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## Unlocking archival censuses for spatial analysis: An historical dataset of the administrative units of Galicia 1857–1910

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### ABSTRACT

The lack of long-term assessment of the administrative divisions of Galicia, a former part of the Austrian monarchy, has so far been a serious obstacle in the mapping and spatial analyses of archival census data. To fill this gap, we reconstructed the boundaries of 5944 cadastral communes, court districts, and political districts into circles (<https://doi.org/10.7910/DVN/PXDP41>). Geometric boundaries are accompanied by different names according to census and cartographic sources. We found that a detailed reconstruction of the administrative units for Galicia is critically important for appropriately using census data in spatial analyses. So far, it has been neglected or considered difficult to perform because of the large area of the region, frequent administrative changes, and time-consuming map processing.

### KEYWORDS

Historical GIS; Galicia; Austrian Monarchy; Ukraine; Poland

### JEL CLASSIFICATION CODES

N43; N93; Y91

## Introduction

A great deal of data on demographic and economic processes, e.g. population censuses, forest and agricultural statistics, and industrial and trade statistics, have been and are still being collected for administrative units, such as districts and communes. Therefore, the reconstruction of historical administrative divisions is critically necessary for the correct spatial referencing of these data, their mapping, the determination of different patterns, and various spatial analyses (Gregory and Southall 2002; Cunningham 2014).

This is why we have undertaken to reconstruct the long-term (1857–1910) administrative boundaries in Galicia at the level of circles, districts, and communes from medium- and large-scale maps so that the data from each of the censuses that were conducted in the Austro-Hungarian Empire every ten years or so from 1857 onwards can be mapped for them (Teibenbacher, Kramer, and Göderle 2012). The frequent and complicated changes in the administrative division of Galicia in the second half of the nineteenth century have caused great difficulties in the mapping and analysis of socioeconomic data for this

part of Europe (Burzyński 1982). Even 19th-century statisticians emphasized the complexity of this problem (Pilat 1883). Therefore, scholars needed to create, from scratch, on a large scale, order, and coherence in the reconstruction of administrative divisions over a period of over 50 years, despite the fact that earlier attempts had already been made for various administrative levels in various parts of Galicia.

Border reconstruction at the circle and district level has so far been carried out at overview scales (1:700,000 and smaller) by Burzyński (1982), Himka (1990), and others. A. Burzyński (1982) checked the comparability of the administrative areas of all of Galicia for the period between 1880 and 1910 at the level of districts at the scale of ~1:3,000,000. Himka (1990) drew province and district borders for eastern Galicia (~60% of Galicia overall) for the years 1867–1868 and 1910 at the scale of ~1:2,500,000. District boundaries were also reconstructed by various authors in historical atlases generally at overview scales of about 1:2,000,000 (e.g. Paździora 2021). These data are therefore generalized and are not available as vector files for use with software employed by geographic information systems. District maps for the entire

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Austro-Hungarian Empire in digital versions, generally for 1- or 2-time profiles, were produced as part of the Mosaic (<https://censusmosaic.demog.berkeley.edu/>) and HistoGIS (<https://histogis.acdh.oeaw.ac.at/>) projects. The basis for the preparation of these files were maps at overview scales of ~1:700,000.

The reconstruction of cadastral commune boundaries has so far been carried out, for example, by Soja (2008) and Affek et al. (2021), both for substantial parts of the Polish Carpathians. Their areas of study cover ~24 and 22% of Galicia, respectively. They used boundaries reconstructed from overview maps of Galicia at the scale of 1:144,000 to 1:600,000 (Soja 2008) and mainly 1:115,200 (Affek et al. 2021). They did not reconstruct circle or district boundaries. One or more commune boundaries were reconstructed also by other authors (e.g. Wolski 2007 for 61.7 km<sup>2</sup>, Wnęk 2011 for 8.3 km<sup>2</sup>, Affek 2016 for 233 km<sup>2</sup>, Sobala, Rahmonov, and Myga-Piatek 2017 for about 45 km<sup>2</sup>).

Research work resembling our dataset has been performed for other parts of Europe and the world in general, increasingly in digital form (e.g. Gregory and Southall 2002; Bičík et al. 2015; Ostafin et al. 2020b; Gay 2021; COMMUNE HIS-DBD Project <https://www.campop.geog.cam.ac.uk/research/projects/internationaloccupations/enchpopgos/france/>). The demand for reliable historical borders is growing due to the digital availability of archival data on the Internet, for example, the Austrian Österreichische Nationalbibliothek ([www.onb.ac.at](http://www.onb.ac.at)), Polona (<https://polona.pl/>), Federacja Bibliotek Cyfrowych (<https://fbc.pionier.net.pl/>). With these data fusion possibilities, it is likely to extend many demographic, economic and genealogical analyses (Massey et al. 2018; Bukowski et al. 2019; Cherkesly, Dillon, and Gagnon 2019; Palma, Reis, and Zhang 2020) as well as to understand the effects of land use changes (Sobczyński 1993, 2018; Munteanu et al. 2015; Szabó et al. 2018; Leyk and Uhl 2018). In the post-communist countries of Central Europe in particular, the need for a historical dataset for mapping is enormous (Drummond and Lubecki 2010; Szady 2017; Haid 2017; Bukowski et al. 2019; Mick 2019).

Our dataset contains 16 digital layers of administrative borders, in zipped shapefile vector format, together with attributes, such as names in several versions according to census and cartographic sources, areas from statistical sources and the geometry of our outline, and codes for different levels of administrative units, so that the correspondence of these areas can be compared. While the borders of cadastral communes were very stable during the period we studied, the borders of districts changed significantly between

successive censuses (Pilat 1883). Sometimes new units were created and sometimes cadastral communes were assigned to different districts (Burzyński 1982).

District borders are very important as the largest number of statistical data publications are given specifically for districts (Österreichische Nationalbibliothek ([www.onb.ac.at](http://www.onb.ac.at)), see: [Supplementary Material](#), Part F).

The user of our database has the option of attaching any type of statistical data to the reconstructed borders with the certainty that he or she is relating them to the geographic areas that we have validated. Our database can be extended for additional years, but this requires going to sources already created under other historical circumstances associated with the countries that had emerged after the collapse of the Austro-Hungarian Empire after World War I.

### Research area

The Polish–Lithuanian Commonwealth (Crown of the Kingdom of Poland and the Grand Duchy of Lithuania) was divided at the end of the eighteenth century by the Russian Empire, the Kingdom of Prussia, and the Austrian Monarchy (after 1867, the Austro-Hungarian Empire). Galicia includes the territories that were occupied by Austria (Pogonowski 1988; Evans 2008; Pounds 2009). The name Galicia has its origins in the principality of Halych, later the principality of Galicia–Volhynia, which emerged after the disintegration of the Kievan Rus' (Wolff 2010; Abbot 2018). [Figure 1](#) shows the boundaries of Galicia that were formed after the Congress of Vienna in 1815, the incorporation of the Republic of Cracow in 1846, and the exclusion of Bukovina in 1849.

Galicia existed until World War I, and after Poland regained its independence in 1918, it was again a part of Poland until World War II. After the Second World War, almost 60% of the area of Galicia fell within the borders of the Soviet Union (as a part of the Ukrainian Soviet Socialist Republic), and since 1991, that same area has been part of independent Ukraine (Himka 1990; Wolff 2010).

