Developing the Polish Cadastral Model towards a 3D Cadastre

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Key words: 3D Cadastre, Polish Cadastral Model, LADM

SUMMARY

The Polish cadastral model was finally defined (after modifications) in 2015, within the regulation of Ministry of Administration and Digitization. According to this legal act, cadastral model comprises information on land, buildings and premises (apartments) being independent estates. These data generally concern two dimensions, whereas chosen information on third dimension for buildings and premises are included within its attributes. The concept described in the paper bases on introduction of classes defining new 3D objects into the model of Polish cadastre. Firstly, they are EGB_GeneralObject3D, EGB_CadastralParcel3D, EGB_BuildingLegalSpace3D and later EGB_RegisterUnit3D, EGB_BuildingBlockUnderground3D and EGB_BuildingBlockAboveground3D. It results in creation of five new diagrams within Polish cadastral model. As new objects (with suffix 3D added to the name) are connected with relationships with already existing ones, they become part of the whole cadastral model. The research described in the paper shows how 3D objects may be introduced into already existing model of Polish cadastre, in order to create 3D cadastral model. This method may be also used for building 3D cadastre in Poland applying solutions proposed by other authors.

STRESZCZENIE

W Polsce obecnie obowiązuje model katastru zdefiniowany (po zmianach) w 2015 roku, w rozporządzeniu Ministra Administracji i Cyfryzacji. W świetle tego rozporządzenia model ten zawiera informacje o gruntach, budynkach i lokalach będących samodzielnymi nieruchomościami. Dane te dotyczą w zasadzie dwóch wymiarów, przy czym wybrane informacje dotyczące trzeciego wymiaru dla budynków i lokali są zawarte w atrybutach tych obiektów. Koncepcja opisana w artykule polega na wprowadzeniu do polskiego modelu katastru klas definiujących nowe trójwymiarowe obiekty. W pierwszej kolejności są to EGB_OgolnyObiekt3D, EGB_DziałkaKatastralna3D oraz EGB_PrzestrzeńPrawnaBudynku-3D, a następnie EGB_JednostkaRejestrowa3D, EGB_BlokBudynkuPodziemny3D oraz EGB_BlokBudynkuNadziemny3D. Skutkuje to pojawieniem się w modelu katastru pięciu dodatkowych diagramów. Poprzez połączenie z istniejącymi już obiektami, nowe obiekty oznaczone przyrostkiem „3D" zostają włączone w istniejący model. Badania opisane w publikacji pokazują w jaki sposób można włączać nowe obiekty 3D w istniejący model polskiego katastru dla utworzenia modelu katastru 3D. Metoda ta może być również zastosowana do budowy katastru 3D w Polsce z wykorzystaniem rozwiązań innych autorów.

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1. INTRODUCTION

There are many various cadastral systems all over the world. Generally, the information on two-dimensional cadastral objects is registered there. However, today's world is different that it was in times when the majority of cadastral systems were established. It results, inter alia, in the need for multipurpose and multidimensional cadastre (Bennett et al, 2011). Research described in the paper concerns three-dimensional cadastre, so cadastre's purposes aspects are generally omitted in the paper.

The year 2001 may be considered as the borderline in 3D cadastre developments as the first 3D cadastral workshop took place in Delft, the Netherlands, then. As it was later concluded as being premature, if you take into account contemporary organizational and legal developments, as well as the state of knowledge and technology in the beginning of 21st century. The second workshop that took place in Delft, as well in 2011, brought back the issue of 3D cadastre into wider discussion. Since then, we can notice that this subject has been getting more and more popular. There seems to be two main reasons of that. The first is the growing need for registration of various 3D objects, whereas the second is the state of technology that enables to carry out a lot of 3D oriented activities.

If you mean the first reason, the modern constructions went very far both above and under the ground, thus creating the strong need for ownership of 3D objects as well as its registration. It is very important, especially if we wish to avoid interlacing or overlapping rights to 3D objects, as it can results in spatial conflicts.

