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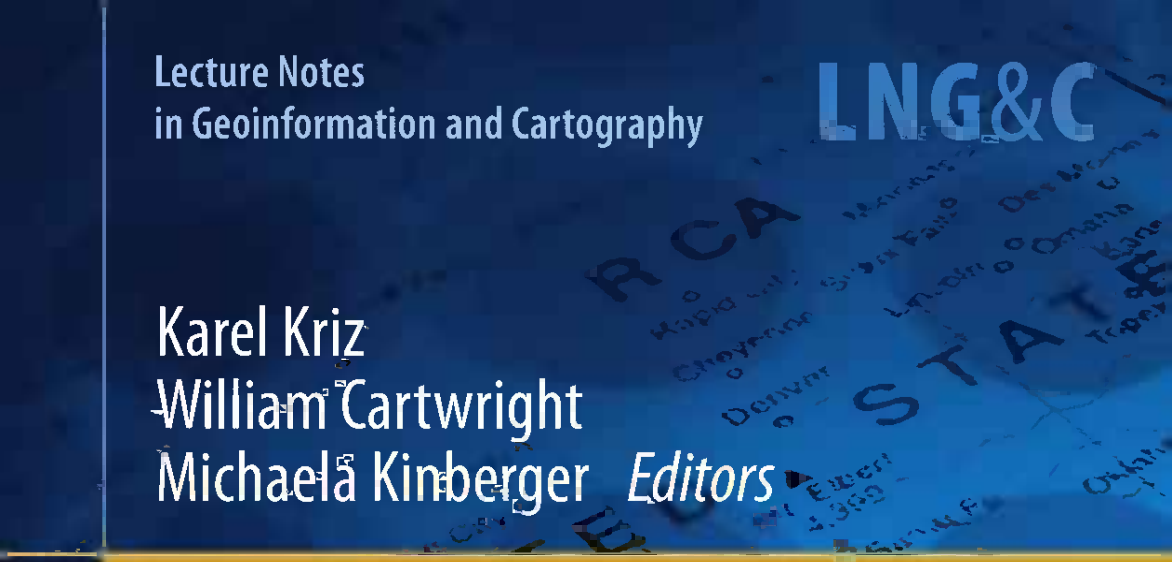

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Understanding Different Geographies

Springer

Lecture Notes in Geoinformation and Cartography

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Preface

Between January 31st and 3rd February 2011, a workshop that explored "Understanding Different Geographies (UDG)" was held in Puchberg am Schneeberg, Austria. The focus was on Communicating Meaning with [Geo]Graphic Artifacts.

Generally, the workshop topics addressed were:

- Exploring Geographic Knowledge.
- Maps in Exhibition Spaces.
- Information and Exhibition Design with (Geo)graphic Artifacts.
- Extracting Meaning from Visualizations of Different Geographies.
- Deconstructing Maps of Information- (and other) Spaces.

This meeting again brought together researchers who either are exploring the development of cartographic products and tools for use in thematic research or thematic researchers who use 'maps' (in their widest context to support their research). This fusion of many diverse research interests resulted in the presentation of information related to a wide range of exciting cartographic research and development theories and projects. As well, wide-ranging discourse was held about the usefulness and applications of cartographic tools for supporting thematic research.

This book is the outcome of the further development of the papers presented at the workshop. Chapter submissions have been reviewed by a panel of academics working in the field.

We hope that this contribution to cartographic research documentation provides information about the various works reported here and the underlying ideas underpinning the work of authors in their efforts to develop concepts, build tools, and to use cartographic artifacts to support endeavors to Understand Different Geographies'.

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Understanding Different Geographies

Karel Kriz, William Cartwright and Michaela Kinberger

Abstract Cartographers endeavour to design and develop tools that can be employed to support theme experts in their research that involves the use of geodata. Having access to appropriate cartographic tools provides the facilities to better address how geography, and the location of things like found objects can better inform. However, 'just' providing and using these tools does not fully embrace the complexity of 'different' geographies, where cartographic applications are applied to geographies that perhaps are outside the conventional thinking of what is meant when a 'geography' is defined in conventional terms. There exists a need to address how cartographic research in the development of appropriate tools for theme researchers who work in areas where geography may be described and measured in ways that can be considered to not be conventional. Once developed and provided, these innovative cartographic tools can be employed in the quest to understand different geographies.

Keywords Cartography · Geography · Representation

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1 Introduction

Different geographies—different workshop: The idea of the workshop and consequently of this correspondent publication "Understanding Different Geographies"—the second in a series of events—that took place at Puchberg am Schneeberg, Austria from January 31st till February 3rd 2011 was to enable an extensive exchange of ideas amongst participants from different disciplines as well as to hear and discuss new views in the field of "Different Geographies". During the first workshop in 2009 "Mapping Different Geographies" emphasis was put on mapping endeavours in novel and interdisciplinary project environments as well as the mapping of non-traditional subjects. The priority of the 2011 workshop was also based on a map-orientated interdisciplinary approach however with a special focus on geo-communicational comprehension of space and time. In this context the following questions were addressed:

- How can users explore information and gain knowledge from visualizations/ maps of 'different' geographies?
- How can meaning be extracted and deconstructed from (cartographic) visualizations?
- How can geocoded artefacts and maps be used to communicate geography in exhibition spaces?
- How can cartographic information design augment exhibition designs?

A loose workshop schedule and plenty of group activities enjoying the great outdoors of the Lower Austrian Alps offered perfect opportunities to get to know each other and give room for in-depth serious discussions. The conclusion of this workshop was besides the fruitful discussions amongst scientists and artists also a publication of reviewed papers that are manifested in this publication. 21 participants from 7 countries used the opportunity to present and discuss the outcomes of various research projects in this diverse field of cartography and geocommunication.

2 Understanding Different Geographies

The focus of the publication is to give the reader an overview on the topic of "Understanding Different Geographies" (UDG) from a general theoretical as well as practical cartographic perspective. The publication is therefore divided into five sections that offer a broad synopsis within the geo-spatial field of cartography and geocommunication underlining the major theme of "Different Geographies".

- Geocommunication
- Artefacts and Geospace
- Exhibitions and Geospace

- Representations and Geospace
- History and Geospace

The first section comprises three contributions that deal with the general term of geocommunication in cartography. The second section includes three entries focusing on artefacts and geospace that give an overview on various approaches on how objects can be perceived and identified in space and time. Exhibitions and their theoretical as well as conceptual realization is the focus of the third section that contains two contributions. The fourth section contains five chapters that give a broad impression of representations embedded in space and finally the fifth section embraces four contributions dealing with historical issues.

2.1 Geocommunication

According to Karel Kriz the proficiency to communicate lies in how maps are designed and in the way they are realized and reproduced. In his contribution "Maps and Design—Influence of Depiction, Space and Aesthetics on Geocommunication" a map is defined as a graphical representation of space exploiting artistic concepts to communicate thematic aspects of geography. In this context design issues play an important role and can be seen within cartography as the art or the action of conceiving an artefact before it is made.

William Cartwright addresses in his article "Understanding Different Geographies Through Drawings and Sketches" the importance of the 'drawing' element in the mapping process. This method explores how the act of drawing improves the comprehension of a geography by the cartographer and thus results in a better cartographic artefact for the user.

The determination to understand place is a grand ambition, and one that requires humans to embrace 'place' as the complex socio-cultural, geospatial and temporal entity that it is. Laurene Vaughan describes in her contribution "Understanding Through Encountering Place" aspects of an interdisciplinary community project that embraced the challenge of understanding place through a deep encounter with one place, the Western District of Victoria, Australia.

2.2 Artefacts and Geospace

William Cartwright reflects in his contribution "Artefacts and Geospaces" on what is considered to be 'good' design and attempts to outline the elements for cartographic utilization contemplating the 'new' cartographic artefacts and their effectiveness as a communicator of geographic information. Furthermore, web-delivered cartographic artefacts are addressed in terms of what is an effective communication method.

Every artefact contains a multitude of spatial references. Fani Gargova aims in her paper "Understanding Artefacts Through Geographies—Perceiving Geographies Through Artefacts" at presenting the idea of space in a different cultural and historical context and to contrast it with a modern view on the geographies of objects. The aim is to facilitate a profounder investigation of art in its spatial existence, while adhering to its original and transformed contexts throughout time.

Verena Widorn explores in her contribution "When Countries Become Gods—The Geospatial Aspect of Deities in India" the iconography of Bharat Mata that is closely connected to the Indian topography. The focus of her paper lies therefore on the alternate tradition of mapping territory with regard to national identity and the sacredness of landscape in the South Asian world.

2.3 Exhibitions and Geospace

Today, a huge variety of museum exhibitions exist, offering an overwhelming amount of artefacts and information. Michaela Kinberger and Alexander Pucher describe in their chapter "Geographic Space in Museums—Considerations Towards a Spatio-Temporal Supported Exhibition" a theoretical as well as practical overview of the relationship of museums and geographic information and explore the possibilities of geographic space in museums.

Using examples of Byzantine art and material culture Sarah Teetor presents in her paper "Potential Information Gains for Exhibition Makers and their Audience by Mapping the Movement of Objects: The Example of Material Culture of the Byzantine Empire" potential information gain from the visualization of object movement for both exhibition makers and audience.

2.4 Representations and Geospace

Stephanie Deitrick postulates in her contribution "Uncertain Decisions and Continuous Spaces: Outcomes Spaces and Uncertainty Visualization" how uncertain scientific results serve as the foundation for public policy decisions in local and global society. Communicating these findings to policymakers poses an immense challenge, as information considered beneficial for evaluating a problem is very different for scientists and decision makers.

To emphasise the complexity of modelling uncertainty Anneka Reuschel, Barbara Piatti and Lorenz Hurni go one step further in their submission "Modelling Uncertain Geodata for the 'Literary Atlas of Europe'". Mapping literary spaces is an interdisciplinary challenge for both literary theory and cartographic realisation. The inherent properties of textual space compared to real-world geospace are introduced and discussed in relation to build a data model for the on-going project, 'Literary Atlas of Europe'.

A pragmatic GIS approach is presented by Anna Czinkóczky and György Szabó in their contribution "The Effect of the Ancient Chinese Philosophy and Geography on our Contemporary Landscape Development Using GIS Models". Utilizing the latest GIS technology the ancient principle of beauty and harmony is analysed and successfully modelled to highlight the areas which are of lower status concerning yin and yang properties, hence to be developed more intensively.

David Schobesberger and William Cartwright address in their submission "The Potential of Using Webmapping as a Tool to Support Cultural History Investigations" the use of maps on the Web as tools to support cultural history research. The emergence of new applications through Web 2.0 is discussed and results are presented in a comprehensive classification of types of Web maps with representative examples. Furthermore, models of Web map use and possible goals and tasks inherent to user interaction with maps on the Web are discussed.

Gilbert Kotzbek describes in his contribution "Virtual Tabo—Geocommunication for the Preservation of Cultural Heritage with the Help of Multimedia Technology" the concept and implementation process of an interdisciplinary research project of a cultural heritage site that is located in Northern India. Along with the description of the basic data used, the workflow and the media used, the single application elements as well as the problem areas are illustrated.

2.5 History and Geospace

The goal of the paper "Geographic Projections of a 16th Century Trade Network—New Meanings for Historical Research" by Sara Pinto is to reveal the mechanisms of cooperation among merchants that tied together the self-organizing commercial networks of the First Global Age (1400–1800). Focusing on the notion of 'dynamic' that implies an integration of space and time; the aim is to develop a spatial analysis, highlighting the role of space on network building. The contribution intends to present an approach that demonstrates the benefits of carrying on spatio-temporal analysis of historical data sources.

Understanding of historical geography is necessary to create models of historical roads, but once created, they can help to further understand spatial relations in the historical landscape. Markus Breier states in his paper "Getting Around in the Past—Historical Road Modelling" that a key to understanding historical geographies can be found in historical road networks.

Mihailo Popovic emphasizes in his submission "Networks of Border Zones—a Case Study on the Historical Region of Macedonia in the 14th Century AD" on the border zones between the Byzantine Empire and the emerging Serbian mediaeval state in the historical region of Macedonia in South-eastern Europe in the 14th century AD. In the course of the presented case study the 'classic' approach of analysis of settlement patterns and its 'analogue' picture is evaluated by introducing indices of centrality.

Finally the contribution by Johannes Weiss "The Itinerary and Palestine Maps of Matthaeus Parisiensis—A new Input to a Never Ending Discussion" elaborates on the history of a cartographer who became most popular for his Itinerary Maps from London to South Italy and his Palestine Maps, which he composed around the year 1250.

3 Conclusion

This chapter has provided an overview of the contributions that appear in this book and their general areas of focus. The topics address both the provision of appropriate cartographic tools and their use in exploring different geographies. The chapters that follow address how appropriate tools might be delivered and exploited in various research applications.

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Part I
Geocommunication

Maps and Design–Influence of Depiction, Space and Aesthetics on Geocommunication

Karel Kriz

Abstract A map is a graphical representation of space exploiting artistic concepts to communicate thematic aspects of geography. In this context design issues play an important role and can be seen within cartography as the art or the action of conceiving an artefact before it is made. However, in order to communicate spatial results efficiently, from a cartographic perspective, both the conception and construction of maps must be well-considered beforehand. The proficiency to communicate lies therefore in how maps are designed and in the way they are realized and reproduced.

Keywords: Design · Perception · Geocommunication · Thematic cartography · Aesthetics

1 Introduction

The saying "*A picture is worth a thousand words*" refers to the concept that complex information can be transported efficiently in just a single image. This has been—and still is—the case in cartography. However, it is important to be aware of the cartographic fundamentals and their utilization. Not all pictures, graphics or maps communicate efficiently. Rules and specifications dominate the cartographic production procedure in general and must be advisedly considered during the design process. Communication is the concluding stage of the map development process and the goal of geographic communication is to transport and exchange information via maps and map-related objects. Whether the process is successful

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or not depends greatly on how design and aesthetic elements are used in combination with cartographic realization. Design and aesthetics should therefore not only be seen as the domain of art, but also in cartography. They play an essential role ensuring that cartographic products communicate spatial information effectively and efficiently. Thus, a map is the outcome of this process and can be seen as a geocommunicator.

This contribution discusses the role of design within the cartographic production process and showcases methods and examples that underpin this task. Various representations are provided to demonstrate both the cartographic principles of knowledge acquisition and the design approach that supports geocommunication.

2 Geocommunication

Communication depends on the capability to understand and to adopt the basic functionalities of information exchange. This assumes literacy—the skill to read, to write and to use language proficiently—numeracy—the capability to work with numbers and to deal with mathematical concepts—and articulacy—the competence of being able to express oneself fluently and coherently. These skills are essential to our society and form the basis of our educational systems as well as being the foundation of communication generally. However, in order to communicate efficiently with geo-related, cartographic information, the receptors as well as the communicators also must have the ability to exchange information via graphics. In everyday life we are constantly confronted with manifold graphic information. This information is filtered, processed and transformed, resulting in a decision that, in many cases, can trigger an action. Much of this information is stored in graphic form. Without (carto)graphic expertise, the dissemination of information in our society would be a very tedious process. Here, it is implied that indispensable structures of our modern communication would fail without the ability to successfully communicate information using graphics, including geo-graphics.

Map interpretation uses graphic communication that is stimulated through our visual sensors. The object of interest is scanned optically then transferred to a visual register before being stored in short-term memory. Thereafter, if the interaction was successful, short-term storage is relocated to long-term memory and sustainable usage is ensured; otherwise information loss occurs (MacEachren 1995). Visual cartographic communication builds upon information retrieval from long-term memory as well as the detachment of graphical layers. This allows the observer to conceive the content. In every map there is at least one defined layer for orientation, the base for locating thematic content in a spatial context. On top of this layer thematic content is defined and communicated. This can vary from a very simple depiction all the way to a multi-dimensional, complex visualization. Objects can be grouped together to create chunks that help structure and organize the overall cartographic representation (Kriz 2009).

Fig. 1 Newspaper advertisement. *Source Der Standard*, Austria 10.10.2009

An example of how delicate communication with cartographic representations can sometimes be is shown in the newspaper advertisement (10.10.2009) in Fig. 1, published in a leading Austrian newspaper. This advertisement was commissioned by a large mobile telephone company and uses a small scale map of the eastern hemisphere to advertise their special worldwide business offer. The depicted geographic space is, interestingly enough, not the whole world, but just a portion—defined from 0° east of Greenwich all the way to the date line at 180°. However, it excludes New Zealand. The message of the advertisement starts with a question: "*We asked 100 people worldwide, where is Austria?*" The answer is then given through the map. The map shows 99 interviewees locating Austria in Australia, with only one respondent giving the correct answer. The conclusion of the advertisement is therefore … "*make it easy for you and your customers. Give them one number and don't bother them with country codes and other unnecessary things*". At first glance the observer is presumably somehow amused or maybe, to a certain extent, even irritated. However, if the message of the map is thoroughly deconstructed then potential customers and, ultimately, all users of that mobile telephone company must be seen as being unintelligent, not knowing the difference between Austria and Australia.

Such representations show the raw potential, as well as subjective approach, of cartography and illustrate how perception in geocommunication works—knowingly and unknowingly.

Views and proposed activities derived from the interaction with maps can trigger an action and thus effect what we experience. Every observation and interpretation of a map is, therefore, subjective even if objectivity is proclaimed through cartographic standardization. Using visual variables to distinguish cartographic primitives helps keep interpretation, to a certain extent, consistent. This underpins the principles of geocommunication. However, not all objects depicted within the visual field are perceived equally. Discrepancies can direct attention to certain elements on a map that can also lead to controlled or uncontrolled actions. Even though a map reader can sometimes be misled or even manipulated, the result can still result in good communication practice. An example of intentional user manipulation is the cartographic depiction of public transportation networks, such as those depicting the underground railway systems in metropolitan areas. The manipulation of real geographic space into a false geographic space is deliberately employed in order to keep the visual display clear and understandable. Regular geometric design is adopted to avoid distraction of the map user. Colour is used as a dominant visual cue to communicate qualitative information about the transportation system. The communication of geographic reality is, therefore, not the primary factor of these maps. Instead, visual object recognition plays an important role that again utilizes information acquisition through effective graphics.

Various examples of underground maps from around the world can be found at the following locations:

http://www.webdesignerdepot.com/2010/03/design-around-the-world-metro-maps/
http://www.clarksbury.com/cdl/maps.html
http://www.londontubemap.org.uk/london-tube-map.jpg (accessed 28.6.2012)

These and other fundamentals of graphic communication, in relation with visual object recognition and graphic design, play an important role in cartography. They have been part of what can be considered to be ‘good cartographic practice’ since maps have been produced. Essentially, all cartographic artefacts are composed in the same manner. This is done based on the graphic primitives of maps—point, line and area. And, these can vary according to the visual variables—size, shape, value, colour, texture and orientation—to transport graphic elements (Bertin 1982).These principles are ubiquitous in all maps. When combined with syntactic and semantic rules their application contributes to effective geocommunication.

3 Effective Geocommunication

Historic cartographic examples can be employed to showcase the various aspects of mapping that have utilized effective geocommunication. They provide information regarding the heterogeneous nature of maps and how elaborate and aesthetically pleasing they can be.

Fig. 2 Fragments of turin papyrus—an ancient Egyptian mining map (*left half*) for Ramesses IV's quarrying expedition, 12th Century B.C. (New Kingdom). *Source* Museo (2012)

One of the oldest known artefacts that can be seen as a map in a broad sense is the depiction of an underground village that was overlooked by an erupting volcano in Central Anatolia, Turkey. This spatial representation was recorded in the wall paintings of ÇatalHüyük in modern Turkey. It can be dated to around 6,200 B.C. This illustration shows geographic space generalized in a vertical projection with a schematic relief depiction, giving the observer a cohesive view of an area of land that is graphically totally distorted, but nevertheless efficiently communicates reality (Meece 2006; Milestones 2012).

Similar principles of relief depictions are also found in Egyptian documents of the 12th Century B.C. The so called'Nubian Goldmine Map'is an example of a large scale map of an excavation site for precious metals as shown in Fig. 2. Here, mountains are depicted in a vertical projection while the overall perspective is planimetric. The discrepancy in geographic space does not primarily distract the user in utilizing the map, due to the fact that the major focus is on the location of the mine in relationship to the rest of the generalized topographic features (Museo 2012).

The Tabula Peutingeriana, a Roman street map from the late 4th Century A.D., shows yet another fascinating facet of relief depiction. This spatial representation of parts of the northern hemisphere at a small scale is implemented in the form of a list of cities and transportation routes, which is comparable to a topogram. The relief depiction is simple yet very artistically composed and contains a hydrological layer consisting of rivers and lakes as well as outstanding mountain ranges that are visualized in a so-called band, ribbon and ornament style. Even though the geometry is distorted, the overall benefit of the map is to communicate the relationship between cities and their environment (Tabula 2012, see Fig. 3).

Towards the end of the Middle Ages precise geodetic surveying and improved graphic techniques were adopted by cartography. Terrain depiction, for example, transformed slowly from a very elementary style to one having a more complex appearance. The so-called 'mole hill' manner used to reproduce third dimensional

Fig. 3 Tabula peutingeriana, Section XII India. *Source* Tabula (2012)

Fig. 4 Section yirol—Waldseemüller 1513, Tabula Moderna Germanie © Bayrische Staatsbibliothek München. *Source* Tirol (2012)

space was combined with basic topographic attributes such as hydrology and transportation routes as a common method to render mountainous areas utilizing artistic design features such as hachuring (see Fig. 4).

Maps became instruments of power through their facility to record and communicate geographic information. This was not only in association with technological inventions that allowed exact measurements of the earth's surface, but also the use of maps as a source of information about geography. The rise of an educated society, the needs for strategic geographic information by the military, the information being gathered through the exploration of previously undiscovered geographic space, as well as inventions like Gutenberg's printing method were just some of many reasons that heralded the eve of modern topographic mapping (Monmonier 1991; Harley and Laxton 2001). At first, maps had low positional accuracy, but they were designed in a very artistic fashion that was aesthetically pleasing and saw them accepted as useful objects (see Fig. 5). Planimetric views became the standard method employed by cartographers for representing geographic space. This included terrain depiction design methods that were adopted from the artistic sector. The intensive use of colour, symbolization, abstraction and modest attempts at generalization determined the design of large scale topographic maps. Over time precise instruments and

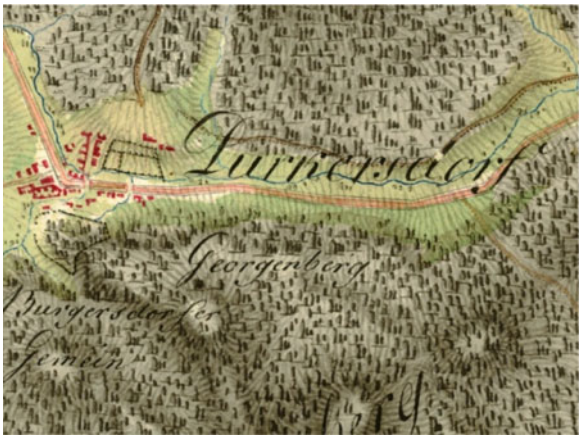

Fig. 5 Section of the historic map BIXa242_section 070c, Josephine Survey (Josephinische Landesaufnahme) from 1764 to 1787. *Source* Landesaufnahme (2012a)

Fig. 6 Section of the map data sheet (Aufnahmeblatt) 4856-1b Weißenbach an der Triesting, Neuhaus from 1872. *Source* Landesaufnahme (2012b)

methods for surveying and for navigation changed the appearance of the map due to the availability of more precisely measured geographic data. Also, the necessity to take measurements from maps in a more precise manner forced cartographers to model the Earth's surface in a more accurate, yet still abstract manner. At first, comprehensive techniques, such as artistic hachure styling to depict and to measure rough terrain, were adopted (Lehmann 1799). These methods were then enhanced (see Fig. 6) and later replaced by contour lines combined with rock depiction and hillshading. These maps closely resemble today's diverse variety of terrain display in topographic maps.

Large scale topographic maps, such as the examples from the Alpine Club Cartography in Austria shown in Fig. 7, communicate the overall outstandingly realistic impression of relief that gives the representation its typical aesthetic as well as artistic quality. The creation of these depiction methods is, however, very time consuming and requires high artistic skills as well as profound topographic knowledge.

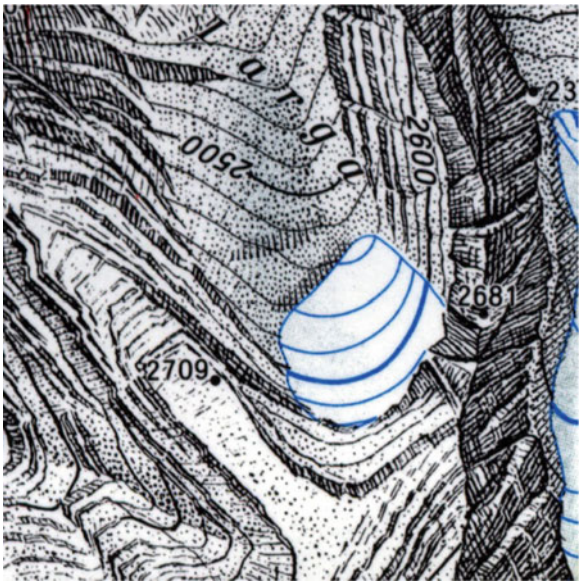

Fig. 7 Section of the Austrian Alpine Club Map, Alpenvereinskarte 51, "Brentagruppe des Deutschen und Österreichischen Alpenvereins" (original scale 1:25,000). *Source* http://www.alpenverein.at/portal/

Other methods of cartographic depiction provide maps that accommodate non-geographic space. They follow the same principles of graphic communication. A remarkable example that documents the use of such non-spatial data is illustrated through a familiar topographic map style in the Map of the Swiss Political Landscape by Michael Hermann and Heiri Leuthold (sotomo—Research Lab at the University of Zurich). This representation portrays the Swiss political mentalities in three dimensions: the x- and y-axis represent ideologies from left to right and modernist to traditionalist, respectively; and the z-axis corresponds to the population density and utilizes contour lines as well as hillshading to imitate the third dimension. Furthermore colouring—using shades of red, green and orange—represents the spoken language of the region (see Fig. 8).

4 Principles of Cartographic Design

The principles of cartographic design are manifold and can be seen as a standard within the design process. They play an important role during the deployment and creation of maps. Cartographic design principles are based on the fundamentals of visual perception and their appropriate applications have a strong impact on how interaction, communication and interpretation in maps work.

The expected and unexpected in maps is often used to stimulate attention and transport messages. The Isolation Effect, also known as the Von Restorff Effect, is a phenomenon of memory in which noticeably different things are more likely to be recalled than common things (Lidwell et al. 2003). The effect is based on

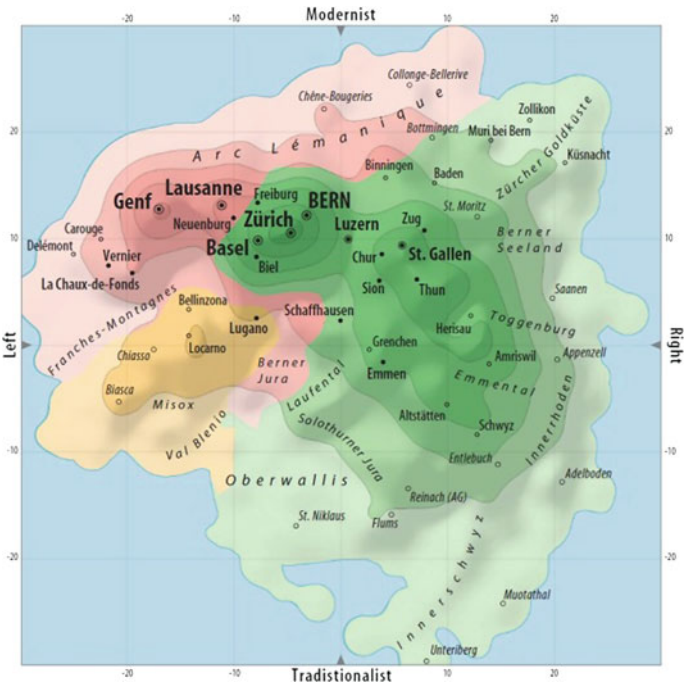

Fig. 8 Map of the Swiss political landscape. *Source* http://www.sotomo.ch/

distinctive encoding, difference in context and difference in experience. In other words, if something should be communicated then it should stand out.

one
two
three
four
five

The chances are high to remember 'two' in the listing above because it stands out. The map of the regional avalanche warning bulletin, shown in Fig. 9, is also a good example of the Isolation Effect. In the map the visual variables (colour and texture) are used to highlight areas of attention. Critical situations can be thus transmitted efficiently to the map user.

A map is a priori neither good nor bad, nor is it beautiful or ugly. An appealing and effective cartographic representation is compiled of many singularities that, in combination, produce the overall composition. Maps are like music. They consist of single notes. When correctly combined they can produce harmony or disharmony. Symmetry is one of many graphic principles that assist visual equivalence among elements in a form. It can be considered as the most basic and enduring aspect of beauty, conveying balance, harmony and stability (Lidwell et al. 2003).

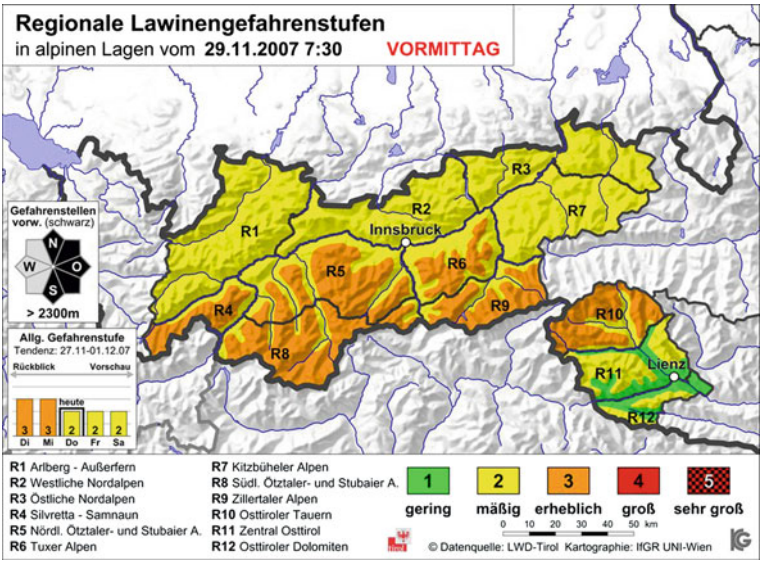

Fig. 9 Isolation effect—avalanche warning map of tyrol, Austria. *Source* http://lawine.tirol.gv.at/. Accessed 28.6.2012

The basic elements of symmetry are reflection, rotation and translation. These are often found in monumental architecture around the world such as Notre Dame in Paris (see Fig. 10). Combination creates harmonious, interesting and memorable design. In maps, symmetry plays an important role mainly in symbol design and is a form of similarity. It assumes that there is a connection between the parts (see Fig. 11).

In everyday life many of our activities require decision support that is assisted by communication and interaction. Correct and comprehensible perception is a prerequisite for such tasks. Elements that are similar are perceived to be more related than elements that are dissimilar, and they help us judge more effectively. The grouping of elements reduces complexity and follows the Gestalt principles of perception. The visual variables colour, size and shape assist the phenomenon of grouping. A low number of colours results in the strongest grouping. When employing size for grouping, they must be clearly distinguishable in order to achieve best results (Lidwell et al. 2003). A TV remote control is a good example of the applied employment of similarity in daily life. In maps, the grouping of objects to higher-ranking coherent categories is also a common task.(Figs. 12 and 13)

Given a choice between functionally equivalent designs, the simplest design should be selected. Efficient and simple design is a key factor to coherent geocommunication. The quotation "*Everything should be made as simple as possible, but not simpler*" attributed to Albert Einstein (http://en.wikiquote.org/wiki/Albert_Einstein accessed 28.6.2012) hits the spot precisely. Unnecessary features should be

Fig. 10 Symmetry—notre dame, Paris 2011. Photography: Kriz (2011)

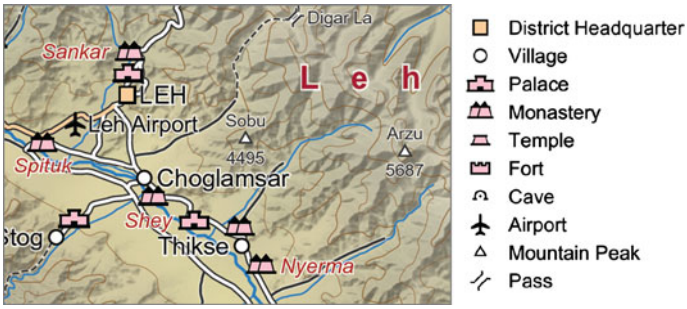

Fig. 11 Symmetry—section of the Himachal Pradesh topographic overview map, 1:500.000. *Source* http://www.univie.ac.at/chis. Accessed 28.6.2012

decreased in order to underpin the tendency to perceive a set of individual elements as a single, recognizable pattern. A good example of simplicity preferred to complexity is currently the omnipresent search engine Google™. The result is high performance paired with ease of use, or, in other words, simple and efficient. The principle of simplicity, also known as Ockham's Razor, is an integral component of cartographic

Fig. 12 Similarity—TV remote control. Photography: Kriz (2012)

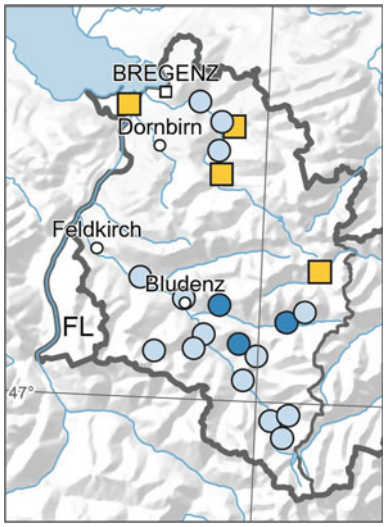

Fig. 13 Similarity in maps through strength of colour as a grouping strategy relative to shape and size. *Source* http://www.oerok-atlas.at/. Accessed 28.6.2012

design (Lidwell et al. 2003). Edward Tufte states that it is important to make all visual distinctions as subtle as possible, but still clear and effective (Tufte 2003). For instance, choropleth maps that use visual variables proficiently are a good example of

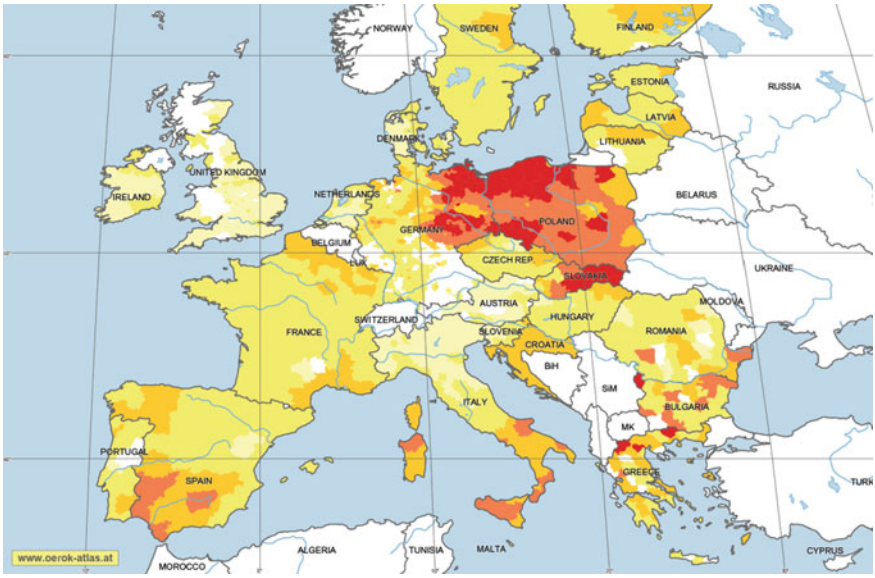

Fig. 14 Ockham's Razor—map of unemployment in Europe 2005. *Source* http://www.oerok-atlas.at/. Accessed 28.6.2012

geocommunication. Within a short interaction time with the map, complex topics can be communicated efficiently to produce spatial connectivity. The red and orange colouring in Fig. 14 attracts attention and indicates regions of high unemployment. The yellowish pale colours are more subtle and are merged into the graphic background. These areas display places of low unemployment. The message of the map is to answer the question: "Where are major hotspots of unemployment in Europe?"

It is easier to remember a face but sometimes difficult to recall the name of the person. This is due to the fact that recognition is obtained through exposure, not necessarily involving memory about origin, context, or relevance. The memory for recognizing things is better than the memory for recalling things. Recall memory is obtained through learning. Decision-making is strongly influenced by recognition, and it merely needs the choice of an option to satisfy the condition for making a decision (Lidwell et al. 2003). In order to recognize, however, information has to have been already learnt, respectively stored and made available in memory. Maps utilize this principle and highly depend on the cartographic knowledge of users and their ability to recognize familiar structures in order to make decisions. Therefore, the act of storing and encoding information in memory is essential (Straker 2010). Once this information is stored, recognition and recall can be evoked. According to Kolacny (1969) cartography can be seen as a communication science utilizing information retrieval and exchange from cartographic products. Thus, it is essential that both the map creator—the cartographer—as well as the map beneficiary—the user—is knowledgeable in cartographic communication.

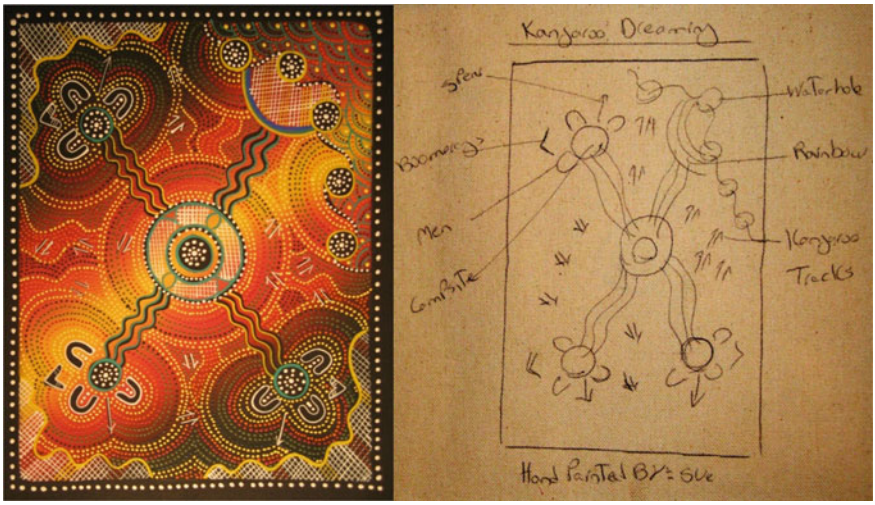

Fig. 15 Storytelling with maps—Kangaroo dreaming, Australia. Photography: Kriz (2012)

Maps tell stories of spatially relevant issues. They are used to transport complex as well as less complex information in a generalized and comprehensible fashion. Storytelling with maps is therefore a prevalent method of creating and communicating imagery, emotions, and the understanding of spatial events through an interaction between a storyteller (map maker) and an audience (map user). Storytelling is uniquely human and represents an effective method of passing information and knowledge on to a receptor. The fundamentals of visual storytelling coincide with the principles of cartographic communication. Figure 15 shows a narrative from aboriginal Australia. This map combines reality with fiction and uses standardized symbology to communicate the plot of the story. The setting orients the audience, providing the sense of time and place (Lidwell et al. 2003). Maps tell stories of imaginary as well as real space.

5 Conclusion

Maps and their design have a strong influence on how geocommunication functions. Performance is effective if the principles of cartographic design are taken into consideration, and consequently carried out in combination with the elaborate use of visual variables. The cartographic process, therefore, embraces design, cognition and communication equally in order to stimulate interaction, interpretation and reaction. Hence it is important to be aware of the principles of design and their application. Maps are more than just an accumulation of graphic symbols. They have an essential impact on how we perceive our world and influence our performance as well as our way of thinking. So be aware of the power of maps!

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Understanding Different Geographies Through Drawings and Sketches

William Cartwright

Abstract Nowadays, when we consider how maps are produced we go directly to the computer-generated artefact. Using computer assisted/supported/facilitated processes databases are built, then analysed and the resulting, selected and classified information forms the basis for generating a representation that is communicated via a paper or an electronic medium. The process is quick, standardized and economically frugal. The image output, once defined, can be replicated at will, providing further economies that faithful replication of a method affords. However, what is questioned is whether the complete removal of the human element of cartography—the drawing of the map—somehow lessens the understanding of geography. It is argued that through the process of drawing that a better understanding of geography is had and, through the process of drawing a better, more considered, representation of geography can result. This chapter addresses the importance of the 'drawing' element in the mapping process. It explores how the act of drawing improves the comprehension of a geography by the cartographer and thus results in a better cartographic artefact for the user.

Keywords Drawing · Geography · Maps

1 Introduction

Generally, when users exploit the medium of cartography to better understand geography, they are presented with a product that is *au fait complet*. The map is provided finished, packaged and delivered (as a paper or digital product) 'ready to go'. The designer/cartographer has already considered the message, observed

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the geography or addressed the data, gone through the complete design and production process, refined and re-defined how the (geo)information is to be presented, generated a final product, and equipped the user with the tool to support decision-making.

The process is complete—but the user is not engaged with understanding how best to represent the geography through the medium of maps.

If the map user is left out of the conception to drawing process altogether, are they less knowledgeable about the geography being depicted? Are they cognizant of the design goals, and the compromises made to what the designer/cartographer considers to be the 'ideal' design, that underpinned the design and production processes? Do they know immediately the message that the map carries, and the weight of what it says? Perhaps, by removing users from the design and 'drawing' process altogether their use of the artefact is harnessed and their view of a geography blinkered.

If a user/cartographer 'partnership' allows users to engage with cartography, engage with drawing, then does an 'enhanced' map use result? And, if users are engaged, do they better understand geographies, and the intricate details that hide behind the formal completed map drawings, that were placed 'just so', guided by the pencil annotations that embellish design manuscripts.

This chapter explores the potential gains that might be had by engaging users in the 'drawing' process of mapping. In so doing maybe a better understanding of a geography results.

2 Understanding Mapping

In the era of the paper map, there was much interest in studying how this process worked. Many theoretical models were developed as a result of such work. The models included all of the aspects of 'mapping'—from conception to consumption—and they linked the cartographer to the map to the user. The model shown in Fig. 1 is a re-drawing of Kolacny's model (1969). It focused on traditional map design, production and use—as applied to paper maps. The model shows the quest in map design, production and consumption—to transmit information about reality. And, in developing the most appropriate communication artefact, to strive for understanding about what best to represent so as to ensure that the intended message (the cartographer's reality) is in fact the message that is received by the recipient (the map user's reality). The diagram shows the problem: how to ensure that the common understanding of cartographer and user (the overlapping area in the topmost portion of the diagram) is maximized. At the centre of this process is the map, the communication medium that links the cartographer's mental model to the map user's mental model. The *lingua franca* shared by cartographer and user is 'cartographic language'.

The same general cartographic processes were employed when computers took over the role of drawing the map.

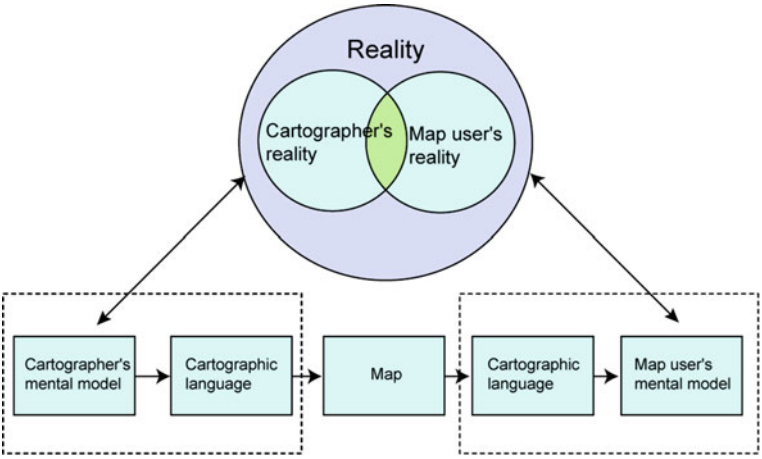

Fig. 1 Theoretical model of map design, production and consumption. After Kolacny (1969, p. 48)

3 Drawing and Understanding Geography

According to Goode and Darling (1904, p. 2), we draw maps because: "(1) geography deals primarily with space-relation, and all record comes sooner or later to a distribution in a map; (2) "the place for the atlas is in the head", i.e. we need definite mental pictures of the map, at least of the fundamentals of space-relation; (3) the study of the essentials, and the exercise of the muscles in reproducing the form, train the attention and fix a clear mental image".

Looking at map drawings in relation to Goode and Darling's four reasons why we draw maps, what is now offered is a consideration about the usefulness of the drawn image to assist in the comprehension of and the better understanding of geography.

3.1 The Distribution in the Map

The concept of moving from the mental map to a representation of geography—the map—and the use of symbology to represent geography is provided in Fig. 2 Here, the designer/cartographer firstly develops a concept about how to best represent a geography. This is followed by a mentally demanding process that considers numerous, linked elements that should come-together to result in the best representation of that geography to transmit the message about what it is like to 'be there'. This process, of moving from the mental map to the formalisation of that map as a sketch or drawing, is what can be considered to be transfer of a human's 'ideation', the very concept about how a physical space should be transformed into a represented space, into a physical form that allows for information about that space to be comprehended and understood.

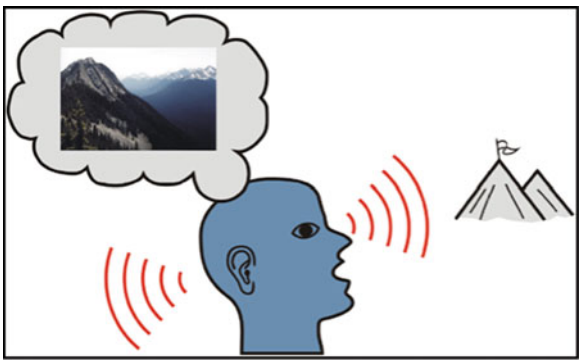

Fig. 2 The map designer uses sketches to formalize the link between the mental map and the paper map, as a representation of geography

3.2 Defining Mental Pictures in the Map

Take for example the famous cover drawing on the *The New Yorker* magazine of March 29, 1976, produced by Saul Steinberg (Fig. 3). This drawing—"The World from 9th Avenue" shows a Manhattanite's perception of what constitutes New York, the USA and its (real, from a Manhattanite's viewpoint) place in the world.

The representation shows that 'the world' stops at 9th Avenue, and after then there is just 10th Avenue, the Hudson River, the west of the United States and then the rest of the world. Nothing else is important to a resident of Manhattan, and therefore the geography of the rest of the United States and the world is insignificant, and only justifies a generalised image. Whilst this sketch is not a formal map, it does convey the national and global viewpoint of a Manhattanite. The sketch provides a succinct representation of the Manhattanite's mental map.

Steinberg's drawing has spawned many other magazine covers drawn in this *'New Yorker'* genre. For example Fig. 4 comes from *The Economist*, and shows China's perception of the world.

Whilst these *New Yorker'* genre drawings are not geographically faithful, as would be a map, they are powerful conveyors of geographically-defined realities. The drawing is used as a conduit to move the mental map (in these examples about one's place in the world) from conceptual space to representing space.

3.3 Fixing the Essentials

When citizens are asked to draw their environment or city they are being asked to engage with the development of artefacts—drawings that formalise their mental map of where they live or work. The resulting drawings can be more revealing about how individuals perceive their environment, or how they see the city 'works'. To illustrate how drawing can convey personal geographies, a number of drawings of one city—London—are used to illustrate the power of drawn geographies.

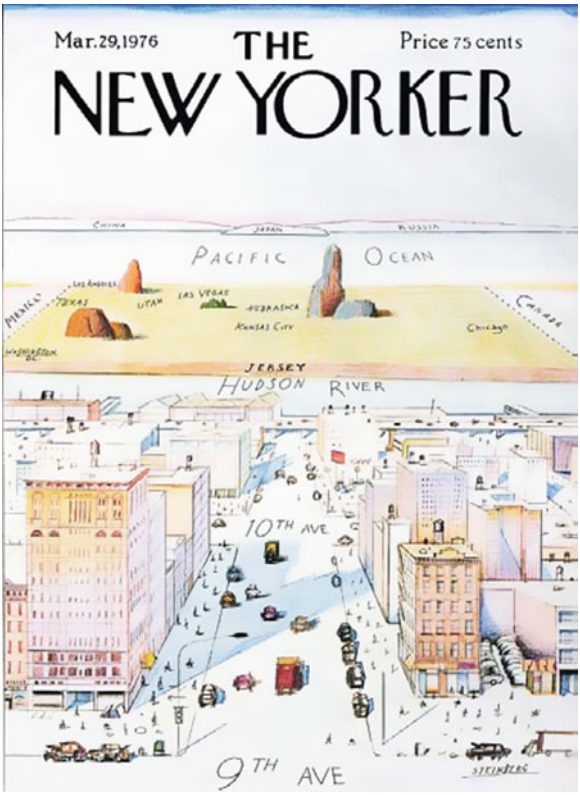

Fig. 3 Saul Steinberg's cover from *The New Yorker* magazine March 29, 1976

The examples begin with examples from 1845. The sketches of London shown in Fig. 5 illustrate how there has always been an interest in drawing geographies of London. In 1845 the Illustrated London News provided free copies of a two-part hand-drawn panorama of the River Thames, from Vauxhall (at the west of the drawing) to Greenwich (in the East).

This example is a depiction of the city by an expert sketcher, and the panorama shows a quite formal representation of the city. As well as this formal representation, less formal drawings can also convey different, more personal representations of the city.

Moving closer to the present is an example from the "Drawing London" project (2010), where the resulting hand-drawn maps were exhibited at the Museum of London. Residents of London were asked to sketch how they 'saw' their city. Some interesting interpretations resulted. The example shown in Fig. 6 was drawn by London resident Anika Mottershaw. She mapped Zone 1 of the London Transport network. About drawing this map she wrote:

> I woke up this morning and felt like drawing a map. Once I get one of these silly ideas in my mind, POW!, it's hard to stop me doing it for the rest of the day Mottershaw (2011).

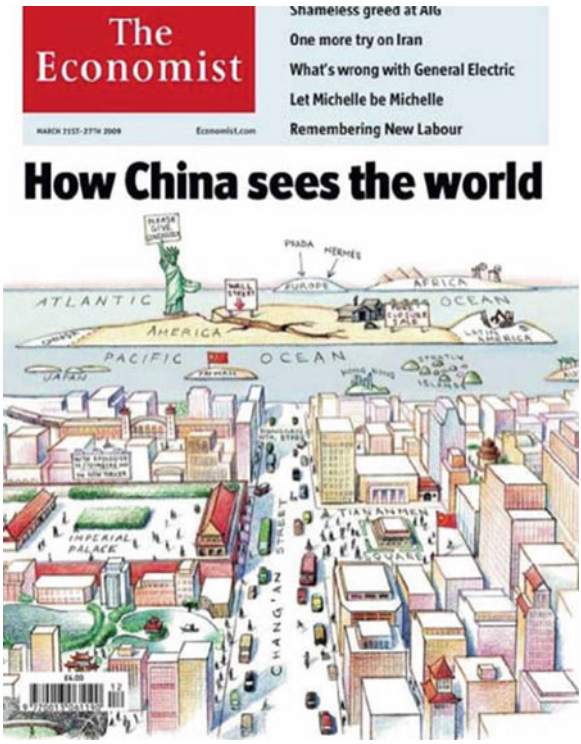

Fig. 4 Cover from The Economist (2009), March 27. "How China sees the world. *Source* http://bigthink.com/ideas/21421

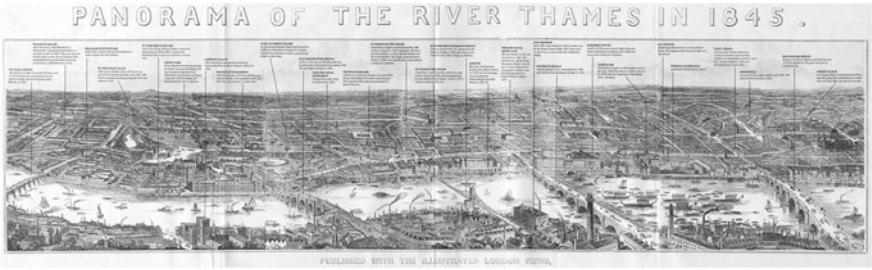

Fig. 5 Hand drawn map of London 1845 Source: http://www.ianvisits.co.uk/blog/2010/08/11/huge-panorama-of-london-in-1845/

This project was publicised by on-line magazine *The Londinist* (londinist.com). About the project they said:

> We're still after further installments, so please unsheathe your felt tips, sharpen your pencils and send us a doodle of your own neighbourhood to tips@londonist.com (londinist.com 2010, np).

The project attracted numerous personal interpretations of the city, providing intimate insights about how individuals consider a city and the way it 'works'.

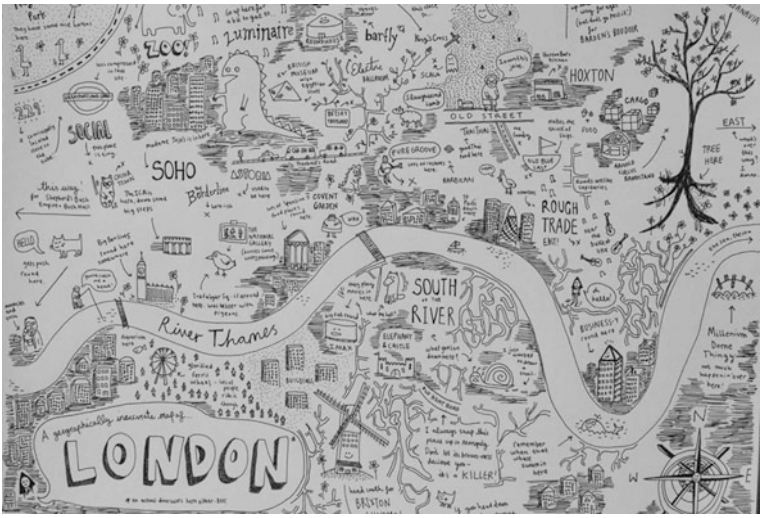

Fig. 6 Anita Mottershaw's map of London. From: Hand-Drawn Maps of London: City Centre *Source* http://londonist.com/2010/03/hand-drawn_maps_of_london_city_cent.php

Also in 2010, in the BBC television series called "Magnificent Maps", one of the maps featured was a highly detailed, hand-drawn map by artist Stephen Walter. This map was the artist's personal mental map of London, output and formalised on paper. About this work, "The Island", Walter said:

> Discoveries such as the First Earl of Salisbury having honeymooned, in 1589, in what is now a dodgy part of Edmonton caused much amusement. The map charts the birthplaces of famous people such as Alfred Hitchcock, Samuel Palmer, Noel Edmonds and Phyllis Pearsall (the originator of the London A–Z). It notes where Winston Churchill went to school, the gymnasium where Arnold Schwarzenegger trained, where the speed of sound was first recorded, the place where Oliver Twist was taught to thieve, the hotel where Hendrix died, sites of old palaces and prisons and the main encampments of the peasant revolts … (Farrier 2010, np)

A section from the map is shown in Fig. 7.

Another London-based project is the Hand Drawn Maps of London Rivers. These drawings focused on the rivers of London, where residents drew their associations with the watercourses that flow through the city. A sample drawn map is shown in Fig. 8.

A final London example is a sketch of a mental map of a Londoner's perception of where the wealthy live (Fig. 9). This simple diagram quickly imparts knowledge about a simple geography of wealth in London. The wealthy live in the west of London, on the north of the Thames. No other wealth exists in this simple na geography. This naive image of where the wealthy live is immediately seen. The place where the wealthy are perceived to live is known and shown.

