

A Concept of a Model Approach to the 3D Cadastre in Poland: Technical and Legal Aspects

Marcin KARABIN, Poland

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

SUMMARY

The paper presents main results of researches done during preparation of the postdoctoral lecturing qualification thesis (D.Sc. thesis). The title of thesis was „A concept of a model approach to the 3D cadastre in Poland”. The thesis presented a proposal of the 3D cadastral model for Poland, based on analysed solutions in the field of three-dimensional cadastres applied in many countries. The thesis consisted of four basic sections. The final (fourth) part of the thesis presented the concept of the model approach to the 3D cadastre for Poland.

The paper focuses on fourth part of the thesis and further author's research works. In paper there is presented a model approach to the 3D cadastre for Poland. This model proposes modification of perception of the extension of property rights as specified in the Civil Code, which would open the possibility to establish this right in "layers" in Poland. Therefore – apart from the currently existing cadastral parcel – it has been proposed to introduce new objects in the form of 2D and 3D cadastral parcels, which would technically allow for such a solution. So in 3D cadastral model there will exist: traditional cadastral parcels (with infinite range of ownership rights, practically limited but not registered in cadastre in the form of the sets of points with 3 coordinates or height levels), 2D cadastral parcels (based on traditional cadastral parcels but with registered minimum and maximum height levels which limits range of ownership rights to the parcel), 3D cadastral parcels (subdivided from 2D cadastral parcels – space parcel, registered in cadastre as a prism defined by set of points with x,y,z coordinates). Detailed conditions concerning creation of 2D and 3D cadastral parcels, as well as the scope of related technical documentation, have been determined. The procedure to distinguish 3D cadastral parcels, following the application of the currently existing cadastral parcel, as well as *ex officio* procedures, implemented to achieve public goals, have been developed. The author performed further tests of implementation of such a model based on an existing building in the town centre and a planned investment (building) which interfered in ownership's space of the building parcel (building planned to build above an existing building and surrounding street, parking places planned to build under the street and under the existed building). The author made a proposition to establish a maximum and minimum layers of ownership rights for 2D parcels and subdivided it into 3D parcels which allow to make this investment (construction) basing on ownership rights to 3D parcels and not on servitudes on traditional cadastral parcels.

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1. INTRODUCTION

Issues concerning limitation of the extend of the property rights in Poland were described by the author in details in Karabin (2011b). Problems concerning registration of buildings in Poland were described by the author in details in Karabin (2011b) and registration of premises in Karabin (2011a).

Second part of author's researches focused on the registration of various untypical 3D objects located within the city of Warsaw, the capital of Poland (Karabin, 2011b, Karabin, 2012) .

As a result of researches on 3D cadastres author prepared the postdoctoral lecturing qualification thesis (D.Sc. thesis). The title of thesis was „A concept of a model approach to the 3D cadastre in Poland” (see Karabin, 2013). The thesis presented a proposal of the 3D cadastral model for Poland, based on analysed solutions in the field of three-dimensional cadastres applied in many countries. The final (fourth) part of the thesis presented the concept of the model approach to the 3D cadastre for Poland.

The paper focuses on fourth part of the thesis and further author's research works.

2. DEFINING OF THE RANGE OF PROPERTY RIGHTS

The first action which in many countries is connected with the introduction of the 3D cadastre is redefinition of the term of the range of property rights; a land property should be considered as a 3D spatial object in the cadastre. The necessity to define the range of property rights was stressed, among others, by Acharya (2011), Dimopoulou and Elia (2012), Erba and Graciani (2011).

In Karabin (2013) the author proposed for Poland the following reading of the domestic act dated April 23, 1964, the Civil Code: „*Within the ranges defines by social-and-economic land destination, considering public-and-legal limitations the property right to lands ranges within the spaces over and under the land surface, which is determined in the cadastre*”.

Following the author's opinion, determination of this range should be performed at the level of a community, i.e. parameters which define the spatial range should be described in the local land management plans. Thus, the local land management plan should consider the land division into zones, for which the maximum and minimum ranges should be determined, with consideration of limitations resulting from the general provisions, detailed regulations, as well as from rules concerning the spatial policy of a given local government unit (see also Karabin, 2013).

The author proposes to set the z(+) level at such a height which would ensure the security of aircraft traffic and which would not be related to the permissible heights of buildings; a special reserve should remain. This idea is presented in Figure 1.

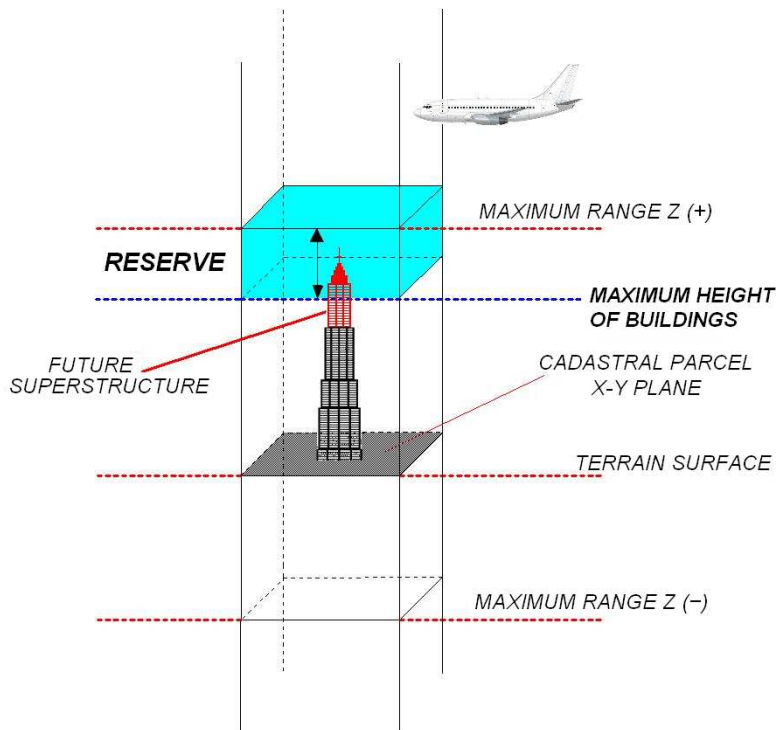


Figure 1. An idea of determination the maximum „Z” range for a 2D cadastral parcel
 Source: Own work, published in Karabin (2013)

The author assume various variants of describing the Z range in the local plans, depending on the available input data. i.e. by specification in metric units the height, which defines the spaces above the land and the depths defining the space under the land or by determination of spatial coordinates (X,Y,Z), which define this range.

