

Article

Active Collection of Data in the Real Estate Cadastre in Systems with a Different Pedigree and a Different Way of Building Development: Learning from Poland and Slovakia

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Abstract: A cadastre is a system of major importance for the economy and for management strategies in support of sustainable development. Thus, its modernisation process (especially in the case of buildings) is extremely important. This study compared the results from the cadastre modernisation process of Poland and Slovakia, that is, countries with a different way of building development and different historical cadastral traditions. It was certain that in countries with dispersed development—such as Poland—the modernisation process could significantly change the cadastre's picture. However, the analysis of the number of buildings in the cadastre after modernisation revealed a change of 3.048% for scattered development and only 6% for compact development. Thus, the urgent need to perform retrofits in countries with a scattered pattern of development was demonstrated. In addition, a comparative analysis proved that excessively frequent changes in the law cause the cadastre base to lose its validity. The Polish building cadastre has become a victim of such frequent changes in the law. It happened that just after the cadastre had been modernised at a high financial cost, the data on buildings collected in the cadastre became outdated as a result of a change in the law. Research highlighted that frequent changes and inconsistencies in the law result in a state of affairs in which activities that should be systemic and technical instead become activities that depend on political aspects.

Keywords: property cadastre; land and buildings records; building development; dispersed development; scattered development

1. Introduction

One of the most important public registers maintaining information on citizens and properties is the real estate cadastre [1–3]. The data contained therein serve, on the one hand, to protect property rights; on the other hand, they constitute a very important reference database in the operations of state authorities and local authorities [4–6]. Both in countries that have been running the cadastre in its full form for a long time, e.g., the Netherlands [7,8], Austria [9], or Germany [10], as well as in countries that are just building a real estate cadastre, such as Poland [11–17], Slovakia [18–20], Latvia [21], and Ukraine [22], the real estate cadastre is indicated by law as a reference base for other areas of the economy.

The property's data need to include a reference to its location and the plot boundaries, as well as the type of land use, the soil classification in the case of agricultural and forestry land, and details on the buildings and their shape. In some cadastres, separate premises in a building are also shown. Special attention in this study was given to buildings as cadastral objects. For buildings, the information contained in the real estate cadastre can be divided into geometric data (e.g., building contours) and descriptive data (e.g., building attributes). As the modern cadastre takes the form of a database containing all cadastral objects, the topological links between the building and the cadastral parcel on which the building is located are also important. According to proper regulations, it covers the personal data of property owners as well [23–25].

The data included in the cadastre are constantly changing, mostly because cadastral databases inevitably become out of date over time due to changes occurring on the ground (for example, the construction of new buildings). From the point of view of the new cadastre's tasks (e.g., showing the buildings or other elements of reality), these databases also may become incomplete [23–26]. In terms of buildings, the incompleteness of the cadastre database is a significant problem for both of the countries which were the research subjects in this study.

As such, it is important to periodically carry out so-called modernisation of the cadastre. However, for the purposes of the following considerations, this modernisation should be understood primarily as the effect of some actions, which consist of supplementing (updating) the database with missing information, as well as modifying the existing data in the case of a loss of their validity. Moreover, improvements in the structure of the information flow, and implementation of or improvements in the functioning of the IT system in which the cadastre is run are also of a modernising nature. Nevertheless, this issue remains out of the scope of this research. Due to the history, development, and specificity of a given country and its laws, the process and effects of cadastre modernisation can take various forms [4].

In this study, selected issues in this field were discussed, based on the examples of Poland and Slovakia. Both countries are located in central and eastern Europe, are adjacent to each other, and remained in the Soviet sphere of influence for many years after the end of the Second World War. However, these countries have cadastral systems with different origins. In Slovakia, there is a system derived from the Austro-Hungarian cadastre introduced at the end of the 18th century (the so-called Jozefinski cadastre), which has been consistent for the whole country since its inception. In contrast, Poland, which was under the partitions of neighbouring countries (Russia, Prussia, and Austria-Hungary) from 1795 to 1918, had three inconsistent cadastral systems after its independence in 1918. In Poland, with regard to the analysed area, there is a substitute system, the so-called register of land and buildings, created in the 1960s. The process of establishing a land cadastre is advanced in both countries. However, Poland and Slovakia, as the research subjects in this study, are currently in the process of building complete cadastral systems. These countries are characterised by different paths of building development; in Poland, the typical form in rural areas is dispersed development, while in Slovakia, compact development prevails. Each of these countries introduces buildings into the property cadastre in a slightly different way, which will be presented in this study.

Despite the fact that cadastral issues concerning Poland and Slovakia are presented in the literature (as cited in this study), there are no studies comparing the two countries in terms of their building cadastres. The activities of both countries, although comparable in some aspects, are different in others. Thus, the authors wanted to illustrate the way forward for countries with similar historical conditions and geographical locations. These two countries, despite many similarities, are characterised by different approaches. Why is this the case and what implications does it have for the future? This is the knowledge gap that the authors wanted to address.

Some of the important objects, the disclosure of which in the cadastre database causes significant consequences for both their owner and the municipality, are buildings [27,28].

