REGISTRATION NEEDS IN THE THIRD-DIMENSION CADASTRE

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ABSTRACT

All over the world the population and population density is growing especially in the urban area. As a result of this, land surface and subsurface is used for the residential and commercial purposes and public services. Turkey's national cadastre services are carried out by The General Directorate of Land Registry and Cadastre (TKGM) according to the principles of The Cadastre Law, Number 3402. The cadastral works and lad registry activities focus to the two-dimensional ownership in Turkey, but a lot of activities have three dimensional ownership structure, like subways, pipelines, communication lines, underground shopping centers and car parks ect. As a result, a lot of registry problems occur in the land registry offices and other public organizations. Turkish cadastral works have been completed across the country by the Land Registry and Cadastre Organization. The Organization has to be draw a new road map and the new roadmap should include a three-dimensional cadastre. In this study, current cadastral system in Turkey was briefly evaluated in the light of three-dimensional ownership. Some determinations were made about of three-dimensional ownership activities.

Keywords: 3D Cadastre, Ownership, Technical Infrastructure, 3402

ÖZET

Dünya genelinde kentlerde nüfus ve nüfus yoğunluğu artmaktadır, bunun sonucu olarak arazinin yüzeyi olduğu kadar ve yüzeyin altı da gerek konut ve yerleşme, gerek kamu hizmeti ve gerekse ticari amaçlar için kullanılmaktadır. Türkiye'de kadastro hizmeti 3402 sayılı yasa hükümlerince Tapu ve Kadastro Genel Müdürlüğü tarafından verilmektedir. Türkiye'de Kadastro ve tapu işlemleri iki-boyutlu taşınmaz mal mülkiyeti esaslarına gore yürütülmektedir, ancak yeraltı metro hatları, boru hatları, iletişim hatları, yeraltı otopark ve alışveriş merkezleri gibi pek çok uygulama üç boyutlu mülkiyet yapısına sahiptir. Bunun sonucu olarak tapu müdürlüklerinde mülkiyetin kayıt altına alınması hususunda birtakım problemler yaşanmaktadır. Türkiye'de kadastro çalışmaları yurt genelinde tamamlanmıştır. Tapu Kadastro teşkilatı bu aşamadan sonra üç boyutlu kadastro kavramı ve uygulamalarını da içeren bir yol haritası belirlemelidir. Bu çalışmada Türkiye'nin mevcut kadastral sistemi değerlendirilmiş ve üç boyutlu mülkiyet uygulamaları hakkında belirlemeler yapılmıştır.

TURKISH CADASTRAL SYSTEM

The history of the land registration and cadastral works reach to the middle of the 19th century in Turkey. After establishing of Turkish Republic Cadastral works were started in 1925 under law No. 658 by the General Directorate of Land Registry and Cadastre (TKGM) (Yaşayan etal. 2011). Then cadastral work was started in some major cities and urban areas in 1934 under the law 2613. In 1950, the Land Registry Law numbered 5602 was put into practice to speed up cadastral work in rural areas. Known as 'land cadastre' was changed in 1964 and 1966 and became the Land Registry Law (No 766) (Demir, and Coruhlu 2008). Cadastral work had been carried out in urban and rural areas under two different laws until 1987. The Cadastre Law Numbered 3402 was put into practice to eliminate the problems originating from having two different laws and to gather all cadastral regulations into one law. However, in the forest areas the cadastral works are still carried out under a different law (Number 6831) undertaken by the General Directorate of Forests. Up to the 1990's over three hundred thousand cadastral maps were produced in non-digital (analogue) format. The production method, coordinate system, scale, and base type of these maps were different. Table 1 shows the distribution of maps by production method.

Table 1- The classification of cadastral maps in Turkey (Sisman 2014).

Method of Production	Number of Maps	(%)
Digital maps	258 801	41.6
Non-digital maps (photogrammetric and classical)	271 505	43.6
Non-digital maps (graphical)	91 804	14.8
Total	622 110	100.0

Cadastre Law numbered 3402 was amended by law numbered 5304 in 2005. It was include great changing about cadastral work, one of the most important changing was private sector could take a place in cadastral works with the new law of cadastre. After the last changing in cadastre law, the cadastral production rise fivefold in Turkey (Fig. 1). A total of 32982 (98.7%) units' cadastral works were completed in 2014 (URL 1)

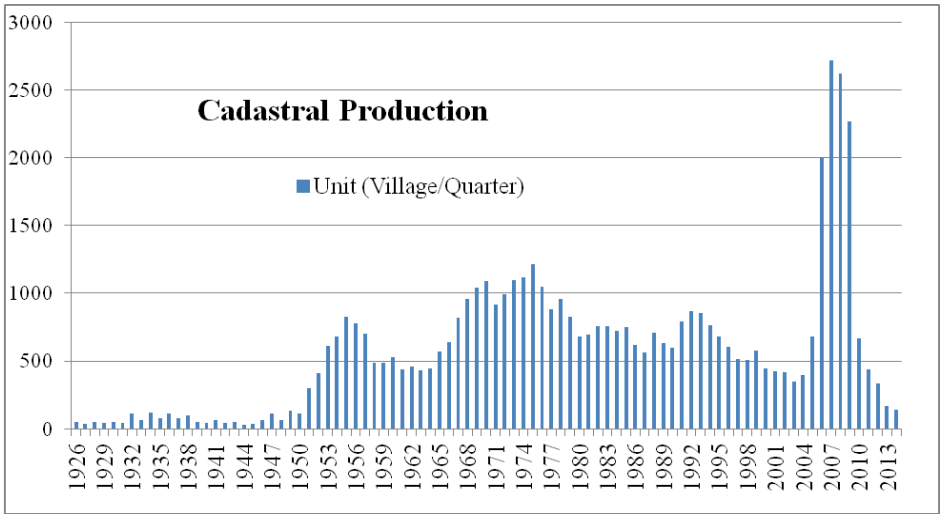


Fig. 1: Cadastral Production in Turkey (URL1)

THIRD DIMENSION IN CADASTRE

The first article of current Turkish Cadastre Law is instruct that "The purpose of the Turkish Cadastre Law is, defining boundaries and the legal status of real estate's and making cadastral or topographic cadastral map according to the national coordinate system and establishing Turkish Land Registry system and building the infrastructure of spatial information systems". (URL 2) .According the current cadastral law there isn't any obligation about surveying under surface objects in the cadastral works. As mentioned above about six hundred thousand cadastral maps were produced however most of them produced in two-dimension (XY). Recently, new cadastral maps have been produced in XYZ coordinates by the public and private sector depends on Turkish National Fundamental GPS Network standards (TUTGA) since 2005, but this kind of maps cannot be accepted as a three-dimension cadastral maps because we don't know about how to use the above surface and underground space (Aydın, 2008).

Cadastral parcels like living organisms, they can be divided two or more parts or, two or more parcels can be joint as a one parcel, in this way the owner of the parcels can be changed, but all of this process occurs in two-dimension surface (Fig. 2).

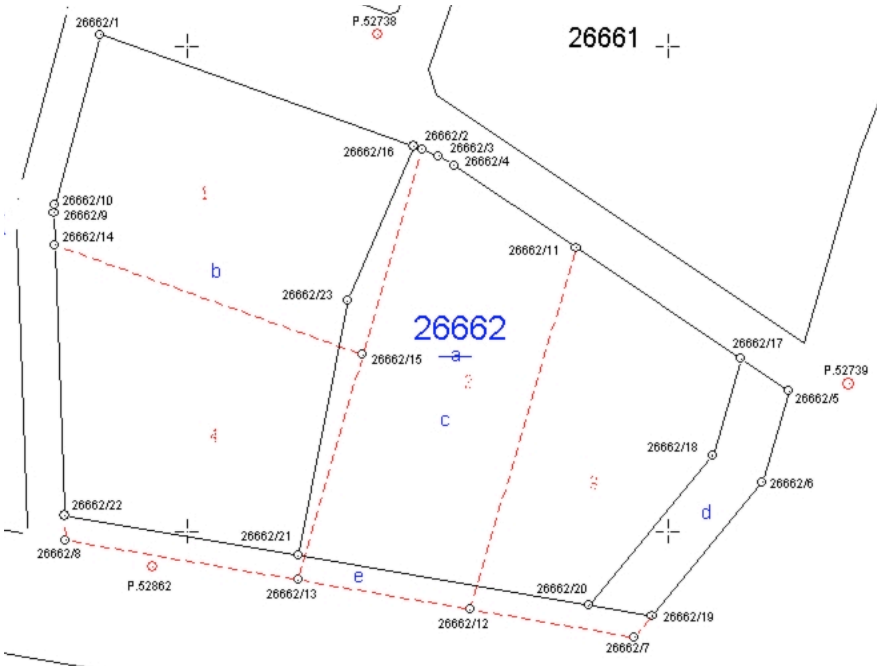


Fig. 2: Cadastral parcel changing

A building is built on a parcel, each separate unit of the building which located under or over the surface has to be registered in land register system as a property unit of the land parcel, so the ownership status of the land parcel completely changes and a three dimension ownership occurs according to the condominium law number 634. A pipe line project is applied in a region, using of some parcels will be restricted, therefore before project the all route of pipe line which located in registered parcels either expropriated or appurtenances procedure is applied for all parcels. After then, the route of pipe line is uploaded on cadastral map and a three dimension ownership occurs according to the Turkish Civil Law number 4721. But all

ownerships are drawn in two-dimension cadastral map. A three dimension cadastre is a cadastre which registers and gives insight into rights and restrictions not (only) on parcels but on three dimension property units, (Stoter, 2004) but in the current situation Turkish Cadastral system cannot be accepted as a three-dimension cadastral system.

Problems on Registration in 3D

Nowadays to provide growing demands of living in the city and to serve them better, in urban area land surface and subsurface is used, and especially their business centers has led to overlapping and interlocking constructions (Stoter, 2004). Subways, streets, rail roads, underground pipe lines, power lines, communication lines, drinking water, wastewater lines etc. are the important urban infrastructures (Table 2).

Table 2- The usage of underground and its surface structures (Aydin, 2008)

Under Surface	**Surface**
Metro stations	Car park, pavement, offices shops
Shopping centers	Road, pavement, building, offices shops
Pedestrian subways	Pavement
Parking lots	Road,
Bus/tram/railway stations	Car park, pavement, offices shops
Infrastructure Objects: Electricity, water, communication, cables, pipelines, sewers, etc.	---

As mentioned above there isn't any obligation about surveying under surface objects in the cadastral works according the current Turkish Cadastral Law. The boundaries of land parcels and other objects subject to registration are measured (Karataş, 2007) however so many objects located underground do not take a place in cadastral maps. Public places like roads, squares, bridges are not registered according to the Turkish cadastre law article 16 they only drawn in cadastral map (URL 2). This point is starting the problem of registration third dimension.

Some Cases about Infrastructural cadastre needs.

We can find interesting examples about third dimension ownership accident. In august 2006 a building contractors had pierced the tube of the Taksim-Levent subway while they were making a geological drilling (Fig. 3a, b). According to the news the parcel owner didn't get any permission and they didn't know there was a metro line under their parcel (URL 3). It was a dramatic accident; thankfully nobody was died or injured.

The BIST (IMKB) is one of the important stock exchange of the Europe. In November 2007 an excavator operator had broken off the main fiber optic cables of IMKB while he was digging of the street. It was an important accident thankfully nobody was died or injured but any stock market operation and trading activities weren't made in the morning session. Approximately 500 million dollars the stock market operation could not be performed in IMKB (URL 4).