The definition of the range of property rights in metric units will allow for implementation of the idea of the "layer" approach to the rights and their spatial ranges, registered in the cadastre, which has been presented, among other, in Dimopoulou and Elia (2012). As a result the space will be divided into the space accessible by the owner, and the space, which will be reserved for the State Treasury, which will be required for implementation of the aircraft traffic, the space where natural resources occur, below the depth accessible by the private entity.

Such modification will allow for introduction of 3D cadastral parcels, as well as for implementation of the 3D cadastre, following one of the three scenarios presented in Stoter, Salzmann (2001), i.e. solutions of True 3D Cadastre, 3D Tags and Hybrid.

3. NEW OBJECTS IN THE CADASTRE

In Karabin (2013) the author proposed introduction of new objects to the cadastre, besides the existing two-dimensional cadastral parcels.

The existing cadastral parcel is defined in Poland as follows (Cadastral Law,2001): the continuous piece of lands, located within the limits of one cadastral district, uniform from the legal perspective and distinguished from the surrounding areas by means of boundary lines.

The new object, being the 2D cadastral parcel would be defined as follows (Karabin,2013): „2D cadastral parcel - located within the limits of one cadastral district, the continuous piece of land, uniform from the perspective of the legal status, distinguished from the surrounding areas in the (x-y) plane by means of boundary lines and characterised by the determined vertical range in the "z" direction”.

As it was stated in Karabin (2013), the only, but important, difference between the existing cadastral parcel and the 2D cadastral parcel would be precise determination and registration of the range of property rights in the cadastre for the existing cadastral parcel in the "z" direction.

Another new object, i.e. the 3D cadastral parcel would be defined as follows (Karabin, 2013): „3D cadastral parcel - a continuous and compact piece of land, uniform from the perspective of the legal status, distinguished from the space of one or several 2D cadastral parcels from a given district - having a specified spatial range”.

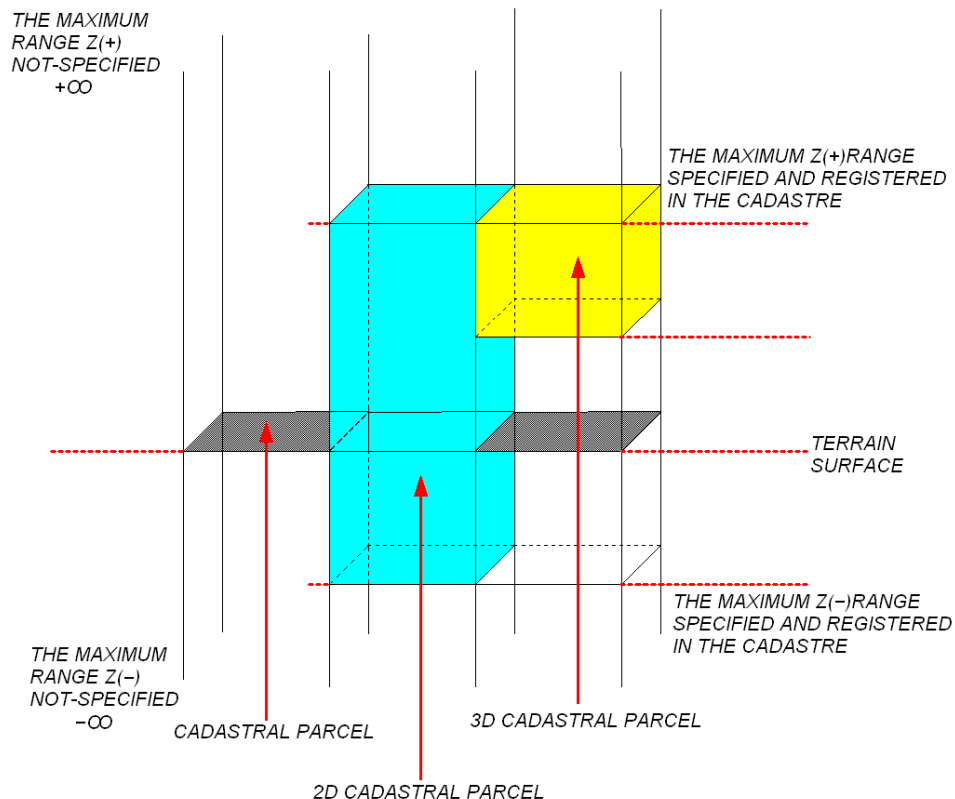


Figure 2. Interpretation of terms: cadastral parcel, 2D cadastral parcel, 3D cadastral parcel
 Source: Own work, published in Karabin (2013)

The objects proposed in the 3D cadastral model are illustrated in Figure 2.

In the above model the author assumed, that cadastral parcels would have the form of prisms or other bodies created by combination of prisms, which points would be determined with the accuracy not worse than 10 cm in relation to the closest geodetic control points. The author assumed the idea of the division of the space, presented by Ying et al (2012).: “we design two types of cadastral geospace: 3D land space and 3D housing/building space. 3D land space is a certain vertical extension of the 2D parcel according to plannings or demands of architecture, and 3D housing/building space is the physical space or its approximation”.

So the legal space of the 3D parcel is a section of the space, which was acquired from the owner of the two-dimensional cadastral parcel, existing on the 3D cadastre, as the spatial object. The space of the implemented construction is a solid, determined by an existing physical structure or a building; this space should be embedded inside the legal space of the 3D parcel. This idea is presented in the figure below.

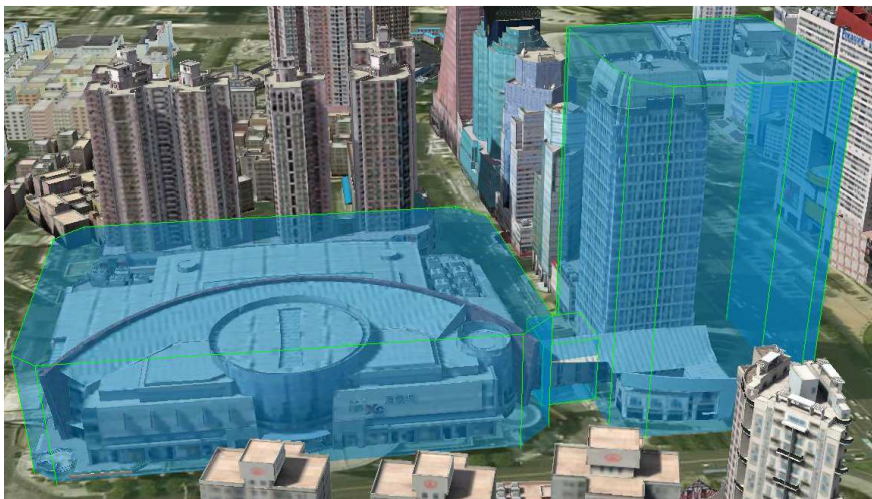


Figure 3. The structures visible in blue determine the legal space of the cadastral parcel, and inside - the 3D space of construction in the form of a 3D city model

Source: Ying et al (2012) - powerpoint presentation

Therefore, the distinguished 3D cadastral parcel should be designed in such a way that it would be possible to implement the planned investment in the future. Thus, in most cases instead of the "3D construction property" this will be an "air-space parcel".

