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Symposium on "Shifting Boundaries: Cartography in the 19<sup>th</sup> and 20<sup>th</sup> centuries"  
Portsmouth University, Portsmouth, United Kingdom, 10-12 September 2008

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ICA Commission on the History of Cartography  
International Cartographic Association (ICA-ACI)

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## **Jüttner's map of Prague of 1816: Research, cartometric analysis and visualization**

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### **ABSTRACT**

The first attempts to represent the view and situation of towns in the Czech lands started at the beginning of the early modern period. Real planimetric plans were, however, only made from the beginning of the 17<sup>th</sup> century.

In 1816 a revolutionary plan was created by Joseph Jüttner. It was the first plan based on practical geodetic measurement. Jüttner, a skilled artillery officer, was well equipped to devise the most precise plan to date. He created a trigonometric network covering the whole of Prague as well as the surrounding area, altogether a region of 16 square miles. Jüttner then proceeded to survey the city using this network; a project which resulted in an accurate plan on a scale 1 : 4,320 which was used as a pattern for many later maps of Prague.

For the purposes of this paper, we undertook a cartometric analysis as well as an analysis of the topographic content of Jüttner's plan. A network of control points was used for geo-referencing the raster image of the plan, after which our research focussed on the visualization of the geo-referenced plan on the Internet, using UMN MapServer.

The publication of old maps on the Internet presents beautiful representations such as these of Prague, and not only contributes to a wider knowledge of cartography, but also increases the public interest in historical maps.

### **PREAMBLE**

Throughout history, human beings have always tried to note and display their surroundings. The oldest preserved map-like representation the Czech lands is a plan of the winding stream of the Dyje river with a camp in its centre and was made on mammoth ivory in prehistoric times. Attempts to present views of towns such as Prague, would develop later. Initially there were elementary drawings of a city, which was followed by a prospectus (a larger and more panoramic view), with proper geometric plans following later on.

This paper briefly discusses the evolution of the depiction of Prague from the oldest preserved plans to Joseph Jüttner's outstanding plan, as well as some later plans. The focus, however, is on Jüttner's plan and its history, together with the accompanying cartometric analysis, and georeferencing and visualization which have been undertaken.

## OLDEST VIEWS AND PLANS OF PRAGUE

The oldest preserved view of Prague is a woodcut by Michael Wolgemut and Wilhelm Pleydenwurff which was published in 1493 in Hartmann Schedel's cosmography *Liber Chronicarum*, also known also as the *Nuremberg Chronicle*.

Since the beginning of the 17<sup>th</sup> century, much progress has been made in depicting Prague. Initially these efforts were connected to the reign of the emperor Rudolf II who had moved his seat to Prague, thereby attracting the attention of many Europeans, as well as the 30-year-war during which the development of mapping played a significant role. At least four important engravers who succeeded in making Prague famous all over Europe, should be mentioned: Aegidius Sadeler, Karel Škréta, Václav (Wenceslaus) Hollar and Volpert van Ouden-Allen. Hollar's view of Prague can be seen in Figure 1.



**Figure 1:** Part of Hollar's view of Prague

The large 1606 prospectus of Aegidius (Jiljí) Sadeler was supposed to contain a geometric plan of the royal land surveyor Šimon Podolský. Old and New Towns were probably completed, but the plan has unfortunately been lost.

The oldest extant planimetric plan of Prague was compiled by Matouš Ungar in approximately 1640. This plan, together with other plans dating back to the second half of the 17<sup>th</sup> century by Samuel Globic, as well as later plans by Ondřej Bernard Klauser depicting the area of the Old Town and the Jewish Town, were closely connected with attempts to separate the Jews and regulate their settlement.

Probably the oldest extant manuscript plan of the entire Prague area was compiled in 1710 by Johann Christopher Müller during his mapping of Bohemia. It is unfortunate that this plan is today not available in the Czech Republic. The other important and famous depiction of Prague, Huber's birds-eye map of 1769, was based on a geometric plan which, like Müller's plan, is today also preserved in Vienna. A part of Huber's map of Prague can be seen in Figure 2.