The second factor is the growing development of technology that also includes 3D geoinformation. Dissemination of technologies like for example those used by Google Earth or Bing Maps, not only for desktop computers or laptops but for variety of mobile devices as well, makes the so called 3D geoinformation accessible nearly for everybody. The need for 3D cadastre development goes along with this trend.

The second workshop on 3D cadastre was in some way a milestone in 3D cadastre developments and popularization. The workshop and the 3D cadastre questionnaire (van Oosterom et al, 2011) boosted the 3D cadastre interest in many countries including Poland, where 3D cadastre aspects started to be widely discussed among geoinformation professionals.

2. LAND INFORMATION SYSTEMS IN POLAND

There are two systems containing information concerning land in Poland. The first is the land registry, whereas the other is the cadastre. The land registry in Poland captures, keeps and

reveals information concerning legal objects (Act, 1982). This information generally concerns description and designation, rights, restrictions and responsibilities (including mortgage). The land registry is managed by the courts of law. The land registry objects in Poland are generally real estates. The real estate may consist of land parcels, buildings or premises (apartments).

The cadastral data are mainly objects spatial description, cadastral objects attributes, values and corresponding official documents. The cadastre is managed by the local authorities at the *powiat* level (*powiat* is similar to county in countries with legal and administrative system based on Anglo-Saxon law). The cadastre objects are land parcels and buildings or premises (apartments) being separately owned estates. The bases of cadastre in Poland are defined by the Geodetic and Cartographic Law (Act, 1989). The details regulating contents and operation of cadastre are defined by the Regulation of Ministry of Administration and Digitization from 29th of March 2001 (Regulation, 2015).

3. MODEL OF POLISH CADASTRE

The regulation (Regulation, 2013) defines the new model of Polish cadastral system. The application schema of cadastral database was, inter alia prepared there, applying UML notation, according to the ISO 19100 series standards methodology, as well.

The Polish cadastral model contains 71 classes. The classes of Polish cadastral model begin with letters "EGB". Relations between classes are presented within 16 diagrams. The conceptual model of Polish cadastral data consists of application schema, objects catalogue and GML application schema. The application schema of cadastral data is defined applying Unified Modelling Language, which is then transferred into Geographic Markup Language (GML) listing. The catalogue of objects contains definitions and descriptions of the objects types presented in the application model, their attributes and interrelations between them, occurring in one or more diagrams. All objects included in the cadastral database hold attributes concerning the date of their establishment and archiving, specifying the life cycle of object as well as the dates of creating and archiving of object's successive versions and the identifier of spatial information infrastructure.

There are following diagrams in the Polish cadastral model (Bydłosz, 2015) based on Regulation, 2013:

- GeneralObject,
- Inheritance,
- CadastComplexCadastSection,
- ParcelContourOfSoilQualityValuationInParcel,
- BuildingPremises,
- ObjectDataGlossaries,
- Party,
- PartiesGlossaries,
- RegisterUnits,
- Shares,

- RegisterUnitsPartiesGrouping,
- RightsToPropertiesGlossaries,
- Address,
- BoundaryPoint,
- Lease,
- LegalBasis.

This diagrams cover the extensive aspects of land administration concerning i.e. property registration, rights registration and land use aspects. The diagrams describing the cadastral model are grouped in the following eight thematic packages (Bydłosz, 2015) based on Regulation, 2013:

- General Object,
- Objects,
- Parties,
- Rights To Properties,
- Address,
- Boundary Point,
- Lease ,
- Legal Basis.

4. RESEARCHES ON 3D CADASTRE IN POLAND

Ideas on 3D cadastre started to gain wider popularity in Poland since the years 2010-2011. In 2010 the questionnaire on 3D cadastre for Poland was completed (3D cadastres, 2010) within the activities of FIG joint commission 3 and 7 Working Group on 3D Cadastres, whereas in 2011 during the second workshop in Delft, the context of 3D cadastre in Poland was presented (Karabin, 2011). Since then 3D cadastre ideas have been getting growing popularity and the researches in various academic centres have been conducted. They are based on practical examples or there are theoretical models, whereas the majority is the mixture of both. The most important of them are shortly described below.

