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USING MAPS OF THE FORMER AUSTRIAN CADASTRE ON THE SCALE OF 1:2880 TO ANALYSE THE DATA IN THE LAND AND BUILDING REGISTRY

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Summary

The aim of the paper was to present the possibility of processing cadastral data in order to obtain material that could serve as a valuable source of information in the analysis of the current state of records. The paper presents a methodology for processing cadastral data, which provides material that can be compared with data from the Land and Buildings Register (EGiB).

The research area was the Niedzieliska cadastral precinct, located in the municipality of Szczurowa, in the Brzesko district, in the Małopolskie Voivodeship. Based on processed cadastral data and data contained in the EGiB database, the paper determines the differences in the area for 15 cadastral parcels. A comparison of the two records showed that cadastral data allow for analysis of the current state. The implemented methodology confirmed the usefulness of archived cadastral documentation in the analysis of the current state contained in the Land and Building Register. The analysis of the obtained results showed that the differences in the area of the cadastral state and the area of the cadastral parcels exceeded 10% in none of the cases, and the average difference did not exceed 0.0075 ha.

The developed output material can be applied to detect discrepancies and differences between the source data and the current data contained in the EGiB. This makes it possible to identify areas where the causes of discrepancies need to be explained and the necessary corrections need to be made to remove the discrepancies.

Keywords

transformation • cadastre • land and buildings register

1. Introduction

The land cadastre – *capitastrum*, later called *catastrum* – after centuries of modernisation and updating has become today's land registration. In the past, its main purpose was to optimize tax collection by thoroughly analysing the land and determining the potential profit from properties and crops. Over time, this led to the development of a system that facilitated the accurate calculation of tax values [Wolski 2001]. The tax covered both the land itself and the property. Unlike modern cadastral parcels, the Austrian cadastral

system focused on land parcels, which were a continuous area of land defined by boundaries, a single land use and a single owner. The location of these parcels was directly connected to a single arable land and municipality [Fedorowski 1974].

Historical cadastral documentation includes among its resources the public registers of land and buildings that are the subject of the cadastre, as well as the registers related to property rights [Chlupp and Moriz 1877]. It is no secret that preserved archival data serve as valuable historical resources. They are often used in various spatial planning and urban development initiatives. In addition, information on property rights is needed for legal regulations as there are many inconsistencies between the actual state of a parcel and its legal status. Because they are very useful for comparing the actual state with the status documented in the cadastral documents, they are the subject of numerous analyses and studies. These properly verified materials are an invaluable source of information in administrative processes and scientific research [Lisec and Navratil 2014].

The main aim of this paper was to examine the possibility of using cadastral documentation as a material for analysing the current state contained in the Land and Buildings Register (EGiB) in the area of the former Austrian partition based on the transformation of plane coordinates from the 'KUL' system to the currently used '2000' system [Kadaj 2000].

The current land and building register is one of the most important elements in the administrative functioning of a community. It is an extensive source of records subject to constant modernisation. In Poland, the modernisation of this system was already included in the 1955 decree [Taszakowski et al. 2018]. The biggest change in the Polish cadastre was caused by the transition from the former land parcels to the current cadastral parcels in the 1970s. The establishment of cadastre in accordance with the principle of keeping the designations in the newly created real estate register caused many difficulties resulting from the disruption of the connection between the registration document and the real estate register [Kwartnik-Pruc et al. 2012].

Cadastral archives serve as a reference for dealing with issues of the contemporary land registration and property law. The benefits of using cadastral data are also demonstrated in spatial planning, where they provide information necessary for planning [Augustynek et al. 2015]. However, the most important advantage of the Austrian cadastre is its potential for legal and fiscal issues. For these reasons, it is important to understand the complexity of the whole system, as the formalisation of processes requires deep reasoning. The resultant analysis of the cadastral state is its IT implementation by adapting the data and realising the objective [Navratil and Frank 2004].