These consequences are related to the assessment of property tax, the beneficiary of which is the municipality. It should be emphasised that the disclosure of a building in the cadastre of real estate gives two types of benefits in terms of the municipality's income. First of all, determining the current parameters of the building (its contour and attributes) is the basis for determining the amount of tax on the building property. Secondly, the disclosure of the building in the cadastre gives rise to an update of the land use of the built-up area and the accompanying infrastructure. The indicated compounds are the subject of this research, along with a comparison of their results in the group of countries indicated above.

The authors set out the research hypothesis that there is a strong relationship between the active collection of data in the real estate cadastre and updates of quantitative and qualitative information about constructed objects (including buildings) on the one hand, and the possibility of determining an adequate property tax on the other. At the same time, by comparing the examples of the modernisation of cadastres from Poland and Slovakia, an attempt to determine how strong this relationship is in the case of cadastres with varying degrees of advancement is presented. One of the elements of this comparative analysis between cadastres in both countries is a catalogue of the descriptive data about the buildings (i.e., their attributes) related to the legal state of the country in different time periods.

2. Methods

The research covered two administrative units located in Poland and Slovakia. In each of them, modernisation (updating of databases) of the real estate cadastre was carried out in the recent past. On the basis of the results of the modernisation, a comparative analysis of the changes in the cadastre across time between of the two sites was carried out. The aim was to answer the question of what tangible effects the modernisation of the cadastre brings in terms of buildings and what elements hinder these measures.

2.1. Study Area

The first research object was the Serniki cadastral district, located in the Lubartów district in the Lublin Voivodeship (Figure 1). It is a rural commune, constituting a cadastral district consisting of 10 cadastral precincts (villages). All the precincts were covered by the cadastre's modernisation procedure as part of the project 'e-Geodesy digital geodetic resource of the Lublin Voivodeship' in the years 2017–2020.

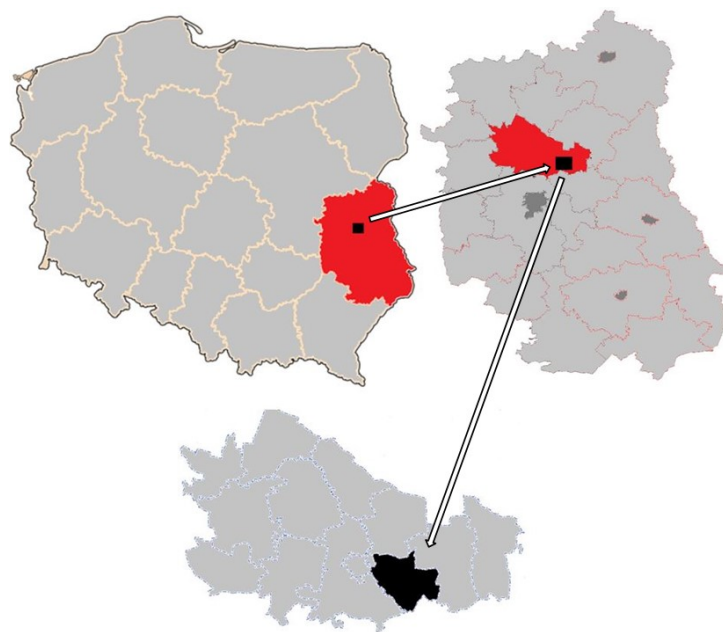


Figure 1. Location of the commune of Serniki in Poland, the Lublin Voivodeship, and the Lubartów district.

Rusovce is a suburban part of Bratislava on the right bank of the Danube (Figure 2), and the origins of the settlement stretch back to the Bronze Age. Today, Rusovce has low economic significance, as there are no industrial factories, and it serves mainly as a residential suburban area.

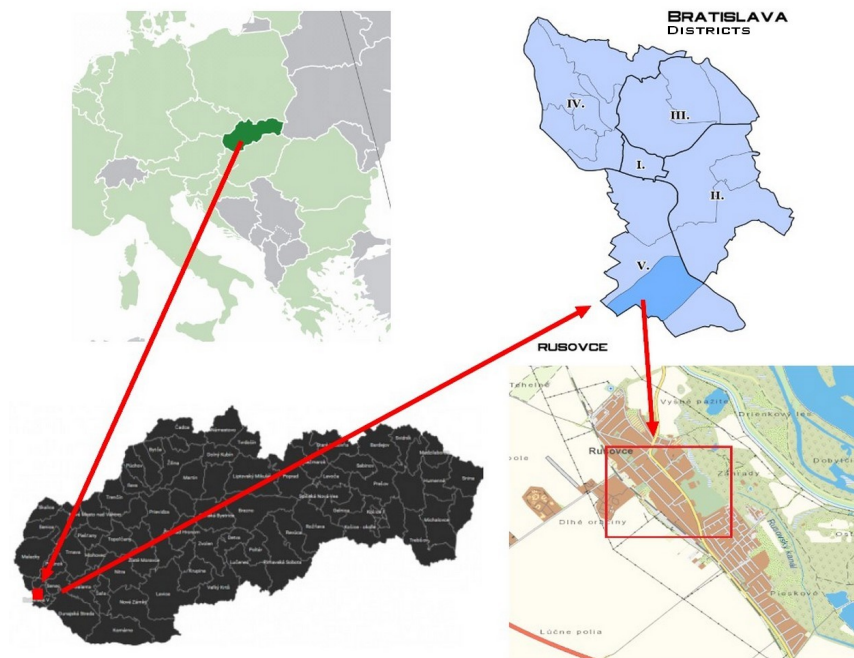


Figure 2. Location of the testing location in the historical part of Rusovce (Slovakia).