Basis for some of these works was the Digital Terrain Model. The model of 3D+time cadastre was proposed in (Siejka et al, 2014). The way of transition from 2D cadastre into 3D cadastre (including time) was describe there. The UML simplified models for real property register, land and building cadastre, spatial registration of utility infrastructure and 3D+time cadastre are presented in abovementioned research, as well.

The possibility of applying Digital Elevation Model (DEM) into creation of 3D cadastre on large areas is studied in (Sanecki, et al, 2013). According to Sanecki et al (2013) digital elevation model obtained from application of LIDAR technology may be used for creation of 3D cadastre if meeting proper technological and precision criteria.

The model approach to the 3D cadastre in Poland is proposed in (Karabin, 2013) and (Karabin, 2014). The model which enables the registration of rights in layers (strata) is

recommended there. Apart from registering traditional cadastral objects, Karabin (2014) proposes registration of new 3D objects, like 3D cadastral parcel, 3D land space and 3D housing/building space. According to Karabin, such a model should help to explain possible 3D conflicts that cannot be solved by establishing easements.

The application of CityGML for 3D representations of buildings is described by Goźdź et al (2014). Basing on practical examples obtained from airborne laser scanning and applying GML, the 3D representations of building legal spaces were proposed there. The UML models based on LADM, as well as those resulting from CityGML, for Polish land administration components are described in the study.

The very interested cadastral concept is proposed by Góźdź and Pachelski (2014). It is based on 3D-LADM country profile development for Poland. Land Administration Domain Model packages are applied there and the new 3D objects like PL_3DParcel, PL_RestrictedParcel or PL_UnrestrictedParcel are also implemented.

Felcenloben (2013) suggests introduction of spatial real estate into the Polish legal system. It should enable establishing the ownership right for objects build above or under the terrain surface. According to Felcenloben, the 3D cadastre should cover the registration of not only geometric data on 3D cadastral objects, but spatio-temporal rights as well.

The expansion of cadastral system functionality for the new 3D objects was proposed in (Bydłosz et al, 2013) and (Bydłosz, 2014). The three-dimensional parcels are represented there by the classes EGB_CadastralParcel3D and EGB_BuildingLegalSpace3D. The proposed 3D parcel is a polyhedron presently restricted to the right prism. Such parcel can be situated aboveground, underground or both ways. One of constrains is that the parcel cannot be suspended in space. The legal space of 3D building is created when building is already built.

5. DEVELOPING MODEL OF POLISH CADASTRE

The author started his research from cadastral model decreed by Ministry of Administration and Digitization (Regulation, 2013). The cadastral model's main part is UML application schema for land and building cadastre. As mentioned above, it generally consists of information on two dimensions with some 3D information on buildings and apartments/premises.

The author's idea is to implement 3D objects proposed earlier in (Bydłosz et al, 2013) and (Bydłosz, 2014) into the Polish cadastral system that is defined in (Regulation, 2013) and later in (Regulation, 2015). The new defined classes receive suffix "3D" added into its name.

The fundamental classes in this concept are EGB_CadastralParcel3D and EGB_Building-LegalSpace3D. Cadastral parcel 3D is defined as the part of space restricted by the right prism where top or bottom is traditional 2D cadastral parcel. Building Legal Space 3D is defined as part of space restricted by either:

- Right prism when contours of underground and aboveground parts are identical,

– Two right prisms adjoining (less than 100 percent) at the surface.

Building Legal Space 3D is created if the building object is situated (built) on the traditional 2D parcel. "Building" is the building object within the meaning defined in the Regulation of Council of Ministers of 30 December 1999 on the Polish Classification of Constructions Types (Regulation, 1999).

After defining these two new 3D objects, the works on implementing them into Polish cadastral model started. The first step was definition of EGB_GeneralObject3D. It inherits attributes like object ID, date and time of beginning and end of object and it versions, from EGB_GeneralObject. On the other side the new 3D objects inherit from EGB_General-Object3D attributes concerning volume and precision of its description. EGB_RegisterUnit3D inherits attributes directly from EGB_GeneralObject. The new 3D objects inherit all attributes of EGB_GeneralObject trough EGB_GeneralObject3D.