### Historical background

Before 1848, there were two levels of state administration of Galicia: circles (Kreise) and dominions (Landgut, Dominium) (Wolff 2010; Grzybowski 1959). Circles included several hundred localities (300–400 villages and towns). The head of a circle included a circle head and circle commissioner whereas dominions, ranging from one to several dozen localities, belonged to a single landowner. The heads of a circle

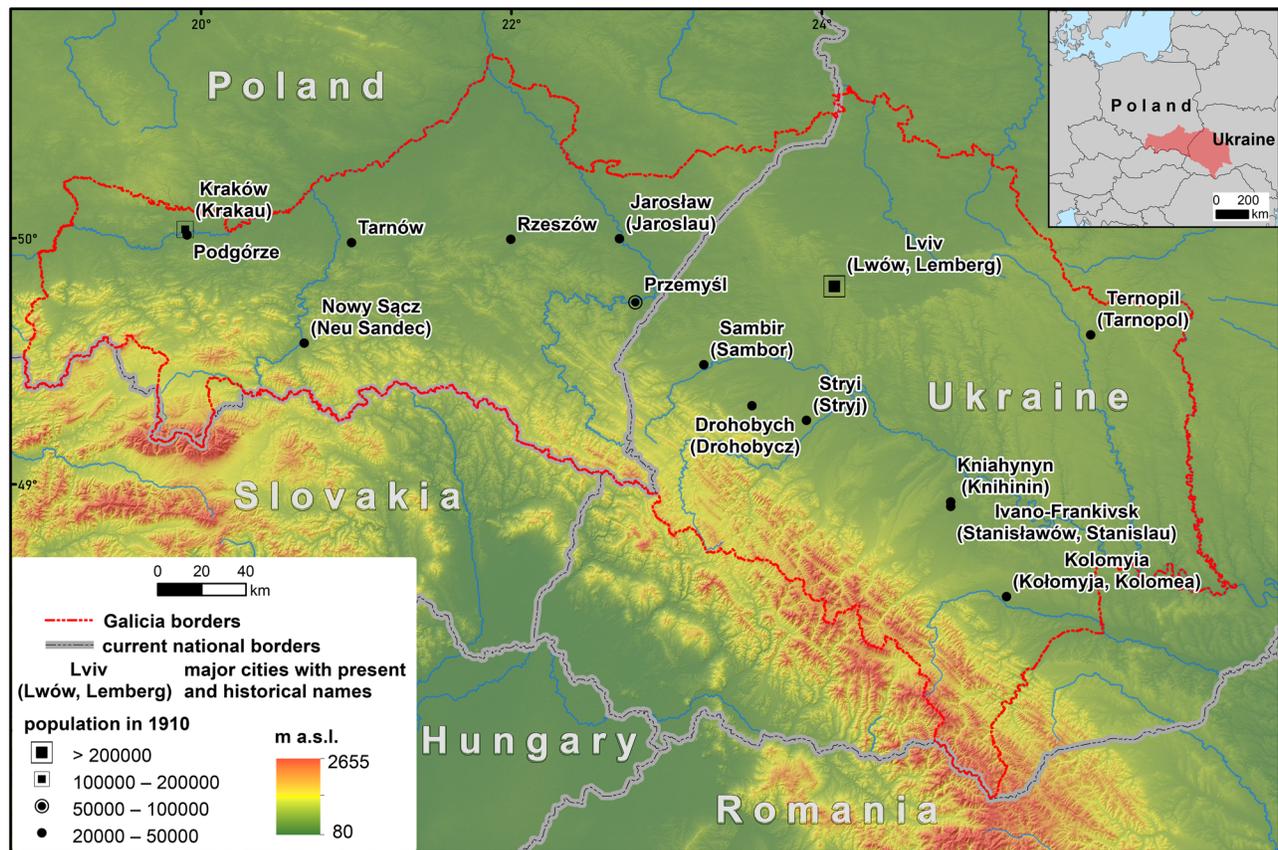


Figure 1. The study area. Source: The Authors.

were responsible for registering migrations of the population, recruiting for military service, supervising customs and passport matters, and controlling dominions (Grodziski 1971). The owner of a dominion was the feudal overlord of the population residing on his land. He was responsible for judicial, policing, and administrative matters typical of state administrations (Pilát 1878, 1883; Grzybowski 1959; Grodziski 1971).

After 1848 and the Spring of Nations, enfranchisement reform abolished the landowner's jurisdiction over his subjects, and the dominion—as the basic administrative unit in Galicia and a pillar of the feudal system—lost its *raison d'être* (Ślusarek 2002). The development of a new administrative system became a necessity, and the foundations for such a system were laid between 1851 and 1855. The new administrative division had three levels, with the highest level being circles, the middle, districts (*Bezirke*), and the lowest, communes (*Gemeinde*) (Pilát 1878, 1883; Grzybowski 1959).

Before the new administrative division was stabilized, two parallel administrative systems, old and new, operated in practice for many years (Pilát 1878). This duality was only abolished in the 1860s. After Galicia was granted autonomy and communal and

district local governments were established, circles were abolished in 1865, and their competencies were mostly transferred to the districts. Thus, instead of the planned three-level administrative system, a two-level system was introduced, in which the basic units of territorial administration were political districts (*Politische Bezirke*), each of which contained several court districts (*Gerichtsbezirke*), and communes became the second level. The head of a district was a district commissioner. He performed tasks assigned by higher government authorities, supervised communes, supervised the collection of taxes, adjudicated in criminal and administrative cases in the district, and watched over security and public order (Pilát 1883; Grzybowski 1959).

The commune was first introduced “an institution by the Provisional Municipal Law of March 17, 1849, but it was regulated by a new Imperial law on March 5, 1862, and an act of the national Galician parliament on August 12, 1866, on the organization of communes. This law passed by the national parliament recognized ‘every settlement (village, town, city) that currently ha[d] its own communal board’ as a commune.” At the same time, manor areas (*Gutsgebiete*) were created; these were defined as “holdings of land”

that were “formerly dominions” and that had a supervisor who was usually the owner of the dominion. The head of a commune or the mayor of a town performed tasks assigned by higher government authorities, registered population movements (registration of residence, marriages), adjudicated on criminal and administrative matters in the commune, oversaw safety and public order (local police), managed the commune’s property and roads, and operated and maintained communal schools (Pilat 1883; Grzybowski 1959).