The cadastral map is numerical, so every building (even if it is displayed only using a complementary line) has a numerical description of the building's outline. Cadastral mapping is executed only in 0.5 % of cadastral units annually in Slovakia.

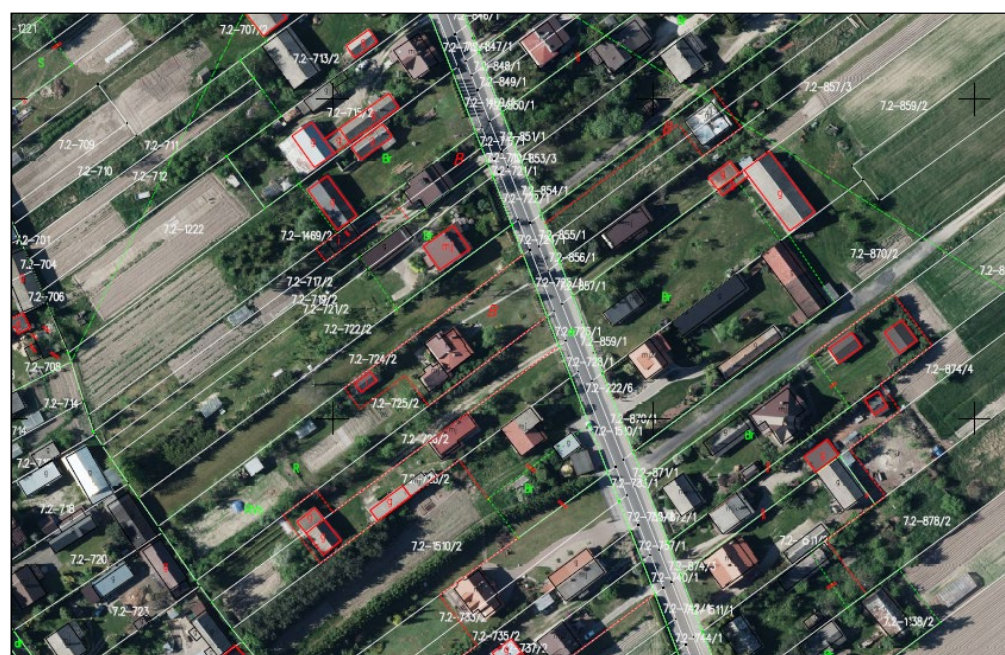
2.2. Data Acquisition and Analysis

The translation of the number of changes in cadastral bases concerning buildings, plots, and their status affecting the owners' tax obligations was different for each of the examples. This was demonstrated by an appropriate comparison of the source data. A comparative analysis of the scope of information on buildings collected in the cadastres of the individual countries was also carried out. Most of the geometric data of the shown changes were obtained as a result of measurements based on the photogrammetric method, selected due to the fact that it is much more effective. Only incidental cases required ground measurements (GPS supported by classical surveying techniques) [29,30]. For grouping the objects and for comparing them, attributes (of plots and buildings) deposited in the databases of the analysed cadastres were used.

In this study, special attention was paid to buildings as cadastre objects; the study summarised basic information about buildings covered by the cadastres' modernisation project. When modernising, the number of buildings not present in the cadastre, despite their actual existence on the ground, should be estimated. The condition of the cadastre base in the study area in Poland before modernisation is illustrated by the data in Table 1. The table compares the number of buildings in particular precincts existing in the cadastre before modernisation against the estimated number of buildings actually present in the field. These data were compiled on the basis of a comparison of the cadastre base before modernisation and an illustrative orthophotomap of the area under study. The orthophotomap, although not directly useful at the stage of the building survey, was a basic tool during the in situ interviews and was the basis of the field interview map (Figure 3; Table 1).

Table 1. Building information, pre-modernisation status.

No.	Cadastral Precinct	Information about the Precinct				
	Name	Estimated Number of Buildings				
		Estimated total Number of Buildings	Descriptive and Geometric Data (Fully Revealed in the Cadastre)	Descriptive Data only (without Geometry)	Geometry only (no Descriptive Data)	Number of Buildings Missing in the Cadastre
1	2	3	4	5	6	7
1	Brzostówka	1320	38	76	349	857
2	Czerniejów	413	19	25	68	301
3	Nowa Wola	1365	35	102	258	970
4	Nowa Wieś	515	11	33	150	321
5	Wola Sernicka	1266	20	49	310	887
6	Wola Sernicka Kol.	276	11	27	62	176
7	Serniki Wieś	441	31	51	140	219
8	Serniki Kolonia	443	17	74	121	231
9	Wólka Zabłocka	334	12	33	53	236
10	Wólka Zawieprzyczna	442	8	32	69	333
Total		6815	202	502	1580	4531

**Figure 3.** The field interview map against the background of an orthophotomap (example from the Polish part of the study).

