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The establishing of raster data archives at the Bayerisches Landesvermessungsamt

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ABSTRACT

At the Bayer. Landesvermessungsamt (Bavarian Land Surveying Office) people already in the year 1989 have begun to scan topographical maps of several scales. The following paper deals with data acquisition, data processing, data archiving and usage of the corresponding raster data.

1. INTRODUCTION

Already in the year 1989 people have begun with the establishing of raster data archives at the Bayer. Landesvermessungsamt . An order of the German Federal Defence Forces at that time gave rise to let scan the military edition of the Topographic Map 1:50000 (TM 50) and 1:100000 (TM 100) at the Bayer. Landesvermessungsamt [Appelt,1989].
Raster data archives have been constructed furthermore because of the encreased demand for raster data not only of the Bayer. Landesvermessungsamt but also from other interested parties. I want to confirm restrictive, that the following paper refers only to raster data of scanned topographical maps. I will agree to planings in the topographic and photogrammetric domain only with a few words at the end.

2. ACQUISITION OF THE RASTER DATA

2.1 Scanner

At the Bayer. Landesvermessungsamt two scanners exist for acquisition of the topographic maps. The technical details of both are listed in figure 1:

	Hell CTX 330	SGI EN 850
Light source	Laser	CCD
Resolution	max. 320 lines/cm (813 dpi)	max. 800 dpi
Scanning size	112 cm x 110 cm	115 cm x 84 cm
Radiometric resolution	B/W, grayscale, colour	B/W
Scan time (about 50x50 cm und 800 dpi) within fitting	40 min	20 min
Data volume after scanning (800 dpi, 50x50cm)	up to 150 MByte	40 MByte

Figure 1: Technical datails of the scanners at the Bayer. Landesvermessungsamt.

There is one important difference between both scanners: the HELL-CTX 330-scanner uses a laser spot, whereas the CCD-technics is in action at the EN 850-Scanner of the company Scan Group

International (SGI). Though both scanners haver the same high resolution, you can obtain clear better results with the laser scanner in extremely situations of the map (that is very thin lines respectively narrow spaces). For this reason all groundplan- and conturline -films, in which those extreme situations often appear, are scanned with the laser scanner.
The internal accuracy is -beyond the already mentioned resolution- an important point of view in use of scanners in cartographic sphere. At present tests for precurement of a new scanner for cartographic tasks are made. The first experiences show, that some scanners do not satisfy those accuracy requirements.

2.2 Resolution

The unit of resolution is specified differently:

- as lines/cm respectively lines/mm
- as dots per inch , abbreviated dpi
- as mm (micron).

Example: 320 lines/cm are equivalent to 813 dpi respectively 31 micron.

If you want to record all informations of a map, the aperture size of the scanner may not exceed the halfth of the thinnest existing line [Lichtner,1981]. In case of topographic maps line widths of 50 micron are possible, that means the scanner must have a resolution of 25 micron (= 400 lines/cm respectively 1016 dpi).
The films of topographic maps are scanned at the Bayer. Landesvermessungsamt with the highest available resolution of 320 lines/cm (=813 dpi). This does not at all come up above mentioned requirement, the quality of the raster data is nevertheless satisfactory.

2.3 What is be scanned?

The quickest method of areafilling recording maps is to scan the coloured printings. For each sheet of map you have to scan one time. However this proceeding has the disadvantage, that only the information on top of those areas of the map, which are multiple printed, can be scanned, i.e. that wood masks, for example, are destroyed by types or other elements of the map. The levels of wood, scanned from the printed map in that way, can not be used for certain applications.
There is another disadvantage, that, as a rule, the results are more inferior than if you scan the separate films [Weber,1991]. For this reason the individual films of a map are scanned at the Bayer. Landesvermessungsamt. A black- and white-scanner will do for those pattern.

3. PROCESSING OF THE RASTER DATA

After scanning the films the raster data are be corrected (rectified).
The rectification is necessary because of the following reasons:

- The films are not on scale
- The scanners have geometrical inaccuracies
- Adaption of the different resolutions of the two used scanner (320 lines/cm = 813 dpi and 800 dpi)
- The individual films of one map can not be fit on the scanner exactly at the same position

- Rotation of the image, so that the coordinate system of the scanner and the Gauß-Krüger system are parallel. This is a precondition for the projected out of sheet line system management of the raster data in future.

The rectification of the raster data happens by a seperate rectification software, which calculates a complete new raster matrix. All films rectified in this way are covered then exactly. The sheet corners are used as register points.
In this context there is one fact interesting : the rectification in computer systems of some companies happens only on the screen. These data can only be used by customers, who apply the same computer system.
The raster matrixes of the individual films can have different sizes in x- and y- direction. Therefore the images are calculatory filled up with background pixels to have equal size. This procedure is necessary because in the diverse computer systems the image set up of the raster matrix is put through from top to bottom respectively contrary and from left to right respectively contrary.
Before archiving the raster data a total image is created by calculating a pattern combination of the individual films to check the scannings and the above mentioned processings. Only in this copy you can well recognize errors like wrong measuring of the register points, unnoticed inverted scanning and others.

