

Journeys through time with the Swiss national map series

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Abstract. In 2013, the Swiss Federal Office of Topography swisstopo celebrates its 175th anniversary. Since its foundation in 1838, swisstopo has produced three national map series which include approximately 7500 first and updated editions of maps in different scales. This cultural heritage of national significance, which can be considered as the «topographical landscape memory of Switzerland», became re-published by the «Journey through time» web service.

Keywords: National map series, map history, web based online services

1. Introduction

In 2013, the Swiss Federal Office of Topography swisstopo celebrates its 175th anniversary. Since its foundation as «Bureau topographique fédéral» by general Guillaume-Henri Dufour in 1838, swisstopo has produced three national map series (Topographical Map of Switzerland 1:100.000 (TM100), Topographical Atlas 1:25.000/1:50.000 (TA25/TA50), National Maps (NM) in different scales). They include approximately 7500 first and updated editions of maps in different scales. Furthermore, the historical collections of swisstopo contain approximately 23 000 manuscript maps (a.o. original field surveys) and half a million aerial and terrestrial photos. In the last years, several digital data sets have been added to the paper products. Nevertheless, the map editions form the longest time series produced by swisstopo (Figure 1 and Table 1).

The totality of these holdings is a cultural heritage of national significance which can be considered as the «topographical landscape memory of Switzerland». The new Federal Act on Geoinformation (GeoIA), in force since 2008, commits all data producers to guarantee the lasting availability of the

spatial data.¹ This temporal dimension represents a new challenge for a national mapping agency, because engineers usually deal with the present and the future, not with the past.

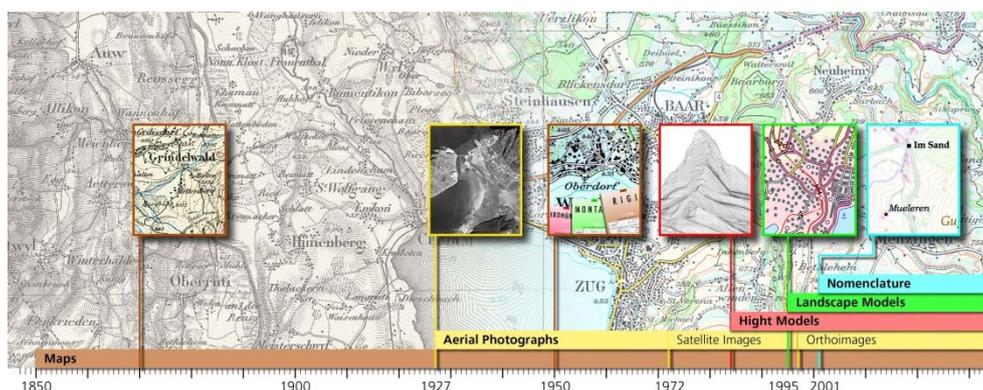


Figure 1. Chronological development of the different product types at swisstopo (Gerber & Rickenbacher 2010).

According to its vision 2015, swisstopo functions as the Federal Geo-Information center and therefore guarantees to provide data and fundamental bases for monitoring spatial development in Switzerland.² To realize this vision, swisstopo created – among other measures – the center of competence Base Data for Environmental Monitoring by beginning of 2007. In August 2010, this small unit submitted a report explaining the problem field of time series to the executive board of swisstopo (Gerber & Rickenbacher 2010). One of its conclusions was that swisstopo can be compared with a big box of which many people know that it contains a historical treasure, but the users can only profit from it with big efforts and corresponding high costs. The authors suggested to realize a web based map service to re-publish all the printed maps of the scales 1:25.000, 1:50.000 and 1:100.000 in the context of the anniversary year. The executive board of swisstopo decided in January 2011 to realize this idea. «Journey through time» was officially launched at the media conference of January 17, 2013.

¹ Federal Act of 5 October 2007 on Geoinformation (Geoinformation Act, GeoIA), Art. 9. http://www.admin.ch/ch/e/rs/c510_62.html. Accessed 15 April 2013.

