

The proposal to extend the Polish cadastral model towards rational land management

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ABSTRACT

Land use research is a crucial aspect of sustainable land management. The study aims to introduce a new land use class into the Polish cadastral model, based on land use registration systems in other European countries. The proposed addition of a new land use class aims to link the tax system with land and building records, facilitating the identification of taxable land. It has been proposed to extend the UML application schema with an additional class of land use and land cover objects, namely the Area of Special Functional Character. The proposed new land use class could be a very promising solution for unambiguously identifying areas with special functional character. Unambiguous identification of land classification into specific land use classes is essential for sustainable land management, as it enables better planning and resource allocation. The study results can serve as practical guidance for local authorities responsible for land administration and property taxation. Furthermore, they could constitute the first step towards developing a multifunctional real estate cadastre that incorporates the tax system.

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1. INTRODUCTION

Understanding changes in land use over time and space is crucial to supporting international debates on the development of urbanization. Changes in land use and urbanization, including urban sprawl, influence the amount of tax benefits that are based on land use. Factors influencing changes in land use may include income from real estate, which has a direct impact on the investment potential of certain areas. Effective implementation of activities that enable rational space management requires the use of appropriate land use classification [Karabin-Zych, 2021, Matuk, 2021]. The scope of registration and application of land use data is a crucial element of space management and it directly translates into fiscal aspects in the form of taxes. The tax system in Poland is based on data contained in the real estate cadastre, which is a public register. Taxation is also related to the possession and use of developed and undeveloped real estate for specific purposes. The amount of taxes charged depends on entries regarding land use [Act 1991]. Records in the real estate cadastre are crucial for determining tax liabilities.

It should be emphasized that the primary source of information on land use and land cover is the cadastre. This register collects information about land. The primary role of the cadastre is to record, update, and share data, including data on land use. Changes to legal regulations concerning the real estate cadastre in Poland have affected the detailed land use registration. [Matuk, 2023] Among other things, changes have been introduced to the designations of individual land uses on cadastral maps, hindering further harmonization of Polish resources with the INSPIRE (Spatial Information Infrastructure in Europe) data specifications [Stańczuk-Gawniczek, 2018]. The reliability and usefulness of cadastral data is influenced by the way land and building registers are maintained. [Noszczyk, Hernik, 2017] Ongoing, continuous updating of cadastral data guarantees their high usefulness. A passive approach causes delays in data updating and therefore leads to a lack of reliability.

The problem of developing a globally applicable land use classification system has been addressed in numerous studies. The concept for future database development proposed by Jansen and Di Gregorio was based on the use of standardized classifications as a reference base, and its primary goal was to facilitate the comparison of land cover data on a uniform basis. The authors envisioned that this would make the data accessible to users and allow for broad application. Letourneau, Verburg, and Stehfest-Elke proposed a new method for land use classification and modeling using a classification based on land use systems (LUS) and land use models on a global scale. Furthermore, Jansen and Di Gregorio also proposed a land use classification method that combined land function, by grouping all land used for similar economic purposes.

A land classification system based on uniform land use definitions would represent the next step in research on global environmental and economic change. The main factor contributing to environmental change and the proper implementation of land use-dependent fiscal policy is the temporal variability of land use. The connections between land use and global change are still the subject of numerous studies and have not yet been sufficiently understood, which is partly due to the lack of uniformity in the semantic description of land use and land cover across neighboring countries.

Research aimed at organizing and harmonizing the various components of space and the functions they perform links directly to definitions detailing individual land use and land cover methods. This system forms the backbone of real estate management [Mika, 2020].

This article presents the land use registration systems used in Germany. The extent to which the semantic descriptions of land use within them are consistent with each other was examined. For this purpose, land use classes and classifiers defining individual land use methods were distinguished. The study made it possible to propose an extension of the Polish cadastral system by adding a new class of land use, taking into account land use classifiers and land use methods used in other countries.

This article addresses the question of whether, based on an analysis of information on land use registration methods in other countries, it is possible to propose a new land use class with a specific functional nature.

2. MATERIALS AND METHODS

The study covered topics related to land use in two European countries: Germany and Poland. The study examined existing legal acts in Poland [Regulation 2021, Regulation 2023, Regulation 2024] and in Germany (Brandenburg) [Act 2009, Regulation 2019, Regulation 2024].

