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Atlas Information Systems – Current Developments at ETH Zurich

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Zusammenfassung

Seit Jahrzehnten ist das *Institut für Kartografie und Geoinformation* der *ETH Zürich* für klassische gedruckte Atlaswerke redaktionell verantwortlich. Diese Atlastradition ermöglichte es, diverse Projekte von interaktiven Atlasinformationssystemen erfolgreich zu entwickeln und einzuführen. Der multimediale *Atlas der Schweiz*, der Web-basierte *Schweizer Weltatlas interaktiv* für Schulen sowie der interdisziplinäre *Literarische Atlas Europas* stehen für vielbeachtete technologische Innovation und gestalterische Qualität.

Schlüsselwörter: Atlas, Informationssysteme, Graphical User Interface, Interaktivität

Summary

The *Institute of Cartography and Geoinformation* at *ETH Zurich* has a long tradition in the design of classic printed atlases. These experiences enabled the Institute to successfully develop and implement diverse projects of interactive Atlas Information Systems in the last two decades. The *Atlas of Switzerland*, the national multimedia atlas, the Web-based *Swiss World Atlas interactive* as the Swiss school atlas, and the interdisciplinary *Literary Atlas of Europe* are proofs of successful technical innovations and high-level cartographic design.

Keywords: atlas, information system, graphical user interface, interactivity

1 Information Society and Atlas Information Systems

The *Institute of Cartography and Geoinformation* (formerly the *Institute of Cartography*) started the first project on Atlas Information Systems (AIS) in 1995. In the previous time, map production had mostly been put on a digital basis. Using the computer screen not only as a means to draw but also to present maps formed the next logical and promising step towards interactive atlases.
At that time, the way to go was already roughly outlined. Geographic Information Systems (GIS) had demonstrated the power of spatial data handling, first electronic atlases had been presented and on a theoretical basis and Ormeling (1995) postulated the AIS characterised by successive levels of interaction: view-only, interactive and analytical.
The initial approach was to transfer a subset of GIS functionality to an event-driven authoring environment, based on the pioneer work of *HyperCard* and its cross-platform successors. The first development of an interactive atlas, the *Atlas of Switzerland*, was planned as a replacement of the heavy-weight and meanwhile slightly aged printed version of the Swiss national atlas, initially designed in the early sixties by Eduard Imhof. The interactive version inherited much from the excellent cartographic style and the contents from its ancestor, adapted computer graphics methods for the rendering of perspective and panoramic terrain views and followed its own ways with the design of the user interface (see chapter 3.1).
The successful launch of the renewed Swiss national atlas also stimulated similar projects at the *Institute of Cartography and Geoinformation*. With the *Swiss World Atlas interactive*, the youngest audience was addressed with a supplementary Web version of the well-established printed school atlas (see chapter 3.2). Rather a collaborative tool for literary experts than a fully elaborated atlas accounts for the *Literary Atlas of Europe*, an interdisciplinary project originating from the humanities

and challenging cartographers and developers at the same time with the often loose and fuzzy conception of space in literature (see chapter 3.3). Due to its expertise in AIS, the Institute was also involved in a number of EU projects such as *STATLAS*, a statistical atlas, *GEOWARN*, a volcano monitoring system, and *ORCHESTRA*, an open system for risk management.
It is possibly right to say that University research has much contributed to today's widespread use of interactive maps. Maps are omnipresent on the Web today and many have contributed: individuals, firms, and institutions. Authorities and national agencies have installed geo-portals to offer maps and even for big players such as Google, Apple and Nokia, maps are attached great importance. Surprisingly, maps, an analogue representation of space, play a most prominent role in a digital world. But the focus is rather on maps than on atlases, the Web prefers the more specific, the finer grain and not necessarily the analytical map.

