SURVEYING AND MAPPING

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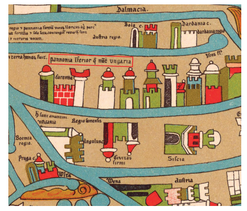
History of mapping in Hungary

The earliest mapping of Hungary

The earliest maps of Hungary's territory are found in the world's first cartographic work, the *Geography* by **Claudius Ptolemy,** the 2nd-century scholar from Alexandria. Based on geographical coordinates, the maps show the provinces of the Roman Empire 1. The *Tabula Peutingeriana*, which has survived in a medieval copy, displays the road network and many settlements in the Carpathian Basin of the 4th century.

The *Mappa Mundi* (the 'Cotton' Anglo-Saxon world map), which dates to the mid-11th century and was based on ancient and medieval sources, indicates the presence of the descendants of the Huns (i.e. Hungarians) in the Carpathian Basin. The 13th-century *Ebstorf Map* includes the following wording: *Lower Pannonia, which is today Hungary.* 1 On medieval shipping charts, the continental interiors are usually blank areas, but a dozen or so settlements in Hungary are marked on a *portolan chart* by **Angelino Dulcert** (or **Dalorto**) dating to around 1330.

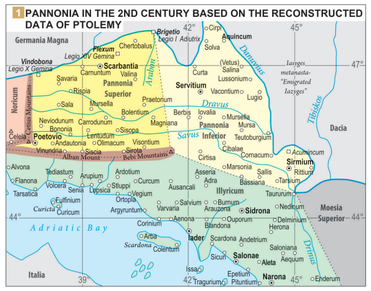


1 *Detail of the Ebstorf Map (13th century)*

The *Cusanus map* (circa 1450) constitutes a 15th-century harbinger of modern European cartography. In view of the limited accuracy of astronomical measurements, more detailed and accurate regional maps could be created based on the relative distances between settlements. In the Middle Ages, surveying and mapping were linked with efforts to determine and mark the boundaries of estates. The land descriptions in the historical works by **Antonio Bonfini** (1427–1502) and **Petrus Ransanus** (Pietro Ranzano, 1428–1492) attest to a knowledge of geography.

The map of Lazarus

The oldest map of Hungary, the map of **Lazarus Secretarius** (1528), has been preserved in a single copy.



2 *The Lazarus map (1528, detail)*

As part of the UNESCO World Heritage, it is kept at the National Széchényi Library. 2 Johannes Cuspinianus, an imperial diplomat who visited Buda after the defeat at Mohács (1526), took Lazarus' map manuscript to Vienna and published it there. The four-sheet *Tabula Hungarie* (1528) is the first printed edition of the Lazarus manuscript. 2 The map is difficult to read and understand because the map is not oriented to the north and the cardinal directions are incorrectly marked on the frame. Consequently, the River Danube flows diagonally across the map. The map editors rotated its contents by about 45 degrees counter clockwise, publishing it in the portrait layout of contemporary pamphlets.

Lazarus Secretarius made his map in response to the Ottoman threat. After 1526, in order to defend the territory of Hungary, king Ferdinand I was in dire need of the support of the Austrian and German provinces, which in turn sought information about the country. The Hungarian defeat at Mohács is depicted in a miniature battle scene, while Louis II's death place is marked by a cross.

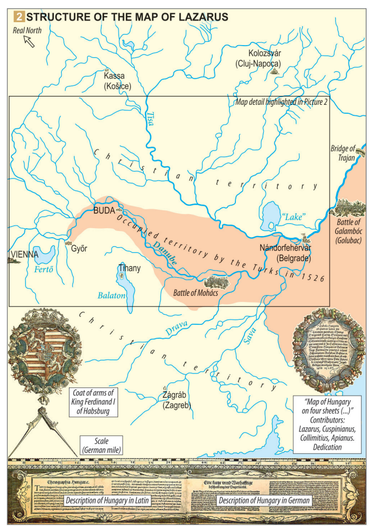
The *chorographic* map shows around 1,400 settlements in the Kingdom of Hungary. At the time, a reliable map of such detail could only be made in the knowledge of road distances and directions. Settlements are marked along the roads, and the explanatory text refers to itineraries and road measurements. The Viennese humanists recognized the exceptional value of the Lazarus map, which was far ahead of its time and constituted a milestone in modern European cartography. The significance of the 1528 map is amply demonstrated by the publication of further editions up until the early 17th century (Venice, 1553; Rome, 1558–59; Vienna, 1566).

Utilizing the Lazarus map, the Transylvanian Saxon **Johannes Honterus** (1498–1549) created the first detailed landscape map of the Saxon Land in Transylvania. 3 Fragments of the 1532 map are known from a printed and corrected version of its sole copy. The copy may have been made when, in Brassó (Kronstadt) in 1542, Honterus printed his cosmographic textbook entitled *Rudimenta Cosmographica*. This textbook contains the first maps printed in Hungary.

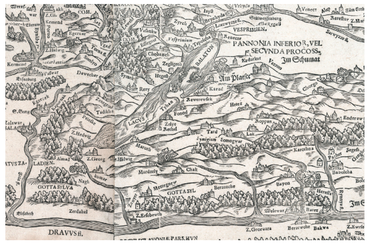
3 *Map of Transylvania by Honterus (1532, detail)*

Maps of Hungary at the time of the Ottoman wars

In the mid-16th century, Ottoman expansionism turned Hungary into a battlefield. Maps became useful tools in modern public administration: for example, the manuscript maps made for the Viennese court and the Aulic War Council facilitated military decision-making. The events of war – especially military victories – were celebrated in Austrian printed maps that both informed the general public and disseminated Habsburg imperialist propaganda.



In 1566 **Wolfgang Lazius** (1514–1565) published in Vienna a sizeable map of Hungary. Without correcting the orientation of the Lazarus map, he amended its geographical content. Although his horizontal map is more detailed than the earlier map, its geometric structure is weaker. In a particularly striking error, the Tihany Peninsula is shown on the southern shores of Lake Balaton. 4 Twenty-four Hungarian experts took part in the making of the map, as a consequence of which the toponyms are indicated in Hungarian, with a pronunciation guide for foreign readers. It is on this map that the 1,400 settlements of the Hungarian counties feature for the first time. **János Zsámboky** or **Sambucus** (1531–1584), served as physician and historian at the court in Vienna, where in 1566 he arranged for the printing of the maps by Lazarus and Honterus. In 1571, Sambucus published a further printed map of Hungary, which had a quite different structure. 5 This map was used from 1579 by **Abraham Ortelius** (1527–1598), who had already been including the Lazarus map in his world atlas since 1570. In the following century, publishers of atlases in Western Europe tended to copy the Lazius map. Even so, the 1528 Lazarus map did not fall into oblivion. **Gerardus Mercator** (1512–1594) used it when compiling his own map entitled *Hungaria* (1585).



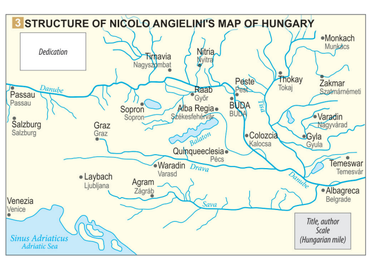
4 *Depiction of Lake Balaton on Lazius' map (1556)*

5 *János Zsámboky's map in the atlas of Ortelius (1579)*

In 1689, after the recapture of Buda by Christian forces, the *Parvus Atlas Hungariae*, the first pocket atlas of Hungary, was published. This was produced under the direction of **Gábor Hevenesi** (1656–1715), a Jesuit scholar. The pocket atlas actually consisted of sheets of a country map, but it also described the map editing principles, gave an overview of the country and listed nearly 2,500 toponyms in the index. 6

Military engineers and military cartography

At the time of the fortress wars along the borders in the 17th century, national surveys were impossible. Even so, military engineers working in Hungary often made fortification plans, topographic drawings, and map sketches. 7 Their manuscripts prove that new maps were still being made of major territories, in particular the environs of the fortresses on the frontiers. A map by **Giovanni Giacopo Gasparini** from the 1590s shows the captaincies in Transdanubia. Both this map and the *Woldan map* (circa 1595) demonstrate the interaction between printed and manuscript maps.

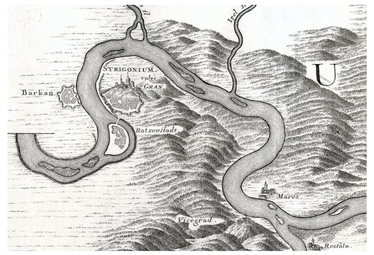


8 *Mountains in the plain on Stier's map of Hungary (1664, detail)*

Among the various master builders working in Vienna and in the borderlands, members of the **Angielini family** compiled major fortification atlases in the 1570s. One of these atlases contains a large map of Hungary by **Nicolo Angielini**, which is about as detailed as the Lazarus map. 3 Beginning in the 1560s, surveys were made of the line of Habsburg border-fortresses, a development presaging Habsburg military mapping. The work was continued in the 17th century by, among others, **Martin Stier** (1620–1669). In the latter half of the 17th century, Stier's map of Hungary represented a new source for the publishers of atlases, who, however, even incorporated the mountain ranges wrongly shown in the Alföld region. 8

At the time of the Ottoman wars, there was great interest throughout Europe in the Hungarian theatre of war. Such interest led to the publication of map leaflets. Subsequently, **Hieronymus Ortelius** (1543–1616) produced a military chronicle and further similar works richly illustrated with maps.