The data contained in Table 1 are those produced during the study phase of the cadastre modernisation project in the municipality of Serniki. As can be seen from Table 1, before modernisation, only 202 buildings were revealed in the cadastre. On the basis

of supplementary photogrammetric measurements, the existence of 6815 buildings was estimated. Of the remaining buildings not fully disclosed in the cadastre, some have only geometric data but no descriptive data (1580 buildings). This means that these buildings exist only on the map, without attributes which could be the basis for calculating the property tax. Another group of buildings (502 buildings) exists only in the descriptive part of the cadastre but does not appear on the maps. From this list, it can be seen that 4531 buildings (which is the difference between the value in Column 3 of the table and the sum of Columns 4, 5, and 6) do not appear in the real estate cadastre at all, despite their physical presence in the area, generally having existed for many years. These figures show how big a problem the state of the building cadastre is in Poland and how urgently the cadastre needs to be modernised so that it can fulfil its statutory function as a reference database for tax authorities.

3. Legal and Historical Background of the Compared Cadastres

3.1. Poland

Section 2.2 describes the structure of the building cadastre in Poland and showed how it is highly incomplete. The initial work leading to the creation of a building cadastre theoretically started in 2001, with the introduction of the Regulation on the Land and Building Register [31]. However, both the definition of the building contour and the catalogue of descriptive building data (attributes) have changed in Poland, along with amendments to this regulation (mainly in 2013 and 2021). For this reason, solely due to changes in the content of the legal acts concerning the real estate cadastre, the building cadastre database existing in the previous legal state has become obsolete. The catalogue of descriptive building data (attributes) has been changing in Poland over time due to changes in the content of legal acts regarding the real estate cadastre.

Currently, the state is defined by Article 20.2.1 of the Geodetic and Cartographic Law [32], and also §18.1 of the Regulation of 27 July 2021 on land and building records [33]. In Poland, the property cadastre, based on its authority in legal acts, is indicated as the basis of operation of many areas of the economy, such as economic planning, spatial planning, real estate management, public statistics, land and mortgage registers, registers of agricultural holdings, and, most importantly in terms of the subject of this article, the assessment of taxes and benefits [34,35]. All the information indicated above is contained in the cadastral report, which consists of databases of the real estate cadastre and documents justifying the entries in the databases.

In countries where the cadastre is yet to be built, its incompleteness and obsolescence is a significant problem. In Poland, this problem mainly affects buildings. Practically until 2001, buildings in the real estate cadastre were not registered in Poland at all. To some extent, buildings existed only on maps; they were only graphic objects without descriptive data. The buildings were also not topologically connected with the cadastral plot, and therefore, it was not possible to update the land use within the plot on their basis. The process of disclosing buildings in the real estate cadastre started to gather pace only after the accession of Poland to the European Union and, consequently, the need to apply the European Parliament Directive of 14 March 2007 for establishing a Spatial Information Infrastructure (SDI) in the European Community (INSPIRE) [36]. The result of the directive was the adoption of a law on the spatial information of infrastructure in Poland [37], and the subsequent adoption and amendment of further national laws and regulations issued in this area, including those specifying the rules for the disclosure of buildings in the real estate cadastre.

3.2. Slovakia

The Slovak Republic has its own solutions for its cadastre, with the historical background derived from the first Austro-Hungarian cadastre dating from the early 19th century. Today, it is named the Land Administration System (LAS) and is one of the largest government information systems in Slovakia [18,38]. The LAS is a parcel-based and up-to-date

land information system containing a record of interests in the land (e.g., rights, encumbrances, and responsibilities). It includes a geometric description of the land plots linked to other records describing the nature of the interests and often the value of the parcel and improvements thereto. The LAS carries out some of its functions, namely that of protecting rights as well as the economical–organisational function (establishing conditions for the real estate trade, establishing conditions for business activities and for protecting the land’s resources). It also serves as an information system for tax and duty purposes, for the purposes of creation and protection of the environment, for the protection of cultural monuments, for building other information systems for real estate, for the purposes of providing information on the evaluated soil and ecological units, and for the protection of mineral resources [39,40].

The complete digitisation of the cadastral data in 2015 introduced the possibility of improving the cadastral database and electronic services for both citizens and surveyors. In recent years, the real estate cadastre in the Slovak Republic has focused on data refinement as well as improvements in and expansion of the services related to the provision of data from surveying and descriptive information files. The territory of the whole state is covered by a coherent layer of vector cadastral maps, which are updated daily [41]. Analogue maps are no longer used, and all property rights are registered on the deed of ownership. The current open cadastral system has become an integrated and modular service that utilises data stored in a common database with a consistent user access channel.