The original classes of Polish cadastral model (Regulation, 2013) have brown background in the diagrams whereas new classes (3D) are yellow. The schema with generalizations is shown in Figure 1.

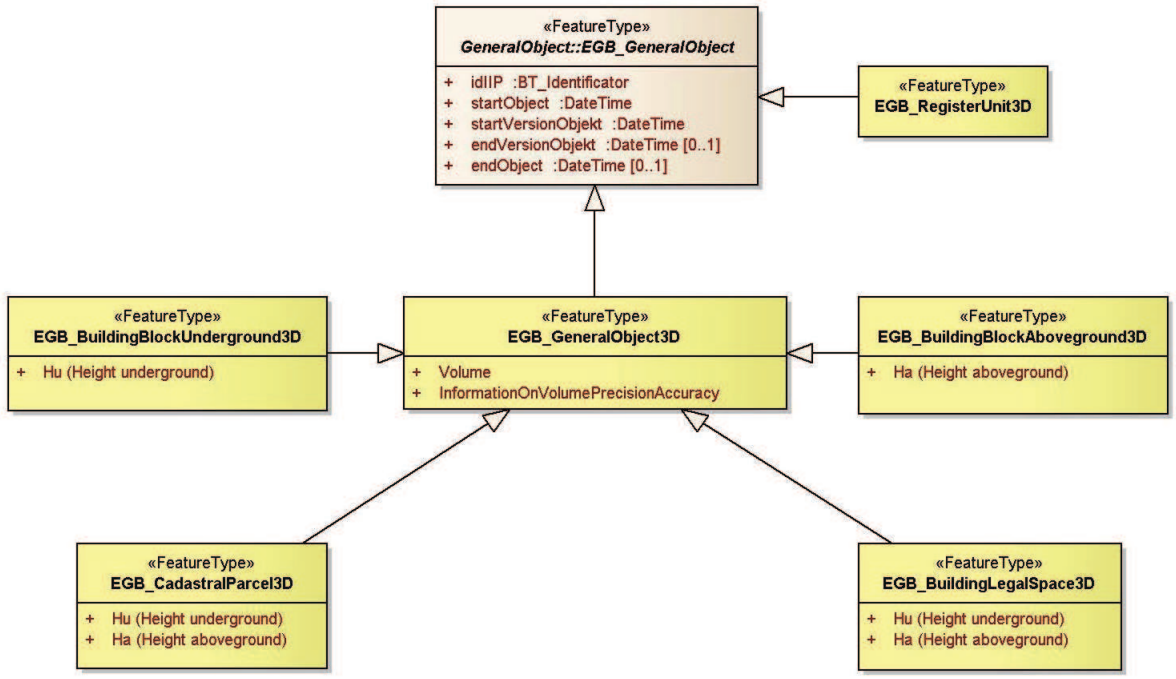

Figure 1. The generalization relationship between new classes concerning 3D objects and EGB_General-Object3D

The class EGB_CadastralParcel3D is based on class EGB_CadastralParcel. In the UML diagram EGB_CadastralParcel3D is connected by navigation relationship with EGB_Cadastral-Parcel (Figure 2), and it appears with all diagrams when the EGB_CadastralParcel occur.