2 The Institute of Cartography and Geoinformation and its Atlas Tradition

2.1 The Roots and the Pioneers

Atlas cartography has a long tradition at the *Institute of Cartography and Geoinformation*. Although his predecessor Fridolin Becker was involved in several school map and atlas projects, it was Eduard Imhof (1895–1986) who made this field one of the traditional focal points in research and development. His successor Ernst Spiess (*1930) introduced new, digital atlas production technologies for printed atlases already in the 1970ies and he initiated the first interactive version of the Swiss national atlas.

2.2 Schweizer Weltatlas (Swiss School Atlas)

The official printed Swiss school atlas, the *Schweizer Weltatlas* (formerly the *Schweizerischer Mittelschulatlas*), was initiated in 1898 by the Swiss Conference of Cantonal Ministers of Education (EDK). In 1927, Eduard Imhof won a competition for the complete revision of the atlas. He introduced numerous new maps with thematic and topographic content, among them also synoptic maps with the Swiss-style colour relief shading (Jenny and Hurni, 2006) (Figure 1). After a further revision in 1962, the next editor-in-chief, Ernst Spiess, introduced a new, fully revised edition in 1993 (partial revision in 2002; SWA, 2012) with a strong focus on thematic maps (e.g. economic maps, thematic world maps) and detailed maps of specific areas or topics of interest. Currently, an entirely new edition is under preparation and should be published in 2015.

Fig. 1: Physical map of Europe in the *Schweizer Welatlas* (french edition 2010) with Swiss-style colour relief shading.

2.3 Atlas der Schweiz (Swiss National Atlas)

Although Eduard Imhof brought up the idea for a printed Swiss national atlas already in the 1940ies (Imhof, 1941), the work on the *Atlas der Schweiz* only started 20 years later. During 35 years, 200 large format tables with a total of 600 maps were published, covering all relevant thematic aspects describing Switzerland. The printed atlas served as a model for many other national or specific thematic atlases world-wide. Around 1995 it became obvious that a printed atlas did no longer meet the requirements imposed by rapidly changing and growing data and by the demands of the users. In 2000, the first interactive edition of the (now officially called) *Atlas of Switzerland* was published. It comprised a digital elevation model with a resolution of 25 metres, covering entire Switzerland, as well as of 350 statistical datasets on community level. The software allowed for orthogonal, block diagram and panorama visualisation of the elevation data as well as for 2D visualisation of the thematic data. In 2004, the 2nd version with an extended range of topics (including e.g. nature and environment) and more sophisticated 3D-visualisation tools was published.

3 Current Projects in the Field of Atlas Information Systems

At the *Institute of Cartography and Geoinformation* there are currently three interactive atlas projects under active development. Each of them reflects a specific state of technological development but also the changing user expectations: The *Atlas of Switzerland*, the third edition of the highly interactive national atlas, the *Swiss World Atlas interactive*, the Web-based school atlas, and the *Literary Atlas of Europe*, a tool that incorporates the idea of expert collaboration. In the following chapters, these interactive atlas projects will be presented in detail.