(a) (b)

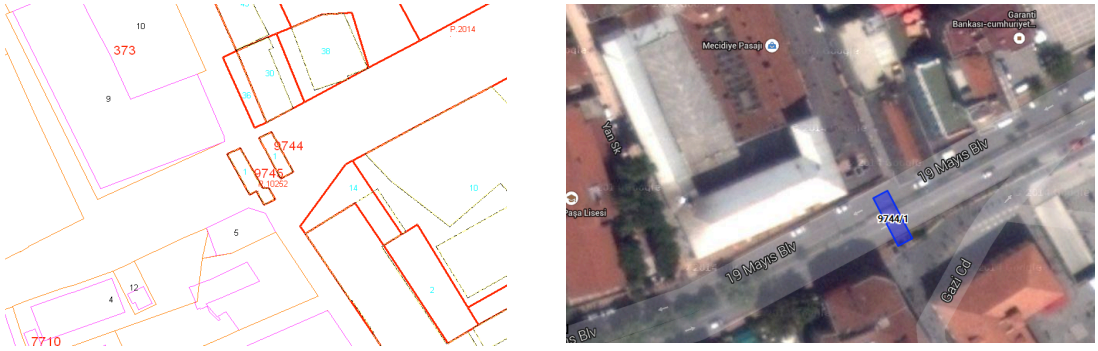
Fig. 3a, b: Pierced tube of the Taksim-Levent subway

Natural gas is an important fuel and a raw material in manufacturing. It was used electric power, industry, vehicles and homes. In Turkey 74 cities were provided with natural gas other 7 cities are in engineering or construction phase (URL 5) so almost all cities in Turkey used natural gas. Due to the natural gas is an explosive and flammable material, distributing natural gas to homes is an important and serious work. Although natural gas distributors work very carefully, a lot of accidents can happen. One of the important reasons of these accidents is unregistered infrastructure objects. Pipelines and other infrastructure objects don't belong to any registered parcel so they cannot be registered in city center.

The shops located under street (Fig. 4a, b) aren't registered according to the current cadastre law, because they don't belong to any registered parcel as pipe lines. To solve this problem TKGM has declared some opinions and streets were registered according to these opinions (Fig. 5a, b). Shops located under the street were registered as a real estate in spite of the cadastre law article 16.

(a) (b)

Fig. 4a, b: The shops located under street



(a) (b)

Fig. 5a, b: Registered a part of street

RESULTS

The current Turkish cadastral system can be defined two-dimension cadastre and there isn't any obligation about surveying and registering public places like roads, squares, bridges. Nowadays to provide growing demands of living in the city and to serve them better, in urban areas land surface and subsurface is used. Some infrastructure objects don't need registration like drink water and wastewater lines but we have to register tunnels, pipelines (natural gas, crude oil) metro lines, subways, pedestrian subways ect. But registering subsurface objects don't have any legal basis. Under these circumstances following works have to be done;

- Some regulations are needed about three-dimension cadastre
- Public places should be registered,
- The outlines of ownership must be defined, how deep or how height,
- Three dimension cadastre data model should be defined.

Growing population and developing technology made our world smaller. We have to recognize our world better.

REFERENCES

Aydin, C.E 2008, Usage of Underground Space for 3D Cadastre Purposes and Related Problems in Turkey Sensors 2008, 8, 6972-6983

Demir, O, Coruhlu Y.E. 2008, The graphical cadastre problem in Turkey: the case of Trabzon province. Sensors 2008, 8, 5560-5575.

Karataş K, 2007, Urban Technical Infrastructure Facilities, Cadastre and The Organization of Its Applications in Turkey, Phd Thesis, Blacksea Technical University, Institute of Natural Science,Trabzon.

Sisman A, 2014, An Experimental Design Approach on Georeferencing Boletim de Ciências Geodésicas, 20, 3, 548-561.

Stoter E.J, 2004 3D Cadastre, NCG Nederlandse Commissie voor Geodesie Netherlands Geodetic Commission Delft.

Yaşayan A, Erkan H, Seylam SG, 2011, Kadastro Kavramı Ve Türkiye Kadastrosu, TMMOB Harita ve Kadastro Mühendisleri Odası 13. Türkiye Harita Bilimsel ve Teknik Kurultayı 18-22 Nisan 2011, Ankara

URL 1 .http://www.e-tkbm.gov.tr/publisher/projeizleme.htm 20.02.2015

URL 2 http://mevzuat.basbakanlik.gov.tr/Kanunlar.aspx 10.01.2015.

URL 3 http://www.hurriyet.com.tr/gundem/4898570.asp 21.12.2014.

URL 4 http://www.gazetevatan.com/500-milyon-dolarlik-kepce-149289-ekonomi 16.12.2014.

URL 5 http://www.botas.gov.tr 22.02.2015

LAND RECORDING OF OBJECTS SUBJECT TO 3D CADASTRE IN TURKEY

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SUMMARY

Turkey have been encountered the fact of densely urbanization with population growth particularly since 1950. At the present day, even though the population of some cities is steady or decreasing population of some cities is increasing rapidly. In Turkey, especially to meet the growing demands of living in big cities and to give them better services, multidimensional use of urban land such as water, wastewater, electricity, natural gas, metro, underground bazaar etc. structures are built. Since land recording and representation in Turkey are mostly done in 2D, 3D representations of such structures can be remained incapable. Three-dimensional cadastral information requires 3D cadastre of property rights, 3D planning and construction of surface and underground engineering projects, land management, life and goods safety. In this study, in structures subject to 3D cadastre problems of property, registration and representation are explained by different example cases.

Key words: 3B Cadastre, Property Rights, Subsurface/Utility Cadastre, Servitude/Easement.

INTRODUCTION

The proprietary right is a right that allow the owner to say "This is mine and it belongs to me" and that has historically been subjected to discussions (Erdoğan, 2012). The proprietary right is not nowadays considered as an unlimited right in developed legal systems and legal approaches. It is a social right. Besides the authorities, it also loads some obligations to its owner. It has been accepted that it can be limited for the public interest (S. Tuğrul, 2004). Following the right to live, the proprietary right is one of the main fundamental rights. In United Nations' Universal Declaration of Human Rights and European Convention on Human Rights, it is stated as fundamental human right.

According to Turkish Legislation, the proprietary right is protected constitutionally and legally. By stating in Constitution of Turkish Republic that *anybody has the proprietary right and right of succession and these rights can be limited by the law for public interest*, the proprietary right has been taken under legal protection. Moreover, in our constitution, it is also stated that the protection of proprietary right cannot be against the public interest. According to the 683th Article of Turkish Civil Code (TCC) Nr: 4721, the owner of the proprietary right is given the right to use, benefit and dispose on the properties within the legal limits.

In order to secure the proprietary right, land register records are kept under the responsibility of General Directorate of Land Registry and Cadastre. As real estate, these can be recorded to the Book of Real Estate Registers:
1. Lands,
2. Independent and permanent rights on the real estates,
3. Single spaces subjected to condominium (TCC, Article Nr: 998).

The properties that are not subjected to private ownership and that are reserved for public benefit are not recorded to the land registry records unless there is any real right that requires recording. If a recorded real estate becomes a real estate that is not subjected to the recording, then it is removed from the registry records (TCC, Article Nr: 999).

The proprietary right is sometimes limited especially in urban lands for investments such as water, wastewater, metro, electricity, monorail, bridge, and etc. These limitations are done vertical and horizontal to the property for public interest.

BOUNDARIES OF THE REAL ESTATE

The horizontal boundaries of a real estate are the boundaries that are shown on earth and cadastral map sheet. If these are not consistent with each other, then the boundaries in cadastral map sheet are taken into consideration. The boundaries of the real estates are under the guarantee of the Governments through the land registry and cadastral map sheets. In order to eliminate any illegal infringement towards them, the owners are authorized for prevention through filing a claim. These boundaries may be intervened for public interest due to the technical arrangements made on land (Bıyık, Karataş, 2003).

The real estates don't consist of only 2 dimension (2D), but they have three-dimensional (3D) use, and their boundaries exhibit variation due to this reason. That's why; besides the horizontal boundaries, the real estate has also vertical scope. Vertical scope consists of extensions below and on the surface of real estate (Figure 1). Land ownership should be considered as a right on surface with its extensions below and above the surface (Zevkliler, 1976).

The boundaries of the proprietary right are arranged in 718th Article of the Turkish Civil Code. In this article, it is stated that *"The ownership on the land covers the air on the land and the earth segments as long as there is a benefit in its use. In the scope of this ownership, the structures, plants, and resources are included, the legal limitations are kept."* The owner of the real estate must content himself/herself with boundaries to the extent that are useful for him/her, and he/she has the right of ownership within these limits. The rights of disposition and ownership on the areas other than that are under authority and disposal of the Government (Köprülü, 2015).

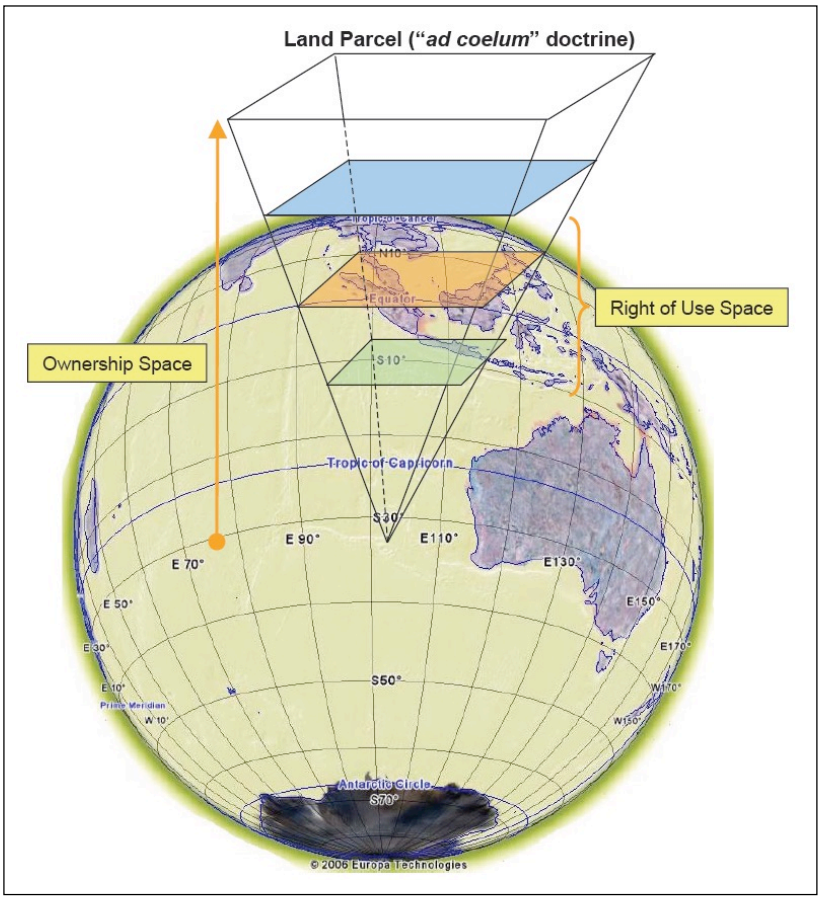

Figure 1. Right of ownership and use of space (Chong Seng Chai, 2015)

Servitude

Servitude is the limited real rights that follow the right of possession and that must be recorded to land registry. These rights don't provide their owners with all the rights and authorities that the right of possession does, they only provide limited rights. These rights are the authorities of use and usufruct. They constrict the rights and authorities of the owner of the real estate in related real estates (Karagöz, 1995). The servitudes are arranged in Articles 779-838 of Civil Code.

Servitude in favor of real estate; it is a load put on a real estate in favor of another real estate, and it forces the owner of real estate to avoid from enjoying some of the rights provided by the right of possession or to put up with using the loaded real estate in a certain way (TCC, Article Nr: 779). According to TCC, the types of servitudes are as follows:

- Right of way.
- Installment servitude.
- Right of resource.
- Right of construction.
- Right of usufruct.
- Right of habitation.
- Other servitudes.

In order to establish the servitudes, recording to the land recording is required. In achieving and recording this right, save as otherwise provided, the provisions related with the ownership of a real estate are implemented.

According to the provisions of civil code; the owner of a real estate also owns the below, above, surface, any complementary parts, products, and details of that property. This ownership can be limited only through special laws. Hence, it is a legal necessity to establish easement for the establishment of any kind of infrastructure bringing costs to the use of the real estate (Karataş et al., 2006).

