LANDSCAPE DYNAMICS AND HISTORIC MAP SERIES OF SAXONY IN RECENT SPATIAL RESEARCH PROJECTS

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1. Landscape dynamics

Landscapes are changing. Human influence on landscaping and landscape protection should consider information about how the landscape was centuries ago. Researchers of spatial sciences, as well as landscape ecologists, analyse data about historic landscapes - primarily about historic land use. They learn about former landscape components, such as alleys or hedges, or the existence of potentially sensitive areas. They also learn about the dynamics of landscape functions like water retention or recreation potentials. The results of the analysis are to be included into recent documents of landscape planning and nature protection. This will help to preserve scenic and biological diversity.

2. Historic land use information

Who could tell us what the landscape was like centuries ago? Paintings can picture portions of regions, and writings can describe the appearance of scenery and contemporary land use. According to their nature maps offer homogenous terrain information that covers a certain area – sometimes a whole country or even greater areas.
The suitability of the historic maps concerning exploitable land use information depends on different features. These include scale and thematic content as well as the accuracy of survey and compilation at that time. Moreover, the maps have to exist somewhere in archives and be available to the researchers.

3. Historic map series of Saxony

3.1. "Sächsische Meilenblätter" - Saxon mile sheets

In 1780, Major Astor began a military-topographic survey of Saxony based on a triangulation covering the whole country. Following the measured baseline near Dresden, all map sheets are turned for about 42° to the west. The name of the map series is caused by the mapped area per sheet; one Saxon mile (about 6,8km) is projected to 56,6cm on the map; and that in both east-west- and north-south-direction. The scale is 1:12,000.

The topography was surveyed trigonometrically; the distances were measured by counted footsteps or just estimated. The detailed map content like buildings, lanes and roads, surface waters, various land use types and the dominant relief hachuring was hand drawn with coloured ink. One copy was made for the King of Saxony. These sheets are now archived in Berlin and called "Berliner" copy. The survey, due to some interruptions, became a task of decades. In 1819, another copy was made now dedicated to the mining industry and sciences with a slightly different notation called "Freiberger" copy. Note: The "Meilenblätter" contain no legend to explain the map symbols.

Fig. 1: Detail of the **"**Sächsische Meilenblätter" - Saxon mile sheets.

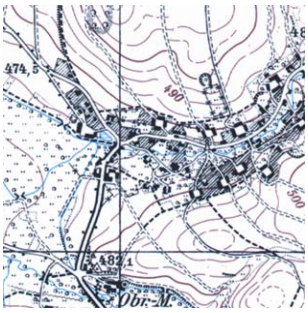
3.2 "Äquidistantenkarte" - Map with constant contour value

The developing sciences and industries of the late 1800's required an up-to-date map for public use in a proper scale. In 1870, Colonel Vollborn started to direct the works for a map with the scale 1:25,000. The relief in these maps was represented by lines of a constant contour value "Äquidistanten". The advantage was that there was more space available for thematic entries in the map. This new map series based on the topography of the mile sheets supplemented

with additional measurements and accessory maps. It has a different sheet line system, and is now north-oriented. Different colours are used to show buildings and settlements, waters, roads and railroads, land use and the added hill shading. The map published by copperplate print and lithography looks very aesthetic but doesn't show a legend either.

Fig. 2: Detail of the "Äquidistantenkarte" Map with constant contour value.

3.3 "Messtischblätter" - Plane table maps



In 1900, Saxony got surveyed once again. Results of European and former Saxon geodetic measurements were now included. Major von Carlowitz led the very precise plane table survey of topographic elements and included elevations. He had to apply Prussian prescriptions for the map making process. Among other things, they prescribed the classification of the topographic objects and specified their map symbols through a detailed legend. The scale for the 156 Saxon map sheets is 1:25,000. The map was printed in three colours and published in many editions up to the middle of the 20th century.

Fig. 3: Detail of the "Messtischblätter" - Plane table maps.

Can these maps be useful to gain historic land use information? And what has to be done to explore them in geo information systems (GIS)?

4. Utilization in Geo Information Systems

A team of cartographers and landscape ecologists working at the Dresden based Institute of Ecological and Regional Development (IOER; www.ioer.de) started to use the three historic map series of Saxony to extract land use information from the past. Previous projects like MURBANDY (Monitoring Urban Dynamics) had delivered a large amount of airborne and satellite information especially for the Dresden region. Now these data sets from 1998 down to 1950's had to be expanded into the past till 1780.
Some steps were necessary to utilize these maps in the digital world of GIS:

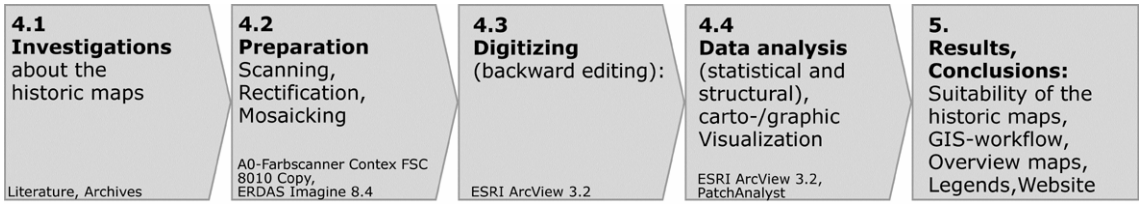


Fig. 4: Workflow

4.1 Investigation

Usually it takes some time to find out which library or archive stores the precious cartographic documents. More than that, it depends on trust and willingness to cooperate to get the map sheets on loan.
Work with historic maps requires knowledge about the initial map making – original purpose of the map, procedures and accuracy of survey, instructions for thematic data capture, guidelines for drawing, compilation, selection, and last but not least, about eventual map revisions. "Modern" investigations using the internet failed for the lack of relevant websites. The traditional way of investigation - detecting and studying special publications, led to valuable information especially by Stams (1, 2, 3) and Brunner (4, 5), experts on historical cartography in Saxony.

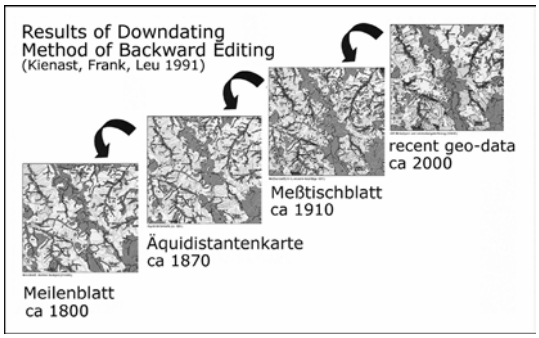
4.2 Preparation - digital workflow

The analysis of the historic maps is currently done with the help of geo information systems. So the analogue maps have to become digital data. Scanning with the CONTEXT FSC 8010 scanner generates TIF-files as first digital results.
The further steps like rectification and mosaicking are professionally supported by ERDAS Imagine - a powerful geo information system for the analysis of large image data. Thus the TIF-files have to be converted into the ERDAS-file format IMG. Certain data options have to be set to allow optimal processing.

Geo-rectification, with recent topographic maps as reference data, connects the pixels of the “simple” raster data file with geo-coordinates. Using these coordinates and a special resampling model the image will be geometrically corrected. The resampled images can finally be joined with their neighbouring sheets generating a so called image mosaic.

4.3 Digitizing

Now the historic maps are prepared to be explored in GIS for example ESRI ArcView.
The relevant land use classes have to be identified and manually digitized on screen. This is possible if the legend reveals the meaning of the map symbols. But neither “Meilenblätter” nor “Äquidistantenkarte” contain such keys. Most of the symbols are more or less self-explanatory. The rest had to be interpreted with the help of special knowledge and the particular map context. At this time a matrix of map symbols of the three historic map series has been compiled (see 5.1 Fig. 8).
Diligent work is necessary to extract the relevant land use classes and fix them into vector data sets.



To gain information about landscape dynamics three map series varying in age had to be interpreted (see 3.). Therefore it makes sense to digitize the historic land use information according to the approved method of backward editing (Kienast, Frank, Leu 1991 (6)). Thus the current geo-data (like recent topographic information) have to be compared and edited according to the previous map information. This avoids the time-consuming digitizing of each period.
The results of digitizing are a series of vector data sets with appending attribute information.

Fig. 5: Downdating of the historic land use information.

4.4 Data analysis

GIS supports various ways to visualize and analyse the extracted historic geo-data.
The vector data can be overlaid with each other to demonstrate the temporal changes. In recent research or planning processes the vector data can be combined with different geo-data and contribute the historic land use information. The accuracy of mapping makes it possible to detect areas which had no land use changes within any period. That could be an indictor of a potentially valuable ecosystem.
Methods of statistical analysis not only lead to numerical results, but also to a variety of chart types illustrating the data characteristics. The ESRI ArcView extension PatchAnalyst supports structural geo-data analysis. It allows the derivation of landscape metrics describing structural characteristics like shape or neighbourhood relationships (Walz (7, 8)).

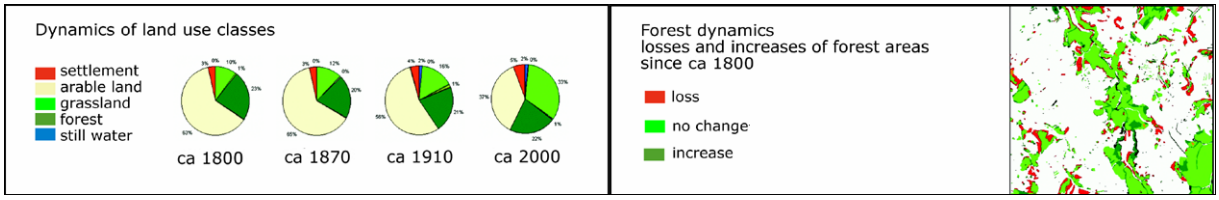


Fig. 6: Results of the data analysis.