Unfortunately, the LAS still maintains the 1990s information system and an obsolete manual record system, for which the structure and the links of the real estate records and ownership titles are unable to meet the current requirements of companies in terms of the graphical representation and visualisation of data. Basically, it is a partially structured and digitalised, but still analogue system for recording land titles [42]. Current cadastral data in the models found in Slovakia use only a 2D land parcel concept. Discussions on a possible extension of the content of the cadastral database, as well as changes in the display of objects on the map, are ongoing [43].

Legislative and technological reforms of the building registration process have been carried out many times in recent years, but mostly as an urgent solution to some other unrelated problem. For example, in 1997, it was stipulated that the individual plots of land had to be created under the buildings that were used for non-housing purposes. In 2002, it was stipulated that an individual plot of land had to be created under a new building during the process of cadastral mapping and updating the measurements [40]. Its purpose was the development of mortgages in cases when the banks provided these mortgages to the subjects, who could also use a building as a guarantee. These changes to the registration of buildings were not designed to improve the quality of the cadastral data, e.g., for the purposes of better tax collection. This resolution from 2002 was valid for all the buildings, so we can consider this year as the start of the first stage of modernisation of building records in Slovakia.

3.3. Brief Conclusion and Limitations

An analysis of the cadastral data collection systems and their modernisation has shown different approaches in the two countries. It can be stated that there exist some doubts during the calculation of tax, not only in the determination of a building’s area but also in the determination of a building’s type. Nevertheless, the purpose of this study was to compare the two countries and demonstrate the potency of the modernisation process. It should be mentioned that such unification is expected by the International Federation of Surveyors (FIG). They have been pursuing the concept of unification of the cadastral systems in Europe since the beginning of the 21st century.

4. Results

4.1. Comparison of the Information about Buildings Collected in the Cadastres of Different Countries

An important problem in the creation of the real estate cadastre, at least in the Polish situation, are the frequent and important changes in the law regarding the rules for revealing buildings in the cadastre. In theory, the process of creating a building cadastre began in Poland in 2001, according to the attributes summarised in Column 1 of Table 2. However, in practice, the process of creating a building cadastre on a mass scale began in Poland with the publication of the amended Regulation on the Register of Land and Buildings in 2013. According to the records, as many as 27 attributes had to be specified for each building (Column 2 in Table 1). In 2021, this regulation was amended again, and the number of building attributes was reduced to eight (Column 3 in Table 1).

Table 2. Information about buildings collected in the cadastres of different countries.

Building Attributes in the Real Estate Cadastre			
Poland from 2001 to 2013	Poland since 2013 to 2021	Poland from 2021	Slovakia since 2002
(1)	(2)	(3)	(4)
Building ID	(1) Building ID	Building ID	-
Attribute was not present	(2) Building status: (a) the construction of the building has been completed; (b) the building is under construction; (c) the building has been subject to a demolition order; (d) the building is the subject of a building permit or notification, but its construction has not begun	- (Withdrawn)	The finished and unfinished buildings can be distinguished
Numerical description of the building's contour (primary definition)	(3) Numerical description of the building's contour (definition amended)	Numerical description of the building's contour; definition amended, virtually a return to the 2001 definition	Numerical description of the building's outline in all numerical maps, but in non-numerical maps only where an updating measurement has been performed
Attribute was not present	(4) Building type according to the fixed assets classification	Building type according to the fixed assets classification	-
Attribute was not present	(5) Building class according to the Polish classification of construction objects	- (Withdrawn)	-
Primary function of the building	(6) Main function of the building	- (Withdrawn)	Building's function (class according to the Act (1995b)
Building's value	(7) Building's value, if determined	- (Withdrawn)	-
Date of the completion of construction	(8) Date when construction was completed; in the case of reconstruction, the reconstruction date is also obtained	- (Withdrawn)	-
Attribute was not present	(9) Degree of certainty of setting the dates referred to in Point 8	- (Withdrawn)	-

Table 2. Cont.

Building Attributes in the Real Estate Cadastre			
Poland from 2001 to 2013	Poland since 2013 to 2021	Poland from 2021	Slovakia since 2002
(1)	(2)	(3)	(4)
Information about the material from which the outer walls of the building were built	(10) Information about the material from which the outer walls of the building were built	- (Withdrawn)	-
Attribute was not present	(11) Information on the scope of reconstruction of the building	- (Withdrawn)	-
Number of aboveground and underground storeys of the building	(12) Number of aboveground and underground storeys of the building	Number of aboveground and underground storeys of the building	-
Building's area	(13) Building's area	Building's area	-
Attribute was not present	(14) Usable area of the building, determined on the basis of: (a) standards; (b) information contained in the construction project	- (Withdrawn)	-
Attribute was not present	(15) Total usable area: (a) premises constituting separate real estate; (b) non-separate premises; (c) rooms belonging to the premises	Total usable area: (a) premises constituting separate real estate; (b) non-separate premises; (c) rooms belonging to the premises	-
Number of independent premises disclosed in the register	(16) The number of independent premises disclosed in the register	- (Withdrawn)	-
Number in the register of monuments if the building is entered in this register	(17) The number in the register of monuments if the building is entered in this register	- (Withdrawn)	Information that the building is a monument
Attribute was not present	(18) Building's address	Building's address	-
Identifiers of the cadastral plots on which the building is located	(19) Identifiers of the cadastral plots on which the building is located	Identifiers of the cadastral plots on which the building is located	Identifiers of the cadastral plots on which the building is located
Attribute was not present	(20) Information whether the building has been put into use in whole or in part	- (Withdrawn)	-
Attribute was not present	(21) The designation of the part of the building put into use	- (Withdrawn)	-
Attribute was not present	(22) The date of commissioning of the building or part of the building	- (Withdrawn)	-
Attribute was not present	(23) The number of dwellings according to the construction documentation in a residential building	- (Withdrawn)	-

