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Exploring and mapping the Danube: Reading a hydrographical map of Buda and Pest (1833)

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ABSTRACT

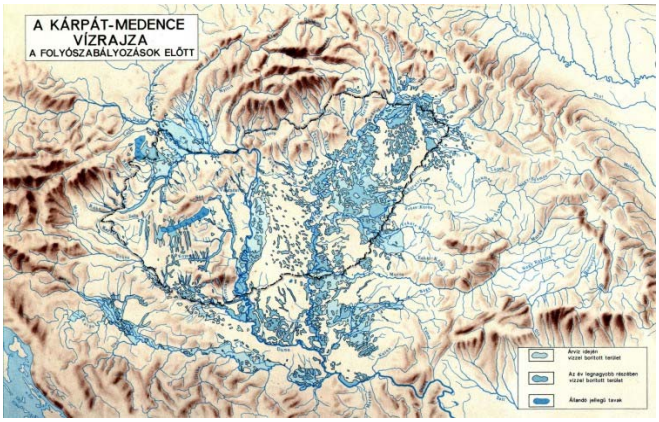
Systematic survey of the waters in Hungary started as a late Enlightenment project in the early 19th century and hydrographic maps were produced by a new generation of civil engineers. László Vörös (1790-1860), who studied at the *Institutum Geometricum et Hydrotechnicum,* the world' first university level engineering school (founded 1782), worked as surveyor, engineer, engraver and map maker for the Danube Mapping Project from 1828. The mapping of the river's section between Buda and Pest became a priority task for the regular floods threatening the developing and expanding sister cities. Vörös was commissioned to construct a detailed and accurate map from the available topographic and hydrographic data.

The large, detailed and elegant map was lithographed by the author and was published with the support of the Bridge Builder's Union in 1833 in Pest. The building of a permanent bridge connecting Buda and Pest became part of the national development movement led by count *István Széchenyi*. Vörös' early thematic map is considered as a milestone in the history of Hungarian cartography and the *Chain Bridge* (1849), a symbol of the Hungarian capital, is the evidence for its importance.

How can we read and understand this decorative map? At first sight it looks like another early city map, but the interpretation of its rich data content is very difficult, especially for the modern reader as it was produced by a specific, hydrographic mapping mode which can not be fully understood in the topographic paradigm. In our presentation we would like to demonstrate that the map's data content, its thematic layer, can be interpreted in historical contexts. We put the map into contemporary technical, cultural and social contexts to make its numeric data meaningful. The interactive exploration of the map, the visualization of the spatio-temporal database by the modern reader requires - apart from modern geoinformation technology - the expertise of the historian of cartography.

Introduction

In the early 19th century on the map of the Kingdom of Hungary, the central part of country , the Great Hungarian Plain, was a huge flat area with rich hydrography: apart from the tributaries of the two main rivers, the Danube and the Tisza, thousands of smaller waterflows, lakes, swamps and marshes indicated the importance of water. After the Turkish Wars in the previous centuries, when whole regions became deserted, from the 18th century with the returning Hungarians other nationalities, Slovak, German and Romanian settlers arrived and created the characteristic settlement pattern of large villages and market towns. The increasing population and the extending agricultural production required more and more cultivated land. The work the generations of Hungarian civil engineers done since the Age of Reform in the early 19th century can be appreciated if we consider the earlier hydrographic conditions, the state before systematic water regulations started.



Enlightenment cartography in Hungary

The Habsburg government in Vienna realized the importance of water regulations in the modernization of the country. The existing maps were unsuitable for planning purposes, so the survey and mapping became a priority task already for the first civilian engineer of the Hungarian Chamber.

In 1735 *Samuel Mikoviny*, after his studies at the University of Altdorf-Nuremberg and his engineering activity in Pressburg, was nominated as “court geometer” in Selmecbánya (Banska Stiavnica). As the first professor of the mining school, he surveyed and mapped the counties of Hungary, surveyed and mapped the counties and made several construction plans. The priority of the water regulation works is best exemplified by his life. In 1750 Mikoviny

worked on the regulation of the river Vág in Upper Hungary, caught cold during this survey and died on his way home.

