COMPLIANCE OF MAPS AND LAND AND BUILDING REGISTERS WITH THE ACTUAL STATE, ERROR ANALYSIS – A CASE STUDY FROM POLAND

Stanisław Bacior, Bożena Chmielowska

dr hab. inż. Stanisław Bacior, prof. URK,
University of Agriculture, Department of Land Surveying, Cadastre and Photogrammetry;
al. Mickiewicza 21, 31-120 Krakow, Poland
+48 607 162 192, s.bacior@urk.edu.pl

mgr inż. Bożena Chmielowska
University of Agriculture, Department of Land Surveying, Cadastre and Photogrammetry;
al. Mickiewicza 21, 31-120 Krakow, Poland
+48 12 662 45 03, chmielowska.bozena@student.urk.edu.pl;

Abstract
Land administration system has evolved significantly over the last century over the world, from its legal and fiscal function to the multifunctional role. Land and building cadastral maps and registers maintained in geoinformatics systems include data on property ownership and property boundaries. These data are the basis for survey works, legal and administrative procedures, infrastructure projects. Errors in these records can lead to a decrease in data reliability and completeness, inaccuracies in ownership issues, land division, boundary determination, land management and spatial planning. Finding an effective method for identifying and eliminating errors in cadastral data, both those relating to recorded land and buildings, as well as data on entities possessing them, is essential for high-quality data used in real estate management and for effective integration of registers maintained by various state institutions in Poland. This research presents an original identification and classification of errors in the land and building register records and maps in the Krakow County in Southern Poland.

Keywords: *Inconsistency of cadastral data, Error classification, Quality and reliability of cadastral data, Causes and effects of inaccuracies*

INTRODUCTION

Land administration systems have evolved significantly over the last century. In its current form it reflects both available technological advancements and growing societal needs. Early function of cadastral systems was legal and fiscal, whereas contemporary issues have changed more to their multifunctional role (Uşak et al. 2024).

According to the statutory definition, the Land and Buildings Register is an information system designed to collect, update and make available, in a uniform manner across the country, information on land, buildings and premises, their owners, and other entities holding or managing land. The Land and Buildings Register constitute the statutory source of data on land, buildings and premises for economic planning, spatial planning, the assessment of taxes and benefits, the registration of properties in land and mortgage registers, official statistics, property management and the register of agricultural holdings.

The history of property registration systems around the world dates back to ancient times, and their evolution is closely linked to the need to regulate property rights, manage natural resources (including land), and collect data for purposes such as taxation and land management (Williamson et al. 2010). Nowadays, the land registry system goes beyond simply recording data on plots of land and their owners; it is becoming a register that requires constant modernisation and alignment with global standards (Zevenbergen 2002, 2004). All over the world, increasingly innovative functional solutions for cadastral systems are being developed, such as Global Spatial Data Infrastructure (GSDI), Cadastre 2014, the Land Administration System (LAS), CCDM/LADM, Cadastre 2012, Cadastre 2034, Cadastre Inspired, Cadastre 2.0, Cadastre 3D and Fit-for-Purpose Land Administration (Dawidowicz and Źróbek 2018). Contemporary LAS are not only limited to legal or fiscal functions, but they form an integral part of spatial data infrastructures (SDI), enabling evidence-

based decision-making in different policy issues (Dawidowicz et al. 2020). However, the implementation of new standards requires data that is complete, reliable and error-free, as well as accurate.

Currently, the land and buildings register in Poland contains data on registered plots, buildings and premises, as well as information on owners and their respective shares, or on independent possessors. In addition, the following are recorded: a description of the ownership or possession rights of owners or independent possessors, the dates of acquisition of ownership rights, information on the documents forming the basis for the description of ownership or possession rights, and the addresses of permanent residence or registered offices of owners or independent possessors. The Polish register also includes data on perpetual usufructuaries of land, organisational units managing or exercising permanent management of real estate, state legal entities to which the State Treasury has entrusted the exercise of ownership rights or other rights in rem in respect of its real estate, public administration bodies managing real estate forming part of the State Treasury's real estate portfolio, as well as municipal, county and provincial property resources, and users of state and local government land (Mika 2018).