The author does not assume that the procedure of establishing the range of property rights in the vertical direction would become obligatory; in his opinion this will concern only such areas for which it would be necessary to continue division of the space into layers, due to implementation of building investments, performed at various "levels" of a real estate. Therefore, this problem probably would concern cities.

According to the assumed definitions of objects, determination of the range of property rights in the "z" direction and its further registration in the cadastre will result in transformation of the conventional cadastral parcels into the 2D cadastral parcels of the finite volume. Other spaces, which remain after such separation from the space of a body, which legally belongs to

the owner of the surface parcel – will become the property of the State Treasury (the space above the maximum "z" level and below the maximum "z" level).

On the other hand, it will be possible to distinguish 3D cadastral parcels from the space of the 2D cadastral parcels; the 3D parcels will be required for implementation of investments, which construction will not require the purchase of parcels, covering the land surface, i.e. the existing cadastral parcels or 2D cadastral parcels. Such objects might be tunnels of underground railways, railway tunnels, overpasses or underground parking places.

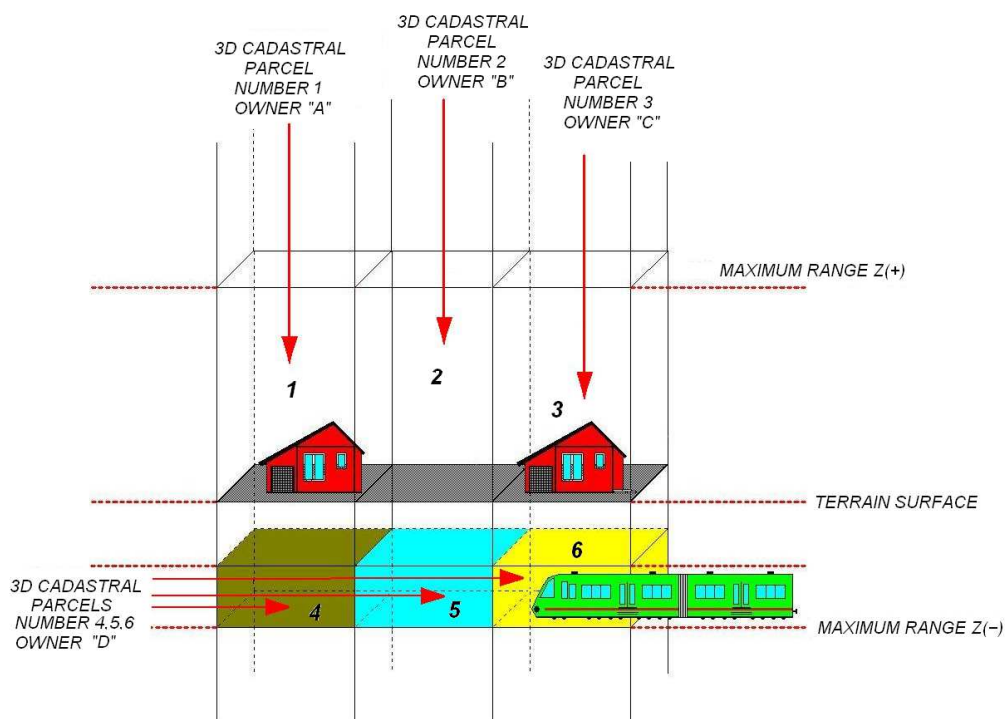


Figure 4. The effect of expropriation, according to the 3D Cadastre approach
Source: Own work, published in Karabin (2013)

Resuming, the introduction of 3D cadastral parcels would result - in the case of many investments - in the lack of necessity to purchase the property rights to "entire" cadastral parcels, as it happens in the case of the two-dimensional cadastre. As it was pointed in Karabin (2013), only in the case of a viaduct the usufruct rights should be established for supporting the viaduct pillars on the past 2D cadastral parcels, which - in the space remained after distinguishing 3D cadastral parcels - might be utilised in the previous way.

In the improved model, the 3D cadastral parcels would be distinguished after submission of an application by the owner of the existing parcel, who would also cover the costs, or officially, according to respective acts; in such a case the costs would be covered by the entity which implements the public investment. In the first case, after the 3D cadastral parcel is distinguished, the previous owner will conclude the purchase contract with the possible investor, concerning the purchase of the 3D parcel to be distinguished. In the second case we would deal with the expropriation procedure, only in the approach of the 3D cadastre, so the 3D cadastral parcel would be distinguished officially, according to respective rights. In the

successive step the property right to this parcel would be subtracted after payment of the respective compensation. As it was pointed in Karabin (2013), the absolute requirement for the expropriation procedure is the presence of statements of a planned, public purpose investment, located in the space of cadastral parcels, in the local land management plans. The alternative would be the establishment of location of the public purpose investment by an administrative decision of the authorised administrative body.

The expropriation procedure in the 3D cadastre approach, as it was stated in Karabin (2013) is a smoother process and it has the advantage over the existing solutions, since the owner of the cadastral parcel is not deprived of the property rights to the entire parcel area or to a part of such a parcel (the parcel division in the two-dimensional approach), but only to the part of the space of the existing cadastral parcel (the distinguished 3D parcel); he may administer the remaining part of the space.

In the situation which is illustrated in Figure 4 only 3D cadastral parcels no. 4,5,6 would be expropriated and the remaining space would be left as the property of the existing owners of 2D cadastral parcels - they would be still the owners of 3D cadastral parcels no. 1, 2, 3. Then, parcels 4, 5 and 6 could be combined in one 3D cadastral parcel, since - according to the model proposed by Karabin (2013) - the following rule was assumed *„the 3D cadastral parcel located in a space of several existing 2D cadastral parcels may be created only as a result of combination of 3D cadastral parcels located in the space of existing individual 2D cadastral parcels, if the final 3D cadastral parcel meet the condition of continuity and compactness and, if it is additionally included within the cadastral district. 3D cadastral parcels, being the subject of combination, must have the same, uniform legal status”*.