3.1 Atlas of Switzerland 3.0

Since its first edition in 2000, the interactive *Atlas of Switzerland* has become a success story both in terms of economy and distribution, as well as in terms of cartographic research and development. Overall, more than 22,000 copies have been sold on CD-ROM and DVD within the last decade.
The third version of the *Atlas of Switzerland 3.0* (*AoS 3*) has been published in 2010 after six years of research, development and editorial work. Conceptually, the focus of this edition was strongly laid on interactivity and on cartographic visualisation of high quality. Nearly 2000 map themes from the fields of *Nature/Environment, Society, Economy, State/Politics, Traffic,* and *Energy/Communication* have been integrated. While most of the themes cover Switzerland and its surroundings, some hundred topics are also available for Western Europe. Together with additional variations in time and spatial resolution, about 10,000 possible maps can be visualised. The wide range of thematic information resulted in various 2D map types: point symbol maps (e.g. alpine huts), chart maps (overnight stays), line maps (power lines), net maps (commuters), focus maps (flight destinations), choropleth maps (uni-variate: geology; multi-variate: prevailing language), and grid maps (precipitation).
For the Swiss part of the *AoS 3*, a *2D map mode* and a *3D map mode* with panoramic views, block diagrams, and prism maps have been provided. Prism maps are well suited to combine two map variables (e.g. number of children and ozone concentration) in one view. Panorama and block diagrams give a vivid impression of the topography, but are also suited for terrain analysis. The *AoS 3* offers explorative analysis tools for terrain visibility, distance, hypsography, slope, aspect, and profile. 3D visualisation tools like lighting, cast shadows, fog, clouds, planets/stars, and labelling are available. As a surplus, the 3D map mode disposes of a set of unique navigation tools (pano lift, climber, look-to, zoomable reference map) to locate oneself on the map and also an index with map centre function. To get additional information, further smart interactive tools are provided, e.g. a legend with modification of colours and classing, a comparison tool for single map values, and an info part with over 700 multimedia panels (text, photos, sound, and videos) in four languages. The graphical user interface (GUI) is designed to allow for a free combination of base map and thematic layers, and for map comparison by means of a multiple split screen function (Figure 2).

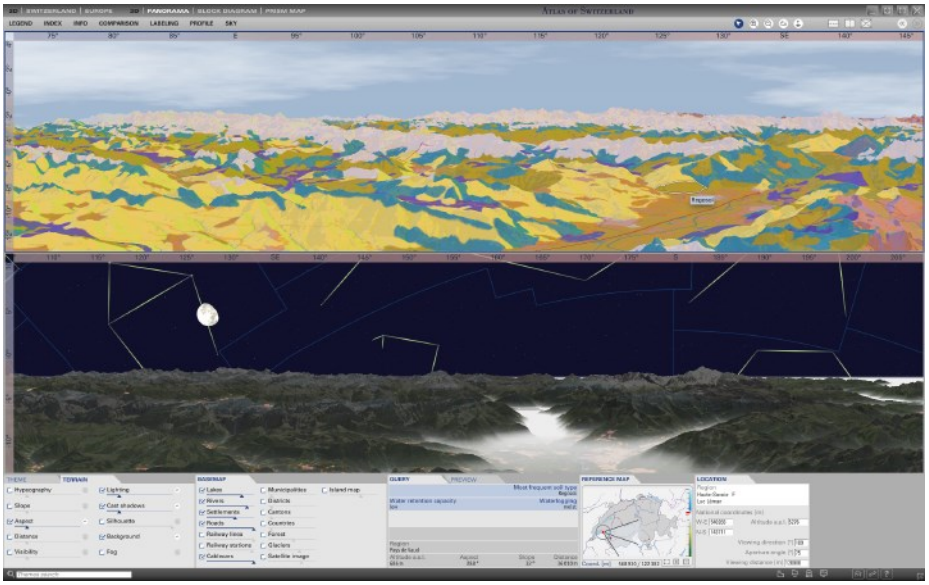

Fig. 2: *Atlas of Switzerland 3.0* showing soil type (top) and night sky (bottom).

Technically, the *AoS 3* is built up from scratch as a client-side C++ desktop application with proprietary data formats and user interface, since there were no suitable standards at that time. The development of the atlas was fully realized at the *Institute of Cartography and Geoinformation*, with a small core team of six collaborators.

As a long-term project of the Swiss Federation, further atlas research and development for another decade is on schedule, considering the rapid evolution in cartography and related fields. Thus, the focus will be laid on online cartography with real-time 3D visualisation of geographic data (Sieber et al., 2013).