Mikoviny introduced the modern surveying and mapping methods of the Enlightenment to Hungary. The novelty of this new mapping paradigm, how he explains it in his introduction to his maps in 1736, was that the maps were constructed on geometrical basis. In the 18th century his students followed his footsteps, and the new maps made the old '*geographical dreams*' (Mikoviny, 1735) gradually obsolete.

By the end of the century, the former capital of the medieval Kingdom of Hungary became once again the center of state administration. This was indicated by the royal decree in 1777, which ordered the Jesuit university, founded in Trnava (Nagyszombat) in 1635, to move to Buda. At the new Royal University a special department was established in 1782. The *Institutum Geometricum and Hydrographicum* became the first institution in the world for university level education of civil engineers. After the first years in Buda, the institution moved to a building, near to the present University Library, in the city of Pest.

Pest-Buda and the Danube Mapping Project

In the early 19th century the two sister cities, Buda and Pest were situated at the opposite banks of the largest river in the country, the Danube. With its German population Buda on the hilly side was very different from the Hungarian Pest at the edge of the Great Plain. The two cities were connected by ferries and a temporary boat bridge. Their capacity was, however, limited. With the rapid development of Pest, where building sites were available, the idea of a permanent bridge became more and more important.

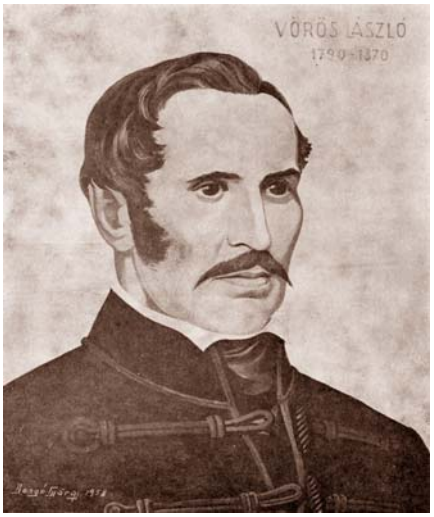
The fast development in the first decades of the 19th century resulted in more than one thousand new houses, the majority built of wood and air-dried bricks without stable foundations. As the constructions were not water resistant, high water or floods were very dangerous in the densely populated city on the river's left bank. The most devastating were the icy floods in the past, as the one e.g. in 1775, when the level of the water reached its measured maximum of 795 cm. Unfortunately, the raising of the embankment above this level and the blocking the *Rákos* channel that endangered the suburbs could not solve the problem. From the 1820s several hydrographic experts alerted the City Council that the flood

is not caused by high water only. In wintertime downstream from Pest-Buda, where the river bed suddenly became wide and shallow, the heavy pack-ice piled up. The ice plug filled in the whole river bed and blocked the stream. The river was frozen for 99 days in the winter of 1829-1830, but the water level rose four meters only, as packed-ice started to move downstream sooner than in the northern section and there was no ice barrier.

Systematic hydrographic surveys of the rivers in Hungary started in the southern part of the Great Plain. After the separate hydrographic maps, constructed by civilian engineers of the counties, *Mátyás Huszár* started the survey of the Körös Rivers in South-Eastern Hungarian 1818. This was a pilot work: Huszár worked out the practical methods of the survey, and his reports included detailed instructions regarding the complex surveying work. He also trained his staff including, among others, the young engineer *Pál Vásárhelyi*, who is the best known representative of the 19th century Hungarian engineers. In 1822 Huszár was commissioned to direct the hydrographic survey and mapping of the Danube, the famous *Danube Mapping Project* (in German: Donau Mappierung, in Hungarian: Duna Mappáció).

Carpenter and cartographer: the career of László Vörös

László Vörös was born in an impoverished noble family with eight children in Hódmezővásárhely in 1790. He had to work for his living, and for years he worked with his father's helper as a carpenter.



Although he was a talented boy, he was already 24 years old when he could enroll in the famous College of the Reformed Church in Debrecen. Most probably he became interested in

cartography here. A decade earlier the students of the college collaborated on the publication of the first Hungarian school atlases, and Vörös could also learn the elements of map constructions and copper plate engraving.

