


Using the former Austrian cadastre source documentation for surveying tasks in Poland

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Kurzfassung

Für die Erstellung des Katasters in Polen werden möglichst aktuelle Daten benötigt, die durch verschiedene Methoden gewonnen werden können. Unter anderem werden vielfach auch noch die Mappenblätter des Österreichischen Katasters verwendet, besonders in ländlichen Gegenden und Wäldern. Diese Mappenblätter stammen aus der Zeit, als sich Österreich noch über Teilgebiete des heutigen Polens erstreckte. Diese österreichischen Katasterdaten werden auch noch für andere Aufgaben gerne verwendet, wie etwa bei Grenzstreitigkeiten, aber auch für aktuelle Vermessungsaufgaben. Daraus lässt sich schließen, dass diese Daten aus historischen Zeiten auch in anderen Gebieten, die damals zu Österreich gehörten, verwendet werden könnten.

Schlüsselwörter: Österreichischer Kataster, Mappenblätter, Vektorisierung, Transformation

Abstract

The real estate cadastre in Poland is created step by step based on a modernization process of the grounds and buildings register. In order to create the real estate cadastre, accurate, reliable, and updated boundary data are requested. These data can be obtained by means of various methods and sources. One of these methods, frequently used in the context of crops and forests, is a cartographic method by using Austrian cadastral maps produced many years ago in the former Galizia, being a part of the southern-eastern Poland's territory. These maps can also serve for other surveying tasks like delimitations, subdivisions, and regulation of the legal status of real estate. Note that the Austrian cadastral documentation is still used in the southern part of Poland for various surveying task.

Using the former Austrian documentation needs some knowledge on cadastre and surveying and also particular experience of the surveyors. Frequently, surveyors get some doubts when they want to use the former Austrian cadastral maps. The reason for this is that the maps were prepared by graphic methods using plane table field surveying with low accuracy.

Former Austrian cadastral documentation, especially the cadastral map, may be fully used for legal aspects, where real estate boundaries play a very important role. The usefulness of the cadastral map for various surveying tasks is evident [4]. Moreover, it offers a chance for the surveyor to avoid possible wrong steps.

As described in the paper, the old Austrian cadastral documentation can still be used even in contemporary surveying; probably not only in Poland but also in those European countries which belonged to the Austrian Empire for many years.

Keywords: Austrian Cadastre, Cadastral Maps, Vectorization, Transformation

1. Introduction

A contemporary cadastre is one of the fundamental tools to perform many important tasks required for the functioning of any well-organized and managed country. Thus, the cadastre plays a fundamental role, not only in Poland but all over the world.

In spite of the fact that the cadastre mainly refers to surveying tasks, it is regarded as an administrative institution in Poland. This statement results from the definition of the cadastre as given in [6]: "cadastre is an official register of spatial and descriptive information about cadastral objects". Cadastral objects are: parcels, buildings, and dwellings.

It is worth mentioning that there are used some other terms for the cadastre in Poland, e.g., "grounds and buildings register", "cadastral system", and "real estate cadastre". Essentially, all of them mean the same, even if the last idiom is considered the most suitable one because it also associates legal information concerning real estate. Thus, the real estate cadastre information is, to some extent, a combination of information given from the existing grounds and buildings register and the land register[1)]. Yet, this cadastre has not been established in Poland so far, because creating such a system is not an easy and quick task [6]. Referring to the surveying administration in Poland, it still remains a big challenge. Thus, the existing grounds and buildings register is currently playing a key role.

1) Land register in Poland is a court register, where legal information about real estate is kept. Land register works on the basis of information obtained from the ground and buildings register. This information is called "real estate description". The grounds and buildings register and the land register are two separate items.

Fig. 1: Coverage of the former Austrian cadastre in Poland and the respective reference systems used for cadastral surveys (source: [3] modified by the authors)

Among the cadastral objects, the most important is the parcel (piece of land limited by boundaries). This statement arises directly from the ancient Roman „superficies solo cedit" rule affecting the ownership right. It means that all what is located on the surface of the land belongs to it. Thus, the parcel may be regarded as the main cadastral object, while buildings and dwellings are objects allied with the parcel [1]. In this context the following rule applies: the more accurate the boundaries of the parcel, the better described are the owner's rights.