At the end of the 19<sup>th</sup> century another planimetric plan was made by a professor at the Estates' Engineering Academy, František Herget. This large plan of Prague as bounded in by the city walls, marks the end of a specific period in the mapping of Prague, measures 2.78 x 2.29 m, and is preserved in the Municipal Archives of Prague. There are, however, also many other plans which

have unfortunately not been preserved and of which we only know from notices, e.g. Knittl's plan (1714), and Dietzler's plan (1740).

It is quite possible that Prague had no accurate city plan until the beginning of 19<sup>th</sup> century. A turning point in Prague cartography is represented by the really revolutionary plan of Jüttner of 1816.



**Figure 2:** Part of Huber's map of Prague.

## PRAGUE IN THE 19<sup>TH</sup> CENTURY

At the beginning of the 19<sup>th</sup> century the city boundaries of Prague's were more or less the same as in medieval times. In medieval Prague the separate boroughs, which have been recently merged under the authority of a common city council, were surrounded by walls. Jüttner's map depicts Prague before its rapid expansion which started a few years later. The result was that new districts developed beyond the city walls, that some walls were pulled down, and that Prague developed into a proper industrial city. One of the outstanding merits of old maps is that they can show us what Prague looked like and how it will never look again. Although many parts of the city have changed completely, some have been preserved without almost any change. The difference between then and now can be seen when one compares the situation on Jüttner's map with that on a present-day orthophoto. Figure 3 depicts the Lesser Town where the situation has not changed much. Figure 4 shows the border of the New Town and the Vinohrady boroughs. On the right-hand part of the figure one can see the building of the National Museum and the Prague Main Railway Station occupying the location of the former city walls.

## JOSEPH JÜTTNER

Joseph Jüttner was born in 1775 in Bernartice near Opava in Silesia, and was an artillery officer and a teacher of Mathematics in Prague. In 1803 he and his pupils from the Mathematics School of Artillery participated in trigonometric measurements in Prague which were executed by the director of the Prague observatory, Martin Alois David. As a skilled surveyor, cartographer and globe maker, as well as a member of the Bohemian Royal Scientific Club, Jüttner created the

trigonometric network covering both Prague and its surroundings. In the same year he was asked by Count F. A. Kolowrat-Libštejnský, who had the support of the emperor Franz I, to draw the



**Figure 3:** Lesser Town and Charles Bridge



**Figure 4:** New Town and Vinohrady

first detailed plan of Prague. Jüttner's work was interrupted by the compulsory military service he had to render during the wars against Napoleon Bonaparte (1813–1814), and by his stay in Mayence (1815–1818). He developed and completed his final plan of Prague during a six-week holiday in 1815. In 1848 Joseph Jüttner died, holding the rank of brigadier.

## JÜTTNER'S PLAN OF PRAGUE

### Map History

In 1812 the emperor agreed to the compilation of a new geometric plan of Prague. The project was given to Lieutenant Jüttner, an experienced artillery officer who was skilled in mapping as well as

in trigonometric and astronomic measurement. He immediately started with astronomic and trigonometric measurements to prepare an accurate frame for the new plan. The fact that Jüttner had earlier cooperated with Martin Alois David on astronomical measurements, enabled him to use his own previous measurements, as well as those of David and other surveyors. The use of previous measurements, as well as his own considerable experience, greatly assisted him in preparing a trigonometric network covering the entire Prague.

Jüttner had also covered the surroundings of Prague with another network as he had planned to also make a map of the surroundings of the city within a distance of 2 miles. In order to achieve this, he counted some distances from different triangles for control, and also used points which had already been measured. The comparative results of these measurements were very satisfactory and a plan of the trigonometric network was set up under the name *Trigonometrische Vermessungen der königl. Hauptstadt Prag und ihrer Umgebungen von 1804*.

The topographic measurement with three measuring tables had already started in 1812. After the surveying of the streets and squares, buildings, yards, gardens, and other objects were also surveyed. The next step was to record all the topographic notes and house numbers. The work progressed satisfactorily and the city of Prague was mapped within a short period. Jüttner wanted to also start on the measurement of the wider surroundings of Prague, but the Napoleonic wars interrupted his works for several years after which Jüttner was moved to Mayence. In 1815 the manuscript of his map was completed during his vacation in Prague. His original idea to also map the wider surroundings of the city was unsuccessful because of lack of time.