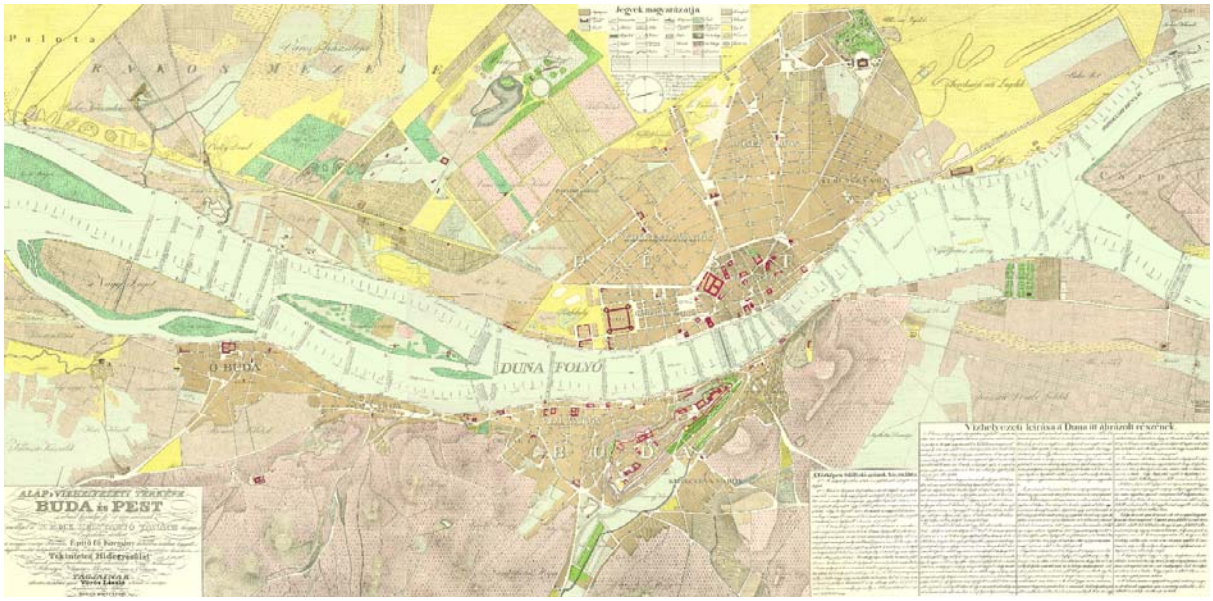
After working as a civil engineer he was invited to join to the staff of Mátyás Huszár and from 1822 he worked as a surveyor at the Körös rivers. After two years, when Huszár became the director of the Danube Mapping he followed him. In Pest-Buda Vörös had the opportunity to enroll the *Institutum Geometricum*, attend the lectures and get a degree. He became acquainted with the excellent engraver and map publisher *Ferenc Karacs*, who helped him and commissioned him with engraving work to make him able to earn some extra money. László Vörös graduated from the *Institutum* in 1828 and, as a young engineer, he was ordered to work at the Danube Mapping Project. This is the period when he started working on the map representing the section of the river at Pest and Buda.

For the urgency of the water regulation and flood control, after the dangerous floods in the 1820s the *Governor's Council* commissioned Huszár and his staff of engineers with the survey. Vörös could use the earlier maps of the city engineers and the survey documents of the Danube Mapping he was personally involved in for the construction of a new map. Unfortunately, in1829 the authorities nominated a new director to the project and the Huszár, whose anti-German, nationalist attitude was not tolerated, had to leave. This outcome led to great indignation among his colleagues and, to protest against this unfair treatment, Vörös also resigned from his position. The consequences of this decision were serious as he could no longer find a proper job to use his talents and continue his career.

However, he would continue his mapping project and, as an extraordinary case, he not only constructed but also engraved the stones for his large lithographic map. At this difficult period of his life news about the map in preparation reached the circle of the Hungarian Reformist movement. Count *István Széchenyi*, fascinated by the modernization of Britain, and the most prominent representative of this national movement aiming at the development of the country, became interested in the project. In 1832 Vörös published two short reports on the advancement of the map in the journals of the reformists.