In Poland, land use registration and its scope are regulated by legal acts. The country has implemented a land register called the land and building register, for which the district heads are responsible. Cadastral data for land includes the plot number, area, type of land use, valuation class, and the number of the document used to disclose data in the real estate cadastre and on the cadastral map. Furthermore, data characterizing property owners were also included. In Poland, there are five basic categories of land use. The basic land groups registered in Poland are: agricultural land, forest land, wooded and shrub land, built-up and urbanized land, land under water, and miscellaneous areas.

On the other hand, in Germany (Brandenburg), land use types are registered in the Official Real Estate Cadastre Information System (ALKIS). Pursuant to the provisions of the Brandenburg Land Survey Act of 27 May 2009, the real estate cadastre contains data on real estate, in particular land surveying, selected public law provisions, intended use, location, type of use, size, and characteristic topographic features. It also contains data characterizing landowners. Pursuant to the Act of 1 July 2024 on land use types and classification in the real estate cadastre

, as amended on 16 September 2024, actual land use must be documented for all plots. The basic land use groups in Germany (Brandenburg) are built-up areas, traffic areas, agricultural and forest land, and land under water.

The subject of the study was land use related to built-up and urbanized areas. The land use registration system in Poland, which applies to built-up and urbanized areas, was examined. In the German state of Brandenburg, land use related to built-up areas and traffic areas was analysed as well.

Poland's classification was used as the benchmark to which land use patterns were compared. The land use description was determined based on the adopted classifiers. The level of detail of the classification depends on the number of adopted classifiers describing land use or development methods. The adopted classifiers, and therefore the level of detail of land use registration, stem from the legal regulations in force in the studied countries. The basic classifications distinguished for land use classes in Poland are presented in Table 1.

Table 1. Basic classifiers for land use classification

Title 1	Title 2	Title 3
1	Residential Areas	<ul style="list-style-type: none"> — Land not classified as agricultural — Land occupied by residential buildings — Land occupied by buildings functionally related to residential buildings — Land between buildings functionally related to residential buildings
2	Industrial Areas	<ul style="list-style-type: none"> — Land built up with industrial buildings — Land built up with warehouse buildings — Land built up with buildings functionally related to industrial buildings — Land built up with buildings functionally related to warehouses — Land between buildings functionally related to industrial or warehouse buildings — Land occupied by transport and repair bases

		<ul style="list-style-type: none"> — Transformer stations — Above-ground pipelines, collectors, and water supply systems — Heaps — Landfills — Water intakes
3	Other Built-up Areas	<ul style="list-style-type: none"> — Land occupied by buildings other than residential — Land occupied by buildings other than industrial — Land occupied by buildings other than warehouses — Structures or facilities related to buildings other than residential, industrial, or warehouse buildings — Land located between buildings, structures, and facilities — Land occupied by active cemeteries — Land occupied by inactive cemeteries — Animal burial sites
4	Urbanized Unbuilt or Under-construction Areas	<ul style="list-style-type: none"> — Land where construction has started but not been completed — Land excluded from agricultural or forestry production — When determining the contours of urbanized unbuilt or under-construction areas, the provisions of the decision excluding the land from agricultural or forestry production are considered
5	Recreational and Leisure Areas	<ul style="list-style-type: none"> — Land of holiday resorts — Children's playgrounds — Beaches

		<ul style="list-style-type: none"> — Landscaped parks — Squares — Green areas outside street lanes — Historic areas such as castle ruins, strongholds, burial mounds, or natural monuments — Sports areas such as stadiums, sports fields, ski jumps, toboggan runs, shooting ranges, swimming areas, or golf courses — Entertainment areas such as amusement parks, funfairs — Zoos — Botanical gardens — Uncultivated green areas not classified as forests or afforested and shrubby lands — Family allotment gardens
6	Mining Areas	<ul style="list-style-type: none"> — Land occupied by active open-pit mines where mineral extraction occurs — Excavations after mineral extraction — Sinkholes and land affected by mining activity
7	Roads	<ul style="list-style-type: none"> — Land under the road corridors of public and internal roads
8	Railway Areas	<ul style="list-style-type: none"> — Land occupied by structures and other facilities intended for the operation and service of railway traffic, transport of people or goods, or maintenance: railway lines, sidings with infrastructure as part of them, stations, ramps, warehouses, etc.
9	Other Transport Areas	<ul style="list-style-type: none"> — Airports — Structures and facilities serving air transport

		<ul style="list-style-type: none"> — Harbour facilities, harbours, structures, and facilities serving water transport — Structures and facilities for cable railways — Tramway tracks outside street and road lanes, as well as objects and facilities related to urban transport — Organized parking lots outside state forests, bus stations — Water protection embankments adapted for vehicular traffic
10	Land Designated for Public Roads or Railways	<ul style="list-style-type: none"> — Land owned by the State Treasury or local government units, allocated for public roads or railway lines based on administrative decisions