Table 2. *Cont.*

Building Attributes in the Real Estate Cadastre			
Poland from 2001 to 2013	Poland since 2013 to 2021	Poland from 2021	Slovakia since 2002
(1)	(2)	(3)	(4)
Attribute was not present	(24) Total number of rooms in a residential building	- (Withdrawn)	-
Attribute was not present	(25) Date of demolition: (a) the whole building; (b) part of the building,	- (Withdrawn)	-
Attribute was not present	(26) The reason for the demolition of the building or part of it	- (Withdrawn)	-
Attribute was not present	(27) Whether the building is ready for high-speed internet	- (Withdrawn)	-

The data compiled in Table 2 indicate the significant redundancy of the information about the building required in the Polish cadastre in the years 2013–2021, in comparison with the Slovak cadastre. This resulted in the time-consuming collection of data, the high costs of obtaining them, and thus the inability to make the cadastre database up-to-date. The Slovak LAS uses only five attributed of structures/buildings specified in Column 4 in Table 2; the remaining attributes—due to Slovak law—must be obtained in accordance with the current legal status. Buildings are not displayed on the LAS’s cadastral map; only the land under the building is shown on the map. As such, buildings have no separate ID in the LAS, and the inventory number is not a building ID either, because only some buildings have an assigned inventory number.

4.2. Effects of Modernisation of the Property Cadastre

Spatial data on the buildings in selected locations of the two countries are presented below. The data were obtained from sources such as:

- Source documentation deposited in the existing cadastre collection;
- A survey made for the modernisation of the cadastre (photogrammetric measurement, GNSS, and a complementary classical survey);
- Architectural and construction documentation;
- Visual inspections of the buildings and in situ interviews with the property owners.

4.2.1. Example from Poland: Serniki

Figure 4 shows the geometric base of the buildings against the boundaries of the registration parcels in the Serniki registration unit before and after the cadastre was upgraded. The buildings are marked in brown and the boundaries of the registration plots are in grey.

Table 3 presents a list of changes in the number of buildings in the cadastre before and after modernisation. After the upgrade of the cadastre database, each building’s shape has been provided along with its individual number corresponding to the plot number (the attribute ‘building ID’ indicated in Column 3 of Table 2).

Prior to the modernisation of the cadastre of the commune of Serniki, the databases of this register functioned in conjunction with analogue maps and their raster figures, which were successively supplemented by vector data in the process of dividing the parcels. As can be seen from the data in Table 3, the original geometrically descriptive data in the cadastre of property presented only a negligible number of buildings. There were only 202 buildings with correct geometrical and descriptive data, and 2 permanently related buildings. A further 6157 buildings and 1225 other objects permanently connected to the buildings were fully disclosed during the direct field survey. During the modernisation process, data were obtained by direct field measurements for 924 buildings and 123 structures permanently

connected to the buildings. Other buildings and objects permanently connected to the buildings were disclosed on the basis of SSCR documentation (archival survey reports) and architectural and construction documentation.

