INFRASTRUKTURA I EKOLOGIA TERENÓW WIEJSKICH
INFRASTRUCTURE AND ECOLOGY OF RURAL AREAS

No IV/1/2017, POLISH ACADEMY OF SCIENCES, Cracow Branch, pp. 1483–1491
Commission of Technical Rural Infrastructure

DOI: http://dx.medra.org/10.14597/infraeco.2017.4.1.113

SELECTED ASPECTS OF CREATION OF A MULTI-DIMENSIONAL CADASTRE IN POLAND

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Abstract

Considerations on the needs and opportunities of introducing multidimensional cadastre have been carried out for several years all over the world, including Poland. The European Union provides the Member States with a legal framework in the form of a standard governing the development of widely understood land administration systems. The cadastre as a source of information about the lands and their owners must first of all enable the proper management of the land. The basic aspect that we encounter in the discussion on the cadastre is the identification of the land parcel and the rights in rem of particular subjects. Registration of rights in the layer system is the core of a multi-dimensional cadastre. Harmonization of all regulations affecting the functioning of the cadastre will be a basic condition of a 3D cadastral parcel definition and creation of a multidimensional cadastre in Poland. The paper proposes a layer system of cadastral parcels, which derives from the current definition of parcel, taking into account the ownership of a traditional parcel along with the space above and below the ground and its constituent parts.

Key words: cadastre 3D, property 3D, multi-dimensional cadastre

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INTRODUCTION

The modern cadastre should be a multi-tasking system and cover broadly understood real estate, environmental and social issues. However, this is a future task. Land administration and cadastral systems should be intended to be used for registration the rights of people to the land and for communication of this information to the society. The need to create a cadastre and, above all, multi-dimensional cadastre is motivated by growing construction technology, and increasingly modern infrastructure. The constructed buildings often extend below the surface of the earth, and above the surface form irregular shapes (Śliwiński 2012). The real estate cadastre itself is subject to changes as it performs various functions depending on changing customers' needs. This may mean registering new object types or new features related to existing objects.

The cadastre organization depends on the laws in force in the country concerned, on the possibility of adapting them to the needs of the newly created system. It is appropriate to take into account the needs of users, as well as the technical capabilities of running the database and completing data in it.

The aim of the paper is to present selected aspects of introducing and operating a multidimensional cadastre in Poland paying attention to the basic aspect, which is the cadastral parcel in 3D space.

LEGAL FRAMEWORK OF THE MULTI-DIMENSIONAL CADASTRE

The international forum has been discussing the subject of multi-dimensional cadastre for many years, but in no country it is fully operational yet. In order to talk about the introduction of a 3D cadastre, it is first necessary to adjust the legal framework to its needs. Cadastral systems in countries around the world are quite diverse, that is why it is not possible to introduce a single cadastre on a global or international scale. However, some steps in this direction have been taken in the European Union. At present, there are two international regulations in the EU countries that are the basis for the creation of a 3D cadastre.

The first of these is the 2007 INSPIRE directive (Directive 2007), which imposes on the European Union the obligation to implement international initiatives aimed at the harmonization of services and spatial data. From the point of view of a multi-dimensional cadastre creation, it is important to define the concept of cadastral parcel. In the INSPIRE specification parcels are defined as areas, but the possibility of extending its specifications to 3D in the future has been considered. Adaptation of the directive to polish conditions is the Law on Spatial Information Infrastructure (Bieda 2015).

The second international regulation of the European Union in force is the Land Administration Domain Model (LADM) (Geographic information). De-

scriptive Standard ISO 19152 provides a reference model for the development of wide understood area management systems and it assumes the unification of vocabulary in this regard enabling consistent communication between different real estate data sources, in particular countries and between them. This standard indicates the general model of the real estate administration system, which can be expanded according to the needs and capabilities of individual countries (Bieda 2015). LADM standard introduces spatial elements such as parcel, building or elements of the infrastructure network represented in the three-dimensional space, which is important for the construction of a multi-dimensional cadastre.

THE CADASTRE IN POLAND

Currently in Poland, as stated in Geodetic and Cartographic Law the Land and Buildings Registry (EGiB) plays a role of the cadastre. Moreover, in Poland exists the Land and Mortgage Register (KW), which is the register containing information about the rights in rem of the various entities in the given property.

According to the work assumptions of the joint working group of committees 3 and 7 of the International Federation of Surveyors FIG in charge of 3D cadastre – the aspect of the created multi-dimensional cadastre will be apart from the traditional cadastre objects, also infrastructure facilities and overground, terrestrial and underground structures (3D Cadastres). In Poland, these objects are registered in the Geodetic Register of Land Utilities Network(GESUT). All these systems, however, are inconsistent and there are no links between them, enabling efficient obtaining of all information about the objects efficiently. In order to create a cadastral system functioning properly it should be possible to have a good communication between the indicated registers, and the relationships should be easily identifiable. It is therefore important to bring the GESUT database to the state of complete data recording, with the full industry registration of technical parameters and location in 3D (Bydłosz 2012).