Thus, in order to create a high-quality real estate cadastre, reliable and updated data of boundaries are requested. They can be obtained by various methods and from several sources. One of these methods, frequently used in the context of crops and forests, is a cartographic method [6]. It generally depends on digitization or scanning of existing analogue maps containing boundaries of the parcels[2]. One of these maps can be the former Austrian cadastral map, having been produced many years ago. The term "former Austrian cadastre" should be understood here in the sense "cadastre, which has been created in the 19th and the 20th century on the Polish territory by the Austrian Empire". The range of this cadastre shows Fig.1. The area of the former Austrian cadastre covered about 17 % of the Polish territory.

Note that the Austrian cadastral documentation is still used in the southern-eastern part of Poland for various surveying tasks. Investigations dealing with the Austrian cadastral documentation, especially the maps, clearly demonstrate that it is still very useful [7] and, sometimes, is the only one but very good source of information [4].

Thus, one might say that the Austrian Empire covering the southern-eastern part of Polish territory (called at that time "Galizia") brought Poland not only political dependence (although rather light because of wide autonomy) but also a very good cadastral system, which has been serving for various purposes for many years. From this point of view, Poland received a big benefit from the Austrian Empire. It remained a positive heritage after the collapse of the Austrian Empire and disintegration in 1918[3].

As a confirmation of this fact, one can give the following example. After World War II, a grounds register was established in the southern-eastern part of Poland on the basis of the existing documentation of the former Austrian cadastre [3].

As it has been mentioned before, the old Austrian cadastral maps can be used mainly for crop

2) Using these processes, suitable data are received and then a digital map (being the spatial part of the grounds and buildings register file) is created [4].

3) Poland "inherited" from Prussia also an excellent cadastral system for the northern-western territories of Poland (about 47 % area of the whole country). For territories of central Poland being under Russian administration after their annexation, no cadastral system was produced.

and forest lands, where the accuracy requirements of contemporary surveys are not very high. They can also be used in developed and urban lands, if the accuracy requirements are met. These conditions are: 3.0 m for crop and forest lands and 0.6 m for developed and urban lands. Accuracy conditions are formulated in a law act [9] and a technical regulation [8], dealing with the grounds and buildings register[4].

2. The former Austrian cadastre on Polish territories

The basis for establishing the Austrian cadastre was an Act of 1817, given by emperor Franz the 1st, concerning tax land [3], [10]. In that time also a surveying cadastral regulation was published. Cadastral surveys, started in 1817, were carried out in the whole territory of the Austrian Empire, including the respective Polish territories. In 1871, so-called "mortgage books" were also improved by a common Act and dealing with land register.

The former Austrian cadastre was based upon surveys using network points, where the locations were determined in one of seven reference systems [3], [5].

In Galizia, three reference systems were in use called Lvov, Vienna, and Hungary reference systems. They are shown in Fig. 1.

The type of projection, used for the Austrian cadastre, was probably the cylindrical, equidistant and transverse Cassini-Soldner projection [3]. Deformations caused by this projection increase with growing distance from the main meridian. The deformations observed in this projection are less than those appearing in the typical Cassini projection [3].

Parcel measurements were performed using networks points. Networks of the I, II and III class were established through field surveys, while the network of class IV was determined by a graphic method using the plane table.

The essential scale of a cadastral map was 1:2880, resulting from the accepted non-metric Vienna system of measure, being in use at that time.

The cadastral map was the graphic (spatial) part of the cadastre. The cadastral documentation also comprised descriptive parts, mainly in the form of "sheets of possessing", "parcels protocols", and "list of owners". The sheet of possessing is strongly connected with the cadastral map, since it was created on the basis of the map and fully compatible with it.