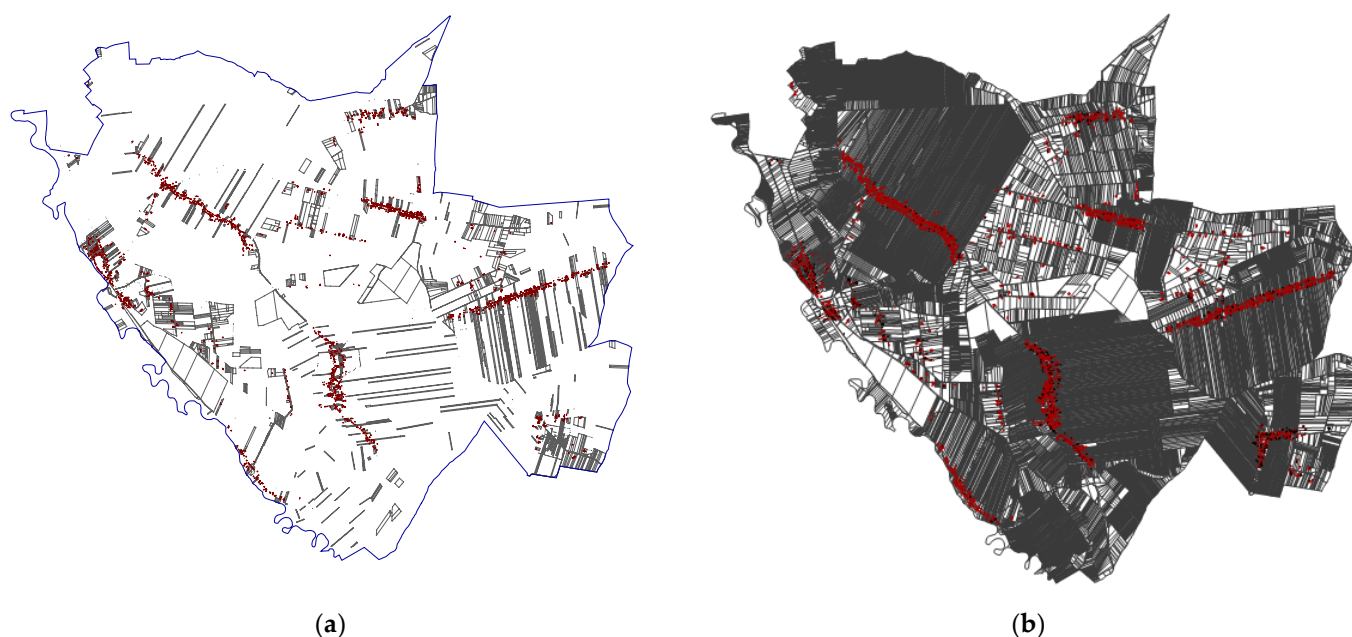


Figure 4. Buildings against the background of the registration plots before (a) and after (b) the cadastre’s modernisation.

Table 3. Numbers of buildings in the cadastre database of the Serniki commune, before and after modernisation.

Item	Number of Buildings Existing in the Cadastre before Modernisation in 2019	Number of Buildings Revealed in the Cadastre after Modernisation in 2019	Dynamics of the Changes (%)
Buildings	202	6359	3048
Structures connected with buildings	2	1227	61,250
Total	204	7586	3618.6

4.2.2. Example from Slovakia: Rusovce

The decision to give each buildings its own plot number was marked as the first stage of modernisation of building records. It started in 2002 after the amendment to the Cadastre Act [40]. A demonstration of how many buildings have been given an individual plot number in the historical part of Rusovce, along with original buildings, is given in Figure 5. For the marked buildings, it was found that the record in the LAS database can be exactly connected with the cadastral map. The increase in the number of buildings with plot numbers is shown in Table 4.

In the testing location (the historical part of Rusovce), there are mostly original houses. In 2010, 267 buildings had an individual plot number (Table 4). In the past 11 years, this number increased to 335 (an increase of 25%). The updated measurements have been performed according to the needs of the owners; they are not planned. Their number depends on the specifications of the real estate market in the particular region and on the spending power of the owners, because the updated measurements are performed during the new construction or reconstruction of buildings.



Figure 5. The location of the testing area within the cadastral unit of Rusovce (inside the red polygon) and individual plot numbers of buildings in an historical part of the cadastral unit of Rusovce in the years 2010 (down left) and 2021 (down right).

Table 4. Rate of individual plot numbers in a chosen location (cadastral unit of Rusovce).

Item	Number of Buildings Existing in the Cadastre before Modernisation in 2010	Number of Buildings Revealed in the Cadastre after Modernisation in 2021	Dynamics of the Changes (%)
Buildings	405	430	6.2
Buildings/structures with an individual plot number	267	335	25.5
Buildings/structures with an individual plot number in %	66	78	18.2

The change in the number of buildings with an individual plot number cannot be predicted. The certainty is that for fast and modernisation of building records across the area, new solutions have to be developed. The vision that individual plots of land will be created under the new buildings during the process of cadastral mapping and updating the measurements is correct, but the date of its completion is unknown. There

are no nationwide statistics on the number of buildings with individual plot numbers because these buildings cannot be identified automatically in the cadastral maps. The true modernisation of building records across the full area has not started yet in Slovakia.

5. Discussion

Turning to the consideration of whether at all (and, if so, how) the introduction of new buildings to the cadastre base affects the potential increase in taxes for the municipality, several aspects should be taken into consideration. In Poland, with regard to the buildings themselves, it can be concluded that this impact is negligible, since taxes on the building are calculated on the basis of the size of the usable area of the building, and this attribute of the building has not been subject to supplementation as a result of the modernisation of the cadastre. However, the very fact of revealing new buildings in the cadastre database gives the tax authorities the basis for requesting information from the buildings' owners about the size of the usable area of the newly disclosed buildings.

Does the disclosure of new buildings allow the municipality to collect higher taxes? The answer is yes, but only indirectly and to a limited extent. It is important whether the disclosed buildings are used for agricultural production or meet only housing, service, or other non-agricultural needs. An increase in the municipality's income will occur when the newly disclosed building is a building that is not related to agricultural activities.

