

On production and importance of digital cadastral photomaps in the newly-formed German states

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1. INTRODUCTION

The supply of large-scale maps at suitable scales and with suitable ground plan data including representation of real estate documentation rates highly among the manifold tasks and problems in the newly-formed German states.

All investors depend on the securing of their property values. A clarification is only possible with the help of the land registry. Each planning - even the most simple one - requires complete and current cadastral maps.

Today's cadastral maps in the newly-formed German states can only insufficiently meet these high demands. Therefore, there are general demands towards a "framework map" series that clearly describes the legal conditions including complete coverage and topography. ("Framework-maps" are maps on which the detail extends over the whole area enclosed by the neat line or to a bleeding edge.) More far-reaching also factually justified demands require the real estate documentation in digital form, related to the national network of control stations.

2. THE STARTING POINT

The only large-scale and exhaustive map series in the newly-formed German states is the cadastral map series which for the most part was established during 1820 and 1864. Even from its beginning it was affected by the fact that it almost completely consists of "island maps". ("Island maps" are maps on which only a selected area is mapped in full.) As "island maps" they are sufficient for proof of ownership, but hardly usable for comprehensive planning work:

- The cadastral map series is heterogeneous in itself. Reasons for that are among others missing network of horizontal control stations during the original surveying and the graphic adjustment of results of cadastral revision surveys.
- The cadastral maps exist at a huge number of scales, the scale denominators of which are partly based on non-metric units of measurement.
- Often the cadastral maps only insufficiently show the present use. The last general field check was carried out in 1954. Because there was no duty of building survey, the current building stock is often missing for over 30 years.
- The cadastral map does not show the gaping between proof of ownership and proof of possession. Often no cadastral revision was carried out for newly-built traffic routes, for modern estates and recently built industrial plants.

Besides the cadastral "island maps" in the newly-formed German states also town plans exist at the scales 1 : 1000 and 1 : 500 for larger towns (former district and region centres). They were often established on photogrammetric base (UA), related to a traverse network. Generally, these maps have no connection to the cadastre because they formed the basis for production of special and complex maps of utility lines and therefore no real estate boundaries were included. In smaller towns and especially in rural communities no systematically structured map series exists. Large-scale maps were produced only for preparing building projects.

Summary:

In the newly-formed German states exist:

- cadastral "island maps" exclusively in analogue form, which are out-dated in contents,
- "framework maps" for big and medium-sized towns with complete topography without connection to the legal holdings of cadastre with various levels of revision.

There is no current cadastral survey network.

This situation actually requires quick conventional solutions if one wants to meet the requirements of state and private investors for immediate availability. Demands on the cadastral administrations caused by

- resurveys or
- simplified resurveys

are not realistical considering the urgent daily tasks of the new administrative authorities.

3. NEW SOLUTION APPROACHES TO SHORT-TERM PRODUCTION OF EXHAUSTIVE LARGE-SCALE MAPS WITH CURRENT INFORMATION CONTENTS

One of the first project proposals from private enterprises was presented by INFRA GmbH München und Partner. It comprised the production of an exhaustive large-scale map of the newly-formed German states under the title "Crash program for establishing a digital cadastral photomap (DLLK) as basis for reprivatization for real estates and other land regulation measures" from December 12, 1990.

This ambitious project which should have to be executed by a digital cadastre plc in every state and which planned "a private-enterprise solution for establishing, up-dating and homogenizing of ground-plan and cadastral data of Eastern Germany" was not realized.

The engineering company IWS Berlin has taken up the project proposal of INFRA München for production of a DLLK in modified form. It has defined the technological measures and realized a first pilot project.

Prerequisites for the realization of the project were:

- agreement of the State Surveying Board Brandenburg and of the cadastral administration with the project DLLK Müncheberg and arrangement for a fruitful cooperation
- the division of labour coordinated in the protocols with the State Surveying Board Brandenburg
 - Department of Geodetic Survey -
- the settlings about the joint use of the final product and about handing over of the cadastral map to the Cadastral Administration.

The objective of the engineering company IWS Berlin is with the production of the DLLK to make quickly available a basic solution to the users

- which represents the true-to-scale and current topography in the aerial photograph (orthophoto) optionally at the scales 1 : 500 to 1 : 2000 as "framework map";
- which is bound up with the digitized documentation of real estates of the cadastral maps;
- which is based upon the uniform geodetic reference system in Gauss-Krüger projection;

- which with permission of the State Surveying Board makes available to the users digital data which can be bound up with factual data of appliers.

Prof. Dr.-Ing. E. Bartsch, President of the Hessian State Surveying Board, expressed in his statement on the crash-program of INFRA GmbH München from February 5, 1991, that only the "blending" of cadastral map and photomap shows the real use and the constructions and thus points out the gaping between proof of ownership and proof of possession.

4. THE TASK

The quick supply of the DLLK for regional offices, district administrations, communities and unions of communities, for utility and public transport operators and all other users could be an essential prerequisite and basis for supporting the necessary decision-making, projecting and documentation processes in the eastern states especially for all measures for

- localization of industry
- reprivatization
- improvement of infrastructure of the road and lane-bound traffic network
- regional planning with setting up land use and building plans
- improvement of agricultural structure
- planning and building construction in house building, in business parks and for communal projects
- redevelopment and reconstruction of utilities
- guaranteeing of environmental protection
- current inventory.

Even the above list of priority fields of application which does not claim completeness shows how important the quick availability of suitable planning documents is for economic development.

5. REALIZATION OF THE TASK

The above-mentioned pilot project comprises an area of 600 ha. The town Müncheberg, district of Strausberg, is situated in the centre of the project. The town is situated on the major roads No. 1. and No. 5, between Berlin and Frankfurt/Oder.