Errors in the land register have various sources and causes. The large volume of data in the land and building registers concerning land and its owners means that errors and inaccuracies of various kinds are apparent, ranging from errors in basic data to less harmful clerical mistakes. The process of establishing the land register in the 1960s and 1970s was also significant, as was the subsequent transition from analogue to digital formats, the vectorisation of maps and the loss of accuracy (Siejka et al. 2016). During the various periods when basic data was entered into the registers, inconsistent standards of accuracy applied, as did those concerning the scope of the data recorded. Another issue is the updating of cadastral data as a result of changes occurring in the physical environment, including changes in land use, or changes concerning property owners, such as their addresses. Identifying errors can be difficult, sometimes impossible, whilst the consequences can have a significant impact on activities related to property management using cadastral data.

The main objective of this study is to analyse the occurrence, typology and impacts of errors in land administration systems, with particular emphasis on cadastral records. In particular, the study identified types of cadastral errors (legal, spatial, technical, institutional) and assessed the causes of these errors, based on an analysis of cadastral records for selected properties in the Kraków County in southern Poland.

METHODOLOGY

This study adopts qualitative and comparative analysis, as well as case study assessment. The research is based primarily on a systematic literature review, focusing on land administration systems and cadastral data quality.

Errors in land register data and maps were classified into four main categories:

1. legal errors (ownership inconsistencies)
2. spatial errors (boundary inaccuracies)
3. technical errors (data processing issues, typos or missing data)
4. institutional errors (administrative inefficiencies).

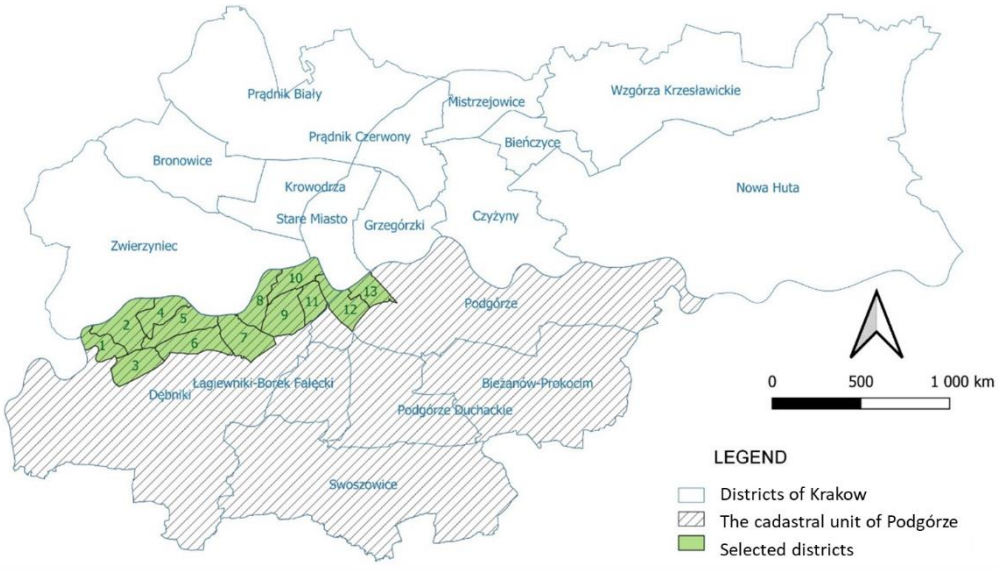


Figure 1. Location of the research area in Krakow. Source: own study.

The research material sourced from the Kraków County Geodetic and Cartographic Documentation Centre for the year 2024 included, amongst other things, changes to the cadastral registers made in precincts 3, 4, 10 and 11 of the Podgórze cadastral unit in Krakow, as recorded in the registers of changes (fig. 1).

The analysis focused on changes to land parcel records, on the basis of which instances of discrepancies between the actual situation and the information contained in the national geodetic and cartographic database were identified and described. The analysis of individual cases was carried out according to a standardised research procedure, comprising the stages shown in the figure 2.

