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LEGAL AND TECHNICAL ASPECTS OF THE INCLUSION OF THE GESUT DATABASE IN THE 3D CADASTRAL SYSTEM

Magdalena Jurkiewicz

Summary

The inclusion of information on utility networks and facilities into three-dimensional cadastres has been discussed for years. The concept of cadastre has changed its meaning from a traditional form of a legal and fiscal register to a three-dimensional multitasking system that combines data on real estate obtained from various spatial databases. This shift follows the development of construction technology and increasingly complex design of buildings and structures as well as related networks and technical equipment. Due to the increasing densification of infrastructure networks, a 2D plane representation cannot guarantee that their full management potential is reached. The lack of complete, reliable information on the location of cables, especially those underground, is causing many accidents and network damage, which have serious financial costs. Therefore, it seems appropriate to include information on the layout of the utilities infrastructure in the 3D cadastre, which would complement the relevant property data.

The paper aims to analyse Polish legislation regarding the possibility of including network objects and utilities in the 3D cadastre. In the Polish context, these objects are registered in the utilities network database (GESUT). Thus, the analysis covered the legal acts relating to the functioning of that database. In addition, the technical possibilities of converting data from the existing two-dimensional GESUT database to its 3D form were analysed on the ground of existing research studies.

Keywords

3D cadastre • utilities networks • GESUT

1. Introduction

The beginning of the 21st century has seen a development of the concept of a 3D cadastre. In 2001, Delft hosted the first workshops of the FIG working group on the basics of constructing a multidimensional cadastre. Economically developed countries gradually engaged in discussions on the shape and extent of the future system, recognising real opportunities for its development [Steudler and Williamson 2005, Benett et al. 2007, Oosterom et al. 2011, Ying 2012, Stoter et al. 2017].

Currently, the Polish cadastral system comprises the registration of land and buildings in terms of object and subject in the land and building register (EGiB). However, it does not directly contain the rights, obligations, easements, and other encumbrances on properties. These elements are the content of a land and mortgage register established for each property.

All around the world, the concepts of 3D cadastre assume the inclusion of network objects and infrastructure devices in the system. In Poland, these objects are registered in the utilities network database (GESUT). Bydłosz [2013] notes that this area is also covered by the provisions of the European standard Land Administration Domain Model [LADM].

Urban development and related modern investments, as well as reconstruction of infrastructure facilities, create a compacted network of cables and pipelines (Fig. 1). Because the various networks of this infrastructure are managed by different institutions, joint administration is becoming increasingly difficult. Individual objects of the underground infrastructure, such as wires or cables, are layered one the other. Thus, another obstacle to the effective management of networks stems from the fact that the classic, two-dimensional visualisation does not fully reflect the actual position of the cables [He et al. 2011].

Source: He et al. [2011]

Fig. 1. Visualisation of the routes of utilities network in an urbanised area

In addition, the main cause of damage to these networks during earthworks is insufficient information on the spatial distribution of the network. The lack of regulation on the 3D registration of technical network infrastructures is causing globally many accidents and collisions, with significant financial losses.

Researchers all around the globe, such as Döner et al. [2010], Pouliot and Girard [2016], Dželalija and Roić [2021], are studying the relation of utilities networks and devices to the 3D cadastre.

This paper draws attention to selected legal and technical aspects of the implementation of a 3D cadastre of utilities network database in Poland.

2. Materials and methods

The study consists of an analysis of Polish legislation, which refers to the scope of the utilities network database. It addressed the feasibility of using current legislation for a 3D representation of GESUT and its implementation in the cadastral system. The basic research material for the analysis presented here was the Civil Code Act [Act 1964], Surveying and Cartographic Law [Act 1989], and Spatial Information Infrastructure Act [Act 2010]. However, the research paid special attention to the regulation on the database of topographical objects and the base map [Regulation 2021a], as well as the regulation on the utilities network database [Regulation 2021b], which were updated in 2021. As an evaluation criterion, the definition of the physical and legal space of the GESUT object in 3D and the scope of technical capabilities of the GESUT database were determined. In addition, the usefulness of a given legal act for the inclusion of the GESUT in the 3D cadastre was assessed.

The second aspect – technical – involves identifying the tools that enable appropriate construction of cadastral databases, taking into account the GESUT database and the transfer of land utilities from traditional two-dimensional to three-dimensional registration.