These examples from London illustrate how personal sketches of a city (here London) can strip away the complexities of a city and show the bare elements. All of

Fig. 7 Hand drawn map of London by Stephen Walter (Neatorama 2010). *Source* http://uploads.neatorama.com/wp-content/uploads/2010/05/london2.jpg

the examples shown do portray the city as a personal place. The space of London is reduced, and each representation provides a complete view of the city—from the perspective of a 'local'. All that is deemed to be unimportant is removed, leaving the key elements that need to be communicated. The individual's mental map of the city is transferred to the representing space (the map) through the process of drawing.

4 The Case for Naïve Representations of Geography

If users cannot recognise where they are they will endure stress, and search for geographical information that puts things in (spatial) perspective (e.g finding their bearings, orientation to north etc.). According to Golledge (2000), p. 1) "We often assume there is no need to learn this type of geography because we already "know" it! And, we have not bothered to make this underlying geography explicit. Golledge thinks that na geography gives an implicit knowledge via environmental perception and that landmark or feature recognition and an awareness of the built environment is part of geographical understanding. He says that "People who claim they 'can't do' geography can provide accurate assessments of their local area. …"Users 'already know it" (Golledge 2000, p. 1). For example, aspects of the geography of daily life that we "implicitly "know" but have not bothered to make the underlying geography explicit (*ibid*, p. 7). Na geography gives an implicit knowledge via environmental perception, through the use of landmark or feature recognition (*op cit*.).

Slate magazine (online Blog) (Slate.com) ran a number of articles that looked at hand-drawn maps (Turner 2010). In the article by Turner (*op cit.),* the review of a number of these maps by Paul Stiff, a professor of information design and a collector of hand-drawn maps were reported. Stiff commented one particular map—drawn by an Australian architect, providing directions to his daughter for traveling from Brisbane to his farm. Stiff noted:

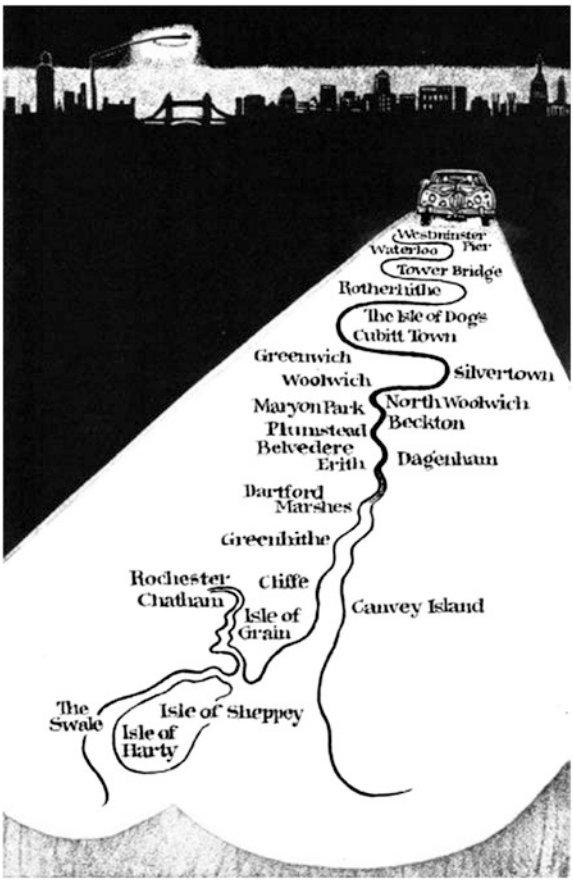

Fig. 8 Hand drawn map of London's Rivers. "Caught by the River". *Source* http://caughtbytheriver.net/2010/06/hand-drawn-maps-of-london-rivers/

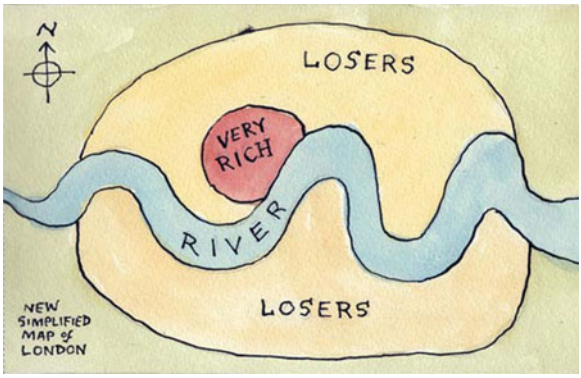

Fig. 9 Sketch of a Londoner's mental map of wealth in London. New Simplified Map of London drawn from memory… (by Nad @ flickr). *Source* http://www.allmaps.com.au/unusual-maps/new-simplified-map-of-london/

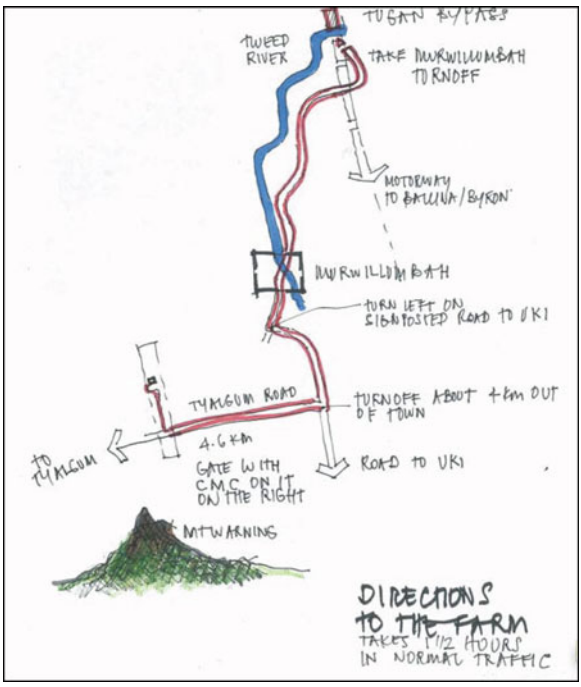

Fig. 10 Sketch map—from Brisbane to the farm

> If you compare this with a topographical map, you'll see that he's compressed the scale astonishingly. There's less detail closer to home, where roads are familiar, … but the scale expands the nearer we get to the destination because we need more information in places that are new to us.

This map is shown in Fig. 10.

Drawings of na geographies have been used successfully to impart more personalized views of geographies. They show personal insights into geographies that would not otherwise be perceived. So, if representations of na geography 'works', what is the best method of portrayal that ensures that the mental map is transferred from the cartographers mind to the map users mind with the greatest chance that both mental maps coincide?

5 Understanding 'Drawn Geographies'

The examples provided in the previous section can be called 'drawn geographies'. When we draw geographies we ask users to do a number of things, including:

- Making transformations from the represented world to the real world;
- Building forms—as their own mental maps;
- Interpreting descriptions that are delivered through the symbology, or grammar or cartography;

- Taking a guided 'fantasy tour' through geographies that might exist in the future—using maps of future projects or envisaged changes to a landscape or urban space;
- Being conducted through a graphic 'walkthrough' via an individual's sketch of a personal geography;
- Imagining specific details by 'filling in the cracks' from the framework provided via a sketch map;
- Interpreting and extrapolating additional information from fragments of information that form the sketch;
- Integrating discrete iconic displays from dispersed graphics and associated notations; and
- Visualising sequences from 'time stamped' graphics.

Readers of the drawings imagine spatial relationships, connections, distributions and sequences through their interpretation of drawings. This is usually done with no formal map reading training or apriori knowledge of the geography, or travel through a geography depicted.

Perhaps the best example of this concept is the use of maps for orientation and understanding a metro rail system. Users of the metro (and the metro map), generally with no formal map reading training at all, are able to quickly understand the complexities of the system, locate where they are, consider where they need to travel to and then devise an efficient route to make that journey. The metro map is 'consumed' in order to negotiate a, perhaps unfamiliar, city, armed with a mental map.

Consider the London Underground system. Transport for London, and its predecessors, has always sought efficient graphics to assist travelers. A number of maps, or sketches, have been produced. Consider the *Metropolitan Railway and Connections* sketch map (1925), produced as part of an official guide. It provides a simplified sketch map that immediately imparts information about the geographic extent and the workings of the system. It is efficient, but a simple sketch that brings-together pertinent information needed (Fig. 11).

In a similar fashion, Massimo Vignelli's redesign (Fig. 12) of George Salomon's New York Subway map simplifies the Manhattan subway system. Produced in 1972, Vignalli's design was used until 1979, when it was replaced by George Salomon's map (Visual Complexity, nd). It was a simple drawing that left out much of the 'real' geography above ground. His map did pay homage to Harry Beck's 1932 design of a new map for the London Underground (Garland 1994) which was based on the use of lines that were only horizontal, vertical or drawn at 45° (The Map Room 2007). The map was simple and provided the navigating underground: lines of communications and intersections (train lines and stations). It is interesting to note that in March 2006, viewers of BBC2's The Culture Show and visitors to London's Design Museum voted Harry Beck's Tube map as their second-favourite British design of the 20th century in the Great British Design Quest. The winner was the Concorde aircraft (Wikipedia http://en.wikipedia.org/wiki/Harry_Beck).

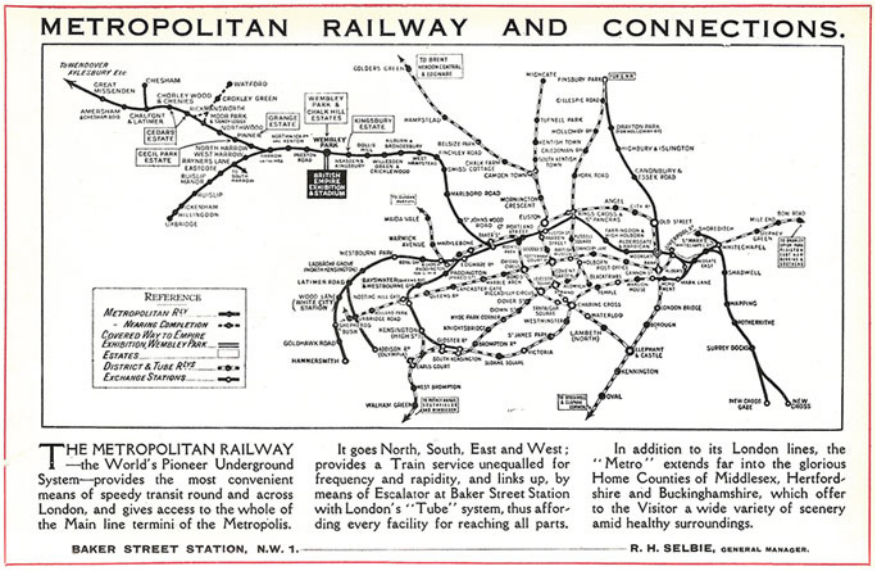

Fig. 11 Metropolitan Railway and Connections sketch map (1925). *Source* http://www.flickr.com/photos/36844288@N00/3971791859/#/photos/36844288@N00/3971791859/lightbox/

In these examples, the recipient reads' the (represented) geography that has been drawn by the person wishing to communicate that information. Therefore, we have both 'readers' of geography and 'drawers' of geography. Both combine to translate, depict and communicate geographic information. It is this simplification of geography, and the insightful drawing of geography, that makes the map a successful communicator.

6 'Read' Geography Versus 'Drawn' Geography

In the book *VizAbility: Learn to Communicate Visually*, Woolsley et al. (2004) note that people are 'readers' and not 'writers'. We like to use 'presentational' and 'conversational' diagrams to:

- 'spatialise' ideas;
- provide 'personalised notetaking';
- assist in supporting talking;
- assist thinking and exchanging;
- provide group 'ownership' of ideas; and
- assist when making presentations

Fig. 12 Massimo Vignelli's New York Subway map (1972). http://subway.com.ru/maps/images/1972ml.jpg

They argue that making people draw enhances their ability to understand/comprehend information. By drawing what they know, through seeing what they know and then by showing it in a drawing they are able to visualize what they see and what they imagine. Through drawing their mental map can be realized, assessed and the effectiveness of a map product determined. It must be noted, however, that some authors like Harris (2008) do not see the usefulness of drawings!

Thus there exists the importance of engagement. We gain an understanding of an environment by actually being in the environment—physically or virtually—or traveling through the environment (as discussed by de Certeau (1984), in his book *The Practice of Everyday Life*). Therefore, perhaps by engaging in the development and the subsequent representation of an environment through a drawing we gain a greater understanding about what we really learn about an environment by reading a map or by using a geographical visualization tool. Through the process of drawing we engage with the mental map as well as the physical representation of an environment—the map.

7 Conclusion

Maps are produced to represent many 'geographies'—human or physical, formal or informal, real or imagined. It is argued that a 'good' (map) drawing is something that includes information about the essential components of a geography so that, when read, it communicates pertinent information required so that the map-reader can build a mental map of that geography. It is this selection of information that occurs 'behind' the drawing that ultimately results in a good map—a good drawing. Yes, the actual drawing process itself is important, but also are the processes behind what is drawn.

I assume, perhaps naively, that this process is not that dissimilar to how an artist makes considered decisions when composing and producing a drawing. Where the actual 'marks' are made on a medium are not placed by chance. This is an informed practice, where the decisions and deliberations made before making a mark are the essential 'stuff' that makes a drawing 'work'. It is through that this process that a good drawing results.

Mapping has at its core the requirement to accurately show phenomena in its spatial context. This has been termed 'spatialisation'. Here, the 'stuff' that underpins this discipline is mathematics (developing ways of representing a spherical earth on a flat surface), measurement of data, analysis or information and the final depiction. Designers and producers of map products are concerned with whereness—something that can be formulated and depicted in quantitative terms, and whatness—dealing with qualitative information. The whyness element of mapping is a combination of a user's knowledge about the subject being depicted and the map producer's skill in choosing the appropriate data and designing the most effective portrayal medium.

The depiction of 'somewhere in space/time' depends on a number of elements—the choice of the method of graphic portrayal, the attributes of the information that have to be depicted, the influences on how the nature of the data and its location may alter, the catalysts for change that bring-about the final location in space/time for particular data elements, and the rules and conventions for depiction. The choice of depiction techniques that need to be employed are those that relate to the type of data being depicted, the viewing preferences of the user and the specific demands of the visualization method and equipment being employed.

The collection of data, map design and compilation is informed by location. What is shown, where it is shown, and whether it is shown at all, is determined by the information that needs to be collected to enable to design of an appropriate map.

Before the application of computers to mapping, the profession was focused on 'pre-delivery device', that is the consideration about what should be produced to provide the best representation of geography. This engagement with the actual process of 'drawing' allowed ideas and concepts about what should be represented to be formalised. This was done via sketches, map annotations and actually drawing the map drawings. The mental map was transferred from the designer/

cartographer to a physical representation on some drawing medium. The advantage here was that the cartographer was able to visualize the geography of the real world, form a mental map, and then devise schema that would allow a concept to be transferred onto paper, further developed and refined, and then used as the starting point for actually generating the final representation. The sketch of the idea would then be translated into the language of maps, and symbols, lines and annotations developed to provide 'translations' from the language of the sketched idea to the language of map production, with its associated specifications.

In the era of computer assisted cartography, computers 'assisted' in the development and production of maps. However, relatively recently, the whole process, in some instances, has been transferred from the human cartographer to the computer-as-cartographer. Maps are produced more efficiently, for less cost and much more quickly. However, it is argued, that the 'drawing' input into map conception has been removed altogether. No longer are the concepts behind ideation and the mental map formalized, developed and implemented via drawing and sketching. It is further argued that, by removing the ability to sketch one's mental map, inferior representations of geography result. It is this engagement in the drawing of mental images of geography that results in better cartographic design and 'good' maps.

Yes, machines can collect data, analyse and compile geographic information and draw maps. But it is the human input that develops a good map from a good drawing. Evan in today's computer era of cartography, it is still the engagement in the drawing of mental images of geography that result in better, more insightful, and more effective cartographic design—'good' drawings.

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Understanding Through Encountering Place

Laurene Vaughan

Abstract The ambition to understand place is a grand ambition, and one that requires us to embrace 'place' as the complex socio-cultural, geospatial and temporal entity that it is. Between 2009 and 2011 an interdisciplinary community of researchers embraced the challenge of understanding place through a deep encounter with one place, the Western District of Victoria, Australia. They did this through a collaborative inquiry known as *The Stony Rises Project*. This project brought together researchers from the sciences, arts and humanities and resulted in touring exhibition featuring the work of 10 artists and designers, and a book *Designing Place: An Archeology of the Western District* which included all 17 project participants. Key to the methodology of the inquiry was an 'artist camp' a traditional method of situated inquiry. This was a four day situated exploration undertaken in April 2009. This chapter discusses the design of this camp and how the way in which a series of experiences were designed to enable the participant researchers to develop a deep understanding of this place through an encounter with it.

Keywords Interdisciplinary · Place-making · Artist camp · Cultural identity · History

1 Introduction

The ambition to understand a place or at least the nature of place is a high and perhaps unattainable one. To understand something or in the case of place, we may say somewhere, is to be situated in a web of ambiguity, complexity and contradiction. By definition to understand, is to attempt to perceive the intended meaning

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or significance of something, and to then interpret or explain that something, through some method to others. To conceive of a place as the object of understanding, is to embrace the ambiguity of that place as being a somewhere; an unknown location that we have yet to make sense of. Time, heritage and intention are amongst the frames that will inform and influence this journey into the understanding of place. This may include our relationship to a place, our familiarity with its contexts and contradictions as framed through questions such as—*Is the site of inquiry a place we name as home or a town that we visited once, passed through, were born in or the birthplace of our parent's*? Each of these relational contexts has many variables that will then inform and change what we understand, and how we can potentially know, a place and how we communicate this to others.

In order to explore these many variables in how we understand place, a research investigation into one particular site—the Western District located in the South West region of Victoria, Australia (Figs. 1 and 2), was selected as the location for two interconnected projects that were undertaken by a community of artists, designers, humanities and science scholars and practitioners. This disciplinary mix was important in the research design. It extended the possibility that the relationship between the individual, a location and culture, would also be informed by a range of epistemological and professional layers of interpretation; including both how meaning is made and how it is communicated. The two projects are *The Stony Rises Project* an interdisciplinary exhibition of creative works, and *Designing Place: an archeology of the Western District* a book that integrates the creative works of *The Stony Rises Project* (Fig. 3) with the a series of essays exploring particular facets of the region, its history and cultural contribution. The methodology for realizing these two projects is the basis of this chapter's discussion.

2 Understanding Place Beyond the View

When we understand a place, we have found a way of being inside a location in a manner that enables that place to have meaning for us. As argued by Tim Creswell, place is more than a landscape that can be viewed, 'place is a way of seeing, knowing and understanding the world' (2008, p. 11). This has been a central tenet of *The Stony Rises and Designing Place* projects as the research team sought to move beyond the surface of the land and the grand landscapes of the Western District with its undulating volcanic plain in order to discover the what lay above or below this terrain, and identify different modes and traditions of habitation (Fig. 4). As such a series of events were designed that would enable the project participants to investigate the layers of interpretation, of natural or human intervention, that individually and collectively create this place. Culture is central to any discussion of the organization of space and place for, as Yi-Fu Tuan states, it is 'uniquely developed in human beings. It strongly influences human behaviour and values' (1977, p. 34). Although each cultural grouping has their own unique

Fig. 1 Map of Australia *Source* http://geography.about.com/library/blank/blxaustralia.htm

Fig. 2 Detail of western district of victoria *Source* http://geography.about.com/library/blank/blxaustralia.htm

ways of creating and reading place, there are also universal traits, qualities or values associated to place, and it is this intersection between location and culture that creates place.

There is an intrinsic link between the physicality of a place, and the history and cultural practices of a location and its inhabitants; for it is through this integration that place is realized. Lucy Lippard argues that 'landscape is both the context for places and attribute of places,' for 'place equally defines culture' (1997). Without socio-cultural interventions, a landscape may exist in the abstract, but once viewed, connections are made for the viewer and a place, for that person, is born. This is the process that is central to the translation of meaning that understanding place requires: a 'somewhere', becomes located geo-spatially and socio-culturally and thereby becomes, place.

Fig. 3 Stony rises project *Source* http://stonyrisesproject.com

Fig. 4 View across western pleins *Source* Vaughan 2010

The Western District of Victoria is a complex socio-cultural, political and geological landscape. It is a site of colonization, ancient civilization, of tales of abundance and scarcity, of farming innovation from the indigenous eel farming and smoking techniques, to contemporary methods of large-scale food production.

Inhabitants have been slaughtered, new settlers have taken ownership, and there have been environmental immigrants and economic opportunists. The population of the Western District is a multi-racial cultural mix and yet within contemporary cultural and political discourses it continues to be perceived as predominantly Anglo Saxon and privileged. At times this is a magical landscape full of rolling hills, rainbows and small hamlets, at others it is full of violent rain and wind, a land that is harsh and burning dry, of salt lakes shimmering on the horizon. Endeavoring to understand and to convey this multiplicity to an audience was the challenge for the 17 participating researchers whether it would be through text, image or artefact.

Paul Carter asks in the opening chapter of his book *Dark Writing: geography, performance, design,* 'How did our representations of the world become so hard and dry?' (2009, p. 8). The premise of his argument is that since the evolution of Empiricist Geography, the complexity that we call the world has become reduced to a line, and that these lines that form and limit our understanding of the world. 'To think the line differently is not only to read—and draw-maps and plans in a new way. It is to think differently about history. To materialize the act of representation is to appreciate that the performances of the everyday life can themselves produce historical change' (p. 9). This was the ambition of this interdisciplinary investigation to find a new means of representing the complexity of place, through an archeology of difference, contradiction and compatibility.

The *Stony Rises Project* and *Designing Place* are examples of a new way of thinking about place, of discovering it and of representing it. The complexity of the project and the many disciplines involved in this archaeology of the Western District, were an attempt by the project curators to use these many different epistemologies, methodologies and subsequent outcomes, to enable a deep understanding of this region of Australia. To understand a place, involves much more than a surface or cursory glance at a terrain, a line or marker on a map, or text that describes some aspect in detail. To engage with this landscape it was essential that we participate in the performances of the region if we were to find a way of representing our understanding of this place.

2.1 Encountering Place: The Artist Camp

Discovering ways of moving beyond 'the view' as a way of initially seeing and then knowing a place was explored in these projects through the use of the traditional embedded method of discovery of landscape—the artist camp. There is a tradition within Western creative education and practice of groups of practitioners leaving the boundaries of the studio and taking residence in the landscape or site of investigation in the form of a tour or a camp. These events like their scientific counterpart, the field trip, utilise a method of discovery through community and extended exposure to the site of investigation as a means to enable deep knowing. The artist's camp was a means for the project participants to move beyond merely

Fig. 5 Viewing the landscape to Lake Corrangamite

'looking at' a terrain to (being with) a place. For both the *Stony Rises Project* and *Designing Place* this camp was to be the foundation for individual explorations within the collective research outcomes.

In April 2009 this community of researchers traveled to the Western District to encounter the socio-cultural geography, the cultural heritage and geology that is this landscape; the objective of each of the activities that was designed into the event being to facilitate the group in moving beyond the view, to a literal experience with place.

It was a diverse group comprised of a geologist, an architectural historian, an anthropologist, an art curator and a cultural theorist, each with a different theoretical perspective, ready to interrogate and inform their interpretation of the site of investigation. Whilst at the same time a diverse group of ten artists and designers were prepared to do likewise. As we sought to challenge the limitations of viewing as a method for understanding, we wondered as individuals and a community—*What kind of view are we discussing when we speak of looking at a place; who is doing the viewing?* The view of the geologist who sought to understand and communicate to the non-geologists that were his project peers, that the landscape which the surface suggests in form and undulating horizon line, can only be known by going underground. At the same time the historian and the cultural theorist, each of who sought to understand and position human interventions and practices in order to know more about the inhabitation of the place. This is what we might categorise as being situated upon the ground. Together this resulted in a dynamic or pulsing view of habitation in the past, present and future, embracing place as a spatial and temporal entity; temporal in both its evolution over time (historic development) and through time (the experience of being there) (Fig. 5).

As our experience of the camp evolved so did our understanding of the importance of time and vicinity in informing our evolving understanding. Across the research community there was a diversity of temporal engagements with the Western District. For some of the participants there were generations of family connections to land and country both from an indigenous connection that had existed for thousands of years,

to those of white settlement and birth that was at most 50 years. For others the artist camp was their first encounter with this landscape, resulting in what can be described as a truly 'tourist' view. There are those who knew the narrative of the region as represented through cultural artefacts such as literature and art, which through the duration of the camp came alive as an encounter with the physicality of the place. Memories, fantasies, enticements and critique, each of these were catalysts to the research process, the camp and the subsequent research outcomes.

2.2 Details of the Camp

An artist camp is a form of situated or embedded discovery. In order to optimize the experiences of the researchers involved a series of events and activities were designed with the aim of facilitating not only individual experiences but also a shared and deep knowing of the region under investigation within the research team. This series of events exposed all the participants to different aspects of the region's socio-cultural and geological history.

The Western District is a volcanic plain and millions of years of transformation have resulted in its distinctive landscape of craters and cones. Until something dramatic such as an earthquake or volcanic explosion occurs we typically we view landscapes as being stable or settled and viewed from above. To address this surface view of geological place, Professor Bernie Joyce of Melbourne University accompanied the research team on a one-day site visit to the region, where through a series of locations (a mountain top, a cave or crater edge) he explained the slowly evolving landscape that is still in a state of evolution. He referenced geological facts and features including stone types, formations and ruptures which he then related to indigenous practices that had existed long before white settlement. As the day progressed people's reflections on their ability to read the landscape and to see lava flows, cones and the evidence of living geology increased. The day concluded in a public lecture 'The Geology of the Western Plains' and subsequent publication 'Geology, Environment and People on the Western Plains of Victoria' (2010).

As a colonized nation, Australia has a layered history and subsequent discourses of habitation and colonization. For some it is a narrative of exchange, others of war and loss of land. Within the indigenous Australian vernacular home or the place of one's birth and heritage is referred to as country. This country is physical and narrative. The stories of place are the stories of heritage, law and socio-cultural tradition. The Gundjitmara people are the traditional owners of a significant part of the region that was the focus of the project. There is a common perception that all Australian Aborigines were nomads, walking from one place or location to another across the country. Although true for some clans, this is not the case for all. One of the astounding features of the Western District are the remnants of the complex aquaculture and associated sedentary habitation of the Gundjitmara people on the lands of the around Budj Bim, now known as Mt Eccles. Under the guidance of Budj Bim Tours the team of researchers were

taken out ‘on country’ where some of the historic stories of this place were shared and the evidence of complex cultural practices were shown. For most of the researchers this was the first time that they had seen evidence of traditional modes of habitation. It challenged their understanding of how the land had been occupied prior to colonization, and how biased much of what they had been told had been. This encounter with the evidence of a different mode of habitation was to have profound effects on all. Our assumptions, even with the most liberal of intentions, were challenged, and our comprehension of this place was transformed.

There are many cultural devices that we use to cultivate and inhabit landscapes in order to make them place. This project with its interdisciplinary exploration including a team of 10 artists and designers who working towards the exhibition, were, by the very nature of their inquiry and resultant creative work that was produced, another aspect of this ongoing cultural interpretation. Historically the region had been a rich site for the immigrant Viennese painter Eugene von Guerard (1811–1901) who’s paintings of the landscape and people of the area were formative in the establishment of a local visual narrative of place. Like all art, these paintings were interpretations by the artist of what he saw, and what he wanted to show or tell. The outcome of which are iconic representations and interpretations of this place. As part of the camp itinerary, the researchers visited key mountains and lakes such as Mt Eccles, Mt Elephant, Mt Noorat, Mt Napier and Lake Bullen Merri all of which were locations of significance in the views that he painted in the nineteenth century and which have gone on to become iconic in the development of Australian art. These site visits enabled this later generation of creative practitioners to investigate and imagine the view that he saw, and to re-imagine it into their own works in the exhibition. This was a process of translation and re-interpretation of geological and cultural artifacts across time.

The final aspects of investigation of the site visit were the enduring design and architectural artifacts of white settlement that have transformed the landscape, and marked the establishment of European settlement, new industries, communities and places of being. Throughout the nineteenth and twentieth centuries the Western District of Victoria was a region transformed from volcanic plains to an abundant landscape for agricultural development. With this transformation in land use came new modes of habitation and new residents, markedly wealthy landed gentry from English and Scottish heritage who established grand homesteads across the district. Many of these are architectural feats, some are follies and others are sprawling evolutions of styles that have grown through increased wealth, associated family numbers and ownership. As the architectural historian Harriet Edquist, notes ‘Over a seventy-year period hundreds of homesteads were built in the area, some modest, some very large’ (2010, p. 128). Throughout the camp a series of visits to and tours of homesteads were undertaken including tours of the gardens and other features that convey the grand transitions that this landscape has known, over the past 200 years of colonization and before.

The homesteads of the Western District are a prominent marker of the settlement and presence of the new habitants of this landscape. The demarcation of land for ownership and use is another important aspect of this, typically realized in the

Fig. 6 Drystone wall, skipton *Source* Vaughan 2010

form of lines and fences. As a volcanic plain settled by European and predominantly British, Scottish and Irish immigrants, have transformed and laid their claim to the land using their traditional methods. As a result this region of Victoria is marked by the traversing lines of dry-stone walls (Fig. 6). These walls are a method of dividing the land is typical in any basalt plain world over. It is a method of building and land clearing at the same time. Dry-stone walling is a practice of necessity and aesthetics, and in Australia distinct to this region. The dry-stone walls of the region were, for the curatorial team of the project, foundational in their selection of this locale as a site for investigating the multifarious and at times contested, ways that we make and know place. Design devices such as the dry-stone walls are an effective way to make and imitate place and perhaps even re-make home. In order to deepen this proposition the visiting researchers were taken on a tour of different walls in the region and introduced to the subtle stylistic differences that a lay observer may not see. They also partook in a dry-stone walling lesson so that they could experientially begin to understand the labour that had made this particular enduring feature of the landscape.

The itinerary of the Artist Camp engaged the participants in embodied exploration of:

- The geology of place
- The origins of habitation of a region
- Colonization and acts of transformation
- Grand vistas and creative interpretations
- Practices of making home and habitation
- Localised lines of demarcation, ownership and use

This itinerary realized in the design of the events of the Artist Camp were pivotal to the *Stony Rises Project* and the publication of *Designing Place*, utilized a methodology of unfolding or disclosure in order to enable participants to experientially discover and understand this place. The same methodology was applied to all the participants no matter the longevity of their experience or knowing, and the fact that this was undertaken as a community of inquiry that collectively developed their own narrative of place from walking on country or riding in a bus, was also part of our understanding that the making of place is both individual and a communal activity.

3 Conclusion

Central to our position in designing this investigation is that understanding different geographies is an act of understanding different ways of knowing, and making, the phenomenon that is place. In *The Stony Rises Project* we attempted to do this not only through multi-disciplinary ways of engaging with place, but also through multiple forms of experiencing and articulating the phenomenon that is the Western District of Victoria. To do this, three types of engagement with place were undertaken: a four-day Artists' Camp in the region, an exhibition (*The Stony Rises Project*) and a book (*Designing Place. An Archaeology of the Western District*). Throughout the course of its evolution this project has engaged with many different forms of geography: the geography of landmass and terrain, the human geography of people, and the cultural geography of their built and ephemeral artefacts of habitation. Layer upon layer, through the different strata of habitation, past and present, indigenous and colonial, understanding the geography of the Western District has been a multifarious exploration of the making of place.

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Part II
Artefacts and Geospace

Artefacts and Geospaces

William Cartwright

Abstract In the era of paper maps everything seemed simple: produce a map according to the specifications that had been developed over many years; deliver the completed artwork to a printer; print the map according to 'tried-and-true' methodologies; and distribute the map. Simple! Working to methods that had been developed for over 500 years, within an established cartographer/printer framework, meant that paper maps could be efficiently compiled reproduced and used. Now, with the advent of Web mapping—delivered as 'standard' products or user contributed/collaborative products via Web 2.0—the era of 'just' paper maps has passed. Users, and producers, have access to a plethora of digital archives, base maps, geo-information, imagery and artifacts. They can retrieve or generate cartographic documents and tools that have the currency, accuracy and focus for knowledge-gathering and decision support that needs to consider geography as an underpinning resource. This chapter firstly considers the 'new' cartographic artifacts and their effectiveness as a communicator of geographic information. It reflects on what is considered to be 'good' design. Then it outlines the elements of good cartographic design. Finally, Web-delivered cartographic artifacts are addressed in terms of what is an effective communication method.

1 Introduction

Cartography has always sought to apply the latest in communication technology to make available its products in a more efficient manner. It applied Gutenburg's press to make maps more widely available and to be reproduced more efficiently,

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photography was utilised to make data collection more efficient and photogrammetry utilised to measure information about topography shown on aerial photographs and to convert it into mappable data, computers were adopted, first assisting in computations and later as a production tool using DeskTop (DTP) publishing applications. This was done to both speed-up production and to make more accurate depictions. Later, with the advent of videodisc, and later CD-ROM optical storage was embraced as a mode that facilitated the storage of the voluminous amounts of data and to provide mapping products what included interactive components. More recently, the Internet, the Web and mobile devices have been used as methods for the rapid communication of mapping media. The world of mapping has rapidly moved from provisioning users with static two-dimensional hard copy displays to maps that are on-line, immediate and dynamic. Cartography is being challenged by an increased demand for more advanced and sophisticated presentations, stimulated by developments in scientific visualization, integrated media, virtual reality and geospatial analytics.

These cartographic artefacts are produced to assist and support decision-making. They provide the tools to theme experts to consider and assess geo-located information. At the very core of 'good' mapping is communication and effective communication with cartographic artifacts 'works' when maps are designed with due consideration to: (1) General good design principles; (2) Good map design principles; (3) Good Web (and Web mapping) design principles; and (4) Good design for effective use. This chapter explores these themes in the context of providing cartographic tools to support theme expert researchers who now can produce and use cartographic artifacts via Web 2.0 to understand different geographies.

2 The User/Producer and the Provision of Cartographic Tools: Citizen Cartography

There has been a digital convergence of communications equipment, office machines and consumer electronics. This has been brought about by all of the elements talking the same electronic language and the digitising of pictures, sounds and video. Ideas take some time to develop, but once proven it may only be the progression of time and the development of techniques and technologies that convert strokes of genius to 'matter of fact' realities.

Mapping has progressed from a hand-drawn image to one that can be self-generated and moved around the world, almost at will. When we now consider the Web and what it means to cartographers and consumers of their products it is obvious that a revolution has occurred in cartographic design, map production, map 'delivery' and map consumption (or use). For cartographers it means that almost (within reason) any idea for a mapping product can be realised and delivered as a digital product. The plethora of cartographic tools for graphics

production, image manipulation and product authoring enables design to be transformed into interactive maps, enabled to be delivered on discrete media, through intranets, the Internet and the Web. Maps can be delivered 'on-demand' and composed dynamically. Maps can almost be built and delivered in tandem to the data being collected. And, for users not just one map is available, but many, from worldwide resources, in many cases for free or at minimal cost. We can design, produce and use maps freely and liberally, globally.

Relatively recently there has been a paradigm shift, leveraging on the powerful possibilities of Web 2.0, social software and relatively inexpensive consumer electronics-delivered tools that can be geo-enabled, mobile and incorporating media capture and generating tools. Web 2.0 is the use of the Web by individuals and groups to provide and share information, including geographical information. It provides a new model for collaborating and publishing. This has meant that the consumer can now be the data collector *and* map producer.

Maps can now be published on the Web by user/producers using a process called 'mashups' with Web 2.0 and Social Software. The mashup describes the combination of functionalities from more than one source into a single integrated tool by using APIs (Applications Programmatic Interfaces). Users are able to develop their own 'marked-up' maps by appending their overlay information as an additional layer of information, usually using the default symbology provided (and usually map pins are employed), to self-publish their maps via the Web. This has been given many names, including 'Neocartography'.

3 Crowdsourcing

Part of this different approach to the provision of cartographic artifacts is the methodology of using the general public—from inexpert novice to informed semi-professional to gather and share geographic information and to produce their own maps. By using data and information from the general public and by making digital information freely accessible via the Web outcomes that would otherwise not happen is the our come. This concept of making data freely available for problem solving or by 'harvesting' information from Web users has been termed 'crowdsourcing'. Crowdsourcing can be a most powerful way of providing data where not other provision method exists. For example, a recent project by the Royal Institution of Chartered Surveyors (RICS) (GIM 2011) assessed the usefulness of using crowdsourcing to improve land tenure security in poor communities. RICS and the company Know Edge are undertaking research that focuses on removing the 'security-of-tenure' gap.

In an article in *Wired* magazine Howe (2006) outlined the crowdsourcing phenomenon:

> Technological advances in everything from product design software to digital video cameras are breaking down the cost barriers that once separated amateurs from

> professionals. Hobbyists, part-timers, and dabblers suddenly have a market for their efforts, as smart companies in industries as disparate as pharmaceuticals and television discover ways to tap the latent talent of the crowd. The labor isn't always free, but it costs a lot less than paying traditional employees. It's not outsourcing; it's crowdsourcing (Howe 2006).

As well as collecting and sharing data, 'the crowd' are also being used in the decision-making process. By placing data onto a Web site, making it freely accessible and inviting the crowd to interrogate the data, the analysis of a massive amount of data can be done through shared processes. This type of methodology for problem-solving has been called "The wisdom of the crowds" by James Surowiecki (2004). He says: "Ask a crowd, rather than a pair, and the average is quite close to the truth".

This approach was formalized somewhat in 2001 when the pharmaceutical company Eli Lilly funded *InnoCentive* (http://www.innocentive.com/), that invited researchers from outside the company to address the company's research. Later, companies like Boeing, DuPont, and Procter & Gamble also used *InnoCentive* to put their research questions to the crowd. Lakhani, from MIT, studied *InnoCentive* and said: "The strength of a network like InnoCentive's is exactly the diversity of intellectual background" …"We actually found the odds of a solver's success increased in fields in which they had no formal expertise". He links this method of problem solving to sociologist Mark Granovetter's "strength of weak ties" (Granovetter 1973), where "efficient networks are those that link to the broadest range of information, knowledge, and experience". A similar application is Amazon's Web-accessed *Mechanical Turk* (https://www.mturk.com:443/mturk/welcome) that invites individuals to make interpretations of imagery. Here these "HITs" (human intelligence tasks) require little time and input to complete. The fee for completing these tasks is also modest.

4 Decision-Making with User-Generated Web Maps and Crowdsourced Decision Support

In any research endeavour getting appropriate information can be difficult. The decision flow is depicted in Fig. 1, where underpinning knowledge is provided through observation—in the field or via access to appropriate 'remotely-provided' via the Web, it is then represented by a map or a map-related object like a *Google Earth*™ 3D product or an animation. Once information is available decisions can be made and any advice or action follows.

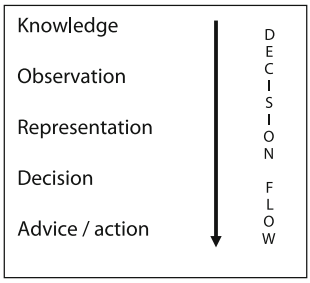

Fig. 1 The decision flow

5 Crowdsourcing, the User/Producer and the Naive Cartographer

New technologies enable both professional and non-professional cartographers alike to produce maps and other cartographic artifacts. The artifacts produced by non-professionals can nevertheless be viewed as naive mapping products in the eyes of professionals. Using social media and Web 2.0 functionality, these artifacts can be developed and produced without a cartographer's input whatsoever, as long as the producer has access to software, data and communications systems. Software is readily available for a modest cost or, in many instances, for free, data providers are more than willing to make data available to anyone who has the ability to access or pay for their resources and wired and wireless Internet has become ubiquitous and it is available almost anywhere, again for free or for a reasonable cost. Add to this the widespread incorporation of GPS into consumer electronic devices like smart phones and digital cameras and the knowledge that the general public now has about digital mapping, geo-coding and geodata availability, then the reality is that almost anyone can access or produce maps to record information that is geocoded. As well, they can then use these artifacts to support the building of personal repositories of geo-coded information and media, which might be employed to assist research themes that are located in a traditional geographic space or a 'different' geographic space. These geographies could be considered to be 'naive geographies'.

The term 'naive geography' was coined by Mark and Egenhofer (1996) to describe a formal model of common-sense geography. They proposed that this could form the basis for developing intuitive and 'easy-to-use' Geographic Information Systems. Naive geography was defined by Egenhofer and Mark (1995) as "the body of knowledge that people have about the surrounding geographic world"—the primary theories of space, entities and processes (Mark and Egenhofer 1996). This was also described as something that "… captures and reflects the way humans think and reason about geographic space and time. Naive stands for instinctive or spontaneous" (Egenhofer and Mark 1995, p. 4).

6 Crowdsourcing, the User/Producer and the Provision of Decision-Making Support Tools

Increasingly theme experts base decisions using Web-delivered information, images and representations. The use of user generated information, mated to user/producer cartographic artifacts, delivered via Web 2.0 offers the potential for provisioning theme experts with decision support tools. Maps produced in a matter of minutes using a *Bing*™, *Google Maps*™ et al.—provisioned map base allows the user to become the producer. However, there is a proviso that must be noted—without real cartographic expertise awful, and in many cases, unusable maps can result. As with any mapping product good design is essential and form should not follow function. To be useful, these products must be developed and provisioned with due respect to 'good design' principles and 'good' map design strategies.

The following sections reflect on the elements of good design in general and good design principles for cartographic products.

7 'Good' Design

Internationally-renowned designer, Dieter Rams, who designed many iconic electrical products in the 1950s for Braun, that were praised for being high on form and function, proposed ten principles for good design. He said, in an interview in the 1980s VITSOE (nd) that good design:

- Is innovative;
- Makes product useful;
- Is aesthetic;
- Makes a product understandable;
- Is unobtrusive;
- Is honest;
- Is long-lasting;
- Is thorough, down to the last detail;
- Is environmentally friendly; and
- Is as little design as possible.

And, Pedersen (2009), in an article: "What is Good Design" also issued his ten essential characteristics of a well-designed product, which must be:

- Sustainable;
- Accessible;
- Functional;
- Well Made;
- Emotionally Resonant;
- Enduring;

- Socially Beneficial;
- Beautiful;
- Ergonomic; and
- Affordable.

Rawsthorn (2008) said that good design must do something useful. For example, the Apple *iPhone* is easy to operate and the user does not need an instruction manual.

Reflecting upon these three opinions about what constitutes 'good design', this chapter now addresses whether the products of contemporary mapping systems in fact do deliver good design.

8 'Good' Map Design

Specifying just one particular map design principle is not a suggested practice. The actual design process is so complex and so closely linked with taste and aesthetics that choosing just one is impossible. However, to provide a staring point for specifying how Web maps might be more effective if 'usable design' principles are applied, one set of principles was been selected to provide a benchmark to judge the quality of these Web-delivered maps.

This 'foundation' benchmark is the elements of the 'Five principles of Cartographic Design', presented to the 1999 British Cartographic Society Design Group meeting (BCS 1999). They were used to gauge if the sample products 'work', in relation to usable map design concepts.

- Principle #1. Concept before Compilation. Design the whole before the part. Consider the user first, and the user last. What does the user want from this map? What can the user get from this map? Is that what they want?
- Principle #2. Hierarchy with Harmony. Important things must look important, and the most important thing should look the most important.
- Principle #3. Simplicity from Sacrifice. Great design tends towards simplicity (a principle supported by Jacques Bertin (1983)). It is not what you put in that makes a great map but what you take out. The map design stage is complete when you can take nothing else out.
- Principle #4. Maximum Information at Minimum Cost. Here, the focus is on functionality not utility. It is good design that makes utility functional.
- Principle #5. Engage the Emotion to Engage the Understanding. The philosophy is simple; beauty (aesthetics) focuses the attention. Focusing the attention is the purpose of map design.

As well, the BCS Design Group (2002) later commented and the impact of just using one style of map (like using *Bing*™, *Google Maps*™ et al. for underlay base maps).

> Another worry was that the same form of mapping (styles) are employed what ever the display medium. For example maps for display on the WWW or for use with PDAs (Personal Digital Assistants), at present, all appear basically the same. The design of maps needs to be lead by the technology available and new a technology (sic) should facilitate new cartographic designs and thus the development of new conventions for use with those mediums. At the moment we seem to be thinking 'how can we fit conventional mapping into new technologies?', rather than 'what does this new technology allow us to do cartographically?'

Supportive and negative comments included the following:

> The positives of using convention included the increased communication of symbolised features if conventional forms and colours were used. Due to the familiarity of many symbols, often as a result of repeated use of styles based on those adopted by national mapping agencies, the user was perceived to gain a certain amount of security and as a result feel more comfortable in their use of the maps produced.…
>
> The negatives of using conventional styles are that there is a lack of innovation in the design of maps nowadays. Most maps appear to be a simile of those produced by the major map producers, and especially in maps used as navigational or general reference tools, there has been little change in the styles or approaches to their design over recent decades.

These general map design rules are provided as an introduction to usable map design. The following sections address Web information graphics and Web map design foundations.

Web graphics and maps

The design of efficient Web pages depends upon both Form and Function. Form refers to the appearance of visual and functional components; and the arrangement of visual & functional components. Form can be considered from two perspectives: Function—good visual design improves function; and Aesthetics—tributes to the visual appeal of a product. For Web design, Form refers to the optimisation of colour, image quality, graphics, typography, visual organisation and map design and the visual design of information structures, navigation and interaction tools in order to maximise the function of a Web page and its aesthetic appeal. Function refers to the way in which a product operates and the way in which a product serves its purpose. A functional design has two components that together define its usefulness according to Nielsen (1993):

- Utility—does the functionality do what is needed?; and
- Usability—how well can users use the functionality?

For Web design, function is provided via appropriate information design, navigation design, map design, interaction design and the development of useful interaction tools (for example, search tools and map interaction tools).

Form and Function are inseparable. One cannot exist without the other in a successful design. For example, navigation design provides function by enabling users to logically move throughout your Web site. But also the form of the navigation tools (for example placement, colour, graphics, typography) determines whether these tools are noticed, whether they are legible and whether their functionality is recognised.

In Web design, Form should follow Function, meaning that design must support function. For example, the focus on content and interaction is addressed first then decisions are made relating to colour, fonts and graphics. It is assumed that the Function of the host Web pages are adequately designed to afford uninterrupted and efficient information delivery. Therefore the focus here is on good Form.

9 Design and Map Mashups

In a mash-up mapping world, maps generated and published via the Web are, in many cases, produced atop of *Bing*™, *Google Maps*™ et al. and, therefore, are 'pre-designed'. By that, what is meant is that each map is similar, the same—ersatz maps substituting for unique, well-designed and focussed products. They are somewhat different from maps that were produced pre-Internet that provided a unique design solution for representing geography. This is especially true of maps produced via the 'GeoWeb'. Here, via the process of Volunteered Geographic Information' (VGI) or crowdsourcing maps are generated by user/cartographers, who might have little cartographic skill. This 'neocartography' facilitates data capture, processing and publishing using social software, available via Web 2.0. It empowers individuals—everyday citizens—to map their community, contribute to national and international mapping activities and to build and make freely available geospatial databases and publish their maps in a collaborative manner (Cartwright 2012).

Before addressing good design principles for *Google* et al. it is worth addressing some bad design applications. The *Google Earth*™ Blog Spot (2007) (http://googleearthdesign.blogspot.com/2007/06/top-10-google-earth-bad-design.html) has published the "Top 10 *Google Earth*™ Bad Design Practices". The design of thematic maps using Google Earth® 'foundation' imagery should avoid:

- Placemark icons that are overly complex and/or have too many colours;
- Offering users a cluttered view when opening a *Google Earth*TM project;
- Not giving users an introduction to what data layers they can view in a file;
- Use of acronyms/code names where unnecessary or where they haven't been explained in a previous Web page offering;
- Using too much text in pop up balloons. Generally users will just not read large blocks of text;
- 'Chart Junk', elements that are in a file but actually do not add any relevant understanding and just get in the way of overall clarity;
- Not editing camera positions;
- Use of overly colourful or thick lines in polygons—lines have less 'clutter' effect on a view if they are as thin or bland in colour as possible whilst still remaining clearly visible;
- Not encouraging users to turn layers/folders on or off to aid understanding; and
- Not picking out key data points or study areas.

So, what is good design, with respect to cartographic artifacts that are generated with the underpinnings of naive cartography?

Good cartographic design is good cartographic design, no matter who the cartographer, no matter who the data collector or potential user (or users, if the geographic data is provisioned as a shared Web 2.0 repository). Both professional and non-professional cartographers alike must address good design when undertaking collaborative mapping practices. There is no excuse for poor cartographic design or unusable cartographic artifacts being generated or provided. It is the responsibility of cartographers and neocartographers to not shelter behind the concepts of Web 2.0 and user-generated geographic information and artifacts to produce inferior, and perhaps unusable decision support tools.

A post from a *Google* user support forum contributor (mtiffany) highlights the concerns about the quality of *Google Maps*™ from the user community:

> I've been using Google Maps for years and I've noticed a significant decrease in quality in the past several months from both the web and the Google Maps for Windows Mobile interfaces. I live in New York, NY, not exactly an obscure place, and the road I live on is not even on the map anymore! It certainly was last year. … "Obviously nothing is perfect, and I assume mapping is hard, but why is Google Maps, overall, worse than it was last year? Before this decrease in quality, I guess I naturally assumed that Google products all get better over time. I think the usability of the interface has gone up, and there are some nice new features, but what's the point, if the actual maps and routes aren't as good? (Google "Maps Help" support forum, posted 23 January 2009).

10 Conclusion

Does cartography need to be re-defined in terms of cartographer and also in terms of naïve producer/consumer as well? Consider that cartographers can control most elements of the provision of products until the final consumption of the product. Perhaps a division needs to be made between the actual 'behind the scenes' elements of contemporary cartography and the 'public face' of cartography—'consumer cartography'.

An argument could be put that cartographers become involved in the elements of cartography that they have both mastered (either academically or technically, or both) and that they also enjoy. Personal satisfaction in producing an elegant and aesthetically-pleasing design or mastering some scientific problem—both resulting in an as-near perfect a solution that is possible—can be a major part of what provides cartographers with motivational input that encourages further refinement of skills and better mastering of particular scientific problem-solving strategies that are unique to cartography. From the producer/consumer perspective, the need to produce a cartographic product that would serve a purpose, as well as mastering a technological skill, provides the motivation to complete a product that works (for them), but they could be uninterested in producing maps for anyone but themselves.

In the current situation, where self-generated maps and maps that are composed and output by non-professionals are a focus, do cartographers view what they do differently, and do consumers of cartographic products influence the actual outcome? Seeing that neocartography could be seen to have as much to do with making a movie as producing a scientific document (although the scientific integrity of all cartographic products is as important now as ever, cartographic artifacts produced under the umbrella of naïve cartography need to be considered as equal partners to their 'scientific' counterparts. Technology may only be something that 'gets in the way' of properly exploiting things like collaboratively-generated media and naïve users of this powerful amalgam of media types demonstrate this by their inability to appreciate and design the best application of the many media types available (and possible) in their rush to 'get their hands dirty' by cutting computer code.

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Understanding Artifacts Through Geographies: Perceiving Geographies Through Artifacts

Fani Gargova

Abstract Every artifact contains a multitude of spatial references. Through them every artifact becomes a map on its own. This map is multilayered and complex, combining virtual with real geographies. It needs to be deciphered according to these qualities and seen in reference to its various ontological contexts. In this sense the artifact—as a map—is a representation of an imaginative geography of the culture it was produced in, encompassing the concept of neighboring cultures. The most important ingredient for comprehending the nature of the artifact is that it at the same time defines and is defined by space. The paper aims at presenting the idea of space in a different cultural and historical context and to contrast it with a modern view on the geographies of those same objects. Those include mobile artifacts and maps. As an overall agenda, the paper is dedicated to the use of the contemporary geo-information and cartography, as well as the humanities to draw from an understanding of space represented by the objects. It examines, from the point of view of the humanities, the forms of application of a historical geography, combined with an imaginative geography when addressing the issue of representing and communicating the history, importance and context of artifacts. The aim is to facilitate a profounder investigation of art in its spatial existence, while adhering to its original and transformed contexts throughout time.

Keywords Artifact · Visualization · Byzantium · Medieval maps · Virtual geography

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1 Introduction

The digital age and the advancement of technology have given invaluable new tools to researchers throughout the disciplines. Within the humanities the availability of all kinds of sources increasingly easily accessible through online databases has profoundly changed the working methods and routines. The accumulation of information has long been a major interest of cultural, as well as state-institutions. By now it has become increasingly obvious that it is not sufficient to collect and to put this information somewhere on the internet, where it might not be found and used. In the first place it is important to structure the bulk of material in order to be able to grasp it. A convincing way of achieving a first overview is the visualization of different common characteristics that could reveal a hidden structure or underline a broader context.

1.1 Visualizations of Time and Space

As every artifact exists in time and space (or to be more accurate, in multiple times and multiple spaces) for disciplines dealing with the arts, it is geography that has always been a good starting point and a common neutral ground for structuring and illustrating, as it provides an comprehensible, (often) visual, and already familiar way of handling information.[1] By now some online databases of key institutions have adapted to structuring their visual material on a geographical basis.[2] And all of the well catalogued artifacts in museums, collections or archives include some sort of geographical information that can be searched.

Isolated initiatives of virtual exhibitions have even adapted to visualizing the information within both parameters of time and space by providing timelines together with a map functionality, thus enabling a rough contextualization and the evolution of a storyline.[3] It seems particularly common and creatively

[1] Another increasingly popular way of displaying content is through a timeline. The Metropolitan Museum of Art (2011b) practices this way of visualizing for over 10 years by now, and the British Museum (BBC 2012) experimented together with the BBC on this concept. On a broader level, timelines have been added to the Europeana (Koninklijke Bibliotheek 2012) and the Artstor (2012) portals within their latest updates of 2011. Both methods though arise from the traditional way history and art history have been transmitted in schools and through survey books. Cf. Nelson (1997, pp. 37–39).

[2] See e.g. the Bildindex der Kunst und Architektur (Bildarchiv Foto Marburg 2012) or the Zwangsarbeit im NS-Staat Project (Deutsches Bundesarchiv 2010). The Google Art Project (Google Inc. 2011), to which belong almost 20 museums, might also be mentioned in this context. Nevertheless the use of a map-based presentation is more thoroughly advanced in the field of popular culture through e.g. the integration of Panoramio (Google Inc. 2012) into Google Maps.

[3] Such as the Edward Muybridge Collection (Kingston Museum and Heritage Service 2011) or the above mentioned Heilbrunn Timeline of Art History (The Metropolitan Museum of Art 2011b). The recently launched and freely accessible tool created by the Library of Congress

implemented within websites specifically targeted at the transmission of history to the general public, as the digital art history textbook Smarthistory.org (Harris and Zucker 2011), Die Welt der Habsburger (Schloß Schönbrunn Kultur- und Betriebsges.m.b.H 2010) and Historypin (We Are What We Do 2011).

1.2 Visualizations and Inaccuracy

Nonetheless, the spatial and chronological information visualized are inaccurate on many levels. They are often punctual, consisting of a pin on a Google Maps surface or the time-span of the creation of the artifact. An artifact never exists on only one point with clear coordinates. This is exemplified by the following two spatial scenarios: a building is a surface stretching over several points; a portable object most probably changed its place throughout time, e.g. from the site it was found to the museum, where it is now preserved.

This same logic applies to chronology. An artifact wasn't just created at a point in time and then stopped existing. If it is preserved, its time of existence endures until today and it has most probably changed in a significant way several times throughout its life, just as it has exercised some influence, which after all qualifies it as worthy of preservation.[4]

What, therefore, is insufficiently explored in the visualization of artifacts, is their context, and especially the context in its changing nature. While inaccuracy can be accepted in the framework of popular education for the sake of simplicity, it should be the aim of researchers to desire technological solutions that can embrace the substantial complexity of their topic area and can provide them with new ways of perceiving all layers of information connected to the subject.