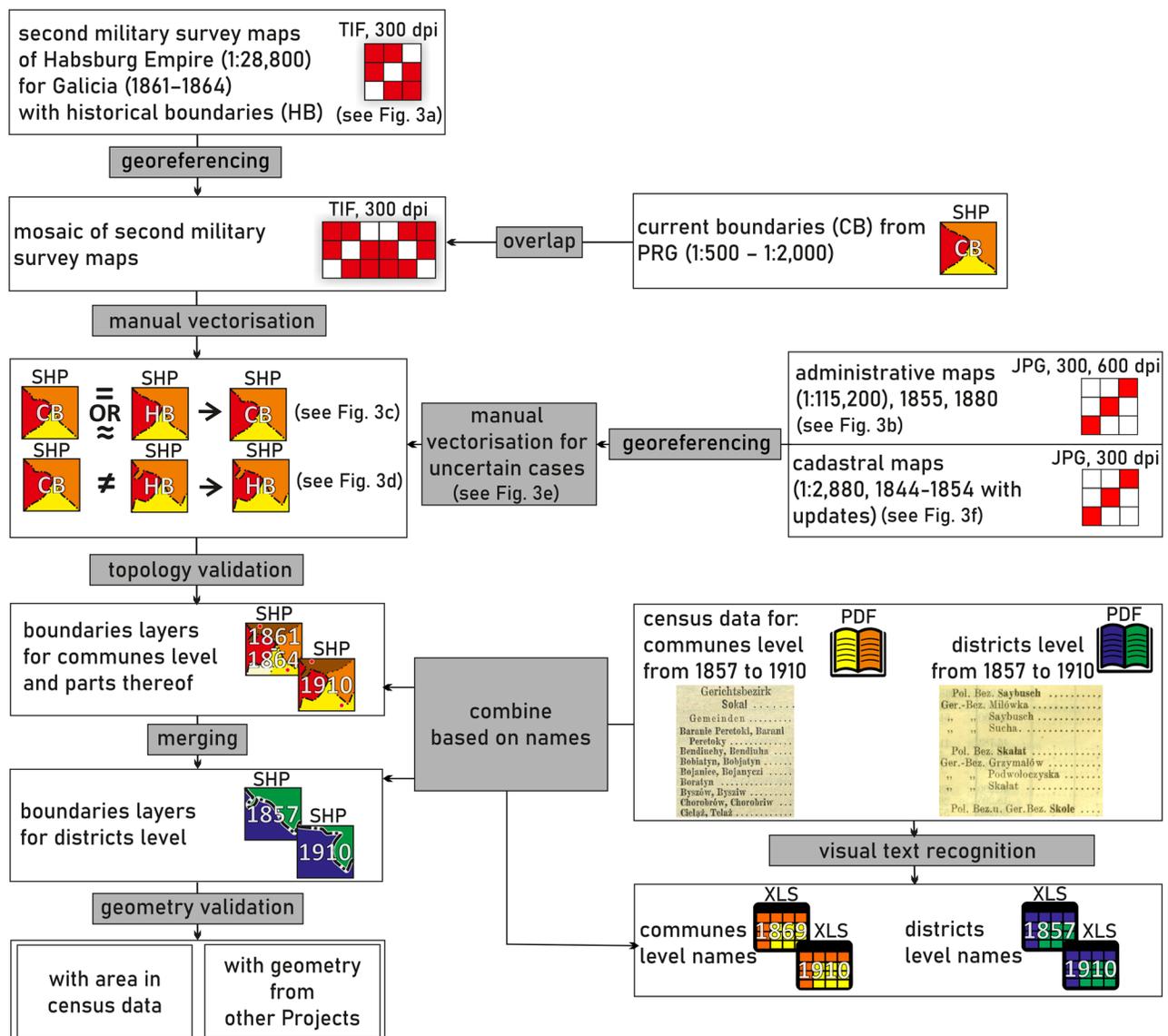
Cadastral communes (Katastralgemeinde) were established as organizational units for the taxation of land cadastre (Stabiler Kataster) measurements. One cadastral commune usually corresponds to one political (administrative) commune and one manor area, but there are also more complex relationships.

Relationships between both divisions—administrative and cadastral—can be found in the census data, which is the most important point of the reconstruction of the administrative division presented in this paper (Pilat 1878, 1883).

A table with the structure for the two administrative systems of Galicia that overlapped in the mid-nineteenth century, the authorities of the units and their prerogatives, and selected additional divisions are available in [Supplementary Material](#), Part A.

## Methods

As shown in [Figure 2](#), our studies included historical map processing, census data preparation and merging, and validation of both sources of historical data. Despite the considerable progress made in automatic



**Figure 2.** Workflow for the production of the dataset. Source: The Authors.

methods of data extraction from historical maps (Piechl 2020; Chen et al. 2021), in our border reconstruction, we used manual vectorization. Manual vectorization is probably more cost-intensive than automated vectorization, but given enough experience on the operator's side, it can better handle difficult cases. In many instances, where the quality of the historical source materials is poor, e.g. paper damage, dark overlapping symbols, or lack of symbols (by default the border is found along other objects), manual work is generally more accurate (Ostafin et al. 2017). During vectorization, it was necessary to use auxiliary maps in cases where the symbols for boundaries on the basic maps were difficult to interpret. Difficulties were generally caused by the dominance of dark colors and dense symbols (e.g., relief depicted by crosshatching) in the Ukrainian and Polish Carpathians. Administrative boundaries in some sections were not marked with continuous symbols, but with various topographic objects, such as roads, streams, and land use boundaries, which also simultaneously served as administrative boundaries. When reconstructing the names of villages, towns, and districts, human operators had to use visual text recognition because of the presence of characters specific to the Polish language and, in some places, illegible fonts in the digital scans.

### **Cartographic data sources**

The most detailed and accurate source of information on the administrative division of Galicia is surveys of the Austrian stable cadastres established for individual cadastral communes (Hernik et al. 2020; Banasik and Borowski 2021). For the cadastral communes of Galicia, the cadastral survey was based on a detailed field survey conducted in this crown land in 1824–1830 and 1844–1854. Cadastral plans based on these measurements, at a scale of 1:2880 (in the mountains 1:5760; in towns 1:1440), document, among other historical features, administrative divisions.

Due to the dispersion and incompleteness of cadastral survey plans (in Ukrainian and Polish archives) for Galicia (Stoksikówna 1975; Nowak 2021), deriving boundaries from these sources is very difficult. Similar efforts for areas much smaller than Galicia, such as Bukovina (10,442 km<sup>2</sup>) (Rumpler, Scharr, and Ungureanu 2015) and Austrian Silesia (5150 km<sup>2</sup>), are long-term projects (<http://www.franziszeischerkataster.at>).

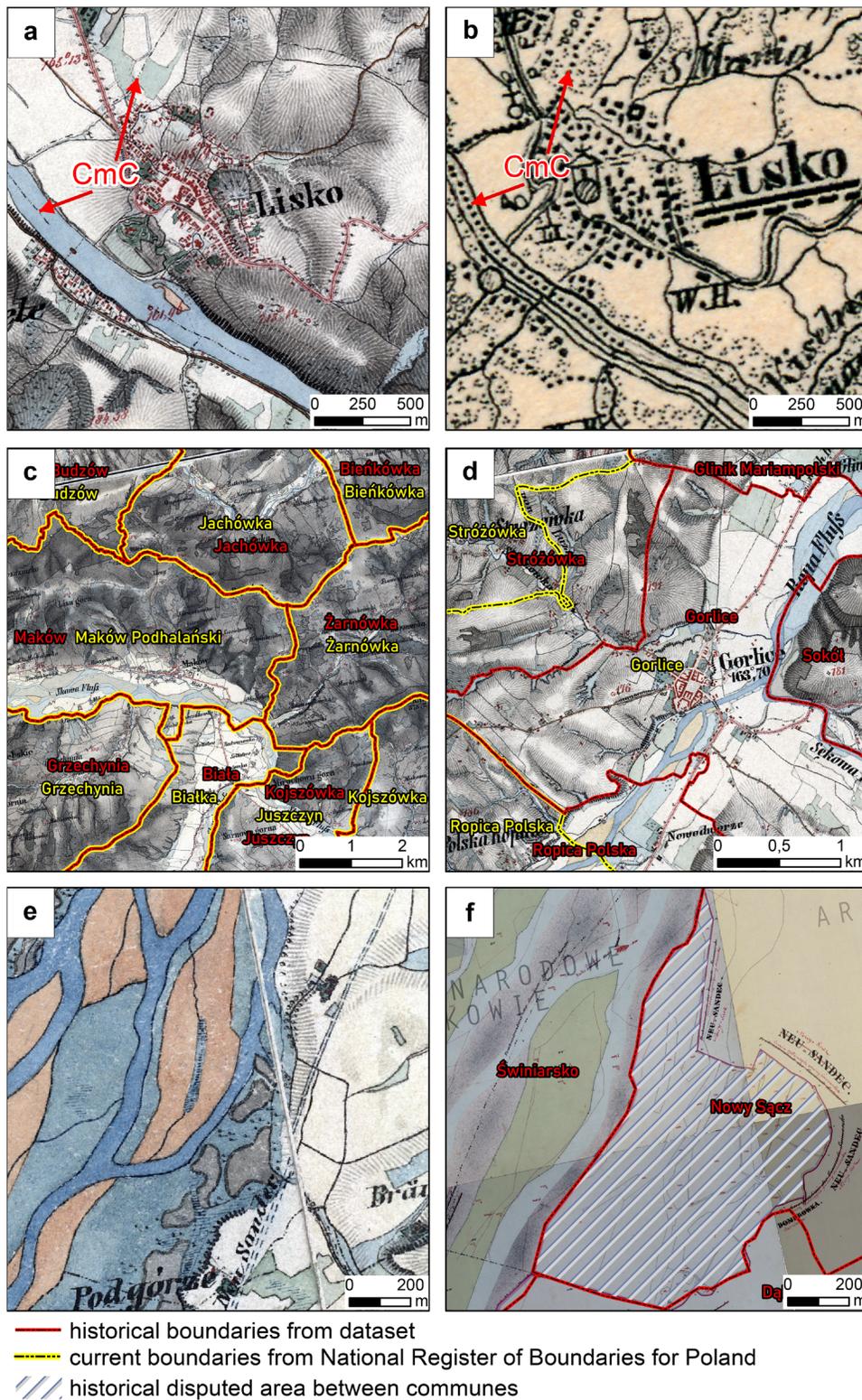
Hence, for the reconstruction of more than 98.5% of the length of the studied boundaries, we used 413 map sheets from the second military survey for