Jütnerr's final plan was greatly appreciated by the Supreme Burgrave of Bohemia, Count Kolowrat, with the result that two coloured manuscripts of the map were made - one for Count Kolowrat himself and, in 1819, another one for Emperor Franz I. The manuscript was entitled *Plan des königl. Hauptstadt Prag trigonometrisch und topographisch aufgenommen von den Oberlieut. Joseph Jüttner des k.k. Baron von Schuhey 1<sup>ten</sup> Feld-Art. Regiments aufgenommen im Jahre 1811 ung geendet 1816*. The count also issued a permit to make the plan accessible to the general public, but this move was hampered by many complications. Political conditions were such that the bureaucracy of the Austrian monarchy was not in favour of any significant mapping project of the capital city of the Kingdom of Bohemia. The emperor's directive also forbade the accurate depiction of Prague's fortification as the city was still considered a fortress at that time. The mapping of fortifications for public use was restricted and they could not to be depicted, or displayed very roughly at the most. Josef Alois Drda engraved the plan on two copper tablets after which it was printed on two map sheets by Franz Hoffmann in an edition published by the Czech National Museum in 1820. The title given to the map was *Grundriss der königlichen Haupt-Stadt Prag, herausgegeben auf Veranlassung und Kosten des böhmischen Nationalmuseums, trigonometrisch und geometrisch beschrieben von Joseph Jüttner, k. k. österreichischer Artillerie Oberleutnant in den Jahren 1811, 1812, 1813, 1814 und 1815*. Each sheet measured approximately 51.1 x 96.1 cm.

Mainly due to its large dimensions, the map unfortunately did not sell well. In the meantime many smaller scale copies were issued by private publishers who were not subject to the military restrictions on fortification depiction. These smaller plans were probably also more attractive and sold very well.

The rapid development of Prague at the time soon made the map lose its relevance. In 1829 Jüttner noted all the changes that had taken place on his plan. A new edition was started, but was never completed. In fact, a new edition would only be produced in 1949, more than one hundred years later. Although Jüttner's plan did not sell well and was not popular with the public, its quality and exceptional accuracy made it a often-used model for later plans of Prague which were to be drawn during the next decades. Of these, the best known example is the famous Langweil 3D coloured model of Prague based on Jüttner's plan.

Jüttner did not finish his plan of the wider surroundings of Prague, but a similar anonymous plan was done. It was the map of Prague's surroundings up to a distance of 3 hours entitled *Plan der kön. Hauptstadt samt der Umgegend im Umfange von 3 Stunden*. The scale of this map is 1 : 19200 and its most probable author Jüttner's associate, František Alois Musil.

### Map Content

The map used for the purposes of this paper was a printed black and white map as the only two coloured manuscripts were inaccessible. All research was therefore related to the printed map.

Jüttner's map displays all the important topographic features of the city of Prague. All buildings are depicted and indicated by house numbers. City boroughs which are differentiated by colour on the manuscript maps, are differentiated by differently oriented hatches for buildings on the printed map (see Figure 5). Different hatches were also used for the various land types. The terrain is depicted using hachuring. A problem of this method is the impression of benching along especially long slopes as can be seen in Figure 6.

The map itself terminates very closely beyond the city borders. Prague's fortification was only schematically displayed and probably even shown wrong on purpose because of the military reasons already mentioned. Most of the streets are named, as are the gates in the fortification, the main roads outside the city, and all city districts.