The main concern of art historians is to understand the circumstances around the production of an artwork, the why and how of the masterpieces of world art, and increasingly also of the everyday artifact. These questions are not easy to answer, but we might get a step further, if virtual microcosms of the past can be created to make the complex contextual world of the subject of investigation comprehensible. The focus of this paper is the Middle Ages and especially the Byzantine Empire. In this respect all further artistic examples and references will be connected to this period, as to show the specific difficulties arising from oversimplifying geography or projecting nowadays spatial understanding to this age.

(Footnote 3 continued)
named Viewshare (2011) makes it even possible for every small collection to explore these functionalities for their holdings.

[4] On this aspect see the contribution by S. Teetor in this same volume.

2 Artifacts as Carriers of Geographical Information

Every artifact is a map on its own, as it contains a multitude of spatial references. To be able to understand this map, it needs to be deciphered and read according to its own signs of geographical placing. The relevant information may be of different nature. They are basically divided into a physical spatiality and one, which is implicit in its content. Complexity arises from the fact that every object exists and is determined by both types of space. As such, although often involving an imaginative geography, they are relevant for the recording, visualizing and thus understanding of the artifact and its context.

2.1 Objective and Physical Spatiality

The spatial information can be contained within the tangible elements as material, technique, provenance, or location. Some of them are easy to determine and reflect a type of objective and physical real-world information. Those are the ones usually recorded in databases and catalogues. They can nevertheless be multilayered and contradictory, which makes them difficult to manage.

The databases of leading museums can offer good examples for keeping track of this physical information connected with geography. Such is the ivory relief of the saints Andreas and Petrus (Kunsthistorisches Museum Wien 2011) that can be assigned to Constantinople due to its inscription bearing the name of the emperor and due to the high quality of its elaboration. The current location is also indicated as the Kunstkammer of the Kunsthistorisches Museum in Vienna. The Icon with the Crucifixion (The Metropolitan Museum of Art 2011a), also an ivory work from the same period, is similarly assigned to Constantinople. The historical city is additionally contextualized within a broader geographical structure through the Thesaurus of Geographic Names (The J. Paul Getty Trust 2000). The visitor is also informed on the provenance of the piece being "Edmond Bonnaffé, Paris; Baron Albert Oppenheim, Cologne; J. Pierpont Morgan (d. 1913), London and New York" and on the current location of display in the Gallery 303 of the Metropolitan Museum of Art in New York.[5]

While the above mentioned artifacts feature plural geographical indications relevant to a certain stage in their time of existence, the visualization strategies of

[5] While in these cases the attribution to Constantinople seems consistent, other examples are less obvious and thus belong to a common tendency to oversimplify the distribution of artistic centers. Due to lack of knowledge about the origins of a vast number of artworks from the Byzantine period and a certain lack of imagination concerning production places of high qualitative art, a disparity between the center, meaning mostly the capital Constantinople and leading monasteries as the Saint Catherine's monastery on Sinai, and the peripheries is still being perpetuated and can be observed in the majority of museum and exhibition catalogues (cf. Evans 2004; Cormack 2008; Frings 2010).

Fig. 1 Icon with the Triumph of Orthodoxy, Constantinople (?), second half of the 14th century (Cormack 2008, p. 109 cat. no. 57)

those same institutions do not seem to use them as valuable sources of information.[6] On the other hand, art historians frequently rely on information that is implicit in the artifacts in order to be able to determine a spatial indication at all.

2.2 Implicit Spatiality

The types of evidence that can be deduced from the inherent characteristics of an artifact are thematic, iconographic, functional or formal. Usually these geographical specifications are far more difficult to categorize, as they can be both real and virtual and the distinctions and borders between those worlds are fluid. The viewers' standpoint, knowledge and attitude often determine if the space is real or imaginative and how it is related to other forms of spatiality.

Another museum item might exemplify the common use of geographical deduction from the content of the artifact: The icon depicting the Triumph of Orthodoxy (Trustees of the British Museum 2011; Kotoula 2006) was acquisitioned by the British Museum in 1988 and has been shown at almost all large exhibitions on

[6] This applies e.g. to the related information on the artifact in the Heilbrunn Timeline of Art History (The Metropolitan Museum of Art 2007).

Byzantium during the last years (Fig. 1). Technically no information on its provenance exists, but, nevertheless, according to the catalogue of the British Museum, this object has also been painted in Constantinople. The clue to the understanding of this geographical designation is in the represented iconography, which is divided into two registers. The upper level shows an icon of the Virgin Hodegetria[7] held by two angels. On its right side stands the empress Theodora—under her regency in the year 843 the images and their adoration after the iconoclasm were restored—together with her son the emperor Michael III. On its left side is Methodios, the patriarch at that time, together with supporters. Thus this part of the image shows a very specific, and though stylized, probably a historic moment after the end of the iconoclasm, which took place in Constantinople (c.f. Brubaker and Haldon 2011). There is no representation of the city itself, but Constantinople is without doubt present through and beyond the gold ground. Interestingly the upper zone of the icon seems to be taken as a "historical fact". The lower register on the other hand showing eleven also historical saints that were vital in the fight for the images are a symbolic underpinning, as they are displayed in a static and somehow anachronistic relation to each other and the above event. While the scene above aims at presenting living people, the figures below are marked as dead, saintly and in another divine sphere. From the ones that can be identified all but one, Saint Theophylactos bishop of Nicomedia, today Izmit, also lived, fought, and died as martyrs in Constantinople.

In registering the icon of the Triumph of Orthodoxy in a catalogue, the city of Constantinople is taken as an indication of a real geography relevant to this object, and especially the iconography of the shown icon of the Virgin Hodegetria in relation to the Hodegon monastery. If the represented monarchs and saints are taken as geographical indicators, the question arises why the inclusion of the local saint of Nicomedia cannot point to a different production place. First and foremost though both places should be recorded as relevant to the artifact, just as the most prominently displayed space—in the figures of the saints, the angels and in the gold ground—, which after all is Heaven. The distinction of real and imaginary geography should be of no importance in this context. Looking at this artifact through the understanding of the 21st century, puts Heaven and the imagination of the paradise outside of real geography. It is so to say a non-place. But the relevant question should be: How did the society that produced this icon understand its spatiality and how did virtual and real space interfere?

[7] Hodegetria is a common type of representing the Virgin Mary, that goes back to the prominent monastery of the Hodegon and signifies "she who leads the way". It goes without saying that within this image a further spatial allusion is hidden. (see e.g. Angelidi and Papamastorakis 2000; Bacci 2005).

Fig. 2 Ebstorf world map (reproduction), Ebstorf monastery (?), around 1300 (Kolossos 2007)

2.3 The Evidence of Medieval Maps

The importance of these implicit indications of virtual spatiality for the understanding of real space in the time, which is discussed here, can be exemplified through Medieval *mappae mundi*, whose study has been advanced significantly since the publication of the first volume of the History of Cartography series (Harley and Woodward 1987). By now researchers agree on judging the quality of those maps in the context of the religious, political, and social circumstances they were produced in (see e.g. Woodward 1985; Kline 2001; Talbert and Unger 2008). Recent scholarship focuses especially on the valuable information that can be gained from their historical worldviews for the understanding of past societies (see e.g. Baumgärtner 2001; Moraw 2002; Englisch 2002; Harvey 2006; Stercken 2010; Lilley 2011; Solopova 2012).

The impressive Ebstorf world map, which was burned during World War II and is today only known through reproductions, can serve as a model in this context (Fig. 2). The elaborate web-edition of this map (Warnke and Kugler 2008) allows for a detailed study of the different elements of the complex work.[8] As a whole the world map shows the earth as a circle with East up. Although full of complex information, the structure follows the tripartite segmentation (Harley and Woodward 1987, p. 236) with Asia above, Europe to the lower left side and Africa to the lower right side. While other mappae mundi, like the precious Hereford map, reference to the religious framework and Christ residing over the Last Judgment (Kline 2001; Harvey 2006), the world in the Ebstorf map formally becomes Christ's body. His head is shown at the very top, thus in the East, just as his feet and hands mark the other cardinal directions.

The map abounds in what might have been the entire geographical knowledge available at that era. Every city has been recorded with a fairly special characteristic and most regions are marked with a note on the reigning people. In the context of this paper two aspects of the Ebstorf map will be of special importance: (1) The interaction and equal treatment of real places on the one hand and biblical and legendary places on the other; (2) The conception of size and distribution related to the identified sites.

In this sense, the extensive variety of references to the legend known as the Alexander romance is remarkable. They are spread over the entire world and form a natural albeit anachronistic part of the portrayal of the 13th century reality. As such exist the man-eating "Gog and Magog" at the far Northeastern part of the world, which were enclosed by Alexander through a wall.[9] Another mythical tribe is the Amazons in the far North, who are accused of misandry and shown as female warriors. Throughout the map the places of the journey of Alexander are provided with a caption, just like the realities, which describe their major characteristics and contribute significantly to their understanding as forming a part of the natural world (Baumgärtner 2009, pp. 157–164).

In the same way the biblical places permeate the surface of the map. Jerusalem, although certainly existing, is shown at the very center of the map, so to speak as the hub of the world, as the largest city in the world, even larger than Rome, because it is the most important one (c.f. Baumgärtner 2001). Christ himself appears at the moment when he steps out of the tomb before his resurrection. It is worth noting that Jerusalem and Rome are also the only two cities shown in "satellite view" or more symbolically said in "God's eye view", while all others are seen from the ground or at best from bird's eye perspective. This distinct treatment of the status of a settlement underlines the central point of symbolic importance. With regard to size two more buildings compete with the above mentioned: the town wall and tower of Babylon. They thus close the circle of the

[8] The digital version is based on the hardcopy edition by Kugler et al. (2006).

[9] Cf. Kline (2001, pp. 184–187), where the biblical reinterpretation of this episode of the Alexander romance is discussed.

three major cities of Christian (catholic) faith. Here too imagination and reality intertwine into the creation of a new virtual space, which is completed by the paradise situated on Earth and at the very East next to Christ's head.

The "real" world on the other hand demonstrates another virtual spatiality, pertaining to the unknown Eastern and Southern parts of the world in contrast to the West-European part, the region the creator of the map knew best. The latter consists of detailed accounts on the spatial distribution of settlements. The geography might not be accurate in a modern sense, but the distances are realistic and there is no major distinction in size between e.g. Aachen or Paris. But already as far as Poland to the Northeast and Venice to the Southeast this concept is lost for a broader almost fictional account. Thus the farther away from the direct experience and needs of the mapmaker, the less careful is the treatment of that space.

3 Implementing Historical Authenticity

The means for depicting the world in the exemplified artifacts bear witness of a more distinct understanding of geography than a modern person would have. They include spaces, like paradise, that rationally do not exist on earth or whose co-existence in the same work of art is anachronistic, as in the Ebstorf map. On the other hand, like in the icon of the Triumph of Orthodoxy, they might omit spatiality in general, as different allusions are meant to create a complex space in the imagination of the viewer. Both of these kinds of spatiality were real for the actual viewer in the late Middle Ages. It is not out of ignorance or inability that those objects are not accurate or illusionistic. They display the immediate worldview of their creators. Thus, how can these understandings be pointed out today through the use of modern technology? How should they be approached, as to make them comprehensible for a modern audience?

When we consider the Ebstorf map, a representation of the understanding of space that (literate) people in the region around Ebstorf had in the late 13th and beginning 14th centuries, it becomes clear that the placing and visualization of artifacts from this area and time-span on a modern map of Europe would not reflect their essence appropriately. Projects like Mapping Gothic France (Media Center for Art History, Columbia University and Art Department, Vassar College 2011) test the ability to show geographical space, as well as architectural space in its changing nature. The use of historical, as well as animated maps, a timeline and the possibility of direct comparison are further useful tools for the construction of a story. Nevertheless, the structural insights gained from this project do not reflect the human experience of space. In this sense the historical Gothic France adapts to today's understanding of this region and its architectural development, not the other way round.

An interesting tool for the display of historical contexts is the Visual Eyes Project (SHANTI of the University of Virginia 2011). The project has so far used

primarily visualization through geography or diagrams in connection with a timeline. Where it is possible, the researchers use only historical maps for this end, thus setting the fundamental piece for the construction of the distinct historical space. Although on a small scale, focusing on the travel of Jefferson to England (University of Virginia 2011a), the history of the library of the University of Virginia and its burning (University of Virginia 2010) or the daily routine of Tibetan nuns (University of Virginia 2011b), what is especially emphasized are the interconnections, movement and change within the historical subjects. A positive feature is also the realization of the entire presentations in an openly accessible XML document. Unfortunately though, the standpoint of the viewer remains an outsider's one, who is following unnatural movements of points through space and mostly taking in the God's eye view looking down on the events.

4 Conclusion

Thus a desideratum seems to remain the creation of tools, including cartographic solutions, that would allow for the investigation of other, historical societies with their own understandings of geography. In the first place there is a need for methods that adapt to the mindsets of the people that produce the artifacts under research, contrary to the common practice of imposing "our conception of the world" onto them and thus distorting "their realities".[10] We might come closer to the goal, if we are prepared to manipulate today's understanding of geography for the sake of a historical form of authenticity, just as inaccurate Metro maps are by now accepted and widely used throughout the world (Cartwright 2011). A further development of Jonathan Harris' ideas for cartography presented in his Non-Geographic Mapping (2004) or chronology through the Whale Hunt (2007) could be just as useful, as a closer orientation on the historical forms of mapping, considered in this paper, or artistic solutions (Harmon 2009) for the exploration of space.

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[10] The designation "our" and "their" are put in quotation marks, as it is not necessarily given who "we" and "they" are. These collective terms would need further definition, a task that can not be further explored in the context of this paper.

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When Countries Become Gods: The Geospatial Aspect of Deities in India

Verena Widorn

Abstract The concept and image of Bharat Mata, the Mother of India, developed along with the struggle for Independence during the British reign in India at the beginning of the 20th century. The iconography of Bharat Mata is thereby closely connected to topography of India. This chapter focuses on the alternate tradition of mapping territory with regard to national identity and the sacredness of landscape in the South Asian world. The author will, therefore, discuss the perception of land by the Indian nation on the basis of maps and images of Mother India.

Keywords Sacred landscape · National and topographic identity · National allegories · Bharat Mata · India

> *I show gratitude to thee, Mother, richly-watered, richly-fruited, cool with the winds of the south, dark with the crops of the harvests,*
> *The Mother!*
> Vande Mataram by Rabindranath Tagore (English translation of the first verse)

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1 Introduction

In 2006 the Indian world was enraged by the advertisement for an art auction using an image of Bharat Mata ("Mother India") (Fig. 1) by recently deceased Indian artist Maqbool Fida Husain.[1] The national goddess of India is set naked on the Indian subcontinent; the outline of her body, painted in red, forms the frontiers of the country while her skin is inscribed with the names of important cities. Hindu fundamentalists were up in arms about this particular map of India, calling it blasphemy against religion and the nation, criticizing the lack of respect for the land, and arguing that the nude deity hurt the proud citizens of India. To understand this outrage, which even forced Husain into exile, one must comprehend more than the meaning of Bharat Mata, who is far more than a national personification. In the 19th century the image of the mother goddess Bharat Mata was created as an icon for the Indian independence movement against colonialism and suppression, and she soon became a symbol for the unified motherland of the Hindu nation. In addition to this political message, one must also take into consideration the territorial aspect of the goddess and the importance of landscape as a sacred space which is often identified with the abode or the body of a deity.

This chapter focuses on the alternate tradition of mapping territory with regard to national identity and in this context on the sacredness of landscape in the South Asian world. The perception of space and territory of the Indian nation is discussed on the basis of the visual representation of land an nation in India and abroad. The analysis of the objects will not only demonstrate the sublime way of conveying national territory through popular material culture but also explain that land and landscape have a special and even sacred value in India.

2 The Concept and Artistic Representation of Bharat Mata

Maqbool Fida Husain, also called the "Picasso of India", was one of India's most well-known artists.[2] In the 1990s, the painter and filmmaker divided the minds of Indian society by his portrayals of Hindu deities in the nude and in an allegedly sexual manner. A series of cases were brought against him, but the controversies about his depictions of Hindu gods and goddesses escalated when, in February 2006, an advertisement for an art auction containing Husain's interpretation of

[1] The painting was originally not titled by M.F. Husain and the artist never commented on the identification of the female figure depicted on the poster. Still, the resemblance to his earlier paintings depicting Bharat Mata is evident.

[2] Maqbool Fida Husain was born on the 17th September 1915 in Pandharpur, Maharashtra and was one of the founding members of the Progressive Artist Group in Bombay in 1947. Beside his great painterly oeuvre, he became also well known as film director. After having left India in 2006, he passed away in London on the 9th June 2011 at the age of 95 without having had a chance to visit his motherland India again. See also his website: http://www.mfhussain.com.

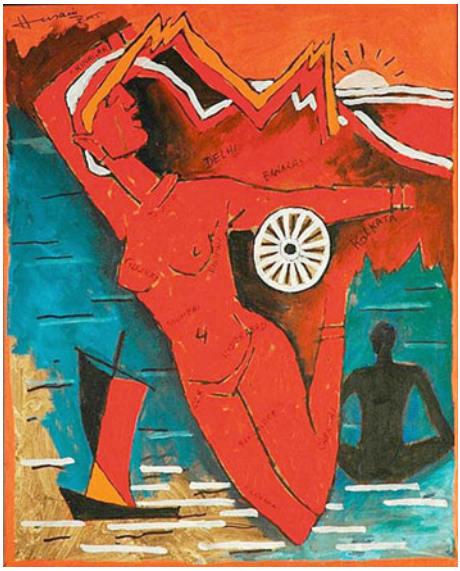

Fig. 1 Maqbool Fida Husain "Bharat Mata", Acrylic on Canvas, 2005. After: Ramaswamy 2010, p. 6, Fig. 3

Bharat Mata. The advertisement entitled "Art For Mission Kashmir" showed one of his paintings of India's national deity as a nude woman posed across a map of India with the names of Indian cities on various parts of her body. Husain was accused and received death threats that finally forced the 90 year old artist to leave India and go into exile in Dubai.

Husain had expressively modified the image of Bharat Mata that was created as an icon for the Indian independence movement, and soon has become a religious symbol for the unified Hindu nation since the late 19th century. Derived from a poem by Bankim Chandra Chatterji and transformed into the song "Vande Mataram" (I worship the mother) by the Nobel Price winner Rabindranath Tagore, the figure of Bharat Mata quickly became a popular motive in the modern Indian art (Ramaswamy 2010, pp. 117–118).

Abanindranath Tagore was among the first portraying Bharat Mata as a young, beautiful woman dressed in a simple saffron-colored robe and an orange scarf covering her head (Fig. 2). The halo around her head and her four arms holding a book, sheaves of rice, a mala (a rosary), and a white scarf remind us that we are confronted not with a girl from the countryside but with a goddess. The icon of Bharat Mata incites nationalist feeling in Indians during the freedom struggle, going out from Bengal and culminated in the nativist Swadeshi Movement (see also Goswami 1998). The painting from Tagore perfectly matches these efforts as Bharat Mata resembles the local population, simple dressed and gracefully elegant. It interesting to note, that this model of Bharat Mata as a village girl was not taken over by successive artists. The iconography of the mother goddess soon changed in artistic representations. A terracotta image from 1911 shows Bharat Mata clearly defined as a goddess wearing a golden crown with jewels and a voluminous blue

Fig. 2 Abanindranath Tagore "Bharat Mata", Watercolor, 1904/05. After: Banerji 2010, Plate I.1

sari (Fig. 3). The sheaves of rice have been substituted for the trident, a symbol of Shiva and a weapon. Another two of the four arms hold the rosary and the book, a symbol of wisdom. Bharat Mata cups her chin in her fourth hand, a gesture that gives her a pensive expression. She stands on the stylized vortex of water—with a lotus blossom next to her feet. The strange sprawling shape of her dress becomes clear when one compares the sculpture with a map of the British Indian Empire at the beginning of the 20th century, when it covered nearly the entire South Asian subcontinent and parts of Southeast Asia (see e.g. Map of India from 1907). The closed lotus-flower symbolizes the island of modern Sri Lanka.

Sumathi Ramaswamy in her publication on Maps and Mother Goddesses in India from 2001 emphasizes the use of the female body to map national territory and argues that the image or "bodyscape" of Mother India transforms dead space into a human place, a homeland and a motherland (Ramaswamy 2001, p. 109). She also discusses this point in her recently published book on the Goddess of the Nation (Ramaswamy 2010) and elaborates on the critical role of the map of India in the iconography of Mother India, which has hardly been considered by earlier publications dealing with the visualization of Bharat Mata (e.g. Kapur 2000; Guha-Thakurta 2006;

Fig. 3 Subramania Bharati (?), "Bharat Mata", Terracotta, circa 1911. After: Ramaswamy 2010, p. 23, Fig. 9

Mukherji 2006; Neumayer and Schelberger 2008). But only Gayatri Sinha, in a small article published in the anthology "Iconography now" in honor of M. F. Husain, links the image of Bharat Mata with the importance of landscape as a sacred space and the holy geography of India (Sinha 2006). Sinha states that already in the Rig Veda (one of the most important, ancient written religious sources of Hinduism dated to the 2nd millennium BCE) the goddess Bharati was mentioned variously as a holy river or the mother of the Bharatas, an Aryan tribe (Sinha 2006, p. 57), which indicates that even at that early time the protective forces and self-sacrifice of a mother and the sacredness of the country especially the homeland has been seen as related. There is a long standing cultural tradition that in India landscape is often identified with the abode or the body of a deity.

3 Sacred Land: Nature and Divinity

The spiritual power associated with the landscape and the topography of India is an ancient concept. Mountain-peaks and lakes are seen as seats of deities or demons (e.g. the Hindu god Shiva resides at Mount Kailash), and one is not supposed to enter

that divine abodes. Rivers are personified by deities, of whom Ganga and Yamuna are only the two most prominent examples frequently depicted on the portals of religious monuments (von Stietencron 1972). Landscape is not always sacred *per se*, but often sanctified by the presence of yogis, practitioners, *siddhas* or pilgrims, who contribute by miraculous actions or tantric rituals to the sacredness of a region in a way that exceeds the purely geographical and natural aspect. Several sites throughout India and also Tibet are therefore associated with the spiritual biographies of these yogis and persons. The predominance of religion plays a pivotal role in the sanctification of landscape in the Hindu and Buddhist world. According to legend, the non-Buddhist demoness Srinmo, who occupied the area of Tibet, was tamed by the first religious king Songtsen Gampo in the 7th century through the establishment of Buddhism and the founding of Buddhist monasteries (Mills 2007). The demoness is often depicted lying on her back and nailed to the ground by important Buddhist sites and monuments placed on her limbs. The Jokhang in Lhasa, the oldest Buddhist monument in Tibet, is situated at the heart of the female demon. Also in India, the concept of taming the land and subduing the demonic spirit by divine power is well known. The Vastupurushamandala symbolizes a geometric, ritual diagram, which is the basis of every Hindu temple and monument (Meister 1979; Bafna 2000). The Vastupurusha—a demon—is nailed to the ground by the gods of the Hindu pantheon, and each part of the demon's body serves as the ground for architectural elements dedicated to the different gods and goddesses.

Like in ancient Western mythology the earth itself is also personified in India. Bhu or Prithvi is equally adored as a mother goddess in Buddhism and Hinduism (see also Dallapiccola 2004). In Buddhism, the Buddha Sakyamuni calls the earth, Bhu, to witness when he attained enlightenment under the bodhi-tree in Bodhgaya. In early Indian art the Buddha is depicted seated in lotus position stretching his right hand to touch the earth to testify that he resists all temptations and has attained Buddhahood. Bhu is shown as a small, often only half-length, figure located below the lotus throne of the Buddha. In Hinduism, Prithvi is seen as another form of Lakshmi and the second wife of Lord Vishnu. A prominent visualization of the earth goddess is her presence in scenes connected to the boar-incarnation of Vishnu, in which he rescues the earth from being flooded by the mighty sea, as shown in a Gupta-period relief of the Udayagiri caves in Central India (Fig. 4). Vishnu, a giant male figure with the head of a boar, stands in a victorious position, while the small figure of Prithvi hangs from one of his tusks. The picture of the rather helpless figure of Prithvi, who had to be rescued by the strong god Vishnu, is markedly different in the representation of Prithvi's manifestation as a holy cow, which, as Ibu Pertiwi, became the National goddess of Indonesia.

4 National Allegories

The female figure that Abanindranath Tagore painted as an image of Bharat Mata is a rather unusual example of both a Hindu deity as well as a national personification, as we might know from other countries. National personifications are often supposed

Fig. 4 Varaha saving the earth goddess, Udayagiri, Madhya Pradesh, cave 5. *Photography* D. Klimburg-Salter 1998, Western Himalaya Archive Vienna

to represent specific and positive qualities of a state, its virtue and wealth, economic progress, beauty of nature, strength and diligence of its people. The depictions of these personifications are either allegories like the Russian Bear denoting the size and power of the Russian Empire or mythological figures provided with attributes that symbolize "unique" features of a country. Germania for example is often depicted wearing a wreath of oak leaves, a symbol for power and fidelity, eternity and long-life. She stands strong and straight, with a sword in her right hand and the German flag in the left.

The image of a national personification hardly refers to a real landscape, geographical setting or topographic peculiarities of a country. It is rather an idealized reflection of nationalistic identity and ideology. Although Germania is set in a mountainous landscape, there is no indication of a real authentic landscape. Also Tagore's Bharat Mata shows no territorial aspects—only some lotus flowers, religious symbols for purity, next to her feet may indicate the sacred space around the deity. She also does not seem to represent the protective function that is often an essential characteristic of national allegories, such as the legendary figure of Holger Danske. The prince is supposed to sit in the cellar of the castle Kronborg in Denmark, where he waits until the country is in danger; then he will arise and lead the nation to freedom.

The idea of defending the freedom of the country and the nation manifest itself in the concept of Bharat Mata. Representations like the terracotta from 1911, above mentioned, intend to show a proud, militant figure equipped with a weapon, the trident, a kind of pendant to Germania's sword. The shape of the dress and the

Fig. 5 Sebastian Münster "Europa Regina" Colored Map in "Cosmographia", 1570. http://strangemaps.files.wordpress.com/2007/07/europeasaqueen.jpg (Accessed on: 26-07-2012)

lotus blossom at her feet symbolize the topography of the Indian subcontinent and its boundaries during the colonial period.

It is rather seldom that the shape of a country or a whole continent dictates the appearance of the national personification; but there are few examples, even from the beginning of world-cartography. A print from 1570 shows Europa Regina, the allegory of the European continent in the form of a crowned queen (Fig. 5).[3] The map of the continent that is the schematic basis for the depiction has been

[3] A block print from 1537, kept in the Map Library at the Michigan University in Ann Arbor, and attributed to Johann "Bucius" Butch has been published by Ramaswamy 2010, p. 88, Fig. 45—The image was later reprinted in the "Cosmographia", the earliest German description of the world, by Sebatian Münster in 1570.

rotated 90° clockwise, so that Europa stands upright with the country of Spain as the crown.[4] The islands of Great Britain operate as the waving banners of her scepter and Sicily becomes her imperial *globus cruciger*. The body of Regina is inscribed with the names of the different countries and nations of Europe. Schematic sketches of woods, mountains and rivers refer to the topography of Europe, emphasizing the most striking features like the impressive Alps or the long river Rhine, but do not match the actual geography.

The Suomi Neito, the virgin of Finland, on the contrary, is mainly depicted as a young, blond-haired, blue-eyed woman holding the flag of Finland or dressed in the national colors of Finland, blue and white. The position of the girl *en face* with arms up in the air refers to the shape of the country—at least before the Second World War. The north-east region of Petsamo, indicated by the girl's stretched left arm, became part of the Russian state. It seems that this change in the size and shape of the country has also effected the position of the national personification; because nowadays one finds images, in which the girl is seen not frontally but from the side and her left arm not stretched, but held close to her body.

5 The Geospatial Aspect of Bharat Mata Depictions

It becomes clear that the idea and also the presentation of the Mother of India epitomize most perfectly the territorial claim of the national goddess. Most images of the last century refer to the idea of a united Hindu motherland before the division of India, Pakistan and Bangladesh following Independence in 1947. The waving of the dress in the colors of the national flag has become a frequent element in the depiction of the goddess and defines more an uncertain space than the real boundaries of the motherland. It still is a rather understandable reference to the outlines of the Indian empire before Independence.

Most images indicate that Bharat Mata is not only a heroic depiction of the national personification of India, but also illustrate the religious aspect of the female figure. People worship the goddess, who truly becomes the Mother of a nation and is sometimes even shown, with two of her four arms, hugging the most famous sons and daughters of India such as Gandhi to protect them against all evil. The depiction of India as a Hindu goddess implies that it is not just the patriotic but also the religious duty of all Indian/Hindu citizens to participate in the nationalist struggle to defend the nation.

In 1997, Maqbool Fida Husain had already produced several versions of Bharat Mata that had not upset the Hindu population. In these images, the goddess is dressed in typical Indian manner with a sari, and although painted in an expressive

[4] Darby Lewes calls these kind of depictions visual somatopia, pointing out the sexual component of such representations and referring on the one hand to familiar cliché and domestic tasks of women, and on the other hand to the protective energy of women. (Lewes 2000, pp. 129–164, see also Ramaswamy 2010, pp. 88–89).

way, the deity conveys a positive, lively, colorful impression of the nation (see Ramaswamy 2010, p. 5; Fig. 2). It is important to note that Husain is not a Hindu but he belongs to the Indian Muslim community, which further inflames the protest of Hindu fundamentalists seeing their deities misused by a pagan. Nevertheless, the artist always pointed out that he has studied the sacred Hindu texts, religious stories and iconography.

In fact, Maqbool Fida Husain seems in many respects to follow the description of Bharat Mata as we find it in poems and in prayers. A popular Indian prayer states: "Ours is a very old country. Our country is like a mother to us all. We call her, therefore, Bharat Mata. We must worship her as a goddess. The Himalayas are her crown. Kashmir is her forehead. Western and Eastern India are her arms. The Western and Eastern ghats [banks] are her legs. The rivers Narmada and Tapti are her girdle. The Malaya Mountain is her foot rest. The oceans wash her feet. The great rivers Ganga, Yamuna and others are the milk flowing from her breast […]".[5] The head of Bharat Mata in Husain's image is not crowned by jewels or gold but literally by the mountains of the Himalayan range. The angled legs of the goddess are placed on both sides of land and form the western and eastern coast. The limbs of the female deity are stretched out to the various parts of India so that her body becomes really connected to the territory and the landscape. A ship with a tricolored canvas marks the ocean that encircles the subcontinent and emphasizes the important of maritime trade. A black figure, shown seated with crossed legs, but only as a silhouette from behind, may lead to many interpretations. One might see it as the shadow of Mahatma Gandhi and his peaceful protest against colonial power. The auspicious icon of the chakra (also an element of the Indian flag) is displayed nearly at the center of the image. Although Husain actually managed to convey the idea that the whole of India can be considered a sacred landscape, the aggressive color red in which land and goddess are painted in a rough, crude way and the agonized expression on Bharat Mata's profile face draw quite a different image of the Indian Nation. Husain has also addressed the reshaped Indian State after 1947. The hands and feet of the deity are not completely worked out and only arm stumps point to the former regions that were lost after the struggle for Independence, namely the regions West and Eastern India, Pakistan and Bangladesh, addressed above in the poem as the goddess' arms. Husain's painting addresses exactly this problematic issue, the loss of territory, the division of the motherland and the segregation of former confederates. The handicapped, mutilated goddess clearly shows the pain that she had to suffer when parts of her body were simply cut off.

[5] http://www.hindubooks.org/culture_course/book1/bharthamata/page1.htm. There are different versions and songs, but in general they are variation of the "Vande Mataram" by Rabindranath Tagore.

6 Conclusion

The idea of sacred space and geography defined by demons and deities is a fixed element in the collective memory of India. It is therefore not astonishing that also the mother goddess of India, the Bharat Mata is closely connected to geo-territory and Indian territory. Evolved as a product of literature and poetry in the late nineteenth century, the artistic tradition soon assigned a geographical aspect to the iconography of the deity. Bharat Mata is mainly represented in front of the outline of the Indian subcontinent and builds the country. Depending on time and on the political situation, the boundaries of the country and nation may vary. But the idea of an extensive area compassing the whole Hindu community as the basis of the Indian motherland is still perceivable. In 2005 Maqbool Fida Husain created an image of Bharat Mata that addresses the loss of territory after Independence and the still traumatic separation of East and West India. One can realize that in general the popular depictions of Mother India, highly adored by the Indian population, do not only reflect a proud, independent nation, but depend strongly on the perception of space and territory of the society.

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Part III
Exhibitions and Geospace

Geographic Space in Museums: Considerations Towards a Spatio-Temporal Supported Exhibition

Michaela Kinberger and Alexander Pucher

Abstract Today, a huge variety of museum exhibitions exist, offering an overwhelming amount of artifacts and information. The presentation methods involved vary from very traditional designs that simply display artifacts behind glass accompanied by a card describing the object to a combination of multimedia and virtual reality installations. Although space and time characteristics are given to all artifacts, regardless their origin or nature, the deliberate use of this information is far from common. This information provides, however, plenty of opportunities to incorporate geographic space within an exhibition concept. This contribution will give an overview of the relationship of museums and geographic information, explore the possibilities of geographic space in museums and present a concept for a numismatic exhibition entitled "The Empire of the Huns in Central Asia and India," which will be hosted at the Kunsthistorisches Museum (KHM) in Vienna, Austria (URL-3).

Keywords Cartography · Information design · Exhibition design · Geovisualization · Geocommunication

1 Introduction

The term museum (Greek: mouseion) cannot be explained in a single, generally accepted all-embracing definition. In ancient times, it implied a temple dedicated to the Muses (Alexander and Alexander 2008). In its simplest form, a museum can

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be described as "a building to house collections of objects for inspection, study and enjoyment" as Douglas Allan, former director of the Royal Scottish Museum in Edinburgh pointed out in the late 1960s (Allan 1967). As a matter-of-fact, developments and changes in society, zeitgeist and technology in the last 50 years have shifted the defined purpose of a museum towards "a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment" (URL-1).

In this context, various aspects are considered important, such as the service component of a museum, the educational purpose and the communication process of both virtual and real artifacts. Little, though, is said about the methods needed to fulfill this extensive list of functions. Throughout all museum exhibitions, the following tasks can be seen as being essential: collection; conservation; research; and communication (Alexander and Alexander 2008). The implementation of all these tasks depends on one major aspect: the spatial, temporal and thematic characteristics of the artifact. Collection and conservation must be organized according to a defined structure. Research is based on the combination of thematic considerations within a certain area and time span. Finally, communication has to transport the holistic information in a both efficient and sustainable manner. The possible ways of communicating information are widespread. Methods can include descriptions in a natural language, graphical visualizations and abstractions as well as multi-sensoric representations (Mark et al. 1999). The ability to construct mental models from text is an essential component to the understanding of narrative stories (Morrow et al. 1987). However, geographical information acquired from pictorial input appears to be retained longer than similar information obtained from text (Federico and Franklin 1997). This implies the use of geographic information as well as its visualization in any form as a suitable instrument to foster the understanding of any kind of exhibited information.

2 Geographic Space in Exhibitions

Cartography has developed numerous techniques to provide visual spatial representations. By investigating the relevant literature on the use of cartography and geographic information as well as through personal observations in various national and international museums, a set of cartographic expressions related to exhibition spaces could be identified. These expressions can be separated according to their relationship with museums and exhibitions. Apart from cases where no spatial–temporal context at all is given, three major application areas could be identified. The first type, maps that are used in museums but outside of the thematic scope of exhibitions, such as a venue map and orientation plans, are a very common form of cartographic expression within museums. See Fig. 1 for an example of this type.

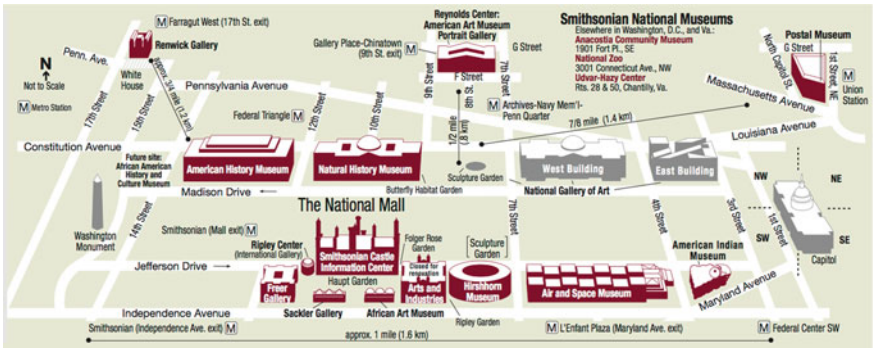

Fig. 1 Orientation plan of the smithsonian museums (*Source* http://www.si.edu/Content/Pdf/Visit/mallmap.pdf, accessed 25.06.2012)

Fig. 2 Maps as artifacts at the national museum of fine arts, Santiago de Chile, Chile. (*Photograph* Kinberger 2009)

Table 1 General overview of cartographic representations in museums

Cartographic expressions	Description
None	No spatio-temporal context is given.
Maps used inside museums, but outside of exhibitions	
Venue map or plan	Plans provided for orientation within the exhibition site. The user is able to locate and navigate. Recently increasing use of digital devices.
Maps used as supporting information within exhibitions	
Written description	Spatial information is given in written form; no (carto)graphic visualization is used to pinpoint a location.
Traditional map	(Printed) map to display a specific issue of the object(s) or event(s). In this case the map offers different possible purposes: object of interest or narrator of a spatial story.
Overview map	A map of global, continental or national scale, used to give a rough orientation. These maps use the fact that most people are familiar with the shapes of continents or countries rather than those of smaller areas. Sometimes overview maps are part of maps for the reasons mentioned above.
Map-related expression	Enlarges the potential of a traditional planimetric map through the use of 2D or 3D map-related expressions, such as aerial pictures, panoramas, reliefs, globes, etc.
Multimedia, virtual reality	Digital, sometimes interactive cartographic representation using multimedia sources, such as sound, videos etc.
Maps used as thematic content of exhibitions	
Map as artifact	The cartographic representation itself is the artifact.

Besides these administrative objects, maps are used as supporting information within exhibitions to facilitate the users understanding of the thematic context. Thirdly and finally, maps can act as thematic content in exhibitions by representing artifacts of historical or contemporary context. Maps and other cartographic representations thereby become pieces of art themselves. Figure 2 shows a spatial representation as example of maps as artifacts.

The table below displays a list of these application areas, their main cartographic expressions, along with a description of their characteristics: (Table 1)

The forms of cartographic expression provided above can be seen to be independent from each other. In most cases, though, a combination of methods is used to guide the visitor through the building, assist him or her in understanding the contextual aspects of an exhibition and act as artifacts themselves.

During the last decades, technical and telecommunication progress have extended the portfolio of cartographic media. The Web provides a variety of new communication channels, new ways of displaying the real world augmented in 3D and in virtual reality. Geographically enhanced web-portals, instant positioning, hyperglobes (Hruby and Riedl 2010) and 3D-applications have changed our (spatial) cognition. The integration of these new presentation and communication aspects into museums and exhibitions poses many challenges for curators and

exhibition managers, which leaves room for further research in various scientific areas. The non-profit organization museum3.org offers an active platform for the exchange of knowledge on the future of museums, galleries, science centers, libraries and archives (URL-2). A series of thematic discussion groups is dedicated to certain areas, such as Linked Open Data and Museums, Virtual Collections and Exhibition Development and Design. However, no group is devoted to cartography and geographic information and its context within exhibitions. This clearly shows the lack of awareness of these fields for exhibition design.

Based on these considerations, the current concept and implementation of a cultural-historical exhibition will be presented in the following section of this chapter.

3 Representations of Geographic Space in an Exhibition on Ancient Numismatics

From November 2012 to March 2013, the Kunsthistorisches Museum (KHM) in Vienna, Austria (URL-3) will host the numismatic exhibition "The Empire of the Huns in Central Asia and India." It will cover the history of coins in the period of about 200 A.D. to 900 A.D. in the relevant investigation area. The geographic space covered in the exhibition ranges from the area once known as Byzantium (Mediterranean area), the Empire of the Sassanids concentrated in the middle of Persia, to historical empires in Central Asia and India (See Fig. 3).

Within an ongoing cooperation, cartographers and geographic information scientists from the University of Vienna, Department of Geography and Regional Research (URL-4), and numismatic experts from the KHM aim at incorporating the geographic information within the available exhibition space in this public numismatic exhibition. In the primary conception phase, the determination of the general requirements as well as the geographical focus point was essential. The focus was laid on three major aspects: The function of the exhibition as a show for the public, the expectations of a visitor, and the task of maps and spatial representations. A concept based on the principles of applying the real world inside the museum, presenting the spatial relationship of the objects, providing tools for knowledge transfer, and creating sustainable visual spatial representations was developed.

The following list presents the main cornerstones of this concept:

- High quality maps and cartographic visualizations in digital and printed form: Topographic maps act as visual base information in multiple purposes. They can be considered the spatial backbone of the exhibition.
- Depiction of geographical space/dependencies in exhibition space: Mapping the real world into the exhibition space will bind the artifacts with their position on earth and thereby emphasize the spatial context.

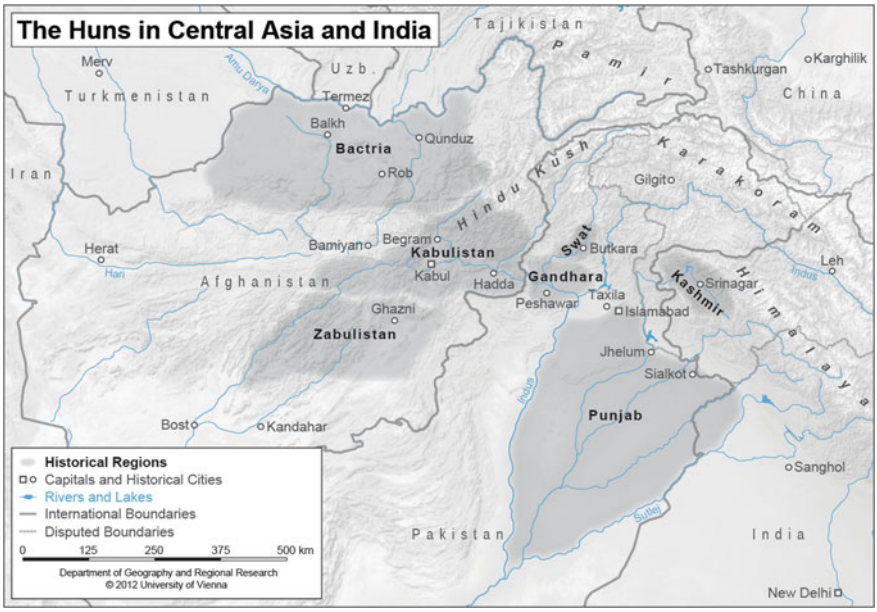

Fig. 3 Geographic area in central Asia and India covered by the exhibition. (University of Vienna, Department of Geography and Regional Research, 2012)

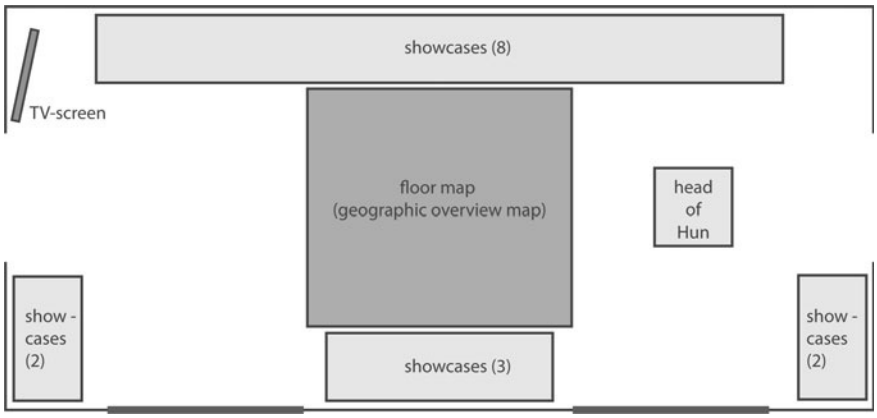

Fig. 4 Layout of the exhibition space. (Kinberger 2012)

- Multimedia implementations: New and innovative forms of geographic visualizations are intended, depending on thematic, technical, logistical and administrative possibilities and constraints.
- Sustainability of exhibition content through online information availability: Information on the exhibited artifacts will be available in an online platform during and following the exhibition.

The exhibition space offers a very traditional setting with a series of 16 wooden, glass-covered showcases. Every showcase is dedicated to a certain period in history affected by a special event, an ethnic group or a kingship in a certain geographic area. The main artifacts will be important examples of coins from each area/period, accompanied by additional information about archeology, their cultural and social history. Figure 4 shows the layout of the exhibition:

In accordance with the most relevant themes a visitor would expect from an exhibition design—background information (including geography), a continuous ordering principle (thematic, chronological, geographical) and an interesting story told by the artifacts—the basic principles and conceptual cornerstones were converted into concrete designs.

These implementations will guide the visitor through the space and time of the exhibition by providing additional information in order to convey a holistic impression of the Huns in Central Asia and India from 200 to 900 A.D. along with the numismatic circumstances in the period.

3.1 Floor Map

A 4.0 × 3.6 m floor map, printed in 50 × 50 cm sections will present the visitor the main geographic overview of the investigation area. This fixed, yet removable carpet will be situated in the center of the exhibition space to provide a physical walk-on of the real geographic space. Since the map is viewed while standing above it, the scale, layout and design must take this greater visual distance into consideration.

3.2 Regional Maps

For each of the 16 wooden showcases, a regional map will be provided. They display the historical regions, current national borders as well as artifact locations within the respected area. These uniformly designed maps serve as spatial connectors in a twofold way. On the one hand, a connection through the use of visual variables between the floor map and the regional map pinpoints the region within the overall area; on the other hand, the artifact locations within the showcase as well as their spatial distribution can be identified by the visitor.

3.3 Short Films

The showcases will present spatially and temporally limited historical circumstances. To cover thematic aspects beyond a certain time span and/or region, short movies will be incorporated. These ‘filmlets’ display narratives in the sense of

geographic storytelling (Cartwright 2004) by making extensive use of cartographic visualizations along with thematic content.

3.4 Online Exhibition Catalogue

The inclusion of digital devices into exhibition concepts has been steadily increasing during the last years. In general, these devices are the museum's property and provided by the museum's employees. With the expanding distribution of personal mobile devices among the general public, such as smartphones and tablet PCs along with broadband Internet connections, the use of these devices can be taken into consideration. To guarantee the sustainability of the present exhibition content even after the official end, an online information repository accessible by PC and mobile devices will be developed. It will include digital representations of all the artifacts, interactive maps and all other information incorporated within the exhibition. The information architecture of the online exhibition catalogue will map the exhibition space layout and the logical structure of the showcases to facilitate user orientation within the system. A simple possibility to obtain information on certain artifacts is given by the implementation of QR-codes within the showcases. These standardized tags (URL-5) will link the showcases to the online catalogue and can be used with any contemporary mobile device.

4 Conclusion

Due to technological and social changes, museums and their exhibitions are in a phase of transformation from static presentation forums to interactive scientific platforms. Geographic information and cartographic visualization foster this development by amalgamating spatial, temporal and thematic information into a holistic expression of the exhibitions context. Based on relevant background information, this contribution displayed the various forms of cartographic expressions in museums and showcased the concrete implementation of a spatio-temporally supported exhibition.

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Potential Information Gains for Exhibition Makers and Their Audience by Mapping the Movement of Objects: The Example of Material Culture of the Byzantine Empire

Sarah Teetor

Abstract The selection of objects shown in an exhibition is dictated by a range of factors including the curator's concept for the exhibition, the condition of the object in terms of conservation, financial and legal issues as well as political concerns. Many objects themselves have a history of movement, both before and after their inclusion in a museal collection, that readily lends itself to mapping. Using examples of Byzantine art and material culture, this paper intends to present some potential information gains resulting from the visualization of object movement for both exhibition makers and audience. These insights could touch on the history of the culture in question, the development of public interest in other cultures and the history of their exhibition, the opening of political boundaries, and the breaking down of common mental borders conditioned through popular reception.

Keywords Curatorship · Movement of objects · Reception · Political borders · Byzantium

1 Introduction

In recent years the use of geographic maps in exhibition spaces and on exhibition websites has increased dramatically. Additionally, through online services such as Google Earth, Flickr, and others, people are becoming visually conditioned and used to interacting with readily available, and tagable, geo-based maps. In the

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context of local museums and virtual museums, there is a budding interest in combining these two trends, which has already generated much enthusiasm among both curators and the public.

The integration of interactive maps in the conception of exhibitions at major museums, however, has been slower to take roots. In the case of 'culture shows', exhibitions focusing on a past culture or a culture other than one's own, maps serve primarily to provide visitors with a general geographical orientation and certain key points of reference. This textbook style map is, of course, useful as a visual aid, but particularly when focusing on a (probably) lesser-known culture and with the more complex research questions addressed in recent exhibitions—specifically questions of cultural interaction and influence—the geographically based map still holds a great deal of untapped educational potential.

The technical ability to map the history of objects of material culture—from their place of origin, through their inclusion in public or private collections, up to their current place of display—can provide exhibition visitors with additional information about the cultural context and journeys of the objects that they are seeing, thus maximizing didactic potential. At the same time an interactive, tagable map can provide exhibition makers with insights into the public's perceptions of a different culture and feedback about their modes of assimilating information. In this paper, three examples of material culture from the Byzantine Empire, a silver censor, an enamel *staurotheke* and a fragmentary ivory panel, will serve as a hypothetical illustration of this potential.

2 The Exhibition as a Place of Intersecting Geographies

In an exhibition—whether physical or virtual—a space is established, objects are placed within it, and a visitor is encouraged to navigate through the space and interact on some level with the objects there. In the planning phase the curators, usually professionals in the area where the objects originated, have developed a driving concept and didactic intentions for an exhibition, but also the average visitor brings with himself prior ideas on the subject being presented. While a visitor to an installation of contemporary art may well be aware of former action spaces and have associations with specific places, the average visitor to an exhibition centered around objects of material culture—with such exhibitions often bearing a geographic or temporal indicator in the very title—carry with them previous notions of this culture's geographical and temporal location. Furthermore, in the selection of objects for an exhibition—the core in assessing the effectiveness or scholarly quality—financial aspects, practical concerns such as the condition and transport of objects, and in some cases contemporary political issues are taken into account. Thus, the exhibition setting represents a unique overlapping of multiple layers of historical and contemporary geographies.

In exhibitions focusing on objects of material culture, this intersection of geographies is most evident. This holds particularly true in conjunction with a

culture other than one's own, whether it be a closed historical entity or an 'exotic' culture from a traditional Western European point of view. These several apparent layers of geography come together in such an exhibition:

- The actual geographic and temporal localization of the culture at the heart of the exhibition as defined by scholarly research;
- The mental maps of the visitors pertaining to this culture, often (if) informed by various popular media (such as school textbooks, movies, magazines, newspapers, blogs) and less scientific works, as well as associations based on current social and geopolitical circumstances of the region;
- The path of each individual object displaying its movement through space and time from its origin to a collection and to exhibitions around the world.

Although it requires some well-thought-out initial input, the overlapping and interaction of these geographies can be visualized and yield a mutual learning tool for curators and visitors. Steps have been made in the general direction to bring together curatorial staff and visitors through virtual media, and some pilot projects have even employed toward this goal an interactive map (see below). Building on these successes, attempts in the area of cultural history seem worthwhile.

3 Case study in Byzantine Material Culture

In the following section, I would like to propose a case study using objects of material culture from the former Byzantine Empire which have been often displayed throughout Europe and North America in major exhibitions devoted to the theme 'Byzantium'. The aim is to demonstrate, firstly, the unique paths of valued material objects through time and space, and, secondly, how the mapping of an object's journey can provide constructive insights into Byzantine culture, our common perception of it conditioned by labeling and categorization, and how these are brought forward in an exhibition context.

3.1 Why the Byzantine Empire?

Examples of material culture originating from the Byzantine Empire provide a perfect testing ground for this hypothesis for a number of reasons:

- The Byzantine Empire, which is commonly defined by its founding in 330 with Constantine the Great's relocation of the Roman capital to Constantinople and its fall in 1453 with the capture of this capital city by the Ottoman Turks (Koder 2001/1984, p. 13), represents in a political sense a closed historical entity. In this over 1,000 year span of history, its borders (Fig. 1) fluctuated significantly from a late Roman empire encompassing nearly the entire Mediterranean basin (under

Fig. 1 Map of Byzantine Empire showing its maximum territorial extension in the mid 6th century (*middle grey*), the Byzantine heartlands in the 14th century (*dark grey*) and the areas of the 'Byzantine Commonwealth' (*dotted*), with current political boundaries

Justinian in the mid 6th century) to a small group of satellite states located in modern Greece and Turkey (from the early 13th to mid 15th century). (see Haldon 2005; Phillippson 1939) Calling themselves 'Rhomaioi', or 'Romans', the people of the empire came into constant contact with other neighboring, and sometimes invading, groups, some of which came to find a common ground in the Orthodox Christianity emanating from Constantinople.

- Although defunct as a political entity after the Ottoman conquest, the cultural legacy of Byzantium continued to play a great role among those in Eastern Europe who had adopted Orthodoxy. In what Obolensky (2000/1971) terms the 'Byzantine Commonwealth', the religious and, some argue, political heritage of the Byzantine Empire was a significant factor in these areas well into the early 20th century, if not until today.
- Accordingly, the Byzantine Empire and Byzantine culture have had various receptions in different regions of Europe. In Western Europe, Byzantine studies has been an established academic discipline since the 17th century; nevertheless, because of its early patronage by the French kings, Byzantium and everything Byzantine became through essentialist Western European historiography during the 'Age of Reason' negatively connotated, representing all that is absolutist, parochial, corrupt, deceptive, decadent (Angelov 2003, p. 8–9). Meanwhile, Russia as an Orthodox but Slavic empire had a more complex reception: In the 19th century it struggled with the 'Byzantine inheritance' in light of Slavophile tendencies, and at the same time perpetuated the tradition of proudly carrying the torch of a centralized, Orthodox empire, sometimes even self-defining as a

'Third Rome' (see Obolensky 1966). On the Balkan Peninsula, the identification with Orthodoxy became a strong cultural marker for those Christian communities under Ottoman rule and has continued to influence identity construction well into recent years (see Kitromilides 2007). In the historiography of Greece, its Byzantine heritage has been especially thematized, from its dismissal in the 19th century on the search for Greek Antiquity (see Ricks and Magdalino 1998) to the conflation of 'Byzantium' and 'Greece' by some Greek and non-Greek historians.