In our legal order, the infrastructure facilities can be seen in several types. The establishment of infrastructure that is arranged as servitudes in Civil Code, Law of Expropriation, and Building Law are as follows:

a) Installment servitude,
b) Right of Construction,
c) Right of Way,
d) Right of Resource (Dörtgöz, 1996).

RELATIONSHIP BETWEEN URBAN TECHNICAL INFRASTRUCTURE AND OWNERSHIP

Infrastructures are not considered to be involved in the class of real estates determined by 704th article of Civil Code. Cadastre doesn't work with real estates that are not drawn in cadastral map sheets, recorded to the book of real estate registers not subjected to the ownership. For this reason, the survey and mapping of the underground plants are not seen to be a cadastral activity. The lines passing through common properties such as roads, squares, parks, parking areas, green fields, kindergartens, and etc. are mapped by surveying, and these maps are utilized when necessary (Figure 2).

The absence of any legal obligation for preparing the maps presenting the locations of technical infrastructures leads to problems in mapping, maintenance, repair, planning and coordination. According to the report prepared by Court of Accounts, it is seen that approximately 44.2% of the technical infrastructures of technical infrastructure institutions in 16 large cities have been given coordinates in digital and non-digital environments. It is seen that this portion is lower than 10% in Telekom and Electricity Distribution Directorates (Table 1). This situation makes it difficult to increase the service quality, to make planning healthier, and to ensure the coordination by utilizing the infrastructural information systems.

The relationship between infrastructures and cadastre exists is related with passage of them through the registered lands. When they passed through real estates registered to the name of private and legal entities, either they are expropriated or the servitude right is established (TCC, Article Nr: 727-744) (Tüdeş and Bıyık, 2001).

Figure 2. Natural Gas Map

Table 1 The actual situation of the lines belonging to technical infrastructure institutions (Court of Accounts, 2008)

Institution	Length of Infrastructure Line (m)	Coordinated in Digital Environment (%)	Non-Coordinated in Digital Environment (%)	Coordinated in Non-Digital Environment (%)	Non-Coordinated in Non-Digital Environment (%)
Water-Wastewater	97,743,856	55.5	16.5	9.0	19.0
Natural Gas	12,963,017	98.0	0.0	0.0	2.0
Electricity	35,561.246	7.0	37.0	3.0	53.0
Telekom	36,507,972	4.0	17.0	0.0	79.0
TOTAL	**182,776,091**	**38.8**	**19.4**	**5.4**	**36.4**

In our legal system, the infrastructures are seen in several forms. The establishment of infrastructure that is arranged as servitudes in Civil Code, Law of Expropriation, and Building Law are as follows:

a) Installment servitude,
b) Right of Construction,
c) Right of Way,
d) Right of Resource (Dörtgöz, 1996).

Three-Dimensional (3D) Cadastre and Urban Technical Infrastructures

According to the Law of Cadastre in force in our country, there is no obligation regarding to surveying the boundaries of the facilities located under the ground. In cadastral operations, the boundaries above the ground are surveyed. For this reason, the cadastral bases doesn't show the technical infrastructure facilities that are located below and above the ground; they are limited to the surface, and hence prepared as two-dimensional (Karataş, 2007).

According to the Article Nr: 1 of Cadastre Law Nr: 3402 (RG:09.07.1987/19512) and to the Regulation of Large-Scaled Map and Map Information Generation (RG:15.07.2005/25876), it is required to produce cadastral topographical maps by obtaining the location information of the boundaries of real estates in 3D. In practice, a small portion of the information about the third dimension is derived and archived, and only the maps of the locations of the places constructed through technical department of the cadastre are prepared in 3D, so in the way carrying the topographical character (DPT, 2005). But this practice should not be understood as three-dimensional (3D), because, the 3D cadastral systems provide the information beyond the typical plan information. These can be used in securing the rights on the surface, below and under the property. So, below, above and surface of the land can be identified, analyzed in this way, and then can be improved and operated in best way (Papaefthymiou et al., 2004).

In order to satisfy the increasing demands of the people living in today's cities and to provide them with better service, the below, above and surface of the urban lands are used intensely. For this reason, the 3D cadastral information gains more information due to the reasons such as proprietary rights, underground and aboveground planning, implementation of underground and aboveground engineering projects, land management, and ensuring the security of life and property. In this case, recording the gradually increasing and complicating use of urban lands, and better-determining the proprietary rights by better-determining the rights and limitations require the preparation of cadastre in 3D (Figure 3).

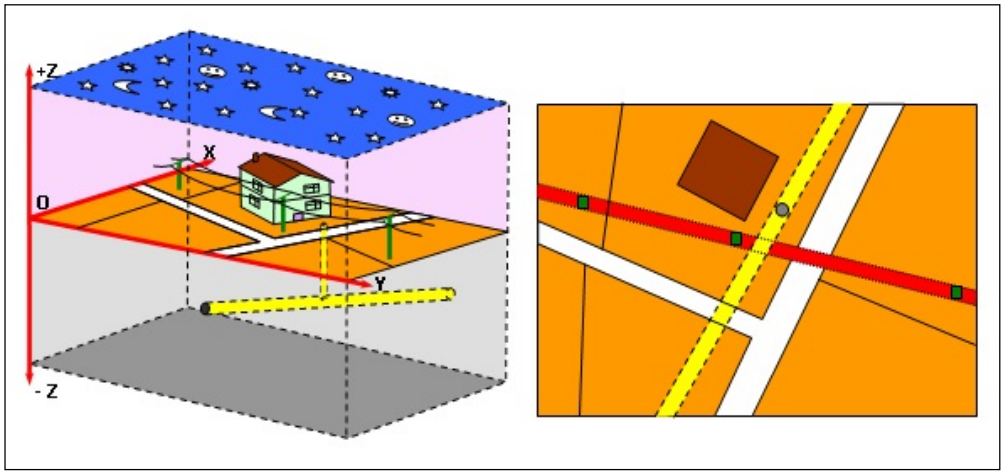

Figure 3. Real 3D world and the presentation in 2D

The 2D recording system used in cadastre of Holland is not completely capable of representing the records, where the 3rd dimension is an important factor. The recording cases, where the 3rd dimension element gains importance, are as follows:
- Structures constructed above each other (underground parking areas),
- Infrastructures under and above the ground (tunnel, metro, and tramway (on the ground)),
- Historical artifacts,
- Apartments,
- Location and ownership of the cable and pipes,
- Polluted zones (Stoter and Zevenbergen, 2001),
- Resource exploration permissions.

All these cases involving the 3rd dimension are required in limiting the legal statuses of real estates. Hence, the legal statuses of the objects mentioned above can be better-identified (Stoter, 2002).

EXAMPLES OF 3D CADASTRE IN TURKEY

In this section, the information about the practice of 3D cadastre from various cities of Turkey will be given.

İstanbul Yerebatan Cistern (Palace)

İstanbul, which is one of the oldest cities of the world and has been capital city of 3 global empires, is a very strong and magnificent bridge between the past and today. Napoleon Bonaparte has emphasized the size and importance of the İstanbul with the statement of "*If there is only one country in the world, then İstanbul would be its capital city*." Besides numerous structures made by hand, it has also magnificent natural beauties (URL-1, 2015)

Located in Sultanahmet Square, the Yerebatan Cistern (Palace) has been constructed in year 542 upon the order of Justinian, the 1st emperor of Byzantine, in order to satisfy the water requirements of Large Palace on other side of the Horse Square (Figure 4).

Figure 4. The map of the region of Yerebatan Cistern

The cistern known as Yerebatan Palace is 145 m in length (inside) and 65 m in width. It covers approximately 9800 square-meters. 12 lines of the pillars, 28 pillars in each line, carry the brick belts and the vaults reinforced by them. 8 of a total of 336 pillars have been taken into a meshed shears in north, and 37 pillars in southwest have been stayed within a curtain walls covering them (Figure 5).

Figure 5. Inside of the Yerebatan Cistern (URL-2, 2006).

Despite that it was dry inside in final restoration; there is still 1.2 m of water in the cistern since water has leaked into the cistern again. In Yerebatan cistern operated by İstanbul Kültür ve Sanat Ürünleri Ticaret A.Ş., various cultural activities of İstanbul Metropolitan Municipality are organized (URL-3, 2006).

In book of real estate registers, the record of Yerebatan cistern is in 14th parcel of 37th cadastral block, 41st map section, Alemdar Neighborhood, Eminönü district (Figure 6). In section of statements, it is stated that "This water cistern covers the sections under the grounds of

All of block 38, parcels 31, 33, 34, 35, 45, 46, 47, 54, 67, 68
Block 39, parcels 3, 4 and
Block 54, parcels 11, 12, 13, 15, and 35, and
Parts of block 37, parcel 29
Block 38, parcels 27, 30, 32, 36, 43, 77
Block 39, parcel 1
And block 54, parcels 1, 2, 4, 5, 6, 8, 16, 33, and 34."

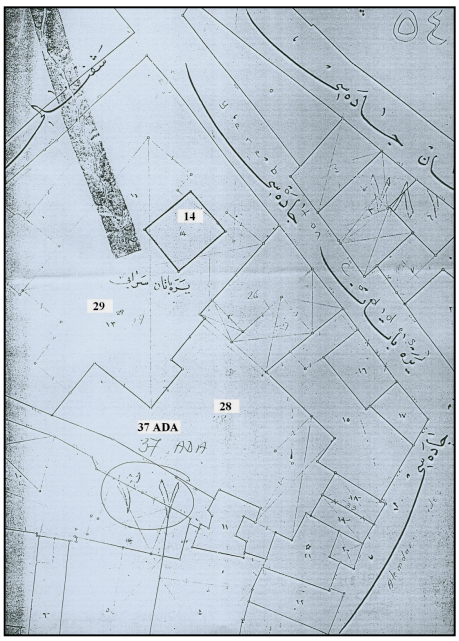

Figure 6. Status of Yerebatan Cistern in cadastral map section

In correspondences of the institutions about Yerebatan Cistern, various cadastral block and parcel numbers are used. Among the parcels stated in statements section of the record of Yerebatan Cistern in book of real estate registers, there is not the statement of historical artifact or the cultural value requiring protection in related pages of cadastral block 54 parcel 15 and block 37 parcel 29.

There is not any clear information about which points on the ground the Yerebatan Cistern corresponds with. Moreover, there is also no location information. There are many structures on Yerebatan Cistern belonging to private persons and legal entities.

Underground Bazaars in İstanbul

The underground passages and bazaars of İstanbul Metropolitan Municipality are located below the roads and squared in various locations of İstanbul (Table 2). The shops constructed in Galata Bridge are under the road and over the sea.

İstanbul Metropolitan Municipality benefits from its shops in underground bazaars and subways by renting them for various purposes. None of them is recorded in land registry (Figure 7/a, b, c).

Table 2 The underground passages and bazaars of İstanbul Metropolitan Municipality

UNDERGROUND PASSAGE AND BAZAARS OF IMM	
UNDERGROUND SPACES	**NUMBER OF UNITS**
Aksaray Underground Bazaar	137
Saraçhane Haşim İşcan Subway	41
Zeyrek Subway	15
Unkapanı Subway	20
Unkapanı Under-bridge Shops	13
Vezneciler Subway	10
Eminönü Yenicami Unkapanı-Side Subway	10
Eminönü Yenicami Subway	22
Eminönü Çarşıkapı Subway	14
Galata Bridge	112

a) b) c)

Figure 7 a) Galata Bridge, b) Eminönü Tramway Subway, c) Aksaray underground bazaar

Underground Bazaar in Kayseri

By Kayseri Metropolitan Municipality, 200 shops have been constructed under the area that is seen as garden, square and road in development plan of Cumhuriyet Square in Serçeönü Neighborhood of Kocasinan district of Kayseri city (Figure 8). 200 masonry shops under the road and square in map section 292-301, cadastral block 2951, and parcel 1 have been recorded to the name of Kayseri Metropolitan Municipality, and condominium has been established.