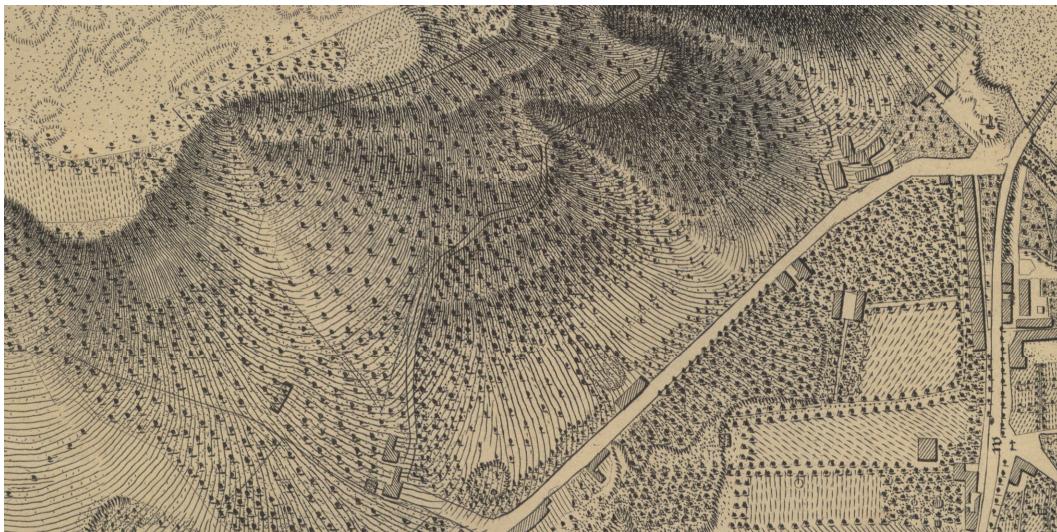
The map is oriented towards the north with its centre being the trigonometric point of Clementinum Observatory which has coordinates of 50°05'18" N latitude and 32°05'00" E longitude on a reference sphere with a radius of 6369.5 km (based on David's measurements – see above). There are no other coordinates displayed within or outside the map frame.



**Figure 5:** Depiction of the Old Town Square

### Map Layout, Map Scale, Map Index and Map Legend

The map layout is unadorned and is compiled according to the rules of military brevity and functionality. The only decoration is a crowned lion which is a heraldic emblem of the Kingdom of Bohemia in the upper left corner. A graphic map scale along the left edge displays 500 Vienna



**Figure 6:** The depiction of terrain hachuring on Petrin Hill

(Austrian) strands. A word scale informs the map reader that one Vienna inch on the map equals 60 strands. The full title of the map is displayed in the lower left corner. Below the title is a map index listing important buildings with the house number allocated by the city district. An example of this appears in Figure 7.

№	Auf Dem Gradschin.
1.	R. R. Burg.
2.	R. R. Theresianisches Damensift.
6.	Oberburggrafenamt.
33.	R. R. Artillerie Kaserne chemahls St. Georgi Kloster.

**Figure 7:** Map index

Below the index appears a brief map legend explaining map symbols pertaining to churches, statues, water towers, guest-houses, gateways, archways, synagogues, etc. A depiction of this legend can be seen in Figure 8.