² <http://www.swisstopo.admin.ch/internet/swisstopo/en/home/swisstopo/vision.html>. Accessed 15 April 2013.

Type of product	from	until	Revision	periodicity [Years]
Maps	1843	today	yes	since 1968: 6
Topographic basis (unpublished)	1832	today	yes	as maps
Terrestrial photos	1918	1950	no	–
Analogue aerial photographs	1927	2008	yes	since 1968: 6
Orthophoto mosaic SWISSIMAGE	1998	today	yes	until 2008: 6 since 2009: 3
Digital aerial photographs	2005	today	yes	3
Height model DHM25	1984	2001	no	
Height model DOM / DTM-AV	2000	2008	no	–
Height model swissALTI3D	2011	today	yes	–
Landscape model VECTOR25	1995	2008	yes	6
Landscape model VECTOR200	1985	today	yes	since 2003: 1
Landscape model swissTLM3D	2011	today	yes	Under construction, planned: 6

Table 1. Overview over the most important product types of swisstopo (Rickenbacher 2013, data from 2010). The beginning of the availability (from), the end of product (until) and information about the revision and its periodicity are indicated. The columns «from» and «until» refer to the availability and not to the data status of the map content.

2. The Swiss national map series

For more detailed product and background information about the national map series and the swisstopo map collection see swisstopo (2011 and 2012).

2.1. 1:100.000 Topographic map of Switzerland (Dufour map)

In 1832, Guillaume-Henri Dufour (1787-1875) was appointed Chief of General Staff of the Swiss Confederation. His duties included the creation of the 1:100.000 Topographic Map of Switzerland. In the Mittelland and Jura regions, the fundamentals for the Dufour Map were surveyed by plane table using the scale of 1:25.000, while the region of the Alps was mapped in 1:50.000. The original surveys were reduced to the scale of 1:100.000, and

the map was then engraved into copper and printed. The various forms of the terrain were illustrated by means of hachures with the aid of shading.



Figure 2. 1:100.000 Topographic map (Dufour Map) (swisstopo, map collection, LT TK 12, 1860). Extract from the first edition (1860) of sheet *XII Freyburg Bern*.

The creation of the Dufour Map coincides with the creation of the modern Swiss Confederation (Gugerli & Speich 2002). It is the first official series of maps that encompassed the whole of Switzerland, a geometrically accurate and aesthetic depiction of the recently formed confederation and an image of a national unity that banished cantonal differences into the background. The Dufour Map established the good reputation enjoyed by Swiss cartography throughout the world and was honoured with a number of international awards.

2.2. 1:25.000 / 1:50.000 Topographic Atlas of Switzerland (Siegfried Map)

While work was still in progress on the Dufour Map, geologists, railway construction engineers and alpinists were already expressing the wish for the original surveys to be published in their respective original scales of 1:25.000 (Jura, Mittelland, southern Ticino) and 1:50.000 (region of the Alps). The Swiss Alpine Club, which was founded in 1863, constituted a strong rope team with the surveyors of the nation calling for the publication of these larger scales (Rickenbacher 2013 a).

On 18 December 1868, two Federal Acts entered into effect governing the continuation and the publication of topographic surveys. The establishment of the Topographic Atlas 1:25.000 / 1:50.000 was directed by Hermann Siegfried (1819-1879), Dufour's successor and Chief of Staff. In his honour this national map series is also referred to as the Siegfried Map.



Figure 3. 1:25.000 Topographic Atlas (Siegfried Map) (swisstopo, map collection, LT TA 319, 1870a). Extract from the first edition (1870) of sheet 319 Bern.

The terrain forms were illustrated by means of contours, the equidistance of which was 10 meters for the Mittelland and Jura and 30 meters respectively for the region of the Alps. The 1:25.000 sheets of the Topographic Atlas were reproduced as copperplate engravings in three colours (black, brown, blue), while the 1:50.000 sheets were reproduced as lithographs.

