Digitisation of maps – only a colourful picture or a value added service?

Keywords: Digitising- and georeferencing-projects; old land surveys; GIS; transformation; WMS

Summary: The digital processing of scanned map sheets and the vector calculation necessary for today’s geodetic systems in order to integrate the maps into GIS driven software is only possible when institutions invest an enormous amount of time, and when they have knowledge in history and geodesy, expert qualification and adequate financial resources. Only the project Sächsische Meilenblätter with a university of applied sciences as cooperation partner has been possible without external financing. They tried to find a new way: for the students it was part of their studies and therefore the project had no staff costs, the results met all expectations and it was worth the efforts. In this context, the possibility for students to write theses is not only a side effect, it can stimulate innovative methods and a continuous dynamic adaptation. For the public and for the research community Web Map Services open new perspectives. The first project, the Digital Wenker-Atlas, has become the basis for an important follow-up project, linguists have obtained a completely new tool for unexpected areas of research and use it very extensively and also way beyond the Institut für Deutsche Sprache. Historic land surveys are not only used by scientists but also by public institutions and a broad group of local historians who are interested in old landscapes. For special applications, new technical possibilities are of immediate use, for example, in the fields of forestry, archaeology, protection of nature or regional planning. It is not only the quantity of the digitised map holdings of now ca. 25,000 sheets from the map department of the Staatsbibliothek zu Berlin, which is rather impressive. What is especially in the focus of our activities is the high-quality and application-oriented processing, which we are only able to achieve with reliable partners at our side.

Introduction

The availability of research sources, independently of time and place, is nowadays generally expected from archives, libraries, institutes and museums. The screen provides only a limited substitute for the original, there is a loss of haptic experience, especially with large objects like maps, the screen allows only a reduced view of the complete item. Cartographic as well as all visual materials have the special advantage that the user has an overview of the whole map and can simultaneously concentrate on details, whereas on the screen the zooming in on details has become a powerful feature. In that respect the electronic copy adds a very useful aspect to the examination of the original. On the web there are already many digital collections of cartographic materials, which allow a comfortable view on or analysis of spatial or spatio-temporal phenomena. The available viewers also get more and more comfortable and efficient. The aggregation of a great number of single images or maps in electronic collections or databases has only a limited value, because the real potential of today’s technical possibilities is barely used. This is particularly true for map series, whose value and purpose lies in the possibility to take single map sheets and form large areas or even to combine several information layers (contents and/or time). Under this aspect, I wish to present three projects carried out by the map department of the Staatsbibliothek zu Berlin, in cooperation with external partners. Map collections which are part of libraries or archives are hardly in a position to carry out digital data processing, as, for example, the complex georeferencing process. On the one hand the de-

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partments lack staff which has been especially trained for these tasks, namely cartographers or surveyors, on the other hand they do not have the hardware and the software which would be necessary for complex vector calculations. So the only way is to search outside the institutions: either one pays for the service, or one seeks cooperation with other institutions. During the past years the map department of the Staatsbibliothek zu Berlin has tried different solutions, which were adapted to the aims of the project and the possibilities of the partners and could be carried out without great expense. The main task for the map department was to provide the digital data, to formulate the objectives of the project, and to give consultation.

**Project 1: The digital Wenker Atlas**

Georg Wenker (1852-1911) was a linguist and librarian who tried to map the regional linguistic differences in the German Empire. For this he developed comprehensive questionnaires, which he sent to teachers at every village school asking them to answer in the local dialect. The survey period for the planned „Sprachatlas des Deutschen Reichs“ (Linguistic Atlas of the German Empire) were the years between 1876 and 1887, during this time the questionnaires were sent to more than 40,000 places. He recorded the survey results of the selected terms and standard sentences on a standard map pattern. For this he selected the index sheet of topographic maps of Germany at the scale 1:25,000, which itself was available at the scale of 1:1 million. Thus between 1888 and 1923 1,668 hand-drawn maps were created, maps for the world’s most comprehensive linguistic atlas, for which Wenker used symbols and up to 22 colours. For technical as well as financial reasons only a small part of the data were published between 1926 and 1956 - in successive parts and printed only in black and white.