Galicia (1861–1864; 1:28,800) (Ostafin et al. 2020a), compiled by a 10-fold reduction in cadastral plans, as a basis for reconstructing the boundaries of cadastral communes. The example of Lesko (Lisko) is provided in Figure 3a. For large parts of central Europe, these maps are available on the web service Mapire (<https://maps.arcanum.com/en/>). The supporting maps (Figure 3b), for the reconstruction of about 1% of the length of our boundaries, are administrative maps, at a scale of 1:115,200, in two editions (1855 and 1880), each with 53 sheets covering Galicia. The administrative map is informally known as the Kummerer von Kammersberg map, after an Austrian military officer. On these maps, the administrative boundaries are significantly more generalized than in the second military survey but are generally legibly drawn. In the second military survey, the interpretation of boundaries was hampered by relief drawing and, to a lesser extent, by the road network and the dense network of symbols, such as in towns. Online cadastral maps (1:2880) available on the websites Szukaj w Archiwach (<https://www.szukajwarchiwach.gov.pl/>) or Gesher Galicia (<https://www.geshergalicia.org/>) were used only in problematic cases, <0.5% of the length of reconstructed boundaries, such as where the course of administrative boundaries was difficult to interpret from the second military survey and administrative maps.

Maps of the second military survey were extracted from the War Archive in Vienna and the Österreichisches Staatsarchiv in the form of 300 dpi TIFF scans. Administrative maps of Galicia were obtained from the Jagiellonian Digital Library (<https://bj.uj.edu.pl/>) for 1855 as 300 dpi scans in JPEG format and from the University of Vienna for 1880 as 600 dpi scans in TIFF format.

### **Geometric correction and georeferencing**

Georeferencing was employed for the second military survey maps using other reference data. For the Polish part of Galicia, Polish topographic maps at a scale of 1:25,000 from the 1970s were used. Maps produced in the 1965 Polish coordinate system based on the Pulkovo-42 reference frame were obtained as raster images transformed to the PL-1992 coordinate system based on the ETRF-89 reference frame. In the case of the Ukrainian part of Galicia, high-resolution World Imagery, Digital Globe imagery, and Soviet military topographic maps at scales of 1:25,000, 1:50,000, and 1:100,000 were used. Soviet maps produced in the 1942 coordinate system based



**Figure 3.** Examples of administrative boundary vectorization based on archival maps. (a) Second military survey map (1:28,800) with cadastral commune boundaries, CmC; (b) administrative map (1:115,200) with cadastral commune boundaries, CmC; (c) boundaries with no changes; (d) change connected to urban expansion; (e) no boundary symbol in the riverbed; (f) explanation of the lack of a boundary symbol in the riverbed based on a cadastral map (1:2880) due to disputed area between the communes. Source: The Authors.

on the Pulkovo-42 reference frame were transformed to the appropriate zone of the UTM coordinate system.

The map sheets of the second Sącz military survey were cropped along a map frame. Each cropped image was processed separately, using at least 20 control points

per sheet. Points were chosen from triangulation points, historical buildings (e.g., churches), recognizable crossroads, bridges, and viaducts. In the absence of such points, river/stream connections (confluences) were also used. Geometric correction and georeferencing to the 1992 or UTM coordinate system were obtained using second-order polynomial transformation. For map sheets with small amounts of coverage along the Galicia border, a first-order polynomial transformation was applied. The total root mean square error for the majority of the sheets reached a value between 10 and 30 m and occasionally exceeded 30 m. The selected method of geometric correction differs from methods used in georeferencing for the second military survey by Timár et al. (2006) and Affek (2013). These authors georeferenced the second military survey using projection and datum parameters, within the case of Affek's work—additional affine transformation based on triangulation points, presented on maps. Such methods do not correct geometric errors or they correct only the smallest errors typical for triangulation points.

Geometric errors for the second military survey may reach 50–100 m (Konias 2000), and the only way to minimize such errors is, in our opinion, to use a dense network of stable control points, regularly distributed across each section of the second military survey. In the final step, the georeferenced set of sheets was transformed to the Lambert azimuthal equal-area projection layout (EPSG 9820) in ArcMap 10.8 using georeferencing tools. Administrative maps at a scale of 1:115,200 were georeferenced to the maps of the second military survey. For 1880, we used 2498 control points, and the average root mean square error was 87.01 m. For 1855, we used 212 control points on the corners of the map content frames, fitting them into the 1880 edition.

### Manual vectorization

Manual vectorization was carried out at scales ranging from 1:2000 to 1:5000. Editing tools in ArcMap 10.8 were used. For Poland, the current administrative boundaries from the National Register of Boundaries ([www.gugik.gov.pl/pzgik](http://www.gugik.gov.pl/pzgik)) were helpful. The Galician cadastral commune is a counterpart of the contemporary Polish communal district, and units of the territorial division are still in use e.g. in Austria (Katastralgemeinde), the Czech Republic (katastrální území), and Italy (comune catastale). If historical and contemporary boundaries overlapped, the contemporary boundaries were accepted, as shown in Figure 3c. Otherwise, the course of historical borders was

reconstructed based on archival maps as in Figure 3d. This was done even when there were clear discrepancies in short sections of borders, such as meandering and changing riverbeds (as in Figures 3e and 3f), or in the case of administrative borders before the construction of reservoirs. Neither the maps of the second military survey at a scale of 1:28,800 nor the administrative maps at a scale of 1:115,200 contained the boundaries of the manor areas. This makes it impossible to reconstruct administrative divisions at the level of political communes and manor areas. In some cases, precise reference of the statistical data to the spatial information is not possible without using cadastral data, as changes in the administrative boundaries could be conducted even at the level of single parcels of land. However, at the scale of the analysis (the crown land Galicia), such changes are negligible.