Figure 8. View of Underground Bazaar

Despite that the land recording of the underground bazaars in İstanbul has not been made, the underground bazaar in Kayseri has been recorded in land registry. In rulings of the Department of Disposals of General Directorate of Land Registry and Cadastre about the land recording or underground bazaars, there are explanations within the frame of legislations. Accordingly; in sum, if the shops are under the road, the constant and private right of building is established by recording it as road to the name of municipality after bordering the projections of the shops on the road. Then the condominium is established on the right of building.

Structures in Mardin

Mardin, where the languages and religions met and the cultures are mixing into each other, with its texture that has hosted 30 civilizations in history, its culture, mysterious streets and architectural structure has taken its place among the rare cities of the world (URL-4, 2015) (Figure 9). Mardin is one of the residential areas of Southeastern Anatolia, which exhibit strange structuring patterns. The city has been established in east-to-west direction on an area,

which is 2500m in length and 500m in width, in southern shoulders of Mazı Mounts. When looking from castle, the houses of Mardin seem like stacked up (URL-5, 2015).

Figure 9 View of Mardin City (URL-6, 2015)

In restricting and surveying drawings prepared during cadastral determination of the structures partially overlapping each other, the lettering is made by taking the actual measurements of the structure, which is ex-parte used by the related user, on the ground. Condominium is established in favor of the immovable on top and against the favor of the immovable at bottom. The records have been made by stating in related columns of the book of real estate registers.

Based on the deed records, the projections of some of the structures on actual ground completely overlap. In determinations regarding with such locations, the immovable on the ground is given a parcel number. And for the immovable on upper floor, by preparing condominium plot as permanent right, the "Condominium" right is established (Figure 10).

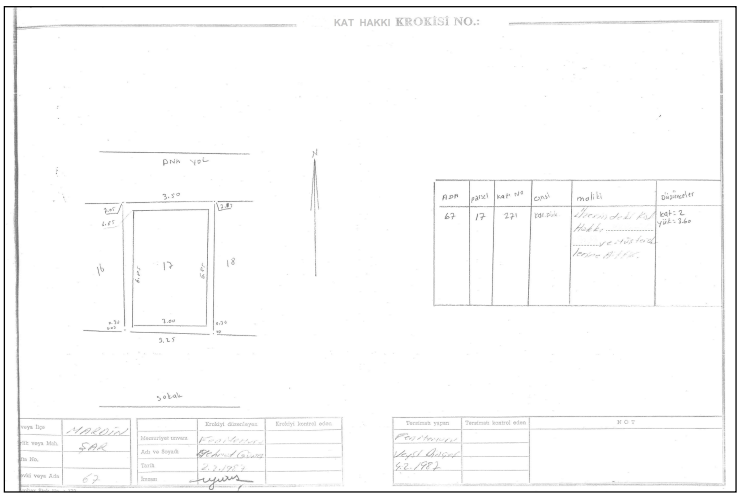

Figure 10. Condominium Diagram and Photo

In the books of real estate registers related with such structures, the registries have been recorded by giving the plot-parcel number of the ground to the structure (Figure 11). The record of the structure, which is above the structure on the ground and doesn't occupy any area on the ground, is made as "Condominium" in the page following the page of the book of real estate registers, where the structure on the ground is recorded. Hence, both of the structures are recorded. The records of the structures on bottom and top in the book of real estate registers are linked to each other. So, the connection between the immovables can be ensured (Figure 12).

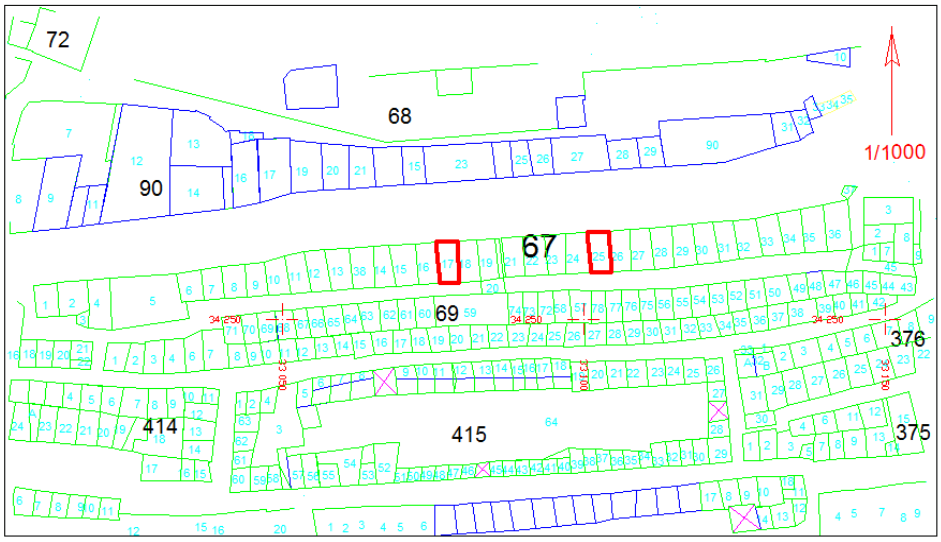

Figure 11. Map of the location of real estates

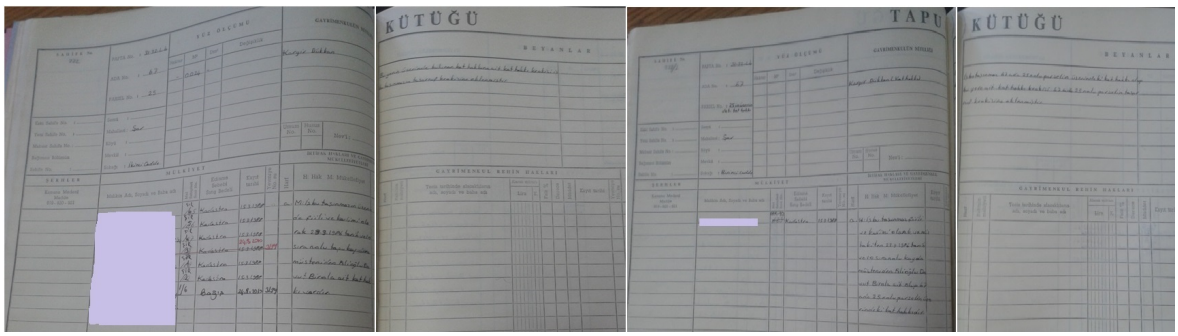

Figure 12. Pages of real estates with condominium from the Book of Real Estate Registers

Natural Structures in Cappadocia (Nevşehir)

Cappadocia (Nevşehir) region has emerged as a result of the corrosion of soft layers, which have consisted of lava and ashes vomited from Volcano Hasan and Volcano Güllü in Erciyes approximately 60 million years ago, by the precipitation and winds for millions of years. This event created a 100-150 m thick tuff layer having different hardness levels in that region. The tuff layer is covered with a thin lava layer consisting of hard basalt. The basalt has broken apart into small pieces, and started to abrade the soft tuff, and the geological structures called

Fairy Chimneys have been formed under the effects of other climatic events (Yılmaz et al., 2010). (Figure 13).

Figure 13. Cappadocia (Nevşehir) region

General Directorate of Real Estate Registry and Cadastre, due to the uncertainties in land recording due to the unique characteristics of the region, has sent a committee to that region in 12.07.1974. That committee has made examinations on that side, and prepared a report in 12.12.1974. The restrictions, determinations and recordings have been made in accordance with that report. In this study, information will be given about the Fairy Chimneys and pigeon lofts.

Fairy Chimneys

According to the Historical Artifacts Law Nr: 1710 (RG: 6.5.1973/14527), the Fairy Chimneys have been approved as historical artifacts. For the fairy chimneys recorded as historical artifacts;

a) In restriction and determining the ones being used as house, barn, hayloft, cellar and pigeon loft by the citizens, the land registers must be taken as ground regardless of being within or out of the boundaries of protection predicted by the Law Nr: 1710 and determined by the Law of Construction. They must be recorded to the name of person seeming as owner, and the statement indicating that it is Fairy Chimney must be enclosed into statements section of the book of real estate registers and the protocol (Figure 14).

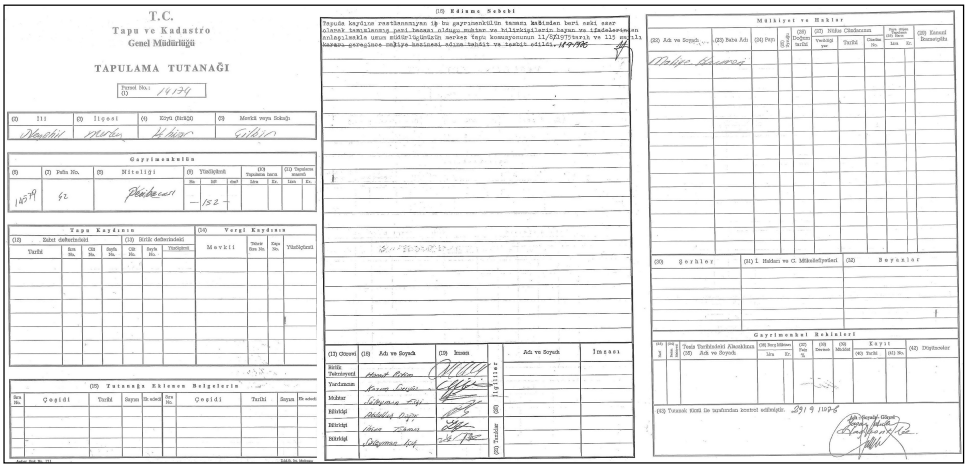

Figure 14 Land Recording Protocol of Fairy Chimney

b) If the fairy chimneys are located on any deedless land, after determining and measuring the outer boundaries, they must be recorded to the name of Treasury. In the section of "Qualifications", the statement of "Fairy Chimney" must be enclosed. When there is any achieved right on it, the independent and permanent right must be established.

c) If the fairy chimneys are located on a deeded land, by taking the land registry reports as ground, they should be restricted recorded to the name of the owner seen in deed certificate. In section of "Statements", the presence of fairy chimneys must be enclosed.

d) If the fairy chimneys are located on a public land, by determining and measuring the outer boundaries, they must be recorded to the name of Treasury under parcel number. In the section of "Qualifications", the statement of "Fairy Chimney" must be enclosed (Figure 15).

Pigeon Lofts

Pigeon lofts have been formed by linking the chambers, which have formed in shoulders consisting of tuff rocks having similar characteristics and rose with steep slope in valleys, with external world. Because of the use of the fertilizer (pigeon feces), they have been passed down from generations to generations or they have passed in other hands through selling. Restriction and determination of the pigeon lofts;

a) For the private-registered pigeon lofts, the restrictions and registrations should be made to the name of deed owner in accordance with the letters shown in vertical drawing. The condominium should be established by opening an independent page in the book of real estate registers by establishing the connection between the parcels recorded to the name of Treasury. It is required to state "Pigeon Loft" in qualifications section and "… m^2 space drilled into the rock" in amount section, and the internal areas of these pigeon lofts should not be surveyed, it is enough to receive information from the owners or experts.