7 *Military engineer during a survey in the 17th century (reconstruction painting, Dongó 1958)*

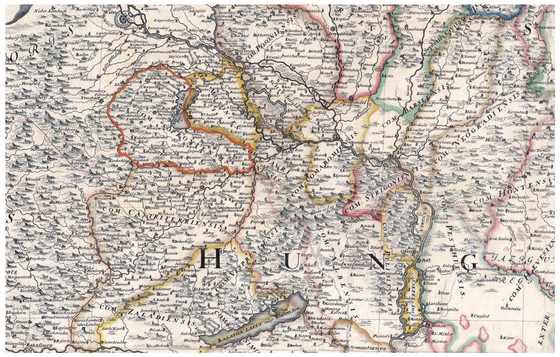


9 *Depiction of the Danube Bend in Marsigli's monograph on the Danube (1726)*

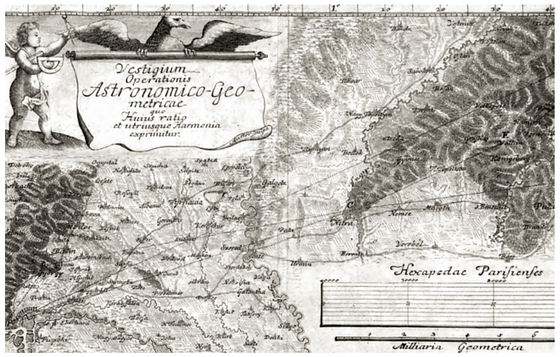
In the aftermath of the wars of liberation, surveying could resume. After the Peace of Karlowitz (1699), **Luigi Ferdinando Marsigli** (1658–1730) worked with **Johann Christoph Müller** (1673–1721) on designating the country's southern border. They surveyed and mapped the middle section of the Danube valley. The river is roughly shown in place on the map published in Marsigli's six-volume description of the Danube. 9 After the map of Transylvania (1699) by **Giovanni Morando Visconti** (1652–1717), **Müller**'s map of Hungary (1709) was published as the country's first official map. 10

Cartography during the age of Enlightenment in Hungary

During this period increasingly accurate and detailed national and county maps were produced. Regular and scientifically based engineering surveys were a prerequisite for such maps.



10 *Map of Hungary by Johann Christoph Müller (1709, detail)*



11 *The triangulation method of Sámuel Mikoviny (1732, detail)*

Sámuel Mikoviny (1698–1750) was a reformer of Hungarian cartography. Beginning in 1731, he produced county maps based on his own surveys to be appended to the descriptions by **Matthias Bél**. He then called for a cartographical survey to be undertaken throughout the country. His maps were based on astronomical, geometric, magnetic and hydrographic surveying procedures, which raised the standard of Hungarian cartography to the European level. 11 Mikoviny became the main Hungarian proponent of Enlightenment cartography. From the latter half of the 18th century, an increasing role was played in the Hungarian counties by the county engineers, who made maps for the purpose of road and, later, railway construction, river regulation, drainage and other technical tasks. Among such engineers, **Antal Balla** (1739–1815) made a particularly striking contribution. 12 In 1769, **Ignác Müller** (1727–1804) produced a decorative twelve-sheet wall map of Hungary.

After the Ottoman occupation, the central southern parts of Hungary destroyed by wars were settled by newcomers, leading to changes in ownership relations. For this reason, property maps showing ownership boundaries were produced frequently. In 1767, Queen **Maria Theresa** (1740–1780) issued a decree regulating the rights and duties of serfs and settling tenancy relations. Estate engineers produced the so-called *socage maps* until the 19th century when cadastral surveying was introduced. In 1785, Emperor **Joseph II** (1780–1790) ordered a survey of land ownership throughout the country. 13 However, in the face of substantial resistance from the county nobles and others, the ruler withdrew the decree in 1789.

Civilian cartography during the long 19th century (1790–1920)

Johann Mathias Korabinszky (1740–1811) became famous mainly for his publication of a book entitled *Geographisch-historisches und Produkten-Lexikon von Ungarn* (1786). He plotted his data on the first economic map of the country (1791), subsequently publishing the *Atlas Regni Hungariae Portatilis* (1804). This publication contained a geographical-political map of Hungary, a postal map, and forty-six county maps. 14

Having published numerous maps in Vienna, **Demeter Görög** (1760–1833) began publishing county maps in 1791. He and **Sámuel Kerekes** (1757–1800) issued 60 such maps in the period until 1811, receiving support from the country's nobles and from the court. 15 These maps constitute the *Magyar Átlás,* to which a *Repertory* containing 20,000 toponyms in five languages was added in 1812. **János Lipszky** (1766–1826) made a detailed map of the Hungary and the other Lands of the Hungarian Crown based on astronomical coordinates. The *Mappa Generalis Regni Hungariae*, published in Pest between 1804 and 1808, comprised nine sheets. The names on the map were based on the local languages. Accordingly, the work has a rich toponymy and constitutes a multilingual source. 16

Hungarian schools – Hungarian maps

The first school atlases in Hungarian were produced in the early 19th century. Having studied at Oxford and Göttingen, **Ézsaiás Budai** (1766–1841) taught at the college in Debrecen. Under his direction, his students designed and engraved the pages of the geographical atlas. The year 1800 saw the publication of the *New school atlas for lower classes*, which was based on the Lotter atlas (Augsburg) and consisted of 12 map pages. 17 Additional cartographical works by Budai were *Old atlas* (1801) and *Hungarian new school atlas* (1804).

Ferenc Karacs (1770–1838) from Debrecen, became a renowned engraver and map publisher in Pest. In 1813, he completed a map entitled *An ordinary map of Hungary and the connected Croatian and Slavonian countries and the Military Border, including the Grand Principality of Transylvania*. The map included around 8,000 placenames. 18

After the Austro-Hungarian Compromise (1867), **Ágoston Tóth** (1812–1889) proposed, in a book addressing cartography as a separate discipline, the foundation of a topographical institute in Hungary. An excellent cartographer at the time of the Dual Monarchy was **Ignác Hátsek** (1828–1902), who worked at the Hungarian Royal Central Statistical Office. 19 In 1880, he published the *County maps of the countries of the Hungarian Holy Crown*, an atlas containing maps of uniform scale. He was also the first to produce a relief contour map of the entire country, showing mostly estimated elevations given the absence of measured data.

In public education there was a growing demand for school maps in Hungarian. **Pál Gönczy** (1817–1892) initially translated German-language maps into Hungarian, subsequently collaborating with **Manó Kogutowicz** (1851–1908) to produce a series of county maps (1890). 20 Kogutowicz then set out on his path, initially cooperating with the Ed. Hölzel Publishing House of Vienna. By 1896, globes and wall maps in Hungarian were being produced. Prior to the outbreak of World War I, the **Hungarian Geographical Institute**, the first Hungarian map publisher, produced maps for schools and for the general public, even becoming an exporter of maps and teaching aids. In addition to its school atlases, the Institute also produced the *Full geographical atlas* (from 1902).

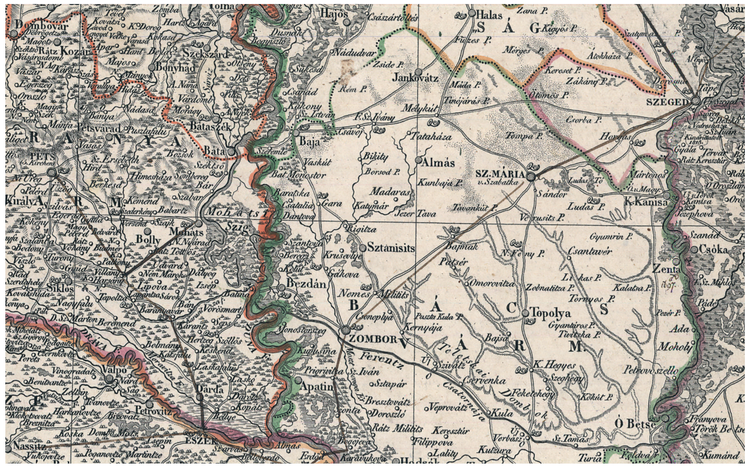
Detailed public administrative maps were published showing the modernized county system and Hungarianized placenames (e.g. the maps produced at the Hungarian State Press in 1914). By this time, toponyms were only given in the state language, in Hungarian. 21 As travelling opportunities improved, travel maps became more common. Stagecoaches were replaced by trains, and the new rail maps informed the public of the growing rail network. The first automobile (road) map also appeared at this time. Further, street maps of Budapest and other cities and towns were published. Meanwhile, the development of mountain tourism gave rise to the first tourist maps (*High Tatras*, 1887) for hikers and nature lovers.

Kogutowicz's atlas was followed by the *Great Hungarian Atlas* (1906), which was published by the **Hungarian Geographical Society**. Although in essence this publication was a Hungarian version of a German atlas, **József Homolka** (1840–1907) incorporated additional elements into the work. In 1912, **Pál Teleki** (1879–1941) and **Károly Kogutowicz** (1886–1948), having been inspired by the German model, began publishing a *World Atlas*, issuing one map at a time. They carefully planned and drafted the maps of Hungary. The outbreak of war, however, brought the series to a halt.

Thematic maps

In the Reform Era, the earlier water regulation schemes were resumed and augmented. There was a need to conduct hydrographic surveys of rivers and to measure their elevations above sea level. The required engineering work was set in motion by **Mátyás Huszár** (1778–1843). In 1818, assisted by his students, Huszár began to undertake surveys along the Körös rivers. He was then appointed to direct the *Surveying and mapping of the Danube*. The cartographic work continued under the direction of his successor, **Pál Vásárhelyi** (1795–1846). Meanwhile, another of Huszár's disciples, **Sámuel Lányi** (1792–1860) oversaw a survey of the River Tisza, which was launched in 1833. In the same year, the engineer **László Vörös** (1790–1870) arranged for the printing of depictions of Pest-Buda and the Danube. 22 Concurrently with the major drainage and water regulation projects, a summary map (1900) was produced under the direction of **Béla Vályi** (1863–1943).