3. Results

The following analysis presents the scope of the provisions, either sufficient as a whole or partly, or insufficient for inclusion of technical infrastructure data in the 3D cadastre. The results of the analysis are presented in Table 1.

The provisions of the Land Surveying and Cartography Act [Act 1989] define the general principles for maintaining the GESUT database as a spatial information infrastructure system. First and foremost, this Act indicates that the maintenance of the utilities network database is a teleinformation system. The Act on Spatial Information Infrastructure [Act 2010], transposed from the EU legislation, takes into account the current trends in the universal provisions of the INSPIRE Directive [INSPIRE]. It can be assumed that, at present, the interpretation of both acts is sufficient for incorporating the technical infrastructure database into the 3D cadastre system.

In terms of the Civil Code [Act 1964], attention should be drawn to Article 49, which stipulates that "equipment for the supply or discharge of liquids, steam, gas, electricity and similar devices do not form part of real estate if they form part of an enterprise". As interpreted in the resolution of the seven-judge panel of the Supreme Court of 8 March 2006, III CZP 105/05 [OSNC 2006], the term "form part of real estate"

means the actual connection of a device to a network. Moreover, that term does not imply that the business has a property right over the devices. In terms of 3D cadastre, the provisions of the Civil Code will require clarification in regard to the ownership of networks and technical devices.

Table 1. Analysis of legal acts in terms of their suitability for the inclusion of the GESUT database in the 3D cadastre

Category assessment / Legal act	Definition of the legal and physical space of a GESUT object in 3D and the technical capabilities of the GESUT database	Sufficient YES/NO/Partially
Civil Code (Act 1964)	• determining the affiliation of networks and devices as components of property	Partially
Land Surveying and Cartography Act (Act 1989)	• definition of the utilities network and GESUT; • scope of construction of the GESUT database; • GESUT as an element of the base map	YES
Spatial Information Infrastructure Act (Act 2010)	• rules for creating and using the spatial information infrastructure; • spatial data and metadata of the spatial information infrastructure; • interoperability of spatial databases and services	YES
Topographic Object Database and Base Map Regulation (Regulation 2021a)	• the organisation, mode, and technical standards of producing the base map; • cartographic representation of GESUT objects and networks in 2D	Partially
Regulation on the Utilities Network Database (Regulation 2021b)	• scope of data collected in GESUT, geometry, attributes; • mode and standards for creating and updating the GESUT database on the district and national level; • sharing data from both the district and the national GESUT database; • conceptual model of GESUT data	Partially

Source: Author's own study

The regulation on utilities network database [Regulation 2021b] will require the greatest changes in and clarification of regulations, including the introduction of an obligation to record in detail the elevation foundation of pipes, wires, and devices. Also, the regulation on the database of topographic objects and the base map [Regulation 2021a] currently defines the cartographic representation of network objects and technical devices, but the provisions will require further determination in terms of three-dimensional representation.

After an update in 2021, the regulation on utilities network database [Regulation 2021b] does not foresee an object representing a point at a determined height for

network objects and devices, as was in the case of the previous regulation on the GESUT of 2015 [Regulation 2015]. This seems to be an oversight, as paragraph 6 states that "each GESUT object may be associated with information determining the heights of characteristic points located on the elements of these objects". However, it was not specified what type of object should represent the information on the height of characteristic points.

Currently, the only information determining the elevation points within the cartographic signs of the base map, of which the GESUT is a part, are artificial and natural pickets. However, according to the regulation on the database of topographic objects and the base map [Regulation 2021a], these objects fall within the scope of the BDOT500 database. For this reason, it is difficult to conclude the legislator's intention to use the artificial picket objects for GESUT objects. This requires specifying under what circumstances an object that represents the ordinate foundations of pipes and cables, as well as utilities, should be introduced into the database, because such information is necessary for the inclusion of the GESUT database into the cadastral system.

Given the above, it seems reasonable to conclude that the above-mentioned legal acts are only partially useful for the 3D cadastre in terms of the inclusion of the utilities infrastructure.

Legal guidelines must correlate with the technical capabilities of processing the database from a 2D plane to a 3D space. Research on these aspects has been carried out under Polish conditions by several researchers.