While research will strongly concentrate on 3D cartography and atlas usability, applications will be developed in parallel. As a basic framework for future atlas products, a general 3D atlas platform *SwissAtlasPlatform (APS)* has been proposed (Sieber et al., 2011). The *APS* system architecture consists of an atlas core and additional atlas extensions. The most important part of the *APS* is the 3D visualisation engine *osgEarth*, an *OSG*-based virtual globe. The *osgEarth* technology offers real-time rendering and navigation, high geodetic quality, dynamic streaming of large data sets, multi-resolution terrain representation including a level-of-detail approach (LOD), and finally the visualisation of raster and vector maps. However, *osgEarth* lacks of a cartographic toolbox with methods for thematic mapping, especially for the representation of point and line diagrams. Yet, the *APS* has an interface for data base connection and Web services and is running by means of a plug-in in the Web browser.

Based on this *SwissAtlasPlatform*, the product line *Atlas of Switzerland* will be launched in the coming years as a desktop version *(AoS–online)* and probably also as a mobile version for tablets *(AoS–mobile)*. They both will offer a broad range of thematic maps in 2D and 3D visualised with 3D techniques (Figure 3).

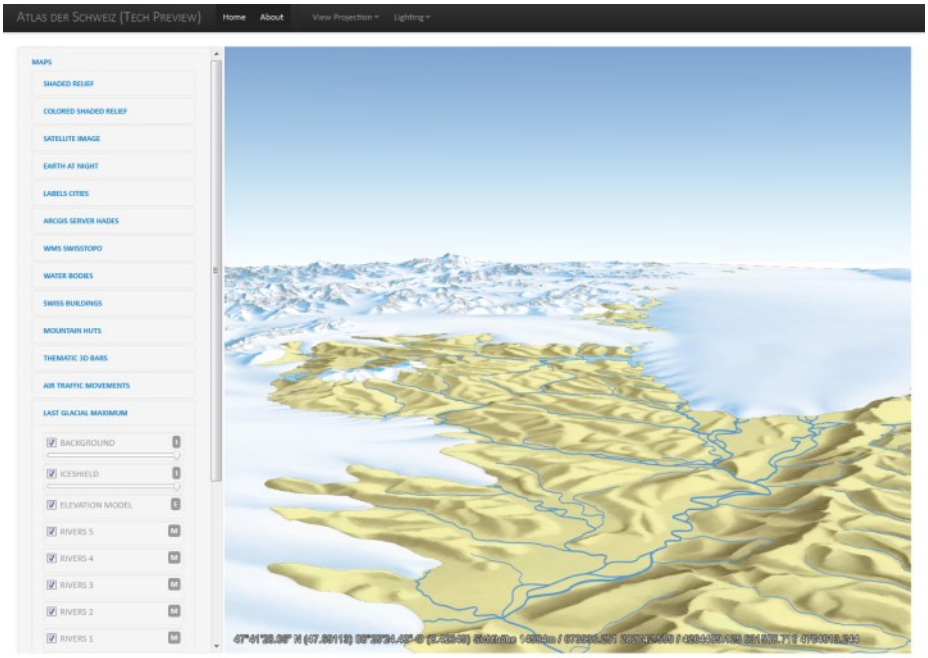

Fig. 3: Prototype of the *Atlas of Switzerland–online* (3D representation of the last glacier maximum in Switzerland).

3.2 Swiss World Atlas Interactive

Although the printed school atlas is well established in Swiss schools of the secondary school level, it contains some deficits and lacks: the complexity of many map types (e.g. economy maps) is rather high; the map content remains static, and the atlas content could not be updated within reasonable time. To face these negative circumstances the project of a web-based and interactive school atlas was started in 2005. The first version of the new *Swiss World Atlas interactive* was then launched for free access in 2010 (Haeberling et al., 2011; SWAi, 2013). This complementary part of the printed atlas is intended to serve in many teaching situations: It can be used as modern wall map to explain geographic features and processes within the classroom as well as a learning tool for students at home. Not at least, the interactive atlas is a valuable source for teachers to prepare their lessons by creating worksheets or presentation slides.