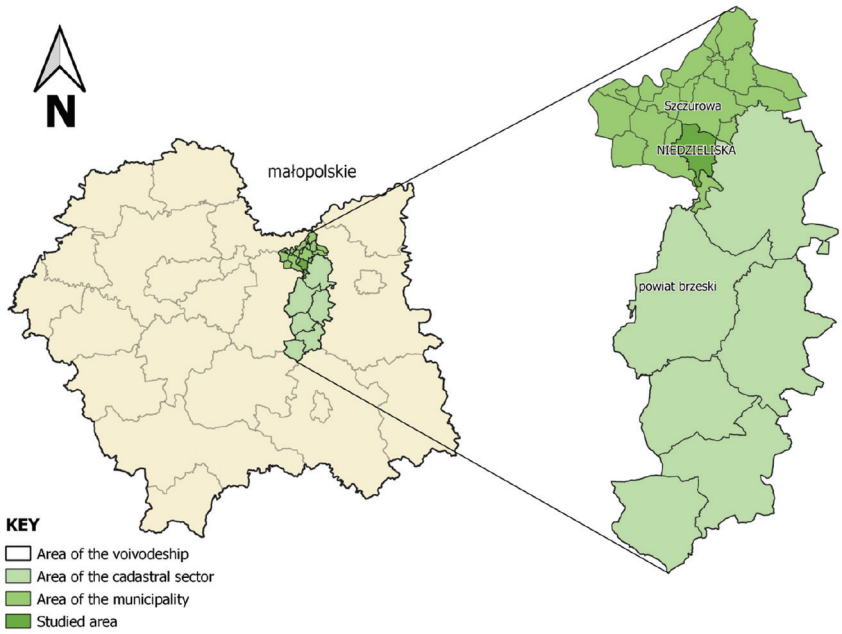
The territory of the Małopolskie Voivodeship was once part of the Austrian partition. Due to the high precision and quality of execution of the cadastral surveys in this region today's State Archives have desirable documentation. This basically enables their further use and provides opportunities for revivification in modern computer software and digital formats [Taszakowski et al. 2018]. There are two methods for processing analogue maps of the former Austrian cadastre into digital formats. The first method involves a transformation of the map of the former Austrian cadastre into a digital format

using direct references to permanent cadastral points. The second method is an indirect transformation of the map of the former Austrian cadastre into a digital format using the coordinates of cadastral triangulation points. The result of such transformation of an analogue map is its vector interpretation. When compared with a contemporary digital map, in the same coordinate system, it allows for a comparison of the former boundaries of land and buildings with the present ones [Hanus and Kremiec 2005].

With a reliably prepared database and cartographic material, contemporary analyses of legal status and boundary issues offer a chance to resolve disputes and problematic situations related to property. Historical synchronisation lists provide a reference point for issues related to missing registration information and entries in the real estate register [Taszakowski 2011].

2. Scope of research

The subject of research and analysis is the area of the Niedzieliska cadastral precinct located in the municipality of Szczurowa, Brzesko district, Małopolskie Voivodeship (Fig. 1). Its total area is 1152 ha, consisting of 2278 cadastral parcels. The village of Niedzieliska borders the following cadastral precincts: Rajsko, Szczurowa, Strzelce Wielkie, Borzęcin, Rudy-Rysie, and Rylowa. As the southern part of Małopolska was under Austrian rule in the past, the selected village fits perfectly into the research scope.



Source: Authors' own study

Fig. 1. Location of the Niedzieliska village in the Małopolskie Voivodeship

3. Methodology of the study

This paper deals with the main issues related to the use of maps from the former Austrian cadastre and focuses on the processing of these cartographic materials for their further use. An analytical and research methodology was chosen to address this issue. The research area covered the areas formerly under Austrian rule. In order to process the analogue map into a numerical version, it was necessary to acquire scans of maps from the former Austrian cadastre, e.g. from the National Archives in Kraków. Next, the corners of the sectional frames in the original KUL layout were calculated. Subsequently, the values of the adjustment points in the secondary layout were calculated based on the known values in the primary layout, according to the catalogue [Michałowski and Sikorski 1932], and then a flat, conformal-multinomial transformation of the second degree was performed. The next task was the initial calibration of the raster by using the affine transformation, followed by the precise calibration of the raster based on field details and characteristic elements of the situation in the field. This was followed by the vectorisation of the obtained results. which consisted mainly of comparing the former parcel structure with contemporary cadastral parcels. For this purpose, area measurement tools were used and appropriate documentation was drawn up.