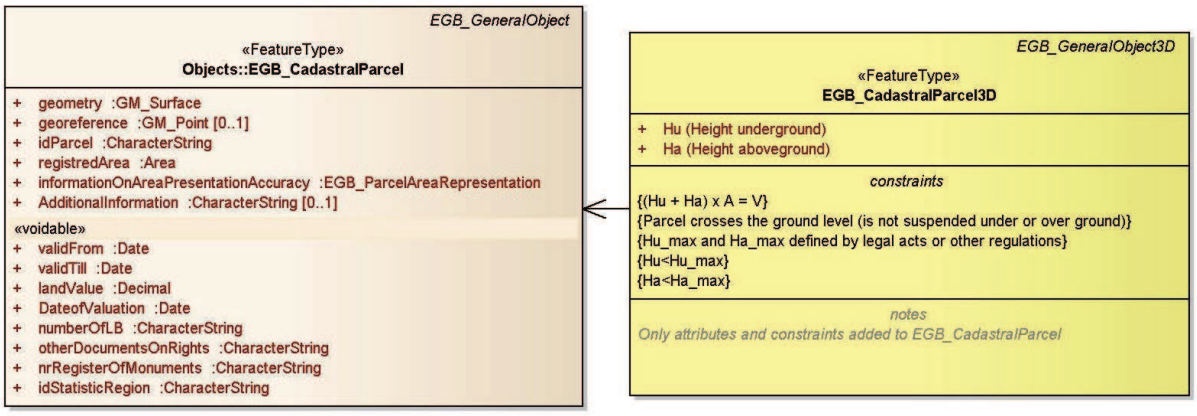

Figure 2. Relationship between classes EGB_CadastralParcel and EGB_CadastralParcel3D

The next step concerns buildings. The EGB_BuildingLegalSpace3D class is introduced into the Polish cadastral model in the similar way as EGB_CadastralParcel3D (Figure 3).