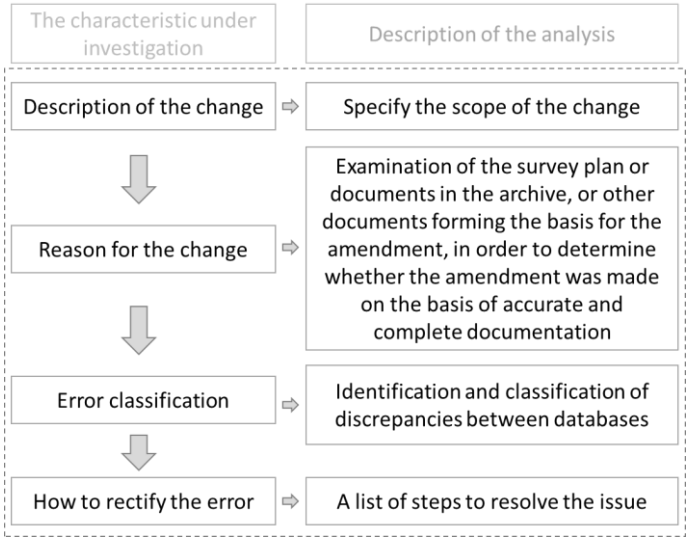


Figure 2. Flowchart for analysing errors in accounting records. Source: own study.

The procedure described enabled an assessment of the accuracy and consistency of the data held in the land and buildings registers, as well as the identification of any discrepancies between the actual situation, the surveying documentation and the records in the register database. The classification of errors forms the basis for the systematic removal of various types of errors, which is a prerequisite for improving the functioning of the land register, as well as enhancing the reliability of the information it contains.

During the analysis of registers and cadastral maps, particular attention was paid to the general characteristics and nature of the changes made to the land register concerning properties. A preliminary analysis of the materials enabled the identification of cases that stood out due to specific characteristics. On the basis of these observations, selected cases requiring more detailed analysis were identified. In the next stage of the research, an in-depth examination of documents relating to the identified changes was carried out. The analysis covered, in particular, technical reports, documents forming the basis for updating the cadastral data, as well as information regarding the date of acceptance of the documentation into the archive and the moment when the changes were entered into the cadastral database. The aim of this in-depth analysis was to reconstruct in detail the process of introducing changes to the registers maintained in the IT system, to assess the consistency and accuracy of the collected documentation, and to identify the causes of any discrepancies between the actual state, the surveying documentation and the records in the cadastral database.

The method for identifying an error in the records involves locating the type of change—such as ‘correction’, ‘amendment’ or ‘deletion’—which relates to errors in the registers. In some cases, changes are linked to other change numbers. The type of error depends on the circumstances in which it arose, and it can be determined after carefully reviewing the type and description of the change and the documents attached to the register of changes, on the basis of which the history of changes can be traced. The documentation attached to the register of changes can be divided into three parts. The first part contains the documents initiating the case, which may be, for example, an application for the registration of a change in the land and buildings register by a natural person, or a letter sent by an authority or institution, including a document from the land registry department. The second part concerns those documents which the authority maintaining the register used to verify the error, or received as an attachment to the application, and on the basis of which it can unambiguously determine the content of the change. The final, third part contains the notification of changes and a document illustrating the status before and after the change. An exception to this set of documents is a situation where the change was introduced as part of a material and technical procedure, based on a technical report submitted by the surveyor to the geodetic and cartographic documentation centre. In such cases, a report is generated from the spatial information system, containing information on the database, category, group and data code to which the change relates.

The type of error is identified by quoting the description of the change from the change log, after verifying that the change relates to an error in the land registry records.

RESULTS AND DISCUSSION

In the Polish land registration system, the registration data relating to a registered plot of land include, in particular: the plot identification number, a numerical description of the boundaries together with details of boundary points, the registered area together with the areas of land use and soil quality classes within the plot, the designation of documents confirming ownership, the number of the land and mortgage register kept for the property, the designation of documents specifying rights to the registered plot other than ownership, the address, if specified, as well as the designation of the land registration unit to which the registered plot belongs. For the purposes of the land and buildings register, a land registration unit has been defined, comprising registered plots situated within the boundaries of a single cadastral district and subject to identical rights and corresponding shares. The area of a cadastral parcel, however, is calculated on the basis of the coordinates of boundary points, taking into account the mapping correction value, and is expressed in hectares with a precision of 0.0001 ha. For cadastral parcels for which the area has not been calculated to an accuracy of 0.0001 ha since the establishment of the cadastre, it is permissible to state the area to an accuracy of 0.01 ha.