4. Transformation of the coordinates

At the beginning of the coordinate transformation, it was necessary to prepare the input data. On the basis of scans of cadastral maps, the identification numbers of individual map fragments were read out, thanks to which the corners of sectional frames were calculated in the Lviv cadastral system – KUL. Then, the values of total points in the secondary system '2000' were determined using the calculation scheme of the 1932 catalogue. The data prepared in this way provided an opportunity to perform a flat, conformal-multinomial transformation of the second degree in the Geonet software.

Table 1. Coordinates of sectional frame corners before and after transformation

No.	Identification numbers of maps	Coordinates in the system:			
		KUL		PL-2000	
		X	Y	X	Y
1	W.C.XXXIII.12.S.bf.	34895.30	-244646.40	5552844.61	7472677.47
2	W.C.XXXIII.12.S.bg.	33378.11	-244646.40	5551329.00	7472739.28
3	W.C.XXXIII.12.S.cg.	33378.11	-246542.88	5551251.74	7470844.78
4	W.C.XXXIII.12.S.ag.	33378.11	-242749.92	5551406.24	7474633.78
5	W.C.XXXII.12.S.dg.	33378.11	-240853.43	5551483.47	7476528.30

6	W.C.XXXIII.12.S.bh.	31860.92	−244646.40	5549813.40	7472801.08
7	W.C.XXXIII.12.S.ch.	31860.92	−246542.88	5549736.14	7470906.59
8	W.C.XXXIII.12.S.bi.	30343.73	−244646.40	5548297.81	7472862.87
9	W.C.XXXIII.12.S.ah.	31860.92	−242749.92	5549890.64	7474695.56
10	W.C.XXXII.12.S.dh.	31860.92	−240853.43	5549967.86	7476590.07
11	W.C.XXXIII.12.S.ai.	30343.73	−242749.92	5548375.04	7474757.35
12	W.C.XXXIII.13.S.ae.	28826.55	−242749.92	5546936.79	7476713.63
12’	W.C.XXXII.13.S.de.	28826.55	−240853.43	5546859.65	7474819.12
13	W.C.XXXII.12.S.di.	30343.73	−240853.43	5548452.26	7476651.84

