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Digital Cartographic and Topographic Products from the Swiss Federal Office of Topography

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The Swiss Federal Office of Topography

The Swiss Federal Office of Topography ("Bundesamt für Landestopographie, L+T") is commissioned with the production of the Swiss National Map series. To fulfill this task the office maintains a nationwide geodetic network. Aerial photogrammetry and extensive topographic field checks allow the contents of the maps to be compiled. Cartographic and reprographic processing provide print-ready map originals. During the last few years, a new demand for digital cartographic products has arisen along with the continuing need for analog printed maps.

The office was founded in 1838 by G.H. Dufour. Under his directorship, the first geometrically exact map of Switzerland was published between 1844 and 1864. Updated versions of the original topographic surveys 1:25,000 and 1:50,000 were published under the name *Topographic Atlas* between 1865 and 1901. In spite of the high graphical quality of these maps, the need for a new map series at different scales arose at the beginning of this century. Precise geodetic networks also had to be measured and calculated. After long discussions, officials and experts finally decided in 1935 to produce and publish new countrywide topographic maps in the scales 1:25,000, 1:50,000, 1:100,000, 1:200,000, 1:500,000 and 1:1,000,000. The most detailed maps, in the scale 1:25,000, were finished in 1979.

Since 1968 all maps have been updated every six years. Based on aerial photographs, stereoscopic models are evaluated on special stereo plotters in order to determine the exact position of each topographic object. Together with information collected in the field, these compilations serve as the source material for producing the cartographic originals. This work is still done manually by scribing on specially coated glass plates. Each printing colour requires a separate original. Finally, the printing department makes printing plates from the

completed originals and prints the maps on paper, using multi-colour offset machines. The 1:25,000 map has eight colours, the 1:50,000 map has six colours and the 1:100,000 map has ten colours.

Digital cartographic datasets

Computer technology has also found its way into topography and cartography; geodetic data is collected and calculated almost exclusively by computer. The stereophotogrammetric compilation of aerial images depends largely on computer-assisted hardware and software. Three map sheets have been updated with excellent results using a digital cartographic system. Due to several reasons (e.g. the age of the system) no further work has been done. Map updates are still done manually, but a new cartographic system is being evaluated at the moment. As already mentioned, during the last few years a new demand for digital cartographic products has arisen along with the continuing need for analog printed maps. At the Swiss Federal Office of Topography, several such products have been created from existing analog maps. They can be used by private clients, researchers and governmental agencies. The datasets have been produced for professional use for possible applications ranging from basic data for GIS (geographic information systems) to scientific modelling.

The Digital Height Model **DHM25** describes the earth's surface (elevations only, without forests, buildings, etc.). It is extracted from the height information of the National Map 1:25,000 (**NM25**). The height content of the complex map image is represented in three colours: brown (contours for the normal surface), black (contours for rock, scree and spot heights) and blue (contours for glaciers and lakes).

In order to produce the DHM25, the first step is to extract the DHM25 basis model (vectorized contours and lake contours, digitized spot heights) from the NM25. All spot heights were previously digitized manually on a digitizing table. Extracting the linear elements from the map image is a much more complicated process. The original colour-separated films are first scanned with a resolution of 16 lines/mm. The complete contour and lake contour image is extracted from the pixel maps using image processing methods. The margins to neighbouring map sheets are edited and the raster data is transformed into vector data. Each contour is then assigned its value. This part of the work, as well as the entire extraction process, is carried out both automatically and interactively.

The basis model contains the following digitized height content from the NM25:

Linear elements:	- vectorized contours
	- vectorized lake contours
Dot elements:	- digitized spot heights

In the second phase the basic model is interpolated with the program CONGRID (written at the Swiss Federal Office of Topography) resulting in the DHM25 matrix model with a 25 m grid. Independent tests are carried out and if necessary, the basic model is corrected. Before the final matrix computation, the adjacent zones on neighbouring sheets are included to ensure that the values along the map margins are accurate.

The 25 m grid of the height matrix corresponds to a mm-grid overlaid on a NM25. The complete matrix of an entire NM25 contains 701x481 height values (a total of 337,181 values or 1.600 values per square km). Both models are available in an ASCII format.