Due to the regulations introduced in the international forum, also in Poland, the legal regulations related directly or indirectly to the real estate cadastre in the last few years undergo constant amendments taking into account technological progress in creating and maintaining databases. They are, inter alia: regulation on land and building register, regulation on GESUT district database and GESUT national database, regulation on topographic database and basic map or Geodetic and cartographic law. Harmonizing all regulations affecting the functioning of the cadastre will be a prerequisite for the creation of a multidimensional cadastre in Poland (Góźdź *et. al.* 2014). So far, however, regulations have not introduced the registration of three-dimensional elements. To make this possible, a thorough analysis is needed and the choice of the most optimal way to introduce multidimensional cadastre so that the changes were profitable at the

same time, the new system should best reflect the idea of a 3D cadastre. There are five options for implementation of cadastre (3D Cadastres):

- Minimalistic 3D Cadastre – 3D objects are available via a symbol that is a link to a document which is a source of spatial data. Infrastructure, road and railway networks are not included here.
- Topographic 3D Cadastre – spatial objects are defined by physical borders.
- Polyhedral Legal 3D Cadastre – parcels are represented by polyhedrons bordered by flat surfaces (they have a volume).It would be suitable for registration of cadastral parcels.
- Non-polyhedral Legal 3D Cadastre – similar to Polyhedral Legal 3D Cadastre, but allows other surfaces, such as cylindrical or B-Spline. It enables the extension of the buildings and structures of irregular shapes registration.
- Topological Legal 3D Cadastre – plots have volume and are topological structures based on nodes, edges, surfaces, and spatial primitives.3D cadastre objects topologically touch with neighbouring on each side. It may contain curved or straight borders.

The easiest to implement seems to be Minimalistic 3D Cadastre, however, it improves too little the functionality of the current cadastre, and its main disadvantage is not taking into account technical infrastructure, roads and rail networks. The best option seems to be Topological Legal 3D Cadastre, because it assumes the best quality description of the spatial borders, however, it is not possible to introduce it on a large-scale with current technological possibilities.

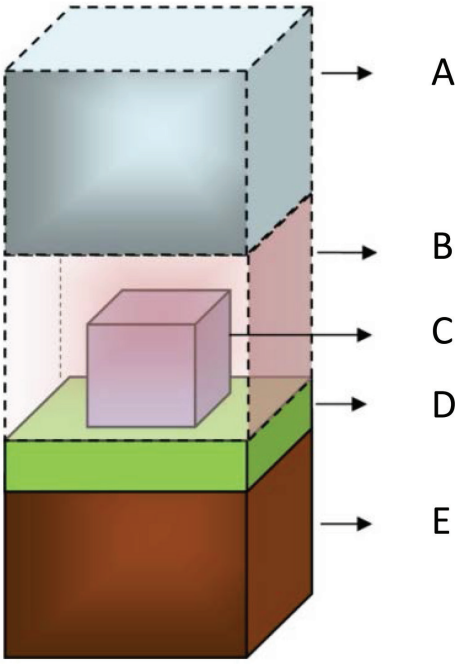
CADASTRAL PARCEL 3D

Currently the cadastral system in Poland is based on three main elements: the parcel, the person and the law, which are linked by relations. The basic pillar of the cadastre is the cadastral parcel, because we can assign to it therights in rem and subjects, to which these rights are applicable.

The construction of a multidimensional cadastre requires primarily the definition of the concept of a parcel as a spatial object. The cadastre since its inception was carried out in a two-dimensional, flat space (coordinates X, Y) and so is defined a plot: „continuous area of land (…) legally homogeneous, separated from the surroundings by means of border lines" (Regulation 2001). Moreover, the regulations in force in Poland determine that the property ownership includes not only the surface of land, but also extends to the space above and below the ground level, but, only within the limits determined by the socio-economic use of the land (Act 1965). Therefore, the provisions cited thus indicate the legal borders of the parcel as a solid.

The concept of determining the rights to a three-dimensional parcel requires the mathematical definition of spatial borders by means of coordinates (X, Y, Z). In the work of Karabin (2013) the layered layout of rights to the property as a spatial solid was proposed according to Dimopoulou and Elia (2012). The base of this solid overlaps with 2D borders, and the space is limited by two planes, which are indirectly defined in Polish law. There is no direct height or depth to which the parcel ownership right goes. But the upper limit is assumed to be the necessary plane for ensuring air traffic safety, as defined in Aviation Law, while the lower limit plane extends below the surface of the ground to the level, borders of which are determined by the provisions of geological and mining law.