It is obvious that the investor who implements the investment in the space of distinguished 3D parcels, would have to possess parcels containing the physical Earth surface in their space. These parcels would be used as building sites for underground railway station, exists from viaducts, entrances to underground parking places etc.

According to the legislation existing in Poland, investments which interfere in the space of "someone else's" cadastral parcels, may be implemented with the use of limited material rights, especially usufruct rights, which are not the attractive form for investors due to the lack of possibility to credit the investment basing on these rights. Remaining rights, such as perpetual use or a separate property of premises, are connected with the acquisition of the right to lands, what may not be necessary in some cases.

4. CONDITIONS OF CREATION OF 3D CADASTRAL PARCELS

According to the model proposed in Karabin (2013) the author proposed several detailed rules. The first rule is to ensure the freedom in disposal of the space of the cadastral parcel and to possibility for the owner to undertake such actions which would be in agreement with the further investment plans.

Following the author (see Karabin, 2013): *„the 3D cadastral parcel - should not preclude the use of the existing, built-up or non built-up, 2D cadastral parcel, according to its destination*

and the existing way of use. In the opposite case the 3D cadastral parcel should be created, which would contain, in its solid, the area of the existing 2D cadastral parcel or the owner, who applies for creation of the 3D cadastral parcel should present a respective statement in the documentation”.

The second rule concerns situation when building objects are located on the cadastral parcel, from which the owner intends to distinguish the 3D cadastral parcel. Following the author (see Karabin, 2013): *„In the process of separation of the 3D cadastral parcel, in the case when on the 2D cadastral parcel, from which the 3D parcel to be separated or on other, neighbouring 2D or 3D cadastral parcels building objects are located - the surveyor should design the range of the new parcel after obtaining the respective expertise from an authorised expert. The range of the designed 3D cadastral parcel should guarantee that the existing constructions will remain unaffected in the course of implementation of the future building works. If the future works are to concern reconstruction of the existing objects, such information should be specified in the documentation of separation of parcels, and the owner who applies for creation of the 3D cadastral parcel should present a respective statement in the documentation”.*

5. PRACTICAL UTILISATION OF THE 3D CADASTRE

Below the attempt to test the 3D cadastral model presented in Karabin (2013) is discussed for the case described in Nowakowska (2011). In the case of the "Sienna Street in Warsaw Project". It was planned to construct the skyscraper by the investor having the perpetual use rights to the non built-up area of the size of approx. 1500 sq.m, characterised by the highly disadvantageous shape, similar to the letter "L", of the width of about 7 m!!! The investor's parcel neighbours the monumental building, constructed within the, so-called, "sharp boundary"; on other sides it adjoins the streets. The vertical diagram of the planned investment, the situation on the cadastral map and in the field, are presented below.

As it was mentioned in Nowakowska (2011), four usufructs should be established for the needs of this investment: first usufruct for location of some underground parking places under the neighbouring street, second for location of underground parking places under the apartment house located on the neighbouring parcel, third for hanging the part of the designed building over the neighbouring street, fourth for hanging the designed building over the neighbouring parcel with the apartment house.

An alternative for this idea is the 3D cadastral model for Poland, presented in Karabin (2013); as a result of introduction of new objects - 2D and 3D parcels - into the conventional cadastre, it would allow to base the discussed investment on the ownership rights to those cadastral objects.

During the first stage, field measurements were performed aiming at acquisition of data required for determination of the maximum range of property rights to the conventional parcel in the Z(+) and Z(-) direction, i.e. for transformation of a conventional cadastral parcel into the 2D parcel, according to the idea presented in Karabin (2013).

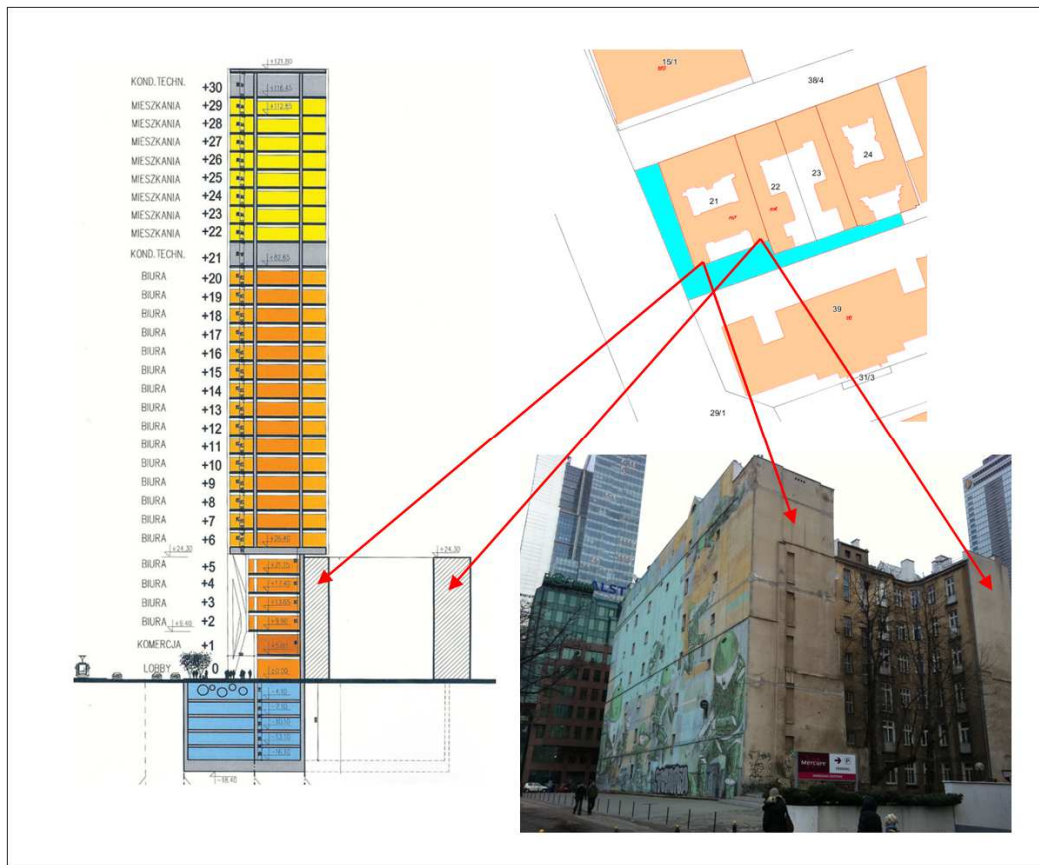


Figure 5. "The Sienna Street in Warsaw Project"

