of 0.0 (unique and non-arbitrary). When the variable equals 0.0, there is none of that variable. In a ratio scale, numbers can be compared as multiples of one another. Because they can be measured on a scale, they are also called scale data.

Reference map: A map that serves as a reference library of geographic information; a map of this kind provides information about the location of featuresenabling estimation of directions and distances between these features.

Representation: A portrayal of the environment. A likeness or simplified model of a territory.

- S –

Scale: The relationship between distances on a map and their corresponding distances on the ground.

Segmented symbol: A symbol in which the parts show the relative magitude of subcategories of attributes.

Semiology: The study of signs and symbols as elements of communicative behavior. Analysis of a system of communication, such as language (graphic or written), gestures, or clothing.

Shape: The outline of an area feature.

Simplification: Operation to eliminate details that are not necessary for the map.

Smoothing: Related to simplification but focuses on adjustments in the location of a feature or possibly the addition of detail. Smoothing affects the appearance of features.

Solid color: an even color; not shaded or variegated.

Standard symbol: A special type of mimetic symbol used as a standard in certain mapping practices or for certain map products.

Standardized data: Data that have been adjusted to conform to a common predefined format.

Symbol: is a shape that is a defined representation of a geographical object, e.g. the shape of an airplane for an airport.

Symbolization: the use of signs and graphic symbolism on map. The use of visual variables to represent data attributes.

Symbology: is the set of rules which relate to how a symbol is used, e.g. a plane can represent an airport.

- T –

Territorial division: a district defined for administrative purposes

Thematic map: A map that focuses on a specific subject and is organized so that the subject matter stands out from the geographical setting.

Time series map: A series of choropleth, prism, or other map used to show changes over time.

Topographic map: A map showing the three-dimensional nature of the terrain (elevations and landforms) as well as other ground features.

Typological or categorical data : Data that consist of categories used to distinguish different types of features in a map theme; also called nominal data.

- V –

Vector data: located points (nodes), lines (a connected series of points), and areas (a closed, connected series of points, also called poygons). Attribute information can be attached to a point, a line , or an area and stored in a related database.

Visual variables: graphic elements for differentiating the data represented on a map. They can change in shape, size, value, texture, orientation and color. Each visual variable has its own characteristics and is more or less well adapted to the representation of spatial distributions. Visual variables are used for map symbolization, they serve to guide basic map symbol design coherent with the characteristics of data (qualitative or quantitative data at points, along lines, or in areas).

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