- Popular perceptions are slow to change, and there is still a general lack of knowledge about Byzantium in 'the West'. Latent negative associations about the division of Eastern and Western Europe (Hunger 1966) may be exacerbated by the modern political history and the apparent 'backwardness' of regions of South Eastern and Eastern Europe which, a 1,000 years ago, were under Byzantine control (or at least strong influence). The hostilities between Greece and Turkey over Cyprus and coastal jurisdiction, the fall of the Soviet Union and the Iron Curtain, and the breakup of Yugoslavia and resulting civil wars still color popular opinion of these regions, not to mention that Byzantine history has been and is still being (re-)written in these national contexts (for a Russian example, see Savost'yanova 2008). Furthermore, the geographical area of the Balkan Peninsula, which was still considered the 'Orient' in written and visual sources of the early 20th century, has recently in the media only attained the status of 'Europe's backyard' despite the expansion of the European Union in this direction.
- While architecture and monumental decoration still exist, much of the known evidence of Byzantine material culture deals with relatively small portable objects, a preponderance of luxury goods of inherently valuable materials. Because of the turbulences of history many objects of everyday life have not been preserved, while objects of material and religious value have had better chances of survival in collections (predominantly) of religious institutions both inside and outside of the former borders of the Byzantine Empire. The collecting history is also varied, with objects leaving Byzantine centers of production and traveling throughout Europe already in the Middle Ages and the rise of targeted collecting as a result of 'rediscovery' by Western Europe in the 18th, 19th and early 20th centuries. More recently, attention is being paid to living institutions such as monasteries, archaeological finds, and narratives of intercultural communication with neighboring cultures, most notably 'Islam'.
- Large-scale exhibitions devoted to Byzantium, and thus the media presence of this culture, have been steadily increasing throughout Europe and North America. Nevertheless, their number remains comparatively small and within a manageable framework. The curators of these exhibitions are fully conscious of the history of exhibitions devoted to Byzantine art and culture, and in recent years several conference contributions and articles have been presented regarding this development and the need for re-consideration (Evans 2009; Hanson 2009; Lowerance 2009; Pyatnitsky 2011).

3.2 Examples of an Object's Journey

As mentioned, many objects of Byzantine material culture displayed in exhibitions are of relatively small-scale (except for the occasional bit of architectural sculpture, mosaic, fresco or large-scale icons), and quite a few were originally intended to be in some respect portable or sometimes even wearable. Thus, many object lives are inherently characterized by the possibility of geographic movement. Mapping and analyzing this movement from purported place of origin, often through various hands, and into museal contexts reveals insights into the cultural context of the historical Byzantine Empire and the reception of their objects of material culture throughout time and in various contexts up to the present day. The following three examples, which have appeared in multiple exhibitions over the past 50 years, will hopefully demonstrate the potential of mapping for gaining such insights.

3.2.1 A Silver Censor Found in Cyprus

This small silver censor (http://www.britishmuseum.org/explore/highlights/highlight_objects/pe_mla/s/silver_censer_from_the_first_c.aspx) in the collection of the British Museum (The Trustees of the British Museum, London, Inv. nr. 1899.0425.3) measures 10.9 cm in diameter, 6.7 cm in height, and displays on its six sides repoussé portrait busts of Christ, St. Peter, St. John the Evangelist, Virgin Mary, St. James and St. Paul. The control stamps on the bottom reveal that it was produced in Constantinople during the reign of the emperor Phokas, 602–610. (Cormack and Vassilaki 2008, cat. 36, pp. 386–387) Probably buried during the Arab invasion in ca. 647, the censer was part of the 'First Cyprus Treasure' found among the ruins of the Byzantine coastal town Lambousa, near modern Karavas, North Cyprus ca. 1898, while Cyprus was under British jurisdiction. The censer and many other objects from the hoard were acquired by the British Museum. Since entering the collection, the censer has been displayed in major exhibitions of Late Antique and Byzantine art, in particular Athens 1964, London 1977, New York 1977–1978, Brussels 1982, and London 2008–2009. In 1902 a 'Second Cyprus Treasure' containing a famous series of 'David plates' was found at the same location; these silver objects of similar date (629–630) have been split among the National Museum in Nicosia, Cyprus and the Metropolitan Museum of Art, New York ('Cyprus Treasure').

The path of this religious utensil (Fig. 2, green) leads us from its place of production, early 7th century Constantinople, to the north coast of Cyprus, and the high quality reveals that this must have been a prosperous area. Its burial for safekeeping indicates sudden threat and violent change. Rediscovered at the end of the 19th century, its removal to a museum collection in London was in accordance with the growing interest in collecting artifacts and the relatively new academic disciplines of archaeology and art history as we know them today. This uniquely small censer became an object of scientific inquiry and has subsequently been presented to the museum-going public in Greece, Great Britain, Belgium, and the

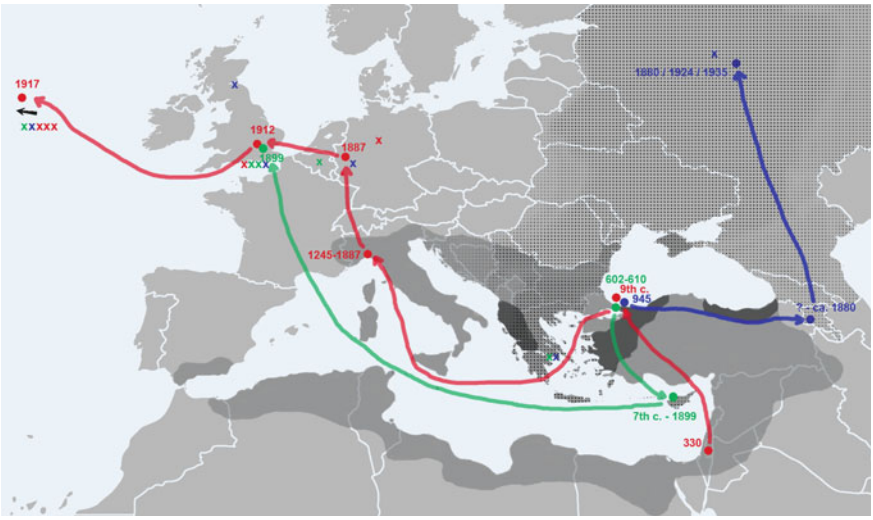

Fig. 2 The movement of three objects of Byzantine material culture: the silver censer (*green*); the enamel *staurotheke* (*red*); the ivory panel (*blue*). The paths of movement are only representative and do not follow documented routes. 'x' marks an exhibition

United States as a representative object of Late Antique and Byzantine religious culture.

3.2.2 An Enamel Staurotheke in Western Collections

The so-called 'Fieschi-Morgan *staurotheke*' (http://www.metmuseum.org/Collections/search-the-collections/170013325?rpp=20;pg=1;ft=staurotheke;pos=1)(The Metropolitan Museum of Art, New York, Gift of J. Pierpont Morgan, Inv. nr. 17.190.715a, b) is a famously-debated cloisonné enamel container for a relic of the True Cross, which according to tradition was found in Jerusalem by the empress Helena, Constantine I's mother, in the early 4th century and in part taken to Constantinople. Measuring 10.3 by 7.1 and 2.7 cm high, it is believed that this reliquary was produced in Constantinople in the early 9th century because of the iconography of the Crucifixion scene on the sliding lid, framed by busts of saints in medaillons, and the (albeit faulty) Greek inscription referring to the Virgin as *theotok*(*o*)*s*, or Mother of God. (Cormack and Vassilaki 2008, cat. 52, pp. 390–391) Relics of the True Cross are known to have been given as imperial gifts; however, tradition has it that this relic was taken to Italy by a member of the family of Pope Innocent IV (Sinibaldo Fieschi) in the course of the Crusades. In 1245 Fieschi dedicated the relic itself to the Church of San Salvatore di Lavagna in Genoa, but the emerald green enamel container remained in the family until it was sold in 1887. In a private collection in Cologne, Germany, for several years, the *staurotheke* had been bought by J. Pierpont Morgan by 1912 and was bequeathed to The Metropolitan Museum in 1917. This incredibly well-preserved enamel reliquary has been shown

in exhibitions in New York 1977–1978, New York 1997, Hildesheim 1998, London 2008–2009 and New York 2012.

The former core of this little container packed full of religious meaning (Fig. 2, red) begins in early Christian Jerusalem, then a part of the Late Roman-Byzantine Empire. The container itself was most likely given form in post-Iconoclast Constantinople and was taken as a souvenir to Italy in the 13th century. The transfer westward underscores the close, but not always peaceful, relations between the growing Western and the waning Byzantine powers during and after the time of the Crusades. Separated from its contents and also religious function, the sale of this fine, but idiosyncratically-worked box entered into the rampant art market of Western Europe at the close of the 19th century. Now in a public collection an ocean away from its place of origin, the reliquary has been chosen for display in the context of exhibition of Byzantine art and culture in the United States (several times), Germany, and Great Britain.

3.2.3 A Fragmentary Ivory Panel in Russian Collections

The original function of a fragmentary ivory panel (http://en.wikipedia.org/wiki/File:Porphyrogenetus.jpg http://www.ou.edu/class/ahi4263/byzhtml/p07-04.html) (State Pushkin Museum for Fine Arts, Moscow, Inv. nr. II 2 b 329) with an image of Christ blessing, or crowning, the emperor Constantine VII Porphyrogennetos (r. 945–959) is not known for sure, although it was probably a commemorative gift to a high official. (Evans 1997, cat. 140, pp. 203–204) Carved in Constantinople in the year 945, the plaque in its current condition measures 18.6 by 9.5 cm and bears traces of red color. The panel was found in Ejmiatsin, Armenia, at an unspecified date, and entered the collection of Count A.S. Uvarov, a Russian archaeologist, around 1880, before becoming part of the collection of the State Historical Museum, Moscow in 1924 and ultimately being transferred to the State Pushkin Museum of Fine Arts, Moscow, in 1935. Despite its damaged condition, this panel received early attention from scholars because of its unique imperial iconography, and it has been exhibited in Edinburgh 1958, Moscow 1977, New York 1997, Athens 2001, London 2008–2009, and Bonn 2010.

The journeys of this object (Fig. 2, red) begin again in the capital city of the Byzantine Empire, but in the 10th century, a period of cultural rejuvenation sometimes termed the ‘Macedonian Renaissance’. Although we do not know how and when it came to Armenia, the path leads to an influential neighboring state and strategic partner of the Byzantines in the Caucasus region around that time. Many centuries later, towards the end of a period of Russian imperial expansion, the ivory carving entered the private collection of a nobleman before becoming part of the young state museums of the newly-formed Soviet Union. This panel, which depicts the indivisible unity of religious and state authority founded in Byzantine ideology, has in the past 60 years been displayed in Western, Eastern and South Eastern Europe as well as in the United States.

4 Additional Value of Mapping an Object's Travels in the Context of an Exhibition

As can be seen by these examples, mapping the movements of objects of material culture has didactic potential in regard to both cultural history and how one's image of a certain culture is informed. The objects themselves are heavily religious in iconography and function, which may well reinforce the image of the dominance of omnipresent religion in the Middle Ages, particularly in Byzantium.

The visualized path of these objects, which firmly identifies Constantinople, modern Istanbul, as a radiant center of artistic production, can deliver in an incredibly compact form much information about the history of the Byzantine Empire, its culture, its connections with its—sometimes friendly, sometimes feindly—neighbors, and its cultural impacts throughout history up to the modern period. The central role of Constantinople, and in the Early Byzantine period other Eastern Mediterranean production centers, which were soon lost to Arab conquest, becomes visibly evident, as does the dispersal of objects from these centers throughout the centuries and throughout Europe (broadly defined).

Also issues of collecting and historically and regionally varying approaches to cultural heritage are addressed. Whether an object was intentionally buried only to be illegally excavated and sold (as one would say today), removed to Northern Italy as a pious trophy in the Middle Ages, or possibly gifted, rediscovered, and shifted from private to public collections, all paths demonstrate the consistently high esteem afforded Byzantine art objects. Simultaneously the rather random nature of preservation and the challenges of working with a somewhat skewed corpus of sources can be thematized.

In addition, through mapping, issues of contemporary history can be opened up to an inquisitive visitor, and one is challenged to reconsider one's own preconceptions. Whether consciously or not, everyone carries latent historiographical baggage which, nevertheless, plays a role in perception. For example, uncertainty about the origin of a luxury object—such as silks with figural Christian motives identified as from either Constantinople, Syria or Egypt (such as Vatican Museum, Inv. nr. 61231)—can spark new mental connections across ingrained geo-political and religious divides, which tend to be reinforced daily in mainstream media. The geography of the Byzantines was not our own, but, nevertheless, we tend to think in terms of contemporary borders. Therefore, gaining a fresh perspective is especially useful when looking at a semi-foreign and historically demarcated culture and those in the regions of its former sphere of influence who arguably are still dealing with, or even reworking, its historical legacy.

Interaction with the visitors in the context of intersecting geographies could also provide potential information gains for curators. Devices such as interactive kiosks, handheld devices and PDAs, and the exhibition website have quickly made headway in exhibition conception and design. Programmed with '(museum) community generated content', they can also serve as portals for user generated content. Salgado (2009) has undertaken case studies in this type of information

sharing. Successful attempts have also been made to engage the general public in the creation of an exhibition through interactive media (LaBar 2010), and in the case of exhibitions of material cultural history, receiving the input of the general public may well provide important insights into their perceptions and expectations. LaBar (2010) also testifies to the fruitful exchange between professional curators and public curators and to the development of the 'long tail', the public pursuit of specific interests through networks and the formation of experts in narrow fields, who often generate useful contributions and online followings; in the case of Byzantine history, one could cite Lars Brownworth's podcast '12 Byzantine Rulers: The History of the Byzantine Empire'.

The potential of using a geographic base for this information exchange has also been explored in the context of local and national interactive community-based projects (Heckert 2009; Liberge 2008). The geographical reference point, the ability to track movement through space and time, and the ability to layer geographies as one does—consciously or unconsciously—in one's mind represents an unique tool to learn inside and outside of an exhibition space, thus gaining valuable insights and additional perspectives on the material objects presented and the culture(s) they were chosen to represent.

5 Conclusion

As stated above, exhibitions—whether physical or virtual—are spaces where various geographies are brought together and sometimes collide. As these three 'usual suspects' of Byzantine material culture have hopefully demonstrated, an object in an exhibition setting reflects various layers of temporal and geographical information, ranging from its production hundreds of years ago somewhere in the Eastern Mediterranean to its travels across Europe, if not across the globe to be displayed as a representative object of the culture of the Byzantine empire and those in its sphere of influence. The analysis of these early and sometimes often movements is in itself a great source of information about historical cultural interactions and patterns of collecting and reception as well as a general impetus for reflection on the use of labels and categories and a reevaluation of one's perceptions of history and the world.

Visualizing the movement of objects in preparation for or in the context of an exhibition is, of course, an undertaking that would require considerable preparatory work. Nevertheless, geo-mapping, especially if interactive for the public, is an educational tool that has the potential to provide mutually the exhibition makers and their audience with valuable insights.

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Part IV
Representations and Geospace

Uncertain Decisions and Continuous Spaces: Outcomes Spaces and Uncertainty Visualization

Stephanie Deitrick

Abstract Uncertain scientific results serve as the foundation for public policy decisions in local and global society. Communicating these findings to policy-makers poses an immense challenge, as information considered beneficial for evaluating a problem is very different for scientists and decision makers. This is especially true in decisions related to climate change mitigation and adaptation, where conflicting results and controversy leaves many decision makers questioning the veracity of results or waiting until uncertainty is reduced. This conflict does not support evaluation of policy alternatives meant to address causes and future effects of climate change. Robust decision making offers a foundation for methods that include the context of uncertainty and decisions, by visualizing the relationship between uncertainty and policy alternatives. This research presents outcome spaces as methods of implicit uncertainty visualization that represent the effect of uncertainty on policy outcomes. Implementation of an outcome space in a water simulation model is presented here. Uncertain variables act as coordinates on an x- and y-axes to produce a space of policy outcomes. This method of uncertainty visualization acts as an uncertainty map, representing all possible outcomes for specific policy decisions. This conceptual model incorporates two variables, but can be extended to multivariate representations.

Keywords: Uncertainty visualization · Outcome space · Decision support · Decision frames

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1 Introduction: Communicating Uncertain Science

Understanding scientific results is critical as policies informed by scientific expertise and developments increasingly affect society. More and more, public policy decision makers, as well as the public, are expected to consume scientific information to inform their opinions and decisions (Nisbet and Mooney 2007; Kahan et al. 2011). For many of these information consumers, knowledge of science comes through policy reports and recommendations, as well as science communications developed for non-science audiences. Often, there is little to no direct experiences with research activities or scientific journals (Corbett and Durfee 2004; Smith 2005). Individuals depend on these communications to inform their decisions and expand their knowledge about the world beyond their experiences (Boykoff and Boykoff 2007). Translating scientific knowledge into consumable information requires that often complex, sometimes contested or uncertain results, be distilled into easily digestible, seemingly certain facts and recommendations. Through this distillation of scientific knowledge, risk perceptions, attitudes and actions are shaped, to some extent, by mediated scientific information (Carvalha and Burgess 2005). This is especially true for issues that exist outside everyday experiences or that occur at a scale (either geographic or temporal) that seems "invisible" on an individual level, including global climate change.

Science communication plays a central role in the climate change dialog between scientists, policymakers and the public (Nisbet and Mooney 2007; Kahan et al. 2011). This influences public perceptions and policy maker action (or inaction) in both climate change mitigation and adaptation. Mitigation is the reduction of environmental impacts and greenhouse gases into the atmosphere to slow or stop anthropogenic contributions to climate change (Boykoff and Roberts 2007). Adaptation is an adjustment in human systems in response to actual or anticipated climactic changes or their effects (Boykoff and Roberts 2007). Communicating the science of climate change is important for encouraging policy actions in diverse policy areas including water conservation, alternative transportation and environmental protection. However, information such as explanations of risk, uncertainty and the scientific process behind the results (Carvalha and Burgess 2005) are not easily incorporated by decision makers into their decision making process. Moreover, the challenge of communicating uncertain science is complicated by competing and conflicting "scientific facts" that are often presented to decision makers though complex statistics and visualizations or bleak scenarios of future conditions. While these methods initially capture the attention of policymakers and the public, they do little to help users incorporate scientific results into their understanding of the problem or the outcome of policy decisions. These methods often ultimately fail to effect societal and public action (Abbasi 2005).

There are many sources of uncertainty in climate change science that end up part of policy decision making. Much of this uncertainty often relates to what is

unknown about the natural variability of climate systems and how changes in greenhouse gases and human behaviors affect these systems (Mearns 2010). These uncertainties are often amplified in studies of future climate conditions, which rely on complex computer models meant to simulate the processes of global climate systems. These models must account for atmospheric, ocean, and land surface processes. Although the development of these models has grown more sophisticated and robust, there are still many processes that remain unknown, difficult to represent or poorly understood. Moreover, when studies focus on climate at a larger scale, these climate models must be scaled down from a global to regional level. This process introduces new uncertainties as scientists must translate global processes to local conditions. Scientists are often comfortable working with and interpreting these inherent uncertainties. Unfortunately, public policy decision makers tend to struggle to incorporate these uncertain conditions even though they often face uncertainty in other policy decisions (Pahl-Wostl et al. 2007; Brugnach et al. 2008). This is especially evident in the realm of climate change, where competing research reports and conflicting scientific findings often leave individuals questioning the veracity of results and whether it is better to wait in the hopes that uncertainty will be reduced (Council 2007, O'Neill 2008). However, holding out for more certainty does not guarantee that new methods or information will result in a reduction in uncertainty. The key is to build on existing comfort with uncertainty in other decision settings by presenting current information and findings to policymakers in a manner that supports evaluating policy decisions and outcomes.

Scientists and policymakers acknowledge the importance of developing methods to communicate uncertainty about climate science in ways that avoid misunderstandings and misuse (C.C.S.P 2003; Nisbet and Mooney 2007; Kahan et al. 2011). Existing approaches often follow a "predict then act" framework, starting with climate science and characterizing the uncertainty of future climate change, then using this information to evaluate the desirability of policy decisions. This is often the method familiar to scientists. However, there are other approaches, such as robust decision making, that frame uncertainty in a way more usable by characterizing uncertainty in the context of the decision making task. Robust decision making includes three key concepts that differentiate it from the predict than act approach. First, instead of using a single view of the future, multiple views of the future characterize uncertainty. Second, robust decision making uses the idea of robustness rather than optimality to assess alternate policies, often focusing on tradeoffs instead of strictly ranking alternatives from best to worst. Lastly, this method identifies the uncertainty most important to the decision making task. Particular decisions provide the context to characterize the uncertainty (Lempert et al. 2004). This research incorporates this context dependent approach by proposing implicit uncertainty visualization as a means to support science communication for decision support.

Most current methods for and research on visualizing uncertainty are explicit in nature (Davis and Keller 1997a, b; Cliburn et al. 2002; Zhang and Goodchild 2002; Aerts et al. 2003b; Devillers and Jeansoulin 2006). Explicit uncertainty

Fig. 1 Uncertainty shown as varying thickness in flows (http://www.girardin.org/fabien/blog/wp-content/uploads/2006/09/_~kpotter_library_uncertainVis_pang1997_pang_1997_image_7.jpg)

visualization directly identifies gaps, errors, and unknowns through quantitative values (including error bars or flows as shown in Fig. 1) or qualitative estimations (as shown in Fig. 2). Uncertainty is conceived of, and evaluated as, unique information, related to, but not the same as, the underlying data. Often, these values are not clearly or easily related to the decision task or the potential outcomes of policy decisions. Implicit uncertainty visualization, by contrast, is context dependent. The specific decision task informs definition, interpretation and, potentially, representation of the uncertainty. Here, specific values of uncertainty are not quantified, but instead representations focus on showing the effect of uncertainty on policy decision outcomes. Uncertainty is treated as an inherent characteristic of the data, and not as separate information. With these definitions, it is possible to explicitly define uncertainty (such as providing probability for a projection), then use implicit methods for visualizing that uncertainty (visualizing the range of probability values for several different projections). As with robust decision making, implicit visualization supports exploration of the relationship between uncertainty and decisions by integrating uncertainty and decision outcomes into an outcome space.

Outcome spaces visualize outcomes over a range of uncertain variables in a single space. For a given policy decision, possible outcomes are mapped for the full range of values for two or more uncertain variables considered significant to the decision problem. For example, in water simulation, future projections for river discharge might range from a decrease of 10 % to an increase of 30 % (this represents the uncertainty in the decision problem). In traditional approaches, if water managers wished to evaluate the impact of a policy on ground water, they would have to run the model several times for each potential discharge value, for a

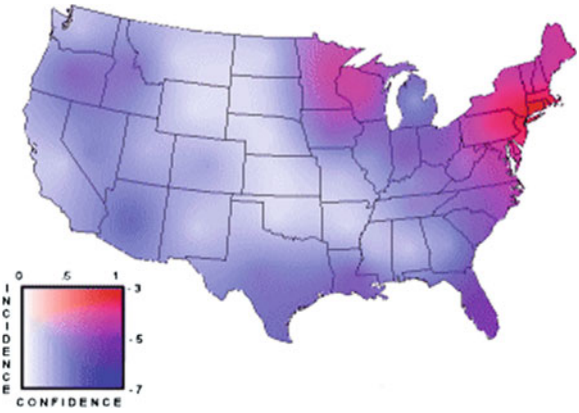

Fig. 2 Lyme disease prediction uncertainty depicted as confidence (http://www.personal.psu.edu/jef243/homepage%20files/GEOG486/Lesson1/GEOG486_Lesson1.htm)

single policy scenario. Each model run would result in one discrete ground water value. Evaluation of the outcome of one or more policy decisions requires comparing these outputs. Outcome spaces in contrast, visualize the full range of possible outputs for one or more uncertain variables for a given policy scenario. This method represents outcomes of policy decisions for all possible values of the uncertain variable(s), providing a continuous range of outcomes. Classifications such as sustainable/unsustainable, favorable/unfavorable, high/moderate/low risk offer a means for decision makers to compare projected results for multiple policy scenarios. Figure 3 presents a schematic outcome space. With this approach, the policy decisions no longer produce single discrete outcomes, but a continuous field of possibilities.

Outcome spaces frame uncertainty in the context of a specific decision problem, similar to methods in robust decision making. Individuals frame decisions based on their experiences, opinions and understanding of a problem. Accounting for these decision frames requires tailoring information to specific audiences, decisions and mediums (Nisbet 2009). Framing helps users relate core ideas to their own experiences, by placing uncertain information in context and making it relevant to the decision problem. Greater emphasis is placed on some pieces over others to narrow down complex questions. Technical details vital to the understanding of science may not matter when deciding what should get done, who should do it, or why an issue even matters (Nisbet and Mooney 2007). In water management, for example, the specific range of discharge values may not matter to decision makers, while the range of ground water draw down which results from these uncertain values might prove very important in making policy decisions on water rationing.

This chapter highlights outcome spaces as a method for communicating uncertainty in climate change science to decision makers. As a context dependent approach, this chapter begins with a review of uncertainty in climate science and existing methods for communicating uncertainty.

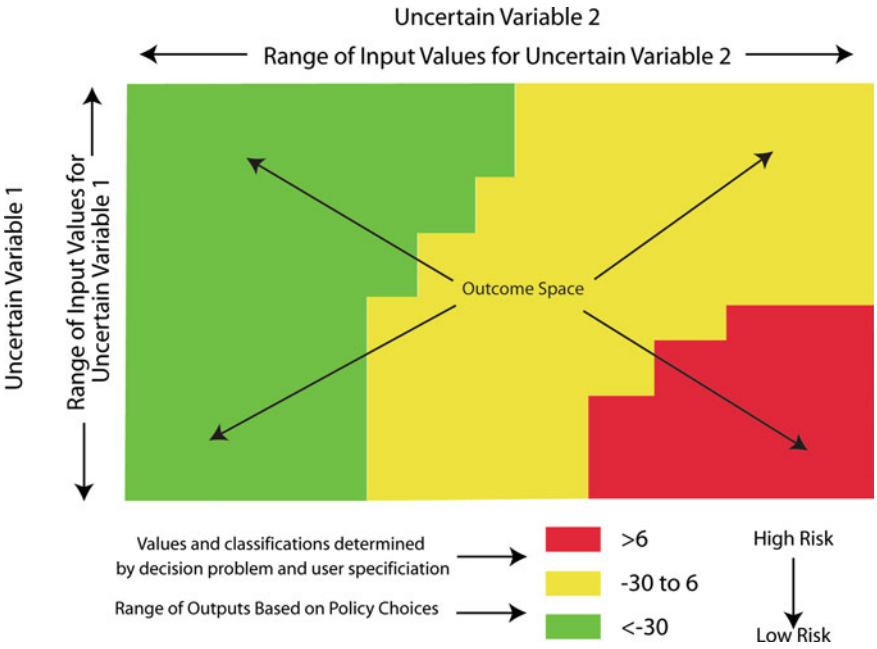

Fig. 3 Implicit representation of uncertainty visualized as continuous values in an outcome space. Uncertain variables considered important to the decision problem are used as the axes. A model is run for the full range of uncertain values based on a set of policy decisions. The resulting outcomes for all model runs are shown as a continuous field in the outcome space

2 Uncertainty in Climate Science Research

Climate models use quantitative methods to simulate the interactions of complex processes in the atmosphere, oceans and land surfaces, projecting factors that would influence future conditions, such as population, land use, technology, and economic development. Simulations of future climate under climate change conditions contain a range of uncertainties in the spatial structure, scale, and timing of events and changes. These uncertainties result from numeric to structural differences between models, biases in datasets, and unknown processes in environmental and climate systems (Wu et al. 2005; Mearns 2010). Assessing the veracity of a given model requires researchers to quantify several sources and forms of uncertainty within individual models as well as between models (Wu et al. 2005; Mearns 2010). Evaluation of these uncertainties presents the challenge of identifying specific probabilities for each model and input variable (Mearns 2010).

Climate models provide discrete predictions about future climate conditions. While researchers strive to develop better models as well as quantifications of statistical uncertainty, identifying methods to weight these results based on the quality of the model and inputs are not widely used. The International Panel of Climate Change (IPCC) reports, for example, use multiple emission scenarios for

future climate conditions, each with different assumptions (Ha-Duong et al. 2007; Schenk and Lensink 2007). Models based on these assumptions are given equal weight, assumed to provide the same level of information about future climate conditions. Without guidance on how to interpret these multiple models, decision makers are left with multiple climate scenarios to consider, without any indication regarding the veracity of any one scenario (Ha-Duong et al. 2007; Schenk and Lensink 2007). Future climate projections from each model developed using these emission scenarios, as well as how the differing assumptions of the scenarios affect outcomes of policy decisions in the model, are a form of implicitly defined uncertainty.

Research into the uncertainty of projections (outcomes) that results from comparing output from differing models exists, but efforts focus on manipulating the inputs to the models and quantitatively describing differences in the outputs as discrete uncertainty descriptions. For example, in an effort to explore the uncertainty of a hydrologic model of the River Thames, New et al. (2007) applied probabilistic information while varying the parameters of the model. The researchers evaluated the difference in the predicted discharge as a means to show the uncertainty of the outputs. While the methods allowed researchers to identify both positive and negative changes in predicted flows, which differed from the single parameter runs of the model, these outputs exist as information separate from the underlying uncertainty. This explicit evaluation does not produce information about the relationship between the range of uncertainty and future river discharge projections. Providing this information offers a step towards integrating climate uncertainty into the process of decision making.

3 Framing Uncertain Science for Decisions Under Uncertainty

Decision making is the process that people go through to choose between alternatives and courses of action. Research in the psychology of decision making focuses on the processes through which beliefs (knowledge, expectations) and desires (personal value, goals) merge and result in a decision (Hastie 2001).

Decision problems are defined by the alternatives, consequences, and probabilities involved with a particular decision. Characteristics of the decision maker heavily influence individual decisions. Individuals frame decisions based on the concepts and values they associate with a particular course of action (Tversky and Kahneman 1981). This reliance on context means people may frame a decision in many ways. Different decision frames arise due to many factors, such as individuals with multiple goals, or by a group of decision makers, with each member having different experiences, expectations and conceptual understanding of the problem.

Decision making under uncertainty involves the evaluation of both the likelihood and desirability of an outcome (Tversky and Fox 1995). However, this often

proves challenging as decisions are generally made without a definitive knowledge of all the factors that may influence an outcome. When faced with decisions under uncertainty, individuals often revert to heuristics, or abstract mental rules to determine a course of action. Heuristics efficiently generate satisfactory outcomes in frequently encountered situations, as individuals learn to apply heuristics that result in the most favorable outcomes, reducing the complexity of assessing the alternatives and potential outcomes in these frequently met problems. Of course, there is no guarantee that, in any specific instance, heuristics are applicable for new situations or problems or will always generate the most favorable outcome (Patt and Zeckhauser 2000). Because they are used and reused in different situations, incorrect heuristics can result in systematic errors and bias in decision making (Tversky 1974; Tversky and Kahneman 1974).

This aptly describes decision problems that consider the impact of climate change, while illustrating the complexity of integrating climate into policy solutions. Decision making requires evaluation of both the likelihood and desirability of an outcome. As mentioned previously, specific likelihood (probabilities) of climate models, conditions or relationships are often unknown. When expected or necessary information is missing, attempts to apply existing heuristics using information contrary to your decision frame may fail or result in poor decision making results.

Applying decision frames to science communication is working its way into applied research in decision making under uncertainty. For example, robust decision making was used to work with water mangers in California to identify water policy options that were robust against the uncertainty of future climate change (Groves and Lempert 2007; David Groves et al. 2008). Robust decision making considers that decision makers often manage highly uncertain situations by identifying and selecting strategies that perform well across the range of uncertainties. Robust decision making starts with the proposed policy action, calculating the performance of that policy action across a range of future possible conditions. Researchers found that providing the water managers with climate change scenarios that represented a reasonable range of future conditions allowed managers to assess possible adaptation strategies. This model of decision support allows users to explore the relationship between a range of uncertain conditions and decision outcomes.

4 The Complexity of Uncertainty Communication

Visual displays mediate the assessment and dissemination of scientific knowledge (Cleveland 1984a, b; Arsenault et al. 2006). Visualization can convey complex and dense information, not easily communicated through the written word, and as such, have been the focus of much research in the visual communication of science (Tufte 1983; Cleveland 1984a; Hedges 1987). There are many reasons that visual displays are powerful means to support the dissemination and validation of scientific knowledge. First, they are absolute, transforming abstract ideas and

ephemeral phenomenon into fixed, invariable patterns discernible by a wide range of individuals, scientists and the public alike. Second, they quickly convey an overall impression of research, accessible without a great deal of effort by the user. Visual displays effectively use human capacity for pattern recognition to make complex, often dense information, that might otherwise be difficult to communicate through words alone, more easily accessible. Third, they are scalable, allowing the visualization of phenomenon that might otherwise be unknowable due to their abstract, temporal, or physical scale. Finally, visualizations can be combined, allowing the identification of relationships and connections that might otherwise be undiscovered (Arsenault et al. 2006). These characteristics lend to the critical role of visualization in science communication—they are powerful because they are persuasive (Latour 1990). Visual representation supports the task of supporting validity of an individual's scientific work. As such, visual inscriptions are central in science communication.

Uncertainty visualization research exists in diverse application areas (Hunter and Goodchild 1995; Goodchild 2000; Lucieer and Kraak 2004; Heuvelink 2005; Devillers and Jeansoulin 2006; Goovaerts 2006) from error propagation to identifying uncertainty in climate science, yet approaches to representing uncertainty are often similar. Much of this research addresses uncertainty from a scientific standpoint, representing uncertainty in explicit and quantifiable ways, with the intention of developing widely applicable methods of representation (Davis and Keller 1997a, b; Cliburn et al. 2002; Zhang and Goodchild 2002; Aertset al. 2003a; Aerts et al. 2003b). In decision support, statistical and complex scientific representations may not be usable or beneficial for developing insights about the relationships between uncertainty, decisions and outcomes. Moreover, uncertainty visualization is often considered either irrelevant or detrimental for successful data communication and insight generation (Cliburn et al. 2002; Slocum et al. 2003; Brugnach et al. 2007) while, decision makers often view uncertainty as potentially integral to the framing of a problem (Pahl-Wostl et al. 2007; Brugnach et al. 2008). In decision support settings, a general awareness of the presence of uncertainty may be more important than knowing the specific form (or quantity) of uncertainty.

Several efforts in recent cartographic research have sought to bridge the gap between research and application as a means to facilitate the incorporation and use of uncertainty information in geographic representations. Researchers have sought the most appropriate and effective means of representing uncertainty to map readers, carrying out experiments comparing representational techniques. A common approach is to begin with the adaptation of Bertin's (1983) visual variables, along with additional variables such as transparency, saturation and clarity, for the representation of uncertainty (MacEachren 1992; Slocum et al. 2004). Advances in computer systems open new possibilities for uncertainty representation, including the interfaces that allow users to manipulate the display of uncertainty by deciding how and when to display uncertainty information (Fisher 1994; Ehlschlaeger et al. 1997; Miller et al. 2003).

A majority of existing research focuses on explicit uncertainty visualization. For instance, Gershon (1998) proposed two general categories of representation strategy: intrinsic and extrinsic. Both categories rely on an explicit definition of uncertainty. Intrinsic techniques integrate uncertainty in the display by varying an existing object's appearance to show associated uncertainty. Although the uncertainty and "object" are depicted in a single representation, for example fuzzy lines to visualize vague boundaries, uncertainty is still shown as separate from the underlying feature. Extrinsic techniques rely on the addition of geometric objects to highlight uncertain, making the explicit nature of the visualization apparent through the use of separate objects to depict uncertainty. Explicit methods (including both extrinsic and intrinsic visualization) offer methods for representing uncertainty of specific features or objects. Implicit visualization integrates the representation of uncertainty, data and decision outcomes.

Often the individual decision frames of the user are not considered in current uncertainty visualization research. Moreover, when the importance of potential differences in users has been acknowledged, it is often included as an ancillary study, and not as the explicit and main focus of the study. The primary focus of most experiments has been on design of the representation and the ability of individuals to identify specific uncertainty values from those representations. MacEachren et al. (1998) developed and tested a pair of intrinsic methods for depicting "reliability" of data on choropleth maps used in epidemiology. Newman and Lee (2004) evaluated both extrinsic and intrinsic techniques for the visualization of uncertainty in volumetric data comparing glyph-based techniques, such as cylinders and cones, with color-mapping and transparency adjustments. Leitner and Buttenfield (2000) focused on the alteration of the decision-making process by changing the representation, through systematically altering Bertin's visual variables. In these cases, researchers made important gains in understanding the development of uncertainty visualization, but the usability of these visualizations by individuals trying to assess data for decision making under uncertainty was never a particular focus.

Geographic uncertainty visualization research has also considered the influence of the user's experience as an independent variable. In these studies, the focus has been on differences between novice and expert users, while factors such as comfort with uncertain information and their experience in making decisions are often downplayed. Blenkinsop et al. (2000) examined the performance of two user groups, one expert and one novice, in determining classification uncertainty. While researchers discussed differences in users, results focused on the effectiveness of representation and not the manner in which different user experience influenced this effectiveness. Cliburn et al. (2002) focus on differences in decision makers in their development and testing of a visualization environment meant to allow decision makers to visualize the results of a water-balance model. The study focused specifically on the effectiveness of intrinsic and extrinsic communicating of explicit uncertain values in a decision support setting. Decision makers were overwhelmed by the complex extrinsic methods, which experts were able to access and use the detailed information more readily. For non-expert users, intrinsic

methods that provide a more general representation of uncertainty were suggested as preferable to more complex and detailed forms of representation. Researchers proposed that to increase the usability of an environment, it is important to incorporate feedback from users, usability experts and decision makers. Aerts et al. (2003a) also focused specifically on what uncertainty representations, toggling animation and a side-by-side static comparison, end users found most useful for specific tasks.

While there are a multitude of examples in existing literature of statistical and explicit representation of uncertainty, methods for linking uncertainty visualization and decision outcomes is lacking. In decision support settings, the goal is to support more informed judgments and evaluations by decision makers, and to provide insight into the effect of uncertainty on policy options. Existing methods do not offer means to evaluate or explore uncertainty in this manner. The disjoint between attitudes towards uncertainty and uncertainty visualization suggests that existing methods do not fit user decision frames. As previously discussed, decision frames encompass the perspectives used by decision makers to establish the boundaries and constraints of a decision problem and particular course of action (Tversky and Kahneman 1981). In decision settings, focusing on the effect of uncertainties on policy outcomes offers a method to incorporate user decision frames, allowing users to explore uncertainty and gain insight into the relationship between uncertainty and the (potential) consequences of their decisions. When reframing uncertainty in this way, the relationship between uncertainty visualization, outcomes and decisions is emphasized over explicit representation frameworks that dissociate the method from the user.

5 Uncertainty Visualization as an Outcome Space

This research considers the application of outcome spaces as a method to visualize uncertainty in water planning due to climate change. A conceptual adaptation of the landscape of plausible futures was developed for WaterSim, a simulation model of water supply and demand for the Phoenix Metropolitan area that integrates land use, climate change, water policy, and population growth. WaterSim allows users to adjust settings related to water supply, drought, population growth, agriculture, policy choices, and climate change to weigh the impacts of these choices on future water supply and sustainability (Gober et al. 2010).

Water systems are traditionally operated under the assumption of stationarity—the idea that natural systems fluctuate within an envelope of variability that does not change (Milly et al. 2008). Climate change challenges the stationarity assumption, as these changes alter the rate of river discharge, mean precipitation, and other aspects of the water cycle and water supply. Considering the implications of climate change on stationarity challenges the decision frames of water managers, often requiring them to evaluate multiple discrete scenarios based on

varied climate change assumption (Milly et al. 2008; Craig 2009). Uncertainty visualization offers an opportunity for decision makers to explore the relationship between climactic uncertainty (challenges to the stationarity assumption) and the outcomes of policy decisions. This approach adapts the methods of robust decision making by providing a visual method to evaluate the relationship between uncertainty and policy outcomes. The methods presented here conceptualize this relationship as a mapped space, where the impact of uncertain variables on decision outcomes can be explored.

Outcome spaces are adapted from visualization methods presented by Lempert et al. (2003) for mapping Landscapes of Plausible Futures. The landscapes provide decision makers with interactive visualizations intended to aid in exploration of the output to robust decision making scenarios. In these landscapes, the axes represent two uncertain variables important to the decision problem. Each intersection point between values on the axes represents the outcome of a given decision. The area within the landscape, represents all possible outcomes (defined in this research as the outcome space) that can further be classified as regions of most/least robust outcomes.

For the purposes of this application, uncertainty is operationalized as the effect of climate change on the assumption of stationarity, in this case, changes to the historical flows in the Salt/Verde Rivers and the Colorado River. For WaterSim, the outcome space consists of the net cumulative change in groundwater (in thousand cubic meters) resulting from running a single set of policy choices in WaterSim. Instead of geographic coordinates, the uncertain variables represent the coordinates (on each axis), and the value in the outcome space represents the attribute at that locations. This method of uncertainty visualization acts as an uncertainty map, representing all possible outcomes for a specific policy choice or decision based on two uncertainty variables. The conceptual model here incorporates two variables, but can be extended to multivariate representations.

With existing methods in WaterSim, users must select a single assumption for the future flow of the Salt/Verde River and Colorado River. These assumptions represent predicted percentages of historical flows on these rivers, such as 80 % of historical flow, and account for the impact of climate change on flow. Once these assumptions are set, users use the model to select policy choices related to future population growth, agricultural land retirement, and residential housing density. The model is run for each set of policy choices using the assumed percentage of historical flows on the two river systems. If users want to see how changes in the assumptions about the rivers effect their policy decisions, they must rerun the model for each new assumption. This can result in thousands of possible outputs.

Outcome spaces eliminate the need to run the model for different assumptions about the flows on the rivers. Instead, policy decisions made by the user are run for all the possible combinations of future flows on the two rivers. These results are then output into a single outcome space for that policy run. A conceptual representation of an outcome space for WaterSim is shown in Fig. 4. Actual outputs from WaterSim into a visualization environment are shown in Figs. 5 and 6.

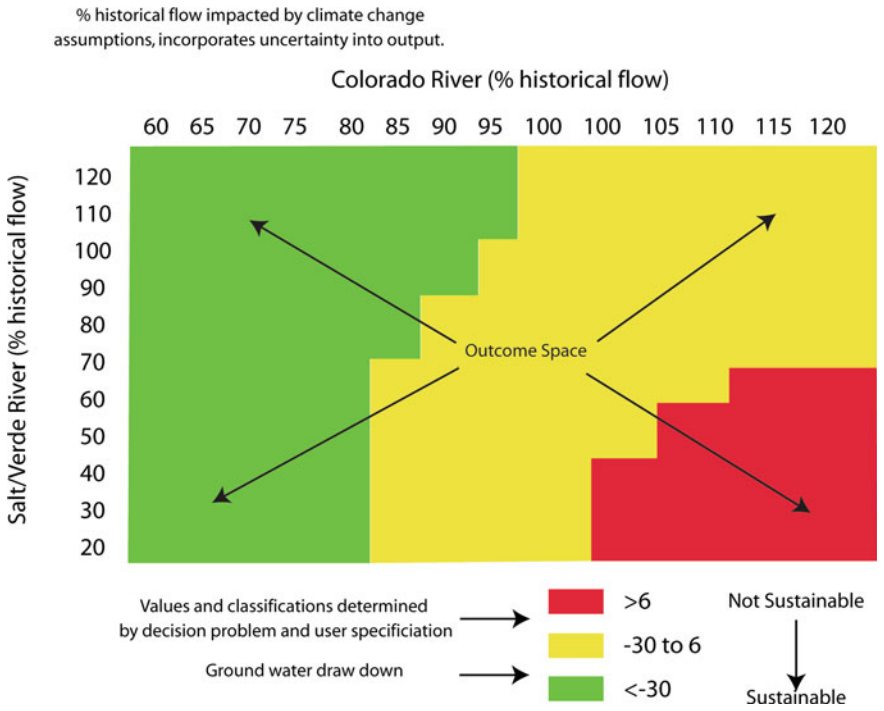

Fig. 4 Conceptual outcome space showing change in ground water based on uncertain river flow

The vertical and horizontal axes of the landscape represent the future flows of the Salt/Verde Rive and the Colorado River as percentages of historical flows. This represents two of the significant uncertainty variables in the WaterSim model, incorporating the uncertain affect of climate change on river flow (one challenge to the stationarity assumption). The outcome space represents the net cumulative change in groundwater. The values mapped in the outcome space are output when the model is run after the selection of certain policy decisions, such as regulation of future population growth rates, retirement of agricultural land, and residential density. As the policy decisions are implemented in WaterSim, the model runs for all possible river flows for the two rivers, resulting in thousands of outputs. These outputs are then mapped to the outcome space. This one space represents the full range of outputs for the specified policy choices. Additionally, areas within the outcome space are symbolized using a range of sustainable to not sustainable based on the amount of change in ground water usage.

While the individual values mapped in the outcome space are discrete values from single runs of the model, when viewed as a continuous space, they present an overall view of the impact of both the policy choices and the climate

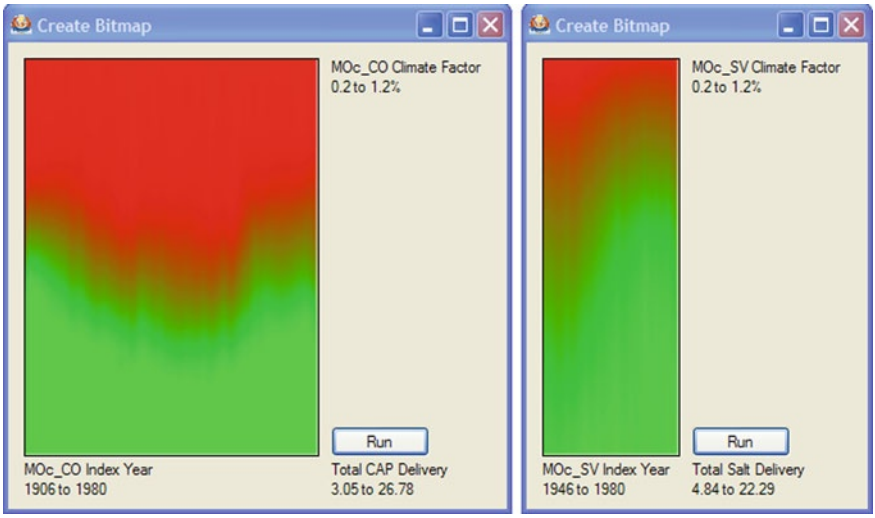

Fig. 5 WaterSim outcome space (*conceptual visualization environment*). The values here represent a single policy decision implemented by the user run for all combinations of projected flows on the salt/verde river and colorado river

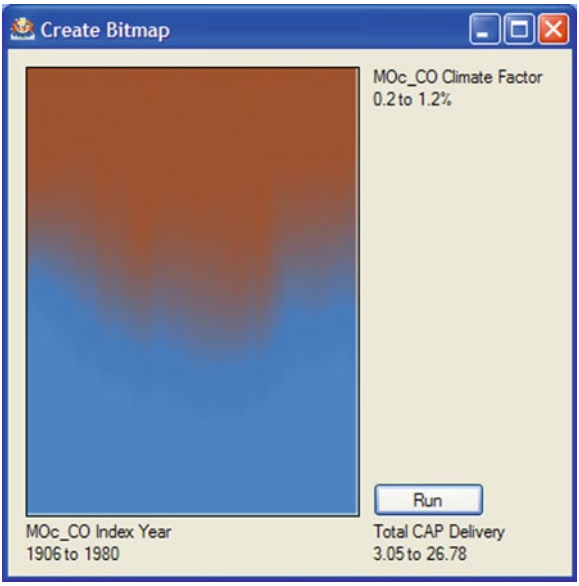

Fig. 6 A second visualization environment for outcome spaces in WaterSim

uncertainty. As decision makers work through several possible policy alternatives, they can evaluate results for the entire range of possible output for those policy choices. This offers a chance to alleviate the concern that a policy choice that works well under one climate scenario (or one set of river flows) may not be the best choice under alternate conditions. Additionally, decision makers can compare the overall effect of differing policy decision, and question whether one policy poses more or less risk than another. For example, if one set of policy choices results in a majority of the outcome space showing as sustainable, that might pose less risk than policy choices that divide the outcome space evenly into sustainable/not sustainable. This removes the focus from climate uncertainty and places it on the actual policy choices and alternatives that make up the decision problem.

6 Conclusion

Scientists are challenged with the task of not only communicating uncertain science results to policymakers, but of providing information in a manner that overcomes the desire of decision makers to wait until more is known or the uncertainty is reduced (O'Neill 2008). This research speaks to the challenge of overcoming this desire to wait to learn more, by evaluating methods to incorporate uncertainty that resemble decision-making processes and heuristics. Outcome spaces support assessment of the relationships between uncertain variables and the results of policy decisions. Representing uncertainty implicitly as a physical space moves away from discrete results that imply a level of certainty to a continuous range of results that reflect the influence of uncertainty on policy outcomes. This allows decision makers to focus attention on the policy decisions and not on the technical aspects of what is unknown. Outcome spaces do not hide anything from decision makers, but instead provides a comprehensive representation in a context with which they are familiar: policy decision outcomes.

This research highlights the importance of considering the decision making context of the user when evaluating and presenting uncertain information. Attempts to develop methods for representing uncertainty that span multiple forms and sources, varied domains, and all users do not address the decision frames of users or context of the decision problem. Outcome spaces address both the need to communicate uncertainty to users while also allowing them to work through ways to address uncertain conditions. If the goal is to support effective decision making, and ultimately action towards mitigating and adapting to climate change, then the challenge of incorporating specific decision contexts into science communication is one with tangible benefits.

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Modelling Uncertain Geodata for the Literary Atlas of Europe

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Abstract Mapping literary spaces is an interdisciplinary challenge for both literary theory and cartographic realisation. The inherent properties of textual space compared to real-world geospace are introduced and discussed in relation to build a data model for the on-going project, 'Literary Atlas of Europe'. Spatial descriptions in fiction are often vague, transformed or hardly locatable within the real-world geospace which serves as basis for the analysis and visualisation. To reflect the fictional world, additional attributes and composed geometries are required. To solve the problem, an attributed spatial data model was developed to meet the requirements for a comparative, flexible study of literary spaces with numerous thematical questions. Using this model, spatial data of fictional texts were classified into settings, zones of actions, projected spaces, routes and marker. To emphasise the complexity of the model, the internal structure and diversity are illustrated with the examples of the spatial objects setting and route.

Keywords Uncertainty · Data acquisition · Data modelling · Literary geography · Spatial humanities

1 Introduction

Exploring space and place with the help of digital maps and Geographic Information Systems is a new trend that can be found more and more within the humanities. As formulated for scholars in humanities in an article recently

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K. Kriz et al. (eds.), *Understanding Different Geographies*,
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published by Cohen (2011) "visualising data helps you to analyze it. The eye is a very good sorter of patterns". Cohen also comes to the conclusion that "humanities had become too abstract and neglected physical space. The value of what scholars are calling "*the spatial turn*" allows you to ask new questions: Why is it that something developed here and not somewhere else, what is it about the context of this place?" With similar ideas in mind, the interdisciplinary project of the 'Literary Atlas of Europe' aims to investigate fictionalised landscapes and cities. In doing so, scholars are interested in the development of the fictionalisation process of a specific region or in finding patterns while comparing the relation of fictionalised places to historical-political, natural (or other) events. To enable statistical investigations and comparable analyses and to consequently gain significant results of a region, a well-founded and if possible complete set of data about the region is required. To develop the methods and exploit the potential of such an interdisciplinary topic, a collection of texts was compiled in which each text is spatially linked to one of three model regions: an alpine landscape (Lake Lucerne/Gotthard in Switzerland), a coastal border area (Northern Frisia in Germany) and an urban space (Prague, Czech Republic).

To investigate the spatial characteristics of fictional texts, every single spatial occurrence needs to be extracted from the text. Within the frame of our project, spatial data of fictional texts are classified into five main categories: settings, zones of actions, projected spaces, routes and marker, as suggested by Piatti (2008). By applying these categories, the entire spatial structure of a literary text can be captured, while the function of the particular spatial entity is indicated at the same time. In the development process of the 'Literary Atlas of Europe' the question of how to collect and organise these data became a key issue.

These spatial data are descriptions by authors within a fiction. However, it is not absolutely necessary to have a spatial frame in each story, as Piatti noticed in her studies: "Actually, the poetic imagination doesn't need to stick to the physical space necessarily, neither to its geographical or topographical principles—but still, this is exactly what is done very often" (Piatti 2008—translated Reuschel). Of course, spatial data in fictions are transcribed in poetical words rather than geographical definitions like coordinate systems and scientifically defined variables.

Unlike spatial data models that attempt to measure, define and delimit boundaries of spatial objects as precisely as possible, based on data and facts, we are moving between objectivity and vague, subjective interpretation of indeterminate locations and their associated attributes. Typical descriptions of spatial data that can be found within fictions are, for instance: "in front of the gates of the city", "a villa on the first slopes of the steep hillside", "a house close to the Karl's bridge" or "a store in the main street". A further complication is that most geographical entities are not precisely delimited as Fisher (1999) notes in his research about *Models of Uncertainty in Spatial Data*. He argues that "well-defined geographical objects are essentially created by human beings to order the world they occupy. Most, if not all, […] geographical phenomena are […] poorly defined to some extent".

In the context of geographical phenomena the terms *vague* and *rough location* appear in various scientific publications and are substantiated with examples, that

could easily be found in the same way as in literary fictions. The authors use examples like the spatial concepts of "the Alps", "the Ruhr" and the "North Sea", more general concepts like "valleys", "dunes" and "forests" and vague transcriptions like "high mountains", "near the marsh" and "the rough end of the town" [compare Erwig and Schneider (1997), Bennett (2001), Bittner and Stell (2002) and Ahlqvist (2009)].

Montello et al. (2003) noticed in their paper called *Where's downtown*?, that "unlike formal languages, natural languages […] typically refer to categories that do not have precise references and are not delimited by sharp semantic boundaries". More geographical-specific terms of the notion *"natural languages"* were shaped and defined by Egenhofer and Mark (1995); (Waters and Evans 2003). The latter used the notion *"vernacular geography"* whereas Egenhofer shaped it to the term *"naive geography",* and realised: "many spatial inferences may appear trivial to us, (but) they are extremely difficult to formalize so that they could be implemented on a computer system".

Within the disciplines of geographic information sciences (GIScience), the term and concept of "uncertainty" is not uniformly defined and may draw on several different concepts such as error, accuracy, precision, completeness, confidence, and lineage. For a comprehensive discussion of the definition of uncertainty see e.g. MacEachren et al. (2005), Pang (2001), Thomson et al. (2005), Griethe and Schuhmann (2006) and Drecki (2007).

To classify uncertainty within literary geography, five uncertainty concepts are identified and listed here with examples from fictional analysis [concept definitions are adapted from Thomson et al. (2005), Waters and Evens (2003) and Fisher (1999)]:

Ambiguity	where geometry data are tied to linguistic expressions (e.g. "close" to a city, one of the neighbouring islands)
Averaging	where discrete geometry data are actually an average of time or scale-varying geographical descriptions (settings combined to form a zone due to the given scale e.g. various places in a town combined to form the town as a zone)
Continuousness	when geometry data are difficult to define because the measurements of an entity produce a gradient (e.g. the start of a setting in general, the start of a mountain, the border of a landscape, etc.)
Subjectivity	when geometry data are defined by adding an amount of interpretation rather than pure facts (e.g. characters passing through a city on a route not mentioned)
Vagueness	when poor definitions of a class of objects or individual objects do not allow a clear distinction of geometry data (e.g. a house downtown, as well as a house in a specific country)

Fictional places often tend to display all five of these criteria. On the one hand, scholars are faced with imprecise descriptions, so that they are forced to define one

possible geometry out of the imagined area. On the other hand, when it comes to the actual digitising, each person would obviously draw the geometry slightly differently. The results differ in scales of detail, more or less precise with a different idea of what could be the estimated extent of the described place of action. The results also depend on local knowledge and historical knowledge, as well as on personal preferences or skills.

In the research of literary geography, this is not at all a counteracting method. Quite the contrary: uncertain geometries matching the characterisation of the fictional space. As Piatti et al. (2009b) states: "This [formalising act of interpretation] is *not* what critics usually do. Instead they produce so-called secondary literature, interpretations and comments covering various aspects in works of fiction […] usually carefully balancing between several possible streams of interpretation. There, *ambiguity* is a sign of quality, here, in developing a database-supported literary cartography, it becomes a problem". Nevertheless, to have a comparable dataset concerning the size, the extent and the level of accuracy of a setting, there needs to be an *adequate data model,* that can deal with this heterogenic collection of data we are facing.