Source: The vertical projection of the investment – designing documents of "Kuryłowicz-Associates" Company published in Nowakowska (2011), photograph taken by the author, the cadastral map - The Office of Geodesy and Cadastre of the City of Warsaw, Poland, All published in Karabin (2013)

Due to the missing rules of determination of the range of property rights in the existing legislation, it was assumed for testing the model, that the maximum level, which can be utilised by the owner of the conventional parcel, located in the area where the future investment is to be performed, would not be greater than in the case of neighbouring objects. This area is not located within the zone of limited use, resulting from the vicinities of the airport, therefore additional limitations in the Z(+) range, required to ensure the air traffic security within the zone of take offs and landings of aircrafts do not occur. The maximum Z(+) range was assumed at the level determined by the Palace of Culture and Science, the highest object in Warsaw, which is located within the distance of about 450 m. Measurements aiming at determination of the height of the upper spire of the Palace of Culture and Science were performed. Measurements aiming at determination of the height of the building, above which it is designed to hang a part of the designed building, as well as the level of the sidewalk, above which a part of the building is to be hung and under which underground parking places are to be constructed.

For the bottom Z(-) level, also due to the lack of detailed regulations concerning the determination of this level, the level of 30 m under the ground was assumed. According to the act of July 18, 2001 The Water Law - Art. 124, the water permit is not required in the case of construction of underground water intake installations for the needs of the standard water use from water intakes up to the depth up to 30m. Therefore, it may be assumed for the needs of testing, that this Z(-) level is accessible for operations performed by land properties (Under the condition that mineral being the property of the State Treasury do not occur within this space), and utilisation of the lower level is limited and it is not accessible for the investor.

Thus, the range of the property rights of the owner of parcels within the planned investment, according to the above assumptions and to the results of field measurements, was determined in the reference system, obligatory in Warsaw (Level Zero of the Vistula River). The upper range Z(+) equals to 274.53m, and the bottom range, Z(-) equals to 5.80m.

Following Karabin (2013), spaces above the maximum level „z” (marked as Z+) and below the maximum level „z” (marked as Z-) will remain in the disposal of the State Treasury and they will not become the subject of the property right of the owner of the existing cadastral parcel.

As a result of determination of the maximum levels Z(+) and Z(-) it is possible to create new objects, being 2D cadastral parcels, proposed in Karabin (2013), basing on conventional cadastral parcels.

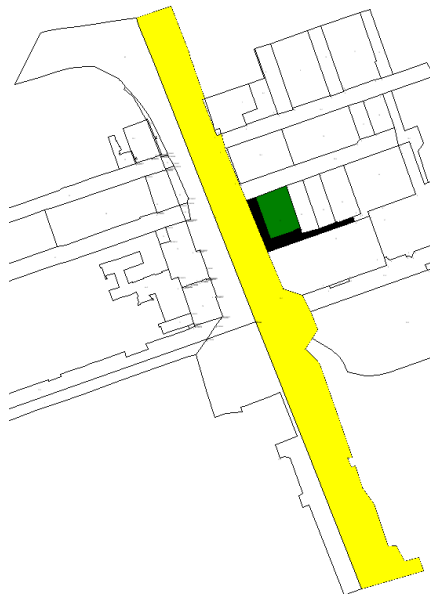


Figure 6. “The Sienna Street in Warsaw Project” – cadastral map
Source: The Office of Geodesy and Cadastre of the City of Warsaw, Poland

The system of parcels of the given investment, according to the existing approach of the two-dimensional real estate cadastre is presented in the fragment of the cadastral map.

The above map presents the cadastral parcel no. 29/1 (in yellow) being the property of the Capital City of Warsaw, the parcel no. 30/2 (in black), being the property of the Capital City of Warsaw, transferred to the perpetual use of the investor who intends to implement the described investment and the parcel no. 21 (in green), being the property of the Capital City of Warsaw.

2D cadastral parcels created of existing cadastral parcels no. 29/1 (the size of 2.4629 ha), 30/2 (the size of 0.1130 ha), 21 (the size of 0.1438 ha) will become simple prisms; their foundations will be determined by boundary points of the parcel (x,y coordinates) and they will be hanging at the levels $Z(+)=274.53\text{m}$ and $Z(-)=5.80\text{m}$. Thus the height of those prisms will be equal to 268.73m. The volume of those parcels will be an auxiliary parameter; it will be equal to the following values: for the 2D parcel 29/1= 6 618 551 m³, for the 2D parcel 30/2 = 303 665m³, for the 2D parcel 21= 386 434 m³. Geometric feature of those parcels are presented in Figure 7.