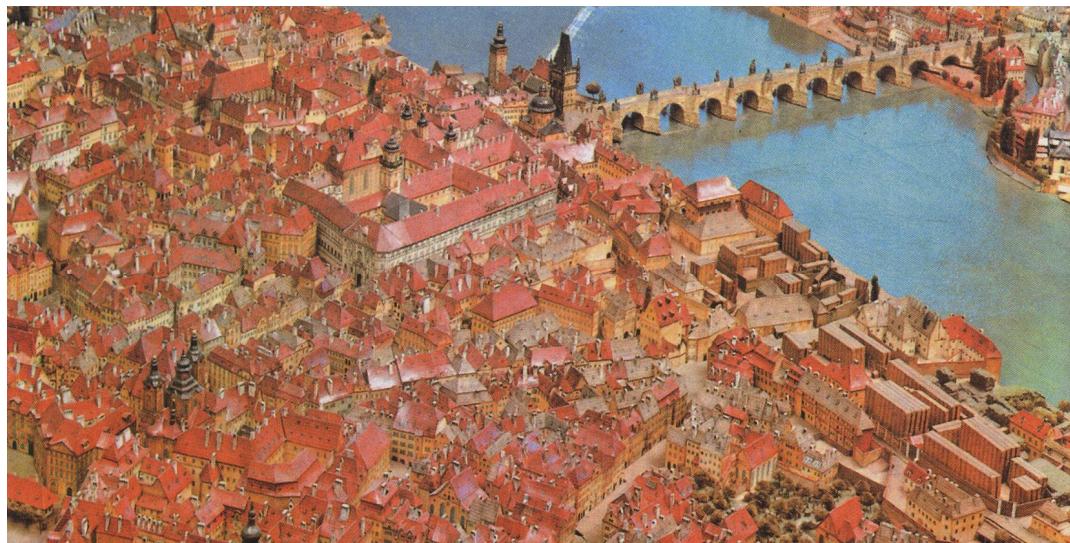
**Figure 8:** Map legend

## SUBSEQUENT PLANS OF PRAGUE

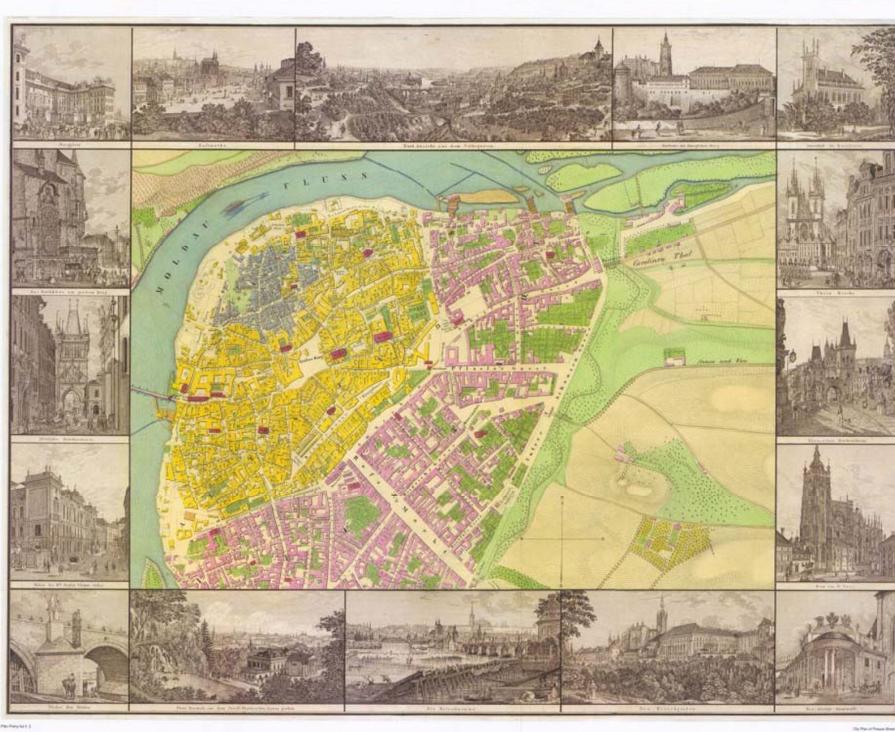
Langweil's 3D model of Prague can be considered a unique transformation of Jüttner's plan. Antonin Langweil (1791–1837) started in the 1820s to create a model of important buildings in the city centre of Prague – the Clementinum, the Clam-Gallas Palace, etc. In 1827 this model was displayed to the public for the first time. Langweil's final decision to create a 3D model of Prague was taken after he had seen the exhibition of the model of Paris in Prague in 1826. He started with the Old Town, then the Jewish Town, and later added the Lesser Town. He used Jüttner's map as a ground-plan, enlarging the scale nine times to 1 : 480. The model was exhibited several times and it appeared in its present form in 1834. Afterwards only newly built buildings were added. The model was made of paper and wood and for statues such as those on the Charles Bridge, even ivory was used. In 1840 the emperor Ferdinand V purchased the model and moved it to the Museum of the

Kingdom of Bohemia. Today the 5.8 m long and 3.2 m wide model (see Figure 9) can be seen in the City of Prague Museum.

Jüttner's plan was also used by Carl, Count Vasquez Pinas, to construct his plan of Prague (Krejčí, 2006). Pinas was also the author of plans of other Austrian cities such as Vienna, Trieste, Baden, and Buda and Pest. Pinas's plans have a similar template and are uniform in appearance. The author concentrated more on the decorative appearance of the plan than on its accuracy. His coloured plan printed on 4 sheets is abundantly decorated with views of the city all around the map frame, but contains factual errors. Despite its impressive elaboration, the plan was not popular amongst the public and just a few prints have been preserved. An example of one sheet of this plan can be seen in Figure 10.