Of the four main classified types of errors—namely legal, spatial, technical and institutional errors—a detailed analysis of the cadastral records reveals that the majority concerned legal errors, including ownership inconsistencies. These most frequently arose when establishing cadastral registers and describe land ownership inconsistently with the existing situation, or arose, for example, through the merging of land parcels, as recorded in the historical cadastre, into a single cadastral plot.

Incorrect entries may also arise from errors resulting from the failure to reflect the actual situation in the land and buildings register, due to a failure to comply with the obligation to report construction works or to carry out a post-construction survey of buildings, which results in the creation of a new land use category.

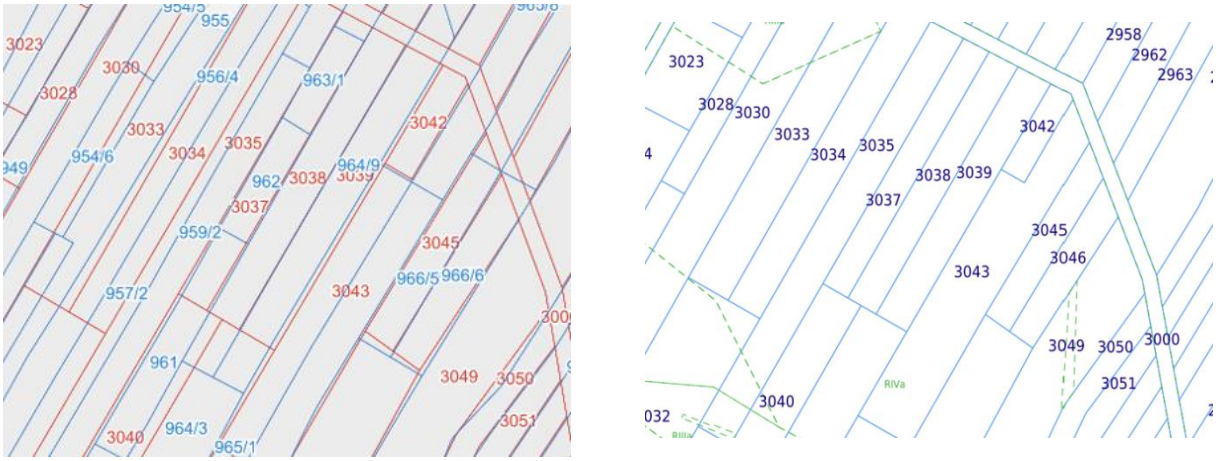


Figure 3. An example of an extract from the cadastral map showing the situation before land consolidation (blue) and after consolidation (red) in the municipality of Jerzmanowice-Przeginia, with visible differences in the course of the boundary lines on maps. Source: the municipality's spatial information system.

Over time, due to factors such as natural forest succession or the occupation of land adjacent to flowing water, a change in land use occurs, which, in the absence of an update to the register, means that the data on land use in the register does not correspond to the actual situation, and this applies to both the data in the descriptive registers and on the cadastral maps. Errors of this kind result in difficulties in the legal transfer of property, including, amongst other things, additional costs associated with the need to make corrections to the cadastral registers, sometimes preceded by the determination of boundary points and lines or the determination of the shoreline (Stańczuk-Gałwiaczek 2018). Errors of this type may also result in boundary disputes and difficulties associated with carrying out investment projects. The issue of errors arising from clerical mistakes is discussed in the article by Bacior and Wróbel (2017). The authors pointed out that such discrepancies may affect the formal and legal procedures associated with property management.

Errors relating to land under water stem from the provisions of the Water Law, which states that, pursuant to Article 212(2) of the Water Law (Act from 2017) Polish Waters exercises ownership rights in respect of properties owned by the State Treasury, situated within a cadastral plot which also encompasses inland flowing waters owned by the State Treasury. Changes to the boundaries of watercourses result in changes to the boundaries of cadastral parcels. The

registration of new rights in the land registers and land and mortgage registers requires a decision confirming the transfer of ownership, issued by the district administrator at the request of Polish Waters. Changes in the use of river valleys are an anthropogenic factor causing a shift in the course of the main river channel (Nawieśniak et al. 2014), and consequently, the riverbank boundaries recorded in the land register quickly become outdated. This is reflected in the difficulties in trading such property and in the use of the plot, e.g. for investment purposes.

