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Comparative studies on the application of 3D cadastre in Russia and other countries

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Abstract

Land relations and land management have always been the most important issues both for individual citizens and for any state in the world. The article considers the use of 3D-cadastre in various countries. The comparative analysis of the literature concerning 3D cadastre showed that the countries are at different stages of 3D-Cadastre implementation. All countries, including Russia, regulate land use issues (and their solutions) through specially created state services. Some of these countries have operational 3D cadastral systems, others have still no interest in introducing a 3D cadastral system. The review showed that each state has its own cadastral system, which was formed and modernized throughout the history and is being transformed at the moment. It is noted that no country has completely developed the three-dimensional real estate cadastre. The article reveals that further research is necessary to draft national and international research proposals and form legislative amendments towards introduction of national 3D cadastral systems and concludes by presenting a possible way forward.

Keywords: 3D Models, 3D Cadastre, Land Management, Urban Areas, Real Estate;

1. Introduction

In economically developed countries, the cadastre of land and other real estate has passed through the stages of formation and development over the past 200-400 years. In the process of developing information and telecommunication technologies, all the necessary conditions for the transition to a new stage of development and organization of spatial data management mechanisms were formed in the early 90s of the 20th century. Such a transition was facilitated by the experience gained in almost 30 years of exploration, implementation and wide use of geo-information technologies. Understanding the need for such a mechanism led to the first experiments to create spatial data infrastructures.

2. Materials and methods

Methods: theoretical and comparative analysis of the study and generalization, as well as other generally accepted analytical methods, geoinformation analysis, methods of cartographic data visualization, 3D modeling of geospatial data.

3. Discussion

From the mid-1990s to the present, national spatial data infrastructure has been established in more than 120 countries, such as America, Australia, and most European countries. At present, these states have a legally complete, institutionalized instrument for accounting and taxation, which is an essential component of the state's economic and social stability. Taking into account modern technical capabilities for collecting, processing, storing and issuing cadastre data, its increasing importance, changes occurring in the public reorganization of Russia, the practice (experience) of leading European countries, as well as the USA and Canada experience, it is advisable to develop a modern approach to the cadastre structure of Russia and the city cadastre, resolve legal issues of creating, maintaining and monitoring the cadastre.

Modern cadastral systems must meet all the existing requirements of the developing world. Increasing requirements for the quality and quantity of information about real estate, the increasing complexity of the architecture of buildings and facilities, including underground, and above-ground infrastructure and engineering services: all these phenomena are pushing the state to a logical decision on the full-scale implementation of three-dimensional cadastral systems. A three-dimensional cadastre is a cadastre model that considers the property as a closed space figure, which is defined in three-dimensional coordinates and has a fixed boundary [5].

The introduction of the three-dimensional cadastre will result in developing a highly accurate and detailed model of the property. This model will fully eliminate the major shortcomings of the system of capital construction object recording in the real estate cadastre such as:

• it is impossible to ambiguously describe and discriminate structurally complex buildings and facilities in two-dimensional view;

• it is possible to register a capital construction object based on project documentation relating to another object;

• it is possible to include only a small number of individual object characteristics.

The three-dimensional model, in turn, can serve as the basis for both the two-dimensional recording system of real estate objects and the three-dimensional one. Such a model makes it possible to obtain a wide list of spatial characteristics of an object (configuration of facilities and elements, dimensions, vertical position and plan, geometric parameters, etc.).

4. 3D-cadaster implementation in different countries

The three-dimensional cadastre has been already applied in 24 EU countries. The Netherlands state cadastre with an efficiently functioning cadastral system and a functioning real estate market stands out in particular. This cadastre is professionally maintained and is almost flawless in a theoretical and practical sense.

Individual countries are at different stages of use and implementing a 3D cadastral system; this can help to identify the main concepts of 3D real estate, which are currently being used, as well as their shortcomings and faults, which impede the implementation of 3D cadastral systems, highlighting problems that may not have been identified yet [3].