Having introduced the inherent property of uncertainty within fictional space, this paper will provide concrete solutions to enable spatial analysis and cartographic representation on the basis of a database-supported literary atlas information system. We start with some general declarations about the relation between textual space and geospace and the associated uncertainty. Subsequently, we continue with the actual data modelling. This is followed by a detailed characterisation of fictional spaces with the example of the categories "settings" and "routes" in order to introduce the necessary information to convert the described spaces into geodata. The paper will conclude with an outlook onto possible map- and analysis-outputs and plans for future work.

2 Terms and Definitions of Literary Theory

2.1 Geospace and Textual Space

In order to understand the requirements of the data model for an atlas of literature, an examination of the usage of space in both disciplines, the geosciences and the literary sciences, is necessary. Hereafter, we differentiate between **geospace** and **textual space**. Geospace is the real, physical space, which can be described geographically and represented cartographically, with measurable distances between any desired points. This space is called the *"first space"* (compare Soja 1996). In the contrast, textual space is the virtual space, generated and communicated by means of linguistic expressions. It may contain imaginative representations of the first space and functions as the "*second space*".

It is obvious that the specification of textual spaces, even if it refers to the same geographical extent, differs in every fiction. If one analyses the relation between

Table 1 Scale of reference classification (Extract of content-related attribute table, see Reuschel and Hurni 2011)

Relation Elations Between Textual Space and Geospace		
Terms	Explanations	Examples
Imported	The setting corresponds to geographical reality by realistically portraying the surrounding.	Libuše Moníková: *Verklärte Nacht* (1996): Moníková's characters stroll through Prague, each specific place is linked to a specific event or history. The reader is very well orientated within the town.
Transformed	The setting is transformed; this includes techniques of remodelling, renaming, relocation or a synthesis of several places.	K. von der Eider: *Antje Möller. Eine Eiderstedter Binnerdeern* (1911): Secondary literature identifies a lot of renaming and remodelling of settings within this story.
Invented	An invented setting within the known geographical reality.	Wilhelm Lobsien: *Der Halligpastor* (1914): One of the central settings of the story, a Hallig called "Westeroog" neighbouring to "Hoogeroog", does not exist in reality.
Imagined	There is no hint at all about the position of the setting, it is located "somewhere", with no real-world counterpart, only existing within the narration. Consequently, it is not possible to assign coordinates.	L. Frank Baum: *The Wonderful wizard of Oz* (1900): The "Land of Oz" is an autonomous geography surrounded by a desert, without any link to the real world.

textual space and geospace, it can be observed that literary plots range from the realistically rendered through various remodellings to the completely imaginary. In order to describe and formalise these relations, a four-part **scale of reference** is defined and used for places of actions (settings) and places of longing or remembering (projected places, see definitions at Sect. 3.1). Realistically portrayed places (*imported)* are arranged at the lower end of the scale, close to the geospace. All places that are somehow modified or alienated are assigned to the category *transformed*. Individual places that are purely fictional and integrated into the existing reality are covered by *invented*. In contrast, entirely *imaginary* spaces without any connection to our well-known reality are classified at the upper end of the scale, far from the geospace. Definitions and a selection of specific examples can be found in Table 1.

2.2 Scale of Reference and Uncertainty

At first sight, a relation between an increasing uncertainty and the scale of reference (Table 1) seems to be obvious: An imported setting that exists in reality should more easily locatable than transformed or even invented settings that are at a much higher level on the scale. Closer inspection shows, however, that a

correspondence between the scale of reference and the spatial uncertainty will be a fallacy. In fact, an author may include an invented place so cleverly and precisely into the existing environment that only a person with local knowledge would recognise it. Conversely, it may be that real, imported settings are only described superficially, or the author just mentions an approximate region. In those cases, the delineation possibilities of the corresponding places are rather uncertain. However, if the place of action is completely detached from reality, we reach the end of both scales: imaginary places are neither locatable nor representable on the basis of a topographic map.

Despite this categorisation, one has to be aware, that a certain geospace, used as textual space within different fictions, is never the same: Prague through the eyes of Paul Leppin (German Prague writer) is another Prague than through the eyes of Alois Jirásek (Czech Prague writer), even though both were living at the same time and using imported places by the majority. Their descriptions of Prague differ to such an extent that one might think they were writing about different towns. Prague is described as bizarre town, facing the past, in the works of German writers, whereas the Czech Prague is understood as a lively, booming city. On the one hand, the authors choose different literary topics (love story, crime fiction, historical fiction, utopic-fantastic fiction, etc.) or ambiance (for instant mythic, interchangeable scenery or symbolically-allegorically). On the other hand, time plays an important role. Both the time in which the story is set and the time in which the author is living influence the textual space. To put it differently: the authors' temporal and spatial perspective, their imagination and the changes of the geospace influence textual space. Many textual places are renamed or even do not exist anymore in the meantime. For these reasons, it is sometimes difficult to reconstruct the reality and to clearly classify every textual space into the scale of reference. The complexity of textual space is obvious: to characterise and visualise literary space scientifically, one needs more than just a geometry and a spatial category. This is also emphasized by Ungern-Sternberg (2009) in his work about mapping literature and narrations. According to him, "it is less important that a text names New Orleans than what it makes out of it". Joliveau (2009), who researches the relation of real and imaginary places in general, gains similar insights: "The spatial dimension of a document cannot be reduced to the juxta-position of place names. As demonstrated by Moretti [(1998, 2005)], it must also integrate elements of polarity, distances, itineraries and points of view".

3 Data Modelling for the Literary Atlas of Europe

3.1 Organisation of Fictional Space

When it comes to the actual analysis of textual space, we call it **fictional space**. This narratological generic term combines functions of all spatial objects.

A distinction is made between five spatial objects: *settings, projected places*, *markers*, and *routes* and *zones of action* (either of settings or projected places).

Setting	where the action takes place, characters are actually present
Projected Place	characters are not present, but they dream of, remember, or long for this place
Zones of Action	several settings or projected places combined to form a zone
Marker	a place that is just mentioned, but not part of the categories above; markers indicate the geographical range and horizon of a fictional space
Route	along which characters move through the fictional space; connections between waypoints with projected characteristics or setting's characteristics

Figure 1 illustrates schematically, how literary scholars differentiate between objects in fictional space. The spatial description and the existence of a (main) character and actual action are related to each other: if there is an action but the protagonist is dreaming or remembering it, it happens most probably on a projected place (middle column in Fig. 1). In this case, they have to decide to define an individual projected place or a zone with combined projected places or a projected route along the character is moving within its minds. The presence of action and the presence of characters are mostly directly linked to each other. Settings, projected places, routes and zones of action are inseparably connected with the story line, whereas markers merely serve as geographical indications.

However, it is not always possible to unambiguously determine a spatial description by one of the spatial categories. What are we going to do, for example, with jumps on the time scale: for instance, a fiction starts with a short frame story wherein the narrator remembers a past situation whereupon the actual story starts set in the past, again with the acting, present protagonist. Does the narrator's memory have the character of projected places or are those spatial descriptions of settings? Function changes (a place first marked as a topographical marker may become a setting later in the plot) or gradual changes of the described space itself (the changing of geospace may become the subject of the story) are, in fact, a different challenge. Therefore, in order to enable various interesting spatial analyses about literary space and to offer sophisticated visualisations of various properties, a number of attributes are added to each category.

3.2 Data Model

A data model was developed to realise and organise a coherent data basis for the 'Literary Atlas of Europe'. The data basis can be structured into four parts: general text information, including bibliography and assigned model region, data about the author, the temporal structure of the story line, and last but not least the spatial objects. All parts were taken into account within the data scheme shown in

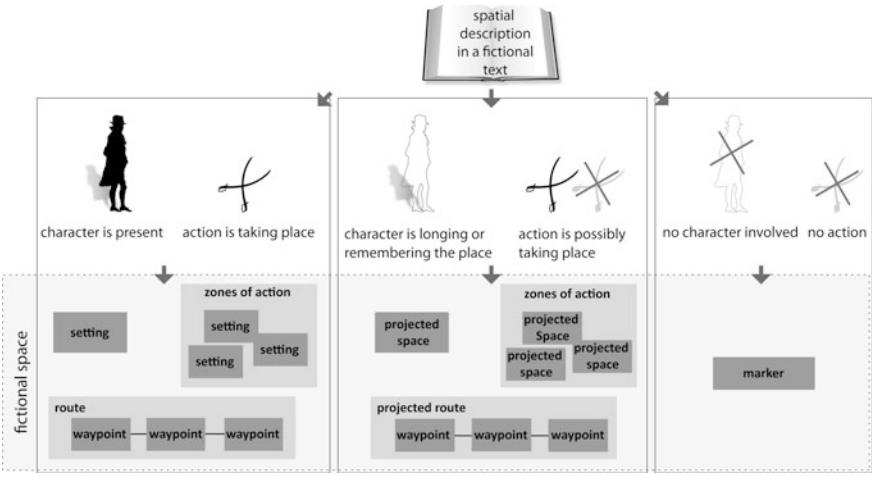

Fig. 1 Schematical differentiation of the fictional space

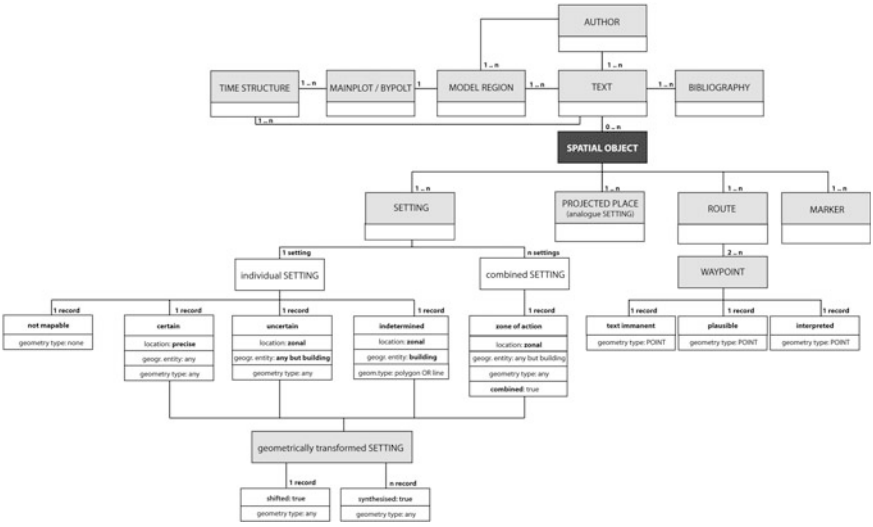

Fig. 2 Data model breaks down the space of a literary fiction into individual spatial objects

an overview in Fig. 2. Particular emphasis was put on modelling of the spatial structure of the text—the modelling of spatial objects. You will find the above-defined spatial entities that compose the geography of fiction and its complex structure. The geographical information is based on the Simple Features Specification (Open Geospatial Consortium 2011). Settings and projected places with uncertain, transformed or hardly locatable spatial objects necessitate

additional attributes and composed geometries respectively in order to reflect the fictional world. This leads to complex attributed spatial data. In Sect. 4 we will go more into detail and follow up with the data model of the categories "setting" and "route". The data model is implemented within a relational database management system and connected to an online submission form used to receive scholars' analyses of the data. Moreover, it serves as basis to process the automatically rendered maps for the 'Literary Atlas of Europe'.

3.3 Data Acquisition

To allow a comparative spatial analysis of literary space, its complex properties need to be broken down into geometries and attributes. This data preparation process involves careful interpretation, semantical and geometrical generalisation. We determined and predefined a number of attributes, which are assigned to individual spatial entities. Despite extensive data acquisition, it is impossible to reach complete representation through the transformation of spatial descriptions to geodata. We are aware of this, as Piatti et al. (2009a) advise: "be prepared to lose something—the complexity of a fictional text you encounter while performing a close reading (we lose style, vocabulary, psychology to name just a few elements)—but you also gain new insights." Furthermore, our chosen properties are not the only way to describe settings nor do we raise a claim for completeness. Quite the contrary: depending on the topic of the fictions, the framing research questions or the chosen geospace, attributes need to be supplemented or replaced.

As it is the main objective of the project to develop visualisations for literary spaces and to enable detailed spatial analysis, the question of the geometry acquisition arises. What possibilities exist to achieve geometries for literary spaces? An automatic text analysis of toponyms with a subsequent connection to an existing gazetteer database was ab initio not worth considering. Those techniques would not provide the desired complex and detailed information that is needed, such as coordinates from approximated zones or historical regions and would not find hidden, camouflaged places, not to mention additional thematic information. To capture the geographical locations of literary space and place, literary scholars are able to generate these themselves with the help of geocoding tools built upon Openstreetmap or Google Earth maps and satellite images, which are connected to the entry form (Fig. 3). In that way we have the possibility of covering worldwide geospace information. But the freely selectable scale of digitising leads to heterogenous data concerning scale, geometry type (point, line, polygon) and generalisation, respectively.

To enable extensive data acquisition, an online data submission form was developed, specially tailored to the needs of literary scholars. This submission form is connected directly to the database and controls the data reading and recording process of the scholars. It is designed to allow intermediate storage, data modification and manages redundant entries. For instance, a new text from an

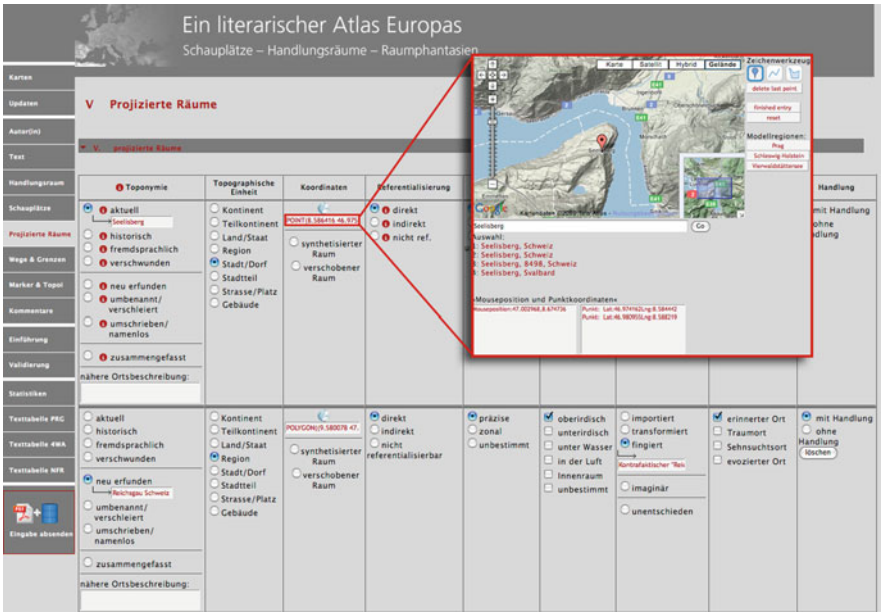

Fig. 3 Online submission form with digitising tool

already entered author is added without re-entering those bibliographic references, by assigning the fiction to the existing author record. Furthermore, the submission form provides scholars with an overview through "action-reaction" buttons: particular entry fields only appear when a specific button is pressed. To ensure an error-free entry, fields expecting numbers are marked and tested before sending it to the database. Similar precautions have been taken regarding coordinate fields: the coordinates are directly constructed through the geocoding tool. All data entered into the form are automatically evaluated and transferred into the database.

4 Concept and Realisation of Spatial Objects

4.1 Settings

Settings are defined as places of action where the fictional characters are present and acting. The way settings are described within a novel are quite different from fictional account to fictional account and have their own, inherent rules. Reuschel and Hurni (2011) identify five aspects (point 1. to 5.) that make fictional space unique and consequently so difficult to capture and visualise. Those aspects were developed for fictional space as a whole, but can easily be transferred to the main

category, the settings. Some further characteristics, which are specific for settings are additionally added (point 6. to 8.). The following list summarises them:

1. Settings are fragmentary, fictional space is completed and developed through the imagination of the reader.
2. Settings have uncertain, vague boundaries, neither physical nor natural, nor administrative, man-made boundaries.
3. Settings are sometimes difficult to localise and can result in an indeterminate location.
4. The "real-world counterpart" of a setting can lie in any time epoch; the intervening years may have altered the topography.
5. Settings can be transformed or remodelled by the author from the beginning or in the course of the story.
6. The extent of a setting can vary from a room inside a building to an international or worldwide level (theoretically, even galactic expansions such as in most science fiction).
7. The density of settings per text can vary between occasional and accumulated places.
8. Settings are used to create an ambiance or are used as a metaphor; they also have aesthetic functions.

Spatial analysis and visualisation of settings rely on the presence of coordinates. But using point coordinates only to spatially describe the location of a setting is not appropriate for a detailed spatial analysis, because the expansion of a place of action can indeed be determined in more detail. Depending on the map scale used for the acquisition and the extent of the setting, digitising with simple geocoding tools is—from the cartographic perspective—unattractive and leads to heterogenous data concerning scale, geometry type (point, line, polygon) and generalisation. A test analysis with students demonstrates how the same settings may be captured geometrically in different ways.

About ten groups of students were asked to analyse Schiller's *Wilhelm Tell* (1804) with settings in central Switzerland. An extract of the resulting geometries can be seen in Fig. 4.

To evaluate the results we compared them with each other. Three neighbouring villages are places of action. Not surprisingly, the students used either points or polygons with varying degrees of detail. This is also influenced by the base map information. With one single exception, all of the depicted geometries do overlap, even though they are depicted quite differently. Spatial statistical analysis is therefore possible. The visualisation of individual settings may show unpleasant rectangular shaped polygons, which should be avoided. We became aware of that no polygon definitions for villages really match their idea as fictional places. For instance, it would not help to use official data, such as those from swisstopo, the Swiss Federal Office of Topography. There, you would find built areas combining several villages. The official commune boundaries are defined politically and do not give the right impression of a spatial fictional description either. What would

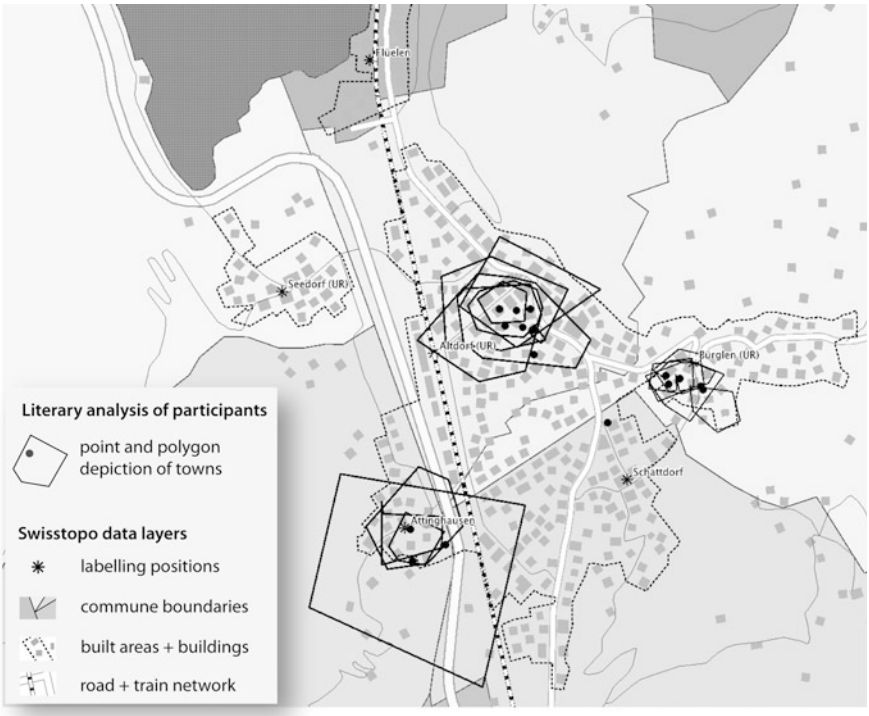

Fig. 4 Evaluation of town depictions of Friedrich Schiller: Wilhelm Tell. Literary analysis carried out by students

fit best at a medium scale within the model region of Lake Lucerne is labelling the position of villages.

To simplify the capture of geometry, we standardised our approach to digitising settings. Those within one of our model regions should be digitised with as much detail as possible. Since we work with three different model regions that vary in scale, the smallest possible geographical entity to be captured is determined as a point relative to scale: villages within the model region "Lake Lucerne" and "Northern Frisia", and buildings for the urban model region "Prague". This means that if, within Lucerne, there are a couple of buildings found to be settings, they are grouped within a zone of action and captured by a point (compare Fig. 5 left). Within Prague, however, each of the buildings is given its own geometry (compare Fig. 5 right). Settings that are located outside the model region are captured as points. In order to distinguish coordinate points that refer to a country, a village or just a building, we additionally ask for an indication of the approximated geographical entity. This information is used to present the entities on the map with different symbols and depending on the scale. Figure 5 schematically shows the usage of geometry types and the content per map scale respectively.

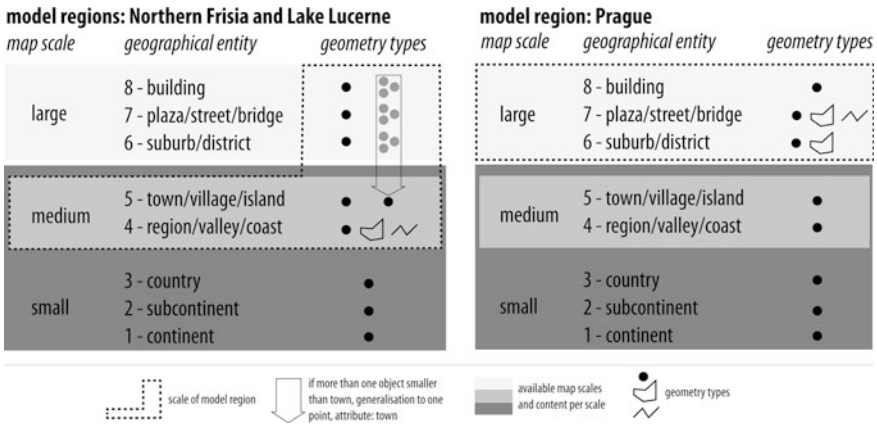

Fig. 5 Determination of the usage of geometry types and map content within and outside the model region. Medium scale model regions: Northern Frisia and Lake Lucerne (*left side*). Large scale model region: Prague (*right side*)

Other attributes used to visualise literary settings are a distinction between certain (precise) and uncertain (zonal) location and a specification of reference to actual geospace: imported, transformed, invented or imagined (Sect. 2.1). In addition, scholars can always add a comment or a quote to emphasise an interesting spatial feature within the text. With transformed places, there are two exceptional cases which we termed *shifted* and *synthesised settings*. In both cases, additional coordinates are necessary: a shifted setting needs one more geometry, the position of the original location (secondary geometry), whereas synthesised settings need at least one more geometry to break down the synthesis of the newly created place. In both cases, the primary geometry specifies the setting's position used within the fiction.

Another composed attribute is the toponym, or name of a setting. If the toponym used in the fiction differs from the current name or is not mentioned directly, we distinguish between a numbers of revealing properties, such as: *historical, foreign language, disappeared, neologism, renamed, veiled, paraphrased* or remaining *nameless.* If possible, the current name to which the toponym refers is also added. Consequently, three pieces of information are needed to specify the setting's designation: two different names and the property of the name used within the fiction. Visualisations of literary toponyms are discussed in Reuschel et al. (2009).

Further attributes of settings are used to describe the function and meaning of literary space. These can be summarised as *thematic attributes*. In contrast to *visualisation attributes*, thematic attributes do not describe the "where" and "what" of a setting; instead they provide interesting metaphors or are used for a particular purpose. Thematic attributes are only added if explicit indications are found in the text; they do not record interpretation or information from secondary literature. Table 2 lists and defines attributes that are used to thematically

Table 2 Setting attributes describing function and meaning of literary space

Function and meaning of literary space	
Simple scenery	The scenery is theoretically replaceable, it only serves as background, and it doesn't play an important role for the story.
Thematic scenery	The scenery is essential for the plot and is described plastically (portrayal of landscapes, architecture and atmosphere). Thus, the scenery is not replaceable.
Protagonistical physical	The setting takes physical action, usually in terms of natural phenomena or natural hazard events like avalanches, landslides or floods.
Protagonistical psychological	The setting influences the mind of the characters, for example by causing a feeling of being trapped or threatened; also positive feelings like freedom are possible.
Mythical connotation	The setting has obvious mythical ambiance or meaning.
Allegorical, symbolical connotation	The setting has an obvious metaphoric or symbolic connotation.

characterise settings. There are also some thematical attributes related to each model region, but due to particular local or historical knowledge we have not listed those attributes too.

Let us take a closer look at the implementation of all properties into the settings data model at Fig. 6. We distinguish between combined settings and individual settings. The latter can further categorised as certain, uncertain and undetermined objects. Except in those cases where a setting remains unmappable, all of the objects contain one simple feature geometry and describing attributes. Unmappable settings only contain attributes but cannot be used for a spatial analysis because of the missing geometry. If a geometric transformation has been determined, a secondary geometry can be added as separate object. In contrast to usual geodata models, where attribute values are tied to each individual entity, literary attributes of interest are not necessarily connected to the setting object, but rather to the text. This happens if a property—for instance, a mythical connotation (compare Table 2)—cannot be attached to a particular spatial object, but after reading the whole text, there are nevertheless clear signs of a mythical connotation within the text. In this case, any spatial object inherits the property from the text object.

As mentioned, necessary attributes that describe a setting can be divided into visualisation attributes and thematical attributes. In the following, three selected settings, one from each model region, are intended to show the diversity of the category setting and the way of obtaining and handling information for both visualiation and thematic attributes. The first example, Fig. 7, is taken from a novel called *Quatemberkinder* written by the Swiss author Tim Krohn. In his novel, the mythical world of legendary creatures is merged with the human world. Thus it is possible to directly link mythical connotations to the novel's settings. In this case, an additional comment provides information about what is happening. Krohn describes the settings of his homeland very precisely and in depth. In an

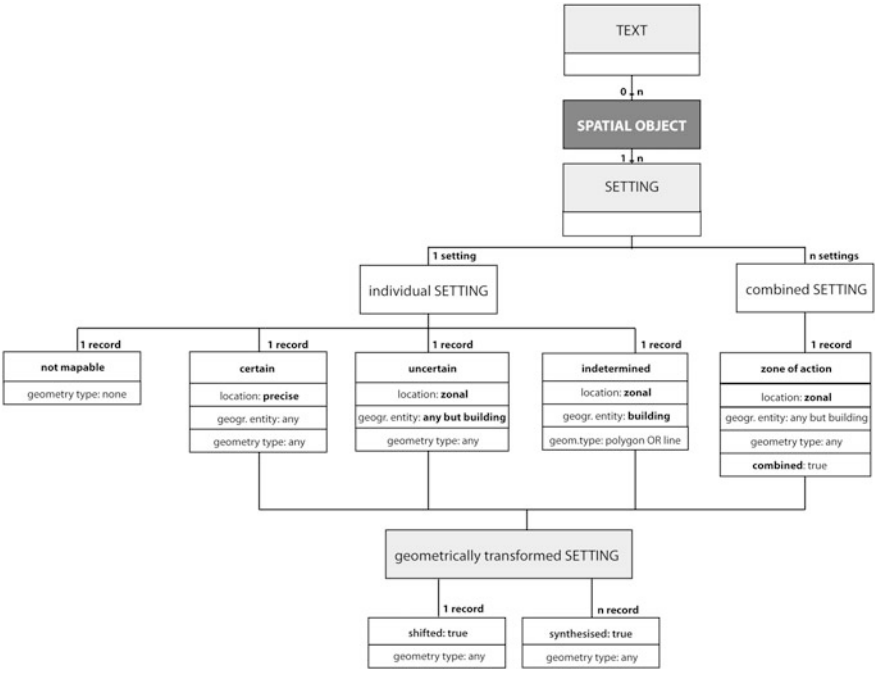

Fig. 6 *Data modelling of the literary spatial object: Setting*

interview he stated: "Writing the novel, I orientated myself with maps and a guide book. I waived doing on-site research, because it would have limited my opportunities" (Geisel 2007). Appropriate attributes for the setting were entered as in Fig. 7. Lake Zug is roughly digitised by a polygon and visualised as a red area with a blurred border, indicating a realistic imported place.

The second example is from the analysis of Paul Leppins ghost novel *Severins Gang in die Finsternis* (English translation: Severin's Journey into the Dark) of 1914. The scenery of Prague is inseparably linked to his novel. Like almost all German-speaking writers from Prague, he describes a bizarre town that comes to a standstill, facing the past. Within their texts, they revive legends and use locations such as jumble markets, cemeteries or morbid houses. The digitised polygon in Fig. 8 is the zonal position of a building, Dr. Konrad's atelier. The resulting representation shows a labelled symbol in the centre of the polygon, indicated by thin radial lines starting from the centre to the polygon's border.

The third and last example (Fig. 9) is taken from a Frisian novel, *Rüm haart—klar kimming* (Frisian slogan translated with "open heart—clear horizon"), written by Thusnelda Kühl. In terms of literary geography, this fiction from 1903 has a number of interesting settings. The one chosen for this example describes a ferry crossing that lands directly next to a restaurant. This river crossing is used as a metaphor for the transition between village idyll and the outside world. However,

Setting:

Attribute	Value
Toponym used in fiction	Zugersee (Lake Zug)
Location	precise
Location details	above-ground
Reference to reality	imported
Direct reference	true
Geographical entity	region
Mythical connotation	true
▼ Comment to mythical connotation	On this place a romance between the protagonist and a mermaid takes place. Mythical creatures exist naturally beside humans. Two different worlds do exist and interact with each other.

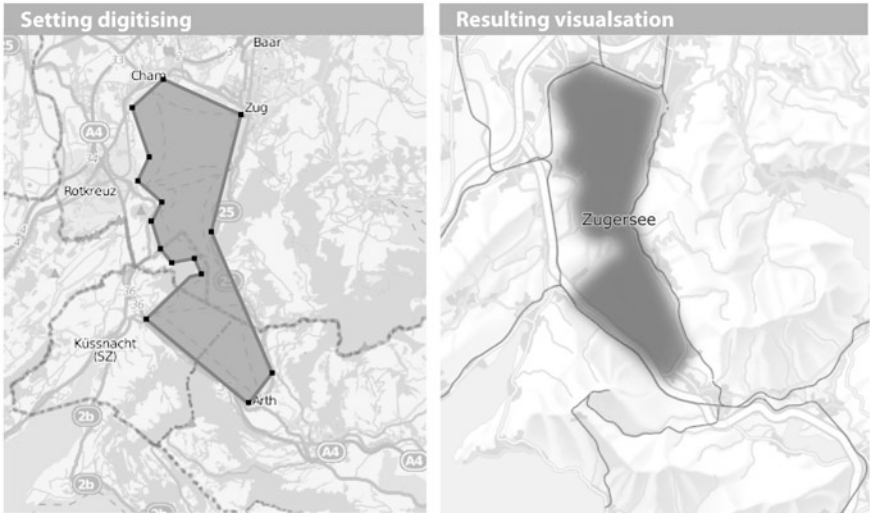

Fig. 7 Complete depiction of a setting, model region of Lake Lucerne, taken from Tim Krohn: Quatemberkinder. (Literary text analysis carried out by B. Piatti)

inquiries revealed that there is no ferry at this point. Kühl was apparently relocating an existing ferry service from down the river for her purposes. The database needs two separate geometries to record this shift: the primary position from the author's description and a secondary, the real position of the ferry service. In this way, the direction can be represented with a dashed Bezier curve. Thereby only the primary geometry is colour-coded as a setting, whereas the secondary geometry remains grey, like the base map, the "real world model".

Setting:

Attribute	Value
Toponym used in fiction	Dr. Konrads Atelier
Location	zonal
▼ Comment to location	This setting is located in one of the new buildings of the redevelopped area. Consequently it is located somewhere in Josefov, the former Jewish quarter.
Location details	indoor
Reference to reality	imported
Direct reference	true
Geographical entity	building
Thematic scenery	true
▼ Comment to thematic scenery	The scenery of the redevelopped area is essential for the plot and not replaceable.

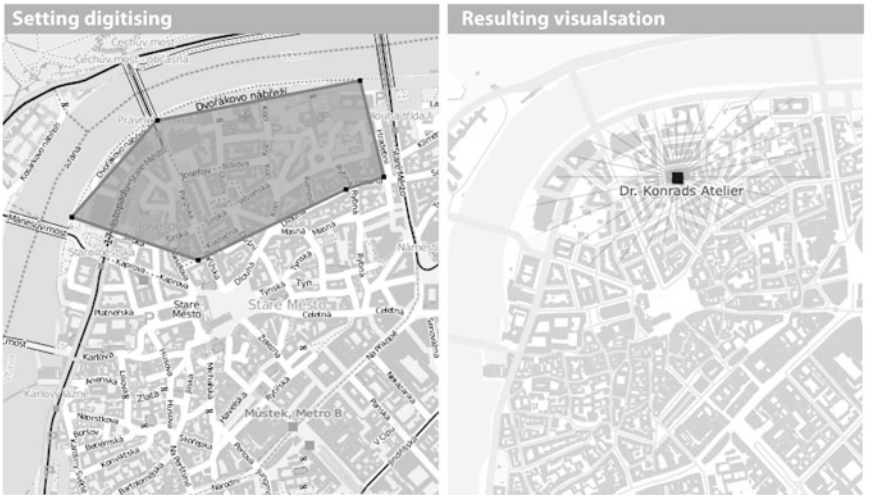

Fig. 8 Complete depiction of a setting, model region of Prague, taken from Paul Leppin: Severin's Journey into the Dark. (Literary text analysis carried out by E. Markvartová)

4.2 Routes

One of the most challenging categories within literary geography are routes, the dynamic element that links settings or projected places to each other. Here, vague, uncertain locations meet vague or even unknown connections. We distinguish between implicit and explicit routes. Implicit routes do not thematise the course of a journey; they are comparable with a movie cut: characters leave place A and the

Setting:

Attribute	Value
Toponym used in fiction	Fähranleger (ferry pier)
Toponym description	nameless, described
Location	precise
Location details	above-ground
Reference to reality	transformed
Translation	true
▼ Comment to translation	translated: the author placed the pier directly next to the restaurant called 'Fährkrug'.
indirect reference	true: secondary literature
▼ Comment to indirect reference	there is no ferry at 'Rothenspieker habour', it had to be the ferry service between 'Wollersum habour' and 'Oldenswater Vorland' down the river
Geographical entity	plaza / street / bridge
Thematic scenery	true
▼ Comment to thematic scenery	The river crossing functions as transition between village idyll and the 'outside world'.

Fig. 9 Complete depiction of a setting, model region of Northern Frisia, taken from Thusnelda Kühl: Rüm haart—klar kimming. (Literary text analysis carried out by K. Seifert and K. Winkler)

next moment arrive at place B. However, explicit routes describe the actual movement of the characters and the places they are passing. Within the scope of our project we are only interested in explicit routes. Nevertheless, there is variation in the completeness and comprehensiveness of explicit routes. In some cases, routes can be used as detailed travel guides, while often the route network remains patchy and imprecise. Similar to settings, we defined specific characteristics that are inherent to routes and need to be considered during the process of data modelling and visualisation. These are:

1. Start or end of a route is often untraceable: characters show up "out of nowhere", or their path dissipates "into nowhere".
2. Route linkages are often ambiguous; drawing connections requires interpretation.
3. The scale may change within a route description.
4. Routes are described by individual toponyms along the way.

To depict literary routes in as much detail as possible, an acquisition in the form of a line is insufficient. Rather it requires additional attributes to waypoints, which comprise the individual elements of routes. The start and end point of each route is differentiated between "known" and "unknown". In the case of "unknown", the waypoint is the first or last known location before the characters (dis)appear. To distinguish between waypoints that can be taken directly from the text and those that result from interpretation, we classify each waypoint into one of three categories: **text immanent point** (taken directly from the text), **plausible points** (anchor points) and **interpreted points** (the most probable way according to the scholar's analysis). Text immanent points are also provided with a toponym. Furthermore, the information of the moving character is attached to each complete route construct, whether or not the route is projected. This individual information enables different ways of handling and visualising the category of routes. If one is only interested in facts from the fiction, one chooses a **schematised route** that only consists of text immanent points. The alternative is an **interpreted route** including all kinds of waypoints. Note that a route is defined as a connection between waypoints with projected properties or setting's properties, but routes are of different degree of details than the spatial object setting or projected place. This means, if an intermediate place of a route is a setting or a projected place simultaneously, an additional more detailed entry of the setting or projected place is required.

Let us take a closer look at the routes data model in Fig. 10. The route object itself does not contain any geometries, only the general attributes mentioned above. The attributed point geometries are part of the waypoint object. At least two waypoint objects form a route object. Waypoint objects with different attributes enable alternative route creations.

A detailed example from a spatial analysis of Paul Verne's *De Rotterdam à Copenhague à bord du yacht à vapeur Saint-Michel* (1881) will demonstrate the acquisition of data for routes. The text is about a common ship journey taken by the Verne brothers, Paul and Jules. The title of the text already hints at the

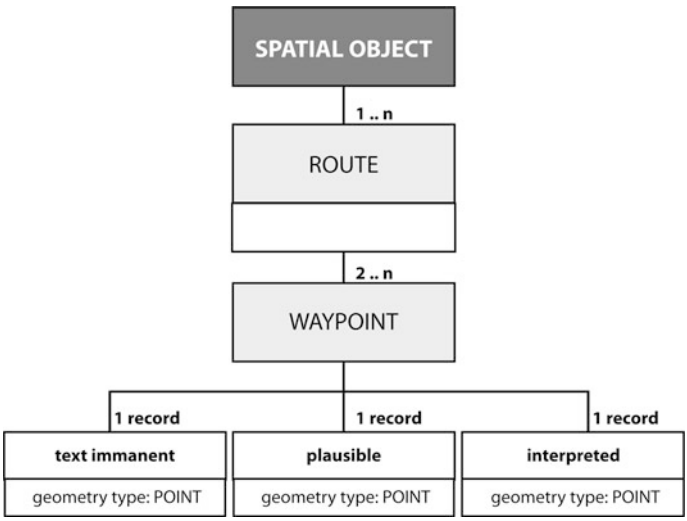

Fig. 10 Data modelling of the literary spatial object: route

departure harbour and the port of destination. Several intervening stations, where names are known and mentioned in the text, were added as text immanent points. All other points, not directly mentioned, could be added plausibly because the means of transportation is by water. Remarkable is a changing of the route's level of detail: Sections along the North Sea coast were digitised quite generously, from harbour to harbour, probably from a small-scale map (outside Fig. 11), whilst the route along the meandering Kiel Canal within the model region of Northern Frisia is determined in too much detail to be shown on the medium scale map. With the help of the point attributes, two types of routes are derived as shown in the resulting visualisation. The schematised route (Fig. 11, *middle*) connects all settings along the cruise, whereas the interpreted route (Fig. 11, *bottom*) gives a quite detailed impression of the travel.

5 Summary and Outlook

The data model we have developed for literary spatiality provides a basis for the 'Literary Atlas of Europe'. Our approach includes the usage of attributed geometries to deal with inherent uncertainty properties, as demonstrated at the outset. The atlas will allow scholars to see patterns and information that are literally invisible. It will work as a generator for new ideas and may provide foundations to answer questions such as: *When does the fictionalisation process of a certain region start and are there still people writing about this region today? Are there particular regions that are often mythical connoted?* You can even think of more complex questions like: *Under which (political-historical and other) conditions*

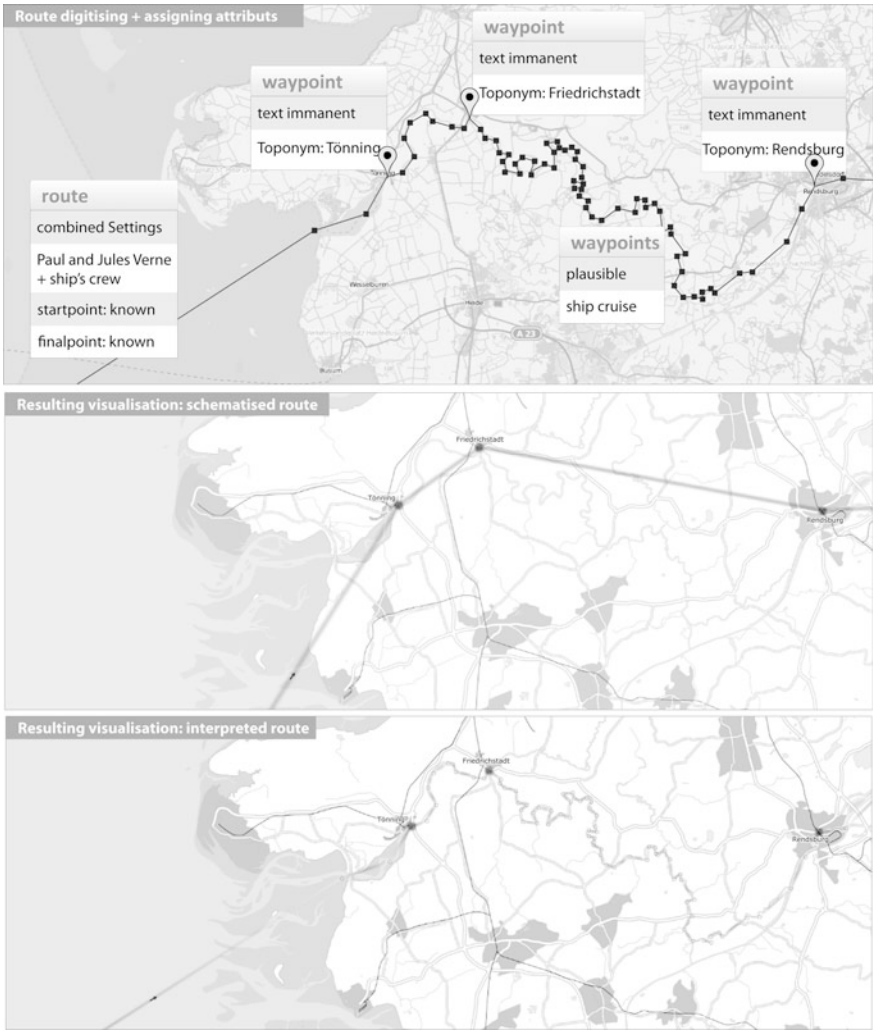

Fig. 11 Complete depiction of a route, model region of Northern Frisia, taken from Paul Verne: De Rotterdam à Copenhague à bord du yacht à vapeur Saint-Michel. (Literary text analysis carried out by K. Seifert and K. Winkler)

does the (imagination-) space of literature contract, and under which does it expand? How international is the space, or do almost exclusively native authors describe it? The generated maps are thereby the visual basis, interactive tool and output of the spatial analysis of literature. The subsequent task for literary scholars is to determine the reasons and connections for the resulting patterns. The database-oriented approach enables spatial and thematic analysis. Various perspectives on fictional spaces can be achieved through almost unlimited possibilities of

spatial data combinations controlled by their attributes. The data model allows us to show how literature creates and organises space, for entirely different fictional worlds, with different elements and density.

In order to visually analyse the results on a map, two different map types are currently under development. On the one side, we visualise individual spatial objects with a scientific uncertainty geovisualisation, for instance, for a single text. On the other side, we calculate statistical surfaces of a statistically significant number of literary places, resulting from queries to the whole data corpus. First results can already be found in Reuschel and Hurni (2011), Bär and Hurni (2011). Both automated visualisations are working with the data model presented here.

Further efforts are necessary to enhance the examination possibilities of a fictional space. Is it, for example, possible to show a detailed fictional space not only in a very enlarged map section, but also in an overall view? How do we handle places that change their functions within the text? We also investigate the integration of further properties of spatial objects that could be of interest for future literary work. For example, how could we add and visualise a chronological order of the important settings? Could we analyse from which place a projected place has been triggered? How can we model moods of different characters associated with a place of action into the existing model? The close cooperation between cartographers and literary scholars remains an indispensable prerequisite to achieve its ambition. So we agree and conclude with the insights of Joliveau (2009): "There is a lot of room for innovations in this domain, but we need to focus on improving the connection between researches in scientific geovisualization and artistic experimentations".

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The Effect of the Ancient Chinese Philosophy and Geography on our Contemporary Landsape Development Using GIS Models

Anna Czinkóczky and György Szabó

Abstract Modelling the man-made and natural environment is an essential task of those who are engaged in the design, planning or scientific research of the geographical space. In cartography or in the application of Geograpical Information Systems (GIS) the traditional geometrical modelling is based on the binary logic, which means that something is either absolutely true or absolutely false concerning a given object and a given criteria. This exclusive approach was successful only in rough, basic descriptions of the environment, but a more refined, human-scale modelling requires smoother transitions between different states—that are not necessary strictly equal to "1" or "0"- but can be of any value in between. This continuous scaling between transitions of two opposite states can be symbolised with the ancient Chinese yin-yang principle. In our paper we show how the ancient principle of beauty and harmony can be successfully modelled with the latest GIS technology and how it could be used to highlight the areas which are of lower status concerning yin and yang properties, hence they have to be developed more intensively.

Keywords GIS · Contemporary landscape · Chinese philosophy

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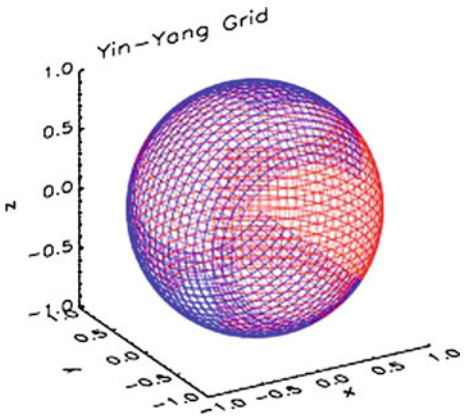

Fig. 1 Yin yang grid in geospatial model (*Source* http://www.aanda.org/)

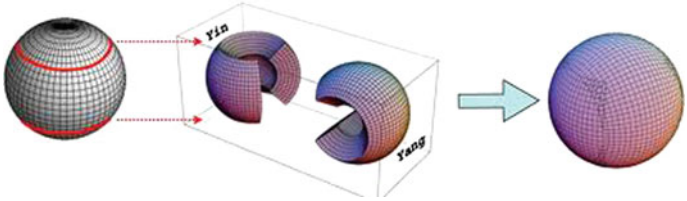

Fig. 2 The combination of the two identical components (*Source* http://www.aanda.org/)

1 Introduction

The well known *yin and yang* symbol, the entity of two entwining symmetric black and white semicircles used to describe how seemingly polar and contradictory forces can result in a harmonious state that represents permanent change and constant equilibrium. It has inspired not only philosophers and artists, but it has influenced the modern computational geoscience as well (Fig. 1).

In the latest geoscience model—Yin-Yang grid is composed of two identical component grids that are combined in a complement way to cover a spherical surface with partial overlap on their boundaries. Each component grid is a low-latitude part of the latitude-longitude grid. The construction of the model (Fig. 2).

The ancient symbol shown on Fig. 3. Originated from the Chinese culture around 1250 B.C. (Osgood 2008). According to this *yin and yang* are complementary opposites that interact within a greater whole, as part of a dynamic system. Everything has both *yin and yang* aspects, but as a total they result in the eternal completeness—the whole circle.

Fig. 3 Taijitsu, the ancient yin yang symbol (*source* http://www.archihtectlines.com/)

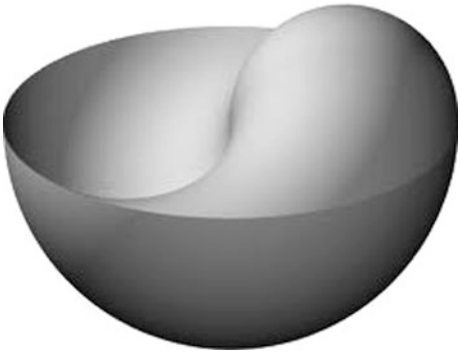

Fig. 4 Yin yang in 3D (*Source* http://www.berkeley.edu)

There is a perception (especially in the West) that *yin and yang* correspond to evil and good. However, Taoist philosophy generally omits good/bad distinctions and other dichotomous moral judgments, in preference to the idea of balance (Fig. 4).

Eventhough *yin and yang* are opposites, they never disturb each other, moreover each of them requires its asymmetric pair for existence. They are equal in magnitude, hence are equal in importance as well.

According to the ancient Chinese wisdom the following properties represent *yin and yang*: shadow or light - or in a broader sense any opposite forces of nature.

2 Yin and Yang in Nature

According to Porkert (1974), Yin and yang can be perceived as:

- Intrinsic natural entities: light and shadow

Fig. 5 Mountain and lake (*Source* http://www.culture.deldap.tw)

- Winter or summer
- Cold or warm
- Male and female (that can create an offspring)
- Natural reproduction of plants (i.e. a seed will sprout from the earth and grow upwards towards the sky—an intrinsically yang movement. Then, when it reaches its full potential height, it will fall to complete a dynamic cycle of growth and decay)
- Wave of water in the ocean- high and low point of waves
- Mountain and lake

Mountains (places of high elevation) and lakes (places of low elavation) together can be considered as a perfect combination of yang and yin found in nature. This pair of opposite entities is unique not only due to their antitethical characters concerning height, but also beause of the opposite nature concidering wetness (lake) and fire (mountain, volcano). It is well known that most people find the scenery of mountain and lake together as one of the most attractive, most relaxing place to visit (Figs. 5 and 6).

Yin originally means the shady, Northern part of the mountain, while *yang* means the sunny (Southern) part.Similarly *yin and yang* can be also related to the sides of a river (*Nota bene*: the river has also two sides, yin and yang). Later these were generalized to arbitrary opposite concepts as well.In Chinese geograhic and place names one can still find ancient words that correspond to yin and yang. In geographical context "*yang*" means southern (sunny) side, while "*yin*" corresponds to the northern, shady one. Similarly the city called "Louyang" means the city on the southern part of the Lou river (Fig. 7).

Fig. 6 Yin yang mountain (*Source* http://www.taoism.about.com)

Fig. 7 The yin (water) and yang (mountain) (*Source* http://image.shutterstock.com/display_pic_with_logo/478609/478609,1278869711,3/stock-photo–chinese-landscape-painting-56988670.jpg)

3 The Traditional Chinese Landscape Paintings

The beauty of Chinese landscape can be rooted back to BaGua or "eight symbols" system reflecting the dualistic philosophy of '*yin*' and '*yang*', and it goes back to 10th century BCE. This system has been adopted by the Chinese culture and it is still very popular, even in modern days in China (Fig. 8). The original meaning of *yang* (southern, high, sunny) can be associated with elevation, positivity, power

Fig. 8 Chinese landscape painting shansuihua (*Source* http://www.educators.mfa.org)

and light. The opposite complementary of the prevoius is *yin* (Northern, low, wet, dark) represented by the lakes, water and low points of the landscape.

The traditional Chinese landscape painting, the so called *shansuihua* means water and mountain (yin and yang). Chinese paintings are usually displayed in faded color, mainly using ink and water, with light coloring. Their strokes are softer, more graceful, and suggestive. Water washes on the existing brush strokes of ink produces softer and subtle effect.

Lake is separated from water, as the mountain is being separated from Earth, showing the special significance of mountains and lakes or rivers.

4 Yin Yang in Fractal Geometry

The fractals—objects with a self-similar property—(shapes with a rough or fragmented structure that can be split into parts, each of which is approximately a reduced-size copy of the whole), are also related to the *yin and yang.*The mathematical beauty of fractals is that infinite complexity is formed with relatively simple equations. By iterating or repeating fractal-generating equations many times, random outputs create beautiful patterns that are unique, yet recognizable. Mountains and trees can be considered as natural fractals.The following figure shows a fractal resembling to the original taijitsu (yin and yang as shown on Fig. 3) (Fig. 9).

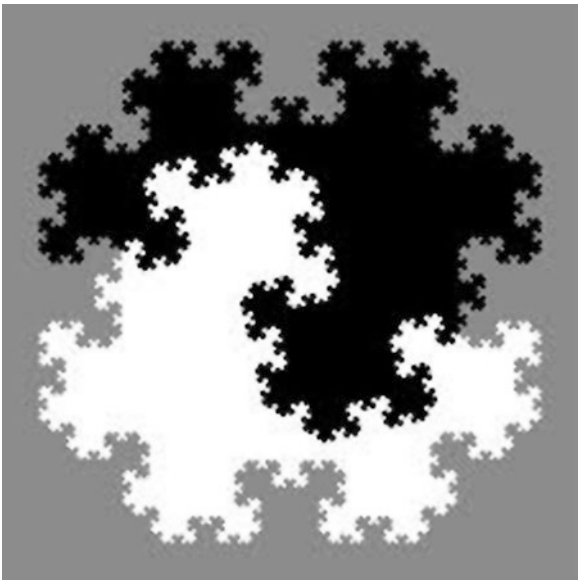

Fig. 9 Yin and yang fractal (*Source* http://www.markdow.devianart.com)

5 Yin and Yang in Contemporary Urban Space

Chinese people have always valued the traditional beauty of *yin and yang* and it is still considered as a contemporary value. The **National Centre for the Performing Arts** (**NCPA**), and colloquially described as *The Egg*, is an opera house in Beijing. The Centre, an ellipsoid dome of titanium and glass surrounded by an artificial lake, seats over 5,000 people in three halls and is almost 12,000 m^2 in size. Construction started in December 2001 and the inaugural concert was held in December 2007. The new Chinese national theatre (Fig. 10) is an emblematic example of the revival of the antient tradition and philosophy in contemporary architecture. Several other new and famous community places can be found in China (e.g. Chengdu Comtemporary Art Centre, designed by Zaha Hadid).

6 Yin Yang: A Duality Principle and its Effect on Landscape Design

The French Geographer and Japanologist Augustin Berque (Fung and Jackson 1992) has observed that the polarity principle of yin and yang that can be observed in a relative context (or environment where both entities are found) is fundamentally different from the duality principle of the Western world (where the the terms of yes/no, or true/falseare absolute terms). In philosophical terminology, it is agreed the polar (yin yang) terms are related to correlative (comparisonal) thinking, while the dualist logic of the Western world is rather a casual description of the whole (cause and effect relationship).

Fig. 10 The Chinese national theatre in Beijin (the egg) (*Source* http://www.unusualarchitecture.com)

Since the Chinese philosophy and landscape art is based on the dinamically changing equilibrium and balance of *yin and yang*, in urban and design and architecture these principles still can be found.

The aesthetics of a city is a combination of many sensory stimuli as well a visual one. The monotonious flat structures and surfaces of buildings and roofs of the same levels can be nicely complemented with high structures (towers, temples, lookout towers, skyscreapers) which can be used as landmarkes to show central location and can be used to accomodate large crowds (city centre towers, Eiffel tower). Currently almost every large city is seeking to build such a specific landmark to be famous and to attract tourists.

This vertical expansion was to symbolize power and to control a territory and space. Every religion (western or Asian cultures) used height to express sacral importance. Gothic churches, pagodas, Indian stupas are also examples of this tradition.

The *yin and yang* principle—i.e. making harmonious structures with oppositely changing dynamic entities—inspite of its simplicity and age is still used by contemporary architects.

Tamás Meggyesi, one of the most prominent architects in Hungary in his book called *Morphology of Urban Architecture* (Meggyesi 2009*)* has analyzed the urban space in structural –morphological context and emphasized the importance of dichotomous, dinamically changing entities (open or closed space, linear or centralized road systems, etc.) which can be considered as an extension of the ancient *yin yang* philosophy.

7 The Yin Yang Principle and GIS

GIS is a relatively new science and it is used for capturing, storing, checking, integrating, manipulating, analysing and displaying data related to positions on the Earth's surface .

Since the original meaning of *yin and yang* has spatial implications (high–low, Southern–Northern, sunny–shady) it is plausible to use current technology and GIS to characterize certain regions in terms of *yin-yang* aspects.