The **Hungarian Royal Geological Institute** produced a detailed map of the country (1869), and in 1900 a geological map by **Lajos Lóczy** (1849–1920) won an international prize. Numerous ethnic maps were produced in the multiethnic country. A work by **Jenő Cholnoky** (1870–1950) was published in several editions from 1901. Of particular significance were the five demographic map series published in 1918–19 by **Zsigmond Bátky** (1874–1939) and **Károly Kogutowicz** in cooperation with the **Hungarian Royal Statistical Office**. 23 The composition of the population according to mother tongue and religion in all settlements of the country was shown on forty-five maps. A map (or cartodiagram) by **Pál Teleki** (1919) used novel methods to show the real ethnic structure of population. 24 As the Hungarian-inhabited areas were shown in red, the map became known at Trianon Treaty as the *'Carte rouge'*. However, neither the Hungarian maps composed for the peace negotiations, nor the trilingual atlas entitled *The economies of Hungary in maps* (1920), which had

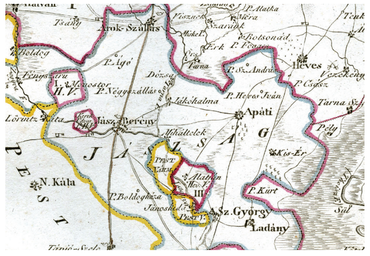


18 *Map of the region between Pécs and Szeged by Ferenc Karacs (1813)*

12 *Antal Balla's map of Pest-Pilis-Solt-Kiskun County (1793, detail)*

13 *Property survey in the time of Joseph II (reconstruction painting, Dongó 1958)*

14 *Postal map of Hungary from Korabinszky's pocket atlas (1804)*



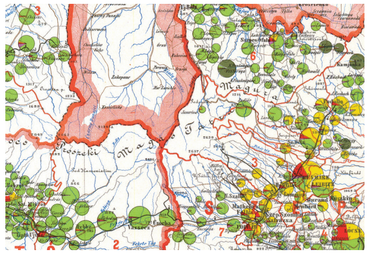
15 *Jászság in the Görög–Kerekes atlas (1811)*

16 *Kolozsvár and its surroundings on Lipszky's map (1808)*

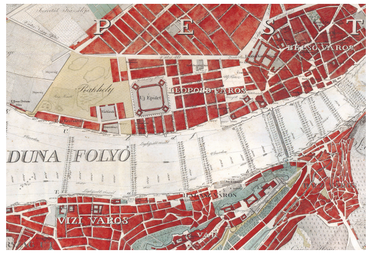
17 *The area around Debrecen and the Partium in the New school atlas (1800)*

19 *The area of Miskolc and Tokaj on Ignác Hátsek's wine map of Hungary (1875)*

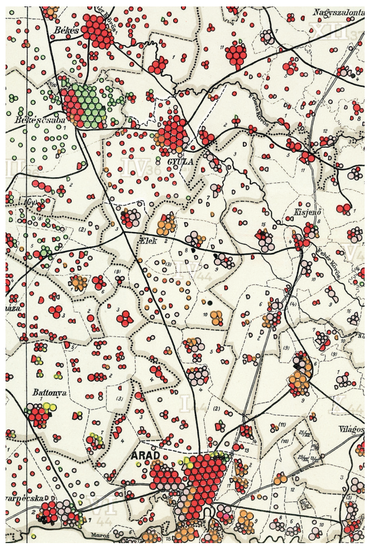
20 *Map of Sopron County (Manó Kogutowicz, 1880, detail)*



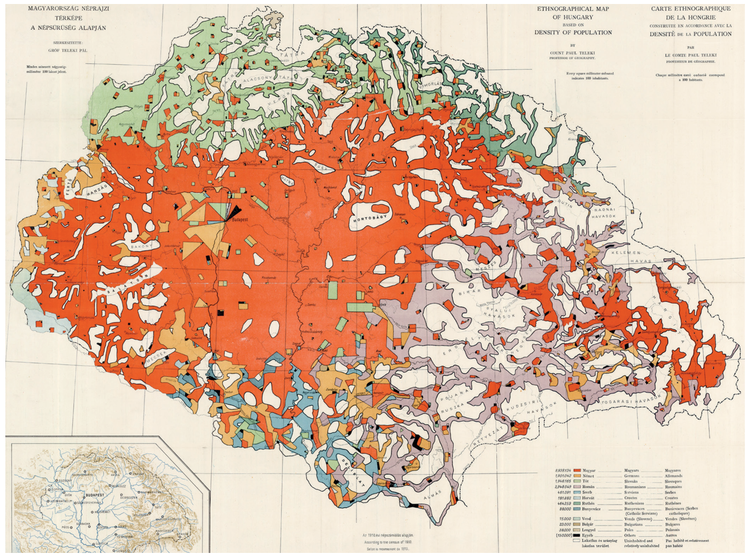
21 *The High Tatras and the surrounding area on the administrative map of the Hungarian State (1908)*



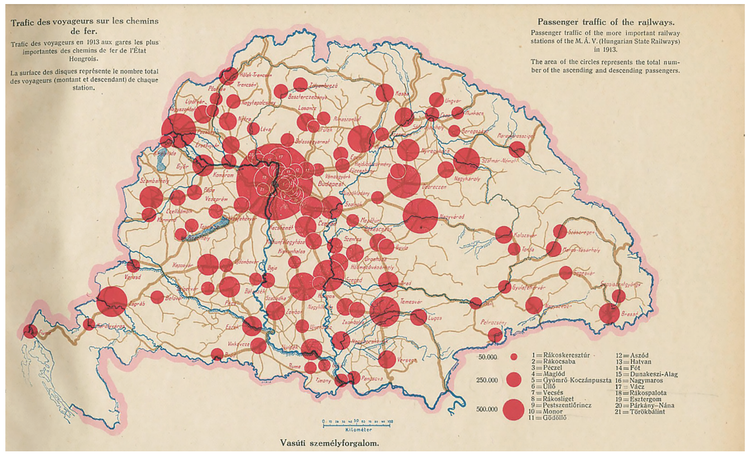
22 *Map of Buda and Pest by László Vörös (1833, detail)*



23 *The area of Arad and Békéscsaba on the ethnographic map of Zsigmond Bátky and Károly Kogutowicz (1919, detail)*



24 *Pál Teleki's 'red' map: the 'Carte rouge' (1919)*



25 *Detail of the atlas of Aladár de Edvi Illés and Albert Halász: The economies of Hungary in maps (1920)*

been produced by **Aladár de Edvi Illés** (1870–1958) and **Albert Halász** (1890–1945), succeeded in demonstrating the complementary unity of the country's various regions. 25

Habsburg land surveys

The military aspect had always been an important factor in surveying and mapping. In the early 18th century, the concept of line infantry was replaced by troops in arrangement, a development that extended the battlefield and resulted in increased demand for detailed maps. In the Habsburg Empire, the change in battle tactics was overseen by the Military Engineering Corps, a body established in Vienna in 1747. Its tasks included the construction of fortresses, the drafting of encampment plans, and the production of marching-route maps. Furthermore, it supplied general maps to the various Habsburg provinces.

The Habsburg Empire's first military (ordnance) survey (1763–1787)

The topographic mapping of the Habsburg Empire, which in terms of its extent and detail was the most extensive of the period, was undertaken after the Seven Years' War (1756–1763) in response to the grave problems that had been caused by the lack of detailed maps. The survey was conducted by the Quarter Master General Staff and by officer engineers deployed from the regiments; it had no projection and geographic coordinate grid. Ordinarily, mapping was based on graphic triangulation and plane table surveying. When depicting the topography, it was customary to show the relief of mountains, while the inclines were expressed using hachures.

German was the language of use in the army. Accordingly, regulations and data given outside the map frames were in German, as were also the country descriptions. Toponyms were usually shown in German, but sometimes they were featured in the local language, as were also settlement names.

The surveys were conducted in individual provinces (21 surveys) at a scale of 1:28,800. The more than 3,000 manuscript map sheets covered the entire Empire. Their uniform size was 63.2×42.1 cm. 4 26

The survey sheets were treated as top secret. Even so, they were used when producing smaller-scale military manuscript maps covering larger areas. Maps of Hungary were made at a scale of 1:115,200 (1785) and 1:192,000 (1786). The first survey-based printed map of the Habsburg Empire was published only in 1822. The map's scale was 1:864,000.

4 FIRST MILITARY (ORDNANCE) SURVEYS IN THE CARPATHIAN BASIN (1769–1785)

Date of survey	Countries/provinces	Number of map sheets of the survey
1769–1772	Banat of Temesvár	208
1769–1773	Grand Principality of Transylvania	280
1774–1784	Croatian-Slavonian Military Border (6 surveys)	246
1781–1783	Slavonia	66
1782–1785	Hungary	965
1783–1784	Croatia	71

The second military (ordnance) survey (1806–1869)

In the early 19th century the growing Napoleonic threat and the deficiencies of the first survey necessitated the drafting of more accurate maps in the Habsburg Empire. In 1806, an Astronomical Triangulation Department was established under the auspices of the Quarter Master General Staff. Then, in 1807, two further bodies were formed: a surveying department and the Topographical Institute. The latter made the derived scale maps. In 1839, the aforementioned bodies and the Milan military cartographic institute were merged to form the Military Geographical Institute in Vienna, which oversaw military mapping until the dissolution of the Austro-Hungarian Monarchy in 1918. The scale of the second survey was also 1:28,800, and the colour manuscript maps were made in two sizes: 63.2×42.1 cm and 52.7×52.7 cm. Geodetic baseline measurements were used, with the geodetic points being further condensed in the field by the mapping officers using drawings made by plane table surveys. The trigonometric elevation measurements were begun in 1833 and were calculated in relation to the mean water level of the Adriatic Sea. Lehmann's hachures were used to show the relief, with the thicker black lines indicating steeper inclines.

The military (ordnance) surveys were based on the cadastral surveys conducted between 1817 and 1861 in the Austrian hereditary lands. At that time, the Cassini–Soldner transverse cylindrical equidistant projection had been applied. To overcome distortions, ten origins of the starting points were determined for the whole territory of the Empire. In several places, the second military survey made use of the origins of the cadastral projection. In the case of the Kingdom of Hungary, this was the tower of Saint Stephen's Cathedral in Vienna.

The second military survey was also conducted by country and by province (14 individual surveys), with

26 *The 1:28,800 scale sheet of the first military survey showing Pest-Buda (1783, detail)*

5 SECOND MILITARY (ORDNANCE) SURVEYS IN THE CARPATHIAN BASIN (1809–1873)

Date of survey	Countries/provinces	Number of map sheets of the survey
1809–1869	Hungary (with the Banat of Temesvár and the Banat Military Border)	1,112
1853–1858	Grand Principality of Transylvania	42
1868		7
1869–1873		294
1865–1869	Croatia, Slavonia, Croatian-Slavonian Military Border	224

3,676 sheets being made in the territory of the Austrian Empire. 5 27

In Hungary, the establishment of a 'permanent cadastre' was decreed on 20 October 1849, but as the second military survey largely preceded the cadastral revision, cartographers could not rely upon it.