2.3. National Maps of Switzerland

The shortcomings of the existing sets of national maps were already becoming increasingly apparent towards the end of the 19th century. swisstopo then examined new forms of depiction with a large number of trial maps. After 1927, the debate on the production of a new series of national maps intensified under Eduard Imhof, professor of cartography at the Swiss Federal Institute of Technology Zurich, who later on referred that period to as the «seven-year map war». As an outstanding member of the Swiss Alpine Club, he claimed again for larger scales (Rickenbacher 2013 a). On June 21st, 1935, the Swiss Federal Act on the production of new national maps was passed.

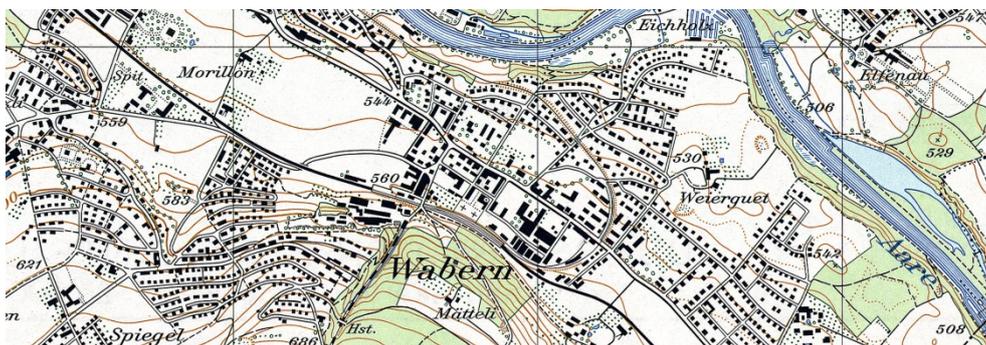


Figure 4. 1:25.000 National Map (swisstopo, map collection, LT LK 1166, 1954). Extract from the first edition (1954) of sheet 1166 Bern.

The original survey plans, in the Mittelland and Jura provided by cadastral plane table and photogrammetric surveying, were used as basis of the National Map 1:25.000 (NM25). In the region of the Alps, the topographic data was collected by swisstopo using terrestrial photogrammetry, largely via the 1:10.000 fortification maps.

Cartographic reproduction was carried out using layer engraving on glass. After two successful tests initiated in 1989, from 1996 onwards map production was successively transferred to CAD systems using special software. For this purpose, all films were scanned. From 1992 onwards, the national map series were also offered in digital form (pixel maps). Printing of maps on paper was carried out using the offset process.

3. Time series

Out of the fact that swisstopo has now been producing spatial data for the same regions for 175 years at varying intervals, time series result. They are a product of historical preservation, i.e. the process of securing and permanently storing all earlier versions of maps and spatial data sets. To date, swisstopo has kept all of its spatial data. Therefore it is possible for swisstopo to make time series available.

All map sets produced by swisstopo have been documented in the map collection. On average, each sheet in the National Map series is updated every six years in accordance with the updating cycle introduced in the late 1960's. A clearly defined cycle has not yet been defined for older series of maps, instead their updating has been carried out on an ad hoc and temporary basis depending on the momentary needs. This steady and still ongoing cartographical-topographical process has till now produced more than 7.500 sheets (Table 2).

The creation of time series to document landscape changes was not the main objective of the original map production, but may rather be regarded as a logical consequence of the lengthy timeframe encompassed by swisstopo's production activity. Taking that into account, certain restrictions have to be taken into consideration while using swisstopo maps for time series. Certain landscape elements such as glaciers and forests should for instance be treated with caution. At times it was not always possible to fully update such elements with the necessary degree of completeness due to capacity reasons. Furthermore, it should be noted that, due to changed cartographic illustration guidelines, some elements no longer appear on maps from a certain time onwards, even though the landscape itself has not actually changed.