For Ukraine, the borders were vectorized without any reference to modern borders. Until the completion of vectorization in Ukraine, there were no unit boundaries available for lower-level administrative units. The changes in territorial division under the USSR and later in independent Ukraine were greater than those in Poland (Himka 1990). Cadastral communes were aggregated into higher subdivisions using the Dissolve tool in ArcMap 10.8.

### Census data

The basis for reconstructing the higher-level units in each census year from the vectorized cadastral communes was the commune and district lists signed by the Central Statistical Commission (K. K. Statistische Central Commission). The geometries of the administrative boundaries were accompanied by attributes of the names of the administrative affiliations according to the lists.

Several supporting publications generally gave the areas of higher administrative units: the *Tafeln zur Statistik der oesterreichischen Monarchie—Neue Folge*, published in 1849–1865, and then the *Statistisches Jahrbuch* published from 1863 to 1881. These were later followed by *Österreichische Statistik* for 1880–1910 and *Österreichische Statistik und Neue Folge* for 1910–1914. The largest collection is available at the *Österreichische Nationalbibliothek* (<https://www.onb.ac.at/>).

### 1857

Data on the affiliation of cadastral communes with circles and districts were established based on a publication from 1855 (*Skorowidz wszystkich miejscowości*

1855) and an administrative map at a scale of 1:115,200 from 1855. For Eastern Galicia, the affiliation of communes with districts was checked against the list of settlements for 1857 (*Handbuch des Lemberger Statthaltereis* 1857).

Data on the upper-level administrative division of Galicia came from the publication of census data for the whole monarchy as of October 31, 1857 (*Statistische Übersichten* 1859). According to this source, Galicia consisted of two parts: the Eastern (Ost-Galizien) under the administration of Lviv (Lemberger Verwaltungs-Gebiet) and the Western (West-Galizien) under the administration of Kraków (Krakauer Verwaltungsgebiet). Eastern Galicia was divided into the city of Lviv (Landeshauptstadt), 12 circles, and 110 districts (Stadt- und Land-Bezirke), and Western Galicia into the city of Kraków, 7 circles, and 67 districts (Table 1). As shown in [Supplementary Material](#), Part E, thanks to reconstruction at the level of cadastral communes, it is possible to establish an enclave of circles in other circles, as well as enclaves of districts in other districts.

According to the abovementioned census publication of 1857, Galicia would have an area of 1360.66 square Austrian miles, which converts (Jansen 1900) into 78,301.14 km<sup>2</sup>, which can be compared to the area of the cadastral Galician communes we have indexed, 78,463.81 km<sup>2</sup>.

## 1869

The main source for ordering administrative units was the publication of the 1869 census (*Orts-Repertorium des Königreiches Galizien* 1874). In this publication, the districts are arranged alphabetically with lists of communes and parts thereof (Ortschaft). The list includes the division of communes into political communes (Orts-Gemeinden) and manor areas. For both areas, the number of buildings and the population are indicated, giving the number of men and women individually. The values for these two areas, generally with the same name, sum to the value for the cadastral commune.

The difficulties in compiling the data are indicated in the preface to the publication, even though 5 years have passed since the census was conducted. The difficulties resulted from the short time that had passed since the major administrative reform of Galicia and the specific conditions of land ownership in Galicia on a monarchical scale, that is, the large number of manor areas. The problem was also the definition of census units within districts, that is, parts of the communes and settlements (Pilat 1878, 1883).

An additional data source was seven published volumes containing the census for the entire monarchy at the district level (*Bevölkerung und Viehstand* 1871). In the available volumes, there was no direct information on the area of the districts. This can be calculated indirectly, for example, from the population density (*Bevölkerung und Viehstand* 1872, 39). Population figures from commune and district publications coincide and amount to 5,418,016. The population totals agree for 73 of the 74 districts and two cities with their own statutes. In only one district (Zhovkva, Żółkiew) did the population sums differ (by 10 persons). This was an error in the summation of men and women in the publication compiling political communes and manors. In the publication for districts, as in the publication for communes, discrepancies regarding population density in districts were noted. The published areas of the districts were obtained by the Central Statistical Commission from the Lviv Governorate (K. K. Statthaltereis in Lemberg) and diverged from the cadastral measurements by 8.69 square Austrian miles (~500.10 km<sup>2</sup>).

In the publications of the Statistisches Jahrbuch series for Galicia from this period (*Statistisches Jahrbuch* 1871), the same population figures are given for individual districts, and as in the seven-volume publication mentioned above, the area of the districts is missing.

For 1869, after comparison with the census publications, we vectorized two cities with their own statutes, 74 districts, 5875 cadastral communes as areas, and 931 political communes and parts thereof or

**Table 1.** Summary of the numbers of reconstructed administrative units and parts thereof for census years and second military survey years.

Layer	Geometry type in the dataset	Years						
		1857	1861–1864	1869	1880	1890	1900	1910
Circles, statutory cities	Polygons	21	–	Do not exist				
Districts or political districts, statutory cities	Polygons	179	–	76	76	76	80	83
Court or judicial districts, statutory cities	Polygons	–	–	–	178	179	186	188
Cadastral communes	Polygons	–	5944	5875	–	–	–	5870
Parts of cadastral communes (political communes, manor areas)	Points	–	–	931	–	–	–	432

manor areas as points, as shown in [Table 1](#) and [Supplementary Material](#), Part E. For Galicia in 1869, neither the list of communes nor the list of districts indicated the court districts, unlike such neighboring crownlands as Silesia or Bukovina.

### 1880

The primary source for 1880 was the compilation of communes (*Special-Orts-Repertorium* 1886). This bilingual German-Polish publication lists the communes in the alphabetical register of districts with data for buildings, population divided into men and women, four categories of religious affiliation, and four categories of vernacular language. Schools, parish seats, railways, post offices, and telegraph offices were listed under the name of each commune. Political communes are listed separately from the manor areas. A second source of information was the reference books for the districts of the monarchy from the census of December 31, 1880, in the *Österreichische Statistik* series (*Oesterreichische Statistik* 1882).

Additional publications included reference books for the districts in the *Statistisches Jahrbuch* series (*Statistisches Jahrbuch* 1883). In 1880, the total population of Galicia differed by 6953 inhabitants from the total population in the list of communes. This volume included an annotation (on page 9) regarding inconsistencies in the districts relative to the data from 1877. It is worth noting that the next volume of the *Statistisches Jahrbuch* series provides direct areas for all political and court districts, together with the population for 1880 (*Statistisches Jahrbuch* 1884). The total area of Galicia, summed from the areas of the individual districts, was 78,507.89 km<sup>2</sup>. The population is in agreement with that given for the list of communes (*Special-Orts-Repertorium* 1886); for example, the area of the city of Cracow differs by 4.91 km<sup>2</sup> but has the same number of inhabitants (66,095). For 1869, we reconstructed the borders of the two cities with their own statutes (Lviv, Kraków), 74 political districts, and 176 court districts ([Table 1](#)).

### 1890

For 1890, a compilation of communes published in a bilingual German-Polish edition was used (*Special Orts-Repertorium* 1893). This publication lists the communes in the alphabetical register of districts (*Bezirks-Hauptmannschaft*) and court districts (*Gerichts-Bezirk*) with data for buildings, populations of men and women, four categories of religious

affiliation, four categories of vernacular language, and various types of institutions present in the communes. Manor areas are listed separately from administrative communities. The second source of data on the area of districts from cadastral measurements as of December 31, 1890 are publications from the *Österreichische Statistik* series (*Oesterreichische Statistik* 1892). We also reconstructed two cities with their own statutes, 74 political districts, and 178 court districts ([Table 1](#)).