This mentioned system was obligatory for the Galizia territory. In 1918, Poland continued to use it, just after getting back its independence. A similar situation occurred for the other parts of Poland, namely the former territories occupied by Prussia and Russia. Since both the Austrian and the Prussian cadastre were not uniform and differed from each other significantly, and, in addition, there did not exist any cadastre of the former Russian territories after World War I, Poland started immediately to create its new cadastre on the basis of existing sources of cadastral documentation. Yet, it proved to be a very complicated and complex problem. Therefore, serious efforts to modernize the cadastre started in 1935 but were stopped by World War II. Just after its end, Poland started again to create a completely new cadastre[5]. In spite of errors made in the context of establishing this cadastre, it nevertheless became a good basis for its later improvements.

During establishing the Polish cadastre, both the Prussian and the Austrian existing sources of cadastral documentation were successfully used, although they were mutually completely diversified.

3. Technical aspects of using the former Austrian cadastre documentation

We mainly consider its spatial part, i.e., its cadastral map. The descriptive part is used less although examples of its contemporary application can be given [4]. A suitable use of the analogue cadastral map is connected with some necessary technical works: digitization or scanning (with later vectorization), transformation, and creating a correct topology between spatial cadastral data.

In the context of this paper, we assume that the old Austrian cadastral maps (called also shorter: cadastral maps) are scanned and then vectorized. This method, transforming analogue information from a cadastral map into digital information, has been used for the research activities of the authors for this paper.

3.1 Preliminary processing of cadastral maps

For the preliminary processing of cadastral maps, the changing of their format from ana-

4) As it has been proved, the old Austrian cadastral maps fulfil these conditions for most of the applications [4].

5) On the basis of a Decree about grounds register given in 1955 [2].

logue to digital must be performed. A possible method is scanning and processing the map into raster data. Since a raster map is not useful for measurement activities, it must be vectorized to obtain a vector model [4]. However, the coordinates of this vector model (i.e., a set of points) are not determined in one of the obligatory reference systems. Therefore, the coordinates must be transformed.

Note also that several errors are comprised resulting from network points, field survey, mapping, frequently using the map, scanning. Yet, as some investigations proved, a properly selected type of transformation and also properly chosen control points may minimize or even exclude the influence of most of these errors. The only exceptions are the errors resulting from field survey and from network points [5].

3.2 The process of vectorization of a cadastral map and its accuracy

The process of vectorization of a cadastral map depends on "redrawing" the contents of this map by any CAD program. As a result of the vectorization process, a vector model of the reality is obtained. It consists of a set of points arranged in space by special rules [4].

Although the vectorization process itself is not a complicated activity, it nevertheless needs some basic knowledge of technology of preparing maps. It is also important to get coordinates of selected points with maximum accuracy after the vectorization. They will then serve for various "surveys" on the map, done in digital format. Thus, it is worth knowing the size of the medium error of vectorization.

In order to determine the error of the vectorization process, a simple experiment has been performed. Some maps have been selected from the territory of the former Galizia in different references systems. They have been cadastral maps or have been prepared on the basis of cadastral maps. Moreover, they have been prepared in different scales:

- contemporary cadastral map at scale 1:1000, made in cadastral unit Krzeszowice (Lvov reference system), with 0.11 m medium error of transformation,
- contemporary cadastral map at scale 1:2000, cadastral unit Lipnica Mała (Vienna reference system), with 0.18 m medium error of transformation,
- old Austrian cadastral map at scale 1:2880, cadastral unit Podwilk (Vienna reference system), with 0.48 m medium error of transformation,
- contemporary cadastral map at scale 1:5000, cadastral unit Pstroszyce Drugie (Lvov reference system), with 0.62 m medium error of transformation.

Before the error of vectorization has been determined, all maps have been scanned. Then, all maps in raster format have been transformed (fit-in) into the obligatory reference system by a simple method. In order to get reliable results for the errors of the vectorization process, a part of each map has been selected and independently vectorized by a group of persons (students). All of them were well acquainted with the rules of the vectorization process. After a preliminary analysis (omitting results with blunders), the medium error of vectorization for each map has been determined by the well-known Gauss formula. The results of the analysis are shown in Table 1. The results show that the error of vectorization is not linearly related to the scale of the map.