Map series	Scale 1:	Code	from	until	Updated until	Sheets	editions
Topographical Map (Dufour Map)	100.000	NM100	1843	1865	1939	25	497
General Map	250.000	GM250	1867	1898	1945	4	40
Topographical Atlas (Siegfried Map)	50.000	TA50	1870	1926	1949	142	4088
Topographical Atlas (Siegfried Map)	25.000	TA25	1870	1922	1949	462	
Overview Map	1.000.000	OM1000	1878	1895	1972	1	17
National Map	50.000	NM50	1938	1963	today	78 ½	367
National Map	25.000	NM25	1952	1979	today	249	2171
National Map	100.000	NM100	1954	1965	today	22 ½	117
National Map	500.000	NM500	1965	–	today	1	10
National Map	200.000	NM200	1971	1976	today	4	13
National Map	1.000.000	NM1000	1992	1994	–	1	2

Table 2. Overview over the map production of swisstopo since its foundation in 1838 (Rickenbacher 2013, data from 2010). This table shows the beginning of the availability (from), the completion of the first edition (until) and the end of update.

4. The „Journey through time»

The idea to visualize time series of maps with suitable means is not new (e.g. Peuquet 2002). Already the swisstopo videos «dream maps» and «landscape changes» from 1990 show corresponding sequences by means of original map representations. But these videos have the big disadvantages that they are only available for a certain section of the landscape which has been chosen by the director, and that they furthermore had to be created within an elaborate process.

4.1. Time scale

The today's digital age with its high interactivity and user friendliness offers other means of dynamic visualization of time. At first, the term «time map» was chosen for this kind of representation. If one wants to play time as the

fourth dimension with cartographic components, one has first to decide how long the process will take from the oldest to the most recent issue. This has the effect that time is also represented in a certain scale which may differ considerably from that one of the map. If you want to play the 175 years of swisstopo's existence in one minute, the time scale is approximately 1:92 million.

4.2. Prototypes

To cement the idea of dynamical time representations of maps, several prototypes have been realized. The first ones were prepared for the 2nd Swiss Congress of Historical Sciences, which took place at Basel in February 2010. Three animations (landscape changes in general, communications network (both 1838–2006), settlement areas 1680–2006) were produced, using standard functionalities of GIS software (Rickenbacher 2010).

To satisfy higher cartographic requirements, a more sophisticated second prototype was produced with regard to the 15. Kartographiehistorisches Colloquium in Munich in September 2010. For various reasons, original map images are not the best base for time representations. Here, the different types of cartographic standards have to be mentioned first: They are not time-invariant (Figure 5). For instance, it is not easy to compare topographical features drawn by hachures with those given in contour lines. Furthermore, the displacement of the lettering can result in negative effects. Therefore, 16 normalized maps were produced (Figure 6) by three apprentices in cartography and then integrated into the «interactive time map Sissach» (Rickenbacher 2010 a).

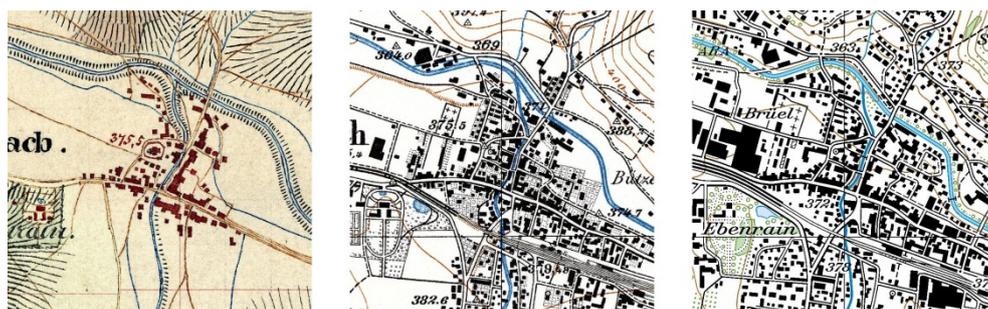


Figure 5. Extracts of the original maps (swisstopo, map collection). The development of the landscape is shown by means of the time-variant original cartographic representation. From left to right: Sissach 1838 (manuscript map used as base of the Dufour map), 1940 (last edition of Siegfried Map), 2006 (newest edition of NM25).