Mróz et al. [2014] proved that it is possible to convert the GESUT database into a 3D form, but only through an elaborate, multi-stage data conversion diagram. It requires dividing all fragments of the network into elementary segments, which – through a topological relationship with the characteristic points of the wire axis refraction – create a representation of the GESUT database in three-dimensional space. To determine the depth of the foundation of the network points, the elevation ordinates recorded in the pickets corresponding to the network refraction points (a given depth of the wire's location and the source of its acquisition) were used. Depth values can be obtained from direct measurement, vectorisation of analogue map rasters, or archival reports. If no such data is obtained, the height attribute should be supplemented by a detector measurement, which originates in individual industry databases, or, as a last resort, the standards for the location of cables of a given type are adopted.

Lewandowicz and Kacprzak [2014] also attempted to transform the rainwater sewerage network into a three-dimensional form using CAD and GIS software. The conversion did not go fully as planned due to incomplete data on the depth of the foundation of sewerage pipes. The content of the GESUT digital map under transformation was created from the digitisation of the original maps, supplemented with industry data and the data obtained from representatives of enterprises supervising the underground infrastructure networks. In addition, the data were supplemented by field research.

In a similar study, Siejka et al. [2014] proposed a methodology for transferring data into a 3D form using a digital terrain model generated in LIDAR technology and visualisation developed in CAD software. The scope of their research covered

the entire cadastral data, such as plots, buildings, and technical infrastructure. We would like to focus on the part of the mentioned publication which addresses the utilities network.

The further stages of research focused on the 2D data on the location of pipes and cables of technical networks, which were imported and superimposed onto a generated digital terrain model. Then, the position of the wires below the terrain surface was shifted successively. Due to the incompleteness in the register, i.e. the actual ordinate positions of the cables, information from technical standards was also used.

The research shows wide possibilities for transforming existing GESUT databases into a 3D spatial form in the Polish legislative context. However, this will be possible provided that the source data is complete and consistent. The technological process of data conversion itself also allows detecting and eliminating errors within a database. Errors may stem from the conversion of data from analogue form, as well as be measurement errors or collisions of designed objects with existing objects.

4. Summary and conclusions

The integration of the GESUT network with the cadastral data is an important issue that researchers are addressing globally. So far, there is no fully functional cadastral system in Poland. However, a series of studies show the need for the implementation of such institution, also in the 3D form, and providing its multitasking capabilities.

The presented analysis of legal acts related to the GESUT database shows that in Poland it is possible to integrate the GESUT data into the 3D cadastre. Some of the provisions will require some clarification or amendment in this respect.

In technical terms, Poland is ready to bring GESUT to 3D form, thanks to the wide use and availability of GIS and CAD tools. Achieving the consistency and completeness of the existing data – so that the transformation can be carried out and the most precise data on the location of networks and facilities can be incorporated into the cadastre – seems to be the fundamental difficulty. This task poses a significant challenge for the geodetic service requiring the cooperation of many scientific and industry communities.

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References

Bennett R., Wallace J., Williamson I.P. 2007. Organising land information for sustainable land administration. Journal of Land Use Policy, 25, 126–138.

Bydłosz J. 2013. Polski system katastralny w aspekcie ISO 19152. Roczniki Geomatyki, XI, 2(59), 15–23.

Döner F., Thompson R., Stoter J., Lemmen Ch., Ploeger H., van Oosterom P., Zlatanowa S. 2010. 4D cadastres: First analysis of legal, organizational, and technical impact. With a case study on utility networks. Land Use Policy, 27, 1068–1081.

Dželalija G., Roić M. 2021. Utilities Data in Land Administration Systems. 7th International FIG 3D Cadastre Workshop 11–13 October 2021, New York, USA.

He J., Hu J., Tang Q., Guo S. 2011. Layout optimization of urban underground pipeline based on 3D digital city. Joint Int. Conf. on Theory, Data Handling and Modelling in GeoSpatial Information Science. International Society for Photogrammetry and Remote Sensing (ISPRS), 38, II, 279–283, Germany.

INSPIRE. Dyrektywa 2007/2/WE Parlamentu Europejskiego i Rady z dnia 14 marca 2007 r. ustanawiająca infrastrukturę informacji przestrzennej we Wspólnocie Europejskiej (INSPIRE). Dz. U. UE L 108/1, 25.4.2007.