Chinese government has proposed a strategic development plan named as Harmonious Society, which contains the requirement to apply Chinese traditional theory to contemporary urban construction. The first step is to develop the model and define those properties which contribute to the yin and yang characteristics of a given area. Some geospatial parameters are the following:

List of parameters (1)

- Altitude
- Slope
- Exposure to sun
- Average height of the grid cell
- Standard deviation of the heights (variability of the elevation)
- Distance from industrial zone or main road
- Green area proportion
- Soil fertility
- Yearly precipitation
- Air quality
- Existence or closeness to water (see, river, lake, pond, artificial objects, fountains, etc.)
- Cultivated/natural landscape
- Wind
- Earthquake danger
- Flood danger
- Noise level

In the paper we tried to analyze the fusion of remote sensing techniques (imagery, aerial-, terrestrial lidar, hypersectral data) which offers an efficient way to create and update GIS-ready land cover information. High resolution imagery produces large number of pixels, but such increase in resolution does not necessarily produce more information. The methodology developed for low resolution sensors basically supports small scale related feature extraction. The important semantic information that can be used in the interpretation of an image is not represented in single pixels but in meaningful image objects and their relationships. The increased use of high resolution image data sources like the digital orthophotos supported by hyperspectral images and lidar derived surface information give theoretical possibility to produce high resolution features automatically. The high resolution images require more advanced interpretation methods because of the different texture and additional spectral and range information. The small details of images like shadow effects, terrain relief effects and the non-required feature details give more information for the visual perception, but they contain additional noise sources for the conventional image processing techniques. Finding the structure in data requires classifying it according to similar attributes and patterns.

Fig. 11 Sample area (Szekesfehervar, Hungary) Urban object extraction from heterogenious data sources (produced by the authors using Bentley Microstation based Terrasolid engineering planning environment and Trimble eCognition Image Analysis toolsets)

These attributes are quite diverse and a careful expert knowledge is necessary to find the appropriate range and scale that can be used for GIS analysis.

In the following figures we briefly display some outputs of GIS analysis of a sample region (city of Szekesfehervar, Hungary) with respect to different parametric observations.

Figure 11 shows the digital image of the sample region above.

7.1 The Altitude Range

Figure 12 displays the vertical segmentation of the area 108–145 m, scaled to 0–255. The whiter regions represent the higher areas whereas the darker segments correspond to the lower places. This coincides with the original meaning of yin (low) and yang (high).

From this segmentation it can be clearly seen that a geographical region (city) can be segmented into *yin* (low) and *yang* (high) regions.

7.2 Other Factors

According to the parametrisation criteria, the standard deviation of elevations (variability of the heights of spatial objects) can be also used to divide a certain area into *yin* and *yang* regions. The following figure shows an example of such subdivision. As before, the darker areas show the small standard deviation values (0–1) in elevation (i.e. where the height is relatively constant), the intermediate values of 2 and 3 are colored with blue and green, respectively (Fig. 13).

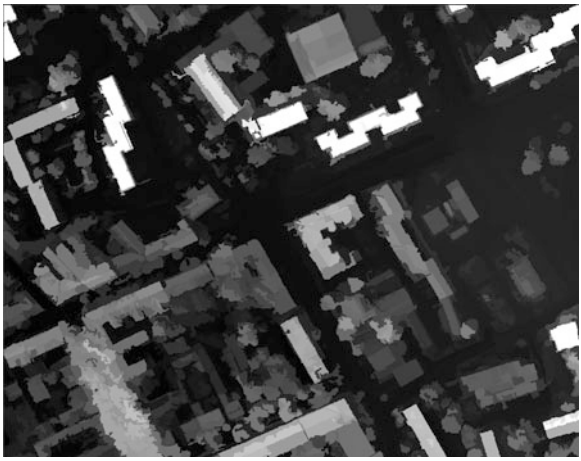

Fig. 12 Altitude segmentation of the area Urban object extraction from heterogenious data sources (produced by the authors using Bentley Microstation based Terrasolid engineering planning environment and Trimble eCognition Image Analysis toolsets)

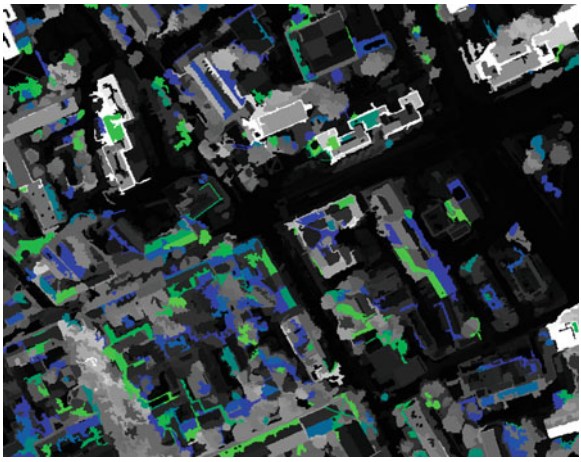

Fig. 13 Segmentation by standard deviation of elevation (by variability of heights) of objects Urban object extraction from heterogenious data sources (produced by the authors using Bentley Microstation based Terrasolid engineering planning environment and Trimble eCognition image analysis toolsets)

7.3 Segmentation by Ellipticity

Ellipticity measures the roundness of spatial objects. For perfect squares of spheres the roundness value is 1, for striped or elongated shapes the roundness value is 0. Intermediate values can occur depending on the shape of the spatial object. The following figure displays the sample area according to the yin and yang segmentation considering ellipticity (Fig. 14).

7.4 Segmentation by Compactness

Compactness measures space occupation rate. It can be represented by the ratio of area and perimeter. For compact, dense objects this ratio is close to one, for

Fig. 14 Segmentation by ellipticity (black or "ying": more elongated, white or "yang" is round) Urban object extraction from heterogenious data sources (produced by the authors using Bentley Microstation based Terrasolid engineering planning environment and Trimble eCognition image analysis toolsets)

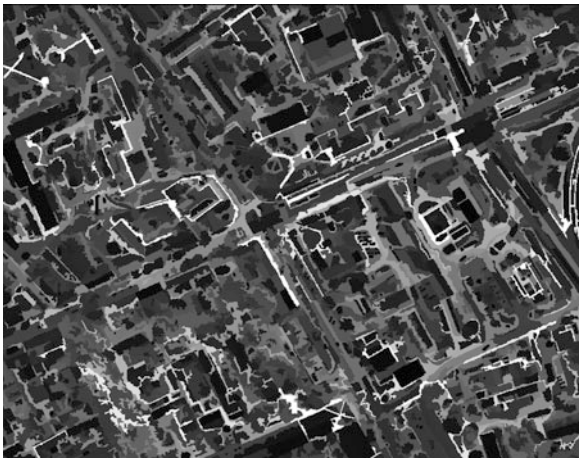

Fig. 15 Segmentation by compactness. Urban object extraction from heterogenious data sources (produced by the authors using Bentley Microstation based Terrasolid engineering planning environment and Trimble eCognition image analysis toolsets)

spreaded objects it is closer to zero. Compactness can be related to optimal space use, minimizing the surface area of a building having a certain volume (i.e. capacity).

Without discussing this issue further, analysis of compactness can be a further criteria to solve spatial problems of overpopulated areas or countries (Fig. 15).

7.5 Segmentation by Vegetation Index

Vegetation index can be determined by the spectral analysis of the digital image of the investigated area. The following figures show the distribution of the vegetation

Fig. 16 Segmentation by vegetation index I. (*Red channel*)

Fig. 17 Vegetation index (*Green channel*, clearly shows the vitality of the area) Urban object extraction from heterogenious data sources (produced by the authors using Bentley Microstation based Terrasolid engineering planning environment and Trimble eCognition Image Analysis toolsets)

index. It can be observed that the vegetation index (spectrum of light) clearly coincides with the vitality of the area due to the existence of plants (trees, shrubs, grass etc.)

Image segmentation is the task of sub-dividing an image into constituent parts or objects. After segmentation, each image pixel is assigned to one of several specific classes. Segmentation is a basic preprocessing task in many image processing applications. In agricultural or in machine vision applications, segmentation is essential to separate plant from the background, i.e. soil and residue. Two general classes of methods have been used to separate a plant from its background in color images of agricultural crops. Pérez et al. (2000) introduced the so called normalized difference index (NDI) along with morphological operations for plant segmentation.$NDI = \frac{G-R}{G+R}$, where G is the value of green channel, and R is the value of red channel remote sensing to estimate the amount of vegetation represented by a pixel (Figs. 16, 17).

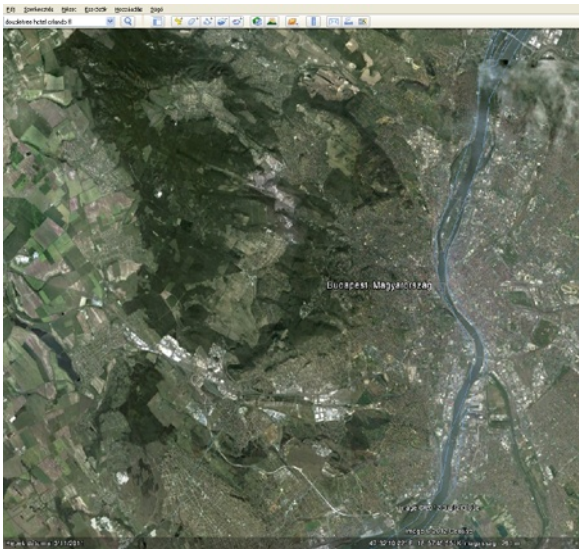

Fig. 18 Google maps of Budapest

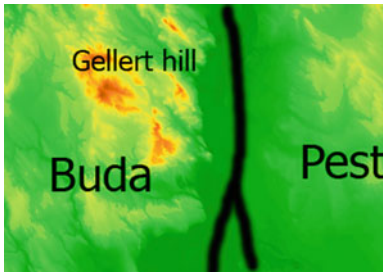

Fig. 19 Division of the Hungarian capital, Budapest into yin (*green*) and yang (*reddish or yellowish*) regions (*Source* authors' analysis)

As the example above shows it is possible to divide a certain area into "yin" or "yang" regions, according to some geographical parameters. It is also possible to assign weights relative to their importance and combine the separate figures into one complex segmentation.

Furthermore, one can observe that the weights that correspond to the importance factors that have to be determined as well (100 means the highest impact, 0 means no impact at all).

The Chinese research (Yuan et al. 2007) used 24 different parameters and 11 indices. They could divide the downtown of Nanjin city into three zones: the area of low total score (yin) and a average area (both yin and yang) and a high total score area (yang). This result was a clear indication for the future development programs and plans.

Contemporary mapping and geographical systems such as Google Earth also provide a detailed, 3D view of a geographical region or a capital city—such as

Budapest, where one can observe the different levels of heights in buildings, mountains, rivers, creeks or lakes. Hence, we can have a subjective evaluation about *yin and yang* and characterisctics of a city or place. Nevertheless, these impressions are rather unverifiable and personal, so the main question and research goal was to find whether it was possible to give a complex, objective separation of a main city (such as Budapest) into *yin* and *yang* regions with respect to certain parameters.

In our project we have incorporated only few parameters from the possible range of descriptors mentioned in *List of parameters* (1). We have chosen only height, standard deviation of altitude values, vegetation index, since we had access to these (Figs. 18, 19).

8 Conclusion

The instrinstic harmony of nature and civilisation has been in focus for thousands of years. The modern science tries to capture and analyse the essential features of a harmonious and sustainable geographical entity. Since the object of the project is rather complex, a harmonious area has geospatial and socio–economic attributes, so an interdisciplinary approach is necessary to find the appropriate parameters that describe a harmonious space.

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The Potential of Using Web Mapping as a Tool to Support Cultural History Investigations

David Schobesberger and William Cartwright

Abstract Paper maps have always been a valuable resource for cultural history research with a geographic component. The shift from paper to digital maps facilitates a new way for researchers to access, interact with and analyse geographic data. This chapter addresses the use of maps on the Web as tools to support cultural history research. It discusses the emergence of new applications through Web 2.0 and provides a comprehensive classification of types of Web maps with representative examples. As well, it covers models of Web map use and possible goals and tasks inherent to user interaction with maps on the Web.

Keywords Web maps · Classification · Web 2.0 · Web map use · Use goals

1 Introduction

For researchers undertaking investigations into 'other' geographies their work needs information. And, in most cases, this information has a geographical element. In order to support research activities access to cartographic information is essential. Once paper maps were the essential ingredients for research that depended on knowledge about geography. Now, digital maps are the tool of researchers, and, increasingly, digital maps and associated geographical visualization tools delivered

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Lecture Notes in Geoinformation and Cartography,
DOI: 10.1007/978-3-642-29770-0_13,

via the Web. Web-delivered cartographic information has become a useful aid to researchers, including researchers exploring geo-located art artefacts.

This chapter provides a classification and overview of different types of maps on the Web and Web 2.0 applications with representative examples. Moreover, it discusses the use goals and tasks that can be accomplished with these categories of Web-maps.

2 Classification of Web Maps

Kraak (2001) provides a general classification of Web-maps that builds upon the actual appearance of the maps. He admits that this classification is only a preliminary one, since the development of the Web proceeds at a tremendous rate. His schema (Fig. 1) distinguishes between static maps and dynamic maps, with a further subdivision into 'view only' and 'interactive' maps for both groups.

The differences between paper maps and other, on-screen maps are visible in four attribute areas (Kraak 2001): the users; the providers; the content; and the usage environment. Kraak argues that the Web environment has restraints on image and file size, since both influence the speed of transmission. Furthermore, users of the Web tend to devote relatively short spans of attention to what they see. This poses a challenge to map designers to produce clear and concise maps with a lower graphic and information density, which limits the content of Web maps. Additional information, which overburdens the graphic arrangement of Web maps, could be made available by interactive components.

In 2001 "the most common map found on the WWW was the static view only map" (Kraak 2001, p. 3). This has changed considerably over the last decade. Peterson (2008) says that the Web as a communication medium has changed maps from static entities to dynamic interactive products. While definitely increasing in number due to the massive expansion of the Web, the percentage of static view-only maps has constantly decreased in favour of interactive Web mapping applications. Today a great variety of interactive online maps is available via the Web, a fact that makes a further classification and distinction of products necessary.

Figure 2 shows a classification and the development of Web maps from scanned images and map collections, and interactive mapping products on the Web to the diverse applications which have emerged out of the paradigm shift towards Web 2.0, Web 3.0, and Web 4.0. Cartwright (2003) identified 6 types of Web mapping products that are different in terms of how and for what tasks users are accessing them online. These are:

- Map and image collections;
- Downloadable data storages;
- Information services with maps;
- Online map generation services;
- Web-atlases; and
- Hybrid products.

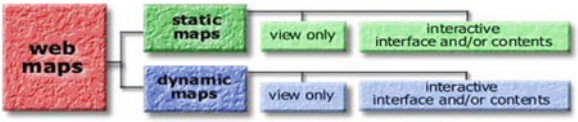

Fig. 1 Classification of web maps (Kraak 2001, p. 3). Web maps are divided into static and dynamic maps which can each be view only or dynamic

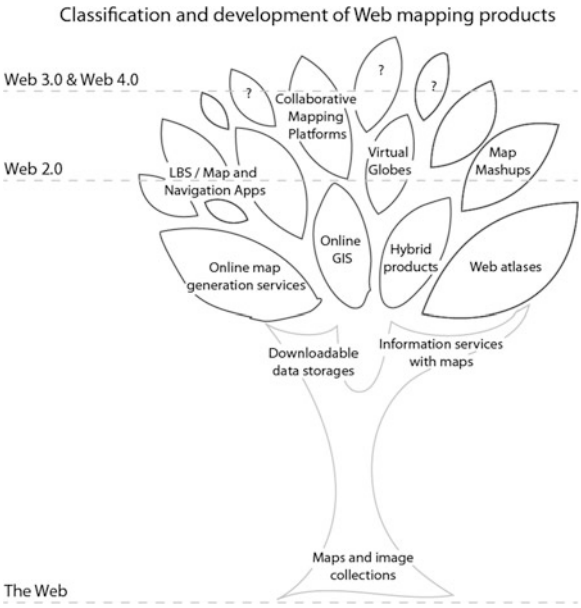

Fig. 2 Classification and development of web mapping products. With the advances of web technologies web maps become increasingly diverse offering a variety of possibilities for information dissemination

Apart from the first category—digitized maps in map and image collections—most of the maps within these categories feature a high degree of interactivity. Over the last decade, maps on the Web have become more and more abbreviated forms of their analogue counterparts in terms of access and interaction. It is argued that further categories of Web mapping applications have, or are evolving rapidly. These are:

- Web-based geographic or cartographic information systems;
- Virtual Globes;
- Collaborative Mapping Platforms;
- Map Mashups; and
- Location Based Services (Map and Navigation Applets).

The sections below describe these types of applications in further detail and provide examples for each kind of application.

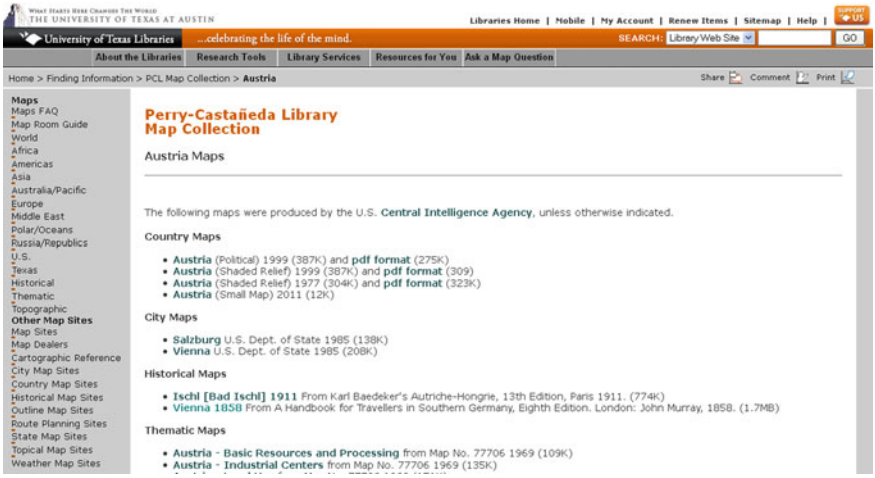

Fig. 3 The Perry-Castañeda library map collection offers many static for download and links to some interactive maps (University of Texas Libraries 2011) (*Source* http://www.lib.utexas.edu/maps/, accessed 18 December 2011)

2.1 Map and Image Collections

These online maps are mostly digitised (scanned) images from map collections and therefore are often available via library Websites. The information can be spatially indexed using the hyperlink principle. Still, most times there is only a small degree of interactivity. This has been the most common type of Web map in the early days of Internet cartography (Kraak 2001). A good example for this type was the Website Odden's Bookmarks (discontinued) which offered an extensive overview of cartographic Websites and Web maps (Köbben 2001). Other prominent examples for this type are the Perry Castañeda Library Map Collection (University of Texas Libraries 2011) which offers mostly static downloadable maps with a variety of topics (Fig. 3), or the David Rumsey map collection which focuses on historical maps and makes available more than 27,000 scanned maps for online exploration and download (Cartography Associates 2009).

2.2 Downloadable Data Storage Sites

This type of Web mapping product is usually authored by governmental or private organisations as a service for marketing, selling and delivering geodata and map products. The products are more readily available to the general public and professional map users, and the costs of delivery can be reduced due to lower staff requirements. A prerequisite for online geodata repositories is that high quality and up-to-date metadata is available for describing the characteristics and attributes, as well as the genesis of individual datasets.

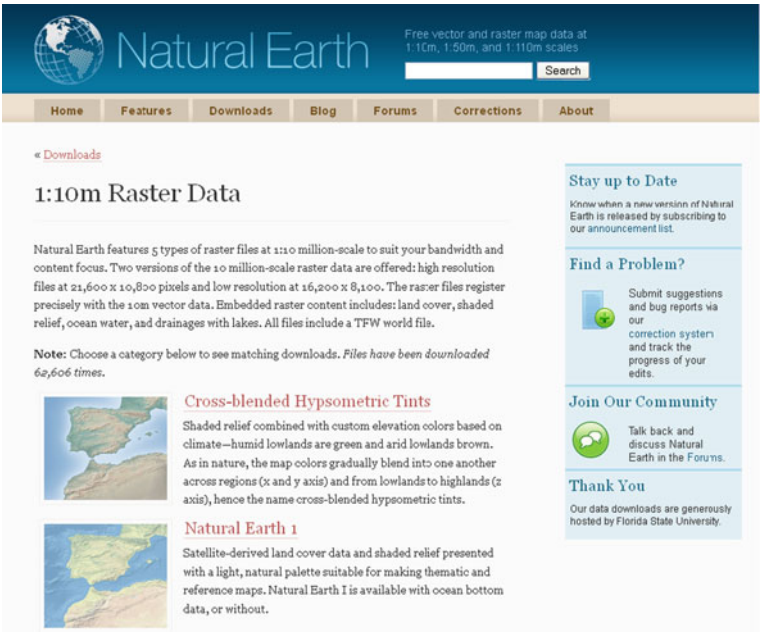

Fig. 4 Natural earth data, an online geodata storage for free download of mostly topographic high quality datasets. (Natural Earth 2011) (*Source* http://www.naturalearthdata.com/, accessed 18 December 2011)

An example for this kind of product is NAVmart (Korem Corp 2011) which is the online geodata warehouse for Navteq/TeleAtlas data. Another example is Natural Earth Data (Natural Earth 2011) (Fig. 4) which offers a range of free mostly topographic high quality geodata.

2.3 Information Services with Maps

Products in this category are manifold. The goal is to provide geo-referenced information that helps the users with a variety of tasks. The products can either be stand-alone services, or they provide extra information to support and advertise other products of a company.

The most prominent example for this type of service is *GoogleMaps* (Google Inc. 2011a) which serves as an application for address or route finding and offers spatial search capabilities that provide location-based information about many different businesses (Fig. 5). Similar services are offered for example by the well-known applications *MapQuest* (MapQuest Inc. 2012), *Bing Maps* (Microsoft 2012) and the open source project *OpenStreetMap* (OpenStreetMap 2011). Other examples are online public transport information services that feature interactive maps of bus and train stops, or company/shopping websites that show on maps, where their branch offices/chain stores are located.

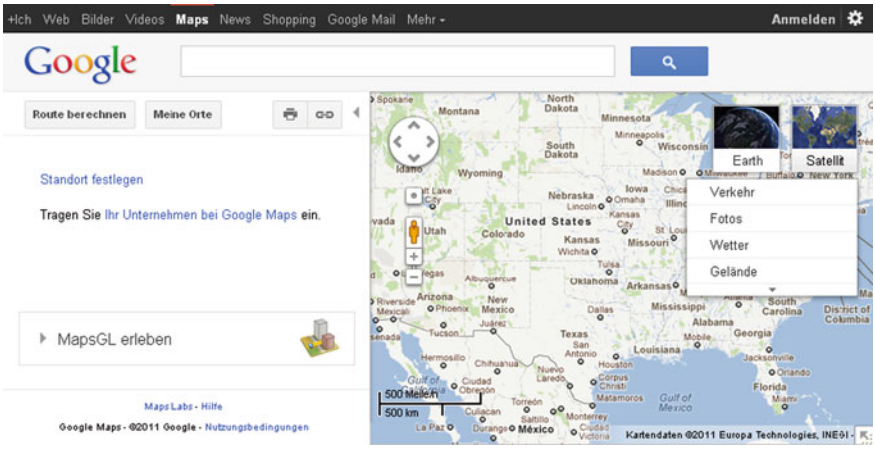

Fig. 5 Google Maps (Google Inc. 2011a) offering spatial searches, routing and address finding capabilities (*Source* http://maps.google.com, accessed 19 December 2011)

2.4 Online Map Generation Services

These services allow users to compile tailor-made maps from a variety of data sources to create their own maps or as a background for thematic maps. An example for a map generation service is the *MyMap* application by the Department of Geography and Regional Research of the University of Vienna (2003), which allows users to generate customized choropleth maps of Austria based on their own data (Fig. 6).

2.5 Web Atlases

Web Atlases are available in a variety of formats. They reach from regional scale levels to world atlases and cover either one topic area for specific countries, regions or the world or an array of different topics. Online atlases communicate geographic information to the general public (e.g. the *ÖROK Atlas* (Österreichische Raumordnungskonferenz 2011), Fig. 7) or if they have a special topic mainly to domain experts or the interested public [e.g. The Literary Atlas of Europe (Piatti et al. 2009)].

2.6 Hybrid Products

These types of products can also be categorized as other types of Web maps (e.g. Web-atlases). The main difference is that these maps are not only distributed via the Web but also by utilizing other distribution channels and media

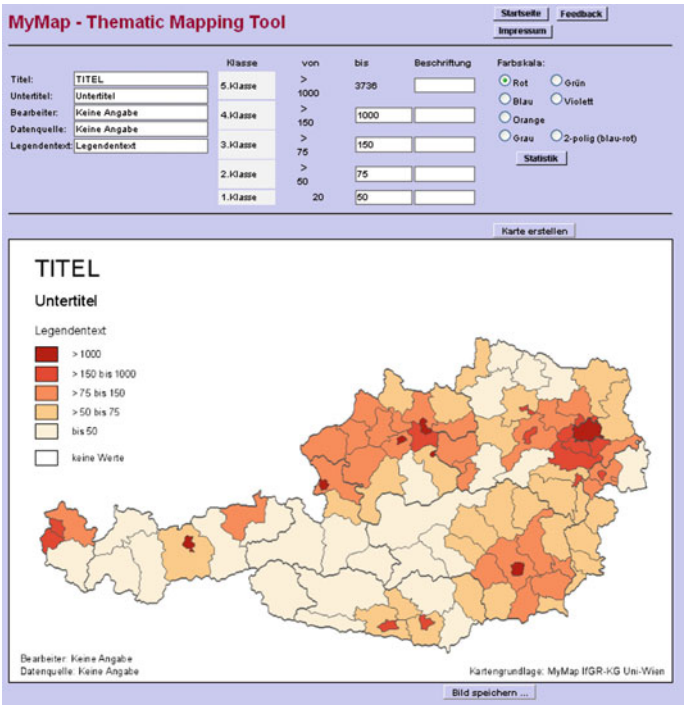

Fig. 6 MyMap–thematic mapping tool for Austria (Department of Geography and Regional Research, University of Vienna 2003) (*Source* http://leto.geo.univie.ac.at/project/mymap/, accessed 18 December 2011)

(e.g. CD-ROM, DVD, printed). The *ÖROK Atlas* mentioned above (Fig. 7) is, for instance, not only available as a Web atlas, but also as a printed atlas (Pucher 2008). Within the *MenoMaps* project scholars at the Finnish Geodetic Institute, Department of Geoinformatics and Cartography, developed a prototype for a hybrid multi-publishing service for the dissemination of maps by a variety of channels (printed maps, Web maps, mobile map applications and interactive multimedia) (Flink et al. 2011) (Fig. 8).

2.7 Web-Based Geographic/Cartographic Information Systems and Geovisualization Applications

These products are often a mixture of online atlases, information services with maps, online GIS and geovisualization applications. They are thematically and regionally focussed mapping applications that offer additional multimedia components and advanced functionalities for exploring and analysing spatio-temporal relationships between objects of relevance. Common for these products is

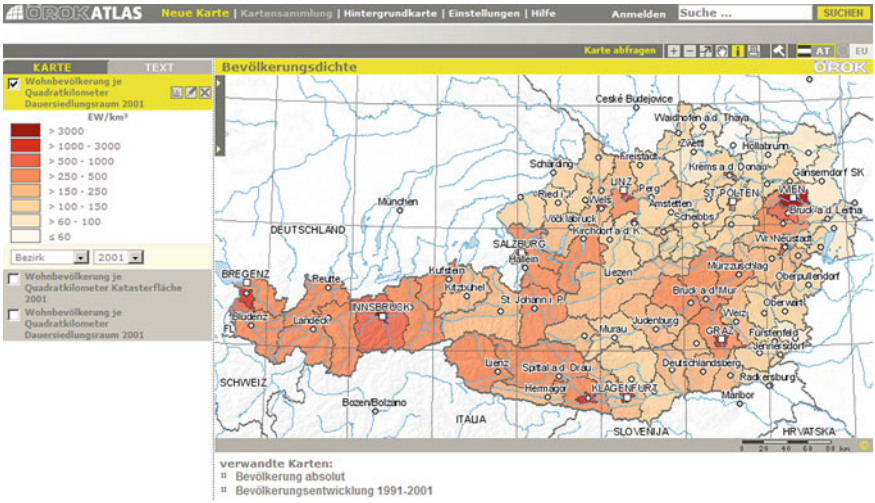

Fig. 7 The Oerok-Atlas Austria (Österreichische Raumordnungskonferenz 2011): Interactive online atlas for spatial planning, teaching, and the general public (*Source* http://www.oerok-atlas.at, accessed 13 December 2011)

Fig. 8 The hybrid product MenoMaps. Output as printed maps, web maps, mobile map applications and interactive multimedia (Flink et al. 2011, p. 1)

an interdisciplinary development that serves communication and information purposes between domain experts and the general public, for example the Cultural History Information System (Department of Geography and Regional Research, University of Vienna, 2010) which has been developed by the Department of

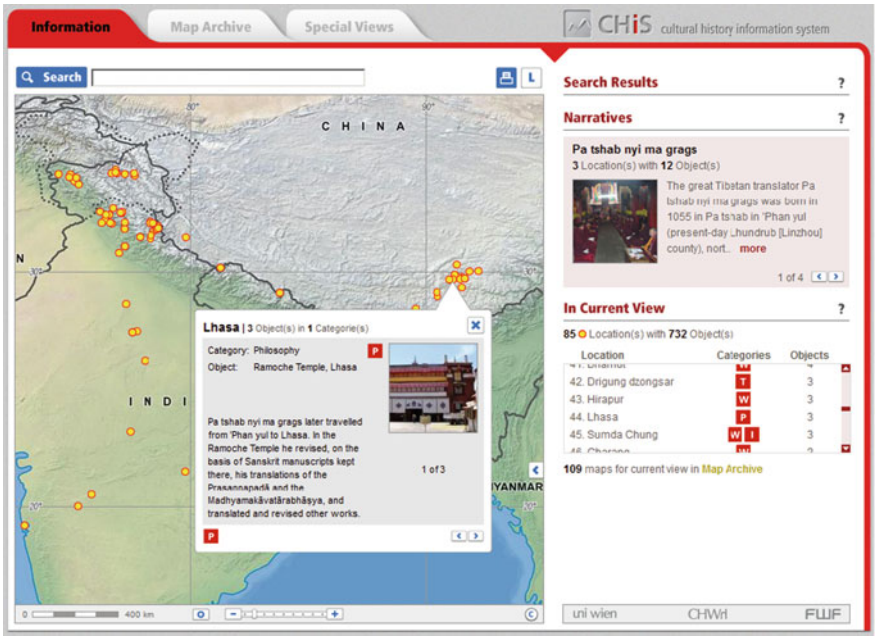

Fig. 9 Cultural history information system (Department of Geography and Regional Research, University of Vienna, 2010) (*Source* http://www.univie.ac.at/chis, accessed 29 November 2011)

Geography and Regional Research, University of Vienna (Fig. 9). This particular product has been designed expressly to support cultural history research.

2.8 Virtual Globes

These relatively young products, also known as geo-browsers, earth-browsers, or hyper globes (Riedl 2000) serve as an interface to spatially referenced data of all kinds. According to Riedl (2000) the advantages of hyper globes compared to traditional globes are manifold. Virtual globes can be produced faster and they are less expensive. They facilitate learning by providing interactive tools and animation for visualising dynamic phenomena (Riedl 2000).

Today, virtual globes enable users to look at thematic datasets from global to local scale-levels. Virtual globes offer the possibility to import and display user data. They feature digital elevation models allowing the user to view satellite images, maps and thematic data not only from above but also through perspective views. Virtual globes are available as stand-alone packages or in-browser applications. Examples for this type of Web-delivered products are *Google Earth* (Google Inc. 2011b) (Fig. 10) and NASA *World Wind* (National Aeronautics and Space Administration, NASA 2011). These products have a high popularity [Google Earth was downloaded over 100 million times in the first 15 months after

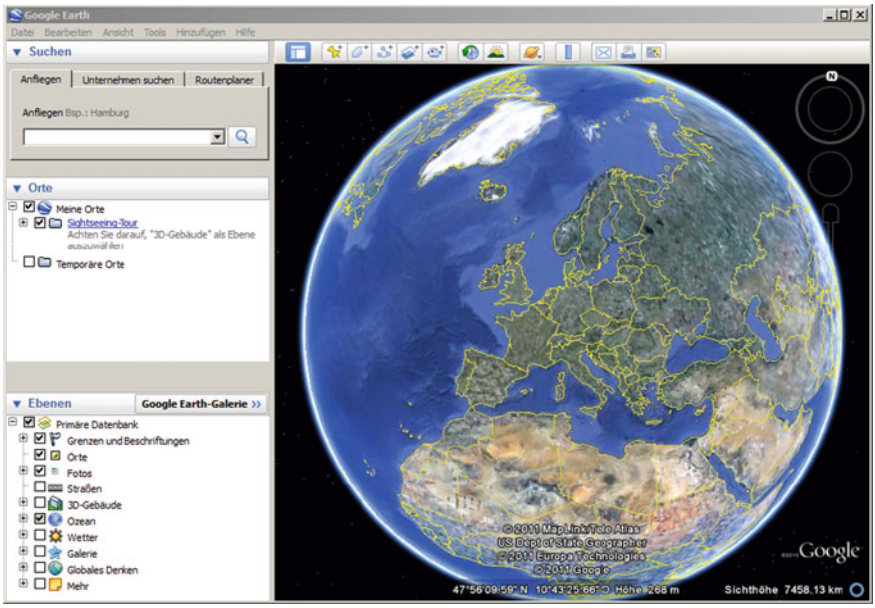

Fig. 10 Virtual globe Google earth (Google Inc. 2011) (Downloadable at http://earth.google.vcom, accessed 25 July 2011)

its release (Schöning et al. 2008)] and therefore, they have the potential to promote the utility of cartographic and geoinformation products to the general public.

2.9 Collaborative Mapping platforms

As an offspring of the Web 2.0 revolution a number of internet platforms have emerged in which mapping is based on the collaborative effort of dedicated communities. This type of Web mapping applications includes platforms with the aim to create general world-wide street-level maps (OpenStreetMap 2011) (Fig. 11), or platforms where specific data is mapped by the community (hiking trails, bike routes, etc.).

2.10 Map Mashups (Via Web 2.0)

A mashup means the synthesis of different applications, interfaces, and data sources on a single platform with the aim to produce added value for the users. This form of application or platform is a typical emergence of Web 2.0. Gartner (2009) distinguishes three general types of map mashups: consumer mashups; data mashups; and business mashups. Consumer mashups combine data from various disconnected resources and make it accessible through a single interface. Data

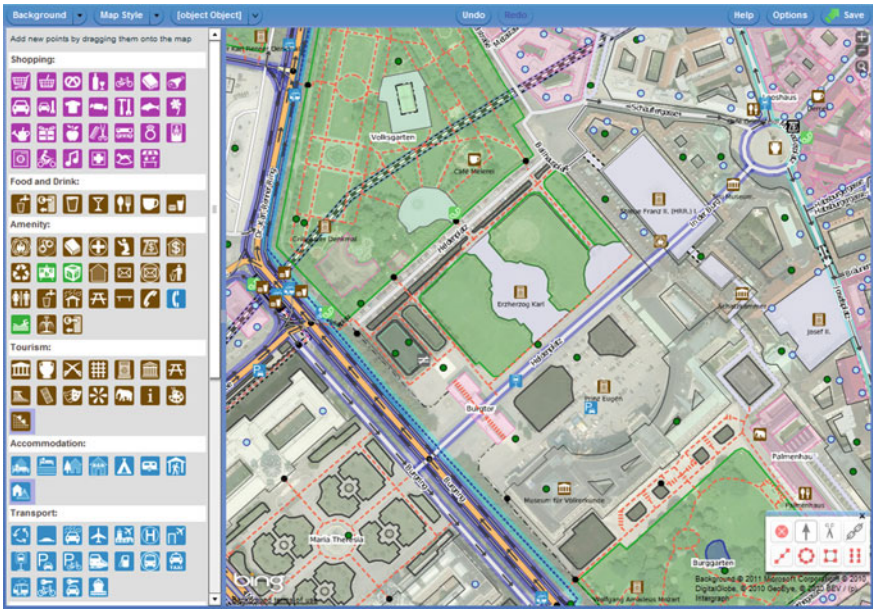

Fig. 11 Open street map (Browser Editor Potlach II) (OpenStreetMap 2011) (*Source* http://www.openstreetmap.org/, accessed 12 August 2011)

mashups collate mixed data of similar types from different resources. Business mashups focus on the aggregation and presentation of data, often adding collaborative functionality and using the outcomes for commercial purposes (Gartner 2009).

An example for a data mashup is the District Taxi Fare Estimator (Washington Post 2008) combining Google Maps street data and routing functionality with data about average taxi prices in the metropolitan area of Washington D.C. (Fig. 12).

2.11 Location Based Services/Map and Navigation Applets

Location based services subsume all information and map services that deliver information based on the current location of the user. Apps are small software packages for usage on smart phones and tablet computers. These apps are utilizing integrated GPS receivers, or get a position via the cells of telecommunication networks. A number of location based services for navigational purposes, outdoor activities or locational information are available that use WIFI and phone connections to access databases on the Web. Car and pedestrian navigation software constitutes the most important group of apps with a spatial component (Steininger et al. 2010). Because of their additional functionality and portability they are

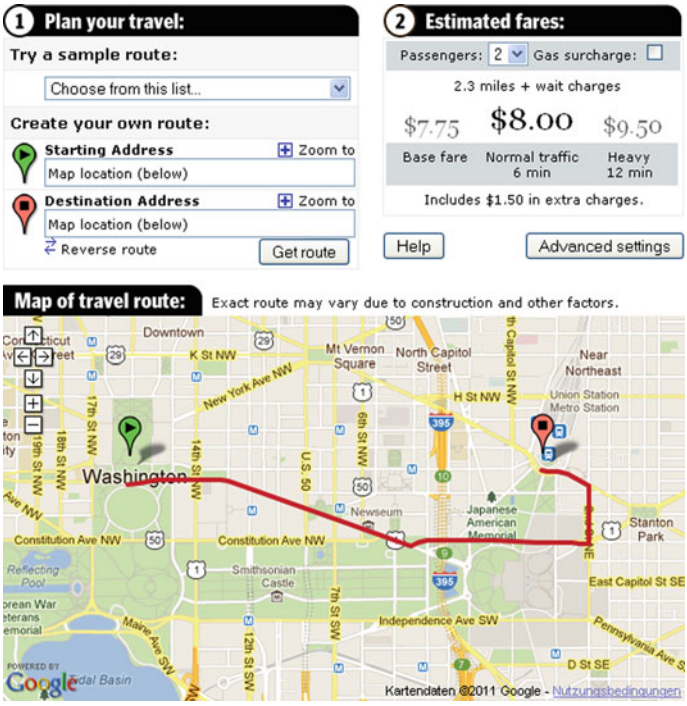

Fig. 12 Washington post district taxi fare estimator. A data mashup combining Google Maps with data about taxi prices (Washington Post 2008) (*Source* http://www.washingtonpost.com/wp-srv/metro/interactives/taxifares/, accessed 18 December 2011)

currently in the process of outrunning classical purpose-built navigation devices (Bitkom—Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V. 2011).

Figure 13 shows a smart phone app based on the Android operating system. The mobile version of Google Maps provides search possibilities for addresses and businesses and routing from A to B with turn-by-turn instructions.

3 Use of Web Maps

MacEachren and Kraak (1997) identified four general map use goals located within the map use cube (Fig. 14):

- Exploration (examination of unknown data);
- Analysis (manipulation of known data in a search for unknown relationships);

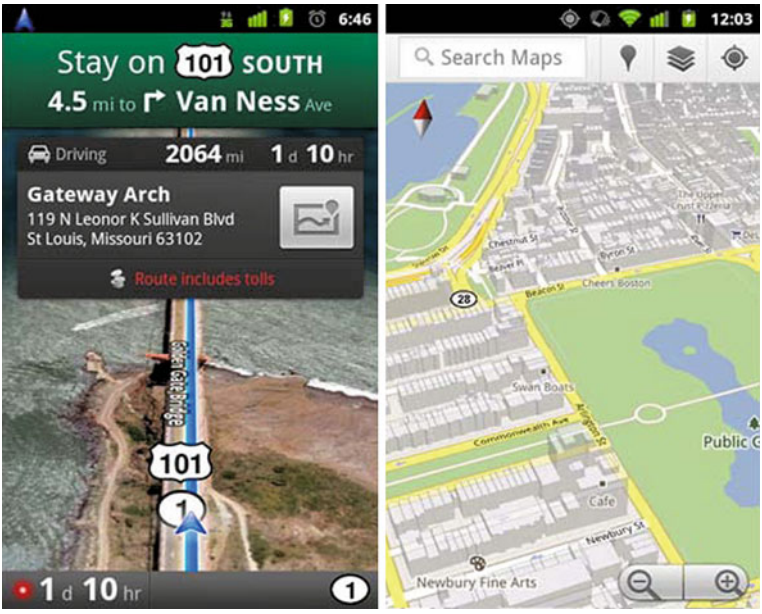

Fig. 13 Google maps app for android smart phones (Best Android 2012 2011) (*Source* http://bestandroid2012.net/2012-app-suggestion-google-maps-with-navigation-places-and-latitude/, accessed 3 December 2011)

- Synthesis (multiple sources of often interdisciplinary data, or a combination of different philosophical perspectives); and
- Presentation (cartographic communication, transfer of spatial knowledge, new insight by the users).

Based on the cube different Web mapping applications can be classified from a user perspective. Due to the characteristics of Web publishing, most of the maps are generated for a wider audience and not for private consumption. Exceptions from this are for example virtual globes, which allow the users to store and visualize private information for personal usage, or online map generation services which enable the users to generate and download personalized maps. The share of highly interactive Web maps has seen a large increase over the years. Today, the majority of Web maps does feature a medium to high degree of interaction, except those from the category 'map and image collections' which mainly includes static digitised maps and images. Generally, the focus of most Web maps is put on the goal of presenting information (e.g. information services with maps) and exploring (e.g. Virtual Globes), but there are also a number of applications on the Web which facilitate data analysis (e.g. Web GIS) and synthesis (e.g. Mashups).

Figure 15 illustrates the attempt of allocating the position of selected Web mapping applications in the map use cube. Information services with maps

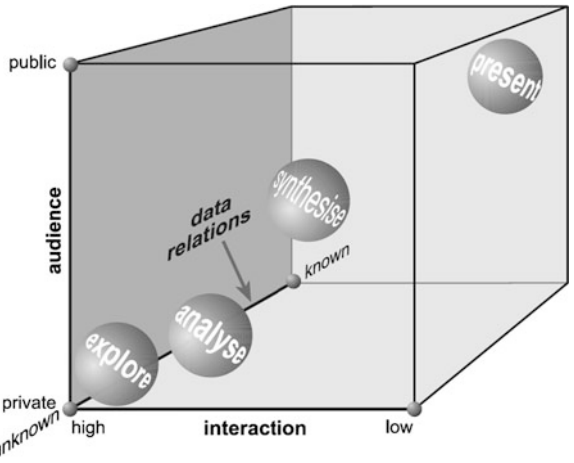

Fig. 14 Map use cube with allocation of 4 general map use goals: explore, analyse, synthesise, and present (MacEachren and Kraak 1997) in (van Elzakker 2004, p. 12)

(*Mapquest*, *Bing*, *Open Street Map*, *GoogleMaps*) are highly interactive. These maps are publicly available and they are mostly used as a reference for searching locations, getting driving directions/distances, etc. Moreover they are sometimes used for exploring unknown areas (e.g. tourism destinations). Virtual globes like *Google Earth* or *NASA Worldwind* are highly interactive as well. They can be used for analysis, synthesis, for communication to the public, or for private visualisations of data. Map mashups are also highly interactive. Through a combination of different data sources they facilitate synthesis and can reveal unknown facts. Map collections, as collections of static maps, usually feature a low degree of interactivity. For the most part they are publicly accessible and used for communication purposes. Sometimes collections of historic maps are used for research purposes and thus for revealing unknowns. Online map generation services are usually highly interactive tools that allow the users to create private personalised maps for analysing and presenting known data.

4 Transition from Static Web Maps to Interactive Collaborative Web Mapping

Many advantages come along with the Web as a publishing platform (Skarlatidou 2010):

- By eliminating the processes of printing and distribution, maps can be produced faster and cheaper and users from all around the globe can access them instantaneously;
- Web developers can make use of Application Programming Interfaces (APIs) for combining distributed data sources;
- Several open source tools are available, that offer an economic way of producing maps, even with limited expertise;

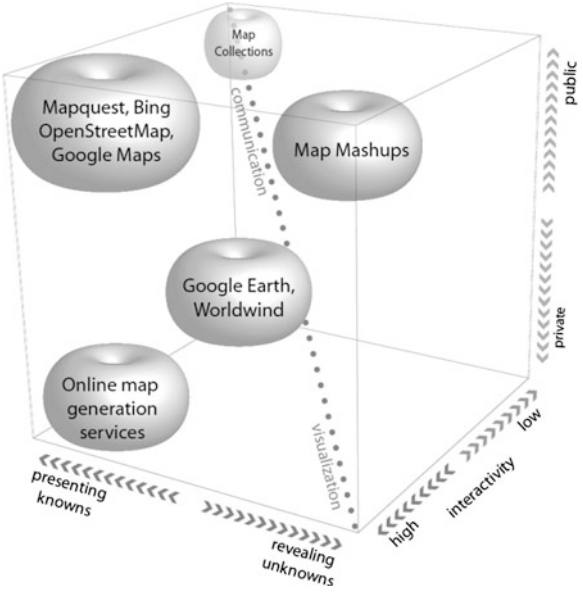

Fig. 15 Allocation of selected Web mapping applications in the map use cube (adapted from MacEachren 1994, p. 6)

- Interactive systems offer many possibilities for personalization and adaptation to user needs and context; and
- Multimedia (text, video, audio, 3D visualizations and hyperlinks) can be used to enrich the maps with a variety of additional information.

The growth of the Internet and especially the popularity of the Web have made maps and related forms of geographic information delivery commodities that are taken for granted and utilized by many users. The diversity of mapping applications which arose on the Web and their potential for cartographic information exchange are demonstrated by vast numbers of users and diverse usage scenarios. Skarlatidou (2010, p. 248) argues that "the Web created new opportunities and changed the way people build, view, use and access maps."

Information services with maps are used by many for everyday tasks like searching for locations or retrieving driving directions. Web maps and virtual globes allow their users to travel to places virtually. The increasing availability of high-resolution satellite imagery, aerial photographs and street-view images offers realistic and immersive perspectives without being at the location. New generations of mobile phones with built-in GPS receivers and constant internet connections are used for personal navigation and other location-based services. Collaborative open source projects like *OpenStreetMap* (OpenStreetMap 2011) spearhead a new way of distributed data collection, often driven by the efforts of people who—to a large part—did not have much prior exposure to cartography. The number of users of cartographic products and geo referenced data has seen a large increase through the Web and mobile technologies.

It can be argued that through all the above mentioned developments, maps have become ubiquitous on the Web. They are often produced in real-time and consumed within seconds. Because of the limitations of screens, lacking expertise of the map producers and/or economic reasons, Web maps often have a lower quality than printed ones [cp. (Gartner 1998; Black and Cartwright 2005)]. Users of Web maps are not always interested in quality or accuracy, they are satisfied when the maps are functional and usable (Kraak 1998).

5 Conclusion

As noted at the beginning of this chapter, paper maps have now augmented with a plethora of digital counterparts. These digital products are delivered on-line, on-demand and, increasingly, at location, when mobile devices are employed. This has changed altogether how researchers think about acing research support tools. This now means that, in many cases, Web delivered cartographic products are the first choice, or first point of access for cartographic information.

This chapter presented an overview of Web mapping applications with various examples of Web maps provided. It provided a synopsis of the types of Web-delivered cartographic products that can be accessed to support research in cultural history. When using cartographic artefacts to assist in understanding different geographies Web delivered resources provide timely, usable tools.

Acknowledgments The doctoral research underlying this chapter is part of an interdisciplinary project called "The Cultural History of the Western Himalaya from the 8th Century" (NFN-S98, project leader: Dr. Deborah Klimburg-Salter), which has been underway since 2007 at the University of Vienna, Austria. This Austrian National Research Network (NRN) project, supported by the Austrian Science Fund, includes cartographers, art historians, numismatists, Buddhist philosophers, and Tibetan and Sanskrit philologists. The main objectives of the NRN are to intensify research on the cultural history of the Western Himalayas as well as to develop a map-based Cultural History Information System (CHIS) for sharing the outcomes with other experts and the interested public.

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Virtual Tabo: Geocommunication for the Preservation of Cultural Heritage with the Help of Multimedia Technology

Gilbert Kotzbek

Abstract In the context of an interdisciplinary research project at the University of Vienna a multimedia application was developed. It offers scientists an interactive tool to access a Buddhist temple complex in the North-West of India (Himachal Pradesh). The developed 3D-model is the key component of this application as it contributes a spatial representation that is superior to a 2D one. In addition, the QTVR-panoramas can also be used. They build connections to the archives in order to provide detailed information about the temples. The following chapter describes the concept and implementation process of this project. Along with the description of the basic data used, the workflow and the media used, the single application elements and problem areas are illustrated. Finally, suggestions for possible development and improvement of the application are provided.

Keywords Tabo (Himachal Pradesh India) · 3D-modelling · Multimedia · QTVR-panoramas · Cinema 4D · Shockwave 3D · Google Earth

1 Introduction

The 'Cultural History Information System' (CHIS: http://www.univie.ac.at/chis) is one of seven subprojects of the Austrian National Research Network (NFN), 'The Cultural History of the Western Himalaya from the 8th Century'. It is an interdisciplinary project, that included scholars from art history, numismatics, Buddhist philosophy, Tibetan and Sanskrit philology and cartography.

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Lecture Notes in Geoinformation and Cartography,
DOI: 10.1007/978-3-642-29770-0_14,

In this interdisciplinary research environment CHIS contributes to a map-based on-line information system for visualizing, archiving and analyzing the cultural history of the Western Himalaya. One section of the system embraces so-called 'Special Views'. It includes special object perspectives, for example, temple complexes that are of special significance for the Research Network. At the moment there are two temple complexes available as 'Special Views'. One of them is 'Nako 3D', which is a 3D-model that can be observed as a kmz-file on *GOOGLE EARTH*. The other project is 'Tabo 360', an application, which provides two QTVR (QuickTime Virtual Reality) panoramas. It is planned that this project will be replaced by 'Virtual Tabo' (Nausner 2009).

The Buddhist monastery in Tabo (Himachal Pradesh, India) is of special interest for researchers, as it appears to be the oldest Buddhist monument in India. Since its foundation in the year 996, the Gelugpa School of Tibetan Buddhism has continually been practiced there. Furthermore, the monument is famous for its unique decoration, its great beauty and iconography. Moreover, it played the key role in the transmission process of the Indo-Tibetan Buddhism and culture in the 10–11th century (Klimburg-Salter 2005).

2 Virtual Tabo

The main goal of 'Virtual Tabo' is to give a comprehensive insight into the temple complex of Tabo and to illustrate the spatial structure of the building. Moreover, additional information about the depicted objects can be provided. Researchers are provided with a central interface between the spatial components and the 'Western Himalaya Archive Vienna' (WHAV: http://whav.aussereurop.univie.ac.at/). As well, it is important for the project partners that the spatial imprint is delivered in the most appropriate manner. The development of the 3D-model is paramount to the provision of a comprehensive tool.

'Virtual Tabo' is an interactive application, and, in the sense of geocommunication, it interconnects various elements like graphics, exhibits, audio, animation and text, all provided via an interactive platform. In order to guarantee the highest level of user-friendliness it is essential to invest in platform independence. The original plan was to transferred the application into the html5 standard. Unfortunately, this markup language is still under development, so the file formats needed are not yet supported. For that reason the reliable tools of the Authoring-Software *DIRECTOR* 11.5 (http://www.adobe.com/products/director/) from Adobe were used for the development of 'Virtual Tabo'. This enabled the import of a large number of different data formats. The use of the programming language *LINGO* enabled unlimited creativity, interactivity and flexibility to be added. In order to utilize the application the users need to install the *SHOCKWAVE* (http://get.adobe.com/shockwave/) browser plug-in.

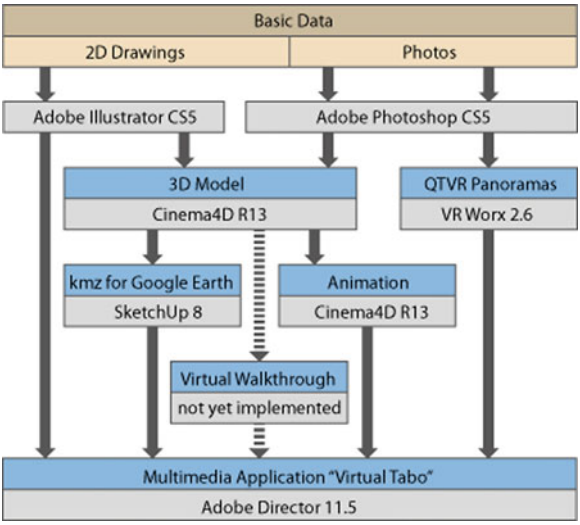

Fig. 1 Flow chart of the implementation of 'Virtual Tabo'

3 Implementation

This section describes the implementation and realization process of 'Virtual Tabo' from the collection of the original data, to the 3D-modelling and the preparation of QTVR-panoramas, to the production of the actual multimedia application. The flow chart (Fig. 1) below demonstrates schematically the main production.

3.1 Basic Data of the 3D-Model and Their Collection

As the quality of the end product is directly connected to the quality of the original data, data collection is of the highest importance. While, there exists detailed architectural plans of the whole temple complex and the single temples, photographs were in fact used as basic data for 'Virtual Tabo'.

The architectural plans were developed as part of the project 'Buddhist Architecture in the Western Himalaya'. They are available as free PDF-files via its Internet portal (http://www.archresearch.tugraz.at). The single PDF-files were imported into the vector-graphic program Adobe *ILLUSTRATOR CS*5 and adjusted for further import into *CINEMA* 4*D*. Due to the need for partially high level detail, generalization had to be implemented. In order to guarantee efficient processing in *CINEMA* 4*D*, it was, additionally, necessary to connect single splines (e.g. roofs, separating walls, etc.) to entire objects. Although it is possible to do this in *CINEMA* 4*D*, it needs a lot of effort. With the help of additional structuring measures, like the foundation of different layers, the ordering of data and subsequent visualization can be completed. Consequently, this can simplify and thus accelerate the further development process (Fig. 2).