3.3 Transformation of cadastral maps

In order to use cadastral maps in the best possible way, i.e., to gain maximum accurate and reliable information from them, they must be suitably prepared and processed before their use. Thus, they must be properly transformed.

As it is commonly known, maps, especially cadastral ones, can easily be transformed from their local reference system into an obligatory reference system. The transformation is carried out by control points. Yet, the main problem is that such possible points (of the former cadastral network), fulfilling the requirements of transformation, rarely

Map scale	Number of persons (samples)	Number of points being vectorized	Total number of examined points	Medium error of vectorization [m]
1:1000	34	7	224	0.095
1:2000	58	6	340	0.113
1:2880	41	10	402	0.167
1:5000	13	6	74	0.525

Table 1: Results of the medium error of vectorization

exist in Poland. The reason is that they have been simply destroyed or damaged in the course of the years. The lack of such control points requires the use of other methods, e.g., based on the assumption that the former cadastral map must "fit" to the existing, real situation in the field. In order to achieve this without "true" control points (being points of networks), one must measure characteristic field points both on the map (local reference system) and in the field (obligatory reference system). Then, some transformations must be carried out to check which points fulfil the accuracy requirements. These points can then be used as control points for the final transformation. Afterwards, based on the map the location of any point (for example: point of boundary of dispute) in the field can be determined with the requested accuracy (but influenced by the accuracy of transformation). As it has been proved in [7], the accuracy of the cadastral map in the scale 1:2880 reached 0.60 m by this method. This very satisfying value, determined by authors, served the court for its final verdict, finishing the endless dispute on boundaries. The old Austrian cadastral map proved to be the only and priceless source of information enabling the correct location of parcel boundaries[6].

Before the transformation process, the cadastral map must be scanned delivering raster date which in turn must be vectorized. Frankly speaking, only specifically chosen characteristic points are vectorized. Thus, we have at our disposal a set of points with coordinates in the local reference system. Some of them are arbitrarily taken as control points, serving for the later transformation.

Choosing control points (both in the map and in the field) must be done carefully. This is the crucial activity because it affects the later transformation and its accuracy. Thus, when selecting control points it should be taken into account that they should remain stable as long as possible. Therefore, the best points fulfilling this request are:

- so called: "three boundary strips", that is a location where three boundary lines of parcels intersect in one point,
- old trees, very often planted along the boundary lines,
- points of old, well-preserved fences,
- corners of old buildings.

All these points are usually visible well and enable an easy identification in the field.

Control points for cadastral map transformation can also be obtained by another method. This method uses so-called "zoll dividing lines" visible on map sheets. These lines cross out with the outer line of the map sheet frame, giving as a result characteristic points. These points are taken as control points. The negative aspect of such an approach is the lack of control points inside the map sheet which can cause some deformation in the middle of the cadastral map sheet upon transformation. Yet, this method is primarily used in Poland. A transformation, performed in this way causes that the raster has suitable geometric features to allow for the vectorization process. In order to locate exactly such a raster in the two- dimensional space, it is necessary to apply the second stage of transformation on the points identified both in the map and in the field. Their positions must be obtained from the map (by the vectorization process) and also determined in the field based on direct and accurate measurements.

The size of the transformation error depends on the map scale. Assuming the scale is 1:2880, the transformation error amounts to about 0.29 m [4]. Unfortunately, taking into account various circumstances connected with preparing cadastral map, one should rather expect worse results (possibly up to about 3 x 0.29 m). Such a size has just been reached in a boundary dispute court case, as presented above.

In order to verify these assumptions, some simple investigations have been done to point out errors of the transformation process and their directions on the cadastral map in the scale 1:2880 [4]. The results are shown in Fig. 2.

Transformation errors vary from 0.43 m (affine transformation) to 2.15 m (Helmert transformation).

6) The case occurred in 1995 in Korbielow near Zywiec, close to the southern border of the former Galizia. There was a boundary dispute between two parties, which seemed to be a „never ending story". Two independent surveyors were asked to provide their opinions to the court. Both opinions were questioned by parties and were refused to be taken by the court because of unexpected mistakes made by the surveyors. They had used the cadastral map existing there, but they used it wrongly. Afterwards, as mentioned earlier by the authors of [7], the researchers were asked to prepare an ultimate opinion. It was fully successful and approved by the court because the method described above was used and high accuracy was reached. This opinion was also accepted by the two parties without any doubt.