3. RESEARCH ON CADASTRAL REGISTER ENTRIES IN THE GERMAN LAND BRANDENBURG

In the studied land use classes, i.e. developed and undeveloped land, the definition of residential land explicitly states that the area is to be used exclusively or predominantly for residential purposes. This class is further detailed to include residential areas used for single-family housing, as well as a class in which the area constituting residential estates, i.e., multi-family housing, is recorded. Within developed and undeveloped land, residential areas are also distinguished, which include areas not included in the above land use classes.

Another land use class is industrial and commercial space, where industrial, commercial, and other commercial areas are located. This class is further detailed to include industry and trade, and is recorded as a separate class for warehouse space, understood as an area where economic goods are stored, both indoors and outdoors. Additionally, shipyards, defined as areas with buildings and other facilities intended for shipbuilding or repair, are recorded as a separate land use. A separate class of land use is commerce and services, defined as areas dominated by buildings in which commercial and/or service activities are conducted.

This class is further specified to include areas closely related to commerce, exhibitions and fairs, and horticulture.

A separate class in the German state of Brandenburg is public utility facilities, defined as areas primarily containing facilities and buildings used to supply the general public with electricity,

heat, and water. This class is further specified to include six classes of facilities related to energy and water supply.

Furthermore, land uses are registered for areas containing facilities for the extraction of raw materials and energy sources. This class is further divided into two classes: areas containing facilities for the extraction of crude oil, a liquid and flammable mixture of hydrocarbons, and a class referring to the areas containing facilities for the extraction of natural gas, a flammable natural gas found in the Earth's crust. In Germany, there is also a separate waterworks class, defined as an area with buildings and other facilities used for the extraction and/or treatment of (drinking) water. The power plant class is defined as an area with buildings and other facilities used for electricity generation. This class is further subdivided into six classes related to different types of power plants. German law also distinguishes, a separate utility substation class, encompassing areas with facilities and other facilities used for converting electricity to different voltage levels. Moreover, refinery and heating plant classes are distinguished. The heating plant class is further subdivided into 4 classes.

The next class is land used for waste disposal. These areas primarily include facilities and buildings used for recycling, sewage, and solid waste disposal. This registration is further detailed to include sewage treatment plant areas and waste processing facilities.

In Germany, a separate class is also established for commercial and industrial parking lots. Furthermore, spoil heaps, i.e., areas where material is stored for extended periods, are also registered.

Another class of land uses includes areas used for the extraction of mineral material from underground and areas where mining operations have been discontinued.

In Germany, there is a very extensive registration system for areas associated with open-pit mines, which relates to areas where soil material is extracted. Open-pit mines are registered separately depending on the type of mined material. The classes "open-pit mine," "pit," and "quarry," include as many as 22 different types of areas registered in this land use class. The classification based on the type of ore mined is related to the country's geographical location and its natural resources. In Germany, areas of a specific functional nature are recorded as a separate class.

In Germany, a separate class is also registered for areas of a special functional nature. This class is further detailed into 12 categories of facilities, such as:

- An area of special functional nature, including "open" development in terms of how individual buildings are used in this area.
- Special usage area, where building development exceeds 50% of the (surface of the) plot.
- Public tasks and community purposes.

- Administration.
- Education and scientific research.
- Culture.
- Religious institutions.
- Health, spa.
- Community, referring to an area mainly containing social buildings such as kindergartens, youth and senior centres, shelters, and facilities for the homeless.
- Security and order.
- Areas containing publishing houses, radio, film studios, television, and areas used for communication.
- Historical complex.

A separate class is designated as areas of a specific functional nature, which refer to land not included in the above classes.

Another class of land registered in Germany are sports, leisure, and recreation areas, which are associated with both built-up and undeveloped areas. These areas are designated for sports, leisure, or recreational activities. This class is further subdivided into sports facilities, which are areas containing buildings and facilities intended for (competitive) sports and spectator sports. The sports facilities class is further subdivided into golf courses, which are associated with buildings and facilities used for playing golf.

Another class includes recreational facilities, characterized as areas containing buildings and facilities designated primarily for recreational purposes or for exhibiting animals. Recreational facilities in Germany also include: safari parks or wildlife parks, zoos, amusement parks, open-air theaters, open-air museums, drive-in cinemas, and open-air cinemas. Furthermore, in Germany, a separate class is registered for areas used for model flying practice.