### 1900

The list of communes for 1900 (*Gemeindelexikon der im Reichsrat* 1907) is the most detailed published list for 1857–1910. It contains information about administrative communes, cadastral communes, and manor areas with mutual relationships. For both types of communes, the area is given in hectares. For administrative communes and manor areas, the publication contains the number of inhabitants divided into men and women, religious affiliation, and four categories of vernacular language, as well as the number of buildings. For cadastral communes, the publication lists, among other items, five categories of data on land use, four categories of farm animals, and the number of large land holdings and factories. For 1900, we reconstructed two cities with their own statutes, 78 political districts, and 184 court districts ([Table 1](#)).

### 1910

For 1910, the publication on communes for parts of the Austrian monarchy was used (*Allgemeines Verzeichnis* 1915); it lists Galician districts, administrative communes, parts thereof, and manor areas. It provides population data for each of these. The publication was issued in 1915, and the compilation lists the communes with administrative changes made after 1910. However, thanks to the list of changes in the affiliation of communes, it is possible to reconstruct the status in the census of December 31, 1910. For 1910, we reconstructed two cities with their own statutes, 81 political districts, 186 court districts, 5870 municipalities as areas, and 432 points for parts of administrative communes or manor areas ([Table 1](#)).

## Results

### Data records

The resulting dataset of administrative units (accessible at <https://doi.org/10.7910/DVN/PXDP41>) is an

open vector SHP format that is used by most GIS programs and is easily converted to other formats. We attach metadata to each shapefile layer as a file with the same name as the layer with an XML extension based on the ISO 19139 Metadata Implementation Specification GML 3.2 standard, in which the data sources for the geometry and the aggregation method and the source of the administrative unit names are explained. For each layer, there is also a readme file with metadata in the form of a simple text file.

These layers are stored in 16 compressed ZIP archives. The ZIP archives can be opened directly using open source software, such as QGIS or after extraction, e.g., using 7-Zip or WinZip, as well as with a single command Add Data to ArcGIS Desktop or ArcGIS Pro. The layers are given the acronyms GAL (Galicia) and YYYY (years); the special reference units are given the acronyms CL (crow land), Cr (circles), DP (political districts), DC (court districts), CmC (cadastral communes), CmPp (part of political communes), and CmCp (part of cadastral commune) (Table 2).

The attributes in the layers contain names, areas, and administrative unit codes similar to Ostafin et al. 2020b (see Supplementary Material, Part A). The names of the communes are listed in the attribute table (.dbf file) according to the cartographic and census sources (Table 3). The source of the names is in the metadata of each layer. Names for the same communes may differ, for example, because of the different inscriptions of Polish characters or phonetic notations in the sources. In some cases, the differences were due to an actual name change. Polish characters are in UTF-8 encoding.

The names of the districts are written in accordance with their census sources for the districts in each census year. Additionally, each district has had a name since 1910, when the names were well established. The codes for each level of administrative units can help the user to create a time series of the duration of administrative units. The codes of the same units are the same between 1857 and 1910.

The areas are given as geometric and statistical source areas. The affiliation of cadastral communes

**Table 2.** Names of layers in the dataset.

Layer	Geometry	Year
GAL_YYYY_Cr	polygon	1857
GAL_YYYY_DP	polygon	1857, 1869, 1880, 1890, 1900, 1910
GAL_YYYY_DC	polygon	1880, 1890, 1900, 1910
GAL_YYYY_CmC	polygon	1861–1864, 1869, 1910
GAL_YYYY_CmPp, GAL_YYYY_CmCp	point	1869, 1910

with units of a higher level of administrative division enables the analysis of changes in administrative divisions in the time sections of censuses.

A complete list and maps of administrative units—circles, political districts, and court districts—can be found in Supplementary Material, Part B.

### Technical validation

The data acquired by manual vectorization were inspected by topological correctness tools in ArcMap 10.8, using the rules Must Not Overlap and Must Have no Gaps, with a tolerance of 0.001 m.

The areas of the vectorized cadastral communes were compared with those of cadastral communes published in the 1900 census (*Gemeindelexikon der im Reichsrate 1907*). For 98.0% of the cadastral communes, the differences between the spatial and census data were between  $-5$  and  $5\%$ , with the absolute values being highly dependent on the size of the commune (see: Supplementary Material, Part E). For the 58 cadastral communes with  $>5\%$  area differences from the average size of the commune (total area: 1321 ha), the average area was 646 ha, and for the 61 communes with  $<-5\%$  area differences, the average area was 543 ha.

In the case of the 119 cadastral communes with the largest discrepancies, that is, for 53 cases,  $>5$  or  $<-5\%$  real boundary changes were identified by comparing the second military survey maps with the 1880 administrative maps or the textual and graphic annotations on cadastral plans. For 23 cases, no boundary changes were identified between the second military survey and the 1880 administrative map, and cadastral plans that could explain the discrepancies, mainly

**Table 3.** List of attributes covered by the dataset.

Attributes	For communes	For districts	Description
SrcNm_YYYY	1861–1864, 1869, 1880, 1900, 1910	1857, 1869, 1880, 1890, 1900, 1910	Names according to the cartographic or census sources
GArsqkm/ haYYYY	1861–1864, 1869, 1910	1857, 1869, 1880, 1890, 1900, 1910	Area in km <sup>2</sup> or ha from manual vectorization
SArsqkm/ haYYYY	1900	1857, 1869, 1880, 1890, 1900, 1910	Area in km <sup>2</sup> or ha from manual vectorization
Cr_YYYY	1857	–	Name of the circle for the cadastral commune
DP_YYYY	1857, 1869, 1880, 1890, 1900, 1910	–	Name of the political district for the cadastral commune and part thereof
DC_YYYY	1857, 1869, 1880, 1890, 1900, 1910	–	Name of the court district for the cadastral commune and part thereof

from Ukraine, were not available online. For 37 cases, the boundaries were in the beds of large rivers, where boundary changes may have occurred, for example, due to changes resulting from floods, and may have been areas disputed by two communes. In numerous sections, the border of Galicia with the Russian Empire in the Vistula riverbed does not coincide with the borders of cadastral communes, which should simultaneously serve as borders with the Russian Empire. For the six cases with an average commune size of 44 ha, the error may be a result of the processing of underlay maps (root mean square error) or the generalization of borders on the 1:28,800 map.

We checked the reconstructed circles and districts, both political and court, by comparing their areas with those in the statistical censuses issued by the Central Statistical Commission in Vienna.

In 1857, for 86% of the circles (including Lviv, a city with its own statute), the differences between the area of the geometry and the area from the statistical censuses were  $< \pm 1\%$ , whereas 14% of the circles (including the city of Kraków) showed differences of between 1 and 3%. For 93% of the districts, the differences between the area of geometry and the area from the statistical censuses were  $< \pm 5\%$ . In subsequent time frames, 72% of the districts had  $\pm 5\%$  area concordance for 1869, 97% for 1880, 100% for 1890, 100% for 1900, and 100% for 1910. For court districts, the percentage of correspondence between the geometric and statistical areas within  $\pm 5\%$  was as follows: 92% (1880), 98% (1890), 100% (1900), and 98% (1910) (see: [Supplementary Material](#), Part E).