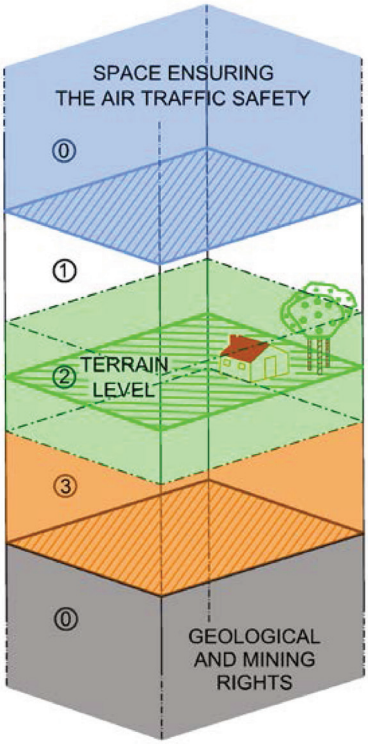
Karabin (2013) analyses the idea of layered cadastre distribution with reference to the proposals of Dimopoulou and Elia (2012), which assume 5 layers, potentially possible to be build-up by various subjects (Figure 1). The space marked A and E is determined as the property of the State Treasury or the municipality, B with buildings (C) – the ownership of a traditional parcel owner, however, in space D one or more owners are foreseen. Karabin (2013) proposes that the ownership of A-D space should be granted to the owner of the traditional parcel and that space E should not be distinguished at all.



Source: Dimopoulou, Elia (2012)

Figure 1. Distribution of 3D parcel rights

The authors partly agree with the above suggestions, but they propose a different arrangement of layers separated in space, which are potential parcels possible to extract (Figure 2). All components that cannot be disassembled without destruction or damage should be part of 3D real estate, and the right of ownership should be vested to the person to whom the 2D cadastre parcel belongs. Taking into account the components of parcel it should be noted that part of them reach under the surface of the ground (e.g. foundation). Therfore, the space of the spatial plot should extend to a certain area above and below the surface of the ground. In this connection, the separation of layers of ownership on the surface of the ground is unjustified. Figure 2 shows a schematic layout of a 3D parcel. The space marked ② shows the plot in the current meaning, however, the possibility of separating the spatial plots over ① and under ③ which can be attributed rights in rem is considered. The proposed following scheme also shows the spaces not available to the owner of the traditional parcel due to limitations imposed by Air Law and Geological and Mining Law – ⓪.



Source: own elaboration.

Figure 2. Example of distribution of the ownership rights of the real estate as a 3D spatial object; space ①, ② and ③ belongs to the owner of the cadastral parcel.

In turn the separation of space D (Figure 1) points to the important role of networks of underground infrastructure, which is separated of the components of the property, when it is a part of an enterprise. Nevertheless, the possibility of using a part of the underground parcel to some extent by the owner cannot be ignored.

Despite many advantages and increased investment opportunities, the spatial distribution of parcels has many negative consequences. The separation of the land parcel over the built-up land will prevent to some extent future change of the land use and its possible development. The creation of uniform regulations governing the issue of layered land division will require a comprehensive approach to a wide range of issues, primarily, defining a spatial parcel, analysis of the local spatial development plan, type of constructions or future investment.

The need for a coherent cadastral system is also being caused by the more and more dynamically developing connections of people with parts of the Earth surface. Property rights are often temporary or spatially limited. Hence there is the interest in the third dimension of the surface. The introduction of the cadastre is primarily related to the solution of the problem of rights in rem to 3D objects.

CONCLUSIONS

In literature more and more often the question arises as to how and when realize a multidimensional cadastre in Poland. Increasing expansion of underground and aboveground investments and facilities, which is particularly visible in urban agglomerations, requires the information on the third dimension, i.e. the Z coordinate. The current system does not fully meet its role and expectations of users very often.

Still, there is no good idea to create and implement a new cadastre system so that the changes are cost-effective and optimal for our country. The cadastre organization depends on the applicable laws and their adaptability, users' needs, as well as the technical feasibility of maintaining the database and collecting data in it.

The basis will be the introduction of the concept of cadastral parcel in 3D and the possibility of separating and consolidation of such parcels. The layer approach to the parcels proposed in the paper is an inherent part of the 3D cadastre and enables to assign rights to real estates separated in space. Figure presented by the authors in a universal way shows the scope of the proposed division of parcels in the 3D dimension. Reach of the plot remain in existing concept (the property ownership extends to the space above and below the ground level), but in limited range, it is possible to separate the spatial plots over and under the primary parcel.

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Received: 26.04.2017
Accepted: 02.10.2017