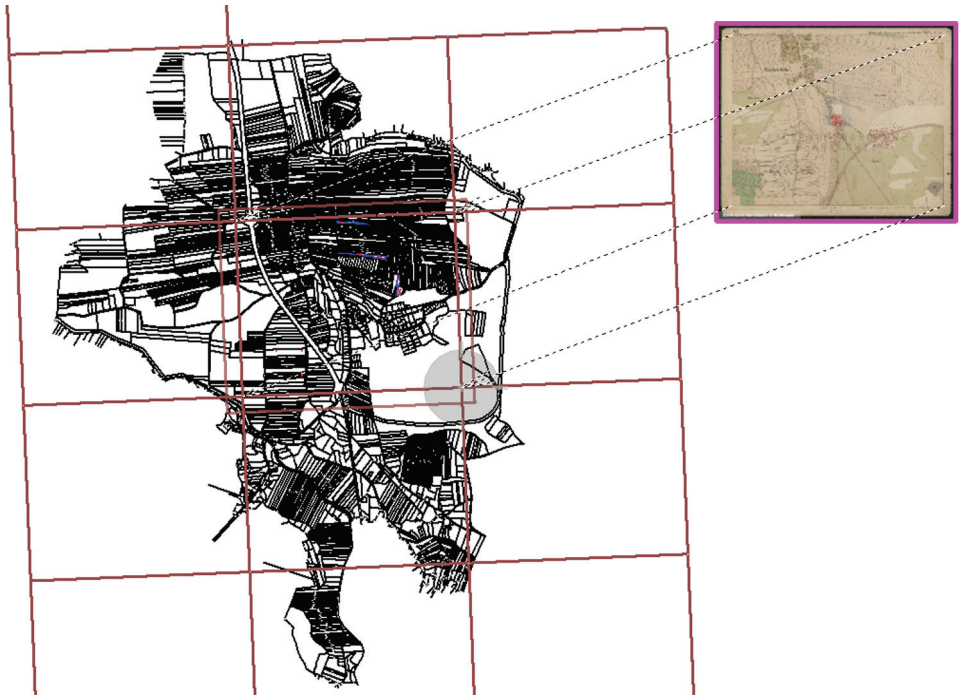
Source: Authors’ own study

There were 44 points observed in the primary system and 30 points in the secondary system. There were 30 points of adjustment. The corresponding mean square deviations are shown: SX = 0.4770 m and SY = 0.6951 m. Moreover, the resultant mean value was 0.8430 m, its maximum value was determined at the point 48031035, i.e. 1.3987 m. The average unit error of the transformation was 0.6309 m, which indicates the correctness of the process performed. In order to summarise the coordinate transformation, the points outlining the section frame grid in the ‘2000’ system were collated. A summary of before and after the transformation is given in Table 1.

5. Raster calibration

To calibrate the rasters according to the adopted PL-2000 coordinate system, the process was divided into two steps. First, the coordinates of the corners of the sectional frames were imported and the nominal frames were defined. Then, the rasters were oriented using an affine transformation. For this purpose, four adjustment points, corresponding to the four corners of the sectional frame, were selected, resulting in the adjustment of 13 rasters according to the PL-2000 system. The advantage of the affine transformation is that it preserves the parallelism of the opposite sides and significantly eliminates map shrinkage and random errors (Fig. 2).

The second stage focused on detailed calibration. This was carried out on the basis of field details and characteristic situational elements. The desired points were locations where the angle formed by parcel boundaries or baulks was close to 90°. Elements with many changes in their structure, e.g. roads, and rivers, were not included in this process. The detailed calibration was also performed with the affine transformation, which allowed the borders of the former parcels to coincide with their contemporary counterparts (Fig. 3). A point of the vector map was combined with the corresponding point of the cadastral map base.



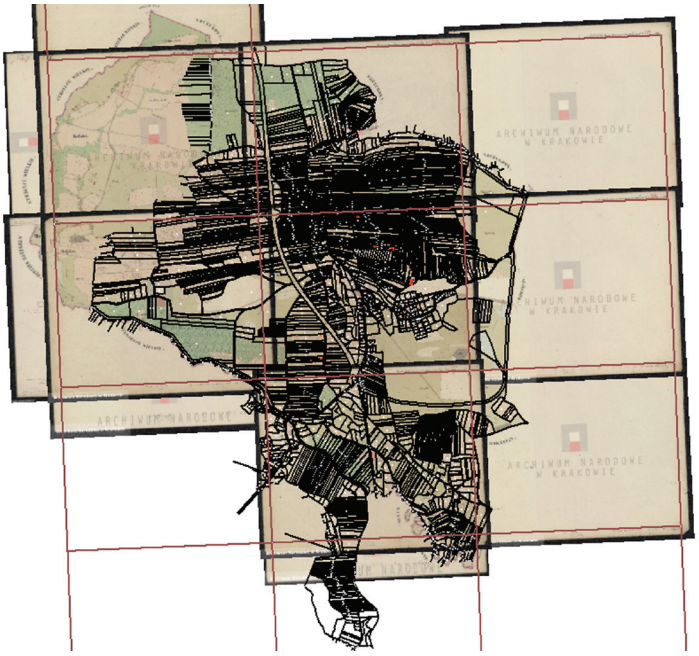
Source: Authors' own study

Fig. 2. Initial calibration of the raster of the cadastral map by the affine transformation

Source: Authors' own study

Fig. 3. Detailed calibration of the raster of the cadastral map by the affine transformation (left side – the state before, right side – after)

Finally, all the fitted rasters formed an image of the analysed map, largely compatible with the contemporary cadastral vector map (Fig. 4).