For 1869, because of the least area concordance among all the timeframes, for districts, we aggregated population data from individual communes, assuming that the partial population data values would add up to the values given for the districts (see below: the example of Chortkiv [Czortków] district in 1869). For 93% of districts, there was full agreement regarding population totals; for 3% of districts, the difference between the totals was  $< 0.05\%$ , and for 4% of districts, the difference was  $< 0.03\%$ . The aggregation of population data from the level of cadastral communes allowed us to verify the areas of the districts and confirmed that some official data on the areas of Galicia's districts for 1869 did not match the list of cadastral communes. Thus, published values for population density or livestock density are unreliable for some districts.

A complete set of comparisons of the areas of administrative units of the higher levels of the administrative division of Galicia (circles, political, and court

districts) for the time frames of the censuses can be found in [Supplementary Material](#), Part B.

### **Example of Kraków city, 1857–1910**

The matching of statistical data with the geometry of Kraków's boundaries is a more complicated example of identification, despite there being numerous sources and studies ([Supplementary Material](#), Part C). Different sources for the same timeframes provide different areas and populations for Kraków.

There are several reasons for the inconsistencies in the datasets for the area and population of Kraków. The first results from a difference in how the territory of Kraków is understood. Kraków could be defined as a territory consisting of city parts or city districts (Stadtteile) or it could be defined as a cadastral commune. From 1857 to 1880, the Central Commission's publications for districts probably indicated the area of Kraków by including the area of the nearby communes Dąbie and Grzegórzki, which were owned by the commune of Kraków (*Skorowidz wszystkich miejscowości* 1868). This area (0.23 square Austrian miles, 13.24 km<sup>2</sup> after conversion) was similar to the area of the Kraków fortress (Festung Krakau), a military area within the territorial range from the 1850s (<https://www.szukajwarchiwach.gov.pl/jednostka/-/jednostka/3065698>).

Between 1857 and 1909, the cadastral commune of Krakow (8.3 km<sup>2</sup>) included the area of eight city districts (5.56 km<sup>2</sup>) and Czarna Wieś (2.76 km<sup>2</sup>), a political commune bordering Kraków to the west. In 1909 and 1910, the area of Kraków was enlarged by 12 neighboring cadastral communes, and the process of enlarging the city continued until 1915. In the Central Commission's lists of communes from 1869 to 1910, the population and number of buildings in Krakow referred to the Kraków city districts. The total population of Kraków consisted of the sums of the population of the city districts. The area of the cadastral commune was given as 832 ha only in the 1900 list of communes.

The second reason for the discrepancies in the sources is the administrative changes to the area of Kraków close to the years in which the census was published. The census source could not take into account territorial changes if the changes were recent, or they might have taken them into account but assigned outdated census data to the changed administrative units. For example, this applies to the list of communes for 1910 published in 1915 (*Allgemeines Verzeichnis* 1915), in which, however, it is possible to

reconstruct the status as of December 31, 1910, thanks to reliable footnotes.

A third reason for the discrepancies may be the adoption of different census population categories for the total population. For example, in the list of settlements made by a postal clerk for 1910 (Bigo 1914), the total population includes only the category of the civilian population (*Zivilbevölkerung*), without military population (*actives Militär*); although for 1880 and 1890, the same author compiled the total population (*Bevölkerung*) for Kraków.

A fourth reason for the differences includes typographical errors, such as 57.7 km<sup>2</sup> for Kraków in 1880 (*Special-Orts-Repertorium* 1886) instead of 5.77 km<sup>2</sup>. There are also mistakes in exchanging the population figures for units with similar names, such as the 59,444 residents of the court district of Kraków being assigned in 1900 to the population of the city of Kraków (Bigo 1904).

Kraków is also a good example of how the slight rounding of the city's area (from 8.32 km<sup>2</sup> to 8 km<sup>2</sup>, representing a large population of 91,323 and a small area) in publications from 1900 can change the precision of population density calculations per km<sup>2</sup> by 439 people. The differences in population density values were even greater when counting the population of the districts of Kraków per cadastral commune area. This problem did not apply to Lviv, where the city center and four suburbs coincided with the cadastral commune of Lviv.

### **Example of the Chortkiv district in 1869**

The example of Chortkiv (Czortków) indicates that statistical sources signed by the Central Commission published for the same year are not always compatible and may juxtapose outdated areas with proper population census data.

The 1869 census of communes for the Chortkiv district lists 49 political communes and 48 manor areas, which can be combined into 47 cadastral communes whose boundaries we have vectorized. A comparison of the areas vectorized from the maps of the second military survey and the 1900 census values of the cadastral communes shows that there were no major changes in the areas of the cadastral communes during the period 1861–1900. The maximum difference in the area of one commune in the Chortkiv district is 74 ha, with an average cadastral commune size of 1724 ha. Statistical data from the 1869 publications for districts indicated that the area of the Chortkiv district was 602.51 km<sup>2</sup>, *vis-à-vis* the 809.59 km<sup>2</sup> we vectorized. When aggregating the

population data of cadastral communes, we obtained 100% correspondence in the population between the publication for communes and the publication for districts for both levels of administrative division.

Hence, for the purposes of boundary reconstruction, we have assumed that our areas, based on the aggregation of cadastral communes and verified by censuses, are reliable for 1869, despite inconsistencies with area data reconstructed based on population density or livestock from district publications. We are reassured by comments in the sources regarding the difficulties in collating the data and by the previously mentioned preface from the 1869 list for communes.

A summary of source data for the Chortkiv district is found in [Supplementary Material](#), Part D.

### **Comparison to other projects**

We have related the vectorized boundaries to two other projects containing data for Galicia: HistoGIS and Mosaic. Data from the Mosaic project included the boundaries of the 1711 court districts of the Austro-Hungarian Monarchy in 1910. They were made by the Max Planck Institute for Demographic Research and the Chair for Geodesy and Geoinformatics, University of Rostock, a slightly modified version of a GIS file by Rumpler and Seger (2010). This dataset for Galicia provides the geometry of 186 court districts and two cities with their own statutes, the same as in our data for 1910. The total length of boundaries for the court districts in Galicia from the Mosaic project is 20,093.86 km compared to the 25,650.01 km we vectorized. Only two districts from our dataset had boundaries shorter than those from Mosaic, with a minimum value of 82.80%. The largest difference in the boundary length was 220.4% for the Muszyna district. The average difference in the court district area for our data is 1.93%. The greatest discrepancies were noted for the court district of Muszyna, for which we vectorized an area 299.66% larger, and the city of Lviv, where the area we vectorized was 44.53% smaller than that of the Mosaic data. For 61 districts, we vectorized <95% of the area given by Mosaic, and for 56 judicial districts, we vectorized more than 105%. For the eight districts of the Mosaic project, we noted incorrect names that were swapped with the names of other districts. The district of Muszyna was within our borders, but in Mosaic, it was assigned to the right bank of Tisa River (*Rechtes Theißufer*), which is not part of Galicia but belongs to the Hungarian part of the monarchy. The existing court district of Muszyna in the Mosaic Project was sectioned from the court district of Nowy Sącz (*Neusandez*).

In the next step of the validation, we generated centroids (geometric centers) for the court districts from the Mosaic project and centroids for the court districts we vectorized (Figure 4). The average difference in the distance of the two sets of centroids was 1349.56 m, the smallest difference being 144.80 m for the district of Rudki, and the largest, 4638.05 m, for the court district of Nowy Sącz.