Another category of errors, which might be termed spatial data errors and which relate to inaccuracies in the course of boundaries, are primarily evident on cadastral maps. It can also be assumed that all boundary lines and points that have not been legally established are subject to errors. There are numerous instances of technical errors, such as those arising from data processing issues, clerical errors or data omissions. These include, for example, errors resulting from clerical mistakes, incorrectly specified land classes, and other errors arising from the incorrect entry of data from well-prepared documentation, including, for example, field sketches.

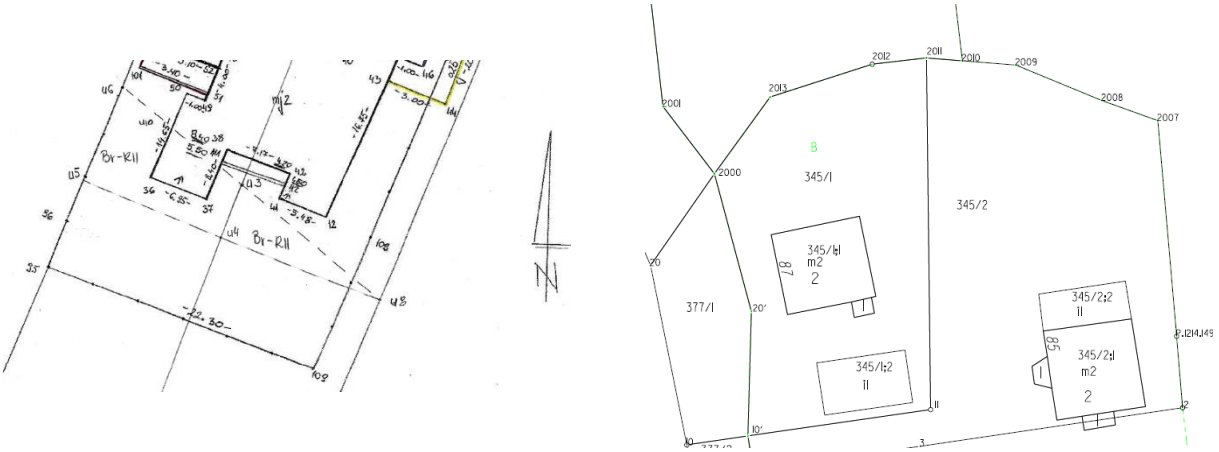


Figure 4. Examples of field sketches used to record changes in the land register. Source: documentation from the District Centre for Geodetic and Cartographic Documentation in Krakow.

The category of formal errors, also known as institutional errors, comprises errors arising from a failure to fulfil legal obligations or from the incorrect implementation of court rulings. Occasionally, erroneous entries may involve several types of errors in a single case, such as discrepancies in the area of a cadastral unit between the descriptive and graphic sections, an incorrect total of ownership or possession shares within a cadastral unit, or a difference in the area of plots or land use classes between the descriptive and graphic sections (Felcenloben 2015).

One example of errors (arising from an unclear legal situation) relating to property registration is the consolidation of mortgage parcels into a single cadastral parcel. The cause of this situation was the method of establishing the land register in the 1960s and 1970s, which involved the boundaries of cadastral parcels being adopted according to the state of possession at that time (Fedorowski 1974). As the state of possession and the state of ownership differed, cadastral parcels were often created containing combined ‘mortgage parcels’, i.e. comprising plots from the former Austrian cadastre that were owned by different entities recorded in separate land registers. Furthermore, such situations could also arise as a result of errors made when establishing the cadastral survey. Where it is necessary to regularise the legal status of a property, it is essential in such cases to ‘return’ to land parcels, i.e. the smallest units of ownership in terms of area depicted on the old Austrian cadastral maps (Bacior 2023). This procedure is known as the demarcation of a mortgage body, and it is a surveying task involving the matching of current cadastral plots from cadastral maps to parcels on the cadastral map, and on this basis, identifying the parcels that formed the new plots. In the next stage of the surveying work, the location of the parcels on the ground is identified. The conversion of land parcels into registered plots was a common practice; whilst it did alter the designation of the land, it did not change its location (Przegon et al. 2017).