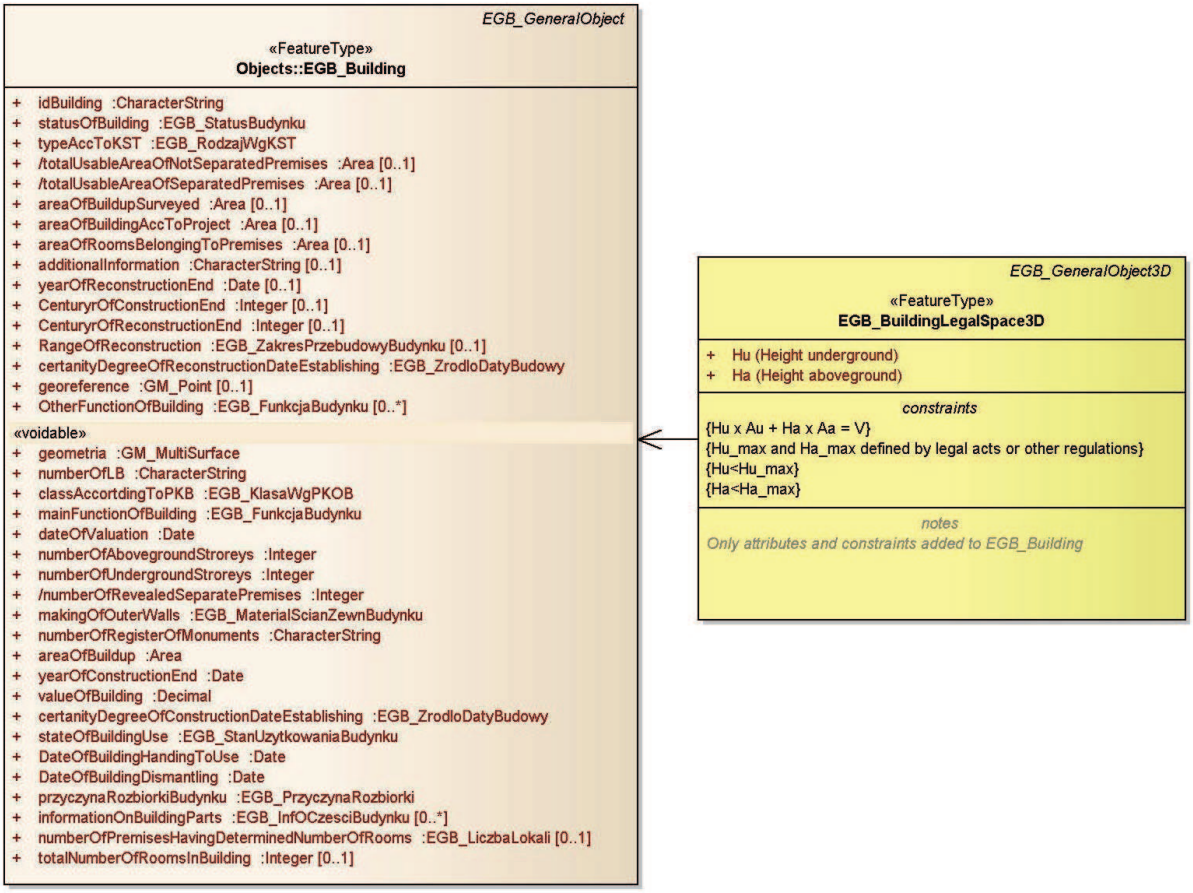

Figure 3. Relationship between classes EGB_Building and EGB_BuildingLegalSpace3D

Two subclasses are defined for class EGB_BuildingLegalSpace3D. They concern above ground and underground parts of buildings (Figure 4).

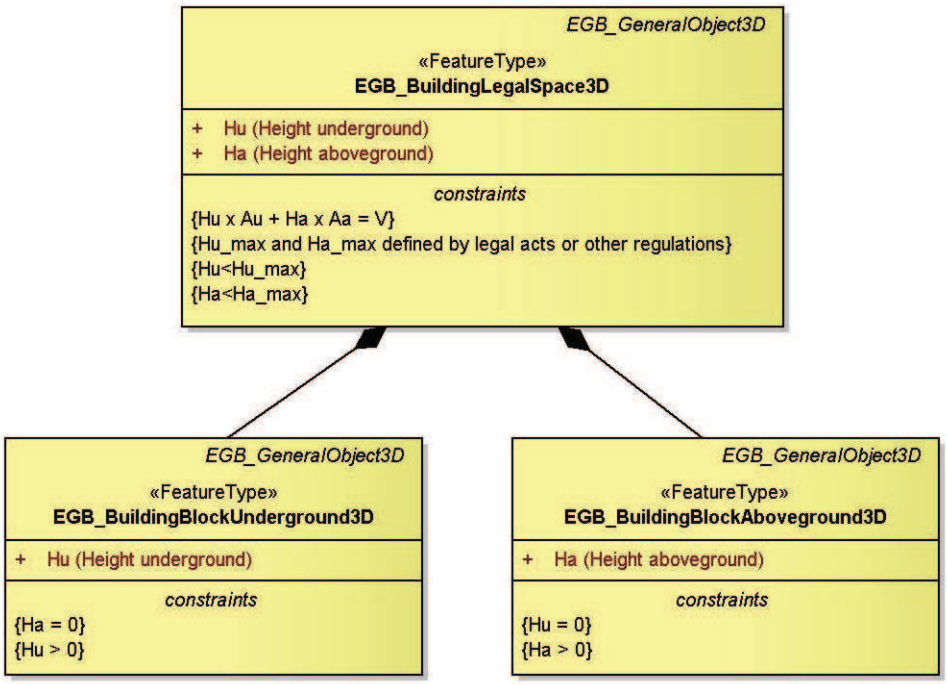

Figure 4. Relationship between classes EGB_BuildingLegalSpace3D, EGB_BuildingBlockUnderground3D and EGB_BuildingBlockAboveground3D

The new 3D objects represented by corresponding classes introduced into the Polish cadastral model appear within its diagrams. The diagram "ParcelContourOfSoilQuality-ValuationInParcel" containing classes concerning 3D parcel, 3D building and its blocks is presented in fig. 5 (attributes are omitted).