4. ARCHIVING THE RASTER DATA

4.1 Which data are archived?

4.1.1 Raster data

The rectificated raster data of the individual films of the topographic maps are archived in the runlength encoded format of the company Dr. Hell. The usage of this format has for the present historical reasons: a Hell scanner exists since 1987 at the Bayer. Landesvermessungsamt, all scanning data from the beginning are on hand in Hell format.
There are more favourable data format compressions. Nevertheless we came to a decision for the Hell format because of the following reasons:

- This format allows encoding of black- and white-, grayscale- and coloured images
- Many postprocessing programms use this format
- A file can be repared in case of data errors, because there are used end of line marks
- No storage of words, that is, no problems by different interpretation of the low-/high-byte
- The description of the data format is wellknown
- The data compression is relativ simple, therefore easy and quick decompression

A second copy of the rectified raster data is made and the raw scan data are archived beyond it.

4.1.2 Describing data

Beside the raster data the image coordinates of the register points are stored. The relation to the Gauß-Krüger coordinate system can be found about these coordinates.
Beyond it the residuals, which result of the rectification calculation, are stored to have a proof about the executed conversions and the quality of the register points.

4.2 Data volume

The number of different films (for example 5 in the of TM 25, 8 in the of TM 200) is not identical in the individual map series. This influences the expense of data acquisition and the data volume. As mentioned above, the data volume depends on the resolution: the doubling of the resolution creates about a quadruple of data.
The expected data volume, corresponding to the resolution of 320 lines/cm and storing in the Hell format, is listed in figure 2.

Map series	Number of films	Number of sheets	Data volume/sheet (MByte)	Total data volume (GByte)
TM 25	5	546	c. 30	16.4
TM 50 (standard edition)	8	152	c. 50	7.6
TM 50 (milit. edition)	4	152	c. 20	3.0
TM 100 (standard edition)	7	41	c. 60	2.5
TM 100 (milit. edition)	4	41	c. 25	1.0
TM 200	8	12	c. 60	0.7
			total:	31.2

Figure 2: Expected data volume of all bavarian topographic maps.

4.3 Data media

At present 1/2 inch 9 track magnetic tapes, Cartidges, DAT-Tapes or Exabyte-tapes are used to store the raster data. The sequent data archiving with these data media is to slow -concerning the access time-, to meet the demands to satisfy great need of raster data.
For that reason a storage on erasable disks, managed in a juke box, is projected. Now the Bayer. Landesvermessungsamt is looking for an archive system with a capacity of about 35 GByte. It is purposed, to annex the juke box to our existing powerful computers.
According to our conception it shall be possible not only to access quickly to raster data of whole maps, but also to totalize any area, which is not in the sheet line system. For example, if there is needed a map extract of the map series 1:25000, which lays in the region of 9 map sheets, you have to take data from 45 (=9x5 films) compressed raster files.

4.4 Available raster data

At present (state: may 1993) raster data of the following topographical maps are available at the Bayer. Landesvermessungsamt (fig. 3):

map series	number of films	resolution (lines/cm)	available portion	
TM25	5	320	ground plan: contour lines: hydrological contours: hydrological mask: wood mask:	15% 30% 40% 40% 95%
TM50 (milit. edition)	4	200	100%	
TM50 (standard edition)	7	320	0%	
TM100 (milit. edition)	4	200	100%	
TM100 (standard edition)	5	320	100%	
TM200	8	320	100%	

Figure 3: Available raster data at the Bayer. Landesvermessungsamt.

5. USAGE OF THE RASTER DATA

5.1 General aspects

Raster data of topographical maps can be used for different applications, f. e.

- ♦ as background image for on screen digitizing
- ♦ as basis for raster to vector conversion
- ♦ as basis for the halfautomatically line following
- ♦ as an additional information for example by hybrid plotting
- ♦ as digital revision of maps.

5.1 Delivery to customers

In the last time the demand for raster data of topographical maps has encreased. The Bayer. Landesvermessungsamt offers raster data of topographical map. The following data conversions are possible:

- ♦ Reduction of the resolution in lower values as those as the original data
- ♦ Delivery of data of individual films or data of any combination of films
- ♦ Different raster formats like TIFF, Scitex type 30, Hell, Intergraph, Anatech, SRG(for the army) are available
- ♦ Any cuts of a map can be delivered

- Almost all usual data media like magnetic tape, cartridge tape, DAT tape, Exabyte or floppy disks are supported.