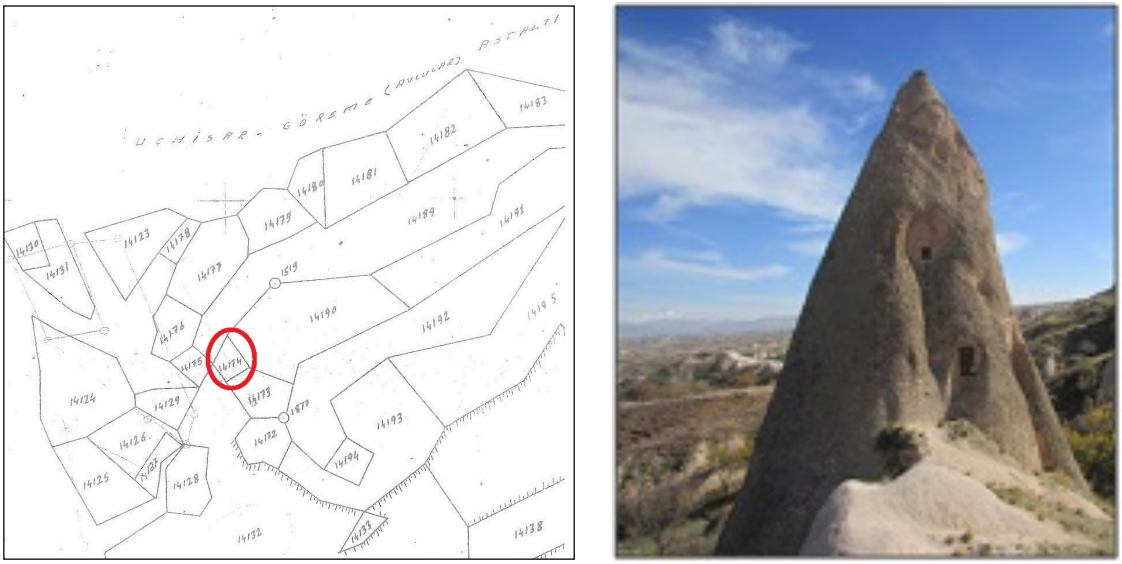

Figure 15. Location of fairy chimney on the map and its photo

b) If it can be understand from the documents or expert opinions that the deedless pigeon lofts have been opened by making effort or bought from anybody else, they must be recorded to the name of owner as independent and permanent right, and the slope should be associated with the main parcel.

In lettering the pigeon lofts on the vertical drawing, the lettering should be made separately for each pigeon loft group, and the slope should be measured only for the regions related with the pigeon lofts, rather than measuring the entire valley in the main parcel.

c) If the pigeon lofts are located in miscellaneous rock blocks, by measuring the ground and middle section of the rock block, the emerging parcel must be recorded to the name of Treasury. By opening a new land recording page by linking with the main parcel and by lettering for the pigeon lofts, the right of the construction must be established.

The pigeon lofts in cadastral block 6 and parcel 14067 that has been registered as historical artifact has been used by woman named P. A. for more than 20 years with the title of owner. It has been stated in "Statements" section that the pigeon loft on the castle, of which ownership has been recorded to the name of Treasury, on the parcel 14067 belongs to woman named P.E. (Figure 16).

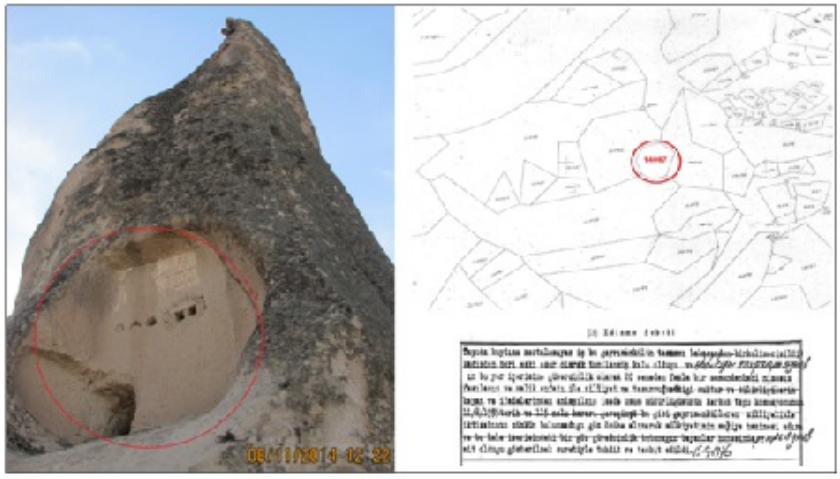

Figure 16. Cadastral map of parcel 14067, and the explanation of the reason of acquisition

Electricity Transmission Lines

It has been ensured in 4th article of the Law of Expropriation Nr: 2942 that the expropriation can be performed for construction of the facilities, which don't totally remove the use of ownership by passing under and on the ground, such as energy transmission lines, oil and natural gas pipeline, and water conveyance lines can be made through condominium, rather than expropriating the ownership.

The areas, where the posts of energy transmission lines are grounded, are expropriated. For the areas on the course of lines and the security distances corresponding with vertical/horizontal oscillation ranges of them, the condominium is established in favor of Electricity Company (URL-7, 2012) (Figure 17).

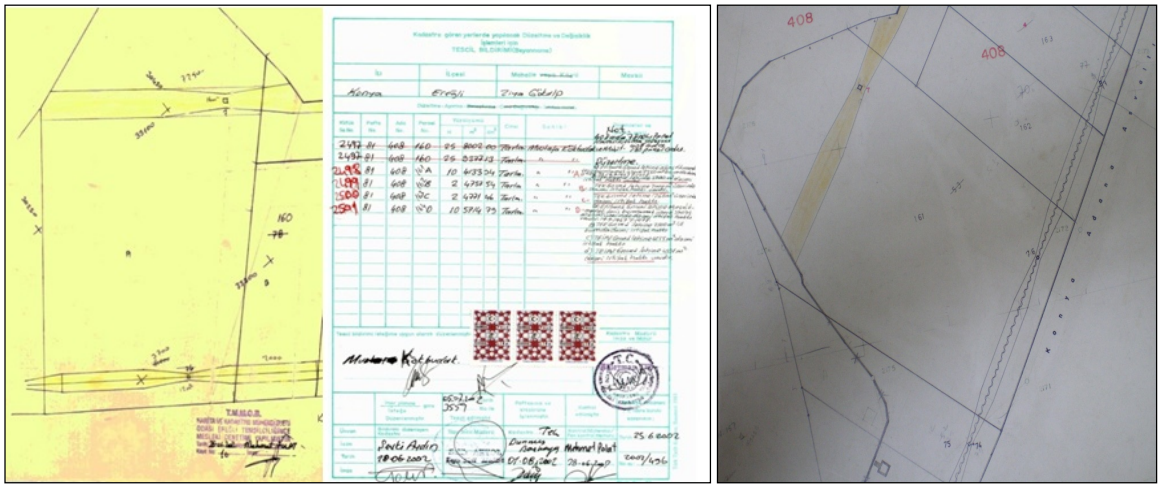

Figure 17. Certificate of the Record of Condominium and the Cadastral Map View

RESULTS and CONCLUSIONS

While the requests for lands in order to meet the increasing needs of the people living in our cities increase, the lands in city centers stay constant. It is tried to satisfy the needs such as metro, water, wastewater, electricity, natural gas, underground parking areas, and etc. by using the land multi-dimensionally. During the works, the limitations are brought to the proprietary right in vertical and horizontal direction. The records of limitations on the land in vertical direction from legal aspect are made by establishing the condominium.

In past, the underground cities, fairy chimneys, and etc. have been formed by nature or human hands, and now there are complex structures that have been constructed in various architectural styles. In recording and representing these structures, 2D cadastre is not efficient at all. The cadastre is supposed to provide sufficient level of data used as fundamental basement for meeting the demands of increasing population, and to sustainably ensure the sophisticated ownership relations.

Nowadays, since 2D cadastral system cannot completely meet the recording and representing requirements of 3D use, the necessity of 3D and 4D cadastres emerges. This situation should not be seen as a deficiency of Cadastre Institution, it should be considered from the aspect of increasing necessities of human beings, technologic developments, and changes in human-ownership relations. Cadastre Institution should prepare multidimensional studies by enlarging the scope and context of the cadastral works in the way covering the future necessities and in parallel with the change. Technologic level and economic size are sufficient for ensuring the modern cadastral works.

Since the technical infrastructures such as electricity, water, wastewater, natural gas, and communication are not considered as immovable in Turkish Civil Code, there is no legal obligation in registering them. There isn't the information about the locations of technical infrastructures at desired level. For this reason, problems occur in planning, maintenance, repair, coordination, and the establishment of spatial information system. Especially in our

cities, in order to secure the proprietary right under legal protection, to ensure the security if life and property, and for sustainable and management, 3D information should be obtained.

REFERENCES

Chong Seng Chai, 2015, http://www.juritecture.net/3ddoc/119.pdf, 19.03.2015
Dörtgöz G. Ö., 1996. Altyapı Tesislerinin Tapu Sicilindeki Hukuksal Durumu, Mülkiyet Dergisi, 20, 22-25.
Erdoğan, Y., 2012, http://www.msb.gov.tr/ayim/Ayim_makale_detay.asp?IDNO=34 12.12.2012
Karagöz, M., 1995. Haritacılıkta Taşınmaz Hukuku, TMMOB Harita ve Kadastro Odası Yayını, Ders Kitapları Dizisi:3, Yeni Fersa Matbaası, Ankara,
Karataş, K., Bıyık, C., Demir, O., 2006, The Underground Cadastre and Its Implementations in Turkey, Shaping the Change XXIII FIG Congress, Munich, Germany, October 8-13, 2006.
Karataş, K., 2007. Kentsel Teknik Altyapı Tesisleri, Kadastrosu ve Türkiye'deki Uygulamaların Organizasyonu, Doktora Tezi, KTÜ, Fen Bilimleri Enstitüsü, Trabzon.
Köprülü, B., 2015, Taşınmaz Mülkiyetinin Yatay Ve Düşey Sınırlandırılmasına İlişkin Başlıca Hukuki Sorunlar
http://www.hkmo.org.tr/resimler/ekler/K6TH_c8dba7d0df1c4a7_ek.pdf 16.03.2015
Papaefthymio, M., Labropoulos, T. ve Zentelis, P., 2004. 3-D Cadastre in Greece-Legal, Physical and Practical Issues Application on Santorini Island.
http://www.fig.net/pub/athens/papers/ts25/TS25_6_Labropoulos_et_al.pdf 20.05.2004.
Saim Tuğrul, S., 2004, Kamu Hukuku Açısından Mülkiyet Hakkı ve Sınırlandırılması, Kazancı Kitap, İstanbul.
Sayıştay Başkanlığı, 2008. Büyükşehir Belediyelerinde Altyapı Faaliyetlerinin Koordinasyonu Performans Denetim Raporu.
Stoter, J.E. ve J. Zevenbergen, 2001. Changes in the Definition of Property: A Considereation for A 3D cadastral registration system. http://www.fig.net/pub/proceedings/korea/full-papers/pdf/session27/stoter-zevenbergen.pdf 07.09.2001.
Stoter, J.E., 2002. Needs, Possibilities and Constraints to Develop A 3D Cadastral Registration System. http://www.gdmc.nl/publications/2000/3D_cadastral_registration.pdf, 17.10.2002.
Tüdeş, T., Bıyık, C., 2001. Kadastro Bilgisi, Birinci Baskı, KTÜ Basımevi, Trabzon,
Yılmaz, H.M., Yakar, M, Mutluoğlu, Ö, Yurt, K, Karataş, K., Yılmaztürk, F., İklimsel Faktörlerin Kapadokya Bölgesindeki Toprak Aşınmasına Etkisi, Harita Teknolojileri Elektronik Dergisi Cilt: 2 , No: 1, 2010 (13-19)
Zevkliler, A., 1976, Gayrimenkul Sınır İhtilafları, Pars Matbaası, Ankara, 1976
URL-1, 2015, http://tr.wikipedia.org/wiki/Vikipedi:VikiProje_Wikimania_2013_İstanbul/tr 16.03.15.
URL-2, 2006 http://www.kultursanat.org/mekanlar/ys.html 30.10.2006.
URL-3, 2006, http://www.yerebatan.com/indextr.html, 30.10.2006.
URL-4, 2015, http://www.tid.web.tr/ortak_icerik/tid.web/154/29-%20mardin.pdf, 19.03.2015
URL-5, 2015, http://www.mardinliyim.com/images/ana-slayt/2b.jpg 19.03.2015
URL-6, 2015, http://www.mardin.gov.tr/web/mardinvaliligi/kultursanatdetay.asp?kategori=MARD%DDN%20EVLER%DD 19.03.2015
URL-7, 2012, http://www.teias.gov.tr/KAMULASTIRMA/PDF/Genelkamulast%C4%B1rma ozeti.pdf 09.04.2012

AUTOMATED EXTRACTION OF BUILDINGS FROM AERIAL LIDAR POINT CLOUD AND DIGITAL IMAGING DATASETS FOR 3D CADASTRE - PRELIMINARY RESULTS

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SUMMARY

The demand for accurate 3D mapping of buildings has increased due to the spatial detail required by engineers, architects and city planners. An accurate information about location and dimension of building features is important for cadastral, city modeling, infrastructure mapping and safety analysis in an urban environment. LiDAR technology provides rapid, continuous and cost effective capability to acquire 3D geospatial information. In this paper, we present an automated approach for extracting building features from integrated aerial LiDAR point cloud and digital imaging datasets. Our approach is based on the assumption that the LiDAR data can be used to distinguish between high and low rise objects while the multispectral dataset can be used to filter out vegetation from the data. We make a use of LiDAR elevation and multiple echo attributes to extract building objects. Morphological operations are applied to the extracted building objects in order to complete their shapes and remove noise. We tested our automated buildings extraction approach on aerial LiDAR point cloud and digital imaging datasets of Istanbul city. The successful extraction of building objects validates our automated approach.