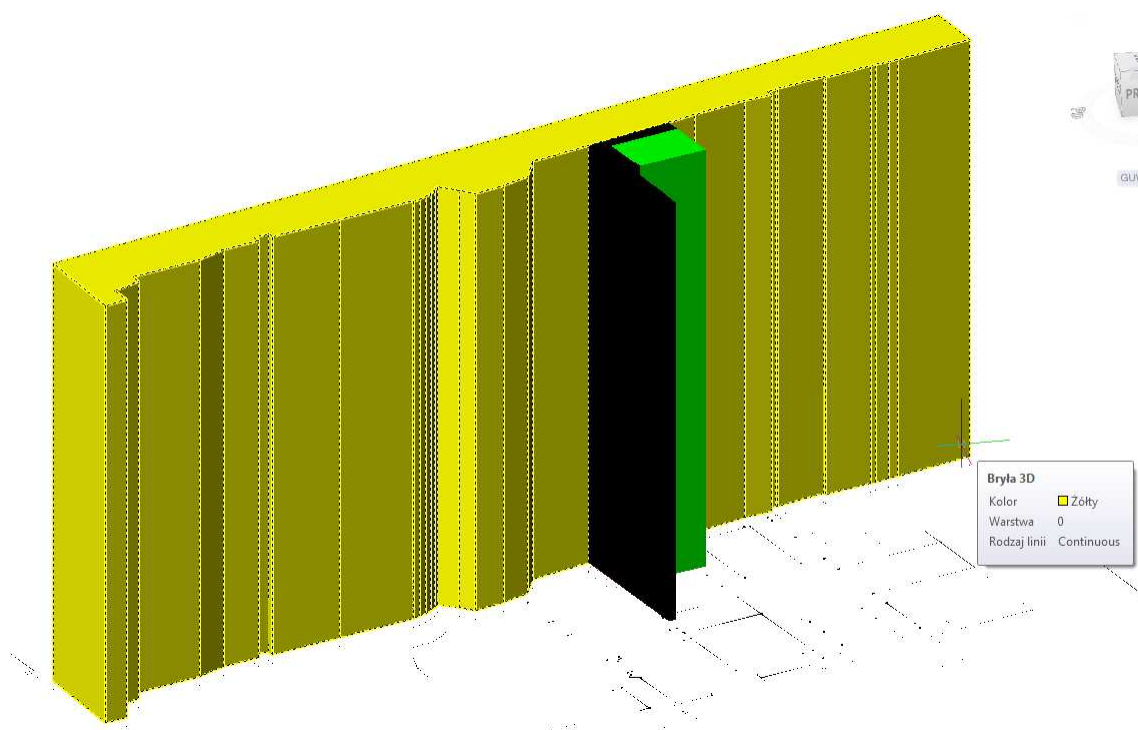


Figure 7. Visualisation of the 2D cadastral parcel – no 29/1 (in yellow)

Source: Own work, with the use of the AutoCadMap 3D software tools (free trial version)

In order to implement the project and according to the model proposed in Karabin (2013) three 3D cadastral parcels should be created from the existing 2D cadastral parcels (from parcels 29/1 and 21). Data concerning the location of the underground parking places under

the building existing on the parcel no.21, mentioned in Nowakowska (2011), was not accessible for the author.

It was stated in the course of performed analyses that data concerning the height of the existing building were incorrectly specified in the projection from the designing documents. As it turns out from performed measurements, the height from the sidewalk to the edge of the building construction equals to 28.67m, and not to 24.30m. Considering that the objective of the investment was to preserve the building existing on the parcel no. 21 without reconstruction, data from measurements were assumed as the basis for creation of new cadastral objects - the 3D parcels.

In the analysed case, 3D cadastral parcels would encompass the space separated from the neighbouring 2D cadastral parcels, in which the investor intends to implement the building object.

Below the vertical projection of the planned investment is presented together with boundaries of cadastral parcels, what illustrates the "interference" of the designed object into the space of particular cadastral parcels (the investor has the perpetual use right for the parcel 30/2 only). The figure also presents calculated "Z" levels, required for creation of 2D and 3D cadastral parcels in the 3D cadastral model for Poland, assumed in Karabin (2013).

The 3D cadastral parcels presented in the above figure would cover the following spaces of the existing cadastral parcels (neighbouring parcels for the parcel 30/2, owned by the investor, basing on the perpetual usufruct) (see Karabin, 2013):

- the 3D cadastral parcel no.1 - would cover the space required by the investor to build an overhead part of the building (floors 6 to 30), hanging in the space of the 2D cadastral parcel no. 29/1 and supported by pillars,
- the 3D cadastral parcel no 2 would cover the space required by the investor to build and overhead part of the building (floors 6 to 30) over the building existing on the cadastral parcel no. 21,
- the 3D cadastral parcel no.3 - would cover the space required by the investor to build the underground parking place under the street existing on the 2D cadastral parcel no. 29/1.

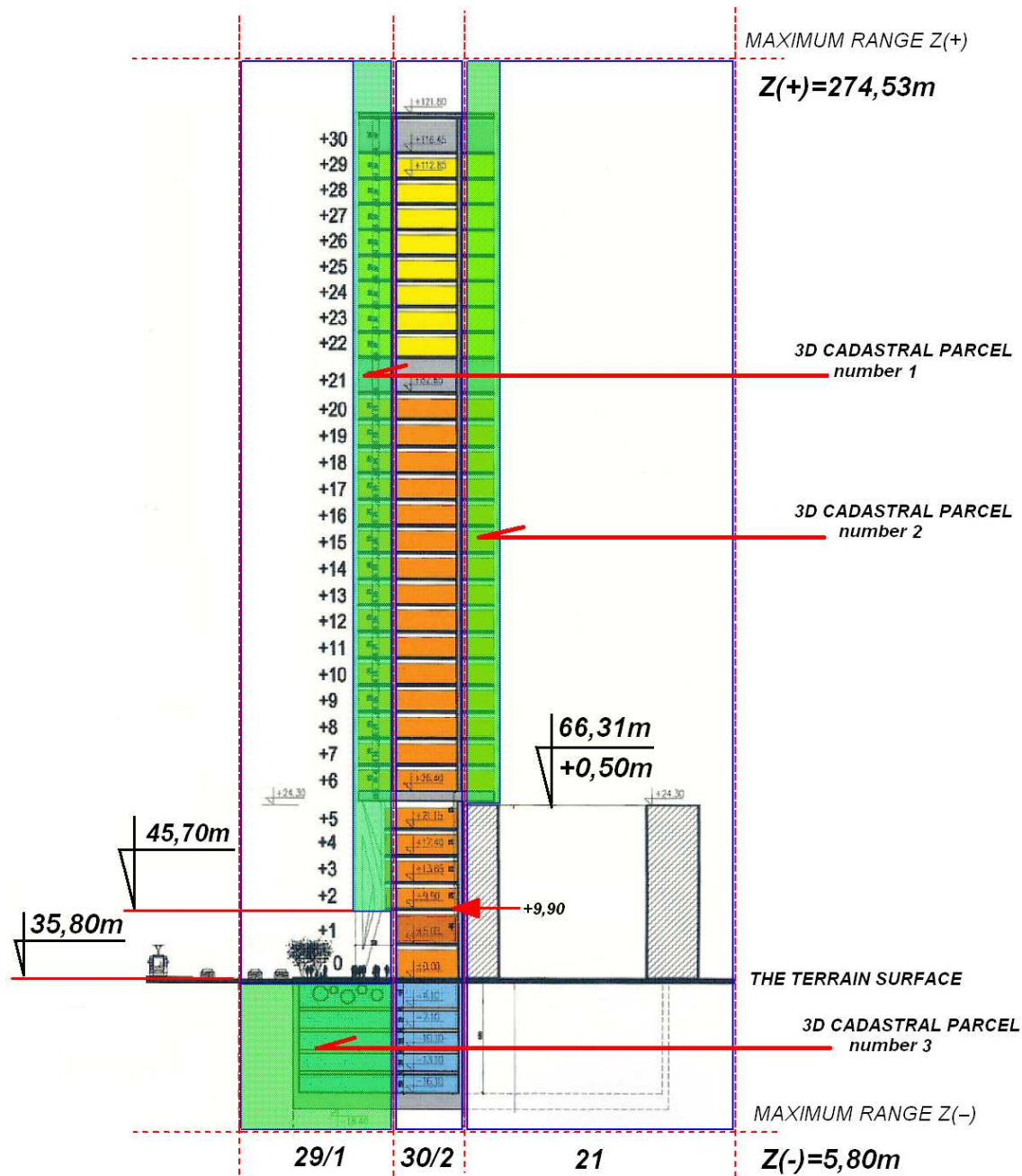


Figure 8. "The Sienna Street in Warsaw Project" – a proposal of creation of 3D cadastral parcels
 Source: Own work, with the use of designing documents of "Kuryłowicz-Associates" Company, published in (2011) and data from own surveys

Figure 9 below presents visualisation of 3D cadastral parcels, performed using AutoCad Map 3D software (free trial version).