Furthermore the development of a software is projected, which enables the data delivery of regions out of the sheet line system.
Till now all data of a map series are ordered from the company Mannesmann to construct a car navigation system (TM 200), from the company DETECON (TM 100), from the Federal Defence Forces (TM 50 und TM 100) and from the Bayer. Umweltministerium (up to now 20 % of the TM 25 sheets).
To hold raster data of high resolution in readiness is an advantage to those customers, who do not need this resolution or cannot process this data volume. Figure 4a shows a ground plan layer, scanned with a resolution of 80 lines/cm. In figure 4b the same image has be scanned with 320 lines/cm and then reduced with calculation to 80 lines/cm. By this way figure 4b shows the better result.

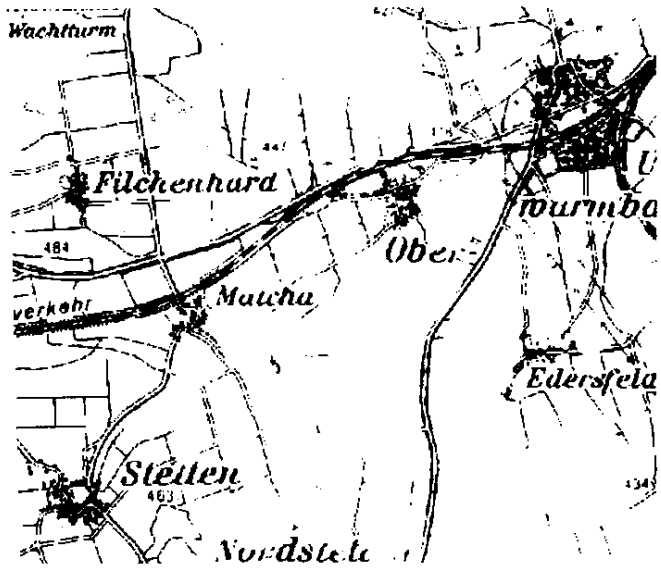

Figure 4a: Image scanned with 80 lines/cm.

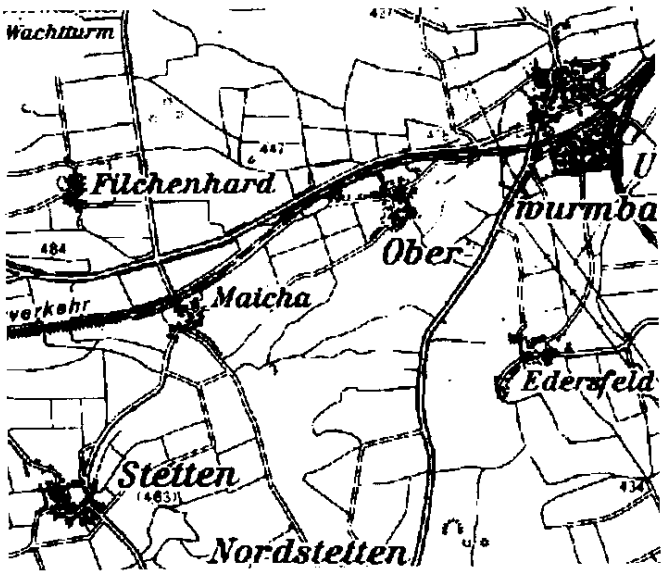

Figure 4b: Image scanned with 320 lines/cm and calculatory reduced to 80 lines/cm.

5.2 Usage for the Bayer. Landesvermessungsamt

Beyond the preparation of the data for customers raster data also are needed for our office.

5.2.1 Establishing of GEOGIS 25 (=Bavarian ATKIS)

The wood areas had been derived automatically by raster to vector conversion to establish the Geographic Information System 1:25000 (GEOGIS25). As already mentioned above, digital wood areas, extracted of the coloured map printings, would not be useful for this method.
At present the hydrological layer is captured by using half-automatically line following. Scanned hydrological films are needed for this procedure [Wimmer, 1993].

5.2.2 Map revision

Scanned films are also wanted for digital map revision in raster mode. For this technique highest demands, concerning to quality, are required. All informations, not captured by scanning, are also not present in the map printing after digital revision [Dresse,1991].

5.2.3 Reprotechnical applications

Scanned maps are used furthermore for analog revision in the topography. For this purpose enlarged plots of the digital maps are produced to compare the actual aerial photographs with the old situation. Some reprotechnical copies can be economized by this way.

6. INTENTIONS IN TOPOGRAPHY AND PHOTOGRAMMETRY

At present a submission of a digital orthophoto system is made. It is not sure now, whether the scanned photos and/or the calculated raster data of the orthophotos should be archived. Decisions about this are dependent on

- the needed resolution, which will be between 30 micron and 15 micron. Corresponding to this a data volume of 60 MByte up to 240 MByte for each aerial photograph is expected.
- the time for scanning
- the time to calculate the digital orthophoto.

It is sure, that every year about 1500 up to 2000 digital orthophotos are needed at the Bayer. Landesvermessungsamt. This would mean a data volume of the aerial photograph raster data of minimum 90 GByte (1500 x 60 MByte) up to 480 GByte (2000 x 240 MByte) every year (!).

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