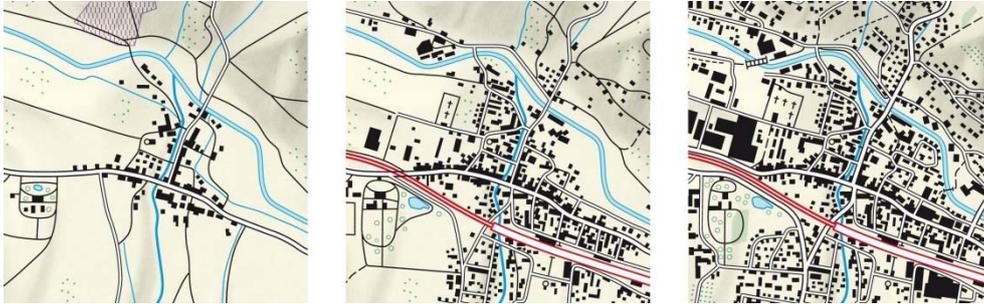


Figure 6. Normalized maps (Rickenbacher 2013). The original map images were transformed into a standardized time-invariant representation. From left to right: Sissach 1838, 1955, 2006.

On the basis of the normalized maps, the time necessary for a retro-cartography of whole Switzerland was roughly estimated to over 400 man years. Such an extraordinary work would not be suitable to the today's capacities of swisstopo and would therefore be unrealistic. It was clear, that a countrywide solution could only be elaborated using the originally printed maps.

4.3. Scanning and geo-referencing

Several measures are necessary to make the «Journey through time» possible. First, all maps which were not yet available in digital form had to be scanned with high resolution (508 dpi) by means of the paper maps. This was done within the project HIKS (Historische Karten scannen) from 2003 onwards.

All data sets were then subject of the geo-referencing process, which means that spatial reference information was allocated to the map files. Thanks to geo-referencing to a uniform reference system it is possible to superpose data sets from different periods and to compare them directly with one another.

4.4. Bibliographic metadata

In parallel, a group of map librarians captured the map bibliographical metadata within Alexandria, the library network of the Swiss Federal Administration.³ This enables the users of the «Journey through time» to request these metadata at any point position of the cursor.

³ <http://www.alexandria.ch> . Accessed 15 April 2013.

4.5. Data base and computation of the tiles

It was decided to restrict the «Journey through time» to the NM25, NM50 and NM100 series. All the geo-referenced map files and the links to their bibliographical metadata were first integrated into the RAHDIS (Raster- und Höhendaten-Informationssystem) data base. This caused an extensive quality check between the different sources, in which several types of errors were detected. One wrong letter or character in a file name could for instance show a wrong map. When for instance a map had been mistakenly scanned without hill shading, this was clearly visible in the context of the neighboring sheets and had to be corrected by re-scanning the corresponding map. After the quality check and the bug fixing, the 36'458'171 tiles (1938 – today, see below) were generated (Zürcher 2013).

4.6. Optimized geo-referencing for the Dufour Map

The first visualizations showed some geometry problems: The different editions of the Dufour Map wiggled on the screen in such a matter that this could not be accepted. Since the Dufour Map was the first map series to be scanned and geo-referenced, this last step was repeated on the basis of the original scans, using a more sophisticated adjustment software. By this measure, the visualization runs in a much smoother way, so that the jerky leaps between subsequent editions disappeared (Zürcher 2013).

4.7. Time references

For a «Journey through time», three different time references must be distinguished: the displayed or selected year, the year of issue (publication year) and the data status (the year in which the elements were recorded). When a map sheet was edited more than once within the same year, only the latest issue was used. For example, displayed the Wabern area (Figure 4) in 1961, this corresponds to the 1956 map revision that was valid at the time. Therefore, several years can be between the displayed year and the data version. The data status of the displayed map and detailed information can be visualized with a simple left click at any cursor position of interest. Bibliographical metadata from the Alexandria library network is linked as well.

4.8. Display modes

The user can choose between two different display modes. With the «Play» mode, the time series can be visualized as a film, which can be displayed forwards or backwards. The «Compare two periods» mode allows to choose the displays of two years to compare, using cross-fading with the «Adjust overlay» slider.