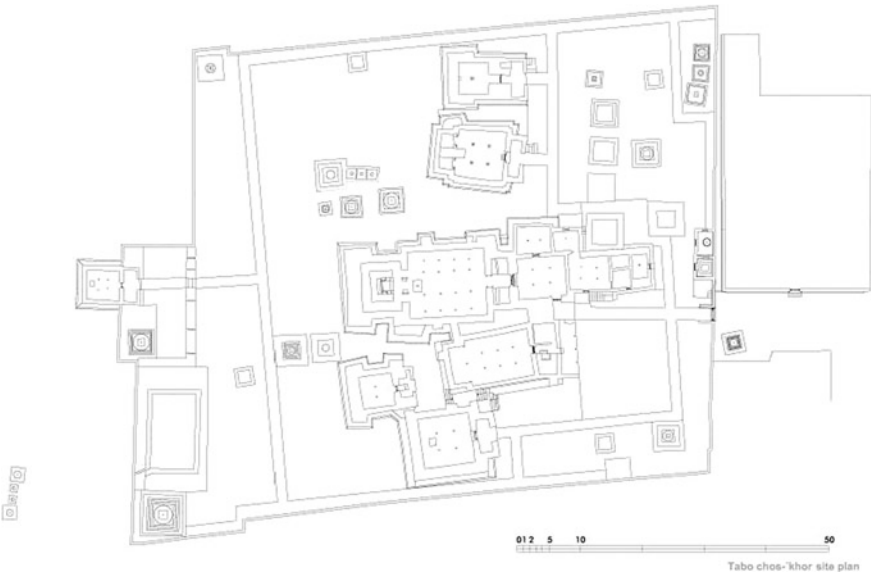

Fig. 2 Architectual plan of the entire temple complex of Tabo *Source* http://www.archresearch.tugraz.at/results/Tabo/tabo3.html Accessed: May 2012

3.2 3D-Modelling of the Temple Complex

After the preparation of the architectural plans, it was possible to import them into the 3D-graphic software *CINEMA 4D* from Maxon. This software is mainly focused on the creation of animations, but it can also be used efficiently for the design of 3D-models. Owing to the numerous modeling tools used, a draft model was created in around two weeks. For that purpose each single temple was designed independently and at separately files. Following thus, the single models were placed in the modeled temple complex in the correct situation. During the creation of the model the available photographs were of great use and they were also used in the design of textures. With the help of Adobe *PHOTOSHOP CS5* single textures for walls, floors, window frames, etc. were designed, where the tiles were retrieved from the available pictures. For the homogeneous creation of the textures, adjustment of tile edges was essential. The finished 3D-model contains about 4,200 objects that consist of about 156,000 polygons. It can be used for develop further features of 'Virtual Tabo' (Fig. 3).

3.3 Animation

In order to provide a first impression of the monastery at the start of the application, an animation introduction was created in *CINEMA 4D*. In addition, it was necessary to design invisible camera splines, along which the camera captures

Fig. 3 3D-Model of Tabo in Cinema 4D

the scene. With the help of so called 'targets' different temples can be observed in more detail during the camera flight around the monastery.

3.4 Implementation of 'Virtual Tabo' in Google Earth

As the entire temple complex was designed, the decision was made to create 'Virtual Tabo' as a kmz-file. This allows the user to observe the model in *GOOGLE EARTH*. This also has the advantage that an entire 3D-environment is available. However, the drawback is that the model has to be simplified. For the creation of the kmz-file that contains the 3D-model, it is essential to transform all objects into meshes, where linear splines are automatically created from Bezier-splines. Consequently, non-linear objects can seem angular, which mainly depends on the number of single polygons generated. Besides, the additional texture features (e.g. reflection, bump maps, etc.) cannot be preserved. The placement of the 3D-model, as well as the creation of the kmz-file, was processed with *SKETCHUP*8.0. For this process it was first necessary, to export the 3D-model as a 3ds-file, because the *SKETCHUP* program does not support the c4d-format (Fig. 4).

3.5 Preparation of QTVR-Panoramas

During the visit of some project workers to Tabo in 2007 some photographs of the temple complex were taken that were suitable for the design of the QTVR (QuickTime Virtual Reality) panoramas. These panoramas allow for the use of

Fig. 4 Simplified 3D-model of Tabo in sketchup

constant zoom levels and individual navigation within the panorama. In total, with the use of the available photo material, 29 single panoramas of different views (from 90 to 360°) were created with *VRWORX*2.6. Before that, single images of each panorama were merged (panorama-stiching) with the help of Adobe *PHOTOSHOP CS*5. Finally, they were cropped and partially graphically processed, so that the transition from one panorama edge to the other appears seamless.

Fifteen panoramas are located in the area outside of the monastery and are suitable for 'panorama-jumping' through the entire temple complex. The remaining panoramas, mostly 360°, are located at the centroid of each different temple. All panoramas are provided with so called 'hot spots'. There are two types of 'hot spots' inside of the application. The first type is 'navigable objects', where it is possible to find the other panorama locations. The second type is where the panoramas are provided with hyperlinks to the WHAV online files that deliver further information about the chosen object (e.g. a statue) to the user.

3.6 The Application 'Virtual Tabo'

'Virtual Tabo' was created with the use of the Authoring-Software Adobe *DIRECTOR* 11.5 and can be seen as a 'Special View' via the CHIS. The interactive application starts with the designed animation introduction. An overview plan of the temple complex can be found on the main page, including interactive panorama locations. Additionally there are more interaction possibilities.

The user can choose one temple from a list. Subsequently the temple chosen will be graphically highlighted on the map. The choice needs to be confirmed with a mouse click. After that the detailed view of the temple chosen will be presented

Fig. 5 Aperture of 'Virtual Tabo'

at the left side of the screen. The associated QTVR-panorama is placed at the right side of the screen. Moreover, a 'view cone' can be also found on the map under the chosen panorama location. The cone rotates synchronically on its axis, providing navigation through the panorama. Where more panoramas for the temple chosen exist, there is a possibility to 'jump' through them or around the map where they are also listed. A hot spot-list is offered for each panorama chosen to facilitate inquiry.

The user also has the opportunity to directly choose a panorama via the map on the main page. In the case of an outside-panorama, an identical view will be opened. This has the same functionality and interactivity as the temple inner views. The only difference here is that a miniature plan of the temple complex is represented. The user also has the opportunity to jump from the view of one panorama to another and to explore the temple complex with the help of visual material provided. In addition, all temples are linked to the WHAV.

The kmz-file is also accessible through the main page of 'Virtual Tabo' (http://www.univie.ac.at/project/chis/specialViews/virtual_tabo/) and can be downloaded. In the Impressum section, which can also be found on the main page, further links and information are provided (Fig. 5).

4 Conclusion

The main aim in the development of the 'Virtual Tabo' application was to integrate the 3D-model into the general geocommunications package on a larger scale. This helps to deliver a much better overview of the entire temple complex,

including its spatial structure. It helps to simplify the perception of the space and to communicate the available information. In the future, the 3D-model plays a key role as an interactive 3D-world for the overall application. The user has to be able to freely move around this virtual 3D-world. Currently, various 3D-engines are being examined for their suitability. The first interactive walkthrough will be developed in the near future. Judging from experience, the technical implementation of a simple walkthrough seems to be manageable and applicable. However, the implementation of the QVTR-panoramas, as well as, of the further hot spots, appears to be more complicated.

The first feedback from project participants was positive. With the help of 'Virtual Tabo' a simple operating application was designed and produced. This provided a package that, with the combination of multimedia technologies, can preserve the cultural heritage of the Tabo temple complex as a virtual world and can assist researches in their virtual exploration of the temple.

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Part V
History and Geospace

Geographic Projections of a 16th Century Trade Network: New Meanings for Historical Research

Sara Pinto

Abstract Since the 1970s, Fernand Braudel has urged for the integration of space in historical analysis, pointing towards to what we call nowadays a "Geographically-Integrated History". For this historian, the creation of a map as an analytical support was necessary to comprehend man′s evolution, in the belief that change happens in a space-temporal frame. Our work is being developed within the research project DynCoopNet ("Dynamic Complexity of Cooperation-Based Self-Organizing Commercial Networks in the First Global Age") which goal is to reveal the mechanisms of cooperation among merchants that tied together the self-organizing commercial networks of the First Global Age ((1400–1800) www.dyncoopnet.eu). Focusing on the notion of *dynamic*, that implies an integration of space and time, our aim is to develop a spatial analysis, highlighting the role of space on network building. This paper intends to present an approach that demonstrates the benefits of carrying on spatio-temporal analysis of historical data sources.

Keywords Historical GIS · Spatio-temporal visualization · Trade networks · First Global Age

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1 Introduction

The research project DynCoopNet ("Dynamic Complexity of Cooperation-Based Self-Organizing Commercial Networks in the First Global Age") aims to reveal the mechanisms of cooperation among merchants that tied together the self-organizing commercial networks of the First Global Age (1400–1800).[1]

Nevertheless, "networks happen not only in socially, economically and historically defined spheres, but also in geographically determined areas" (Beerbühl and Vögele 2004). In order to achieve its goal—to study the dynamic complexity of commercial networks, the team had to integrate space in its analysis. In fact, "some disciplines, such as geography and landscape ecology, emphasize the spatial dimension of world knowledge, and other disciplines, such as history and climatology, take timecentric approaches to organize evidences of reality. However, it is the space–time integration that provides the explanatory power to understand and predict reality. Dynamics is by definition an integration of space and time". (Yuan 2008) Focusing on this notion of *dynamic*, our aim is to develop a spatial analysis, highlighting the role of space on network building.

Being defined as the time of the "world economies" (Braudel 1979) or of the "world systems" (Wallerstein 1990), or even as the First Global Age, the 16th Century is consensually seen as a period of growing interconnectivity between several world spaces, either in a geographical, social, or even in a cultural and mental way. It becomes crucial, thus, to understand how merchants, self-organized in cooperation networks, moved in space, apparently ignoring political boundaries. Doing so, they were, somehow, creators of their own geography.

Since the 1970s, Fernand Braudel has urged for the integration of space in historical analysis, pointing towards to what we call nowadays a "Geographically-Integrated History". For this historian, the creation of a map as an analytical support was necessary to comprehend man's evolution, in the belief that change happens in a space-temporal frame (Braudel 1979). Since then, historians have become more aware of this dichotomy as a crucial paradigm in the historical analysis, and of the need to understand the dynamics between men and space and how they interconnect (Owens 2007). However, so far, approaches centred on spatio-temporal analysis of social networks are rare. Historians still need to further understand how the space plays an important role in understanding human relationships, within social networks.

Moreover, new perspectives have emerged in historical sciences thanks to the massive databases that have become available. Nowadays social sciences are familiar with statistics and graphics. Databases are being built by Historians in order to gather a large number of data sources and therefore allowing this information to be analysed with new computational tools. In fact, the trend within

[1] www.dyncoopnet.eu

the humanities and social sciences towards digital visualization tools reflects the fact that nearly all historical data have some spatial component associated to them (Torget and Wilson 2009). Most of these tools, especially Geographic Information Systems (GIS) have been developed for digitization and georeferencing of historical maps, reconstruction of past boundaries and georeferencing of historical microdata (such as census or parish records) (Gregory and Ell 2007; Knowles 2002; Knowles 2008). In its essence, GIS is a database with an extra spatial component. It allows the historian "to structure, integrate, manipulate, analyze and display data, in ways that are either completely new or are made significantly easier. Using these tools and techniques allows historians to re-examine radically the way that space is used in the discipline" (Gregory and Ell 2007).

However, as a database, GIS requires clear, regular and stratified data, while historians are more familiar with incomplete, ambiguous and missing data which are very difficult to represent properly in digital visualizations. Moreover, GIS does not explicitly handle time and its evolution. Currently there has been some development in this field[2], but displaying data that changes over time is still a problem. Some demanding extra work is required: historical data must be adapted in order to be compatible with the GIS software. The historian must both respect the complexity of the historical source and, at the same time, make it accessible to be processed by visualization tools.

2 Mapping Historical Data

Our study is focused on a 16th Century trade network centered on the figure of Simón Ruiz. He was an important Iberian merchant, whose business expression went beyond Iberian frontiers, reaching European and overseas trade circuits. This can be proved by the extension that his correspondence achieved all over Europe, as well as by the complex network of agents that was established. His settlement, in Medina del Campo, made him succeed through an intensive participation in business, acting as a representative of other commercial partnerships. He seemed to initiate the establishment of his network by placing individuals of trust in key points, as well as engaging a network of informants in important trade places. He also began to act as a banker, exchanging foreign currency through the use of bills of exchange. One can find in his archive over 21.000 bills of exchange, and 56.721 commercial letters reporting to a period between 1553 and 1606, in the Provincial Archive of Valladolid.

[2] The new ArcGIS v.10 allows visualizing temporal data using the new feature *Time Slider*.

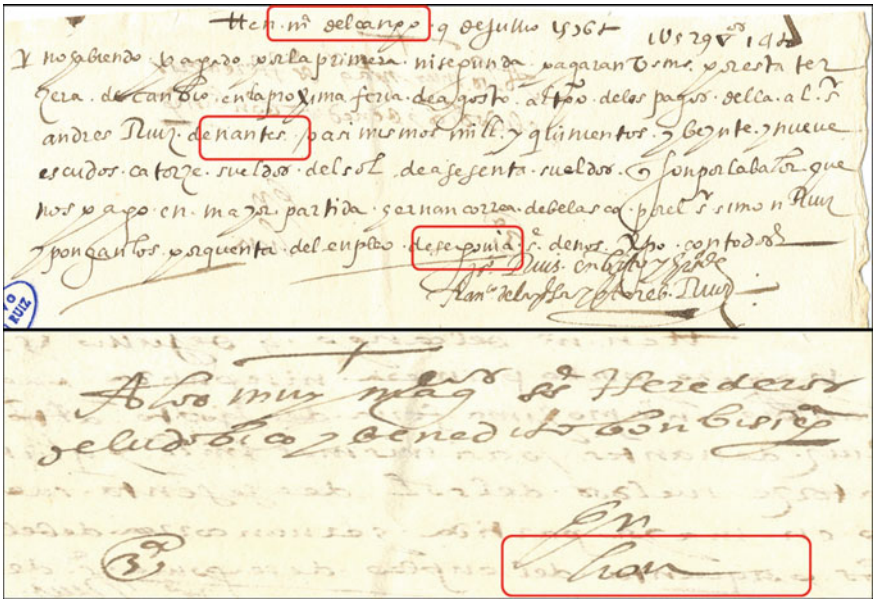

Fig. 1 Bill of exchange of July 9th 1576 (Simón Ruiz Archive)

2.1 Data Source: Bills of Exchange and Commercial Correspondence

Bills of exchange appeared as a mercantile credit tool used in order to solve the risks and difficulties of cash transportation. In the 15th and 16th Centuries, bills of exchange turned into a tool/way of payment, and, frequently, a way of loan as well. The use of bills of exchange in trading became very common, allowing the acceptance of exchanges, payments and liquidations between distant cities. As a long-distance financial tool, bills of exchange are a privileged source for spatial references. We can access several types of locations, such as payment's place or origin, the location of the agents involved and other places connected to them. It allows us to follow the money circulation in the most important European fairs.

Figure 1 shows a bill of exchange where we can find four spatial references:

- Place of origin: Medina del Campo (Spain)
- Place of destination: Lyon (France)
- Location of the agents: Nantes (France)
- Places connected to the agents: Segovia (Spain)

Commercial correspondence is another valuable data source (see Fig. 2). From the 57,000 letters sent and received by Simon Ruiz' firm, we have selected the correspondence exchanged with the Portuguese agents settled in Lisbon. These letters are more detailed information on goods flows, trade routes, prices and other

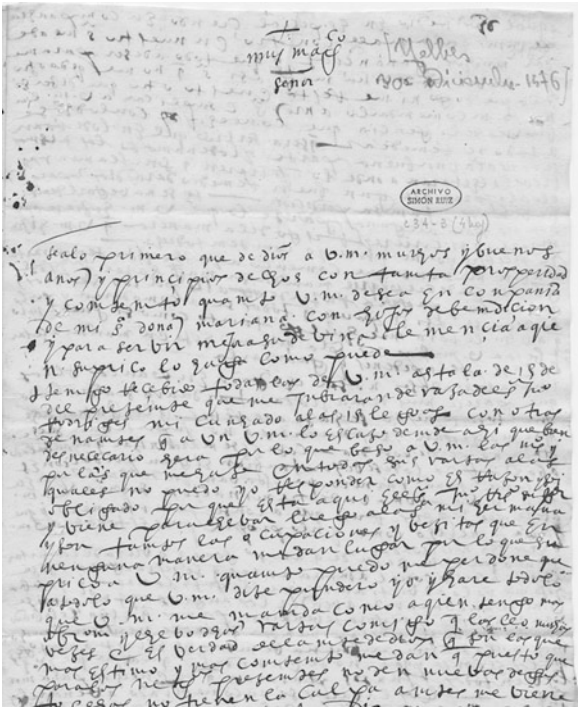

Fig. 2 Letter of December 30th 1576 from Hernando de Morales to Simón Ruiz (Simón Ruiz Archive)

qualitative information. Commercial correspondence testifies to the firm's spatial expansion and agent dissemination across the most important places of trade activity.

2.2 Database:TimeLink

Using *JEdit* (text editing software), we have collected the information as close as possible to the textual form of the document. After that, the information gathered have been translated and imported to a common database using the *TimeLink* software.[3] Developed at the University of Coimbra, Portugal, by Joaquim Carvalho and his team, this tool is based on a micro-historical research approach, with a strong emphasis on network analysis and prosopography (see Fig. 3).

This system is simple and easy-to-use and has allowed us to browse through complex networks of relations, collecting and processing biographical information scattered in different sources, using structured texts instead of pre-defined forms. However, *TimeLink* is an agent-based model focusing on people, i.e. agent identification. In order to carry out a spatial analysis we have developed a

[3] See http://timelink.fl.uc.pt

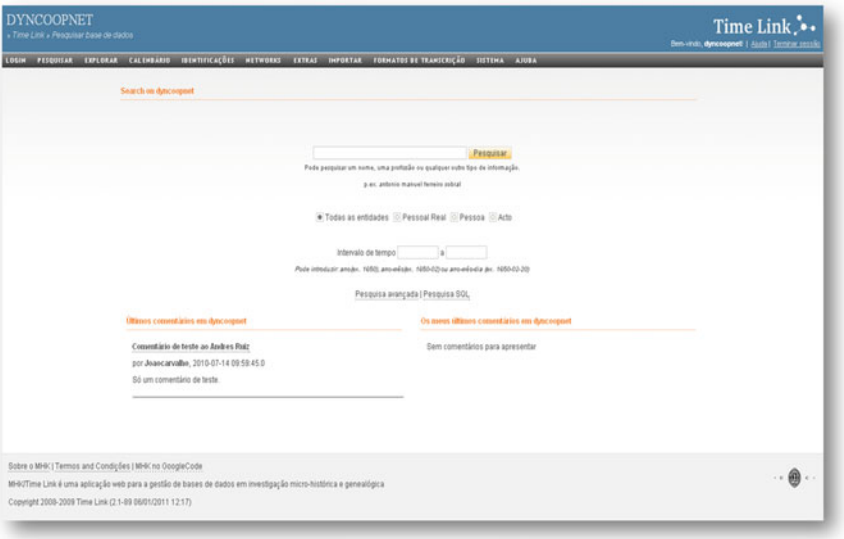

Fig. 3 Timelink: a micro-historical research support (*Source* timelink.fl.uc.pt/mhk)

catalogue for providing a spatial location, dealing with space as if it was a human individual. Human agents and historical activities are associated with a place, conferring upon it their own attributes. A spatial reference becomes a well-defined entity, by using its functions, attributes, as well as relations established with other places. Georeferencing becomes the way to indicating spatial identities. All locations registered in the database become thus geoentities which, at the end, will become real geoentities. This means that, for example, all occurrences for the location "Paris" are gathered, and, at the end of the process, are put within a single real geoentity: Paris. Then, by using Google Maps,[4] in an automatic process we geo-reference it, by simply attributing coordinates to the location, (see Fig. 4).

Frequently, this "geotag" needs to be checked and corrected during the process. In fact, we have to deal with some geotagging problems, especially in what concerns to scale. In our documentation, references to locations range from street names, like Calle de Placentines in Seville (a merchants specific location), to continents, like Africa.

References to regions, like Berberia (the north of Africa) and countries, are also very frequent. A possible way to solve this is to enable *Timelink* to deal with polygons. The "Geometry" feature allows us to geotag broaden areas, as polygons, in parallel with the geotagging of points, which represent cities.

According to this approach, the database presents geographical references related to individuals, developing, however, as an outcome, an approach which

[4] See www.maps.google.pt

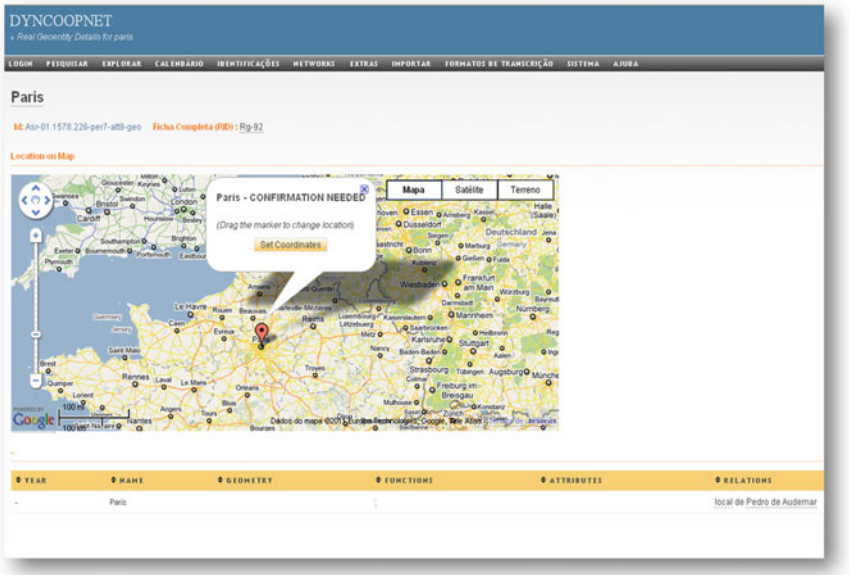

Fig. 4 Real geoentity

allow to provide, to each place, its own "biography". This means that we can see the attributes of a given place (geographical, geomorphological, economic, demographic, political, etc.); how frequently it is mentioned in the documentation; which agents are located there; which functions they performed, together with the connections a particular place established with others.

For example, the city of Lisbon, in 1576, is registered in the database (see Fig. 5) as a financial centre (e.g., receiving and sending money in the form of bills of exchange); as a commercial centre (e.g., selling and buying all kind of goods); as a seaport (e.g., ships with spices arriving and ships with salt departing); and even as a maritime insurance centre. These features attribute a certain value to a specific location. We can recognize Lisbon as an important centre which, in the 16th century, assumed several economic functions besides being a political centre, as the capital of Portugal and of the Portuguese overseas empire.

In what concerns to relations between places, these are established when we have, for example, the origin and destination of a certain good. We can also add to that relation some additional information, like other locations that are referred as stopovers. Moreover, in certain periods, the documentation refers cases of travel risks, like piracy, and the advice of an alternative itinerary. This feature is very useful in what concerns to map and visualize mercantile routes.

Finally, all this information can be filtered and extracted using a SQL search and can be directly exported to GIS software in order to be explored and analyzed.

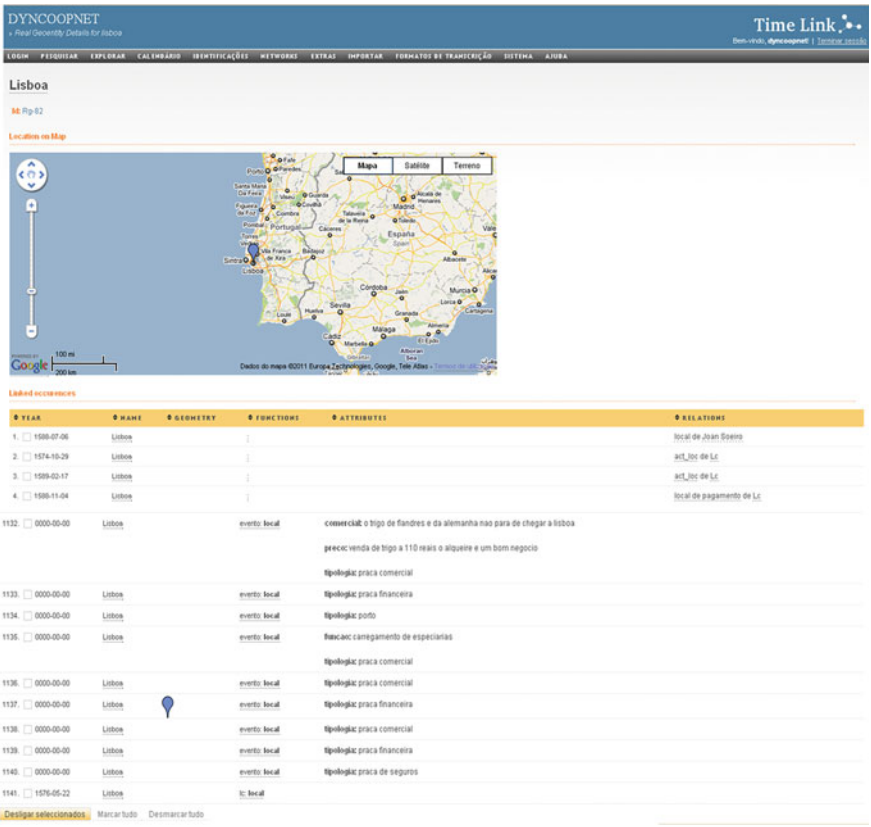

Fig. 5 Lisbon "Biography" in the database

3 Trade Networks' Spatial Framework

As stated above, we are working with two types of data source: bills of exchange and commercial letters, each one with its own context of production. If bills of exchange represent money flows, and the letters refer to good flows, can we expect distinct spatial frameworks? What are the spatial spheres of the network? This research question guided an experiment in order to test our methodology.

From our database we extracted all geographic references between 1558 and 1575. This period represents the beginning of the firm, when Simon Ruiz was engaging his commercial network and was recruiting correspondents in the most relevant trade centers. Then we map the information given by the bills of exchange and the one given by the correspondence.

The map in Fig. 6 represents the locations given by the bills of exchange. What we can see is the presence of the most important fairs of exchange: Poligny, Besançon, Lyon and Piacenza, where almost all European international transactions

Fig. 6 Simon Ruiz' spatial framework 1558–1575. Bills of exchange distribution

were settled (Marsilio 2009). We also see a denser area of action, centred in Medina del Campo, where the firm was settled. This area also includes Madrid, the capital. If we add the location of the main correspondents of the firm: Nantes, Antwerp, Seville and Lisbon, we observe the full financial network.

In the map of Fig. 7 we add the frequency of the references.

We wanted to deeply understand the money circulation. After Medina del Campo, the most mentioned location is Lyon, the French financial capital, where the most important merchant families, like the Bonvisi, were settled. Lyon is followed by Antwerp and Seville, where Simon Ruiz agents sent the money, according to the flows of exchange rates.

In order to confront this picture with other, eventually different, provided by the commercial correspondence, we present a new map on Fig. 8.

To map the locations given by the commercial letters, we had to zoom out in order to include the East. Goa, Kochi and Melaka represent the commercial connections of the firm overseas. But in Europe we also observe a change in the map. The fairs were replaced by the main seaports, like Dunkerque, Morbhian, La Rochelle, Bordeaux, Venetia, Porto and Setúbal. They represent the good's circuits and the buying and selling points of the firm. Besides maritime routes, we can also include a framework which represent the inland connections, like Mérida, Badajoz and Zafra.

As we have selected only the letters exchanged with Lisbon, what we are observing here are the connections with Portuguese agents. So, when we analyze the frequency of the references (see Fig. 9) we are appealed to Lisbon, Seville and Nantes. Contextualizing the production of the data sources becomes thus essential in order to analyze the outputs.

One of the most important mercantile features of the network, in this period, was the exportation of salt from Lisbon to Nantes. Portuguese agents were in charge of the collection of the Portuguese salt, especially from Setubal, and the shipment to the north of France. Remarkably, the strong presence of Seville is not

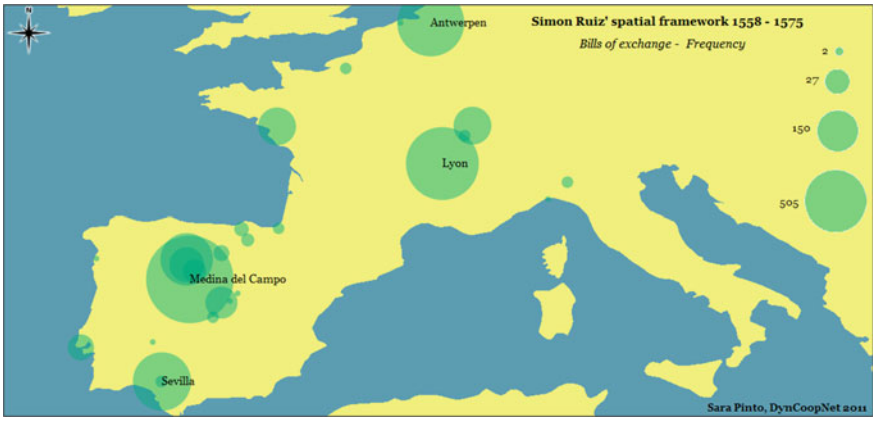

Fig. 7 Simon Ruiz' spatial framework 1558–1575. Bills of exchange frequency

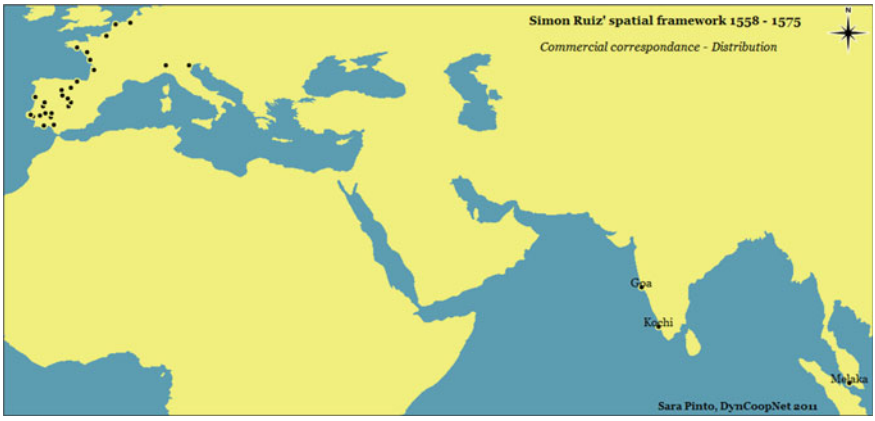

Fig. 8 Simon Ruiz' spatial framework 1558–1575. Commercial correspondence distribution

explained by a commercial reason but by a financial one. In this period, Seville was a main financial centre to where the network sent the money. Simon Ruiz was advised by his agents to send the bills of exchange to Lisbon or Seville according to the exchange rates.

These maps show that the network presents distinct geographies according to the data sources: financial and mercantile. However, to a certain point, they are complementary. There are certain locations that appeared in all the maps, like Seville, Lisbon, Antwerp, or Nantes. These places represent the big nodes of the network, where the agents more closely related to Simon Ruiz are located (sometimes they are even family members) (Pinto 2011). These centers act like branch offices that represent the network interests, locally. They deal with both money and goods. In fact, they create the connections with the more specified locations: the fairs, for the financial activity, or the seaports, to the mercantile

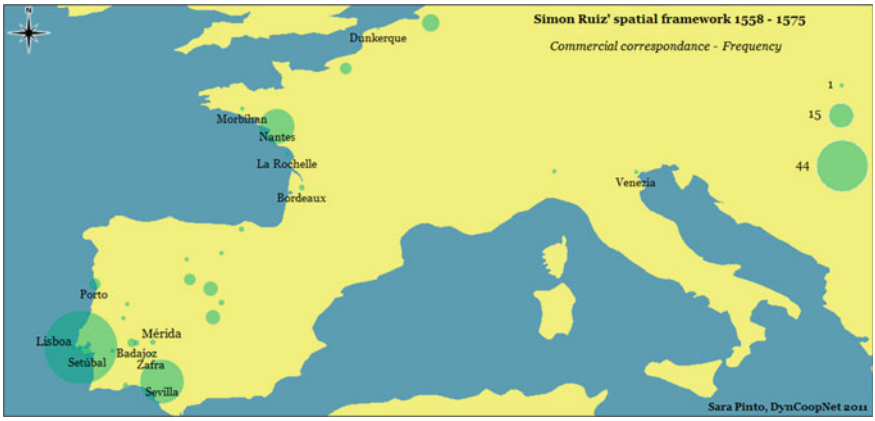

Fig. 9 Simon Ruiz' spatial framework 1558–1575. Commercial correspondence frequency

actions. Furthermore, a successful network demands a strategic location of the agents in order to deal with money flows, trade routes or even nodal points of news' circulation.

4 Conclusions

Nowadays, after the social networks boom, experts in networks analysis are awakening to the importance of space for a better understanding of social network formation, and the role that spatio-temporal constraints play. In fact, they recognize that "traditional graph and random graph models are limited in addressing spatio-temporal questions such as change, trends, duration, migration, mobility and travel" (Shekhar and Oliver 2010). However, social networks aren′t limited to the contemporaneity and historians have been using network analysis to study the development of society and economic behaviors in such distant times as the 16th century. In fact, "empire building in this period established four central forms of interaction: new commercial exchange networks, large-scale migration streams, world-wide biological exchanges, and transfers of knowledge across oceans and continents" (Parker 2010). Moreover, historians and other social scientists begin to admit that these networks acted many times without political or institutional frontiers. They admit that "they cooperated with one another—bringing regions of the world into sustained contact and leading ultimately to the integration of global space" (Parker 2010). Accordingly, historians have also to incorporate space in their analysis. It is not possible to deeply understand the changes and dynamics of the 16th century without drawing its background scenario, meaning its spatial framework.

This approach helped us to understand the versatility of the Simon Ruiz network. We can identify the constitution and the configuration of the network and, moreover, we can visualize it in space. The results show the validity of a spatio-temporal

analysis in explaining the resolutions and strategies of merchants businesses, and whether they were sensitive to a particular place over time. Those are some of the potentialities of GIS applications to historical data source and to mapping historical dynamics.

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Getting Around in the Past: Historical Road Modelling

Markus Breier

Abstract A key to understand historical geographies are historical road networks. GIS (Geographical Information Systems) can provide the tools to model roads of which the exact course is unknown due to lack of archaeological remains. Wayfinding algorithms, like least cost paths, can calculate routes over a landscape, based on assigned cost factors. But which factors are important for the routing of historical roads, besides the relief and rivers? Not just physical factors play an important role, but social, cultural, political and military factors as well. To model historical roads, these factors have to be identified and formalized. Formalization leads to a theoretical model, which can then be implemented in a GIS. Social geographic approaches, like systems theory, will act as framework for the formalization. Furthermore, two case studies will be presented. The first one is a medieval Byzantine road in the Former Yugoslavian Republic of Macedonia, which is mentioned in documents from the 13th and 14th Century. The second case study deals with a historical Buddhist pilgrimage route from the 11th Century in the Western Himalayas. Understanding of historical geography is necessary to create models of historical roads, but once created, they can help to further understand spatial relations in the historical landscape.

Keywords GIS · Historical roads · Geodata · Pilgrimage routes · Modeling

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1 Introduction

Road networks are an important component of historical geographies. To understand traffic relations and cultural movements, it is important to know how roads could have connected different places. In some cases the courses of historical roads are known, either because maps or archaeological remains exist. However, there are cases in which a road is mentioned in written sources, but there is no further evidence, like archaeological remains, of the road. Furthermore, in many cases only fragmentary remains of the road do exist. For these cases, where the exact course of the roads in question is unknown, GIS can provide the tools to model the unknown roads. Wayfinding algorithms, like least cost paths, can calculate routes over a landscape, based on assigned cost values. This is a simple, yet efficient way to calculate historical roads. As most GIS analyses, least cost path calculations need the fitting input data to produce valid results. Which data is used, depends on the factors, which contribute to the development of historical roads. Therefore, one of the key questions is which factors should be used?

The modeling algorithms of a GIS produce sharp results. However, the nature of the research questions allows only fuzzy interpretations, since historical facts always include various uncertainties. Furthermore, most analyses are conducted using recent geodata, since historical data is hardly available or of inferior quality. This also adds to the uncertainty of the final model. Thus, to understand the model, these uncertainties have to be considered in the visualization of the models.

The research reported in this chapter is only at the early stages. Therefore, the research topic itself and the approaches are presented, and the few results so far are provided.

2 Current Research

Various aspects of historical road development are studied by various research disciplines. However, there is no comprehensive framework for the modeling of historical roads, for which only fragmentary archaeological remains exist. Therefore, the aim of this research is to integrate the approaches of the various disciplines to form such a framework.

Transport geography is concerned with transportation networks, flows and patterns. It is also concerned with traffic planning, but the focus is clearly on contemporary matters (Knowles et al. 2008; Rodrigue et al. 2006; Hensher et al. 2004). Transport history is a branch of science which concerns itself with various matters of historical transportation networks and technologies. Especially the study of historical roads deals with well documented roads or roads of which archaeological remains exist (Denecke 2005). However, statements about road

development are either generalized or vague or descriptions that apply only to the observed individual road (Denecke 2005). Formalized theories for medieval road development do not yet exist.

Another discipline which conducts research in the field of historical roads is landscape archaeology, although archaeology largely depends on known remains of the roads (Conolly and Lake 2006).

Geographical Information Science (GIScience) provides methods for way-finding, like the use of least cost paths. They can be used in historical contexts, but certain limitations have to be considered. Most GIS data is recent data, and GIS is also problematic when considering the philosophy of historical science. It has "encouraged the continuation or even re-introduction of a positivist approach that had otherwise been rejected by post-processual archaeology" (Conolly and Lake 2006, p. 8). Since the social factors are much harder to model in a GIS than physical landscape factors, many analyses rely solely on the physical landscape. This kind of environmental determinism is found frequently in historical and archaeological GIS analyses (Gaffney and van Leusen 1995).

3 Theoretical Considerations

Since this research is interdisciplinary, the philosophies of science from the various disciplines have to be taken into account. The research satisfies the requirements of the hypothetical-constructive realism (Schurz 2011, p. 57; Weichhart 2008, p. 398), which is based on realist as well as constructivist ideas, thus providing an epistemology, which is very promising for the issue of historical roads.

For this research, systems theory (Weichhart 2008), based on constructivist ideas, forms the underlying theoretical foundation. Systems theory according to Niklas Luhmann is regarded as a possibility to integrate human and physical geography (Egner 2006) and is an inherent interdisciplinary approach. Thus, it is a useful starting point for this research. Roads are integral parts of traffic systems, which are subsystems of social systems. These traffic systems develop out of general social necessities for transport and movement. Pilgrimage routes are part of the social system as well, but they develop out of other processes than secular roads (Malville and Saraswati 2009). Roads and pilgrimage routes are physical manifestations of these processes on the landscape. The actual routing of the routes is influenced by physical factors as well as social factors.

The physical factors, like the relief and watercourses, are relatively easy to determine. How they are weighted is not that easy to determine, though. The social factors, however, are much more difficult. Not only are they harder to determine, but they are not that easily formalized and modeled with GIS as are the physical factors.

3.1 GIS, Realism and Constructivism: Epistemological Considerations

This research is being undertaken to gain knowledge about historical roads. Therefore, it is essentially to consider which kind of knowledge we can gain, what the knowledge is about and how this knowledge can be obtained. These epistemological questions are very important, especially considering the proposed tool.

GIS relies on data, which represents the real world. This data is then analysed, using mathematical algorithms. This way of thinking has an inherent realist (and even positivist) approach to it.

The first premise of this approach is the assumption that there is an *apriori* reality. This reality can be represented in an objective way by model-building. Model building is the process of encoding a part of reality into a mathematical (computer based) form. The analyses then follow causal chains of geographical phenomena, which are known by empirical research (Schuurman 2002).

But this epistemological conception of GIS is not compatible with constructivist ideas. From the viewpoint of hypothetical-constructive realism, there is an *apriori* reality, but the next step already has to be interpreted differently. The perception of the reality is a social construct, as well as the following encoding process.

Therefore, the subjectivity of every step, from data collecting to choosing the algorithms used for modelling to interpreting the result, has to be considered and examined. The whole process has to be deconstructed.

3.2 Historical Uncertainty

Since the research focus is objects in the past, of which few remains are few, there is cannot be no absolute proof of the course of the roads: "A historical fact is not met with approval by 'proving' it to be true or false, but primarily by finding academically funded arguments for it" (Jordan 2009, p.183, translated by the author).

To find out "how things actually were"(Leopold v. Ranke, 1885) is not the goal of contemporary historical research, since, from a constructivist point of view, this is not possible. Therefore, whatever the results of the analyses, they are only possibilities, not the "true historical reality".

Furthermore, although roads were used over a longer period, the exact course might have changed during that period, for example because of changes in the natural landscape, like landslides or changes in the course of rivers. These factors add to the uncertainty.

3.3 Data Uncertainty

A big issue in GIS in general and even more so in historical GIS is data quality. The availability of free geodata is very limited, and some aspects of its quality are often hard to determine. Commercially available data has better quality

assessment, but is often very expensive. Moreover, in some regions of the earth they are difficult to get. However, regardless if geodata is free or commercial, it is mostly contemporary or recent data. Data about historical conditions is even scarcer, in many cases it simply does not exist.

Historical maps are a possibility to gain knowledge of historical landscapes. Major changes in the landscape, like river regulations, often date back only to the last two Centuries. Therefore, although no detailed maps exist from the middle ages, maps from the 18th or 19th Century can give an approximation.

Nonetheless, there simply is no large scale geodata from the Middle Ages or earlier periods. Recent geodata and historical maps can serve as approximations. To a certain level of detail, this approximation is sufficient, but this has to be considered when interpreting the results of a historical GIS analysis.

4 Methods

All the aforementioned considerations show that historical road modeling is a challenging endeavor. Especially the integration of various concepts of different scientific disciplines is complicated. The first step is to analyze various written sources, like travel reports, and documents. The geographic information gained from these sources acts as a starting point for further analyses. Existing literature and current research papers from various disciplines, which are concerned with transport geography, historical roads and pilgrimage, are reviewed. From this, a systemic view of historical roads and pilgrimage is developed, using a systemic approach. This theoretical model will be further enhanced by including the empirical data gained from the statistical analyses of known routes.

Once this theoretical model has been set up, it will be implemented by the use of GIS. The results of the systemic analyses have to be coded into a GIS-usable data model, consisting of points, lines, polygons and rasters. The appropriate method for this coding will be chosen once the theoretical model has been set up.

Viewshed analyses can determine which point on the landscape can be seen from a specific point. These analyses are used to examine the visibility of the road or certain landmarks alongside the road and should provide additional information about the landscape or rather the perception thereof.

Least cost paths, a type of wayfinding analyses, are the tools which are seen as most rewarding for finding the actual routes on the landscape. The aim of these analyses is to find the way between points A and B over a surface, accumulating the least cost along the way. This surface can be a real surface, like topography, or abstract surfaces like the land price. These surfaces, also called friction surface or cost of passage maps, can be calculated in many ways. The aim of this research is to find a way to integrate the social, sacred and physical landscapes into this friction surface.

Of course, the theoretical model as well as the specific model will be evaluated by applying it to known routes. The results of the evaluation process will be used to enhance the original model.

Cartographic visualization is the method of choice to visualize the results of least cost path analyses. The result of a least cost path calculation is a discrete line. As aforementioned, the results cannot be sharp, due to epistemological reasons. Therefore, a discrete line is a misleading interpretation, since it hides the uncertainty and mimics certainty.

Fuzzy shapes, with their lack of precise boarders, can be used to visualize uncertain geographies (Piatti et al. 2009). With this method, the uncertainty is plainly visible. This will work with maps in which pilgrimage routes are the main content (thematic maps), but can be difficult to implement in topographic or multi thematic maps, where pilgrimage routes are a map content among many other contents. In this cases, visualizing routes as fuzzy areas will overload the map and make it hard to read.

Therefore, a compromise between readability and correct visualization of the uncertainty has to be found.

5 Case Studies

The current research focuses on two subjects. One is a Byzantine medieval road in southeastern Europe, the other are historical pilgrimage routes in the Western Himalayas. The first is considered a secular road. It was used for travel, trade and troop movement. If this road had a sacral function, it was secondary. Pilgrimage routes on the other hand are primarily parts of a sacred landscape. Therefore, the two roads had different functions. They were in a completely different cultural surrounding as well.

5.1 Byzantine Road

The modeling of the Byzantine medieval road is a pilot study to show the viability of least cost paths to model historical roads.

5.1.1 Research Background

The background of the research on the Byzantine road is the project "Tabula Imperii Byzantini" (TIB)[1] at the Institute for Byzantine Studies at the Austrian Academy of Sciences. The research topic of the TIB, which was founded in 1966, is the historical geography of the Byzantine Empire. The project's aims are to create a historical atlas and historical gazetteers of the Byzantine Empire, which existed from the division of the Roman Empire in 394 AD until the fall of Constantinople in 1453 AD. The main sources of the research within this project

[1] http://www.oeaw.ac.at/byzanz/tibpr.htm, accessed 18.04.2011.

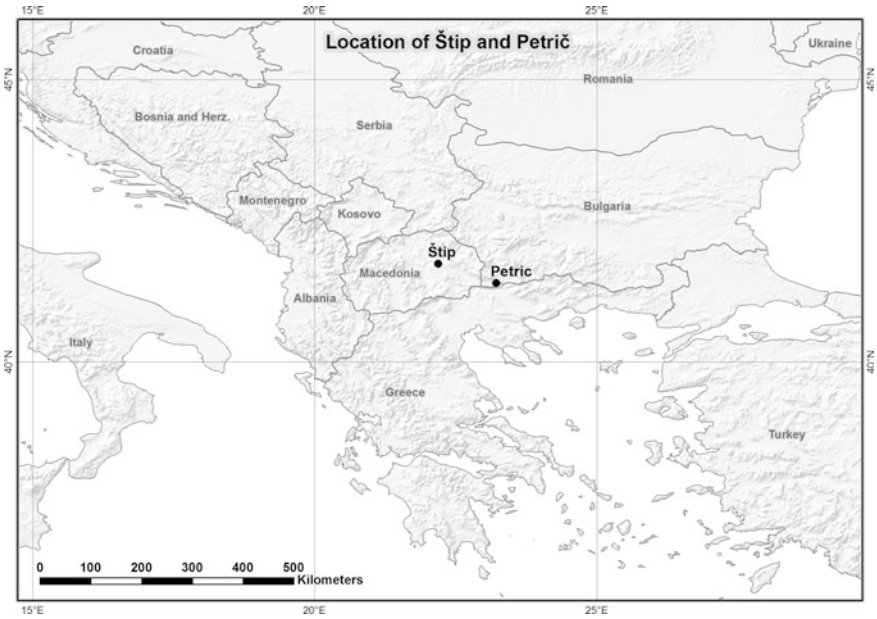

Fig. 1 Location of Štip and Petrič

are written texts, archaeological finds, toponyms and physical landscape properties (Popović 2010a).

Accompanying the TIB is the project "Economy and Regional Trade Routes in Northern Macedonia (12th–16th Century)".[2] Detailed research on regional lines of communication and trade routes is the focus of this project (Popović 2010a). Within its scope, the road in the Strumica valley between Štip and Petrič is given special attention. It is mentioned in a few texts from the late Byzantine era in the 13th and 14th Century AD (Popović 2010b) and is described as *basilikos dromos*, which translates as "*emperor's road*". It is not clear whether this hints at its importance or if the name implies the emperor's responsibility to maintain this road. The road is located in the eastern part of the present-day Former Yugoslavian Republic of Macedonia (FYROM) and Western Bulgaria (Fig. 1). It is part of a connection between two important Roman roads, the Via *Egnatia* and the Via *militaris* (also known as Via *diagonalis* or Via *Traiana*).

Since this road is mentioned in more than one medieval document, it can be assumed that it was not only relevant locally, but on a larger scale as well. Therefore, it is desirable to include this road in the map of the TIB. But since there are no archaeological remains of this road, the exact course remains unclear. Therefore, least cost path calculations are a possibility to create a model of the *basilikos dromos*.

[2] http://www.oeaw.ac.at/byzanz/routes, accessed 10.05.2011.

5.1.2 Considerations

The road at hand is primarily a secular road, without an important sacred function, although some monasteries lie near its course. Therefore, the routing of the road is primarily determined by the physical landscape. For least cost calculations of roads, the most important factor is effective slope. Medieval roads tend to stay at the same height level and taking a longer course. Therefore, the height above sea level, or the difference in height above sea level, plays an important role as a well.

Out of written medieval sources some waypoints are known. The most important is the Ford of Stavrak. Here, the road crosses the river. It is located where the river Turija joins the Strumica, about 11 km east of the town of Strumica (Popović 2010b). Furthermore it is known that the *basilikos dromos* did not go directly to Petrič, but bypassed it on the other side of the river instead. The road also bypassed Kalugjerica and ran between the village of Vladevci and the Strumica.

5.1.3 Implementation

Due to budgetary restrictions of the project, calculations have to be based on freely available data. SRTM data (90 m resolution) and ASTERDEM data (30 m resolution) are used as digital elevation models. Data from the Vector Map Level 0 (Vmap0)[3] is used for the rivers. The locations of settlements and landmarks are recorded using a GPS receiver. These points are then used to define the waypoints for the calculations. Adjustments to the data were necessary to fit the datasets to each other and to get consistent data.

For this calculation, the theoretical considerations mentioned in the previous chapters are not implemented. The calculation is based solely on the cost factors relief, effective slope and rivers and used the basic least cost path algorithm of *ESRI ArcGIS 10 Desktop* (path distance and cost distance). The cost for traversing a slope was calculated by using a formula for the energy expenditure of walking at a specific slope (van Leusen 2002). If the path would change the height above the sea level more than 100 m, the cost for the whole path would also increase. Rivers were given very high cost of passage values, since they are hard to cross.

5.1.4 Results

The results are shown in Fig. 2. The calculated course of the road matches the estimated course. The differences between the calculations based on the SRTM data and the ASTERDEM data is very small. Although the calculation is based on very simple theoretical considerations, the results are viable. Of course, further evaluation, like conducting the calculations on roads, where the course is known, is necessary.

[3] http://geoengine.nga.mil/muse-cgi-bin/rast_roam.cgi, accessed 30.05.2012.

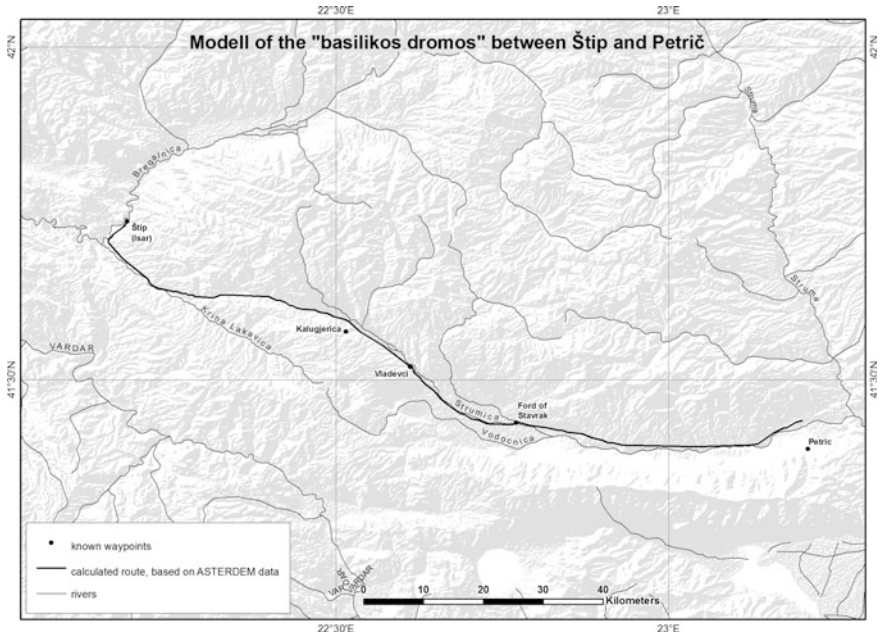

Fig. 2 Final calculation of the *basilikos dromos*

5.2 Buddhist Pilgrimage Routes

Pilgrimage Routes are different from trade routes. They have a spiritual significance, and the course of these roads is determined by the sacred or spiritual landscape even more than by the physical landscape. But contrary to the physical landscape which can easily captured and transformed into a computer model, the sacred landscape is much more elusive.

5.2.1 Research Background

Within the project CHWH (*Cultural History of the Western Himalayans from the 8th Century*)[4] and its subproject CHIS (*Cultural History Information System*),[5] historical Buddhist pilgrimage routes in the Western Himalayans are an important issue. There are very few cartographic representations of these routes, even descriptions and travel reports in written form are rare. Therefore, integration into the CHIS online mapping application is not possible or at least very challenging. Therefore, modeling the routes is a possibility to include pilgrimage routes into the

[4] http://www.univie.ac.at/chwh/, accessed 28.09.2011.

[5] http://www.univie.ac.at/chis/, accessed 28.09.2011.

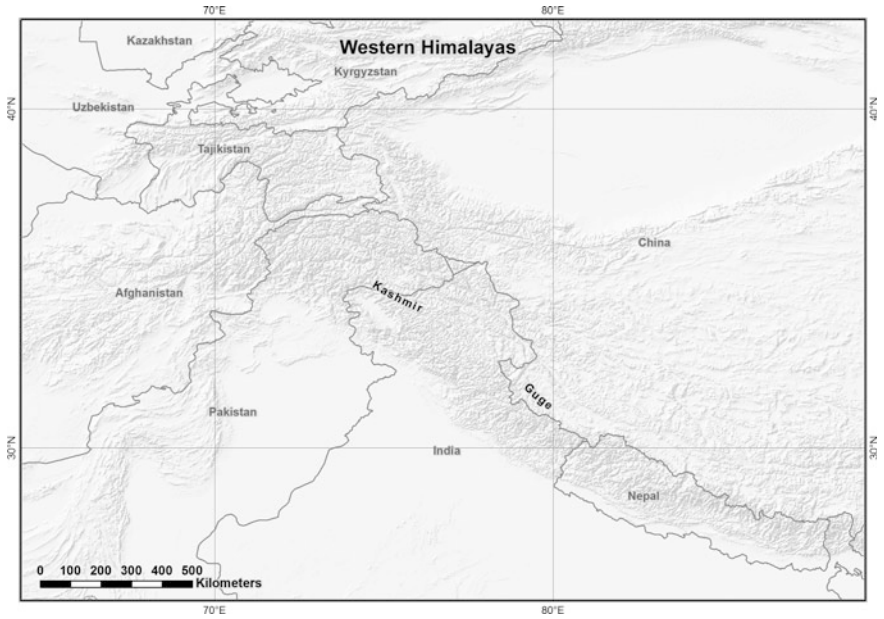

Fig. 3 Western Himalayas

application and the maps. The research also takes place within the interdisciplinary doctoral collage '*Cultural Transfers and Cross-Contacts in the Himalayan Borderlands'* at the University of Vienna.

5.2.2 Rinchen Zangpo

Rinchen Zangpo (also Rin-chen bzang-po) was a Tibetan Buddhist monk in the late 10th and early 11th Century. He was a famous translator of Sanskrit Buddhist texts into Tibetan and played an important role for the Second Propagation of Buddhism in Tibet. He was born in the Kingdom of Guge (western Tibet) in 958 CE and died in 1055CE (Roerich 1988, p. 68f). To study languages and Buddhism, he travelled several times to Kashmir. He is said to have founded over a hundred temples and monasteries, among them many in Himachal Pradesh and western Tibet, some of them still existing today.

Although some waypoints of his travels are mentioned in texts, the exact travel route remains unknown. However, for Tibetologists, it would be desirable to have a more precise knowledge of his travels, as this would help to better understand the religious geography and sacred landscape of the area.

The travel routes of Rinchen Zangpo are not pilgrimage routes in a narrow sense, but as the travels were motivated religiously, the sacred landscape would have a significant influence on them. The monasteries founded by Rinchen Zangpo are important pilgrimage sites even today (Fig. 3).

5.2.3 Sacred Landscape

Sacred landscape is a complex phenomenon. It is created by the perception of the physical landscape and by religious ideas and cosmology. It influences the movement of pilgrims, but is influenced itself by the pilgrims' movement in return (Malville and Saraswati 2009, p. 1). Malville's and Saraswati's (2009) view of pilgrimage as self-organizing system fits the aforementioned theoretical considerations.