It is consciously intended that the content and the graphic design of the *Swiss World Atlas interactive* follow the printed version so that they can easily be used in parallel. Even all the provided topographic or thematic maps are well adapted for screen display regarding the symbol size, the colouring, or the labelling, the strong relationship between the cartographic representations in this and the printed version will be still well recognised.

However, not only classic maps are integrated, but also additional viewing modes are offered in this innovative atlas information system: Block diagrams with different textures are suitable for large scale landscape sections to depict more mountainous regions. The perspective views permit to better understand the relations between the topographic features and the terrain structures. World wide thematic topics can be ideally presented on an implemented virtual globe (Figure 4). Within this mode, regional or global differences of physio-geographic or socio-economic distributions can easily be explored. Additional interactive 3D models and animated illustrations explain intuitively complex contexts and processes. For example by applying the map projection tool, the transformation of different country shapes can easily be visualised. Furthermore, a dynamic 3D model of the earth revolution enables the students to understand the seasonal day length at a specified location.

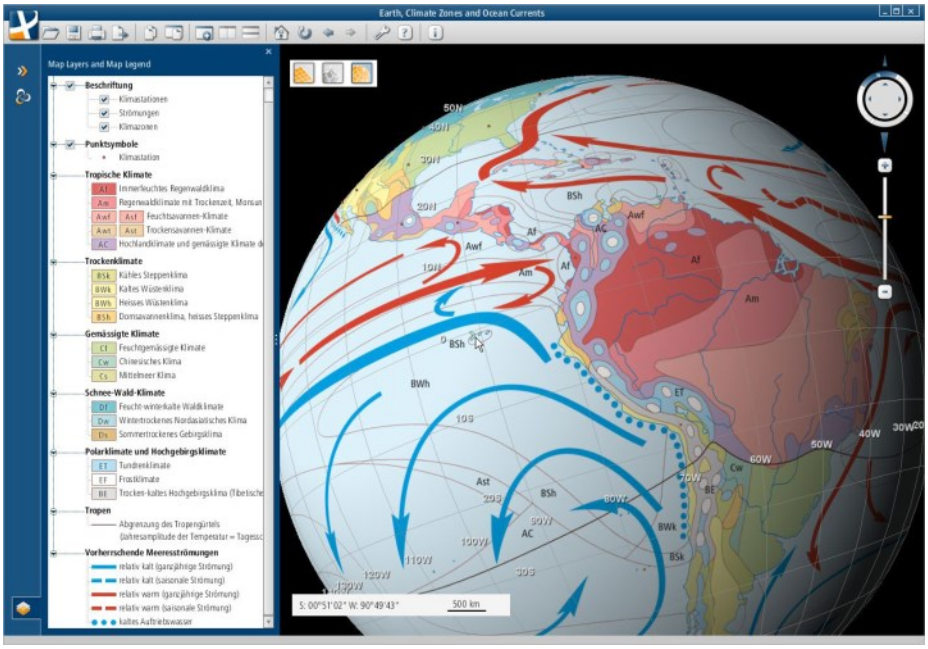

Fig. 4: The *Swiss World Atlas interactive* enables attractive visualisations of global topics on a virtual globe.

For all of the implemented cartographic representations fully interactive legends in four languages are integrated. These legends as well as the map layers are similarly structured respecting the focussed map topics or topographic object classes of the underlying base maps. By clicking the map layers on and off, the map complexity can easily be controlled. Especially the screen-optimised labelling can be hidden for so-called "dumb maps". Doing so, the challenge for students to recognise regional features or processes can be much higher.

The whole functionality and interactivity of the *Swiss World Atlas interactive* is provided with an easily operable but also attractive graphical user interface. It was especially designed for a quick access and an intuitive handling for the two main target groups, teachers and students.

Beside the obligatory and expected navigation tools like panning, zooming, or functions for layer visibility and additional request of object information, some other remarkable specialities of the numerous interactive functions can be pointed out: a special index for favourite self-prepared maps complement the general geographic and a thematic map content index. In addition, attractive views on two or more maps for simultaneous comparison and synchronisation can be achieved by a multiple screen splitting. Last, a bunch of functions for saving and exporting map extracts is also provided.