The digital processing of the original hand-drawn Wenker maps which are part of the collections in Marburg and Berlin could be started in 2001 at the Institut für Deutsche Sprache (Institute for German language) of the University Marburg an der Lahn. It was done in the context of a project financed by the Deutsche Forschungsgemeinschaft (German Research Foundation). Each of these maps consists of 3 parts, a northwest, a southwest, and a northeast map sheet. After scanning, the different parts were joined digitally and then formed one single map. Other parts of the project „Digitaler Wenkeratlas“ (DiWA http://www.diwa.info - further information: http://de.wikipedia.org/wiki/Deutscher_Sprachatlas) were the georeferencing of maps at the intersections of the grid lines on the index sheet and the integration of additional maps from later regional surveys. Thereby it is possible to find signs of linguistic changes on the maps. Yet, also other maps on social demography, traffic infrastructure, or elevation models are available for the analysis of language change (Herrgen 2007 a; Rabanus 2005, Kehrein et al. 2005). In the meantime the financing of the project has come to an end, but the Akademie der Wissenschaften und der Literatur Mainz (Academy of science and literature Mainz) has taken over the financing of a longtime project focussing on the analysis of the data. Its name „REDE“ (i. e. Regionalsprache.de) designates a GIS-based web portal for the study of regional language phenomena. The portal provides a great number of functions, it is an excellent platform for research and the general public, and it opens the way to new research issues (http://www.regionalsprache.de). Not only the use of map layers, but also the links to the questionnaires, to original sound recordings or bibliographic references provide a completely new digital research environment. Modern techniques greatly help to better understand and interpret the original item (Herrgen 2007b; Lameli 2013).

**Project 2: Sächsische Meilenblätter (Saxon mile sheets)**

From 1780 to 1806 the first area-wide mapping of the Kurfürstentum Sachsen (Electorate Saxony) took place. The engineering corps under the direction of Major Friedrich Ludwig Aster (1732-1804) was commissioned to carry out the mapping. The trigonometric survey started at the baseline at Pirna, the method used in mapping was the plane table method. The land survey was car-
ried out with the intersection procedure, at a later moment the hachuring technique of Johann Georg Lehmann (1765-1811) was applied for the representation in maps. As the base line was also the sheet border, the map series is not oriented to the north, but turned about 42° to the west. The sheet size is a square ell and shows an area of a square mile, from that is derived the name „Meilenblätter“. The relationship between the Dresdner Elle and the small Saxon Mile gives a scale of 1:12,000. Today the original sheets belong to the collections of the Sächsische Landesbibliothek Staats- und Universitätssbibliothek Dresden (SLUB). Immediately after the production of the originals, copies were made for the royal house. After the Battle of Leipzig in 1813 these sheets were handed over to Prussia and since 1919 they have been part of the holdings of the map department of the Staatsbibliothek zu Berlin. This collection is called „Berlin edition“ and comprises 371 map sheets. They constitute the best preserved version, and therefore in 2006 they were the basis for the digitisation project, carried out in cooperation with the SLUB (Brunner 2002, Moser 2013).

At the same time the faculty of spatial information of the Hochschule für Technik und Wirtschaft in Dresden (University of applied sciences) became another cooperation partner. Under the guidance of Prof. Müller her students georeferenced the mile sheets. At first it was necessary to reconstruct the historical system in order to be able to relate it to today’s reference system. The grid intersection points on the map sheets were taken as a basis. As early as 2007 there was a first thesis on the workflow for the integration into a Web Map Service (Muschter 2007). For the first time, the server of the university of applied sciences hosted a browser-based version of the seamless presentation of the complete map series including a zoom function for single details. The public may freely access this version. In the meantime the map series has been integrated into the geoportal Sachsen-Atlas (Atlas of Saxony) (http://geoportal.sachsen.de/); thanks to the many application modules it has become an important working tool for federal state planning (Müller 2009).

The connection of the old with the new reference system implies a rotation of the mile sheets, they have to be turned to the north. For the presentation on the screen the writing which originally was horizontal had to be turned. The integration of free data, an infinitely variable transparency of maps, and the availability of drawing as well as other standard tools make the geoportal of historic maps a real multifunctional website for applied research related to local history.