Of course, the natural landscape is the basis for the sacred landscape. The sacred landscape develops by interpreting the physical landscape to fit religious believes. It is therefore socially constructed. To model this landscape (or at least some key aspects thereof) in GIS, it is necessary to deconstruct it.

6 Conclusion and Perspective

Traffic conditions and cultural movements are important, yet elusive components of historical geography. Although GIS can provide algorithms to calculate unknown traffic routes, the question is which factor should be used for such calculations. However, theoretical models about road development are very vague and have yet to be refined to be used as a basis for modeling. Systems theory will provide the foundation for the integration of the various aspects into a theoretical model, which will be implemented in GIS.

The approach presented is in its early stages, but the results so far are promising. The systemic approach can help to integrate the historical roads into the historical landscape and thus help better understanding thereof. It is important to consider the epistemology of historical research and GISscience to satisfy the philosophical requirements of historical science. The course of historical routes cannot be proven with certainty, but they can be argued, following a hypothetical-constructive realist approach.

The greatest challenge of this research is the modeling of the cultural landscape, especially the sacred landscape, in GIS. Due to its complexity and subjectivity, it requires a systemic analysis. Once the elements of these complex systems and subsystems are identified, it is necessary to code them into GIS-usable datasets, consisting of points, lines, polygons and raster datasets.

Furthermore, an adequate visualization method has to be found to visualize the uncertainty contained in the models. Fuzzy shapes are a promising method, but they can be problematic in a detailed topographic map. There will be a trade-off between readability of the map and showing the uncertainty.

This research will hopefully lead to a framework for modeling historical roads, be they sacred or mundane. This will also lead to better understanding of historical geographies.

Acknowledgments This research is undertaken within the doctoral college '*Cultural Transfers and Cross-Contacts in the Himalayan Borderlands*', which started in 2011 at the University of Vienna. This doctoral college is related to an interdisciplinary project called '*The Cultural*

History of the Western Himalaya from the 8th *Century*' that started in 2007 in Vienna. This National Research Network (NRN), funded by the Austrian Science Fund, includes cartographers, art historians, numismatists, Buddhist philosophers, and Tibetan and Sanskrit philologists.

The research on the Byzantine road is undertaken within the project '*Economy and Regional Trade Routes in Northern Macedonia* (12th–16th *Century*)' of the Austrian Academy of Sciences at the Institute for Byzantine Studies with close support by Dr. Mihailo Popović.

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Networks of Border Zones: A Case Study on the Historical Region of Macedonia in the 14th Century AD

Mihailo St. Popović

Abstract This case study puts an emphasis on the border zones between the Byzantine Empire and the emerging Serbian mediaeval state in the historical region of Macedonia in South-eastern Europe in the 14th century AD. The present case study turns to the micro-level of historical geography by focusing on one of the areas of the macro-level, namely the city of Štip and on the adjacent valley of the river Strumica. The valley's pattern of settlement has recently been reconstructed by analysing Byzantine and Slavonic charters. The localised settlements were used to create a model of the abovementioned valley by applying the modified Central Place Theory. In the course of the present case study this "classic" approach of analysis of settlement patterns and its "analogue" picture is evaluated by introducing indices of centrality, namely the König number, and by applying network analysis via the computer software *Ora.

Keywords Historical geography · Macedonia · Central place theory · Network analysis

1 Introduction

This article derives from my research conducted within the framework of the project Tabula Imperii Byzantini (TIB) at the Department for Byzantine Studies of the Austrian Academy of Sciences in Vienna. The project TIB was initiated in 1966 and has the aim to create an atlas of the Byzantine Empire, which existed in

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the Eastern Mediterranean from the 4th century AD until the 15th century AD. Several volumes containing catalogues of toponyms, as preserved in the written sources of that time, have already been published and new ones will be completed in due course on every province of the aforesaid empire (Koder 1996a, b; Popović 2010a).

My task as Junior Scientist financed by the Austrian Science Fund (project P 21137-G19) at the above-mentioned Department is to conduct research on the historical region of Macedonia under the supervision of Professor Dr. Johannes Koder (cf. on my project entitled "Economy and Regional Trade Routes in Northern Macedonia (12th–16th Century)": http://www.oeaw.ac.at/byzanz/routes [accessed 10 May 2011]). The historical region of Macedonia is a part of South-East Europe and is located in today's Greece, Bulgaria and Former Yugoslav Republic of Macedonia (FYROM). One of the results of my research will be a volume (TIB 16) on this historical region in the tradition of those published so far within the overall project TIB (cf. http://www.oeaw.ac.at/byzanz/tib014.htm [accessed 10 May 2011]).

Since 2007 I have been enriching the traditional methods of the discipline of historical geography by gathering and evaluating new types of geo-datasets. Up until now scholars of the TIB have conducted surveys in their respective areas of research in order to document visible monuments—for example Byzantine churches, monasteries or fortresses attested by written sources—by means of digital photography, to describe them in diaries or to collect information on the localisation of old toponyms.

In 2007 I have started to gather new geo-datasets during five consecutive surveys in the historical region of Macedonia. These surveys were conducted in June 2007 (Southwest of Bulgaria), in September 2007 (East of FYROM), in September 2008 (West of FYROM), in June 2010 (Southwest of Bulgaria) and in August/September 2010 (East of FYROM, valley of the river Vardar). The above-mentioned geo-datasets comprise GPS-waypoints of relevant historical locations as well as GPS-tracks of old transport routes. Together with the written sources, archaeological data deriving from excavation reports and maps from the 19th century Juilson J. Jubanski and I have recently succeeded in creating one least-cost path model (Popović and Jubanski 2010) and I have accomplished a further model on the basis of georeferenced maps from 1832 (Popović and Soustal 2011). The enormous advantage of the project TIB consists of its capability to implement surveys on site and to facilitate the formulation of new scholarly questions in interaction with the specific landscape. Thus, features of the landscape can be combined fruitfully with new technologies like GPS or GIS. Consequently, these surveys help to evade the risk to become too theoretical by only focusing on 3D applications as well as satellite images and by neglecting the reality on the ground.

At this point I will present my scholarly results deriving from the combination of historical geography and network analysis in four steps.

Fig. 1 The Approximate border zones between the Byzantine Empire and the Serbian Mediaeval State in 1308 AD. *Source* © 2011 Google, © 2011 Europa Technologies US Dept of State Geographer, © 2011 Tele Atlas; KML layer by Mihailo St. Popović

2 Step One

The first step is to define the area of research. Wagstaff states in his interesting article on "Network Analysis and Logistics: Applied Topology": "First, it is necessary to solve some problems of boundary definition. The most fundamental is the limits of the regions being studied. Regions must be defined using appropriate criteria, which may be, for example, topographic or administrative. Communications systems may be assumed to cross from one region to another and to link the region or regions under study with some, which are not being investigated" (Wagstaff 2006, p. 82).

My case study focuses on the border zones between the Byzantine Empire and the emerging Serbian mediaeval state in the historical region of Macedonia in the 14th century AD. At first, the study evolves on a macro-level of historical geography by taking into account a treaty in Latin language between Charles Count of Valois (1270–1325) and the Serbian king Stefan Uroš II Milutin (ca. 1253–1321) on the partition of areas of influence in the case of the former's reestablishment of the Latin Empire in Constantinople (Mošin and Slaveva 1977). The treaty was concluded in the year 1308 AD and in accordance with its dispositions the Serbian king should have received territories up to the line of *Deber* (Debar), *Prilep* (Prilep), *Prisec* (Prosek), *Ouciepoullie* (Ovče Pole) and *Stip* (Štip) (Mošin and Slaveva 1977, p. 438). This geographical outline in the treaty as well as the relevant secondary literature (Škrivanić 1960; Tomoski 1954; Živojinović 1996) enable us to identify the approximate border zones between the Byzantine Empire and the Serbian mediaeval state at that time (cf. Fig. 1).

Fig. 2 The Valley of the River Strumica (Strumešnica) in the South-Eastern Part of FYROM and in the South-Western Part of Bulgaria. *Source* Wikipedia

Let us now turn to the micro-level of historical geography by focusing on one of the areas of the macro-level, namely the city of *Stip* (Štip) and consequently on the adjacent valley of the river Strumica (Strumešnica), which lies today in the south-eastern part of the Former Yugoslav Republic of Macedonia (FYROM) as well as in the south-western part of Bulgaria (cf. Figs. 2 and 3). I have recently reconstructed the valley's pattern of settlement by analysing Byzantine and Old Slavonic charters from 1152 AD until 1395 AD and by proving the existence of altogether 60 settlements. They were all localised and hereafter used to create a model of the above-mentioned valley by applying the so-called modified Central Place Theory (Koder 2006; Veikou 2009; Mrgić 2011), the results of which I will publish soon within my professorial dissertation (Habilitationsschrift) (Popović 2011).

This "classic" approach of analysis of settlement patterns and its "analogue" picture shows that four central places can be identified in the valley of the river Strumica (Strumešnica) in the above-mentioned period on the basis of the written mediaeval sources, namely the towns of Štip, Konče, Strumica and Melnik (cf. Fig. 4).

Moreover, I have put each settlement within the framework of chronological tables (cf. Fig. 5), which enables me to trace the development of each settlement in the mirror of written sources. For example, villages evolve into deserted villages or vice versa in this period. I will return to this specific result in my conclusion.

3 Step Two

The idea to use graph theoretical methods as well as network analysis in the field of historical geography is by no means a novel approach in the worldwide scientific community. Confer for example Pitt's "A Graph Theoretical Approach to

Fig. 3 The Fortress Isar in the Town of Štip. *Source* Mihailo St. Popović (TIB 16)

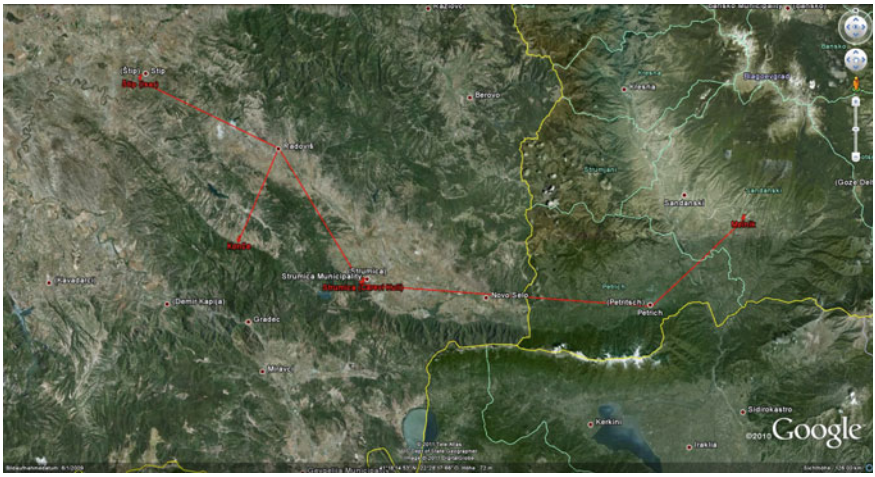

Fig. 4 The Four central places Štip, Konče, Strumica and Melnik in the valley of the River Strumica (Strumešnica). *Source* © 2011 Google, © 2011 Tele Atlas US Dept of State Geographer, Image © 2011 DigitalGlobe; KML layer by Mihailo St. Popović

Historical Geography" published in 1965 (Pitts 1965) as well as "The Medieval River Trade Network of Russia Revisited" from the 1970s (Pitts 1978/79) or Tinkler's "An Introduction to Graph Theoretical Methods in Geography" dating to 1977 (Tinkler 1977). In an article entitled "An Analysis of the Medieval Serbian

Jahr		1303/04	1336 (1. Variante)	1336 (2. Variante)	ca. 1340/41	1366	nach 1366	vor 1417
	Ort							
1.	Brest	Wüstung Brěstokĭ	Dorf Brěstovica	Brěstĭ (D)	Weiler Mproastotzin	–	–	–
2.	Dedino	–	–	–	–	Dorf Dědino	–	–
3.	Grčka (F) (?)	–	–	–	–	Dorf Grkovĭ Dolĭ	–	Dorf Krč'k (K'rč'k)
4.	Konče	–	–	–	–	Dorf Konča	Koníče (D)	–
5.	Leskovica	Wüstung Lěskovica	Dorf Lěskovica	Dorf Lěskovica	Dorf Leaskobitzon	–	–	–
6.	Lubnica	–	–	–	–	Dorf Lubnica	Lubnica (D)	–
7.	Negrenovci	–	–	–	–	Dorf Negronfoti	–	–
8.	Rakitec	–	–	–	–	Dorf Rakit(ī)cĭ	Rakitĭcĭ (D)	–
9.	Šopur	–	Wüstung Še(p)šorovo	–	Dorf Srepsobos	–	–	–
10.	Suvo Grlo	Wüstung Suchogrĭlĭ	Dorf Suchogrĭ	Dorf Suchogrĭ(lĭ)	Dorf ..cho.i…	–	–	–

Fig. 5 The "Static" representation of settlement dynamics in a chronological table on the example of villages in the valley of the River Kriva Lakavica. *Source* Microsoft Excel table created by Mihailo St. Popović

Oecumene: a Theoretical Approach" from 1969 Carter even suggested from the viewpoint of mathematics that the Serbian kings had chosen the "wrong" capital for their state in the middle of the 14th century AD (Carter 1969).

What has changed significantly since these pioneer works, are the technical innovations to compute and to illustrate results deriving from network analysis by using powerful hardware and complex software applications like *Pajek* [cf. http://pajek.imfm.si/doku.php (accessed 17 May 2011)], *Ora* [cf. http://www.casos.cs.cmu.edu/projects/ora/ (accessed 17 May 2011)], *Spatial Analysis on a Network* (*SANET*) by Okabe [http://home.csis.u-tokyo.ac.jp/∼atsu/ (accessed 17 May 2011)] or *ArcGIS* [cf. http://www.arcgis.com/home/ (accessed 17 May 2011)] to a certain extent.

The incorporation of network analysis in the field of historical geography has recently been criticised by Vince and Helen Gaffney in their article entitled "Modelling Routes and Communications" (Gaffney and Gaffney 2010). Thus, they contradict Batty's publication "Network Geography: Relations, Interactions, Scaling and Spatial Processes in GIS" (Batty 2003), when they state: "In the past research into routes and communication tended to presume the significance of traditional network analysis for such work. It is a fact that many technologies now used by archaeologists and historians, including GIS, are indeed well placed to implement analysis of networks associated with full topological attribute data. However, perhaps in contrast to many of these studies, extensive terrain data facilitates the integration of notions of accessibility and connectivity …" (Gaffney and Gaffney 2010, p. 81).

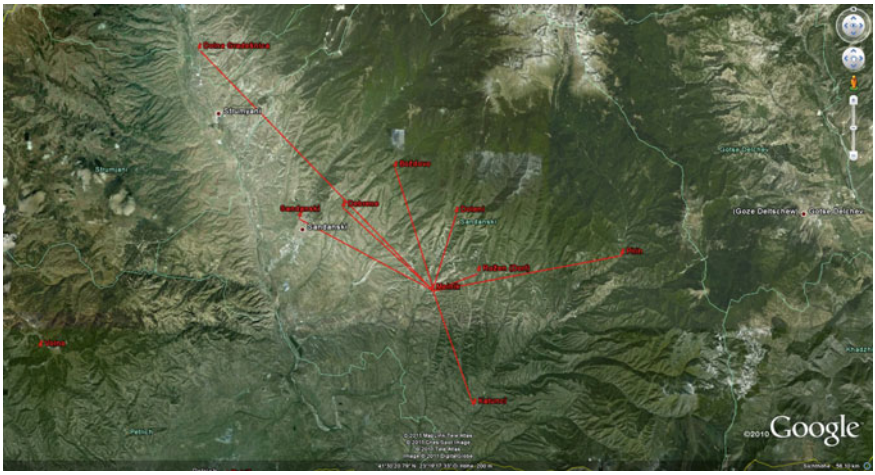

Fig. 6 The Exclusive interaction of Melnik with its eight surrounding settlements. *Source* © 2011 Google, © 2011 MapLink/Tele Atlas, © 2011 Cnes/Spot Image, © 2011 Tele Atlas, Image © 2011 DigitalGlobe; KML layer by Mihailo St. Popović

Still, I decided to include two aspects of network analysis into my case study in order to evaluate impartially the potential of network analysis in the field of historical geography.

4 Step Three

In which way did the settlements in the area of research interact with each other? Let us take the example of the central place of Melnik (Popović 2010b). Can we surmise an exclusive interaction of Melnik with its eight surrounding settlements (cf. Fig. 6) or did all nine settlements interact with each other equally (cf. Fig. 7)? Is it likely that all settlements interacted with each other equally, if we consider the fact that the landscape in this area looks as is illustrated in Fig. 8.

I would like to emphasise that the character of such a landscape cannot be comprehended fully with the help of virtual reality. What is desperately needed under these circumstances is autopsy on the ground in order to understand what is hampered and what is conceded by the landscape.

On the basis of the written mediaeval sources we can discern that the central place of Melnik was the religious, administrative and economic centre of this specific part of the region. This fact and the character of the landscape justify to assume an exclusive interaction of Melnik with its eight surrounding settlements, which leads us to connect the nodes in astral shape. Consequently, an equal interaction of all nine settlements must be excluded. The same is also true for the three remaining central places of Štip, Konče and Strumica. To put it

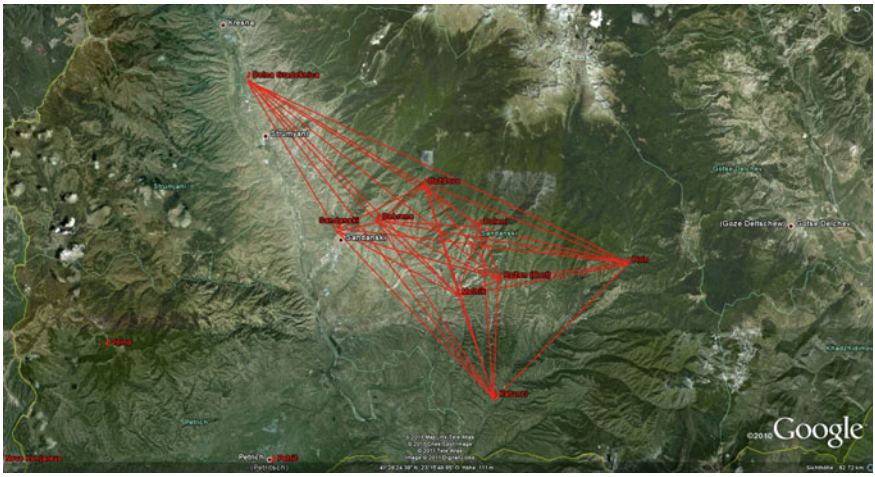

Fig. 7 The Equal interaction of all nine settlements. *Source* © 2011 Google, © 2011 MapLink/Tele Atlas, © 2011 Cnes/Spot Image, © 2011 Tele Atlas, Image © 2011 DigitalGlobe; KML layer by Mihailo St. Popović

Fig. 8 The Landscape in the area of Melnik. *Source* Mihailo St. Popović (TIB 16)

metaphorically, all four centres can be imagined like the sun circuited by their villages as planets (Batty 2003, p. 7–16; Brughmans 2010; Deane et al. 1998; Gorenflo and Bell 1991).

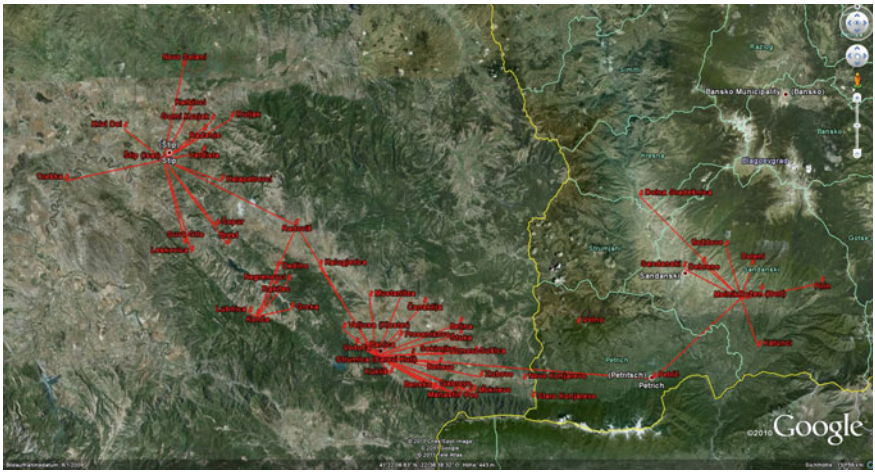

Fig. 9 Connecting the nodes in astral shape and the central places with each other. *Source* © 2011 Google, © 2011 Cnes/Spot Image, © 2011 Tele Atlas; KML layer by Mihailo St. Popović

After connecting the nodes in astral shape and the central places with each other (cf. Fig. 9) we can proceed with step three by introducing the *König number* (*König's theorem*) as index of centrality. According to Wagstaff "The *König number* is derived from counting the number of edges in the shortest path between any given node and the node furthest away from it. […] Low *König numbers* indicate greater centrality in the network" (Wagstaff 2006, p. 81; Dantzig 1960).

The achieved results show clearly that the node of Strumica is the most central one in the network with a *König number* of 3. The three other central places (i.e. Štip, Konče and Melnik) have a *König number* of 5. The villages encircling these centres have a *König number* of 6. Only the villages around the node of Strumica are more central with a *König number* of 4.

5 Step Four

Our next aim is to recheck this stringent calculation based on the *König number* with one of the complex software applications mentioned above. Will our result on centrality be confirmed (Freeman et al. 1991), if we transfer the described network into **Ora Version* 2.2.9 (cf. Fig. 10)?

What can be seen in Fig. 11 are the results in the category *Closeness Centrality*. It shows the average closeness of a node to the other nodes in a network. Closeness is the inverse of the average distance in the network between the node and all other nodes. The city of Strumica has the highest value in this measure followed by Konče and Radoviš.

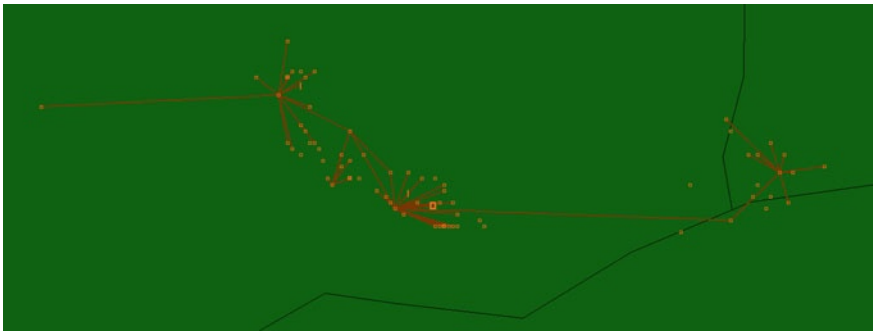

Fig. 10 Transferring the Described Network Into *Ora Version 2.2.9. *Source* *Ora Version 2.2.9, Layer by Mihailo St. Popović

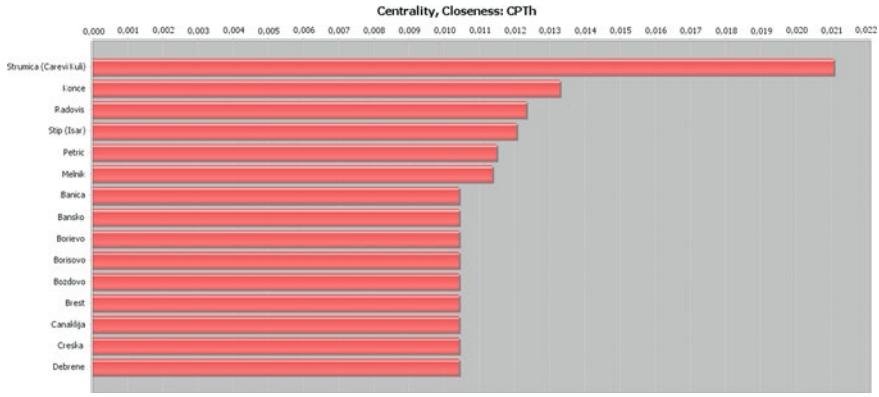

Fig. 11 The Results in the category closeness centrality. *Source* *Ora Version 2.2.9

By applying the category *Betweenness Centrality* we gain a different picture (cf. Fig. 12). The Betweenness Centrality means that a node v in a network is defined as follows: across all node pairs that have a shortest path containing v, the percentage that pass through v. Therein, the city of Štip has the highest value followed by Radoviš and Melnik.

If we take a look at the category *Total Degree Centrality* we recognise that Strumica has the highest value followed by Štip and Melnik (cf. Fig. 13). The Total Degree Centrality of a node is the normalised sum of its row and column degrees. Those nodes which are ranked high on this metrics have more connections to others in the same network.

It becomes clear that our results deriving from the application of the *König number* are confirmed. Strumica is the most central node in the whole network. Additionally, we can obtain further sophisticated data with the manifold applications offered by **Ora*. Compare for example the Betweenness Centrality and the city of Štip.

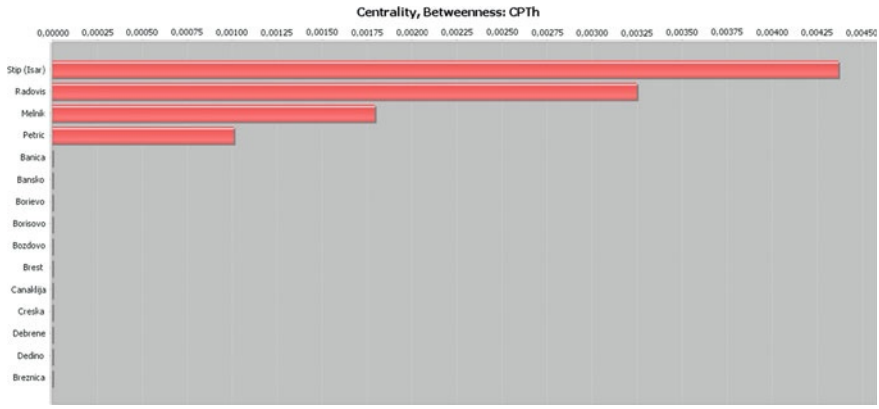

Fig. 12 The Results in the category betweeness centrality. *Source* *Ora Version 2.2.9

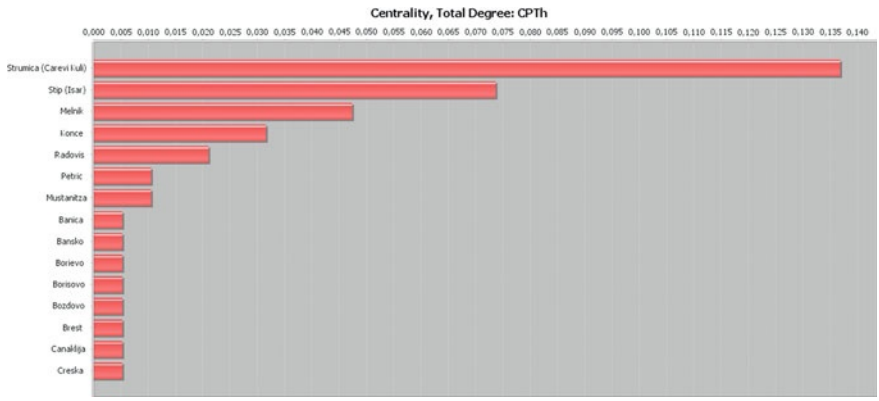

Fig. 13 The Results in the category total degree centrality. *Source* *Ora Version 2.2.9

6 Conclusion

Although we can draw useful results from the methods applied, vital questions still remain unanswered. Some of these questions are:

- Is the settlement pattern, which I have reconstructed on the basis of the mediaeval written sources, complete? If this is not the case, we could lack vital nodes in our network (Bergs 2005, p. 43–59).
- Is the network we have gained so far realistic in view of the landscape of the valley of the river Strumica (Strumešnica)?
- Is the astral shape of the networks justifiable or did the villages also interact with each other and not exclusively with specific central places? By which means could we identify such an interaction?

- May we assume an interaction between the villages bearing in mind the character of the landscape in the above-mentioned valley? Why should the inhabitants of one village for example take the risk to cross the river Strumica in order to reach another village, if they could go to a third village on the same riverside, even if this third village is further away?
- Where do we integrate the human behaviour in our network? Were the inhabitants of villages free in their movement as bond-slaves? Perhaps they transported their agrarian products only on weekends to the markets in the central places? I can also imagine that inhabitants of various villages did not like each other and thus visited villages further away instead of going to villages in their immediate vicinity.

The answer to all these questions is not to be found easily, since we lack fundamental mediaeval written sources on these issues, and it will not be easy to give answers in the future. In my opinion these questions constitute a severe obstacle for a joint-usage of historical geography and network analysis on the one hand. On the other hand they can be overcome.

One possible solution would be the intensive discussion on how to map *perspectives* in the style of an article recently published by Ahamer and others (2009) and also how to combine *space* and *time*. The fusion of *space* and *time* as the fourth dimension was favoured by Johnson in his article "Mapping the Fourth Dimension: a 10 Year Retrospective" (Johnson 2008).

If we proceed with this thought and if we use suitable web-based applications like the *Time Map Project* developed by the University of Sydney [cf. http://www.timemap.net/ (accessed 18 May 2011)], *timemap* by Nick Rabinowitz [cf. http://www.nickrabinowitz.com/timemap (accessed 18 May 2011)] or *Simile Timeline* [cf. http://simile.mit.edu/ (accessed 18 May 2011)], we could combine the effects of time and the character of space, we could combine timelines and cartography.

What such an approach could look like, is shown in Fig. 14. By combining the above-mentioned chronological table (cf. Fig. 5), which lists a specific part of the settlements in my network—namely those in the valley of the river Kriva Lakavica—and which indicates their development in the mirror of written sources, with applications of Google Earth Outreach [cf. http://earth.google.com/outreach/index.html (accessed 18 May 2011)] on the Fourth Dimension, I succeeded in creating an animated timeline.

Consequently, we could apply these features on a broader scale, for example along the whole border of 1308 AD between the Byzantine Empire and the Serbian mediaeval state, in order to gain as well as to define regularities of the evolution and disappearance of settlements.

If we succeed in understanding the dynamics of these settlement processes and if we succeed in mapping them through *space* and *time*, we could tempt to evaluate the achieved results with tools of network analysis.

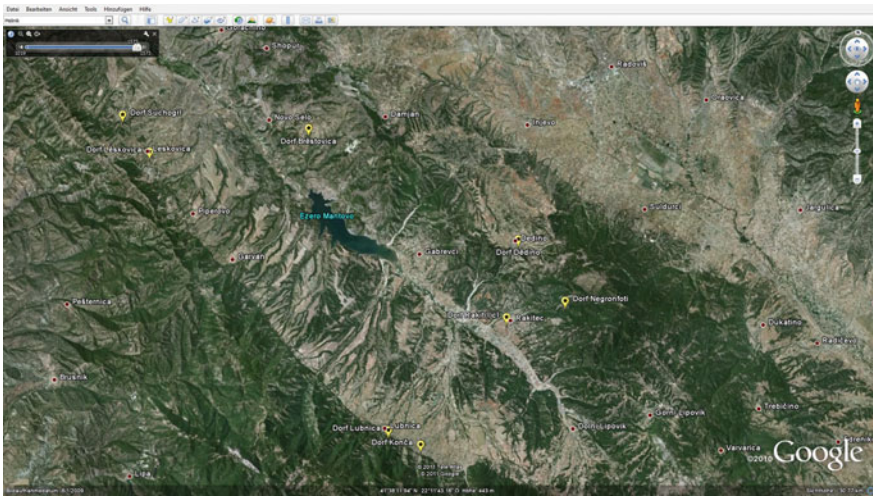

Fig. 14 A Screenshot of the animated timeline created on the basis of the chronological table (cf. Fig. 5) via Google earth outreach. *Source* © 2011 Google, © 2011 Tele Atlas; KML layer by Mihailo St. Popović

This described intermediate step needs skilled historians to analyse mediaeval written sources thoroughly as well as committed mathematicians to enter into an open discussion on the potential and the limits of network analysis.

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The Itinerary and Palestine Maps of Matthaeus Parisiensis: New Input to a Neverending Discussion

Johannes Weiss

Abstract Matthaeus Parisiensis, known in English as Matthew Paris, (ca. 1200–1259) was regarded as a man of many capabilities during his period of critical reception up to the end of the 19th century: as chronicler, "(…) the best of our Historians (…)" (Milton in Patterson 1932, p. 25) as well as an analyst and even as a regional historian—not to mention his non historiographical oeuvre. Before the beginning of the 20th century, however, he had never been seen as an outstanding cartographer as he is nowadays. He became most popular for his Itinerary Maps from London to South Italy and his Palestine Maps, which he composed around the year 1250. The debate over their interpretation is as old as the modern history of cartography itself.

Keywords History of cartography · Palestine maps · Matthaeus parisiensis

1 Introduction

One of the most prolific and well-known cartographers of the Middle Ages is the English Monk Matthaeus Parisiensis. Born around the year 1200, he entered the Benedictine Abbey St. Albans near London, where he died in 1259. Although best known as a chronicler, he is also renowned for his codex illustrations (Lewis 1987, pp. 321–323). These include a comprehensive cartographic oeuvre comprising not only all map types known at his time—such as mappae mundi, regional and local, as well as climatic maps—but also itinerary and Palestine maps, of which map type he is the only known

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medieval author. Hence, he may truly be regarded as the "Shining Light" of 13th century English cartography. This becomes even more evident in the most excellent cartographic creations by Parisiensis' own hand, the Itinerary and Palestine Maps. They form the prefatory illustrations of the three volumes of his principal work, the Chronica majora, which are kept in Cambridge, Corpus Christi College, Ms. 26, fol. I^r–IV^r, Ms. 16, fol. II^r, III^v, IV^r, and in London, British Library, Royal Ms. 14 C VII, fol. 2r-5a. Dating the Maps is extremely difficult; the death of their author in 1259 serves as the only reliable terminus ante quem.

The two complete copies of the Itinerary Map show on five pages the way from London to Apulia. Since the individual maps differ from each other, and because it is not possible to recognize the final destination or even direction—whether to the east or the west—of the indicated route on the last Map page, they cannot be specified more precisely. Whether the term Itinerary Map is even appropriate has been called into question (Vaughan 1993, p. 10).

The strip form in which the Maps are designed takes up two columns per page and is to be read starting from bottom left upwards, and then from bottom right to top right. Consequently, the Itinerary Maps face south, but on the last page this design breaks up and takes on the form of a "geographical" regional map of Southern Italy. Beside the main route, up to three secondary routes are indicated leading from London via France to Italy. The routes pass through different localities, mostly cities, represented by small architectural symbols. For some just the name is mentioned, and, partly, distances are indicated in Old French, e.g. *Cest* or *Le chemin daler en journée*. In addition to the depiction of people, the map is enlivened by an amazing number of animals, but also by ships marking coastal towns such as Calais, Pisa or Otranto. In fact, it was Parisiensis who for the first time used the ship in a map as symbol for port cities and ship passages (Tebel 2008, p. 38; see Wawrik 1995).

The particular value of these Itinerary Maps lies in the fact that they are the only ones handed down from the Middle Ages (see von den Brincken 1988, p. 65).[1] Furthermore, the legends and descriptions in Old French are significant because Parisiensis is successful in seamlessly connecting text and picture; he therefore uniquely combines in his person the writer and the painter (see von den Brincken 1988, p. 65).

In the manuscripts the Itinerary Maps are immediately followed on the next sheet by a two-page map facing east and encompassing the area from Antiochia, Mount Ararat and Damascus as far as Alexandria and the Levant between Tyrus and Damietta. The scientific literature has different names for this map, which are all valid; the only misleading one would be the term Jerusalem Map (see Harvey 2001, pp.165–177).[2]

[1] As is generally known, the most famous of all route maps, the Tabula Peutingeriana, is "only" a medieval copy of a late antiquity original; cf. e.g. Franz Wawrik, Kartographische Zimelien. Die 50 schönsten Karten und Globen der Österreichischen Nationalbibliothek (Wien 1995).

[2] Unfortunately it is not possible to deal here further with the so-called "Oxford Map" in Oxford, Corpus Christi College, Ms. 2 fol. 2b.

2 "Itinerarum in Terram Sanctam"?

Already at a very early date tribute was paid to maps in the English-speaking world. The first was Frederick Madden in the 1860s, and several years later also Konrad Miller in the German-speaking countries. His opinion that the Itinerary and Palestine Maps are station maps to the Holy Land—Iter de Londinio in Terram Sanctam—consisting of two individual parts with unrelated contents proved to be surprisingly longlasting (Miller 1895–1898, p. 84; Vaughan 1993, pp. 241, 247). It proved wrong, though, as Miller had not taken into consideration a fundamental aspect in the map picture. The link to the Apulian harbour town of Otranto, which is missing in the map, is clearly established in Royal Ms 14 C VII by the following legend: *Co est le chemin de acre en poille a ariver a chef de poille. Co est a saver a ortrente ki est de vers la mer de venise la plus proceinne vile de acre ki seit en poille. Al autre chimin sur mer a ariver landroit a la meisun le patriarche de acre sunt hills. La premere est de meschenes e lesse hon secille a senestre. E mauste a destre ki est la costere de barbarie après trove hon crete. E après cipre*. (London, British Library, Royal Ms. 14 C VII, fol. 4r; see Lewis 1987, pp. 325, 504 foot note 12).

This legend appears in a very similar form once again at another point: *A cest enseigne* $\theta \approx$ *Amunt u la nef est peintre a tel signe est le chemin de acre en poille. Co est a saver geska ortrente ki est devers la mer de venise la plus proceinne vile a acre ken poille soit. Al autre chemin sur mer a ariver landroit a la maisun le patriarche a acre sunt isles.La premere meschine e lesse hon sicille a senestre e meaute a destre ki est la costere de barbarie apres trove hon crete. E apres co cipre a senestre* (see Lewis 1987, p. 504 foot note 13). In Ms. 16 and Ms. 26 the legenda state: *Par devers la mer de venise a devers constantinople e sur ceste costere sunt cestes viles ki sunt ci escrites. La premiere est ortrente, ki est eu chef de poille, e apre strane la premiere bone vile ki hon trove en poille devers la marche d'ancoine* (Cambridge, Corpus Christi College, Ms. 16 fol. II^{r}, Ms. 26 fol. 3^{r}). In addition, Matthaeus Parisiensis uses the picture of a ship for Otranto in order to mark the passage to Acre.

All these indices have to be taken as unequivocal evidence of the correlation between the Itinerary and Palestine Maps. As further supporting proof one must mention the Apulian harbour towns, the conscious selection of which was made in place of an imaginary route to the east.

However, refuting Konrad Miller creates new problems instead of solving some of the existing ones. All interpretations based on a map terminating with Apulia are obsolete. The most common theory assumed that the Itinerary Map is a pilgrim map, which leaves unclear where it leads. For various reasons the Urbs Sacra, the City of Rome, has to be ruled out in any case (see Weiss 2008, p. 254). Together with the lack of alternative pilgrimage destinations and because the route runs apart from the Via Francigena which lead the majority of English pilgrims to Italy, everything speaks against interpreting the Itinerary Map as a pilgrim map.

Incorporating the Palestine Map by establishing an original connection as the conclusion of the Itinerary Map does not function either. In this case the same problems that arise for Rome also arise for Jerusalem: as in other maps of the same period, Jerusalem is not the centre of the Palestine Map, while it seems to have been supplanted in its presence by Acre. *La vile de Acre* (London, British Library, Royal Ms. 14 C VII, fol. 4b.) even lays claim to a quarter of the map surface. Furthermore, in Ms. 14 C VII Damascus is the endpoint of the route and not the *civitas hierusalem*. Both Palestine Maps have in common the lack of further localities important for pilgrims that are usually depicted in contemporary itinerary maps, like *Mont de Synay* with the St. Catherine's Monastery, Saint Abraham en Ebron or Capharnaon.

Following the beginning of the Crusades, the number of places in the Holy Land shown to pilgrims increased in an extraordinary way; this lack leads to the conclusion that Matthaeus Parisiensis' maps could hardly have met the contemporary requirements of a pilgrim map.

3 Map Analysis

How to deal now with these maps; which opinion to adopt? "How should we view these maps of the Holy Land […]. Was the Acre map simply a map of the Holy Land […] which is how Miller, Beazley and Professor Vaughan have seen it, or should we follow Dr. Lewis, Dr. Connolly and earlier writers in seeing it as a final stage of the itinerary from London to Palestine, the imaginary pilgrimage to Jerusalem?" (Harvey 2001, p. 177).

It may serve us to return to the beginning and to Miller, who was already of the opinion that the purpose of the Itinerary Map might have had a political background. In this context he refers to the following map legend: *Poille ki est Reaue. Aceste terre tute avoir fu li cjns Ric frere le roi de engletere apelez kil en fust rois. Mais pur la culeitise e la traisun de la curt de Rumme li duna sun conseil Kilni Alast. Co fu el tens innocent pape quart ki li fist lofre en lan de grace MCCLIII* (London, British Library, Royal Ms. 14 C VII, fol. 4r; see Miller 1895–1898, p. 84). The event described here, namely the offer of the Crown of Sicily to Richard of Cornwall, brother of King Henry III of England and brother-in-law of emperor Frederick II, is also included in the Chronica majora. For Lewis the crusade campaigns under the guidance of Richard of Cornwall and Theobald of Champagne, datable in the years 1249–1253, represent a political context of its creation. This assumption is primarily based on the Palestine Map with the oversized representation of Acre—as if the scale decreases in size from the map centre to the map edges. In effect, this city was the main strongpoint of the Plantagenêt during his stay in the Holy Land, which also seems to be the reason for its surprisingly precise rendering (Lewis 1987, p. 357). Within the city, in a similar way as for Rome, individual buildings are highlighted, representing the various quarters of the Crusader Orders and the Italian Communes. Such an illustration

requires personal knowledge, which, in the sphere of Mathaeus Parisiensis, only Richard of Cornwall could have had. An iconographic hint to this person, a sail showing two or maybe even three lions, may actually be found in the drawing of a ship in the waters around Acre. As their heraldic animals, the lions might be a direct indication of the presence of the Plantagenêts in the Holy Land: whether this hint refers to Richard I Lionheart and the capture of Acre in 1191, to his grand son of the same name or, intentionally, to both of them must remain without an answer.

This also holds true for further instances in the map illustration of Palestine, such as the depiction of Damascus. With his representation of the city, Matthaeus precedes the encyclopedic maps in which Damascus belongs to the inherent map features. In fact, the city played a role in the varying system of alliances of the crusaders. Thus it seems that Damascus was represented in Ms. 16 and 26 in reaction to the crusade of Theobald of Champagne (see France 2005, p. 191).

The conception of the Itinerary Maps as well must be considered as the reflection of these circumstances. On the one hand, the main route corresponds to the way that Richard of Cornwall took toward Southern France in order to board a ship in Marseille. The route does not reach to the Mediterranean port city of Marseille, however, but instead leads to the Alpine crossing at Mont Cenis into Italy, where it evidently comes to a preliminary and extremely vague end at the port cities of Southern Italy. This suddenly very confusing picture of the Itinerary Maps in Italy proves that Matthaeus could not revert to really reliable sources for this section—further evidence for Richard Plantagenêt's importance for the map design. It remains unclear why in Matthaeus's map the route makes in a big sweep to Italy. Only few crusaders accepted the offer of the Emperor, who had placed at their disposal the port cities of Southern Italy. This applied also to Richard of Cornwall, who on his way back, however, spent some time in Sicily at the court of Frederick II and from there paid a visit to Pope Gregory IX in Rome. It may very well be that these events of the summer of 1241 as well as Richard's way back through imperial territories can serve to assert the intention of the chronicler to include the Italian "boot" in his overall concept.

Having brought forward the arguments that reveal the important role of Richard Plantagenêt and his crusade of 1239–1241 in the map design of the Itinerary and Palestine Maps, the question of their significance for the interpretation of the Maps arises. Are they sufficient so that we can speak of a cartographic illustration of the crusade of Richard of Cornwall? A series of contradictory motives does not fit with this approach, neither with regard to the contents nor to the sources.

To start with, it cannot be excluded that the rendition of Damascus in Ms 16 and 26 is a copy of Matthaeus's own copy of a map in Oxford, Corpus Christi College, Ms 2, fol. 2b (see Connelly 1999, p. 165; Weiss 2008, p. 258). Likewise, any connection between the rendition of Al-Mansura and the events of 1239/41 has to be denied. Similar arguments are valid also for the many Christian sites along the coast from Tyra to Egypt. Neither can these cities represent the existing, lost, or won territories of Christendom nor even stand for the considerably larger range of action of Theobald of Navarra comprising Beirut, Sades or Gaza or for the comparatively smaller one of Richard of Cornwall.

Furthermore, attention must also be drawn to the large number of legends with economic, regional and cultural but also miraculous contents: for example, in Ms. 14 C VII, in which the following explanation is added to the illustration of a camel: *Hic abundant cameli*, *bubali*, *muli et asini quibus utuntur institores inter Orientales et Occidentales transmeantes*. *Ci en a mut des riches marchantz. E cist de cestes parties sunt riche de or e dargent*, *de peres preciuses e soie e especerie*. *De bugles*, *muls*, *chameus e chevaus igneus e ki mut poent travaus sufrir*, *e les iumentz plus ke les chevaus masles*. *Furment unt ki dailurs vent, vin poi*, *peissun de mer point*; *pleinte unt de oille*, *alemanne*, *figes e zucre*:*de co funt lur beivres*. *Tant unt de femmes cum poent sustenir*. (fol. 4b). All these legends cannot, in any case, be regarded as arguments in favour of a pilgrim map.

Noah's Ark in Ms. 26 also represents an exception as far as its sources are concerned. The Ark is taken from the imagery of the Mappae mundi and is shown here as a relatively dominant depiction of a ship located on two mountains with three coiling serpents at the foot. This is a unique representation deriving from a source, which can be traced back to Armenian monks who visited St. Albans in the years 1252/1253. These monks also refer to the Chronica majora when they bring up, in conformity with the map illustration, the subject of the ark rests on two mountains, unreachable because of two insuperable snakes (Luard 1880, vol. 5, p. 341).

In conclusion it must be emphasized that—as already asserted by Miller and Beazley—beyond the haphazardly congruent nomenclature there is no apparent connection between the textura and the pictura of the Maps and contemporary itineraries such as *Les pélerinages pour aller en Jérusalem*, dated 1231, or later itineraries on the other such as *Les chemins et les pélerinages de la Terre Sainte*, dated 1265, or *La dévice des chemins de Babiloine*, dated 1289–1291 (see Spanke 1955; Pressouyre 1995; Richard 1981).

With regard to the itinerary maps, our attention must be directed once more to Italy. Each and every explanation of its inclusion in the map picture remains contradictory. Motives speaking in favour of its inclusion in the map picture may also be used against it. Specifically, this concerns the route. While in France the route actually follows the direction toward Marseille, in Italy it creates problems that have not yet been solved: neither is the intention of the routing clearly recognizable, nor the reason for Italy's inclusion in the Map. Although Richard stayed in the Kingdom of the Two Sicilies on his return from the Holy Land and started his homeward journey from there, this cannot be asserted as the reason. Specifically, Trapani's role in the Map is only a subordinate one; the same is also true for Roma and for the legends in Ms. 26—all of them do not reflect Richard's presence there in any way. Only in Ms. 14 C VII is the following remark concerning Trapani to be found: *Ci arriva le cute Ric quant vint de la terre seinte* (Miller 1895, p. 90). Furthermore, the complete route, which would render it possible to re-create Richard Plantagenêt's way home, is missing already for Southern Italy and cannot be reconstructed even consulting the sources and taking into account the various city vignettes. There is only evidence of a stay in Cremona, an event that is not rendered adequately in the depiction of the city. In Ms. 14 C VII it is emphasized at least in terms of size, while in Ms. 26 it is hardly present.

Even assuming that this last page of the Itinerary Map shows the unknown way back of Richard of Cornwall from Trapani to Dover, no recognizable importance for the map design can be attributed to it. This is due to the fact that the reading direction of the Maps is unequivocally going form north to south, i.e. from bottom left to top right and not the other way round. Though Richard is mentioned twice as *Ric frere le roi de engletere* and *le cute Ric* in Ms. 14 C VII, this does not change anything, as has already been remarked by Lewis (1987, p. 324). Neither is Richard's name reflected in any way in the Map's creative realization, nor are they to be found in the other two copies of the Itinerary Map. In all, each last page of the Itinerary Map still continues to pose a series of unresolved questions.

4 Conclusions

In summary, the Itinerary and Palestine Maps show a contradictory picture. How should these Maps be dealt with now that all current interpretations could be disproven as inadequate? Should we concur with Lewis who in essence believes them to be a collection of source material without any other purpose (Lewis 1987, p. 325)? This concept, which reflects the quantity of listed places, obviously constitutes the simplest solution. Actually, however, it is the most unsatisfying since it devalues the Maps.

It is still Richard Plantagenêt, Earl of Cornwall, who offers the best approach after all. This is based on the only level where a valid interpretation might be achieved and which nearly all interpretations have neglected, namely the geographic one. In particular, it does not seem very effective to approach the Maps starting from the very complex and detailed contents, as it was intended to demonstrate. The mapped geographic areas offer much better access, except for England, France, Italy and the Holy Land. These all have in common that they represent the territorial and, particularly in the case of Apulia, the dynastic spheres of interest of the English Crown.

This contribution has already outlined how this is applicable to Italy and the Holy Land: the English Crown could, in effect, aspire to the Norman heritage of the Two Sicilies because of Emperor Frederick's II last marriage to Isabella Plantagenêt. With the offer by Pope Innocence IV to Richard as well as to Henry, this hope had already become rather concrete for young Edward. Furthermore, the English commitment in the Holy Land was linked to the crusade conducted by King Henry III and his brother (Carpenter 1996, p. 118; Powicke 1953, p. 106). "It is not too much to say that the recovery of the Holy Land, whether as an ideal, a symbol, or an immediate duty, pervaded the minds of men in the thirteenth century" (Powicke 1953, p. 80). Within this triad, the role of France must not be omitted. King John Lackland had left a very difficult legacy to his heir to the throne, Henry, and his successors. The territories of the Angevin Empire, Normandy, Poitou and Anjou, lost in 1204/06, were a latent source of conflict until the end of the Hundred Years War. Henry III was not willing to renounce his claims to the conquered French territories, and he

Fig. 1 The map of Palestine from the British Library. © British Library Board, Royal Ms. 14 C VII fol. 4^{v}–5^{r}

manifested his territorial interests in a military (campaigns Bretagne 1230, Poitou 1242) as well as in a dynastic manner. In any case, the Maps date to the years before the Treaty of Paris took effect as temporary solution in 1259.

As Armin Wolf has demonstrated taking the Ebstorfer World Map as an example (Wolf 1988, pp. 75–93), in the 13th century it was apparently not unusual to link dynastic-territorial situations to cartography. The form of the itinerary map chosen by Matthaeus must be considered a practical solution for connecting, from an English point of view, the fields of dynastic, political and territorial interests which were concentrated in the person of Richard of Cornwall. In this context, his military expedition in Gascony 1225–1227, his option to the throne of the Two Sicilies promoted by Henry III, and, finally, his crusade to the Holy Land must be remembered. There is no necessity, however, to consider the Map as having been drawn for or commissioned by the Royal Court (von den Brincken 1988, p. 65; Lewis 1987, p. 324). This hypothesis may serve as an explanation for the use of Anglo-Norman instead of Latin but not for other peculiarities such as the bad quality of the parchment.

Such an interpretation of the Maps as dynastic-territorial maps comes to meet the existing interpretations; it just assigns them a different value. Certainly, no objections can be raised against seeing various motives of different importance interwoven within this frame: from the already mentioned economic, regional and

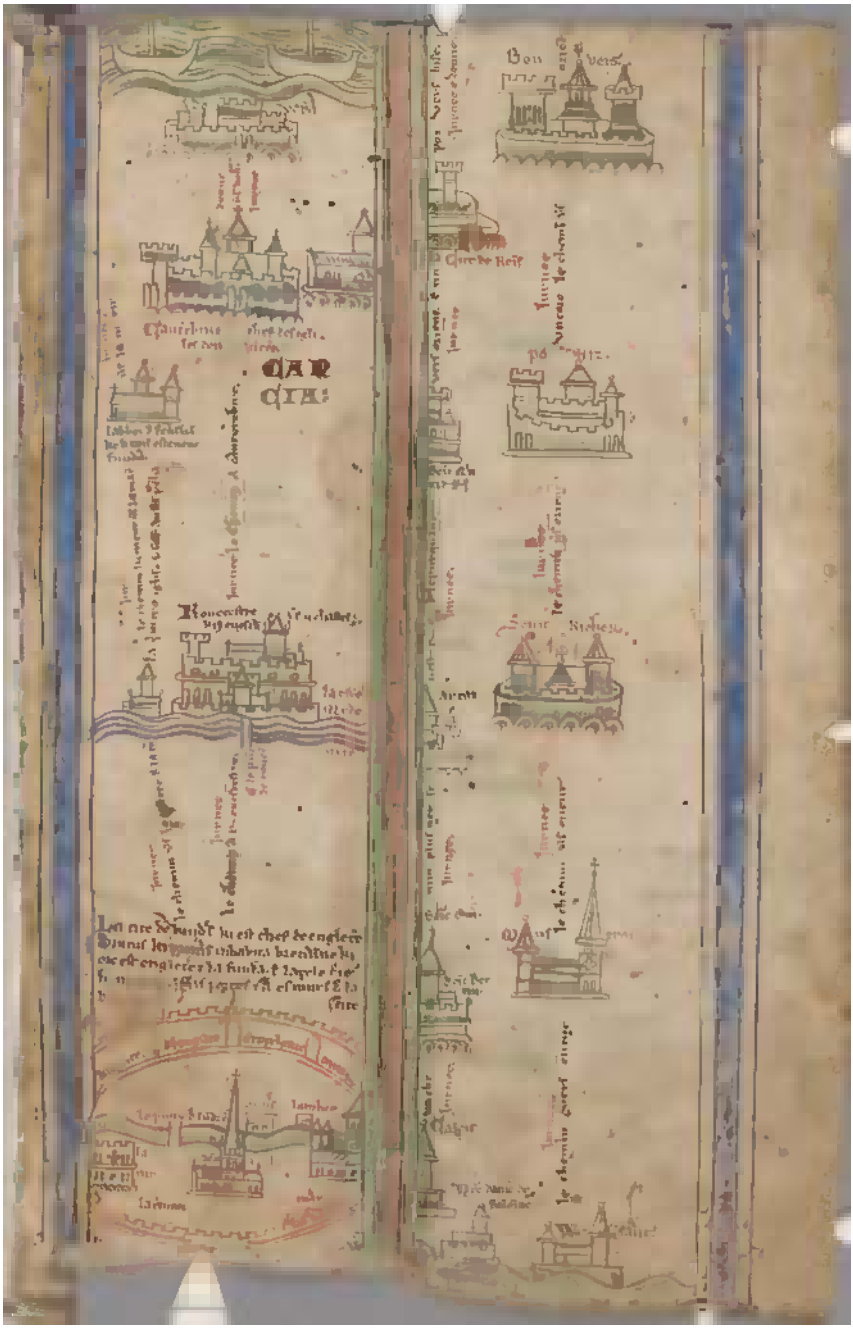

Fig. 2 The first page of the Itinerary map from London to Calais in Cambridge, Corpus Christi College, .Ms. 26, fol. I^r–III^r (with acknowledgement to the master and fellows of Corpus Christi College, Cambridge)

cultural as well as contemporary to religious and political information. This is the best solution to deal with the complexity of the contents and the diversity of the motives in the Itinerary and Palestine Maps of Matthaeus Parisiensis (Figs. 1, 2).

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