The reason of the great interest his mapping project generated was, however, not flood control but the public discussion about a permanent bridge connecting Pest and Buda. This

explains why the Bridge Construction Society was the publisher of *'The Topographic and Hydrographic Map of the free royal Cities of Buda and Pest'*, printed in 1832.



A general and thematic map?

This is the first cartographic work in Hungary with the a neologism, a newly coined Hungarian word, '*térkép*' (map) appearing in its title. In other words, this is the first 'map' in the country. As the early 19th century is the formation period of modern cartography, the conceptual development the title of Vörös map reflects deserves special attention. Vörös included both '*ground plan*' and '*hydrographic*' as the subjects of his work, suggesting that the author clearly realized, his work is different from any other urban plan or topographic map of the city.

At that time the modern concept of the thematic map did not yet exist, although maps with thematic content, based on scientific data collection appeared earlier as an Enlightenment

phenomenon (Török). Anyhow, it was apparently acceptable for the public to include the *hydrographic* content into a *general* map. It must be mentioned that in the case of this map of Pest-Buda the special content, the representation of the Danube, did not cause any graphic problem, because the new information appeared actually on the river, which was left almost blank on other contemporary maps. Vörös simply used this graphic space to include here the vast amount of hydrographic data he collected. The two content layers of his map were spatially separated and visual hierarchy was not a design problem.

As this thematic content was the result of a hydrographic survey, the quantitative data on the map was represented according to the methods of the engineers' plans, and was meaningful for the professional only. This is not a surprising because initially Vörös' constructed his map for planning purposes, first for the regulation of the river. After 1829, when he left the Danube project, the task and target group changed and the map was published for the construction of a permanent bridge. In his 1833 journal article he proudly refers to the appreciation of the British engineers, who found the earlier version of his map perfectly suitable for planning (Vörös 1833, p. 373)

For the *public*, the average contemporary map reader, the data content of the map remained inaccessible. On the other hand, the additional information was highly appreciated and welcome, as it created the image of professionalism and expertise. The contemporary advertisement of the map mentioned its *decorative* function and the large and hand colored copies were offered 'to decorate the walls of palaces and libraries' (Kaján 1988, p.54).

The large, hand colored lithography is still considered as a highly decorative item. The facsimile published in 198?? There is hand-coloured, original copy of the map, today preserved in the collection of the *Danube Museum*, Esztergom. The information of its previous ownership of the Director of the Hydrographic Office suggests that this was a special presentation copy, perhaps made for count Széchenyi. The original letter in the archives of the Museum, written by Vörös on in 1832 to the count refers to a special copy of the map sent to Széchenyi right after the publication.

It is interesting to mention that highly decorative original map was used to decorate count Széchenyi's study in the 2002 historical film drama '*Bridgeman'*.

Vörös well understood the problems of interpretation. In the bottom right corner of the map he placed a longer explanation, a detailed description of the map's content. Although this is written in Hungarian, the interpretation of the professional terms is difficult even for the modern Hungarian expert. Since the publication of the map not only use we a metric system, but, as the 19th century methods of survey and mapping are no longer in use, without the historical context it is really difficult to understand the conceptual framework. Although the map includes vast amount of quantitative data, which make it suitable for modern geovisualization and analysis, without the historical expertise we need to be able to establish the geodetic datum used by the author georeferencing of the map remains impossible.

This explains why we used modern visualization methods to make both the base map and its thematic layer of this old map available for modern readers.

Historical cartographic visualization

The visualization of historical data is different from the generally known methods of the cartographic visualization. In the case of early maps the problem is to provide a historic view for the contemporary map reader when we want them to be able to interpret events or process in the pasts. Compared to static cartographic displays based on database, interactive or web visualization offer much more opportunities for the examination of historical data in cognitively relevant context . Because of the users interactive collaboration with the system the possibilities are theoretically endless.