At present, many countries have introduced elements of a 3D cadaster, some have completely put it into operation (Netherlands). At the same time, there is a significant differentiation between the pace of integration of technological solutions in the field of 3D-cadastre, associated with the flexibility of legislation, differences in the conceptual apparatus, national and technical features.

Let's consider the use of a 3D-cadastre in various countries in more detail.

Netherlands

The Netherlands was one of the first who developed the multidimensional cadastral system and quite successfully managed to adapt it. This is primarily due to the fact that for quite a long time the country has been using a system in which property rights are directly related to the surface of land. As a result, owners receive restrictions on ownership of vertical space, unless otherwise provided by law or documentation.

Object records introduced into a three-dimensional cadastre are information about land plots, buildings, apartments, underground objects, registered rights, permitted use, area, cost, and other legal aspects [4].

The Netherlands successfully continues the practice of keeping three-dimensional cadastre register due to its generally recognized logic nature and consistency, and its being almost flawless in a theoretical and practical sense, despite the small territory of the country itself.

Norway

Like many countries, Norway had its own reasons for implementing the projects of three-dimensional cadaster system in the country. As early as 1995, the Committee was organized which decided to introduce a three-dimensional cadastre into the structure of the existing cadastre system to facilitate the registration of the following objects:

- objects located directly underground (parking lots, tunnels, pipelines);
- buildings and facilities erected on poles or above other real estate objects, mainly above roads and railways;
- supported structures in water.

To implement a multidimensional cadastre, the authorities of the country expanded the existing cadastral law and introduced new characteristics of the property (describing the object as being above or below the land plot). Also, the new legislation made it possible to establish the properties of 3d structures, owing to which the object can cross several borders of land plots, without leaving its own boundaries. A significant drawback of the existing system is the technical impossibility of including three-dimensional information in an existing public cadastral map. Many countries are faced with the problems of registering three-dimensional situations in the cadastre, which was originally developed for two-dimensional real estate objects.

Austria

The Austrian cadastral system was created relatively long ago. The current system was introduced in 1817 and has been applied until recently, with new information about real estate being added. Therefore, much attention is being paid to digitizing maps, spatial data of real estate objects, various projects, which will have been completed by 2024. Since this work requires a lot of effort, the creation of a 3D cadastre had to be postponed [3].

Austria realized the need to adopt 3D cadastre system in 2007.

Nowadays several types of real three-dimensional objects have been registered in the Austrian cadastre: tunnels, apartment buildings and traditional wine cellars, whose 3D representation characteristics are presented in Table 1.

Table 1. Characteristics of three-dimensional objects [3]

Name	a brief description	3D-cadastre display
Tunnels	Can be registered in the 3D cadastre	Not displayed on cadastral maps
Wine cellars	Represent a room associated with a small building, which is located "squeezing press", and then goes into the tunnel, where the wine barrels are located.	The cadastral map shows the small building and the dotted border where the tunnel begins. The actual geometry, length and depth of the tunnel are unknown.
Apartment buildings	Document, the “Parifizierungsplan”, registered in the land registry, describes the geometry of the whole construction and shows all	The cadastral map, however, does show neither the apartment structure nor the spatial distribution of use rights. Since the

	apartments and stipulates the utility value for each apartment	"Parifizierungsplan" contains all building floors, it could be used as a starting point for a 3D representation of condominium.

Summarizing all the above mentioned, it can be noted that, although, the Austrian Cadastral Service monitors international trends in the development of the digital economy, but the current budget does not allow implementing such major projects as the transition to a 3D cadastre. At the same time, the current digitizing of the archive of information about real estate objects and the conditions of the urban environment today requires considerable resources. Thus, being interested in the introduction of a 3D cadastre, Austria has to postpone application this innovative development for an indefinite period.

Poland

In Poland, the 2D cadastral system uses 2D plots to register land rights.

