MAPPING CONSTRUCTED SPACES SPATIALIZATION AND CARTOGRAPHIC VISUALIZATION OF INFORMAL GEOGRAPHIES

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Introduction

Today's scientific research produces large archives of digital data. This information is often accessible via textual and graphical information systems based on highly developed information architectures. According to Fabrikant (2000) the bottleneck in information processing in the communication of schemes and coherencies of complex data seems to lie in the user interface, which is restricting the potential of up-to-date computational and communications technologies. The current query interfaces provide insufficient guidance for information seekers. One way to overcome current impediments in information access and retrieval are spatializations, a special kind of visualization combining techniques from various fields of visual design and communication with spatial metaphors.

In traditional mapping we usually visualize data with defined relationships to geographic space and time. Informal geographies are about non-physical/human geographic information, where, usually, the content cannot be geotagged. Before these topics can be mapped the information has to be spatialized in some way. Due to the fact that the resulting depictions lack traditional geographical information they are mostly not considered to be maps in a common sense. These depictions do not represent geographies that map users are accustomed to, but maps of other geographies. The resulting maps are not a mere cartographic product, but information graphics involving different disciplines.

This research is based on ideas and concepts discussed during the development of a Cultural History Information System (CHIS). Exploring the data archives of a knowledge domain like the Cultural History of the Western Himalaya from the 8th century, which is a combination of data from various scientific fields, including art history, Tibetan and Sanskrit philology, numismatics and Buddhist philosophy, shows that a great part of the information has spare spatial connectivity or the spatial component is not important for a specific research question. This makes it necessary to invest in other forms of visualization, but not without forgetting the main cartographers' task - visual communication.

Different Geographies

Multidisciplinary research projects lead to a huge amount of non-physical/human geographic information with mostly undefined geo-spatial relation. In order to choose an appropriate graphical representation, the nature of the various data has to be analyzed and preprocessed. The best way to distinguish the information is to define the different geographies by describing their main properties; characteristics of the content, representation, reference system and space.

Formal Geographies

When defining informal geographies it is easier to define the formal ones first. Formal geographies are about physical/human geographic information. These are the geographies traditionally mapped by cartographers. In the context of this research the term ‘formal information’ refers to any information, which is either representing phenomena of the real world, well defined in space and time (geodata), or information directly linked to the geodata (thematic data).

Geodata are the references for thematic data and are presented in a spatial model like a geodatabase as point, line or area. Each dataset consisting of different features (point, line, area) needs a defined spatial reference system. Geodata used in the mapping system can either be vector data (mostly in the shape-file format) or raster data (satellite images, elevation models, maps). Usually a special set of geodata is compiled and visualized to present the base map. The base map is important for orientation within an area and as a visual reference for thematic data.

Thematic data can be any information which is directly related to one or more features of the geodata. It is important for the correct integration of all data, that the person collecting data for a certain topic is linking this information clearly to space and time. One possibility to connect thematic data to a spatial reference is a gazetteer, presenting a list of already known geographic locations. Another way to add spatial location to thematic data is the application of a GPS device.

Spatial information is always related to geographic space. Geographic space is presenting the spatial framework used for geographic information. According to Fabrikant & Buttenfield (2001, p. 271) geographic space represents a phenomenon’s semantic structure with a metaphor, which is based on a locational ordering principle (Cartesian coordinate system). This includes concepts of distance, direction, magnitude (height), etc.

Informal geographies

Informal geographies are about non-physical/human geographic information, where, usually, the content cannot be 'geotagged'. This non-geographic information cannot be related to any of the mentioned geodata like other thematic data. Traditionally these geographies are visualized in forms of diagrams, float charts, or other representations not based on a spatial reference system.

Common forms of representation for informal geographies are text or complex database systems. Big amount of information is usually stored in a database, which is administrated by a data base management system. Before these topics can be represented in a map-like representation the information has to be spatialized in some way. This also means reducing multidimensional data into two- or three-dimensional information. Multidimensional Scaling and Factor Analysis are known methods from statistics to solve this problem. A so called 'information space' is created by adding a locational ordering system including the concept of distance, direction, magnitude (height), etc.

Considering the Topic of the subproject this could be for example a "philospace" for the Philosophy project. Using the spatial metaphor of distance this means that philosophical ideas which are more similar are nearer and ideas which have no or little alikeness are further away. In a third dimension (philosophic elevation model) this could mean that ideas which are stronger or more distributed are at a higher level (visualized as a peak). The result will be a philosophical landscape.

The border between formal an informal geographies is not a hard line. Considering the numismatic research for example, there are the coins, physical objects which carry nearly all the information important in the research field. Their current location or the location they were found is a direct link to geographic space. But this location is irrelevant to the research, because there are only a few different locations, which can be linked to thousands of ancient coins. More important for the research is the connection between the different coins like the chronological order. Hence in this case there will be more than one kind of visualization.