The main goal of the authors was to determine whether and how the supplementary measurement of cadastral bases affects the completeness of these databases and, consequently, the possibility of calculating taxes and increasing the income of the municipality. On the basis of these considerations, it is legitimate to conclude that, in principle, the supplementary measurement and replenishment of cadastral databases in the field of buildings affect the possibility of charging increased taxes by the municipality. However, the completeness of cadastral databases does not automatically enrich the databases of tax authorities, which are the basis for calculating property taxes. The relevant tax authorities of Polish municipalities take care of their timeliness on their own. For example, information about the change in land use from agriculture to residential is transferred to the tax authorities from the cadastral databases (both regarding the fact of the change and the area of land with a change in the use). On the other hand, information on the size of the usable area of buildings, the disclosure of which causes a change in land use, comes from the owner of the building and not from the database of the cadastre of the property. Only the introduction of BIM technology [44–46] or a 3D multidimensional cadastre [47–50] would automate these processes, but both countries are far from this stage [27,51].

Slovakia is also facing a critical period in land and property management, and today's principles of building records remain unsatisfactory. The recording of buildings in the LAS is based on historical principles; the records in the database and the displays in the cadastral map were performed according to the regulations in force at that time. Reforms and activities related to the change in the registration of buildings, which were approved until 1990, were rambling and had mainly a political dimension. None led to the goal of more accurate and targeted tax collection.

Solutions connected to buildings which were approved in 2002 after the amendment to the Cadastral Act [40] were marked as the start of first stage of the modernisation of building records. From today's perspective, it is unimportant that the real reason for these changes was the development of mortgage markets. What is important is that such practices were commanded in the cadastral mapping and the updated measurements such that individual plots of land were created in the cadastral map under the buildings. Despite the fact that the insufficiency of this practice was shown in the example of Rusovce, it retains its importance, as it advances the LAS closer to the developed government information system known as Urbion. Urbion will be a reference register for structural objects. For the successful connection of the LAS and Urbion, a building in the cadastral maps has to be identifiable and it has to have its own unique identifier in the database in a way that the plots of land have their own identifiers (plot numbers). The individual plot numbers and

unique identifier for the buildings are the basic assumption for the correct hierarchy and consistent links among objects in the LAS (plots of land, buildings, and apartments) [52]. The change in the data structure of the LAS database is being prepared [43].

In conclusion, the modernisation of the cadastre has resulted in some benefits, as exemplified by the other authors of numerous scientific studies [53–57]. The information collected in the cadastre of property is also the basis for proper spatial management [58–61].

6. Conclusions

Although the European view of the development of cadastral systems is integrational [62], the homogenisation of cadastral systems with the vision of their cross-border connection cannot be expected in the near future. Every country has its own definitions of the cadastre of real estate and the registration of ownership. There is no consistency in what can be considered a property, what a plot of land is, which rights the cadastral system should contain in addition to the ownership rights, which restrictions on ownership rights the system should contain, and what kind of buildings would be included in the system. As a result, cross-comparisons of the state and contents of LAS are of great significance. The transfer of experience and solutions from the introduction of the fiscal taxation system is beneficial for all entities.

In recent years, there have been activities in Slovakia which will result in the connection of the LAS to the central public administration portal and other government information systems (the register of personal entities, the register of legal entities, the register of addresses etc.). Moreover, it is expected that the administrator of the prepared Urbion register of buildings will allow an interconnection with the cadastral information layer. This results from the premise that the LAS should enable the use of information about the territory from other sources in a way that is optimal for the development of society. Practice will show if the connection of the LAS with the Urbion register will prove itself.

The connection of the information about the buildings' owners in the LAS with other information about the buildings in the Urbion information system is a good basis for the precise, structured, and transparent collection of building taxes. For calculating the tax, the state can use technical and structural attributes which do not have to be contained in the cadastral database to the full extent. The tax calculation executed by the municipality would be simplified and the amount of tax would be determined transparently and reliably.

As can be seen, each of the countries studied has taken a different route to disclosing buildings as cadastre objects. In Poland, this has usually involved a comprehensive modernisation of precincts (villages) or entire municipalities. Its scope depends on the financial resources available for modernisation. As a result of modernisation, 100% of the buildings located in the modernised area appear in the cadastre at the same time. The initiation of the modernisation procedure was decided by the municipal authorities. In the Slovak Republic, the process of including buildings in the cadastre is not comprehensive, and buildings are entered into the cadastre selectively. This is often decided by the owners. In both countries, the frequent and inconsistent changes in the law related to the cadastre are very troublesome. This has resulted in a state of affairs in which activities that should be systemic and technical instead become activities that are dependent on political aspects. The examples of the operational models from Poland and Slovakia can be helpful for developing countries that are just beginning the process of establishing a building cadastre.

7. Future Research

Future research should address the importance of the procedure of modernisation of the cadastre and how to raise funds for this purpose. The authors believe that the modernisation of the cadastre can be beneficial for both landowners and administrative units, but deeper research is needed. It would also be interesting to know if the geographic location and historical conditions affect the quality and availability of open cadastral data. This research indicates that such a relationship can occur.

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