The following cadastral maps of land registry are available in this area:

Number	Scale	Established in	
1	1: 1000	1948/50	(resurvey)
5	1: 2000	1920/21	(resurvey)
3	1: 2000	1821/22	
1	1: 4000	1821/22	
3	1: 5000	1821/22	
1	1: 2000	1786	

This distribution regarding to scales and years of creation characterizes approximately the general situation in the state Brandenburg.

5.1 Preliminary work

- establishing the control point project for aerial triangulation
- processing the project for local determination of the position of "map-identical points" (points identical with their cartographic representation) at cadastral maps (selection of points at the sheet margin and their distribution at the cadastral map, if possible without boundary points which had later been plotted into the cadastral map)
- evaluation of existing traverse networks
- clarification of occurring deviations at the sheet margins of cadastral maps with the responsible cadastral office

5.2 Tying to the national network

The geodetic network is in position and height the essential basis for the correct linking of all geographic information. For that, all works have to be related to a strainless finally located field of control points.

Presently the position reference system in the state Brandenburg is the Gauss-Krüger coordinate system 42/83 with the datum 1942 at the point Pulkowo on the KRASSOWSKY ellipsoid, realized by the adjustment of the Uniform Astrogeodetic Network (UAGN) of Eastern European countries in 1983. The trigonometric network is subdivided into 1. order, 3. order and 5. order networks (density of points - 1 TP per 2.3 km²). The reprocessing and readjustment of the 5. order network were finished in 1989. After the adjustment with the introduced error-free coordinates of 1. and 3. order the mean point error yielded 2.1 cm.

In the area Müncheberg the projects "points of aerial triangulation" and "map-identical points" were realized and checked in the field. The coordinates of these points were determined by marked traverses with tying to the 5. order net and by measurement with electronic tacheometers with continuous data flow.

The networks were calculated with the programm system KAFKA as free net adjustment and as adjustment with forced fixing. The mean point error was 1.2 cm after the adjustment what especially indicates the homogeneity of the network of higher order.

5.3 Survey flight

The survey flights were carried out using high-performance cameras and suitable black-and-white or colour films at image scales 1 : 3000 to 1 : 5000 for built-up areas and 1 : 8000 for rural areas. The image material is suited for stereoscopic plotting and is the basis for production of photomaps from rectified prints or orthophotos.

With the control points also the "map-identical points" were signalled.

The survey flight for the area Müncheberg was arranged for by the State Surveying Board after the determination of the survey flight parameters:

- | | |
|-------------------------------------|-------------------------|
| - image scale | : 1 : 3000 |
| - forward overlap(p) | : 90 % |
| - side overlap | : 30 % |
| - calibrated focal length (c_k) | : 300 mm |
| - image motion (A_s) | : $\leq 30 \mu\text{m}$ |
| - aerial film | : PAN 200 |

For checking the planimetric accuracy at the photomap the "map-identical points" and the grid intersections were digitized and an affine transformation was carried out.

Result:

Scale	m_p map-identic. point	m_p map-identic. point and grid net
1 : 1000	0.086 m	0.057 m
1 : 500	0.059 m	0.066 m

5.4 Digitization of cadastral maps

Considering the limited time and the costs a digitization of cadastral maps seems to be a needless effort. But there are important reasons for the digitization:

- Today the computational compilation in adding together the individual "island maps" is a reliable way compared to every graphical adjustment. Here one can make use of the better insight and the overview which the measured and computed digital values of the map in connection with the locally obtained information (the identic points) offers to integrate as well as possible the old measurements into the modern point array.
- Today the possible uses of a digitized map are almost unlimited and the value of a newly created map series increases by several times as much because of the digital form. It should be added that then it is possible to improve the inevitable imperfect map series with every new measurement.

Contents and form of the digitization were agreed with the State Surveying Board. Because the state Brandenburg uses the information system ALK, the instructions

- Catalogue of Object Codes Land registry (NRW)
- Catalogue of Object Imaging Land registry (NRW)
- Compilation Specifications Automation (NRW) and
- Standardized Data Base Interface (EDBS)

are used which are binding for the Cadastral Authorities in North Rhine-Westphalia (NRW). The obtained result of residual misclosures of "map-identical points" of the over-determined affine transformation of the DLLK Müncheberg presented here at the technical exhibition might be of interest:

Fields	Established in	Scale	Number of map- identic points	Mean residual misclosures
1	1949/50	1 : 1000	19	0.336 m
2	1786	1 : 2000	7	1.065 m
6/1	1821/22	1 : 2000	19	1.291 m
6/2	1821/22	1 : 2000	6	1.630 m

The given boundary value $s \text{ [m]} = 0.001 \cdot M$ (M = scale denominator) was not exceeded at any "map-identical point".

If there should arise discrepancies at the edge matching of cadastral maps which can not be solved immediately they should explicitly be marked as provisional representation of boundaries at the map.

After checking and edge matching the recorded map content is put out as transparent plotted drawing in sheet line of "framework map" and is then coupled with the corresponding photomap for the DLLK in analogue output.

6. CONCLUSIONS

As mentioned above many towns, municipalities and supply operators demand complete and current cadastral "framework maps". The DLLK is a possible alternative for that. In such a large scale cadastral maps can not be produced by the state surveying administration. But there are enough tasks which can be carried out by every professionally run surveyor's office if supervised by the surveying administration.

If these tasks shall be carried out they require a high amount of money which mostly the prospective user have to raise. This investment pays. It is immediately effective if areas which immediately need correct (legally authorized planning) documents are worked on with priority. So a firm basis capable of development is formed for all future work at and planning of property.

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