Key words: LiDAR, attributes, digital imaging, buildings extraction.

INTRODUCTION

3D extraction of buildings is required for many applications such as cadastral, city modeling, infrastructure mapping and urban growth analysis. Moreover, an accurate information about location and dimension of building features provides crucial input for the fire-safety analysis and managing other hazards in an urban environment. Traditionally, building boundaries are delineated based on manual or semi-automated reconstruction from close-range and satellite images. These processes are time-consuming and limited to 2D reconstruction of building objects. The lack of automated methods can be attributed to problems in finding an appropriate information from the data and the complexity in the scene (Elberink, 2008).

Advances in geospatial data acquisition techniques have transformed the concept of 2D building modeling to 3D. Light Detection And Ranging (LiDAR) enables 3D modeling of real world environment by measuring the time of return of an emitted light pulse (Kumar et al.,

2013). Laser scanning systems use this technology to acquire an accurately georeferenced set of highly dense LiDAR point cloud data (Kumar, 2012). These systems provide high level of automation during data acquisition and have an ability to capture data beneath tree's canopy. The applicability of laser scanning systems continue to prove their worth in geospatial mapping due to the rapid, continuous and cost effective 3D data acquisition capability (Barber et al., 2006). LiDAR data records a number of attributes including elevation, intensity, pulse width, multiple echo and range information, all of which can be used for extracting various features (Kumar et al., 2015). The methods developed for segmenting LiDAR data are mostly based on the identification of planar surfaces and the classification of point cloud data based on its attributes (Vosselman, 2009).

Automated extraction of building objects has been a topic of intensive research since last few years. Several approaches have been developed over the past decade for extracting urban building features from LiDAR data. Mumtaz et al. (2009) developed a semi-automated approach for extracting building objects from the integration of airborne LiDAR and digital imaging datasets. In their approach, Normalized Digital Surface Model (NDSM) was generated from LiDAR and a Normalized Differential Vegetation Index (NDVI) was developed from digital image. Both the NDSM and NDVI values were thresholded and then morphological operations were applied to binary image for extracting building features. However, in their approach, some of the large vehicles and industrial installations were incorrectly identified as buildings while smaller buildings were missed. Oda et al. (2004) proposed a method to extract building features from aerial LiDAR data in which Digital Surface Model (DSM) was segmented and then Hough transformation was applied for extracting building boundaries. Finally, 3D building model was created by attaching vertical walls from aerial image to each of the extracted building polygon. The proposed method did not addressed the problem of extracting inclined roof. Pu et al. (2006) presented an approach to automatically extract building features from terrestrial laser scanning data. LiDAR point cloud was segmented using the planar surface growing algorithm and then several human-knowledge driven feature constraints such as size, position, direction and topology were applied to extract building features. Mancini et al. (2009) used multi-source aerial LiDAR and multispectral dataset to automatically extract urban building and road objects. They involved multi-class supervised pixel classification using adaptive boosting algorithm to classify buildings, grass, land and tree objects. Finally, filtration and Hough transformation techniques were applied to extract linear road and roundabout features. Rutzinger et al. (2009) extracted vertical walls from mobile and airborne laser scanning data. A region growing segmentation technique based on 3D Hough transform was applied to extract planar surfaces from point cloud data and then the extracted segments were analyzed based on their inclination, size and dimension.

Most of the approaches developed for extracting buildings require semi-automated or manual intervention. The developed methods are also associated with the misclassification of large vehicles, trees and other features as building objects. There is a need to develop an operational and automated approach for extracting building features. LiDAR data provides elevation, intensity, pulse width and multiple echo attributes which can be a useful source of information for extracting building objects. The integration of multispectral digital images with LiDAR data will provide more efficient and accurate extraction of buildings. The use of LiDAR data provides to distinguish between high and low rise objects while multispectral

data helps to distinguish canopies from the building objects. In this paper, we present some preliminary results based on automated extraction of building objects from the integration of aerial LiDAR and multispectral digital imaging datasets. In Section 2, we detail our methodology to extract buildings while in Section 3, we test our approach on aerial LiDAR and multispectral digital imaging dataset. Finally, we discuss the test results and make conclusions in Section 4.

METHODOLOGY

Our methodology is based on the integration of aerial LiDAR and digital imaging dataset to extract buildings. A workflow of the automated building extraction approach is shown in Figure 1. We make a use of digital imaging dataset to remove canopies from the data. The available multispectral digital image consisted of blue, green and red bands which represent brightness information of the targets. We utilize a low reflectance property of the vegetation in the red band to suppress them in the data. We apply empirically estimated T_1 threshold value to the red band image in order to remove the vegetation area.

LiDAR data provides multiple echo information which refers to multiple return of echo pulses from the targets. We filter out multiple reflected points and retain those points that record a single reflection. These single return reflection points belong to buildings, roads and other solid objects. The filtered points are used to generate Digital Surface Model (DSM) using the maximum elevation value of points within the cell while natural neighborhood interpolation method is used to estimate values for cells that do not have points within their extent. We use the thresholded red band image to remove vegetation area from the DSM. We apply empirically estimated T_2 threshold value to the DSM in order to remove ground level objects such as roads, parking areas etc. and retain high rise building features in the data. In order to complete the extracted buildings and remove noise that is introduced through the use of thresholding, we make a use of binary morphological operations. The thresholded DSM is converted into a binary image and is processed using morphological operations. We apply the morphological opening operation in which the binary image is eroded followed by their dilation while the morphological closing operation is applied by dilating the binary image followed by their erosion. In the dilation operation, a binary matrix element is used to dilate the image pixels and in the erosion operation, a binary matrix element is used to erode the image pixels (Kumar et al., 2014). Thus, the morphological operations applied to the binary image are able to extract inherent shapes of the building objects and to remove noise. Finally, contour boundary of each building object is identified and then LiDAR points inside each boundary are estimated to provide 3D generation of extracted building objects.

EXPERIMENTATION

We tested our automated building extraction approach on aerial LiDAR and multispectral image datasets of Istanbul city covering 89.76 Km^2 which was acquired in October, 2012. The multispectral image consisted of three bands i.e. red, blue and green with ground sampling distance of 0.1 m and 8-bit radiometric resolution. The LiDAR data consisted of 2647912 points with 0.18 m spacing. The point cloud was associated with elevation, intensity and multiple echo attributes. The empirically estimated $T_1 = 130$ threshold value was applied to red band image in order to remove vegetation.

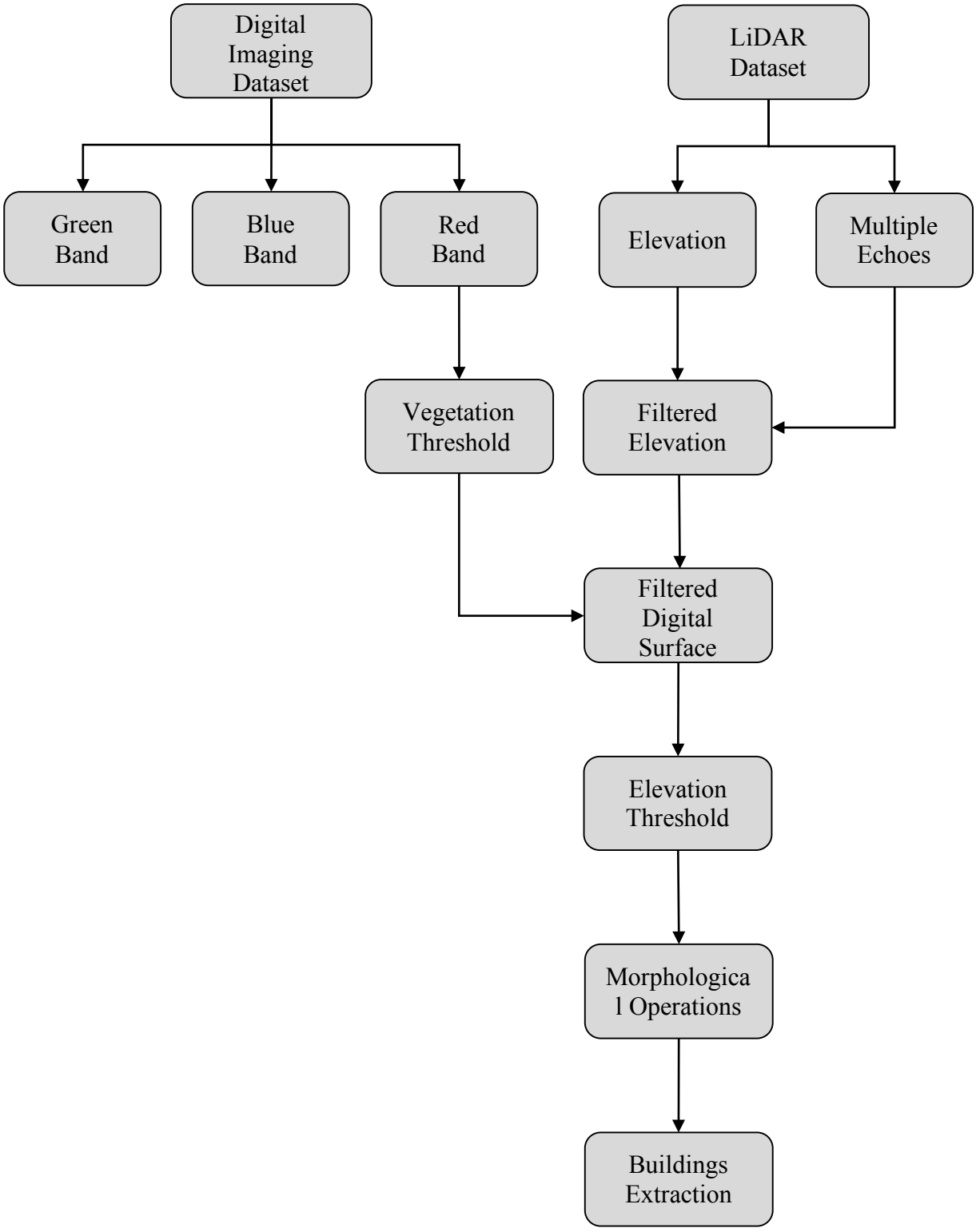

Figure 1: Automated buildings extraction approach.

After filtering out multiple reflected points, the LiDAR data consisted of 2376200 points. The DSM was generated from the maximum elevation value of filtered points with 0.1 m cell size. We applied the empirically estimated $T_2 = 45$ threshold value to the DSM. The morphological opening and closing operations were applied using 3x3 matrix element. The tested multispectral image is shown in Figure 1(a) while the automated extracted 2D and 3D building objects are shown in Figures 1(b) and 2 respectively.