**Figure 9:** Depiction of Langweil's model



**Figure 10:** Depiction of one map sheet of Pinas's plan

## CARTOMETRIC ANALYSIS

A precondition for the visualization of Jüttner's plan on the Internet is the existence of a digital raster image of the map. Because these raster images are also highly suitable for cartometric analysis, two sheets of Jüttner's plan were scanned on a Contex scanner with a resolution of 400 DPI and a 24 bit colour depth.

The main task was to determine the map scale, an exercise for which there are several methods available. By far the easiest method is a simple count using the word scale. As mentioned above, one Vienna inch (2.634 cm) on the map equals 60 Vienna strands, with 1 strand being equal to 1.896 m. This results in a map scale of 1 : 4,320.

A second method is to measure the graphic map scale. There is graphic scale presented by 11 parallel lines each represented by 500 strands with divisions each 100. All parts of three lines were repeatedly measured with Kokes software. The average length of 100 strands is 678.792 pixels in raster image. A resultant map scale of 1 : 4,400 was counted. This method was influenced by a linear distortion of the paper in one direction.

The last method of map scale determination was based on the measurement of distances between known points of topographical content such as the corners of important buildings. Twenty distances in various directions were measured on the map and compared with the actual distances measured on the orthophotomap. No errors were found with regard to the direction of measurement. According to these measurements the average map scale is 1 : 4,426.

The co-ordinates of trigonometric points were counted on the Cassini projection (transverse cylindrical projection) with regards to the centre of the Clementinum Observatory trigonometric point (see above) (Honl, Procházka, 1984). There are no other points with coordinates on the map. This means that the fact of the used projection has not been proven, but with regard to the map extent its influence is negligible. Distance distortions on the projection are trivial because of its extent.

## GEOREFERENCING

For geo-referencing it is advisable to use the known co-ordinates of the map frame corners or the drawings of the geographical grid for transformation to the selected system. As this information does not appear on Jüttner's map, another method of geo-referencing had to be chosen. The method which was selected was geo-referencing by using a network of identical points, the points being the well-recognizable corners of important buildings which have been preserved up to the present. The co-ordinates in the present S-JTSK (Czech national grid) were measured in the Internet map portal. A set of 69 control points was used for the transformation into the S-JTSK. We used affine transformation with a standard error of position of 7.21 m. A comparison of the situation on Jüttner's map and on a present-day orthophoto can be seen in Figures 3 and 4.

## VISUALIZATION

The best method to make maps accessible to the public is by their internet visualization. There are a few methods used on the internet (Cajthaml, 2007), of which we preferred two types of application. For original or merged map sheets some internet viewer is an ideal solution. This viewer should be able to work with large raster data sets comprising hundreds of MB. Thanks to former experience, we recommend Zoomify application. It is Flash-based application which works very fast with large amounts of data. The data is cut into small tiles in many resolution layers and the Flash application can handle these tiles quite rapidly. Using this method, we published Jüttner's map of Prague at <http://maps.fsv.cvut.cz/juttner/zoomify.html>.

The second type of application is used for geo-referenced data. It is based on a UMN MapServer application and its JavaScript interface (msCross library). In the map server data can be very easily compared with other geo-data such current settlements and borders. Our application allowed for the display of a geo-referenced map and the MapServer application can be found on the web <http://maps.fsv.cvut.cz/juttner/index.html>.

## CONCLUSIONS

Jüttner's map can be considered the first really accurate plan of Prague. Although it was not very popular, it was constantly used as a model for later copies for at least the next 40 years. This fact alone reflects its exceptional quality. The two sheets were merged together when the basic cartometric analysis was done. As an important part of our project we considered publishing the resultant map on the Internet. As part of our further project we plan a map portal focussing on old maps of which and views of Prague and Jüttner's map will be an important and integral part.

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## BIOGRAPHY

**Jiří Krejčí** completed his university studies in Geodesy and Cartography at the Czech Technical University in Prague in 2006 with his diploma thesis entitled “Visualization and Cartometric Analysis of the Historical Map of Prague from 1842-1845”. In 2005 he studied for one term at the Krasnoyarsk State University in Russia. In 2006 he began his PhD-studies in the Department of Mapping and Cartography of the Czech Technical University, specializing in old maps and city plans, web mapping, and Geographic Information Systems. He participates in a grant by the Grant Agency of the Czech Republic on “Research of Old Maps” by examining Müller's maps of the Czech lands.