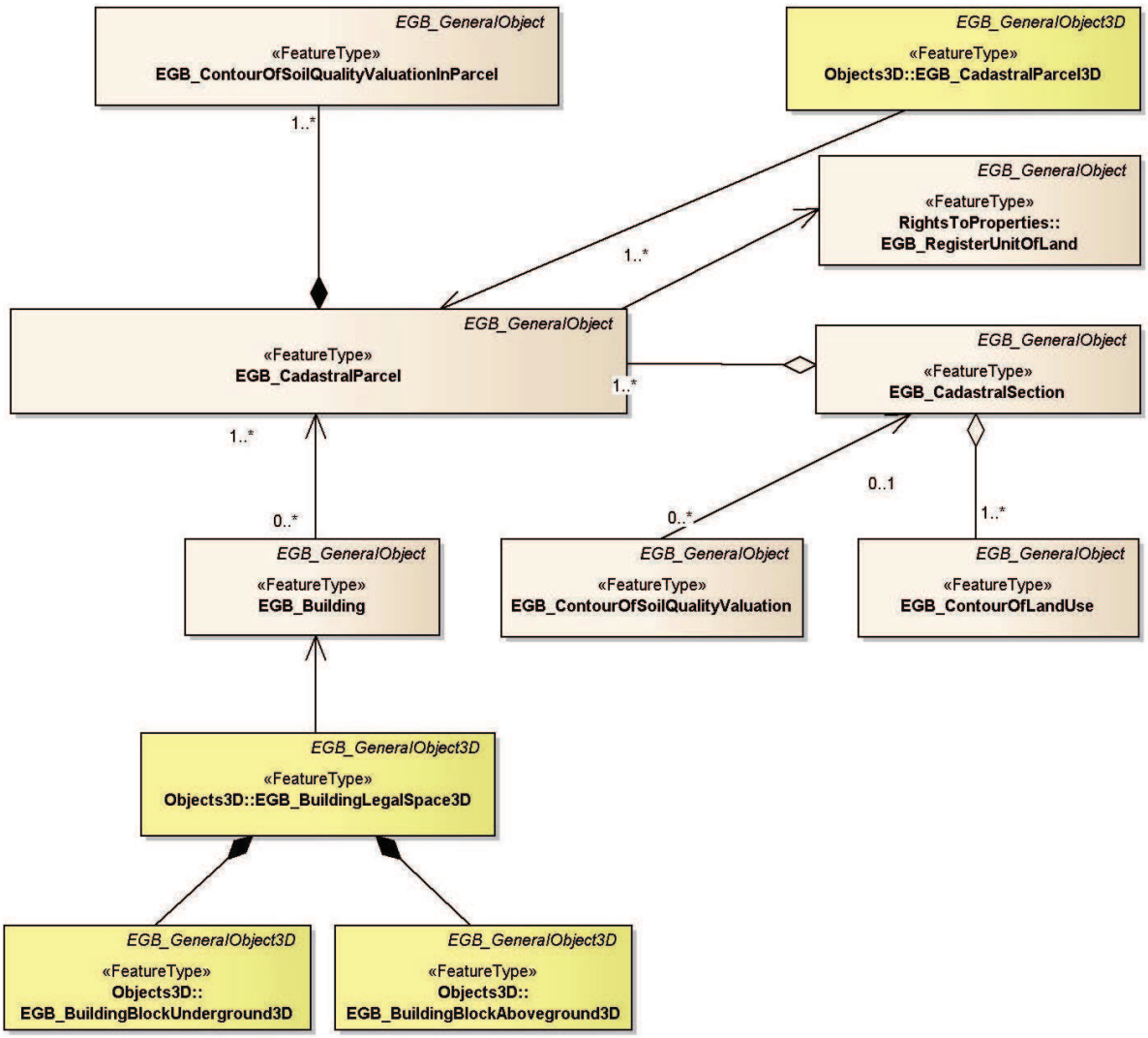

Figure 5. Diagram ParcelContourOfSoilQualityValuationInParcel" of Polish cadastral model with 3D objects added

The traditional Polish cadastral model includes register units for land, buildings and premises. They comprise correspondingly all objects belonging to one real estate. So the analogical one – the class EGB_RegisterUnit3D is proposed in the research. The Register Unit 3D groups all Cadastral Parcels 3D and Building Legal Spaces 3D belonging to one real estate (Figure 6).