**Project 3: Schmettau map series**

The results of the third and most recent project are similar to the results of the second project presented here. It has been developed following an initiative of the land-owned enterprise Forst Brandenburg which had a specific purpose. In order to find the locations of forests and wooded areas of Land Brandenburg at the end of the 18th century, it was necessary to analyse maps which covered the whole area of Prussia at a scale of 1:50,000 and which were created under the guidance of Graf Friedrich Wilhelm Carl von Schmettau between 1767 and 1787. 270 sections altogether were created without the basis of a trigonometric net (Flint, Jordan 2008). In addition to mapping on site, already existing maps were used, and modified according to the specifications for the map series. Nevertheless Scharfe said „… in Inhalt wie in Umfang das Beste (…), was für Brandenburg-Preußen bis zu dieser Zeit an topographischen Karten vorgelegt werden konnte“ [regarding contents and comprehensiveness the best (...) topographic maps of Brandenburg-Prussia existing until that time] (Scharfe 1982, p. 1). The area of today’s federal state Brandenburg is covered by 32 sheets provided for the project in a digital format.

Supported by funds from the European Fund for Regional Development (EFRE), the land-owned enterprise Forst Brandenburg was able to create a web portal for forest geodata, which was to also include historical data on wooded areas. Besides the Schmettau map sheets, topographic map sheets from around 1900 were also analysed. In the geoportal have been included only historic map sheets showing wooded areas with their vegetation characteristics. For this purpose the areas were extracted after the georeferencing process and then, according to their use (closed forest, thin
forest, heathland, broad-leaved forest, coniferous forest, mixed forest etc.), they were colour marked, so they can clearly be distinguished (http://www.brandenburg-forst.de/webgis/).

The complete digital data of the Schmettau map sheets were, however, transferred to the Landesvermessung Geobasisinformation Brandenburg, in order to prepare them for the Brandenburg viewer. That made also this map series freely accessible for the public, though the resolution could have a better quality. I will use this example to explain the efforts connected with the georeferencing of a land survey, in case there is no trigonometry.

A number of work steps were necessary, so the Landesamt Forst Brandenburg, the body responsible for the project, commissioned an engineering firm (Schröder, 2012 and 2013). Because many map sheets were cut and pasted on linen, the trimming edges had first to be joined again and then be adjusted by connection lines (Fig. 1). In a second work step control points in locations were searched for, which then as well as today can be found on maps. Primarily suited for this were churches, city gates or castles. Most surprising was the fact that there were discrepancies regarding the exact position of places Fig. 2). In some cases even the complete location was distorted (Fig. 3), for example: instead of its real position northwest - southeast as shown in the Schmettau map series, the real position of the village Schönow is northnortheast - southsouthwest. More control points were looked for in the open country, control points which can still be found on today’s maps, like tar ovens, mills, bridges or road junctions, so that as many vectors as possible were available for calculation (Fig. 4). In order to make the transition from one map sheet to another as precise as possible, all margin points were filed (Fig. 5). As a result of the vector transformation (Fig. 6) the map sheets were distorted (ill. 7) and could subsequently be joined electronically.

Figure 1: Map sheet trimming edge and connection lines.
Figure 2: Real position of control points in a town (green: position Schmettau, red: correct position, blue: vector deviation).

Figure 3: Distorted position of the place (green: position Schmettau, red: correct position, blue: vector deviation).
Figure 4: Vectors of control points, map sheet Berlin.

Figure 5: Margin points, map sheet Berlin.
The result which you can see in the Brandenburg viewer (http://www.geobasis-bb.de/bbviewer.htm) is a preliminary version offering a still low resolution in the presentation of the historic Schmettau land survey. The usual tools to measure distances and areas on maps are not yet available. Instead, a two version model is being discussed: One version should remain freely accessible for the public and a second one with a very high resolution should be reserved for registered users from the research sector and regional government authorities. The idea is to prevent any misuse in connection with the unique hand-drawn items. Even in the delicate domain of the protection of copy and property rights, the rapid technical development brings about modifications which, though requiring only small investments, will provide a wide range of benefits.
References