5. Some examples of the «Journey through time»

The «Journey through time» shows different aspects of the historical geography and of the cartography at once. Most prominent is the visualization of the landscape change. Human made influences like the urban growth (Figure 7) or the flooding of a whole village in the Alps due to the construction of a dam (Figure 8) can be visualized, just as natural disasters (Figure 9).

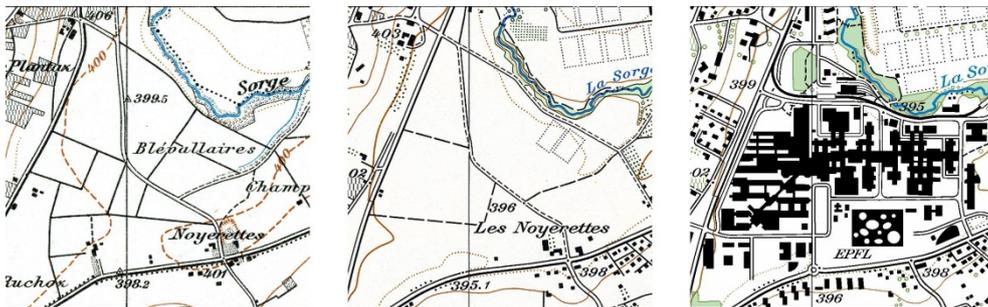


Figure 7. Sample of the urban growth. In 1934, the area southeast of Ecublens was still rural (left). Until 1968 (middle), only a few sports grounds show evidence of the beginning urbanization process, whereas today (right), the terrain is completely covered by the École polytechnique fédérale de Lausanne EPFL (short link <http://s.geo.admin.ch/7ae4d15f>, click start button).

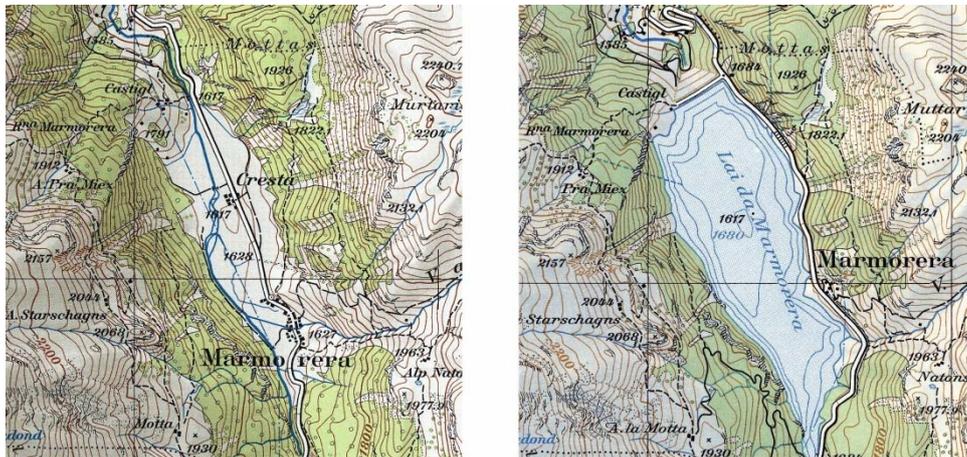


Figure 8. Man-made landscape change in the Alps. In 1948, the construction of the dam northwest of Marmorera is decided. The flooding starts 1954 (left: NM50, sheet 265 Julierpass, edition 1950), and by 1961, the lake is full (right, short link <http://s.geo.admin.ch/84577038>, adjust overlay).



Figure 9. Natural disaster in the Alps. In 1990, a rockslide happened north of Randa, burying the hamlet Unter Lärch. Left: NM50, sheet 284 Mischabel, edition 1988. Right: Edition 1995. (short link <http://s.geo.admin.ch/6ac2301d>, adjust overlay).

Landscape changes, while being the main subject for surely most of the users, are not the only aspects to be discovered. Some human aspects can also be discovered. From the 1980's onwards, a few cartographers succeeded for instance in smuggling some gags into the maps, features which were not detected by the serious cartographical quality check (Figure 10).