It is worth highlighting the topic of spatial data quality assessment, as discussed in the literature, with particular attention to plot boundaries. This can be done, for example, by assessing the quality of cadastral plot boundaries through the analysis of selected attributes of boundary points using a three-tiered rating system. The results indicated that the quality of cadastral data is insufficient (Hanus et al. 2020a). Furthermore, the quality of cadastral data can be assessed in terms of analysing errors in the location of boundary points and their impact on the course of boundary lines (Hanus et al. 2020b). There is also a known method in which boundary quality is assessed by presenting an analytical and graphical analysis of the results and illustrating the distribution of errors (Hanus et al. 2018). The cited articles concern the same type of errors resulting from the positioning of boundary points of cadastral parcels.

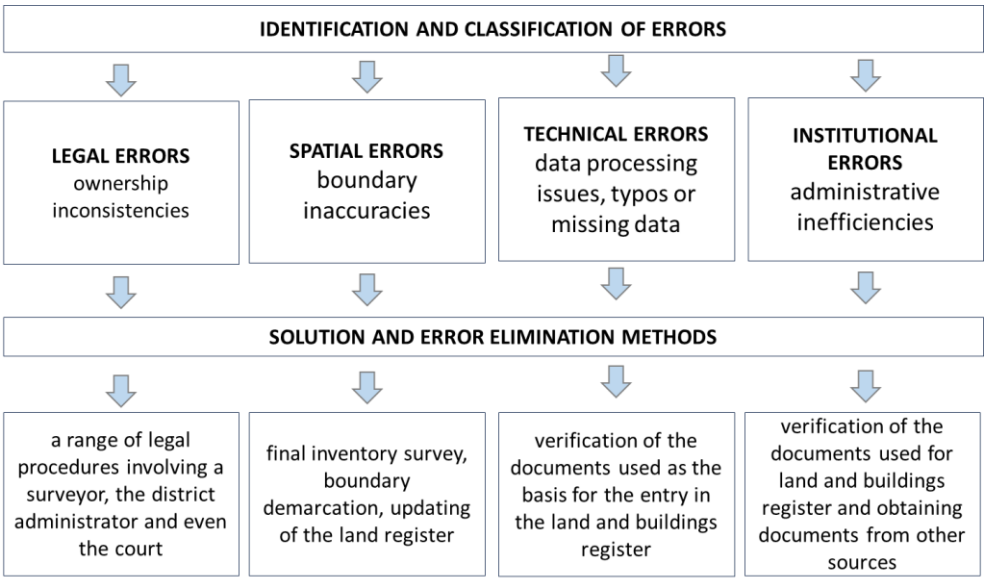


Figure 5. Flowchart for identifying errors in land register records with proposition of their solution and elimination. Source: own study.

The analyses presented by the authors are valuable for assessing cadastral data and the consequences of errors in the cadastre. They may be useful in identifying areas requiring an update of the land register. Given that the primary function of the land and buildings register is to systematically record data on registered plots, as well as on owners and occupiers, in order to enable administrative authorities to carry out their statutory duties, any errors that arise may have adverse consequences and lead to further errors and inaccuracies (fig. 5).

CONCLUSION

This study demonstrates that there are various types of errors, and that their causes vary, including historical factors, inaccurate measurements and institutional constraints. Errors can be classified into four categories: legal, administrative, technical and spatial errors. Each of these types of errors results in a decline in the reliability of the data contained in the land and building registers, which form the basis for the functioning of the tax calculation system, property management and the investment process. This highlights the importance of identifying errors in the registers and rectifying them. The methods for eliminating errors vary depending on the type of error. In some cases, it is necessary to apply an administrative procedure, preceded by evidentiary proceedings, which generates additional costs for the owners. Nevertheless, reliable, accurate and factually correct cadastral data form the basis for proper land management, the effective use of land and the implementation of investments.

REFERENCES

Bacior S. (2023). Austrian Cadastre still in use – Example proceedings to determine the legal status of land property in southern Poland, Land Use Policy 131, 106740, https://doi.org/10.1016/j.landusepol.2023.106740.