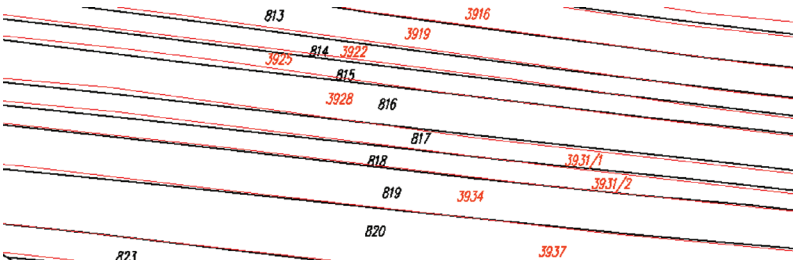


Source: Authors' own study

Fig. 4. Calibrated map of the former Austrian cadastre in relations to the EGiB vector map

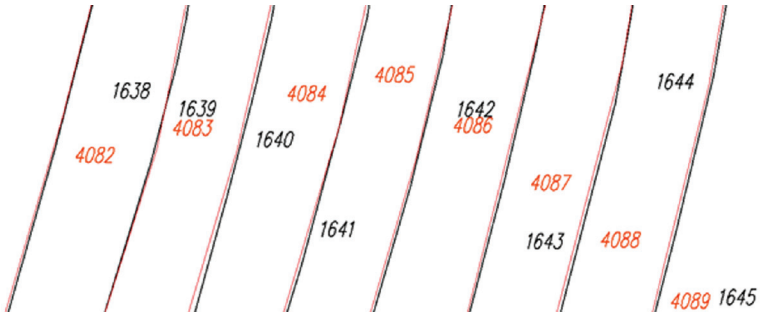
6. Digitisation of the raster map of the former Austrian cadastre

The correctly performed raster calibration process allowed detailed digitisation of the raster. At this stage, no deformations were observed that could adversely affect further use of the vector content (Figs. 5 and 6).



Source: Authors' own study

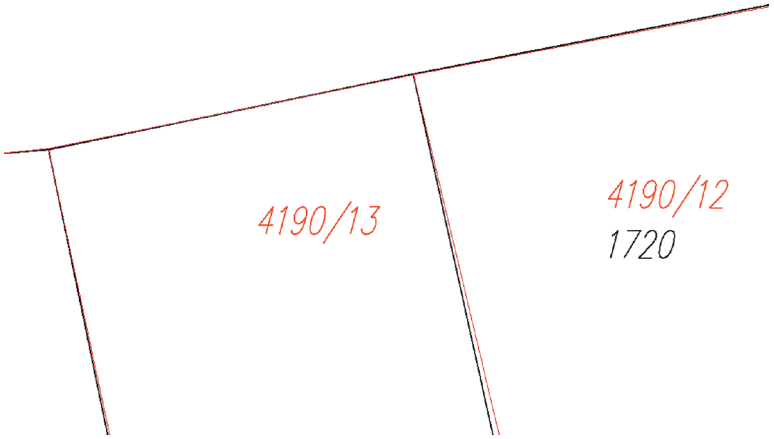
Fig. 5. Vector map of the former Austrian cadastre in relations to the EGiB vector map (1)



Source: Authors' own study

Fig. 6. Vector map of the former Austrian cadastre in relation to the EGiB vector map (2)

In addition, in places where the parcel boundaries run perpendicular to each other, the content of the map obtained from the District Office in Brzesko, almost perfectly coincided with the content introduced at the digitisation stage (Fig. 7).



Source: Authors' own study

Fig. 7. Vector map of the former Austrian cadastre in relation to the EGiB vector map (3)

7. Analysis and evaluation of the use of the map transformation of the former Austrian cadastre

Due to the vectorisation of the raster it was possible to compare the status of the former land parcels with the contemporary cadastral parcels. For this purpose, the area of 15 former land parcels was compared with cadastral parcels of identical shape. The parcels were chosen to be evenly distributed over the digitised area. The areas, with an

accuracy of up to 0.0001 ha, are summarised in the table below (Table 2). Analysis of the results obtained showed that the differences between the areas of the parcels from different systems did not exceed 10% in any case, and the average difference did not exceed 0.0075 ha.