Germany also registers a recreational area class, which includes weekend and holiday homes, swimming pools, and campsites.

The country also distinguishes a separate green area class, which refers to areas planted with trees, shrubs, lawns, flower beds, and containing paths, primarily intended for relaxation and the beautification of the urban landscape.

The green areas class includes areas designated for parks, which constitute developed green areas that perform representative and recreational functions, as well as areas designated for allotment gardens, which constitute a group of garden plots managed and leased by associations serving primarily recreational and leisure purposes. A separate class is designated for sports, leisure, and recreation areas, which include areas not included in the above classes. Areas designated for cemeteries, which constitute the place where the deceased were or are buried, are also identified, unless it would be more appropriate to classify the area as green space. In this case, a separate class of cemeteries is also identified, which will record areas not classified as cemeteries despite their intended use.

Another land use class registered in Germany is traffic areas, which are further detailed by road traffic use. It includes all built-up and unbuilt areas that are necessary for road construction and used for road traffic. Furthermore, Germany also registers the road traffic area class, which is land not being part of the roadway but accompanying road traffic, and the path land use class, which is an area intended for driving and/or walking, including drainage ditches, paths, and verges. Areas designated for squares, which constitute traffic areas in cities, or flat, paved or unpaved areas that serve specific purposes, such as for road traffic, markets, or events, are also identified. The class of areas designated for squares is further refined by the class of areas constituting a pedestrian zone, which constitutes an area designated for pedestrian traffic where, public transport, delivery vehicles, or bicycles may be permitted but only as an exception. There is also a separate class of parking space, which includes areas designated for temporary parking of vehicles, a class of rest area, and a class of rest or truck stop area located along a road, consisting of buildings and facilities that provide accommodation and relaxation for travelers. Furthermore, there is a class of festival grounds, which constitutes areas where temporary festival events are held.

Another class includes areas designated for railway traffic, i.e. those that are necessary for railway traffic, and built-up and unbuilt areas used for railway traffic, which is refined by the class of areas accompanying railway traffic, i.e., areas that are not part of the track systems but are designated for railway traffic. A separate class is rail transport, which records areas used in this way but not included in the above classes.

In Germany, land designated for air traffic is also registered, encompassing built-up areas and associated open spaces used exclusively or primarily for air traffic. This class is further subdivided into seven classes.

A separate class is aviation-related land, which includes land used for this purpose but not included in the above classes.

Last but not least, another class is the shipping area, which includes built-up areas and associated open spaces used exclusively or primarily for shipping traffic. This class is further subdivided into harbour facilities, which include areas within the harbour that are not covered by water and are used exclusively for harbour operations, and a separate class for locks. A separate class is also designated for shipping traffic, which includes land used in a manner that is not included in previously identified land-use classes.

Mixed-use land was excluded from the study, as it encompasses areas for which the dominant purpose cannot be determined, meaning that the land's intended use cannot be clearly determined.

4. RESULTS

4.1. Results of the comparison of land use registration in Poland with land use classification system in the German federal state of Brandenburg.

A study of the level of detail in land use classification related to functioning urban areas revealed that Poland has 52 distinct land use classes, while the German federal state of Brandenburg has 126.

The study demonstrated that the level of detail of land use classification in Germany and Poland is completely different. The distinct classes and classifiers that exist in Germany are not distinguished in Poland, which does not mean, however, that these areas are not registered in Poland. They are simply included in the distinct land use classes in Poland, as shown in Table 3.

Table 3. Comparison of land use registration in Germany (State of Brandenburg) with land use classes registered in Poland

Germany	Poland
Areas of a Special Functional Nature	
Areas of a special functional nature – open space Areas of a special functional use – densely built-up space	Industrial areas, other built-up areas, miscellaneous areas
Public and community services – Other built-up areas Administration Education and research Culture Religious institutions Safety and public order	Public and community services – Other built-up areas

Health, spa services	Other built-up areas or recreational areas
Community Media and communication	Other built-up areas
Historical areas	Residential areas or other built-up areas or industrial areas or recreational areas
Area of a special functional nature – land not classified under the above categories	Miscellaneous areas

The classes:

- Area of special functional nature - open space
- Area of special functional use - densely built-up space

were excluded from the study, as their identification is not dependent on land use but rather on the invasiveness of the development and development potential.