On the map of László Vörös the most important and immediately striking feature is the extraordinary rich data content. The large scale of the map (1:7200), the origin of the data and the aim of the map all resulted in much quantitative information, which makes the work especially suitable for modern, computer based processing and display. Before the cartographic visualization we had to georefer Vörös's map. The GIS data processing and data clustering raised special problems and we had to answer difficult questions regarding the datum the map maker used as well as to solve technical problems regarding the handling of large image files. The preparatory works were indispensable for the making of the coherent database and the result was the next four different visualizations we would like to introduce below.

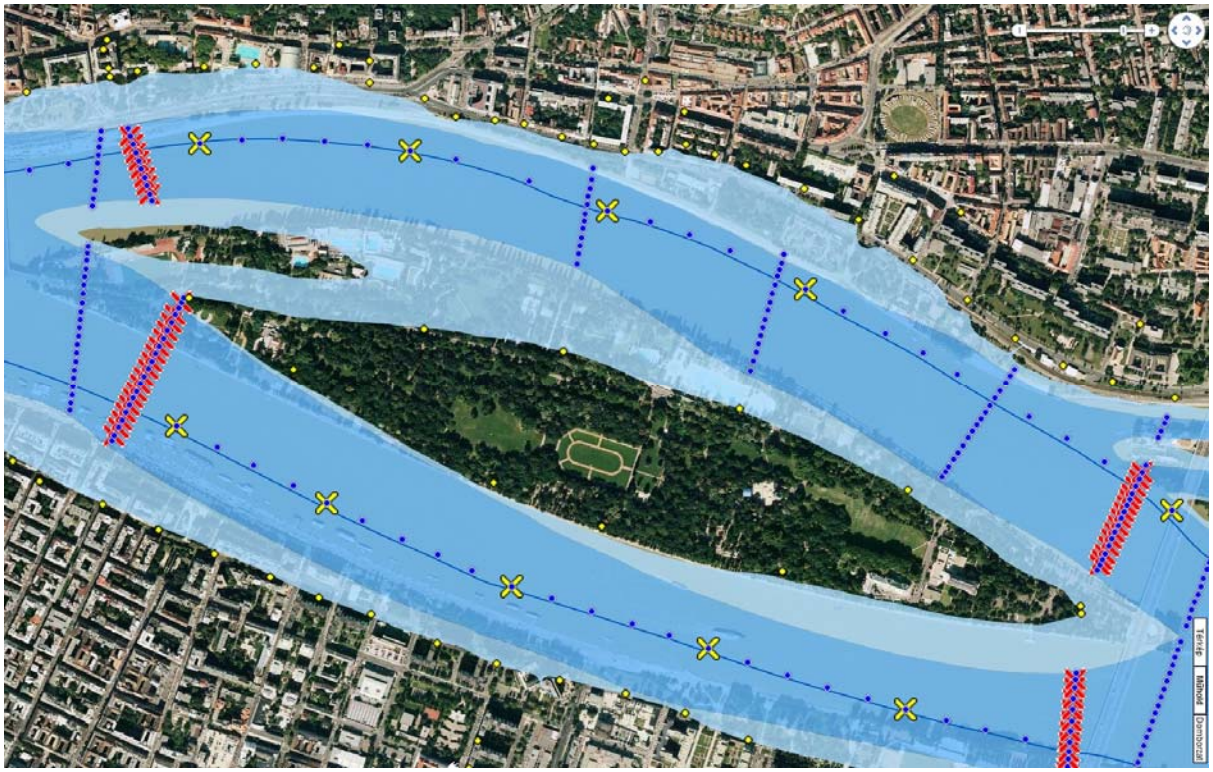
Time travel with a 19th century map of Budapest

The visualization of the map with the use of the Google Earth webpage plugin first of all emphasizes the visual power and propaganda. This visualization compares Vörös' map with the urban conditions of our days. On the well known map and satellite image after turning on the 3D buildings layer the changes of the river (Danube) and the transformation of the built-in area in the last one and half century are well demonstrated. If one takes a look at the Southern Buda area (today Lágymányos), the change is dramatic. The causes were river control and the embankment of the city. With this technology on the layers with Vörös' map we can show the modern buildings and the road network. The two point of temporal reference ares 1833 and 2012. With this visualization the two dates can be simultaneously showed, and the river changes appear spectacularly and the differences can be easily monitored. The interactivity of the visualization made possible by the usual Google Earth navigation options,

and also by the additional thematic layers integrated into the webpage. With these buttons one can turn on and off the terrain model, the road network or the three-dimensional visibility of the buildings. This application is especially prepared for the general public; the layer of the old map on the virtual globe gives a unique viewing experience for all interested.