The final step in validating our data was to compare it to data from the HistoGIS Project (<https://histogis.acdh.oeaw.ac.at/>). This project is described as a geographical information system, workbench, and repository for retrieving, collecting, creating, enriching, and preserving historically temporalized spatial datasets. The collection includes data for many regions of Europe from a very wide time range, but most are from the nineteenth century. As a result of searching the data of this project using the “Tempspatial” filter with the additional criteria (columns) of Start Date, End Date, How accurate is the given date, Source, and Contemporary Administrative Unit, we found 95 records for administrative divisions of Galicia from

1850 to 1918, mainly at the level of political districts. A total of 82 names from the identified districts were unique. For comparison with our data, the Stanislaw political district (Stanisławów), today’s Ivano-Frankivsk, was randomly selected and downloaded as a GeoJSON file and converted to a shapefile format for validation.

The time range for the Stanislaw district boundaries in the HistoGIS metadata was defined as July 10, 1868–October 31, 1918. Hence, we compared the district boundaries with the boundaries vectorized for the 1869–1910 census time sections. The area of the Stanislaus political district was 879.81 km<sup>2</sup> according to HistoGIS, but according to our data, it was 794.78 km<sup>2</sup> in 1869, 851.57 km<sup>2</sup> in 1880, and 868.37 km<sup>2</sup> in 1890, 1900, and 1910. According to the lists of communes, between 1869 and 1880, the following cadastral communes were attached to the Stanislaw political district: Chorostków, Drohomirczany, Międzyhorce, Radcza, and Siemikowce. Between 1880 and 1890, the communes of Bratkowice and Meducha were attached. These changes for each section can be reconstructed from our data. Between 1890 and 1910,

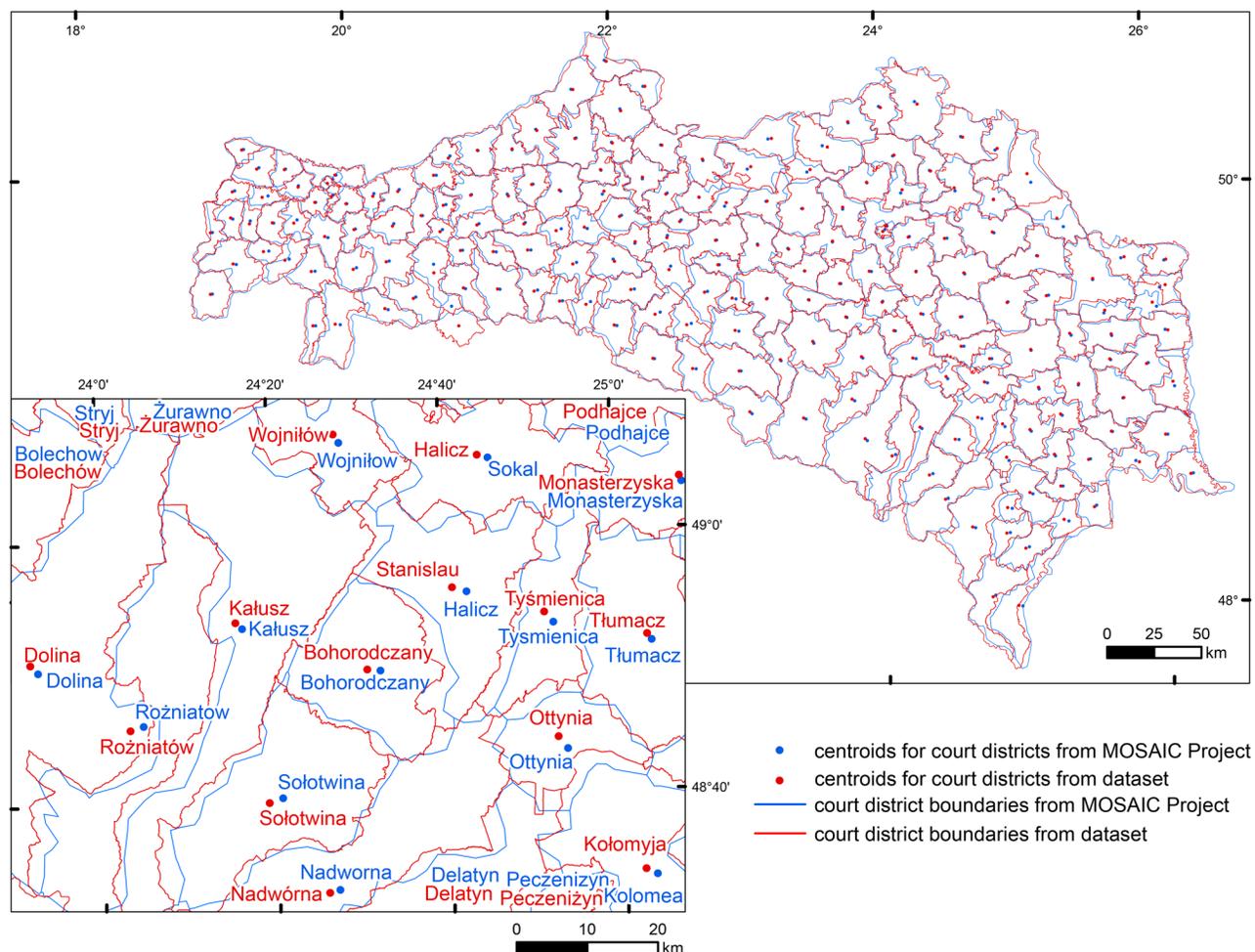


Figure 4. Comparison of centroid positions for court districts from the Mosaic Project and from the dataset. Source: The Authors.

the boundaries of the Stanislaw political district did not change, as shown in [Supplementary Material](#), Part E.

## Conclusion

This paper has presented the possibility of reconstructing administrative changes over time for a large area of Central Europe at a detailed level and then verifying the accuracy of these reconstructions. Such data have not yet been available at this level of spatial and temporal detail (Burzyński 1982; Himka 1990). Furthermore, the reconstruction of the administrative boundaries of districts from small-scale maps may be insufficient to provide certainty regarding which communes belong to which district.

We have shown that it is possible to verify the quality of censuses through the reconstruction of administrative units. Some calculations in the censuses from 1869 for districts (e.g., population density or stocking density for districts in 1869) may be incorrect because they incorrectly referenced administrative units (Zamorski 1989).

For Galicia, the 1857 census must be interpreted in light of preparations for the administrative reform of 1866. The publication of the 1869 census must take into account the short period of implementation of this reform. Censuses from 1880 onwards show very good agreement between the statistical listings and geometrical data from the maps. Administrative changes in Galicia have become very clear since 1880, and it is possible to reconstruct counties accurately for any year between the dates of the censuses. Our studies showed a different situation in the organization of historical data for Galicia from the one observed in Austrian Silesia, another crown country of the Austro-Hungarian Monarchy, where the geometries of administrative units have been very consistent with the census data since the 1830s (Ostafin et al. 2020b).

This level of detail in the reconstruction of administrative boundaries can be a good starting point for linking with modern data. When starting from the reconstruction of district borders, such linking is difficult or even impossible. The dataset can be useful for demographic, ownership, and genealogical reconstructions, as well as for studying land-use changes.

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## Author contributions

K.O. designed the study, vectorized the boundaries, wrote the manuscript, created figures, SHP files, and [Supplementary Materials](#), and secured funding. M.T., D.K., and K.O. prepared the historical maps, revised, and edited the manuscript. K.Ś. and M.T. wrote the manuscript. A.S., A.M., K.G., and N.K. revised and edited the manuscript.

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