Figure 2: (a) Input multispectral image and automated extracted (b) 2D building objects.

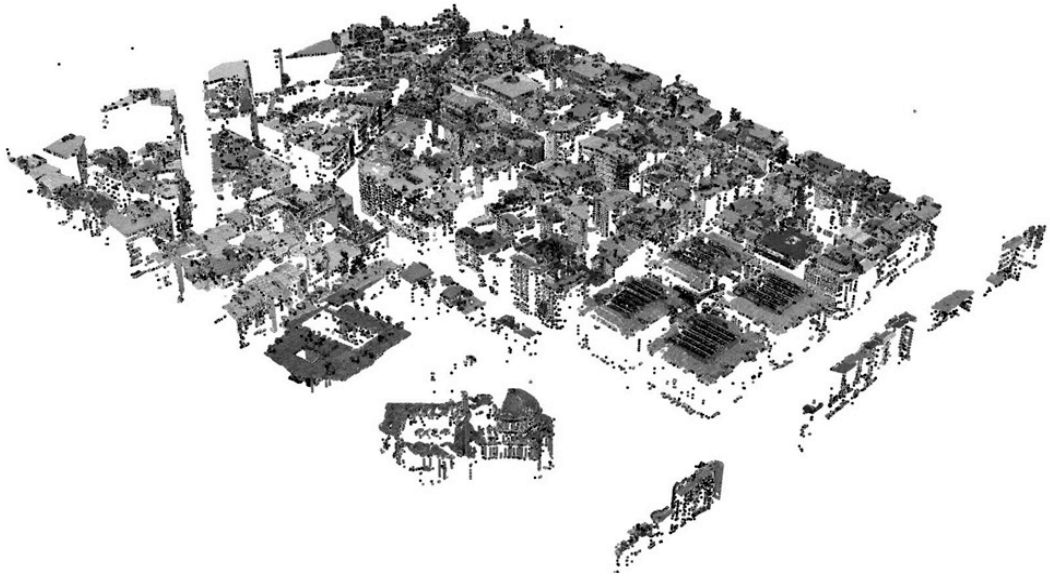

Figure 3: Automated extracted 3D building objects

DISCUSSION AND CONCLUSION

Our automated approach was able to successfully extract the building objects from aerial multispectral digital imaging and LiDAR point cloud datasets. Some of the building objects along the lower-left side of the data were missed while some of the roads were extracted along the middle-right side of the data as false positive as seen in Figure 2(b). There is a need to validate these extraction results with respect to the ground truth. We used red band in the multispectral image to remove canopies from the data however, this information was not adequate. The use of both the near infra red and red bands would provide us to estimate Normalized Differential Vegetation Index (NDVI) which would be more efficient in removing vegetation areas from the data. The use of multiple echo attribute in the LiDAR data was further helpful in retaining the points that belong to buildings, roads and other solid objects. LiDAR data provides intensity attribute that represents the maximum amplitude of a reflected pulse. Intensity values can be used to differentiate buildings from other terrain objects. The minimum elevation value of points within the cell can be used to generate Digital Terrain Model (DTM) which can be further used to estimate Normalized Differential Surface Model (NDSM). NDSM values can be more efficiently used to remove ground level objects and retain building objects as they represent absolute height values of the terrain objects. The opening and closing morphological operations were applied to complete the shapes of extracted buildings and remove noise. There is a need of their inclusive use in which the dimensions of the extracted objects can be used to remove non-building objects. This research study presents preliminary results for extracting building objects from integrated aerial LiDAR point cloud and digital imaging datasets. In future, we intend to develop more comprehensive approach for automated and operational extraction of building objects.

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REFERENCES

Barber, D., Mills, J. and Smithvoysey, S. (2008). Geometric validation of a ground-based mobile laser scanning system. *ISPRS Journal of Photogrammetry and Remote Sensing*, 63 (1), pp. 128-141.

Elberink, S. O. (2008). Problems in automated building reconstruction based on dense airborne laser scanning data. *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences,* 37 (XXX), pp. 93-98.

Kumar, P. (2012). Road features extraction using terrestrial mobile laser scanning system. National University of Ireland Maynooth, *http://eprints.maynoothuniversity.ie/3995*, 300 p., 25-January-2015.

Kumar, P., McElhinney, C. P., Lewis, P. and McCarthy, T. (2013). An automated algorithm for extracting road edges from terrestrial mobile LiDAR data. *ISPRS Journal of Photogrammetry and Remote Sensing,* 85, pp. 44-55.

Kumar, P., McElhinney, C. P., Lewis, P. and McCarthy, T. (2014). Automated road markings extraction from mobile laser scanning data. *International Journal of Applied Earth Observation and Geoinformation*, 32, pp. 125-137.

Kumar, P., Lewis, P., McElhinney, C. P. and Rahman, A. A. (2015). An algorithm for automated estimation of road roughness from mobile laser scanning data. *The Photogrammetric Record*, 30 (149), pp. 1-16.

Mancini, A., Frontoni, E. and Zingaretti, P. (2009). Automatic extraction of urban objects from multi-source aerial data. *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 38 (3/W4), pp. 13-18.

Mumtaz, S. and Mooney, K. (2009). A semi-automatic approach to object extraction from a combination of image and laser data, *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 38(3/W4), pp. 53-58.

Oda, K., Takano, T., Doihara, T. and Shibasaki, R. (2004). Automatic building extraction and 3D city modeling from LiDAR data based on Hough transformation. *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 35 (B3), pp. 277-280.

Pu, S. and Vosselman, G (2006). Automatic extraction of building features from terrestrial laser scanning. *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences,* 36(5), pp. 25-27.

Rutzinger, M., Elberink, S. J. O., Pu, S. and Vosselman, G. (2009). Automatic extraction of vertical walls from mobile and airborne laser scanning data. *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 38 (W8), pp. 7-11.

Vosselman, G. (2009). Advanced point cloud processing, *Proc. Photogrammetric Week*, Stuttgart, 7-11 September, pp. 137-146.

REGISTRATION OF STRUCTURED IMMOVABLE PROPERTIES: 3D CADASTRE IMPLEMENTATION IN TURKEY

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SUMMARY

The aim of the study is to express registration of structured immovable properties in 3D cadastral concept as condominium thanks to selected real implementation and original flowchart in order to see the current situation on this market in Turkey. As stated by the Turkish Governmental Institution there have been produced about 58 million cadastral parcels in Turkey, and about 35 million were surveyed via cadastral works with required point accuracy. Especially in urban areas, buildings or structures have been built on parcels according to the zoning plans. Registration of immovable properties on land registry is an important issue for all areas in Turkey. The building process on a parcel can be reflected to land registry in two ways as "construction servitude" before construction and as" condominium" after construction. In this study, the documents and projects which are necessary to transform ownership type from the book of real estate registers into the condominium on the book of property ownership. In addition surveys, both land and building, have to be controlled by which institution. Finally, 3D cadastre implementation for buildings or structures known as condominium, which can be established for at least one independent unit or more, will be discussed in terms of registration, control, survey and legal perspective.

Key words: 3D cadastre, land object, registration, condominium, independent unit

ÖZET

Bu çalışmanın amacı yapılı taşınmaz malların tescil durumlarının ve ülkemiz arazi piyasasındaki kat mülkiyeti kavramının, seçilen gerçek uygulamalar ve bu uygulamalardaki iş akışları sayesinde, 3B kadastro perspektifi altında açıklanmasıdır. Yetkili kamu kurumu (TKGM) verilerine göre, ülkemizde bu zamana kadar yaklaşık 58 milyon parsel üretildiği, ancak bunların 35 milyonunun arzu edilen nokta-konum hassasiyetine sahip olduğu belirtilmiştir. Bu 35 milyon parsel özellikle kentsel alanlarda üzerinde bina veya yapı olan taşınmazlar olarak imar planı uyarınca inşa edilmişlerdir. Tapu sicili üzerinde taşınmazların tescil edilmesi ülkemizdeki tüm alanlar, ki bunların bazılarında kadastro çalışmaları tamamlanmış ve tapu siciline tesciller yapılmış olup bazılarında kadastro çalışmaları henüz tamamlanmamıştır, açısından önemli bir durumdur. Parsel üzerindeki yapının tescil durumu kat mülkiyeti başlığı altında tapu siciline iki yöntemle yansıtılabilir. Bunlar yapı inşa edilmeden önce kat irtifakı tesisi ve yapı inşa edildikten sonra kat mülkiyeti tesisi ile yapılabilir. Bu çalışma sayesinde, mülkiyet tescilinin tapu kütüğünden kat mülkiyeti kütüğüne

dönüşüm için hangi tip belge ve projelerin hazırlanması gerektiği ile hem parcel ve hemde üzerindeki yapının ölçümlerinin hangi yöntemlerle ve hangi kurumlar tarafından kontrol edilmesi gerektiği araştırılacaktır. Sonuç olarak, en azından bir veya birden fazla bağımsız bölümün tesis edilebileceği kat mülkiyeti olarak bilinen bina/yapı temelli 3B kadastro uygulaması, tescil, kontrol, ölçüm ve yasal açılardan ele alınarak tartışılacaktır.

INTRODUCTION

3D registraation process will be investigated in detail (Official Gazette, 1965). Registration process of properties on land registry should be explained firstly. Registration of properties was defined in Turkish Civil Law number 4721. Article 997 says that "land registry, which consisted of the book of real estate registers and the book of condominiums, has been used to register the rights of immovable property". Article 998 says that "immovable property is recorded in the land registry as follows: 1-Land, 2-Independent and permanent rights for immovable property, 3-Single or independent places, which are subject to condominium ownership."

Studies and registration on property rights are considered today as integrated with real estate, land management models, and 3D-cadastre applications (Aien et al., 2013). Traditionally, land and construction information, which includes geometric, visual and legal data for each property unit, independent section, or common place, has been two-dimensional (2D) and based on 2D land parcels (Kalantari et al., 2008).

3D data that describes the physical dimension of a land parcel and building, while encapsulating the legal information, has the potential to address the complexities of current processes. In this article, the authors addressed the physical world, that is, sourcing the geometry of a 3D model (i.e., building dimensions, semantics, and indoor plans) that will allow for high-level analysis and management and 2D land and property information registration in Melbourne. Integrated approaches can be used for land parcel boundary information, façade, roof and indoors (Jazayeri et al., 2014).

This study is not concerned with surveying methods of parcel boundaries, structure boundaries, floors, independent sections, façade or shared spaces. Rather, this article focuses on the registration process and registration progress according to law 634, condominiums in Turkey. This process also covers the legal world, the physical world and 3D land and property, like Jazayeri's work, and covers registration issues (Figure 1). The secondary aim of the artilce is also to discuss the visualization from 3D buildings/structures on the cadastral system in Turkey.

Can Land Registry and Cadastral System be able to show 3D structures like to Spanish in terms of both registraiton and visualization? Moreover, whenever an independent unit is to be sold to someone, Is it possible to make the buyer see the unit on the screen of a Land Registry or Cadastre Office in Turkey? Especially in recent years, the Turkish Cadastral and Registirial System which is conducted by the General Directorate of Cadastre and Land Registry (GDLRC) can make use of the advantages of e-governance and visualizaiton events thanks to two e-governental application which are TAKBİS and MEGSİS.

TAKBİS (Tapu ve Kadastro Bilgi Sistemi in Turkish): One of the most basic e-government applications that aims to ensure that ownership information is computerized and any type of query can be made across Turkey. Its objective is to ensure that Title Deed and Cadastre records across Turkey are computerized and all activities are carried out through a computer system so private as well as public properties are effectively monitored and checked (URL-6, 2015).