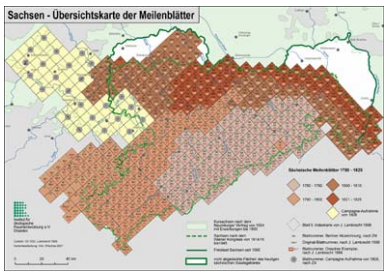
4.5 Storing/archiving

The extracted vector data sets become a part of the geo-data set that is used in everyday GIS work. ESRI shape format is in common use and can be transferred into different vector file formats.
The digital historic maps are of equal value. They have to be archived in an acceptable way – compromising between image qualities and storing capacities. Image file formats that support loss-free data compression are certainly to be preferred. Anticipating a long time storage geo-data should not only be kept on a data-server but also be saved on CD-ROM. Which of the results have to be kept must be determined: scanned raw image data, geo-rectified image sheets or the mosaic as a whole.

5. Results

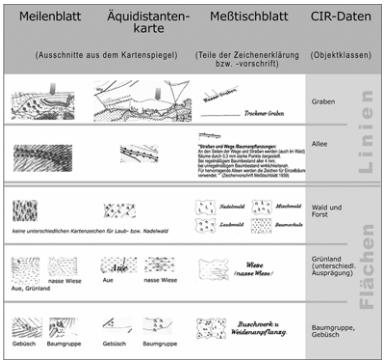
5.1 Landscape Dynamics

The historic map series of Saxony proved to be suitable to get information about the historic state of the landscape. The thematic map content is detailed enough and the accuracy sufficient.
Thus, the recent data-sets of landscape monitoring can be supplemented with the help of historic information.
GIS (in our case ESRI ArcView 3.2) contains appropriate tools to extract, process and visualize the geo-data.
The combination of historic map-information and new GIS-technology supplies valuable information for landscape ecology.
Additionally, some documents were created which have a more general significance for users of the historic map series (Witschas (9)):



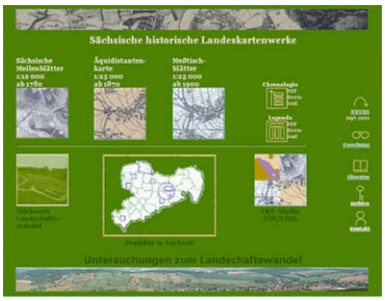
To avoid the trouble of missing or improper map sheet indices an overview map of historic Saxony was created using Macromedia FreeHand. The selected map series with their sheet indices will be shown in a special graphic layer (map by Hild and Witschas 2001).

Fig. 7: Overview map of the historic "Meilenblätter" with map sheet index.



Reading maps means decoding their map symbols. That is usually supported by attached legends. To manage the work with "Meilenblätter" and "Äquidistantenkarte" neither of which contain keys, the necessary map symbols were digitally cut off the maps and compiled in an overview legend.

Fig. 8: Detail of the compilation of the relevant map symbols (Legend matrix).



It is desirable to find more information about historic maps on the internet. It is also necessary to communicate about projects, to publish both problems and achievements. The website www.ioer.de/nathist/ offers information about the historic map sheets of Saxony as well as projects utilizing these maps for research on landscape dynamics. It also allows downloads of the results like the overview maps and legend presented above.

Fig. 9: Website www.ioer.de/nathist/.

5.2 Historic Flood Mapping

The Elbe flood 2002 caused huge flooding damage in Saxony. Future flood management includes comparison with floods of the past. Fortunately, the last two enormous floods of the river Elbe in 1845 and 1890 had been documented in specific maps. Scientists of the Institute of Ecological and Regional Development Dresden succeeded in detecting and exploring these maps. Using the mentioned experiences, they created digital vector data sets describing the particular flood area and the historic riverbanks. These data sets can be overlaid and compared with the recent flood area data helping the researchers to draw their conclusions.

5.3 Basic use of historic maps

The use of historic maps in GIS is not an exceptional case today. Due to the used maps, the aspired aims and the technological approaches they vary. But they have a number of aspects in common. The project teams should communicate problems and insights via worldwide web to solve similar tasks more effectively.
It is indispensable for such research projects to have background information about the historic maps. Thus the knowledge accumulated by specialists of historic cartography over the last decades finds interested readers and up-to-date applications. The internet could be promoting this, too.

Using historic maps in recent research projects develops a source of geo-information from the past. That means not only honouring the work of "ancient" cartographers; but it also supplies landscape ecologists and planners with necessary historic information. Good reasons for a revival of "old" maps.

Selected Literature

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