The smaller scale maps produced on the basis of the survey were published in print. In the case of several provinces, detailed maps were published at a scale of 1:144,000 and more general maps at a scale of 1:288,000. Concerning Hungary, 141 detailed maps were published between 1869 and 1881, while a more general map was published in 1856. 28

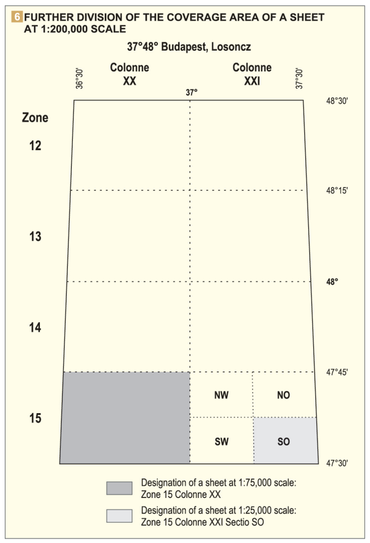
The year 1856 also saw the publication of an overview map of the Austrian Empire at a scale of 1:576,000. This map was also based mainly on the second military survey. The map formed the basis for a Central European map series that was published on 207 sheets between 1873 and 1876 at a scale of 1:300,000.

The third military survey (1869–1887)

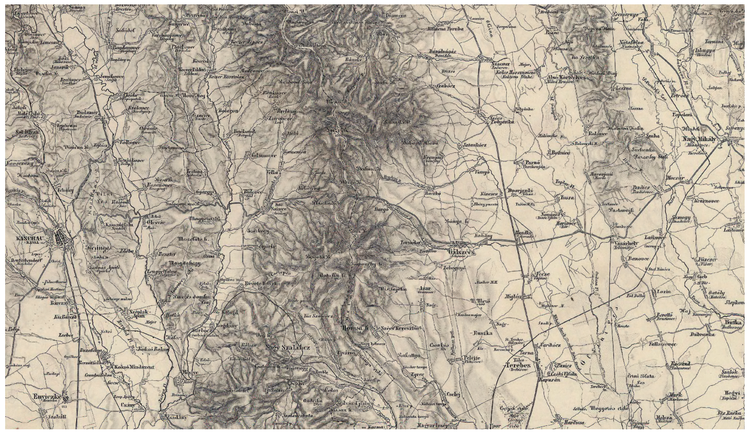
By the late 1860s, the deficiencies of the second military survey had become obvious. The earlier map sheets were now obsolete, and considerable advances had been made in geodesy. A further drawback of the earlier survey was that the measurements had been made by country and by province, with the smaller scale maps being published in the same way.

In 1869, a third military survey was decreed at a scale of 1:25,000. The manuscript military survey was the first integrated survey to be undertaken throughout the Empire. Based on this survey, smaller scale military maps were then produced. Here, it should be noted that a switch was made to the metric system in 1871.

6 FURTHER DIVISION OF THE COVERAGE AREA OF A SHEET AT 1:200,000 SCALE

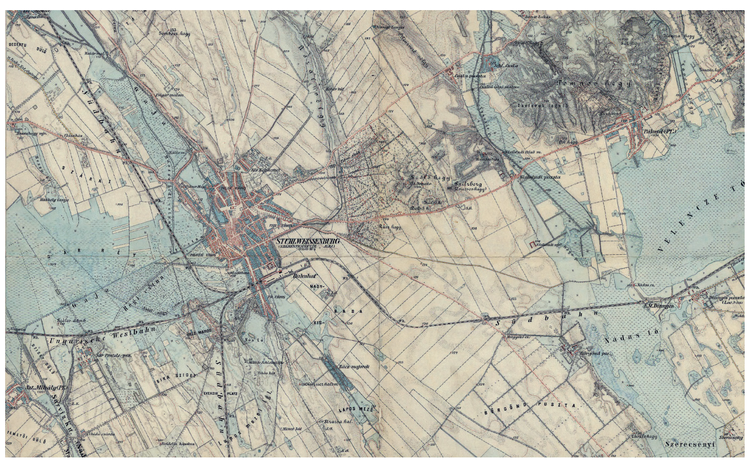


27 *The 1:28,800 scale sheet of the second military survey of Keszthely and its surroundings (1854, detail)*



28 *The area of Kassa on the 1:144,000 scale detailed map, reduced to a fifth of the second survey (1878, detail)*

The Empire's third triangulation data (1867–1898) and the data of the precise levelling commenced in 1873 served as the geodetic basis. The relief was presented using hachures, with contour lines being shown as supplementary information. In the main, the cadastral maps served as the planimetric basis. Where such maps were unavailable, the second military survey sheets were employed. The polyhedric projection was used, with the map sheets in conjunction constituting a polyhedron fitted to the reference surface (Bessel ellipsoid). That is to say, each map sheet lies on a separate plane. The sheets are bounded along geographical coordinates measured from the Ferro prime meridian. The sheet system of the surveyed (1:25,000) and de-



29 *The area around Székesfehérvár on the 1:25,000 scale sheet of the third military survey (1882, detail)*

30 *The area around Kolozsvár on the 1:75,000 scale detailed map (1880, detail)*

rived (1:75,000, 1:200,000) maps shows a correlation, starting from the 1:200,000 maps, whose coverage area is 1×1 geographical degrees. 6

In the Austro-Hungarian Monarchy as a whole, 2,780 survey sheets were produced, of which 1,354 related to the territory of Hungary. The size of a sheet in the middle latitudes of Hungary was 76×56 cm. In a divergence from the two preceding surveys, these surveys were not secret. And although the manuscript sheets were not originally intended for publication, from the 1880s onwards monochrome copies of them were made using photographic methods. 29

A uniform sheet system was developed for the whole of the Austro-Hungarian Monarchy. It was based on the detailed maps at a scale of 1:75,000. The 1:75,000 sheets are monochromatic; the 752 sheets (with 367 relating to Hungary) were published for the first time between 1873 and 1889 and related to the Dual Monarchy's entire territory 30. Based on the detailed maps, two further series were published with colour maps of Central Europe: a series of general maps at a scale of 1:200,000 (265 sheets, with 61 relating to Hungary) between 1887 and 1916 and a series of overview maps at a scale of 1:750,000 between 1882 and 1886.

The fourth military survey

The Austro-Hungarian Monarchy's fourth military survey was decreed in 1896. This survey employed more modern geodetic means and relied upon terrestrial photogrammetry for the mapping of mountainous regions. The previous scales and projections were unchanged. The outbreak of World War I interrupted the work, and in Hungary only a few partial sheets were produced relating to the High Tatras.

Modern surveying and mapping

Hungarian topographic mapping between 1914 and 1945

Hungarian military maps in World War I

During World War I, maps were used to an unprecedented extent. Most were smaller scale maps (1:75,000, 1:200,000 and 1:750,000) stemming from the third military survey. They were often published in combined form, with each military operational area being shown on a single map. In 1916–17, with the advent of trench warfare, the demand for more detailed maps grew. Concurrently, photographic reproductions of maps at a scale of 1:25,000 were made for individual military operational areas.

The greatest change concerned the amount of territory covered by the 1:75,000 maps, which were extended to cover the various military operational areas. By the end of the war, 300 additional maps had been added to the 752 map sheets at a scale of 1:75,000 produced in the first edition and covering the territory of the Austro-Hungarian Monarchy. As of 1 September 1917, a different sheet numbering system was used. A four-digit number now designated the columns and rows, in addition to the Roman numerals and Arabic numbers. During the same period, photogrammetry (terrestrial and then aerial) was used for the first time in mapping. From May 1915 onwards, aerial photographs of military positions were made.

Hungarian military mapping in the interwar period

With the dissolution of the Austro-Hungarian Monarchy, the Military Geographical Institute in Vienna, which had undertaken the joint military mapping tasks, ceased operations. Its functions were performed by new institutions in the successor states. In Hungary, the first independent body, the Hungarian Military Mapping Group, was established under the auspices of the Ministry of War on 4 February 1919. Its task was to produce maps of military operational areas during the Hungarian Soviet Republic. It was headed by Károly Kogutowicz, director of the Hungarian Geographical Institute, who set about revising the military maps. The maps in question were primarily sheets that had been published by the joint institution in Vienna at a scale of 1:75,000 or 1:200,000.

True topographic mapping only came into being somewhat later. On 1 July 1922, the **State Cartographic Office** began operations under the auspices of the Hungarian Royal Ministry of Finance. The body was the legal successor in Hungary of the Military Geographical Institute in Vienna. It was staffed with returning military officers and some former employees of the Hungarian State Press. In accordance with the terms of the Trianon peace treaty, the body was placed under civilian control, with military control only being resumed in 1938 when the office was returned to the Ministry of Defence. From then onwards, it was named the **Hungarian Royal Military Cartographic Institute**, which directed work during World War II.

As legal successor, the State Cartographic Office owned the 1:25,000 manuscript sheets of the third military survey as well as the platens of the 1:75,000 detailed maps. It also enjoyed exclusive publication rights in Trianon Hungary. Further, it had acquired co-publication rights for the 1:200,000 and 1:750,000 series throughout Central Europe. The State Cartographic Office kept this scale series, continuing its work on this basis.

The sheets of the third military survey were produced in polyhedric projection, the drawbacks of which had become strikingly obvious during World War I. Accordingly, in 1923, it was decided to introduce the stereographic projection, in which most of the cadastral maps had been produced. This meant their triangulation points could be used. The advantage of the stereographic projection compared to the polyhedric one is that adjacent map sheets can be arranged in a single plane. Moreover, a uniform kilometre grid covering all sheets can be laid out across the entire territory of the country. A drawback, however, is that as we move away from the origin of the projection, the distortions in distances and areas increase. In the case of interwar Hungary, the centre of the stereographic coordinate system was the main triangulation point on Gellért Hill. In 1936, the starting point of the numbering of the kilometre grid was moved 500 km to the west and 500 km to the south.