LADM 2013. Informacja geograficzna – Katastralny model administrowania terenem (LADM). (Geographic information – Land Administration Domain Model) PN EN ISO 19152:2013-05E, Polski Komitet Normalizacyjny.

Lewandowicz E., Kacprzak D. 2014. Transformacja zbiorów GESUT z postaci CAD do GIS 3D. Roczniki Geomatyki, XII, 2(64), 225–230.

Mróz R., Wiśniewska A., Fijałkowska A. 2014. Przekształcenie cyfrowej mapy zasadniczej do postaci trójwymiarowej dla wizualizacji i analiz przestrzennych urządzeń podziemnych. Roczniki Geomatyki, XII, 4(66), 417–425.

Oosterom P., Stoter J., Ploeger H., Thompson R., Karki S. 2011. World-wide inventory of the status of 3D Cadastres in 2010 and expectations for 2014. FIG Working Week. Bridging the Gap between Cultures. Marrakech, Morocco, 18–22 May 2011.

OSNC 2006 nr 10, poz. 159. Uchwała składu siedmiu sędziów Sądu Najwyższego z 8 marca 2006 r. III CZP 105/05.

Pouliot J., Girard Ph. 2016. 3D Cadastre: With or Without Subsurface Utility Network? 5th International FIG 3D Cadastre Workshop, 18–20 October, Athens, Greece.

Regulation 2015. Rozporządzenie Ministra Administracji i Cyfryzacji z dnia 21 października 2015 r. w sprawie powiatowej bazy GESUT i krajowej bazy GESUT (Dz.U. 2015 poz. 1938).

Regulation 2021a. Rozporządzenie Ministra Rozwoju, Pracy i Technologii z dnia 23 lipca 2021 r. w sprawie bazy danych obiektów topograficznych oraz mapy zasadniczej (Dz.U. 2021 poz. 1385).

Regulation 2021b. Rozporządzenie Ministra Rozwoju, Pracy i Technologii z dnia 23 lipca 2021 r. w sprawie geodezyjnej ewidencji sieci uzbrojenia terenu (Dz.U. 2021 poz. 1374).

Siejka M., Ślusarski M., Zygmunt M. 2013. 3D + time Cadastre, possibility of implementation in Poland. Survey Review, 46, 335, 79–89.

Siejka M., Ślusarski M., Zygmunt M. 2014. Kataster wielowymiarowy, możliwość wdrożenia w Polsce. Infrastruktura i Ekologia Terenów Wiejskich, II/2, 557–569.

Steudler D., Williamson I.P. 2005. Evaluation of national land administration system in Switzerland. Case study based on a management model. Survey Review, 38(298), 317–330.

Stoter J., Ploeger H., Roes R., Van der Riet E., Biljecki F., Ledoux H., Kok D., Kim S. 2017. Registration of Multi-Level Property Rights in 3D in The Netherlands: Two Cases and Next Steps in Further Implementation. ISPRS Int. J. Geo-Inf., 6(6), 158.

Act 2010. Ustawa z dnia 4 marca 2010 r. o infrastrukturze informacji przestrzennej (Act of 4 March 2010 on infrastructure for spatial information) (tekst jedn. Dz. U. 2021 r. poz. 214).

Act 1989. Ustawa z dnia 17 maja 1989 r. – Prawo geodezyjne i kartograficzne (Act of 17 May 1989 – Geodetic and cartographic law) (tekst jedn. Dz. U. 2021 poz. 1990).

Act 1964. Ustawa z dnia 23 kwietnia 1964 r. – Kodeks cywilny (Act of 23 April 1964 – Civil code) (tekst jedn. Dz. U. 2020 r. poz. 1740).

Ying S., Guo R., Li L., He B. 2012. Application of 3D GIS to 3D Cadastre in Urban Environment, 3rd International Workshop on 3D Cadastres: Developments and Practices, 25-26 October 2012, Shenzhen, China.

Dr inż. Magdalena Jurkiewicz
University of Agriculture in Krakow
Department of Geodesy
30-198 Kraków, ul. Balicka 253a
e-mail: magdalena.jurkiewicz@urk.edu.pl
ORCID: 0000-0002-5380-5158