Project **RIMINI** was started in the mid-60s by the Defence Technology and Procurement Agency and the Joint Chiefs of Staff in collaboration with a private company. The data file is a regular array of height values in a 250 m grid and it is the first height model covering all of Switzerland. The heights of these grid points were read manually out of the National Maps 1:25,000 (NM25). Since it is intended to replace RIMINI with the DHM25, it is no longer updated or corrected.

A scanned map in a raster form is called a **Pixel Map (PM)**. It is simply the transformation of a normal map into a digital form. The information is separated only according to the printed colours and not according to any thematic structure. The Pixel Maps are scanned, processed and delivered with respect to the sheet numbers of the Swiss National Map series. All map series are available as Pixel Maps. The Pixel Maps are scanned with a resolution of 20 lines/mm which means, for example, that the actual size of a pixel at the scale of 1:25,000 is 1.25 m (Figure 1). The map sheets are transformed onto the Swiss national coordinate system which is defined by a conformal, oblique cylinder projection. The Pixel Maps are available in SCITEX T30, SCITEX HANDSHAKE and TIFF raster formats.

VECTOR200 is a vectorized version of the Swiss National Map series 1:200,000. Vector data consists of points, lines and area elements represented by their vertex coordinates (national coordinate system). The dataset is divided into 11 subsets which contain roads, railroads, forests, buildings, rivers, spot heights, map symbols, control points in the corners, a graticule, boundaries and place names. It represents, with some exceptions, the contents of the National Map 1:200,000. Single houses in villages and towns, for example, are replaced with generalized representations. Each subset is divided into several levels, thus allowing the even better separation of information (for instance into different road classification). VECTOR200 is available in AUTOCAD DXF, INTERGRAPH DGN and SIF and ESRI ARC/INFO formats.

Besides these digital cartographic products, the Swiss Federal Office of Topography produces several other datasets which are mostly used for thematic

mapping applications. One example is a base map 1:1,000,000. It was vectorized
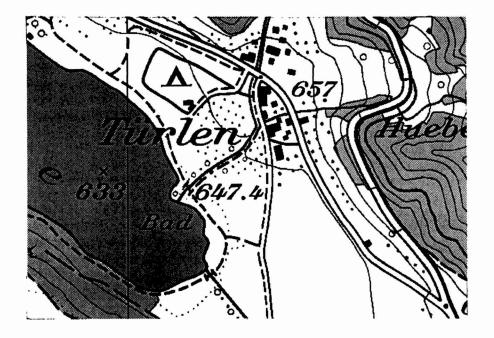and manually edited at the Institute of Cartography of the Swiss Federal Institute

Figure 1: Enlarged extract of the Pixel Map 1:25,000

of Technology (ETH) in Zürich, based on existing conventional sources. This original data is stored in the INTERGRAPH DGN format. The L+T has converted it into MACINTOSH FREEHAND format and has included further manual editing and symbolization of the vector elements. The dataset is also separated into several layers covering administrative boundaries, lakes and rivers in different 'densities' according to their importance. A shaded relief is also added. Another example of such a special digital product is a placename database of Switzerland.

Situation in other European countries

National surveying agencies in other European countries offer similar digital cartographic products. Pixel maps and digital height models are available in almost every country. Some countries have projects to collect digital base data at large scales. The Institut Géographique National (IGN) in France collects such data in vector form using photogrammetric methods (project BD TOPO). In Germany, the aim of project ATKIS is to digitize all 'basic maps 1:5,000'. These data sets can be used -after generalization- for the production of topographic map series at smaller scales.

Future projects in digital cartography at the Swiss Federal Office of Topography

The aim of project CADKARTO is to update existing analog maps by digital means. Therefore, all these maps have to be scanned with a resolution of at least 40 lines/mm. The editing is done in hybrid (raster and vector) mode using photogrammetic and field data. The evaluation of a suitable computer graphics system will be completed in mid-1995. Project TIS (Topographic Information System) is the counterpart to the above-mentioned French and German projects ATKIS and BD TOPO. At the moment this project is still in its specification phase.

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