Visualization

The concept of *mapping informal geographies* comprises map-like representations of non-geographic constructed spaces. Visualizing this kind of information in a map is a way of simplifying the communication of schemes and coherencies of complex data. In this context the term "*spatialization*" is used by Skupin & Fabrikant (2003, p. 95), which describes the extension of geographic principles and cartographic methods to visualizations of non-geographic information.

There are different approaches to visualize informal geographies from simple depictions like data or tag clouds to complex graphical constructions like SOM (Self Organizing Maps). Where data clouds can vary from a simple alphabetical index to different clouds based on certain algorithms, the SOM is always a complex visualization method. For the user it is like reading a map - easy depictions can be understood at one glance and complex maps have to be ‘read’. A common method in information visualization to get a ‘map-like’ representation of non spatial information is the application of spatial metaphors also known as ‘spatialization’ (Skupin & Buttenfield 1997, p. 117).

The distances between occurrences on spatializations cannot be measured in metric units (e.g. kilometers), but in their degree of similarity. Fabrikant & Buttenfield (2001, p. 266) distinguish two forms: semantic and geometrical spatialization. With semantic spatialization the distance between objects is computed by analyzing the textual content of objects. This data will later on be transformed into numerical values. The geometrical spatialization calculates the distances between the objects directly from numerical data (Jongh & Ormeling 2003).

The spatialization ‘terms of geography’ (Figure 1) from Andre Skupin is one example of the application of a geographic metaphor in combination with cartographic design principles. It is visualizing more than 22,000 abstracts submitted to the Annual Meetings of the Association of American Geographers during a ten- year period. The depiction is based on the representation of each document as an n-dimensional vector of terms. These vectors are used to construct a neural network model of the geographic knowledge domain using a Self-Organizing Map (SOM). The neural network model is then transformed a landscape in which elevation indicates the degree to which a single, focused topic is addressed and multilevel text labels associated with regions in the visualization. The final rendering was executed in standard geographic information systems (GIS) software.

The type of visualization used by Skupin for his ‘terms of geography’ is often referred to as ‘themescape’ in literature (Spence 2001, Wise et. al. 1995). Looking like a three-dimensional landscape its reference frame is based in geography and emphasizes the morphological structure of an information space, including geometry, topology, and dimensionality.

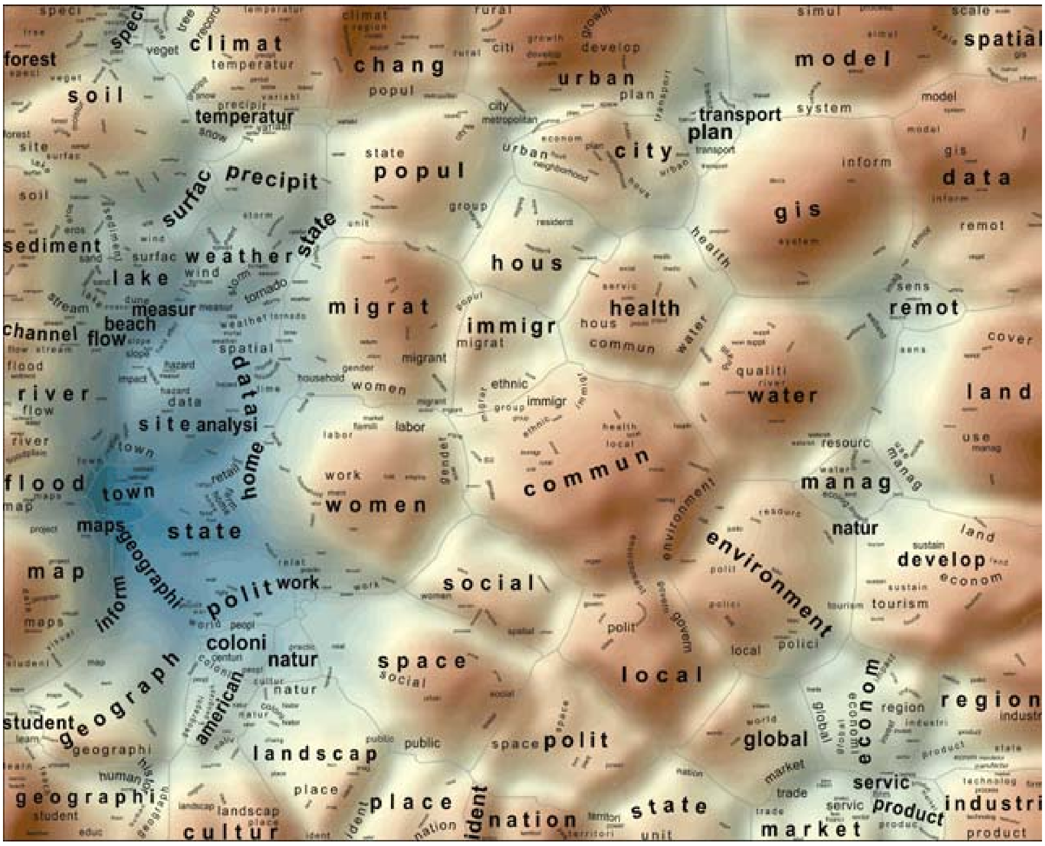

Figure 1: the terms of geography (http://www.scimaps.org)