Table 2. Comparison of the area of plots based on data from the former Austrian cadastre and EGiB

No.	ID number of land parcel	ID number of cadastral parcel	Land parcel area [ha]	Cadastral parcel area [ha]	Difference in area [ha]	Difference [%]
1	4081	1637	0.2240	0.2110	0.0130	6.16
2	4082	1638	0.2134	0.2283	0.0149	6.53
3	4051	1660	0.3279	0.3372	0.0093	2.76
4	4050/2	1658	0.2280	0.2173	0.0107	4.92
5	4085	1641	0.2130	0.2119	0.0011	0.52
6	4088	1644	0.2259	0.2336	0.0077	3.30
7	4112	1673	0.2459	0.2384	0.0075	3.15
8	4190/12	1720	0.3151	0.3193	0.0042	1.32
9	4990/19	1743/1	0.2489	0.2431	0.0058	2.39
10	4190/8	1726	0.1462	0.1424	0.0038	2.67
11	4000	830	0.1311	0.1312	0.0001	0.08
12	4001	829	0.0986	0.1043	0.0057	5.47
13	2329	700/1	0.1647	0.1500	0.0147	9.80
14	1595	3930/2	0.3290	0.3166	0.0124	3.92
15	1315	1539	0.1413	0.1435	0.0022	1.53
				Average	**0.0075**	–

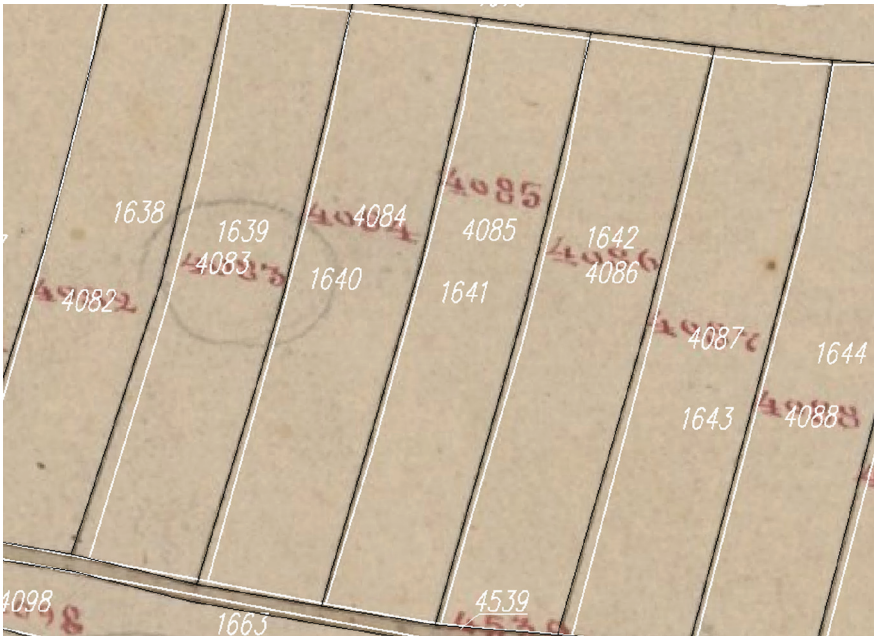
Source: Authors' own study

In the best cases, the differences between the former land parcel no. 4000 and the corresponding contemporary cadastral parcel no. 830 were negligible (Fig. 8). The difference was 0.0001 ha. Similarly was in the case of the former land parcel no. 4085 and corresponding contemporary cadastral parcel no. 1641 (Fig. 9). The difference in the area was only 0.0011 ha.

Examples of large differences in registered areas between former land parcels and contemporary cadastral parcels include former land parcel no. 4082 (today no. 1638) with an area difference of 0.0149 ha (Fig. 10), and former land parcel no. 2329 (today no. 700/1) with a difference of 0.0147 ha (Fig. 11).