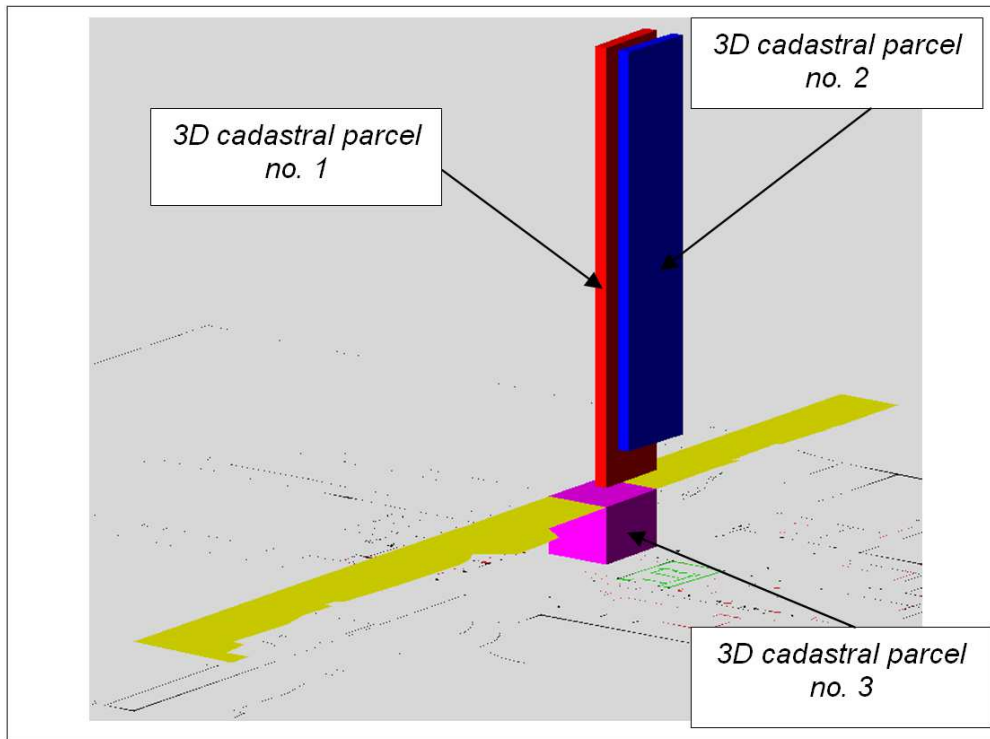


Figure 9. Visualization of the 3D cadastral parcels, no. 1, 2, 3
 Source: Own work, using AutoCadMap 3D software tools (free trial version)

In this case the condition of continuity for separated 3D parcels will not be met and it will be not possible to combine them into the one 3D cadastral parcel. The arrangement of 3D parcels is presented in the following Figure 10.

As it may be seen from the figure below and from rules proposed in Karabin (2013), when 3D cadastral parcels are separated, two of the existing 2D cadastral parcels will lose their status in the cadastre and they will be transformed into the 3D cadastral parcels. This will concern the 2D cadastral parcel no 29/1 (it will be transformed into the 3D cadastral parcel no 4) and the 2D cadastral parcel no. 21 (it will be transformed into the 3D cadastral parcel no.5).