The vertical control network stemmed from the 'precise levelling' undertaken in the Austro-Hungarian Monarchy between 1873 and 1898, with the Nadap fundamental benchmark (fixed in 1888) being the main point of reference in the territory of Hungary (an elevation of 173.8385 m above the water level of the Adriatic Sea).

The 1:25,000 manuscript sheets inherited from the joint army were 40-50 years old, and there had been no revisions. Concerning the Trianon territory of Hungary, there existed 415 sheets. The priority was thus to update and print these sheets. Initially, the plan was to reambulate. In the period 1920–1926, 106 new sheets were made, whose publication in 2, 3 or 4 colours commenced in 1924. Both Ferro and Greenwich longitudes were shown on the frames.

As the relief shown on the reambulated sheets was based on the third military survey, it was somewhat unreliable. Thus, in 1927, a new survey was begun, with aerial photogrammetry also being employed. The appearance of the published maps resembled that of the reambulated maps. However, the former ones were more accurate than the latter in terms of content. Overall, eighty-six 1:25,000 sheets were made 31.

As both the reambulation and the new survey were proceeding relatively slowly, the State Cartographic Office – and subsequently the Military Cartographic Institute – printed, in black and white and without changes in content, the original manuscript colour sheets of the third military survey. The sheets were, however, augmented with a stereographic kilometre grid; this facilitated joining them with the renewed sheets. These sheets were published for the territory of Hungary. Meanwhile, the sheets for Transylvania and Croatia-Slavonia were augmented with stereographic grids according to the 'Marosvásárhely system' (Transylvania) or the 'Ivanić system' (Croatia), with a black circle being used to indicate the exact locations of the (newly designated) triangulation points.

The Austro-Hungarian Monarchy's detailed maps at a scale of 1:75,000 were partially corrected on several occasions after their first edition, with many of the corrections being made during World War I. Even so, there was still a need for map renewal and revision. The territory of Trianon Hungary was covered by 122 map sheets at a scale of 1:75,000. In 1924, an effort was begun to correct (in part) the old Viennese 1:75,000 maps by way of the records. However, the correction work was limited to major planimetric changes and to the Hungarianization of the toponyms; the monochromatic design remained. Up until 1930, all map sheets were published in this way. Concurrently, based on the reambulated and then newly surveyed 1:25,000 map sheets, 1:75,000 map sheets with contour lines appeared. Around 45 of the latter were published between 1924 and the early 1940s. 32

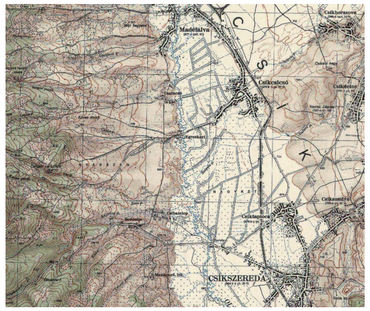
31 *The area around Badacsony on a newly surveyed 1:25,000 sheet made by using aerial stereophotogrammetry (1930, detail)*

32 *The surroundings of Beregszász on a 1:75,000 scale colour contour map (1940, detail)*

Where there was no updated map material, the 1:75,000 map sheets were corrected on the basis of on-site visits. In this way, the map planimetry and toponymy were corrected, with aerial photographs often being used as an aid. The changes were applied to the original etching plate of the map by means of engraving. Thus, similarly to the earlier 1:75,000 map sheets, these map sheets were published in monochrome, with the relief still being shown by hachures.

33 *The northern part of the Danube–Tisza Midland on a 1:200,000 scale sheet (1929, detail)*

34 *Northern Transdanubia on a 1:750,000 scale sheet (1932, detail)*



35 *The surroundings of Csíkszereda on a 1:50,000 scale sheet (1943, detail)*

General maps at a scale of 1:200,000 were published in the early 1920s with the data of the last Viennese correction. However, the toponyms had been Hungarianized. Map sheets with new content only began to appear in the 1930s. They were produced in the same way as before, similarly to the 1:750,000 maps. 33 34

Mapping during World War II

The outbreak of World War II brought changes to the mapping work, and the decision was taken to delay the new 1:25,000 survey. Along Hungary's southern and eastern borders, aerial photographs were used to correct the Viennese 1:25,000 map sheets. In this way, in 1939–1940, as many as 63 map sheets were produced.

In 1940–1941, photographic maps of the Alföld were made at a scale of 1:25,000 using aerial photographs and then rendering to scale. The maps were augmented with stereographic kilometre grids.

Uniformly updated maps were unavailable for the territories returned to Hungary between 1938 and 1941. For this reason, the idea of a new map series was raised. In the period 1940–1944, 1:50,000 maps in stereographic projection were published. These maps were created by dividing the 1:75,000 map sheets along the central meridian into western and eastern halves. Hungary, including the returned areas, was now covered by 403 sheets at a scale of 1:50,000. Reflecting differences in the basic map material, these sheets were diverse in design. Indeed, there were revised 1:25,000 and 1:75,000 sheets and monochromatic and partially revised 1:75,000 sheets. 35 In 1943, based on the 1:200,000 map sheets, the Military Cartographic Institute published a 1:400,000 military and air navigation map in Gauss–Lambert conformal conic projection. Subsequently, based on the latter, a topographic map of Hungary (including the returned areas) was made at a scale of 1:500,000.

7 TOPOGRAPHIC MAPS FOLLOWING 1945

Serial number	Year of making	Sheet number	Scale of survey	Derived scales	Features
I.	1950–1952	1,167	1:25,000	1:50,000, 1:100,000	'Quick correction' based on aerial photographs, change of the reference surface and projection
II.	1952–1980	4,462	1:10,000	1:25,000, 1:100,000	New survey for civilian purpose based on phototopographic methods
III.	1953–1959	1,167	1:25,000	1:50,000, 1:100,000, 1:200,000	New survey based on phototopographic methods
IV.	1964–1967	319	1:50,000	1:100,000, 1:200,000	Introduction of new legend
V.	1968–1982	1,167	1:25,000	1:50,000, 1:100,000, 1:200,000	Revision using the map series II
VI.	1975–1998	4,079	1:10,000	1:25,000, 1:100,000, 1:200,000	Revision of the map series II, implementation of EOTR
VII.	1984–1996	1,167	1:25,000	1:50,000, 1:100,000, 1:200,000	Revision based on orthophotos, the basis of DDM50 and DAT50
VIII.	2000–unfinished	4,079	1:10,000	Not made	Digital transformation of the map series VI, revision of certain areas using digital technology
IX.	2000–2004	319	1:50,000	Not made	Digital correction, change of the projection and reference surface (rules of NATO)
X.	2004–interrupted	1,167 (completed 76)	1:25,000		Digital new survey based on orthophotos (VTopo database)
XI.	2013–2022	319	1:50,000	Not made	Digital revision of DTA50, modernizing the database (DITAB50)

Topographic mapping in Hungary after 1945

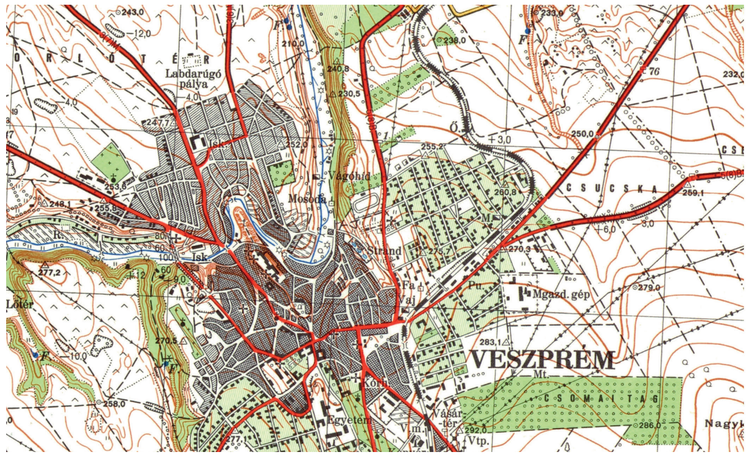
In the aftermath of World War II, Hungary and the Soviet Union signed a treaty of 'Friendship, Cooperation and Mutual Assistance' (1948). In Hungary, this led to changes in the content and design of maps and to a standardization of map legends. The survey scale remained 1:25,000, but thenceforth and until 2004 Hungarian military cartography applied the Gauss–Krüger conformal transversal cylindrical projection based on the Krasovskiy ellipsoid when making a series of international map sheets at scales of 1:25,000, 1:50,000, 1:100,000 and 1:200,000 based on a division of the 1:1,000,000 map. These maps were classified as secret, limiting their broader use. Between 1950 and 2004, several military maps were produced within approximately the same technical parameters. 7

The first survey of the period was the quick correction of 1950–1952, resulting in what may be regarded as maps of necessity. The 1:25,000 maps were based on the rather disparate Viennese maps that had been produced in the interwar period and then rectified in places and/or revised using transformed aerial photographs. Based on the corrected map material, maps at scales of 1:50,000 and 1:100,000 were then designed and published in six colours. They were produced in Gauss–Krüger projection and according to Soviet legend and execution.