Visual analysis

Different considerations led toto the creation of another, also Google-based visualization. The means of Google Maps possibilities exploiting display is the previously interpretation and in GIS software and then processed riverbed and other data open front of the users in easy to understand way, clustered and in vector format. This visualization opportunity focused on detailed data display, on the deeper understanding and the exploration of the more detailed information. Perhaps it is less spectacularly than the previous one, but it may seriously assists the specialist to interpret the contents of the map and provides an effective tool for visual analysis. On the original cartographic document there are height, water depths and additional hydrographical data. These data were classified first and in this interpreted form were displayed in the system. The vector data structure of point, line and surface objects are all related to attribute data. With the interpreted information the content of the display expanded. As a result of data clustering, due to the understanding, approach and the accuracy, the different data types are marked with different graphic objects. The graphics are simple and clean, so the detailed ancient map's content is much easier to overview, and it can be used for



spatial analysis. Overall, this display option enhanced the ancient map's decision support functions, so that it can be used for current purposes.

Compare the former and the current states

Joint study of an old map and a present satellite image of the same area made a lot of potential. The László Vörös's Danube map third display method, the Flash-based, interactive visualization, the above idea keep in the mind. This show opposed the former two is not only with the Internet working. The visualization use only internal programmed and generated files. The essence of this animated show, that the former and present state of the same geographical point can be easily comparable, and so the changes can be followed clearly. During the visualization take from the two time points originating map and satellite image each other precisely matched overlaying. The overlay happen in such a way that the two pictures into one transition represents. This display is good for the illustrative monitoring of the changes and the detection of casual relationship. This visualization result of the addition already that the authorities the standing buildings, building groups in 1833 and still existing. Also good this display for to simple overview the city extent strong growth in. This visualization technique is suitable any representation of spatially well-defined historical topics. The spectacular view application possibilities are wide-ranging.

Virtual terrain model

From the previously described visualization opportunities is significantly different the fourth, the Vörös's map terrain model-based display. Compared to the previous display, the creation and application of this view was much more complex and complicated task. The Vörös's map is equipped with three-dimensional data for the 1833's Danube river bed. By map create a display that, show the former state and describe the Danube in the tested section with a terrain model. After the lengthy data processing, of the linear elements delimiting the Danube, a TIN model was made from the pointcloud depicting the riverbed of the Danube. A DEM model was made from the above in the interest of better visualization. This model depicts the state of the riverbed of the Danube in 1833 on the bases of the cross-section of the river and other points measured in the riverbed. The model only contains information about the riverbed. There was no information about the surrounding terrain from 1833, so the surrounding areas were made on the bases of current data (ASTER). The texture placed on this model was taken from raster image of the original map. After the exaggeration of the heights in the complete three dimensional data an interactive model was made for the general public. The data has been converted into a VRML model. With the help of a plug-in this can be viewed in a web-browser. The model can be enlarged and rotated as best suited to the user. With the use of the tools of modern day cartography the side-view perspective and birds-eye

view are combined. By getting the user involved this process can be made interactive, so any user can study a map or model made by himself / herself.

Summary

László Vörös's printed, large scale thematic map of 1833 is a detailed and accurate depiction of the topography of the contemporary cities, Buda and Pest, but it also a summary of the hydrographic-hydrologic survey of the river. Although the importance of the map has been recognized, the analysis and the interpretation of its content became possible only by the historical approach suggested in this paper. The map is interpreted in the technical and historical contexts of its making, especially in the frame of the discourse on the construction of a permanent bridge connecting Buda and Pest. To visualize the data base a series of different historical visualizations were created, each of them facilitating an interactive visual exploration of the maps' information and data content in a cognitively relevant spatio-temporal context. The applied visualization methodology, rarely used in conjunction with the historical cartography, provides new possibilities for interpretation of historical maps for both specialists and novice users.

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