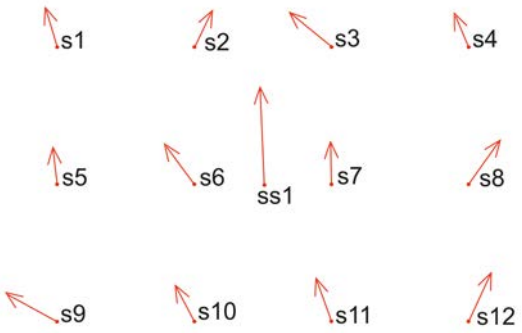

Fig. 2: Trends and sizes of errors of cadastral map at scale 1:2880 by the affine transformation process

4. Using the former Austrian cadastre documentation

As it has been proved in [4], the former Austrian cadastral documentation can successfully be used for some contemporary surveying works as, e.g., made in the southern-eastern part of Poland. Typical applications are:

- real estate delimitation,
- real estate subdivision,
- regulation of the legal status of real estate,
- modernization of cadastre (grounds and buildings register).

Note that mainly the cadastral map is used and the descriptive part of the former Austrian cadastral documentation only rarely, e.g., for the so-called "sychronization process", which is probably specific for Poland to fit descriptive data between the "old" and the "new" cadastre.

The grounds and buildings register modernization in Poland generally depends on the transformation of the analogue cadastral map into digital cadastral maps after adding necessary information. As mentioned earlier, the former Austrian cadastral maps are also used for this purpose especially in rural areas.

The regulation of the legal status of real estate generally depends on a comparison of the ownership rights in reality and the contents of land register. Sometimes, this comparison is made by using the former Austrian cadastral map.

The real estate delimitation and subdivision process also uses the former Austrian cadastral map with the scale 1:2880. It is especially used in areas either without any other map or when contemporary maps exist but have been prepared simply by "redrawing" the old cadastral maps including sometimes mistakes. As some investigations proved [7], [4], these maps can be used only by taking into account some important conditions. First, they must be adequately prepared before using them by the procedure described earlier. The relevant transformation using control points identified both on the map and in the field is the most important step. The results obtained are very satisfying not only for surveyor but also for parties engaged in a court case in the context of a boundary dispute.

The application of cadastral documentation for real estate delimitations and subdivisions always requests the experience of the surveyors and is usually performed by individual approaches where the interpretation of the cadastral maps plays a fundamental role.

However, the cadastral maps cannot be used under all circumstances for contemporary surveying tasks. Insufficient accuracy is sometimes an issue. Moreover, sometimes maps are not clear because of their age and permanent usage. Thus, the problem is to estimate their usefulness by a quick, easy and accurate method. Such a method demonstrating the usefulness of the former Austrian cadastral maps is described in [4].

5. Conclusions

The paper proves that the former Austrian cadastral documentation, especially cadastral maps, can and should be used for various surveying tasks requiring some knowledge of cadastre and surveying and also great experience of the surveyors. Frequently, surveyors hesitate to apply the former Austrian cadastral maps. The reason is that theses maps were prepared by a graphic method and, consequently, the accuracy is sometimes an issue. If a suitable method is applied, a position accuracy of 0.60 m based on the 1:2880 map can be achieved. The method is composed of scanning, then fitting the raster information into the field reference system by a transformation process. The crucial activity is to identify some control points both on the map and in the field. The points should be as stable as possible.

The former Austrian cadastral documentation, especially the cadastral map, may be fully used in cases where the real estate boundary plays a very important role [4]. Beyond that, it offers an important chance for surveyors to avoid wrong steps.

As described in the paper, the old Austrian cadastral documentation can be still used for con-

temporary surveying tasks - probably not only in Poland but also in those European countries which belonged to the former Austrian Empire. Thus, from the perspective of Poland, the Austrian cadastral documentation may be regarded as "positive heritage" of the former Austrian Empire.

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