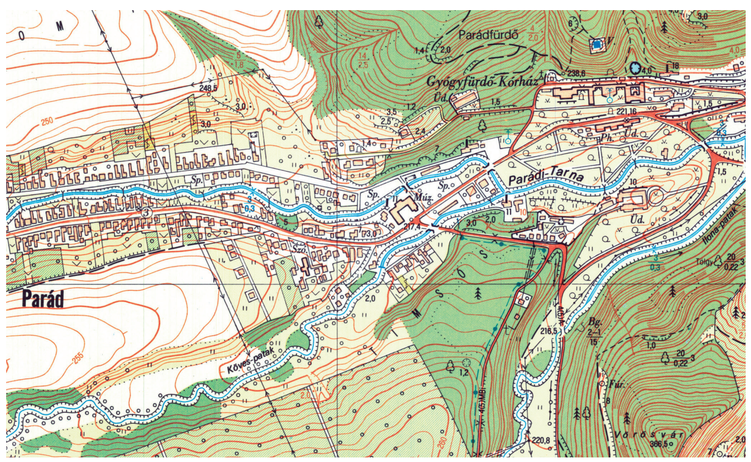
In 1952, following a proposal by the Geodetic Services of the Socialist Countries, it was decided to produce new military maps at a scale of 1:25,000. During preparations for the new survey, aerial photographs were made in 1952. The initial data gleaned from the photographic sheets and the geodetic sources comprised the technical basis for a detailed survey. By the end of 1959, Hungarian military mapping had scored a major success, namely the completion of survey maps covering the entire territory of the country, based on uniform principles and standards and produced using phototopographic methods. In addition, a derived map series had also been completed. 36

The military topographic maps were secret publications. For this reason and owing to their scale, they could not meet the demands of a growing economy. Therefore, following a proposal by the **State Survey and Mapping Office** in the early 1950s, the civilian cartographic institutions initiated the first topographic survey and the creation of state base maps for economic purposes at a scale of 1:10,000. These cartographic initiatives were fulfilled in the period 1952–1980. The survey was initially begun at a scale of 1:5,000 and in a stereographic projection. In 1957, the switch was made to the Gauss–Krüger projection system with a scale of 1:10,000. In 1960, changes were made to the map legend. Then, in 1964, the stereographic projection was reintroduced, and the international sheet division was replaced by the so-called domestic sheet division. In 1967, it was decided to use the 1:25,000 survey sheets to create topographic maps at a scale of 1:100,000. In the late 1960s, correction and revision issues came to the fore. The changes had become necessary, owing not only to the obsolete content but also to standardization requirements. Concurrently with the elaboration of a *Uniform National Map System* (Hungarian abbreviation: EOTR) attempts to revise the maps were commenced. In 1975, the use of the EOTR was stipulated in the production of cadastral base maps and topographic maps. In effect, this resulted in the merger of the two types of civilian (state) base maps. The EOTR maps are in conformal, secant cylindrical projection in oblique aspect developed for the mapping of Hungary, that is, in the uniform national projection on the IUGG 1967 ellipsoid. The sheet system and designation of the maps were based on the division of map sheets at a scale of 1:100,000.

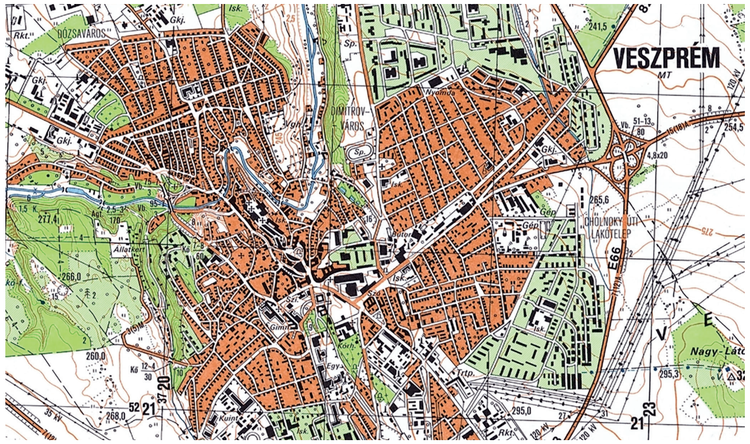
Within the framework of the Uniform National Map System, it was proposed to produce topographic maps at scales of 1:10,000, 1:25,000, 1:100,000 and 1:200,000. Around a quarter of the derived maps at a scale of 1:25,000 were completed. The 1:100,000 and 1:200,000 map series were produced by editing and altering the most recent military maps. The EOTR 1:10,000 map



36 *Detail of the 1:25,000 scale map sheet L-33-36-D-b Veszprém, which was made with the so-called new survey in 1955*



37 *Detail of the 1:10,000 scale map sheet 77-111 Parád, updated and revised to EOTR in 1989*



38 *Detail of the 1:25,000 scale map sheet L-33-36-D-b Veszprém, the last to be revised by analogue method in 1986*

programme ended on 30 April 1999. The maps produced in the course of the programme may be regarded as updated versions of the the base maps for economic purposes produced in the period 1952–1980. 37

The EOTR maps were given the designation 'for official use'. However, the handling rules remained almost identical to those applying to the secret maps.

The use of a new legend in the 1964 military topographic maps necessitated the correction of the 1:50,000 scale maps. The work was conducted until 1967 and made use of aerial photographs and, where necessary, on-site inspections. In the planning of the derived scales and the preparation of fair copies, the introduction of the use of transparent plastic drawing foils, the use of a self-devised scribe coating and scribing resulted in significant technological progress.

The reduction in the cost of fieldwork was a major factor facilitating the technological foundation for the mapping work begun in 1968 and the completion of a new 1:25,000 map. Thus, based on aerial photographs and other records, the maps were designed on the basis of the 1:10,000 map. This resulted in three-quarters of the work being undertaken in the office and thus a smaller proportion in the field. In view of point densification, the need for control point measurements was radically reduced. Based on a precise photogrammetric evaluation, it was possible to implement the basic principle that the topographer's task is to qualify rather than measure the planimetric lines as well as to check and possibly supplement the topographic relief. The use of modern drawing foils and copying procedures enabled the introduction of the block mapping method. The essence of this method is that, within a 1:200,000 map sheet, maps at scales of 1:25,000, 1:50,000, 1:100,000 and 1:200,000 can be produced concurrently.

The last revision of the military map system using analogue technology occurred in the period 1984–1996. 38 The application of the latest technological solutions (aerial triangulation with computerized block adjustment and the use of orthophoto maps) enabled the classical photo-topographic procedure to be developed into the most modern analogue topographic mapping procedure of the period. The 1:50,000 part of the map series constituted the foundation of the DDM50 digital terrain model and the DTA50 vector digital topographic map database.

Even before the end of the revision cycle, the correction of the 1:10,000 EOTR map sheets began in 1995, aided by computer-supported technology. Initially, the aim was not to make digital maps but to produce analogue map originals with the aid of computer technology. Following a proposal by the companies undertaking the revision work, vector data were also produced. However, the main task continued to be the computerized reproduction of analogue technology. Owing to a lack of funding, the revision work came to a halt. Under the auspices of a grant-funded project, however, the vectoral digital transformation of the analogue stocks was concluded by 2007 without content correction.

Act LXXVI of 1996 on Cadastral and Mapping Activities (in 2012, amended legislation was adopted by Parliament: Act XLVI) established the legal foundations for a uniform topographic map system and stipulated the civilian and military tasks and responsibilities. This legislation facilitated the cessation of secrecy for civilian maps (1989) and military maps (1992).

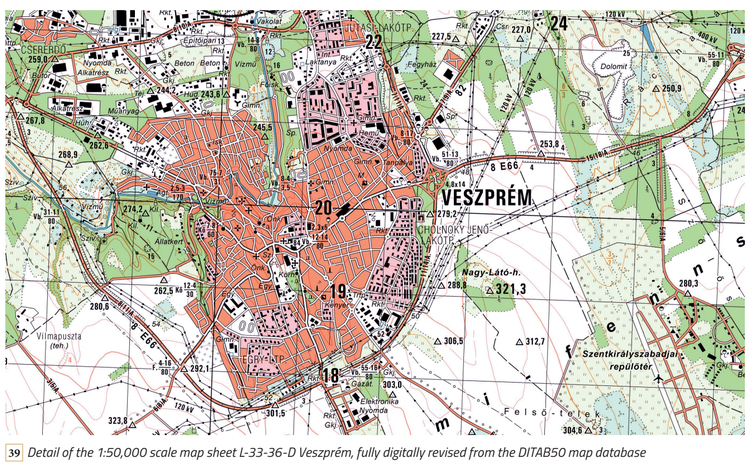
The updating of military maps and their digitization became formal requirements when Hungary joined NATO in 1999. However, owing to funding and capacity constraints, the results were of limited scope. In accordance with NATO rules, topographic maps at a scale of 1:50,000 were produced based on DTA50 and using computer technology alone. Leaving the sheet system unchanged, the maps were made in the UTM projection system on the WGS84 reference surface with bilingual text outside the frame. The revision of the map content was limited to the major elements; in other words, a partial correction was carried out. The process of ensuring the NATO compatibility of the maps did not entail correction of the 1:25,000, 1:100,000 and 1:200,000 scale maps. The Vtopo programme, which aimed to produce the 1:25,000 scale maps based on a digital database, was terminated two years after its initiation in 2006.

In view of an increased demand for maps on the part of the Hungarian Defence Forces, in 2013 the full revision of the DTA50 database could begin, accompanied by the supplementing and updating of content and the creation of a DITAB50 database. The renewal and modernization process, which was based on digital technology and on remote sensing materials, was completed in 2021. Concurrently, the database-oriented technology for the automatic production of 1:50,000 scale topographic maps was initiated. 39

Maps for the general public after World War I

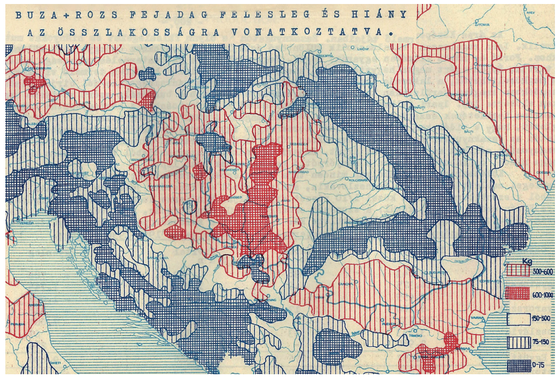
After WWI, Hungarian cartography had two main tasks: to update the topographic maps and to satisfy public demand for maps. Prior to the war, the **Hungarian Geographical Institute** had broadened the scope of its products, producing a new celestial globe (1909) and publishing its *Pocket atlas*. After the war, however, its presence in the market declined. Indeed, the Institute steadily withdrew from the map-making field.