Figure 10. Samples of cartographer's jokes. In edition 1980 of sheet 35 Vallorbe (NM100) a fish swims in the Lac de Remoray (left, <http://s.geo.admin.ch/64628ad0>). In edition 1997 of sheet 39 Flülapass (NM100), a mountaineer climbs the southeast side of the Piz Tea Fondada (middle, <http://s.geo.admin.ch/cdf985cf>, adjust overlay). In edition 1980 of sheet 254 Interlaken (NM50), the famous spider in the north face of the Eiger was represented (<http://s.geo.admin.ch/67a1b5d2>).

But also other effects that crucially influence the cartographic perception occur within the «Journey through time». During Cold War, the military installations were for instance not represented in the National Map, whereas the former maps were based on more permissive instructions relating to the cartographic secrecy (Figure 11).

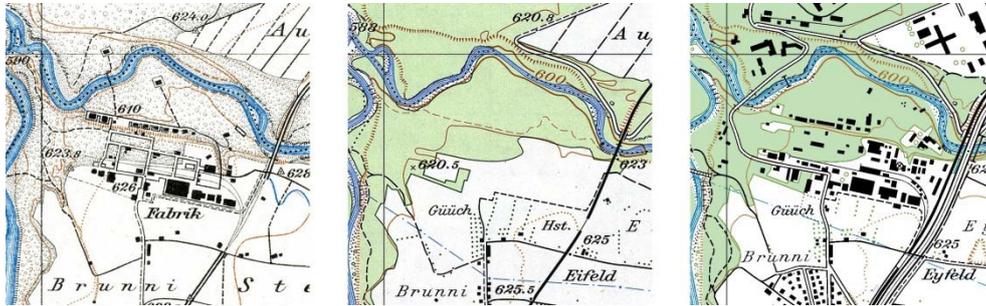


Figure 11. Cartography in Cold War. In the last two editions of the Topographical Atlas of Switzerland 1:25.000 («Siegfried map»), the gunpowder factory of Wimmis is represented, even during World War II (left, sheet 355 Spiez 1929). From the first edition of the sheet 1207 Thun of the Swiss National Map 1:25.000 (NM25) from 1958 (middle), it disappears – probably by secrecy reasons – until the edition 1993 (right), when it cartographically rose like a phoenix (short link <http://s.geo.admin.ch/c87591b2>).

6. Conclusion

swisstopo has realized a tool which enables all users to localize their life within the maps. This might be one of the reasons why it was very well accepted by the public. The huge media response could be observed after the go live on January 17, 2013: Within the first two days, over 50.000 visits were registered, and 70 million map tiles were downloaded, which corresponds to an average of more than 400 tiles per second and a transferred data volume of more than 2.5 TB. The web specialists were very satisfied that there was no system failure. Most important was that 99 % of the reactions, comments and articles were positive (Gerber et al. 2013). Questions from the user side about the presented maps arose which required specific historical knowledge to answer.

With the «Journey through time» tool, it is now possible to navigate to any place in Switzerland with maps of swisstopo, established since its foundation 175 years ago. To get a similar usage in the «analogue age» by means of printed maps, a user would have to travel to a library which holds the complete national map production in their collections. Then, he would have to order all sheets of interest, focused on a specific place, respecting restrictions in the number of sheets which could be ordered at one time. To document this, he then would have to order map reproductions, mostly with considerable costs. The «Journey through time» by swisstopo is accessible from any internet terminal around the world, and it allows a large number of users at the same time. Swisstopo is no longer «only» a map

producer, it functions simultaneously as a digital map library. Which «traditional» map library would be able to serve 50.000 visitors within two days?

As of yet such a web based publication of all printed maps in a geo-referenced frame by a national mapping agency is unique in the world. Historically, this cartographic body of work going public is the modern counterpart of the secrecy of maps which was maintained by the governments in former centuries. But beyond this, this rework of the national map production values highly the effort of all generations of topographers and cartographers which contributed since the foundation of swisstopo to the international reputation of Swiss cartography. One can therefore assume, that Dufour, Siegfried and all their then-collaborators and the later ones would highly rejoice this simultaneous representation of space *and* time.

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