Bacior S., Wróbel J. (2017). Impact of the mistakes in the land and buildings registry on real estate transactions. Geomatics, Landmanagement and Landscape, 3, 21-33.

Dawidowicz A., Źróbek R. (2018). A methodological evaluation of the Polish cadastral system based on the global cadastral model, Land Use Policy 73, 59-72. https://doi.org/10.1016/j.landusepol.2018.01.037

Dawidowicz, A., Zysk, E. and Źróbek, R. (2020). A Methodological Evaluation of the Polish Land Administration System Using the Fit-For-Purpose Approach, *Geomatics and Environmental Engineering*, 14(2), 31–47. https://doi.org/10.7494/geom.2020.14.2.31.

Fedorowski W. (1974). Land register. PPWK, Warszawa, 311 pages

Felcenloben D. (2015). An assessment of the quality of cadastral data and the effectiveness of the land registry system. Wrocław: Wrocław University of Environmental and Life Sciences Publishing House.

Hanus P., Pęska-Siwik A., Benduch P., Szewczyk R. (2020)a. Comprehensive assessment of the quality of spatial data in records. Measurement, 158, 107665, 1-10.

Hanus P., Benduch P., Pęska-Siwik A., Szewczyk R. (2020)b. Three-stage assessment of parcel area quality. Area, 53(1), DOI:10.1111/area.12619 1-14.

Hanus P., Pęska-Siwik A., Szewczyk R. (2018). Spatial analysis of the accuracy of the cadastral parcel boundaries. Computers and Electronics in Agriculture, 144, 9-15.

Mika M. (2018). An analysis of possibilities for the establishment of a multipurpose and multidimensional cadastre in Poland, Land Use Policy 77, 446-453. https://doi.org/10.1016/j.landusepol.2018.05.060

Przegon, W., Bacior, S., Sobolewska–Mikulska, K. (2017). Cartographic analysis of transformations of the spatial structure of lands of Podgórze in Krakow in Poland in the period of 1847–2016. *Geodetski vestnik* 61. 278-292. https://doi.org/10.15292/geodetski-vestnik.2017.02.278-292.

Siejka M., Ślusarski M., Mika M., Leń P. (2016). Modernisation of the land and buildings register in accordance with current legislation. Infrastructure and ecology in rural areas, II (1), 363-373.

Stańczuk-Gałwiaczek M. (2018). Analysis of discrepancies between land use class designations and the conceptual data model specification for the land and buildings register. Rural Infrastructure and Ecology, III (1), 829-842.

Uşak, B., Çağdaş, V., & Kara, A. (2024). Current Cadastral Trends—A Literature Review of the Last Decade. Land, 13(12), 2100. https://doi.org/10.3390/land13122100

Williamson, I., Enemark, S., Wallace, J. and Rajabifard, A. (2010). *Land Administration for Sustainable Development*. ESRI Press Academic, Redlands California.

Zevenbergen, J. (2002). Systems of Land Registration - Aspects and Effects, Publications on Geodesy 51 (ISBN 90 6132 277 4), Delft: NCG, Netherlands Geodetic Commission.

Zevenbergen J. (2004). A system approach to land registration and cadastre. Nordic Journal of Surveying and Real Estate Research 1, 11-24.

BIOGRAPHY



Stanisław Bacior is an Associate Professor at the University of Agriculture in Krakow, Faculty of Environmental Engineering and Land Surveying, Department of Land Surveying, Cadastre and Photogrammetry. He is a surveyor, a member of the Association of Polish Surveyors, a member of the Polish Academy of Sciences in the Engineering and Technical Sciences Section, a court-appointed expert in the field of surveying, a member of the Polish Accreditation Committee, and a member of the committee responsible for granting licences in surveying and cartography. He is the author of numerous academic publications in the fields of surveying, land and building registration, property divisions and demarcations, and documentation for legal purposes.



Bożena Chmielowska is a PhD student at the University of Agriculture in Krakow. In her research, she focuses on identifying tools that can automate the process of identifying, classifying and rectifying errors in the land register, with particular emphasis on the technical and administrative aspects of maintaining the land register. Furthermore, she is interested in issues relating to the establishment of land easements. She is also a representative of the doctoral students' council in the discipline of civil engineering, surveying and transport.