After World War I, the **State Institute of Cartography** (ÁTI), which was in charge of military mapping, published some maps for civilian use. The Institute sought to meet the various needs. For this reason, it had a broad range of maps, including public administrative maps, city maps, various wall maps, and atlases. Its most important publication was *Little atlas* (1937). 40 In 1933, **Lajos Illyefalvi** published an album entitled

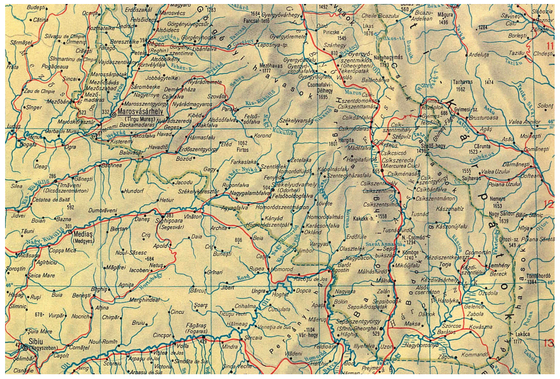


39 *Detail of the 1:50,000 scale map sheet L-33-36-D Veszprém, fully digitally revised from the DITAB50 map database in UTM projection, partly automatically edited in 2017*

40 *The Carpathian Basin in the ÁTI Little atlas of 1938*



41 *An economic map of the Atlas of Central Europe by András Rónai (1945)*



42 *Map of the Hungarian Autonomous Region in the 1959 World Atlas of the Cartographic Enterprise*

The past and present of the Capital, which contained thematic maps and statistical charts. In 1928, **Albert Halász** published his economic atlas about Central Europe. Targeting the general public, it showed the new boundaries in the region (*New Central Europe*).

The **Institute of Political Sciences** was founded by **Pál Teleki**. Owing to the warfare, no more than a few copies of *Atlas of Central Europe*, a work edited by **András Rónai** (1906–1991), were produced. This atlas was published in Balatonfüred in 1945, and a digital facsimile edition followed in 1993. 41 As a forerunner to the National Atlas of Hungary, the 334-page work comprised a social and economic review of both the Carpathian Basin and the broader region. After World War II, the Hungarian Geographical Institute was brought under state ownership (it continued to operate under the name Offset Nyomda), as was also the *Turner's* firm, which had produced globes and relief maps.

At the height of the Cold War in the early 1950s, there was a lack of civilian maps in education, public administration and the economy. Moreover, a state decree was adopted ordering the populace to submit to the authorities all pre-1945 topographic maps. In the end, having recognized the deficiencies, the authorities designated the production and publication of maps for civilian purposes as a state task (in line with the Soviet model). The year 1952 saw the establishment of the **Institute of Geodesy and Cartography**, which in 1954 was merged into the newly founded **Kartográfiai Vállalat** [Cartographic Enterprise]. Both institutions were directed by **József Takács** (1901–1986).

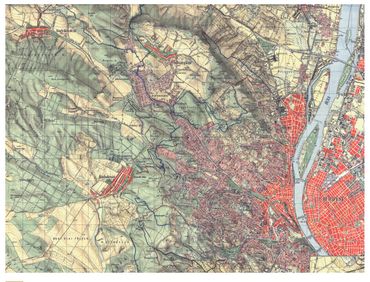
The company, which sought to meet all civilian and educational needs, operated as virtually the sole map publisher in Hungary until the political changes of 1989–1990. Its first tourist map appeared in 1954, and this was followed by the first geographical atlas and geographical wall map in 1955, the first historical atlas in 1959, and a novel series of historical wall maps in 1960. In 1965, a new series of globes was created with the collaboration of **István Turner** (1900–1974) and **László Irmédi-Molnár** (1895–1971). The editorial board, headed by **Sándor Radó** (1899–1981), produced major works such as the *World atlas* (1959) 42 and *National Atlas of Hungary* (1967). Radó also founded the topical map service *Cartactual*, which illustrated changes that modified the content of maps (1965–1993).

Tourist and automobile maps

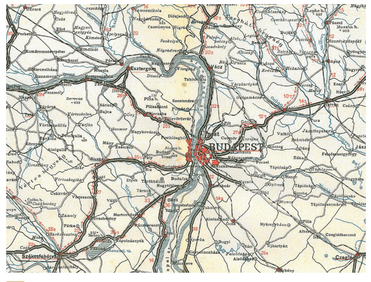
The State Institute of Cartography oversaw the production of a major series of tourist maps in the interwar period. 43 They were based on the 1:25,000 scale topographic maps. The forestry and tourism bodies collaborated in the drafting and correction of these maps. The tourist maps had red covers, while the maps used in water sports had blue covers. In the post-war period, beginning in 1953, a series of travel guides with maps – known as the *Portyavezető* (Raid leader) series – were published under the direction of the Sport publishing house. From 1954 onwards, **Kartográfiai Vállalat** also produced tourist maps, which, in line with the Communist regulations, were distorted and had a reduced amount of data.

Automobiles were still relatively rare in Hungary when the first Austro-Hungarian road atlas was published on behalf of the Tauril rubber factory (1914). 44 This publication was followed by a road map published by the Hungarian Royal Automobile Club and produced by the **Hungarian Geographical Institute** (*Hungary road map*, 1932). Beginning in 1956, maps produced by **Kartográfiai Vállalat** were published, which were distorted in the same manner as the tourist maps. 45

In 1993, **Kartográfiai Vállalat**, a major producer of civilian maps in the second half of the 20th century, was privatized. The successor company, **Cartographia Ltd**, is still active in the publishing and commercial fields of cartography, as are some of the smaller cartographic enterprises established at that time.



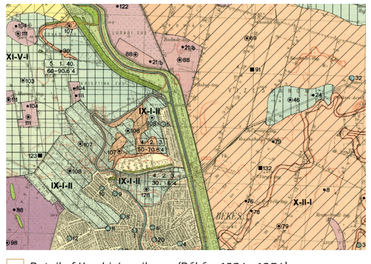
43 *Tourist map of the hills of Buda (1934, detail)*



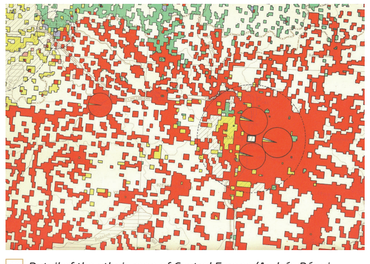
44 *Highways around Budapest in the Tauril atlas (1914)*

45 *Tourist map of Lake Balaton and its surroundings (1958, detail)*

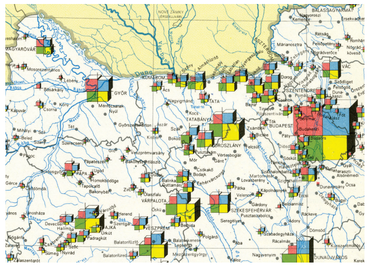
46 *Detail of the geological map of Lake Balaton edited by Lajos Lóczy (1920)*



47 *Detail of Kreybig's soil map (Békés, 1934–1954)*



48 *Detail of the ethnic map of Central Europe (András Rónai, Imre Jakabffy, 1942)*



49 *Detail of a map showing socialist industry from the first edition of the National Atlas of Hungary (1967)*

entire country. The two volumes of *Hungary's climate atlas* were published in 1960 and 1967.

The first Hungarian national atlas was intended to present the country's natural, social and economic geography. It was published as *National Atlas of Hungary* in 1967 49, with a second edition appearing in 1989. The first volume (Natural environment) of the new four-volume atlas was published in 2018, with the second volume (Society) appearing in 2021. The new atlas is being edited by the **Geographical Institute of the Research Centre for Astronomy and Earth Sciences (HUN-REN)**. The Institute (operating until 2011 as the **Geographical Research Institute of the Hungarian Academy of Sciences**) has been a major centre of geographical research and thematical cartography ever since the mid-20th century.

The basic collection of the **Map Collection of the Institute and Museum of Military History** (Budapest) stems from the Military Archive in Vienna; the maps were transferred to Hungary after World War I. Many of the maps in the collection are military topographic maps. The collection now includes nearly half a million items, the most important of which are accessible on the Hungaricana website. **Map Collection of the National Széchényi Library** includes maps from the library founder's collection as well as more than 300,000 maps from the 16th century. The collection's focus is on Hungary-related maps, atlases and globes. Professional cartographic journals have been published in Hungary since the 1930s (e.g. *Térképészeti Közlöny* [Cartographic Gazette]). Today, the **Hungarian Society of Surveying, Mapping and Remote Sensing** publishes the journal *Geodézia és Kartográfia* [Geodesy and Cartography].

The world's first civilian courses in engineering were launched at the **Institutum Geometricum** of the University of Pest in 1782. After the Selmec (Schemnitz) Academy's relocation to Sopron, courses in surveying were launched in Sopron in 1949. Currently, courses in surveying and geoinformatic engineering are available at the **Faculty of Civil Engineering of the Budapest University of Technology and Economics.** Courses in surveying and land management for agricultural engineers were launched in Székesfehérvár in 1962. Today, the courses are run by the **Alba Regia Faculty of Technology of the Óbuda University**, and since 2006 similar course have also been available at the **Faculty of Forestry of the University of Sopron**. In 1953, Eötvös Loránd University established a department of cartography headed by László Irmédi-Molnár. Master's courses in cartography are currently available in both Hungarian and English at the **Institute of Cartography and Geoinformatics of the Faculty of Informatics, Eötvös Loránd University**. In 2022, a master's course was launched in geoinformatics. Hungarian cartographers are influential in the international organizations (e.g. International Cartographic Association, ICA). 50

50 *Hungarian and foreign cartographers in Budapest at a meeting of the International Cartographic Association (2003)*

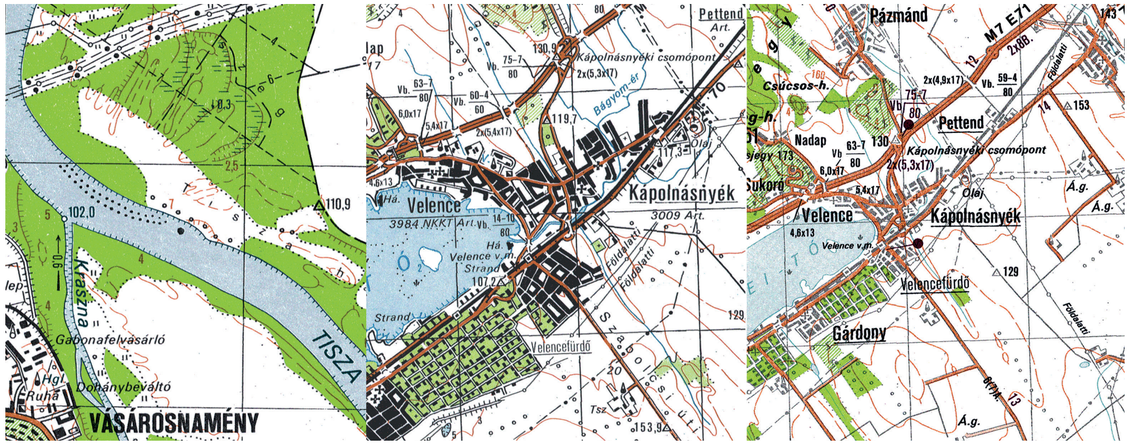
Maps, databases, geoinformatic services

State cartographic databases

The cadastral and mapping data transferred to the state in the course of cadastral and mapping assignments, as well as data stemming from land registry and other procedures, are considered basic data under the provisions of Act XLVI of 2012 on cadastral and mapping activities.