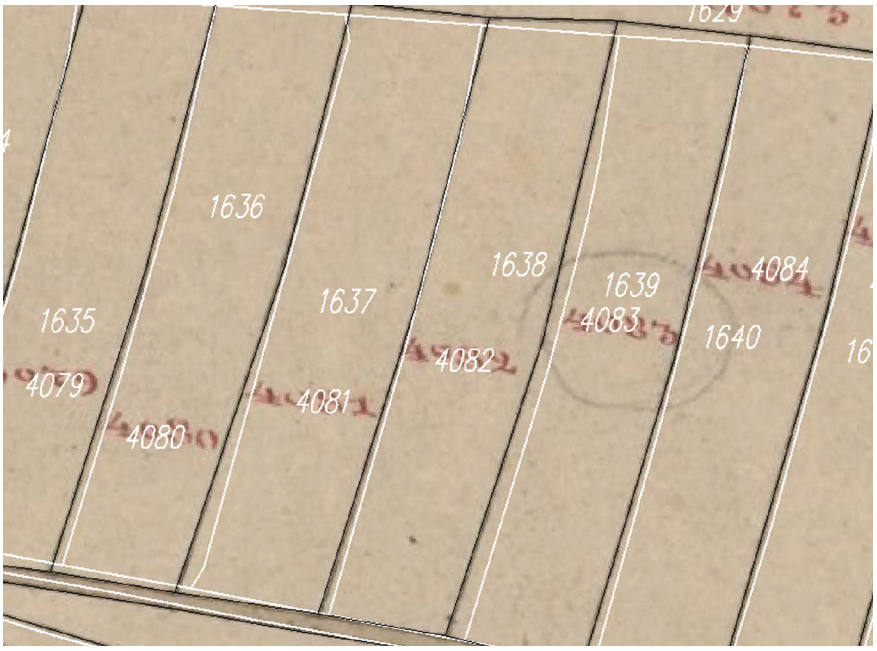
Source: Authors' own study

Fig. 8. Contemporary cadastral parcel no. 830 against former land parcel no. 4000



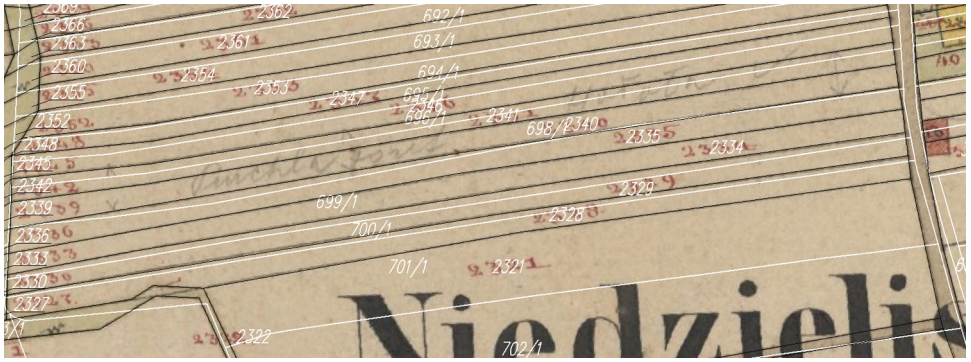
Source: Authors' own study

Fig. 9. Contemporary cadastral parcel no. 1641 against former land parcel no. 4085



Source: Authors' own study

Fig. 10. Contemporary cadastral parcel no. 1638 against former land parcel no. 4082



Source: Authors' own study

Fig. 11. Contemporary cadastral parcel no. 700/1 against former land parcel no. 2329

8. Conclusions

The adopted methodology confirmed the usefulness of archival cadastral documentation in the analysis of the current state of parcels listed in the Land and Building Register

(EGiB). The developed resultant material can be used as it was free from systematic errors mentioned by Taszakowski [2012]. The usefulness of the developed material was confirmed by analysing the results. None of the analysed cases exceeded the threshold of 10% of the difference in the area of former land parcels and contemporary cadastral parcels. The high quality of the study was demonstrated by the even distribution of the analysed cadastral parcels, which allows us to conclude that there are no errors in the entire area that would prevent the use of the developed material. The map of the former Austrian cadastre covering the area of the village of Niedzieliska in the municipality of Szczurowa is characterised by its high value in terms of the data it provides, which can be used to regulate the legal status, as well as be used in surveying and cartographic works, urban planning and civil law [Taszakowski et al. 2018].

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