Fabrikant and Buttenfield (2001) formalize three different spatial frames of reference: geographic space, cognitive space and Benediktine space. They define a frame of reference as "… a perspective or an approach that one takes on to frame a solution to a particular application. A frame of reference emphasizes certain aspects of the solution or allows specific properties of the solution to emerge." For a map-like representation the geographic space seems to be the best solution. Some information does not provide the structure and properties to transform the content in any spatial reference frame.

A tag or data cloud is another popular type of visualization where the connection to a spatial reference frame is not so tight is a data cloud. A tag cloud, in visual design often called a weighted list, is a visual depiction of user-generated tags used typically to describe the content of web sites (wikipedia.org 15.07.2009). There are three common types of usage; displaying metadata, popularity or categories. The ordering can be alphabetical, random, sorted by weight or semantically clustered.

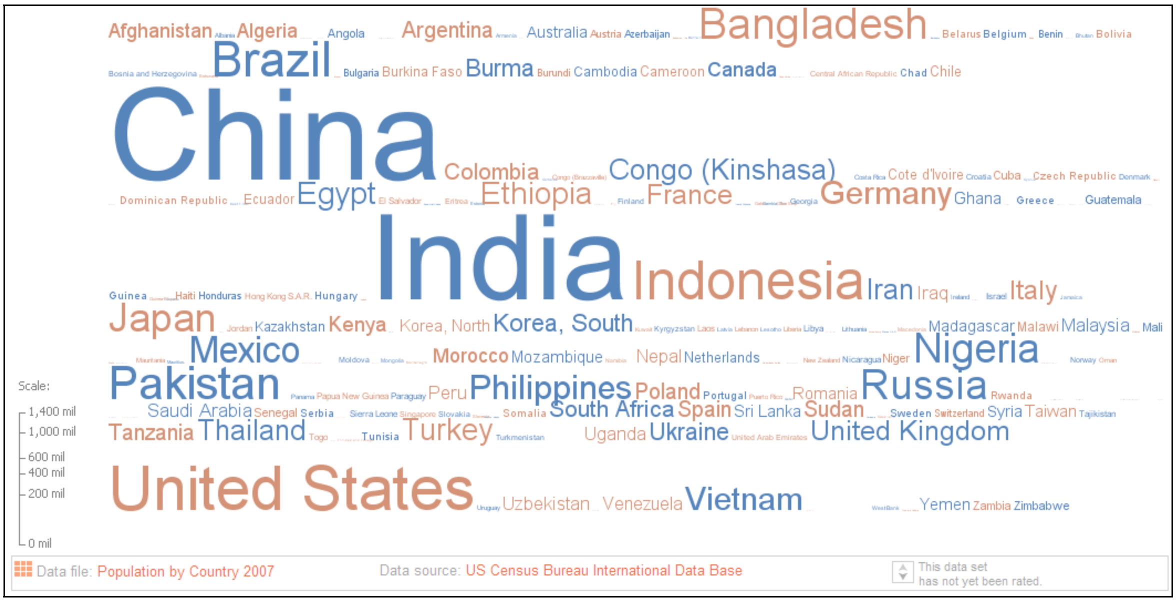

Figure 2: data cloud (http://upload.wikimedia.org/wikipedia/commons/7/78/World_Population.png)

A data cloud (Figure 2) is similar to a tag cloud, but instead of word count, displays data such as population or stock market price. It uses font size and color to indicate numerical values.

Conclusion

The concept of mapping constructed spaces is applicable to formal and informal geographies. The different geographies vary in the geospatial connection of the information. Where the formal geographies are connected to geographic space, the informal once cannot be related to geographic space. To visualize this information there are different kind of methods to spatialize the data and transform them into an information space.

The appropriate visualization is often chosen according to the spatial properties preserved during the transformation. But a real taxonomy of the different kind of visualizations informal geographies is still missing. In the future it is important to define rules for the visualization of informal geographies. This should be based on the properties of the data, the kind of transformation and the kind of spatial reference.

But the most important criteria in choosing a form of visualization should always be to communicate the desired information.

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Biography

Michaela Kinberger, born 1975, studied geography and cartography at the University of Vienna and graduated in 2003 with a thesis titled: "Automationsgestützte kartographische Visualisierung im Internet”. Since 2004 she is a Research Assistant at the University of Vienna, Department of Geography and Regional Research. She is currently working on a PhD and is conducting geographic and cartographic research for the Cultural History of the Western Himalaya project. Her main interests are information visualization, cartographic design and geo-communication in combination with open source web technologies.