Since its launch in fall 2010, the *Swiss World Atlas interactive* has become a well-known electronic teaching tool for the geographic education within Switzerland. Many promotional presentations were given and several scientific contributions have been written since then. Special highlights are certainly the gain of two awards for the most innovative Swiss cartographic product.

Nevertheless, the number of regular users is quiet lower than expected yet. Interviews and discussions with geography teachers show that a lot of them know the electronic atlas from first-hand experience. Many of them derive maps and illustrations to enhance and complete their teaching material. However, the direct use of this interactive school atlas in the classroom is unfortunately rare. Main reasons for this deficient use are the cumbersome operation in many computer labs, the lack of maps covering the appropriate thematic topics, and – last but not least – the strictly limited teaching time.

In future, the content of the *Swiss World Atlas interactive* will be enlarged gently with selected interactive maps and other derived cartographic representations. The current Java-based technology will certainly be transferred to a more user-friendly browser-oriented architecture. Furthermore, an increase of promotional activities like workshops for teachers, presentations at schools, and regular newsletters in educational magazines or websites will hopefully bring this school atlas the deserved acceptance.

3.3 Literary Atlas of Europe

The latest atlas project at the *Institute of Cartography and Geoinformation* is the *Literary Atlas of Europe* (2012*)*. Launched in 2006, this interdisciplinary research project gathers a team of experts from various disciplines and fields: cartography, literary studies, graphic design and software development.

Starting point of this project is the observation, that each literary plot is located somewhere, along a scale of localisations that range from the realistically rendered, highly recognisable to the completely imaginary. So far, a concise theory and convincing instruments to deal with the specific geography of literature have been lacking.

At the core of the project are literary-geographical case studies of three model regions, all three of them offering an abundance of fictional settings: Lake Lucerne/Mount Gotthard as a sublime, alpine landscape, Northern Frisia as a coastal region between water and lands and Prague as one of Europe's cultural capitals, with a rich history and a multilingual background.

Trying to answer the very first and supposedly simple question where literature is set turns out to be surprisingly obstinate. As a matter of fact, literary spaces follow their own rules and consequently confront cartographers with numerous open problems. Fictional space tends to be fragmentary, places often show uncertain or vague boundaries or are hard to localize and possibly extend over vast periods of time. Last but not least, fictional spaces may depart from the "real space" with different degrees.

Unlike loosely related projects, the Literary Atlas does not base on automated, algorithmically extracted literary places but relies on the expertise of literary scientists to build up a consistent and richly attributed database. On a top level, the spatial literary entities are captured either as setting (place where characters act), projected space (where characters are only mentally present), zone of action (a consistent group of settings), marker (mentioned place without action), and route (where characters move along). Maps are conceived for individual texts, but also for large groups of texts, in view of statistical queries. Figure 5 shows a map portraying the literary places of an individual text, Zikmund Winter's "Magister Kampanus". Proceeding to larger collections of texts such as the settings of the complete literary works of a region, statistical representations will be more appropriate. Figure 6 shows an estimation of the literary density of the City of Prague based on all included literary works written between 1861 and 1918.