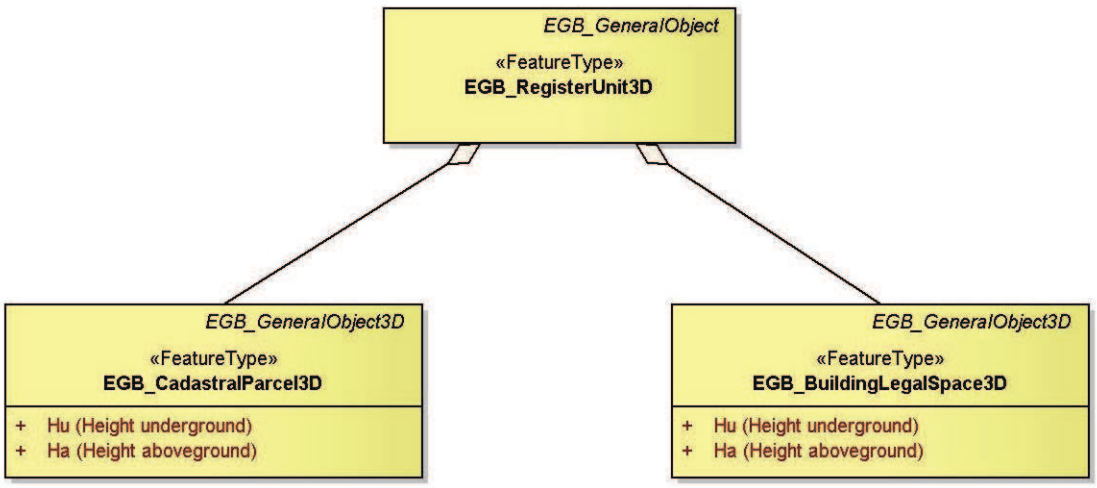

Figure 6. New class representing EGB_RegisterUnit3D

6. RECAPITULATION AND FURTHER WORKS

The research concerns the general idea of implementing 3D objects into the Polish cadastral model. Apart from original elements, the new 3D Polish cadastral model includes additional, following six classes:

- EGB_GeneralObject3D,
- EGB_CadastralParcel3D,
- EGB_BuildingLegalSpace3D,
- EGB_BuildingBlockUnderground3D,
- EGB_BuildingBlockAboveground3D,
- EGB_RegisterUnit3D.

The relationships between them are presented within following five new diagrams:

- GeneralObject3D,
- RegisteUnit3D,
- CadastralParcel_CadastralParcel3D,
- Building_BuildingLegalSpace3D,
- BuildingLegalSpace3D_BuildingBlocks.

The presented model can be developed further. New classes and diagrams may be later added if there is such a need. The resulting model may be combined with other models concerning Polish cadastre. For example, it may be merged with model described in (Góźdź and Pachelski, 2014). It is worth noticing that Góźdź and Pachelski (2014) started to develop 3D cadastral model basing on Land Administration Domain Model, whereas the author started his works from existing cadastral model defined by the Polish law. The concept proposed by the author may be also used for developing model suggested in (Karabin, 2013) and (Karabin, 2014), for they include detailed vision of future 3D cadastre in Poland (not necessarily corresponding to author's ideas), but the UML notation is not given there. The

model proposed in this research may be also introduced into Polish cadastral profile proposed by Bydłosz (2015).

The introduction of proposed model may encounter many implementation problems described in (Ho et al, 2013) as it changes the generally accepted concept of property and real estate. In author's opinion the model presented in the paper goes together with trends in land administrations systems analyzed by Dawidowicz et al (2013). As the proposed changes in the cadastral model concern the cadastral objects but not the parties, the author believes that the it meets the criteria of good governance described in (Gross and Źróbek, 2015).

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BIOGRAPHICAL NOTES

Jarosław Bydłosz obtained PhD at the Faculty of Mining Surveying and Environmental Engineering, AGH University of Science and Technology in Cracow Poland, in 1997. He is a faculty member since 2001 and works at the Department of Geomatics as a lecturer and researcher. Jarosław Bydłosz obtained postdoctoral degree (habilitation) in June 2016. His scope of interests are Geographic Information Systems, cadastre and standardization. The recent activities concern 3D cadastre and issues concerning ISO 19152 "Land Administration Domain Model". He is a member of Polish Real Estate Scientific Society and Polish Association for Spatial Information. Since 2010 Jarosław Bydłosz is an active participant of FIG joint commission 3 and 7 Working Group on 3D Cadastres.

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