The raster/vector digital databases of the basic state cadastral base maps, the land registry maps, and the state topographic maps constitute the basic state cartographic data. The digital cadastral base map database was created in accordance with the DAT-rules and the MSZ 7772-1:1997 standard. It contains the geometric and attribute data for the administrative territories of settlements. Meanwhile, the vector digital cadastral base map according with the layer allocation prescribed in Decree No. 21/1995. (VI. 29.) FM (Ministry of Agriculture) contains the geometric data of settlements with the associated identifiers. The state cadastral map database is a compulsory foundation of the state cadas-

51 *1:10,000, 1:25,000, 1:100,000 and 1:200,000 scale raster EOTR map details (1977–2000)*



52 *Details of 1:25,000, 1:100,000 and 1:200,000 scale raster versions of the military topographic maps in Gauss–Krüger projection (1983–1997)*

tral map database map database. The state land registry map database and the property title database comprise, in conjunction, the property register database. Both elements are kept up to date by the land registry offices.

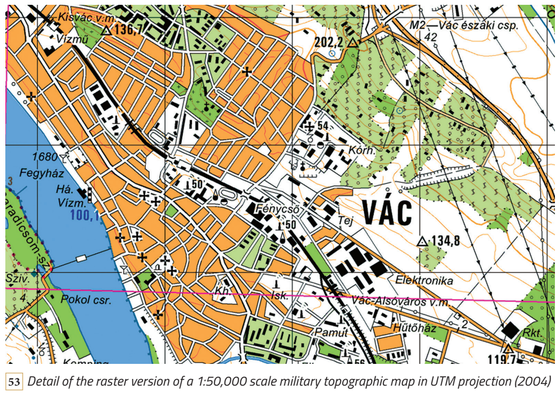
The state topographic map databases are formed from the raster digital versions of the printed maps and from the vector databases produced on the basis of the topographic maps. In raster digital form, the following are available: the 1:10 000, 1:25 000 (for approx. a quarter of the country), 1:100 000 and 1:200 000 EOTR map sheets 51; the 1:25 000, 1:100 000 and 1:200 000 Gauss–Krüger projection map sheets relating to the military maps renewed during the period 1984–1996 52; and the raster digital versions of the UTM projection maps corrected using digital technology during the period 2000–2004. 53 The vector data set of the continuously updated DTA50 and the 1:10,000 scale EOTR maps may be regarded as a vector cartographic database. The digitized contour lines of the topographic maps or the derived digital terrain models serve also as separate data sets. From the topography of the 1:10,000 EOTR map, a topography model with a grid density of 5 m was generated, onto which the major topographic changes that have occurred since 2000 (e.g. motorway construction, opening of open-pit mines, etc.) were transferred in a stereo-photogrammetric process. A terrain model with a grid density of 50 m was created from the contour lines of the military topographic maps at a scale of 1:50,000 revised between 1984–1996. 54

The aerial remote sensing databases contain digitized versions of the various types of aerial photographs (monochrome, colour, infrared, etc.) taken over the decades, as well as the files of digital recordings made since the advent of digital aerial photography. The digital orthophoto database is part of the aerial remote sensing database, which consists of digital orthophotos of any area of the country that can be used for state basic tasks and basic functions. 55

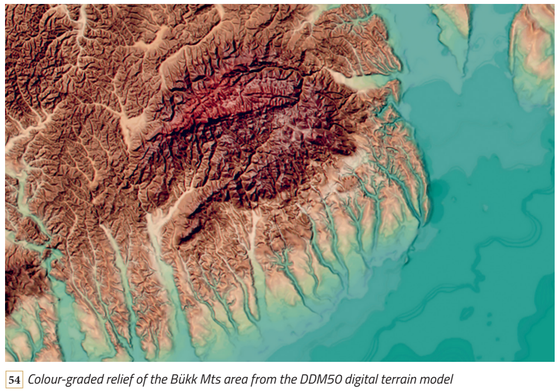
In the early 2000s, various elevation data sets and surface models were created from aerial photographs of the country using digital photogrammetry technology. The digital surface model is a point cloud that is obtained by using stereo aerial photography models and which describes the elevation of the terrain, or the surface of any terrain object located on the terrain when the aerial photographs were made. The coloured digital surface model consists of the points of this point cloud coloured with the colour spectrum of the aerial photographs. 56 The normalized digital surface model is the difference between the raster data content of the digital surface model and the 5 meter resolution terrain model generated from contour lines, which thus gives the relative height of each surface object as the difference between the surface and the terrain models.

The state basic data and databases are stored in national data repositories, map repositories, aerial photography and aerial film repositories, and local data and map repositories. Except for the national defence cartographical databases, the state cartographical data are public data that are provided by the designated organizations subject to the payment of an administrative service fee.

55 *Detail of digital orthophoto*



53 *Detail of the raster version of a 1:50,000 scale military topographic map in UTM projection (2004)*



54 *Colour-graded relief of the Bükk Mts area from the DDM50 digital terrain model*

56 *Visualization of the coloured digital surface model (cDFM, detail)*

Digital maps and online map services

The roots of today's geoinformatics go back to the 1960s, while the emergence of the major geoinformatic applications dates to the 1980s. In Hungary, COMAPO was up and running at the **Department of Cartography, Eötvös Loránd University** as early as 1972. Indeed, it was the first domestic system adapted to the computing possibilities of that era. 57 In cooperation with the Economic Planning Institute of the **National Planning Office**, a method was developed for regional planning that shortened the duration of map drawing. The cartograms broken down by county were primarily used for planning purposes, so the modest graphic quality of the maps was not a major drawback.

The field model (DTM200) of the **Postal Experimental Institute** (PKI), a model introduced in 1978, can be viewed as the first cartographic digital database. At the time, there was a great need for the use of methods supported by computer databases in telecommunications planning

The first digitized state topographic map of Hungary was the 1:200,000 scale military topographic map known as DTA-200. The sheets, which covered the entire country, were digitized by 1987, but at that time they did not include all the contents of the paper maps. At the time, all topographic maps in Hungary were still secret, so the DTA-200 was initially only available for military purposes. In 1989, the 1:100,000 civilian topographic map series was digitized. 58 With the ending of secrecy and Hungary's political and economic transition, the database became widely available, thus facilitating the introduction of GIS systems in Hungary. (The largest database is the digital version of the 1:50,000 scale topographic map, DTA-50.)

57 *Thematic map produced with COMAPO (1972)*

58 *Detail of the OTAB 1:100,000 scale series of state civilian topographic maps (1989)*

59 *Information atlas of Budapest by Invent-Cartopress (1990, detail)*

60 *The Lajosforrás orienteering map (1990)*

At the Budapest Council, the Surveying Department of the Land Registry Office collaborated with the State Administration Computer Service to create a cadastral map of Budapest at a scale of 1:1,000. For the most part, the maps were made only with a black and white or colour plotter, but the cadastral map was also used as a base map for the 1989 edition of the Hungarian National Atlas (MNA).

Systemic change in the IT field of Hungarian map publishing occurred over several years. 59 Even before the fall of communism, **Kartográfiai Vállalat** had used computers for some sub-processes. The first map created using digital technology alone was the *Lajosforrás* orienteering map (1990). 60 There followed several city, county and tourist maps in rapid succession.

The first state institution to switch entirely to digital map-making was the **Hungarian Geological Institute** (MÁFI), which initiated the development of its own digital system in 1986. From 1989 onwards, however, the Institute digitized geological maps using commonly available software. Latterly, a digital map service was unveiled. 61

Since the 2000s, Hungary's national cartographic institutions (military and civilian) have been restructured on several occasions. The resultant instability and the uncertainty of funding account for the continued lack of an exhaustive and updated state map online portal. In March 2022, the **Lechner Knowledge Centre** announced the completion of the *National Geoinformatic Base Map* (NTA). Certain elements of the system (property registry, orthophotos, specialized services, e.g. forestry) are fully functional, being updated on an ongoing basis. Other services/functions, however, are still missing (e.g. full aerial Lidar surveys, vectorization of the topographic base maps).

Various digital map services are offered to the general public on a commercial basis. **Arcanum Maps**, for instance, offers a range of old topographic and cadastral maps. Map-based route planning and ticket purchases are available through the mobile applications *BudapestGO* (Centre for Budapest Transport, **BKK**) and funiQ (**Cartographia Ltd**). Both Időkép and *eMNA* (the full digital version of the National Atlas of Hungary, **Geographical Institute, CSFK**) provide free maps. 62 INSPIRE, comprising more than two hundred data sets of the EU's geospatial infrastructure, is available on the Internet. The online portal of the **Lechner Knowledge Centre** offers geoinformatics data and services to domestic users.

With the advance of information technology, in the 21st century maps have become universal visual tools for the study, research and communication of data and information in the real and virtual worlds.

61 *The web interface of MÁFI's geological maps*

62 *eMNA web interface (Digital version of the National Atlas of Hungary)*

National Atlas of Hungary (MNA)
www.nationalatlas.hu

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