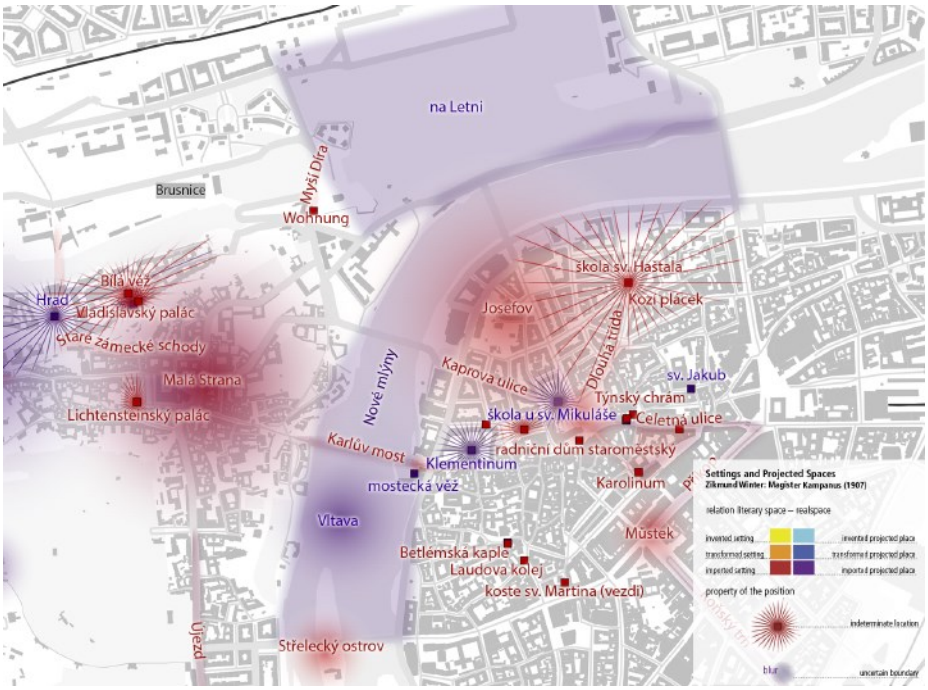

Fig. 5: Literary places of an individual text, Zikmund Winter's "Magister Kampanus".

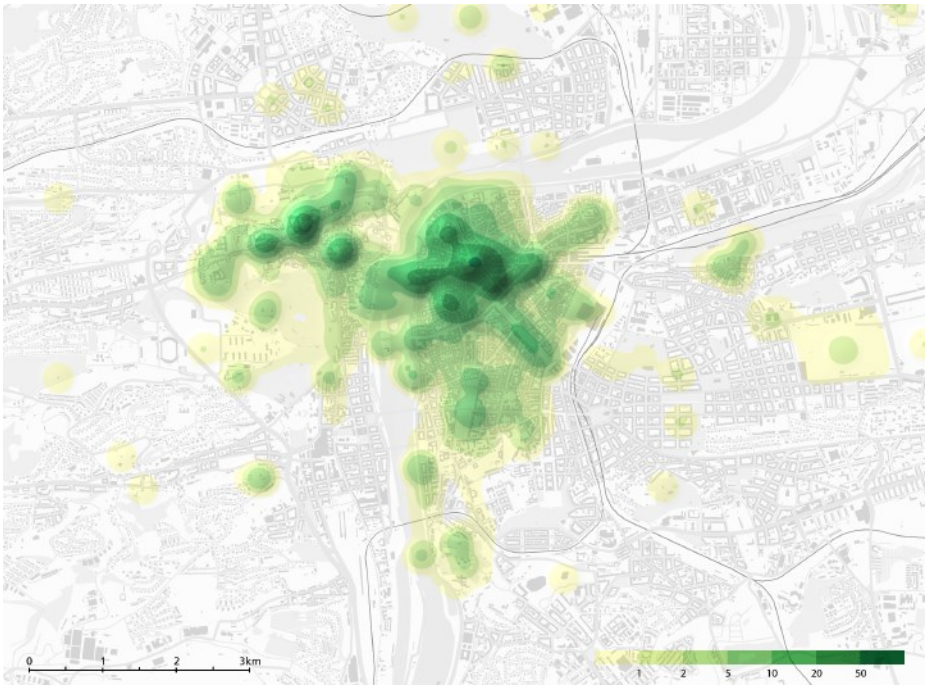

Fig. 6: Estimation of the literary density of the City of Prague based on all included literary works written between 1861 and 1918.