A study of land use classes with distinct classifiers showed that, in particular, object classes identified in areas of a specific functional nature are rarely identified in land use registrations in Poland. No distinct classifications characterizing lands used in this way have been developed in Poland.

4.2. Post-position changes

Research into the classification of individual areas into specific land-use classes in Poland and Germany led to the proposal of a new land-use class in the current Polish land classification.

It is proposed to create a new land-use class, i.e., an area of special functional nature, containing buildings and/or facilities intended for:

- administration,
- education and research,
- culture,
- religious institutions,

- health,
- citizens,
- public safety and order.

It is not proposed to separate media and communication as a separate classifier, as areas used in this way would be included in the broadly defined class of areas of cultural use.

One of the conditions for classifying an area of special functional nature into the class would be the type of ownership, i.e., the land would have to be owned by the State Treasury or local government units.

Based on the analyses described in section 3, changes to the UML diagram were proposed, as shown in Figure 3. Figure 3 shows the Enumeration along with the position of changes to the provisions in EGB_OFU.

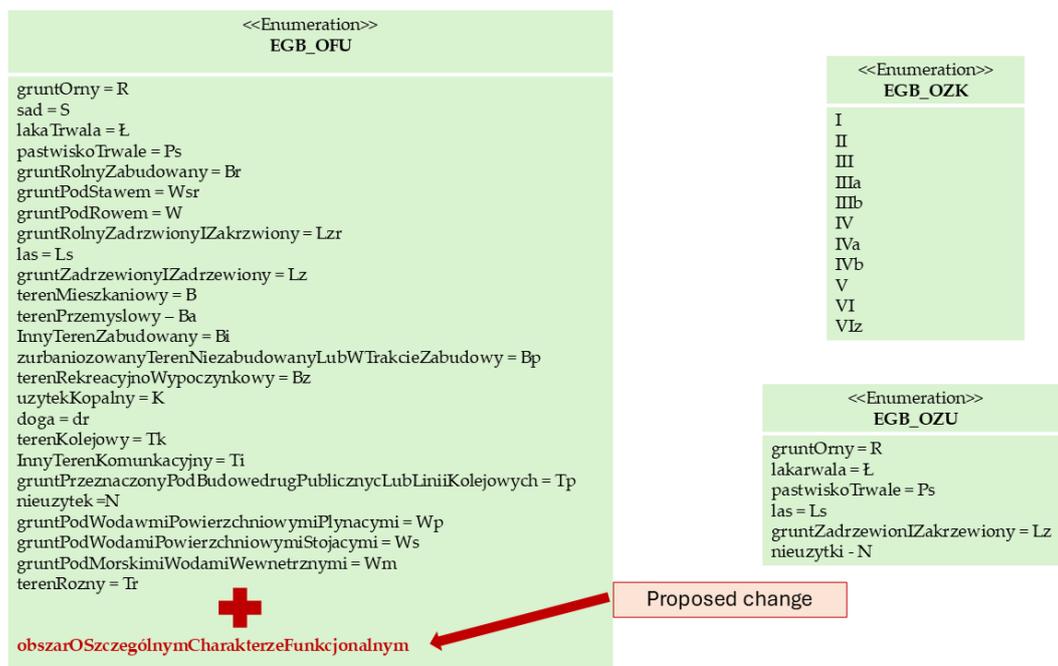


Figure 1. Enumeration – Proposal for Amendments to EGB_OFU Records

The introduction of the proposed changes regarding the registration of a new land use class would represent the first step in identifying land designated by legal regulations for exemption from property tax.

5. Conclusions

This article is an original extension of the Polish land use classification in the cadastre.

A proposed extension of the UML application schema to include an additional class of land use and land cover objects, i.e., areas of special functional nature. The proposed new land use class is the result of research on land use registration in the German state of Brandenburg. It is worth emphasizing that land use in the cadastre is subject to ongoing updates, including through geodetic works performed directly in the field, which ensures its reliability and validity. The proposed changes to the registration of land use in the land and building register may constitute the first stage of work on changing the method and identification of poorly identified land in the real estate cadastre, which is exempt from property taxes. Future research directions will focus on identifying classifiers that characterize distinct classes in the proposed new land use class, i.e., areas of special functional nature.

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Conceptualization and methodology, O.M.; validation, O.M.; formal analysis, O.M.; investigation O.M.; resources, O.M.; writing—original draft preparation, O.M.; writing—review and editing, O.M.; visualization, O.M.; supervision, O.M.; project administration, O.M.; funding acquisition, O.M. Authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest:

The authors declare no conflict of interest

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