In accordance with the cadastral legislation, three types of cadastral objects are registered in the Polish cadastral system: land, buildings and apartments.

The 3D cadastre is not currently used in Poland, there are suggestions for improving the 3D cadastre structure from various academic centers, though [2].

Sweden

Considering the developing construction in the cities of Sweden, in particular, road junctions, underground car parks, complex buildings (shopping centers), buildings and structures above the roads and subways, Swedish legislation has been updated in accordance with the up-to-date requirements and the concept of a multi-level cadastre [1].

The three-dimensional cadastre includes information on land and water areas, buildings, underground facilities (pipelines, subway), apartments, registered rights. The main disadvantage of the existing multi-level cadastral system is the inability to cover all three-dimensional situations, since the facility in each situation can only be a constructed structure.

Russia

Currently in the Russian Federation the real estate cadastre uses two-dimensional data. The location of land plots is recorded by entering rectangular coordinates which mark the points of area border-line turning into the cadastre.

From January 1, 2013, the Federal Law dated July 24, 2007 No. 221 FZ "On the State Real Estate Cadastre" [1] provides (for) the state registration of buildings, structures, premises, and the Federal Tax Service in the State Real Estate Cadastre, which makes the research in the field of creating a three-dimensional cadastre in Russia particularly relevant.

The legislation of the Russian Federation in the field of state registration of rights to real estate and transactions with it and state cadastral registration does not contain references to 3D objects, at the same time there are no obstacles for cadastral registration and state registration of 3D land plots. The cadastre law provides a sufficient basis for development aimed at introducing a three-dimensional cadastre.

In 2010, Rosreestrom announced a project to develop a three-dimensional real estate cadastre of the Russian Federation. In April 2011, a working group was formed to implement the Russian-Dutch cooperation project "Creating a Model of a Three-Dimensional Cadastre of Real Estate Objects in Russia", the purpose of which was to create a prototype 3D cadastre, for subsequent implementation throughout the Russian Federation.

The project, which involves the Federal Service for State Registration, Cadastre and Cartography (RosReestr), the Federal Cadastral Center (FCC) Zemlya, the Agency for Cadastre, Land Registration and Cartography of the Netherlands (advanced European organization), specializing in GIS technology, the Dutch companies Grontmij Nederland, Royal Haskoning and

the Technical University of Delft [6], is also being implemented in Russia for the development of a three-dimensional real estate cadastre.

The results of the pilot project showed a positive attitude towards the application of a three-dimensional cadastre. The closer contact with customers can spur change and reveal real benefits based on the needs and positions of potential users.

The expected results are as follows: creation of a 3D cadastre model, implementation of the model in a three-dimensional environment, recommendations on legal aspects for the long-term development of a 3D cadastre in Russia.

The transition of Russia to 3D cadastral registration is inevitable, but the relevant changes are very costly and time consuming. Currently, there is a gradual transition to a three-dimensional real estate cadastre in the largest cities of Russia. The further use of modern geo-information technologies and developments will to create a three-dimensional cadastre, with one more axis - time being involved, which will follow changes in real estate objects over time.

5. Conclusion

The 3-D cadastre capabilities are of great interest for land management by state and local governments, as well as planning and controlling (the production of) many household operations (for example, construction, underground cable laying), repair works for housing and public utility services. At the present stage of land relations development innovation activities both in Russia and abroad cannot be carried out at the required pace without transformations in Real Estate Cadastre and land management. Therefore, it can be concluded that the pace of the transition to a 3D cadastre, today, depends on the characteristics of the national legal (the existing cadastral registration). Having considered data on cadastre development in the above-mentioned countries, it should be noted that there is hardly any country that has implemented the three-dimensional real estate cadastre to the full extent. It is necessary to note that the further research is required to draft national and international research proposals and form legislative amendments towards introduction of national 3D cadastral systems and present a possible way forward.

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