Unlike a traditional atlas information system, the Literary Atlas will not present a self-contained portrait of a literary landscape consisting of a comprehensive collection of fully designed interactive maps. Foremost, this atlas intends to be a research tool for literary geography, providing a collection of tools and methods for visualizing and analyzing literary spaces and offering a database for literary places and attributes. In order to make this approach widely accessible, work is currently running on an online toolbox, which will allow researchers or research groups to investigate their chosen literary landscape or urban space, according to their specific interests. Hence the *Literary Atlas of Europe* has to be seen as a collaborative project where data and material are collected by future users.
When this atlas project will end in fall 2013, there is a real hope that the effort undertaken will live on. An open source and public browser-based platform will be available with a selection of crucial tools for literary cartography research. One of the goals is that literary scholars can produce convincing illustrations by themselves, without significant help of cartographers. Further plans include a *Handbook of Literary Geography and Literary Cartography* (publication expected in fall 2014), which will contain the research history, the current knowledge in the field, theoretical essays, remarks about unsolved problems, a number of case studies of both, literary cityscapes and landscapes, a glossary and a concise bibliography. The *Literary Atlas of Europe* project will then certainly have contributed a prominent part to the highly dynamic field labeled as Digital Humanities.

4 Future Developments and Trends in Usability and Technology

4.1 General Trends and Developments in the Field of Atlas Information Systems

The experiences with various atlas projects at the *Institute of Cartography and Geoinformation* have shown, that after a phase of stand-alone, off-line Atlas Information Systems (AIS) like the *Atlas of Switzerland*, the time is now ripe for interactive, on-line, Web-based AIS. Display and rendering technologies allow for a graphical quality which is equal to the mentioned off-line systems and which allow for a similar visual appearance as on printed maps, but enriched with various interactive functions. Currently, the migration of such applications on mobile devices is envisaged by many providers of interactive map systems. Generally, it can be said that depending on the size of the available device interface, map extent, functionalities, and interaction possibilities must be reduced. On the other hand, the access to cartographic information is simplified by touch screen interaction. Due to this and to affordable prices, these devices will play an important role in education and outdoor activities. Furthermore, the availability of public, private and user-generated geo-data (e.g. topographic or statistical data) has significantly increased.

4.2 Current and Future Research

In the near future the research and development in AIS will continue in several conceptual and technological directions: The use of such systems is not very well known. Specifically directed user surveys will give insight into user behaviour and valuable hints for further developing atlas content, map design, GUI design and interaction design. The role of vector data will increase. New hardware and graphics devices allow for faster high quality visualisation and interaction of vector-based map objects, both in 2D and 3D. Significant parts of the analytical ("number-crunching") and graphical processing will be outsourced to the Graphical Processing Unit (GPU computing). New computer screens such as the Apple Retina Display allow for resolutions which come close to a paper map. The future of cartographic data management is cloud-based and database-driven: Data for cartographic visualisation, whether it is low-structured "Big Data" or highly attributed statistical or GIS data, will reside in the cloud or in sophisticated multidimensional databases.

The described technological development will hopefully also lead to a more versatile use of software tools in the field of interactive atlas cartography. Fragmented tools (e.g. "Apps") could be individually assembled to fulfil user-specific needs. Larger systems can be based on modularised atlas platforms which allow a proper separation of data from distributed sources and specific functions. We hope to reduce the technical effort in a way that users themselves might be able to combine the data and tools, e.g. in applied student's projects. Another topic might be the question how to internationalise the Swiss specific development of a school atlas (language adaptation, automatic choice of local map extents and thematic data, etc.).

In mobile cartography, the deconstruction of existing interactive atlas concepts into adapted selections of data, functions and interaction possibilities will be a major challenge. The choice of appropriate Apps and interactive models should lead to scenarios for future AIS developments. Based on simulations, self-studies, knowledge tests, and usage or commercial aspects of such Apps can be investigated.

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