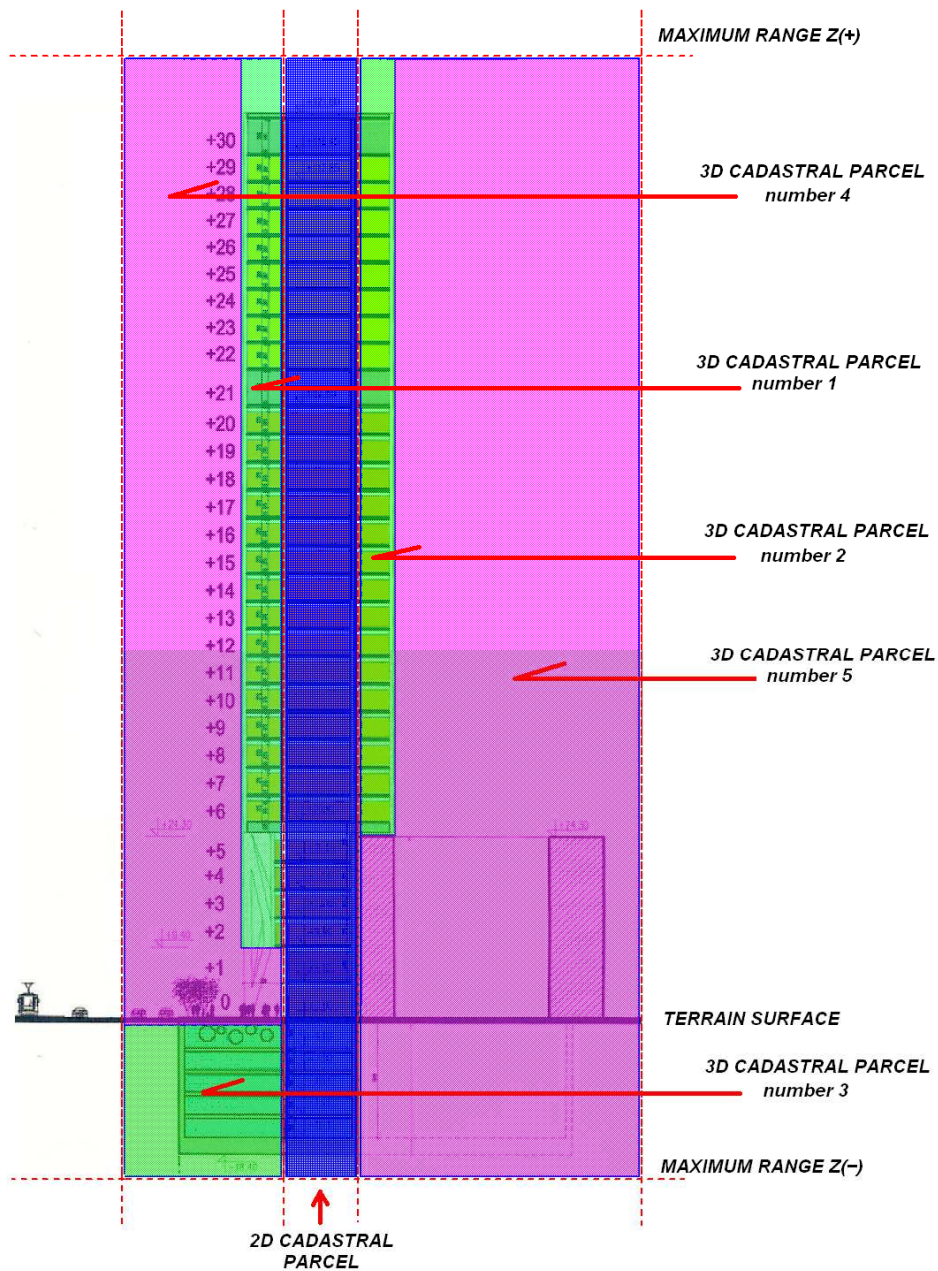


Figure 10. "The Sienna Street in Warszawa" Project – the status after separation of 3D cadastral parcels
 Source: own work, with the use of designing documents of "Kuryłowicz-Associates" Company, published in (2011). All published in (2013)

Visualisation of the 3D cadastral parcels no. 4 and 5 is presented below. They are created of spaces which are not the investor's property; their size is reduced by separated spaces, required by the investor to perform the described investment (reduced by separated 3D cadastral parcels no. 1, 2, 3).

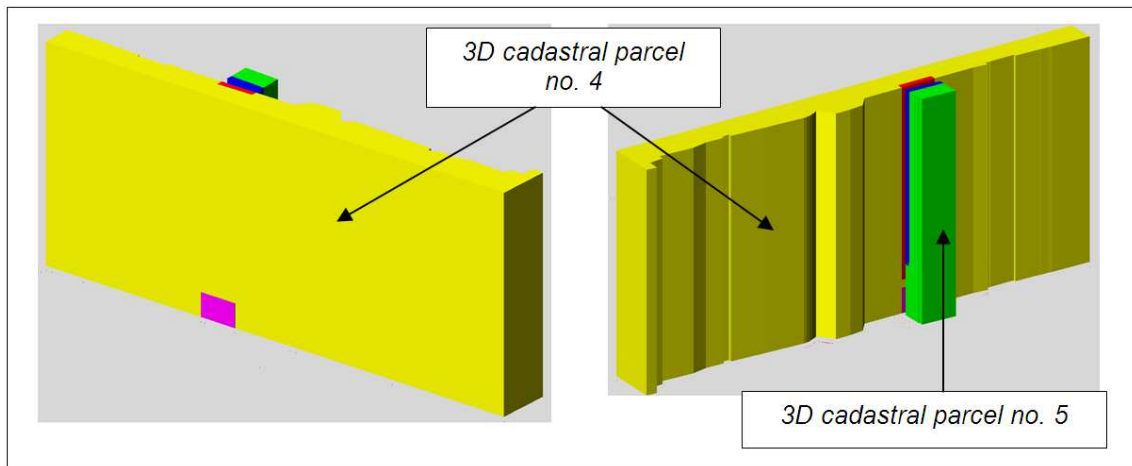


Figure 11. Visualisation of the 3D cadastral parcels no.4 and no.5
 Source: Own work, using AutoCadMap 3D software tools (free trial version)

Finally the author proposes to commission the hybrid approach to the 3D cadastre, i.e. to register both, two-dimensional and three-dimensional parcels in the system. As it was presented above, it is possible to establish the spatial ranges of parcels and to develop respective documentation using the CAD software. Therefore, until the 3D hybrid cadastre is commissioned, the solution based on the 3D-Tags idea together with information about the complex spatial and legal situation on cadastral maps, combined with referring the user to the external documentation (such as dxf files presenting 3D cadastral parcels) could exist.

6. CONCLUSIONS

Both in Poland and abroad it is necessary to solve the problem of the disposal of the real estate space "in layers", basing on the ownership right, which would substitute the method of implementation of investments, basing on other rights, including the usufruct rights in most cases. This requires commissioning of the 3D cadastre which would allow for reference of the property rights (ownership right) to the 3D cadastral parcels and which would enable to financially secure an investment basing on such cadastral objects. The author assumed introduction of the "air-space parcel" type of cadastral parcels as more convenient from the perspective of the investor and implementation of the investment. Introduction of the 3D cadastre will allow for reference of all legal procedures to new cadastral objects, including the expropriation procedure, which will have less dramatic impacts, since the owner of the real property, where the public purpose investment will be implemented, will not be deprived of the property right to the entire parcel, but only to the part of the space, included within the boundaries of the 3D cadastral parcel, distinguished for these purposes. The author assumes that the proposed 3D cadastral model will be operating in such places where the problem of implementation of the investment should be solved according to the "layer" approach, so it will mainly concern cities.

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BIOGRAPHICAL NOTES

Marcin Karabin PhD, D.Sc. Born in Warsaw in 1976. Studies of Geodesy and Cartography at the Warsaw University of Technology. Graduated his (M.Sc.) in Geodesy in 2000. Obtained his Ph.D. with a dissertation ”Conception of the model of cadastral system in Poland based on chosen solutions in European Union countries” at the Warsaw University of Technology in 2005. Obtained his D.Sc. with a dissertation ” A concept of a model approach to the 3D cadastre in Poland” at the Warsaw University of Technology in 2014. Licensed surveyor since 2006. Has professional license in the field of: „Land Surveying, implementation and inventory surveys” and ”Delimitation and division of real estates (plots) and preparation of documentation for legal purposes”. Current position: full-time research worker at the Warsaw University of Technology (Department of Cadastre and Land Management, Faculty of Geodesy and Cartography), also providing surveying services as a licensed surveyor (since 2006).

CONTACT

Marcin Karabin
Warsaw University of Technology
Faculty of Geodesy and Cartography
Department of Cadastre and Land Management
Plac Politechniki 1
00-661 Warsaw
POLAND
Room 312
Tel.: + 48 22 234-75-89
Mob.: +48-608-402-505
E-mail: m.karabin@interia.pl