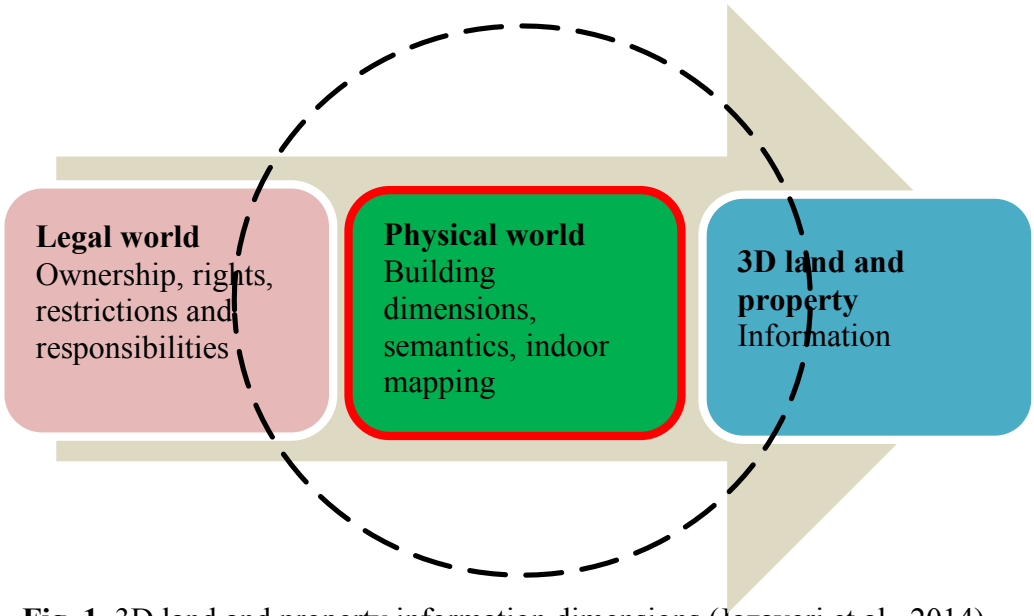

Fig. 1. 3D land and property information dimensions (Jazayeri et al., 2014)

As seen from the figure 2 Spanish Cadastre can make use of the advantages of 3D visualitions on cadastral duties together with parcels boundaries, and building photographies and also other non-graphical information (Doner et al., 2010).

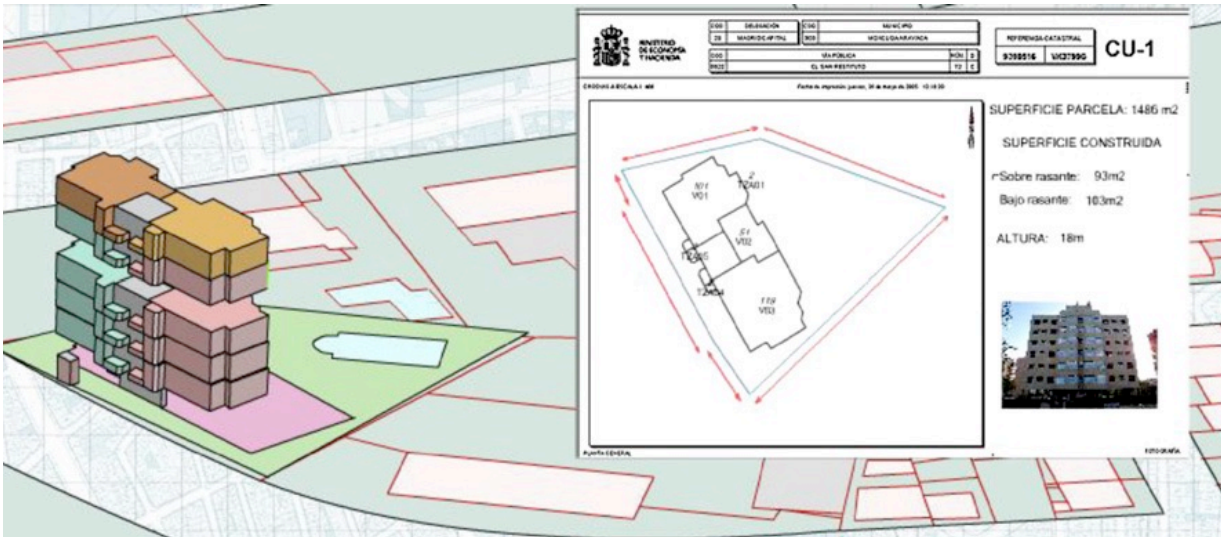

Fig. 2. 3D impression of individual units with floor sketch, photography and relevant attributes (courtesy to the Spanish cadastre) (Doner et al., 2010)

MEGSİS (Mekansal Gayrimenkul Sistemi in Turkish) It is an open-source application developed by the Land Registry and Cadaster General Directorate, where cadaster data are collected by the central system from local users in the cadaster offices in digital .cad format and are harmonized with land registry data in order to be submitted to stakeholder institution, organization, municipalities and citizens by e-government link. Studies held under Spatial Property System (MEGSİS) are collected under four main topics. i) Web-based application software ii) International standard map services iii) E-Government Services iv) Orthophoto Services (URL-7, 2015).

Figure 3 shows that TAKBİS and MEGSİS can reflect their own information for third parties. It is seen in figure 3 that the two systems can be queried and matched together at the same time on one screen thanks to the e-government application of GDLRC from the website of http://parselsorgu.tkgm.gov.tr/. But, a question can arise from someone, are these e-government applications, efficient and effective both for structured and unstructured properties in Turkey? The question can be investigated thanks to this article by exploring the current situations.

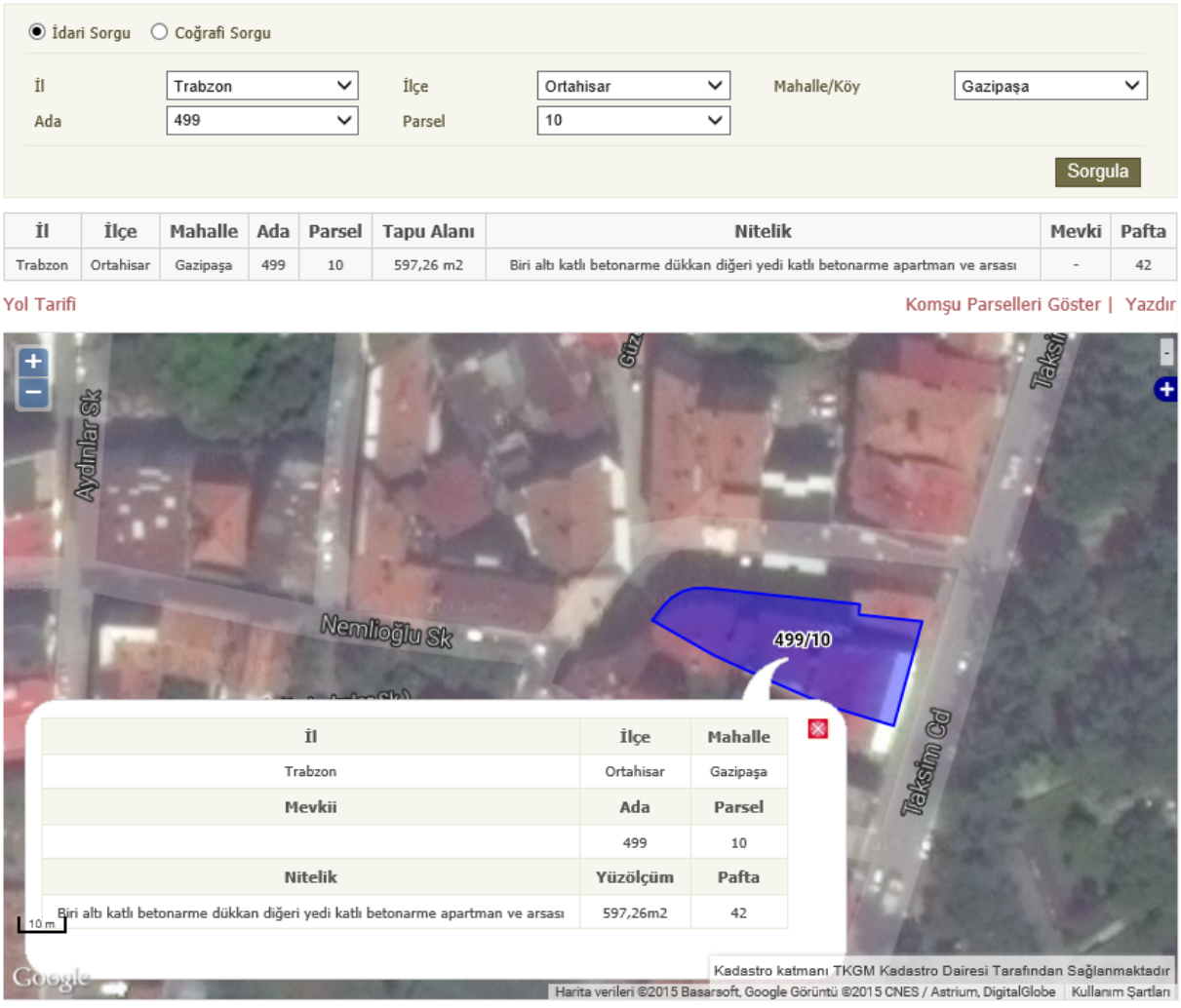

Fig.3. A query for a parcel from GDLRC's e-governance application

LEGAL FRAMEWORK

A title deed is defined as the "proof of one's rights on a land" (Dale and McLaughlin, 1999). The Register of Title Deeds is the name given to all registers, books, and documents kept by the state to indicate the owners of immovable properties and their legal status (Tüdeş and Bıyık, 1997). The Register of Title Deeds responds the "who" and "how" questions with regard to a piece of property (Henssen, 1995).

Property rights are guaranteed by international declarations and conventions, as outlined in Article 17 of the Universal Declaration of Human Rights, which was adopted and declared by the General Assembly of the United Nations on December 10, 1948 (URL-3, 2014).

Property rights are guaranteed by Article 1, Protocol no.11 of the European Convention on Human Rights on the protection of the human rights and fundamental freedoms, signed in Rome on November 4, 1950 (URL-4, 2014).

Property rights are also constitutionally guaranteed in Turkey, according to article 35 of the Constitution of the Republic of Turkey on October 18, 1982 (Official Gazette, 1982a).

Taking advantage of some applications about this matter can contribute to the understanding of this article. Even if the investigation of the transformation process from property ownership in unconstructed buildings into condominiums is intended thanks to current-real implementation and its original documentation can also help facilitate a better understanding of this subject. First, there is a legal framework related to ownership and condominiums.

To establish condominiums for building or structures, a list of all independent units, with their valuation and land share and construction management plan, have to be prepared to register them on the land registry, in accordance with law 634 (Official Gazette, 1965)

Land Plans Regulation
This regulation was put into practice in 2008, associated with law numbers 4721 and 634. It aims to draw the layout plan along with buildings/structures with parcel corner points and building corner points on the ground and to draw plans for independent units with their number. Therefore, building or structures within parcel(s) or block(s) can be related to cadastral coordinates and cadastral bases as layout plans. In addition, all plans of independent sections, can be prepared with their independent section numbers (Official Gazette, 2008).

As known, all ownership types for each structure or building in registerable areas must be transformed into condominiums with the required documents detailed below. For example, before starting construction on a structure or building, projects must be prepared by engineers and architects with construction details, such as architectural, static, electric, and mechanical details. Then, all projects must be controlled and evaluated as to whether they follow laws and regulations. If all projects and their controls can be properly suitable to laws and regulations, a construction permit can be prepared for the structure. After receiving the construction permits, the construction process can begin. After completing construction in accordance with construction permit-based projects, the occupancy permit can be prepared. After applying for an occupancy permit, construction, projects, and construction permits are evaluated whether

they are the same or not. If all of these can be evaluated as suitable for each other or minor defaults occurred within the tolerance given by laws, an occupancy permit can be prepared. Once again, condominiums can be established for the construction(s) or building(s).

Building(s), type,the number of independent units, the area of common place, the number of floors, the list of independent units with their market value, land share, and the construction management plan have to be prepared by the owners. Then, all independent units can be registered on the title deed as a condominium and all documents to be kept in the Land Registry Office. Therefore, the building stock can be known easily. Thus, all structures and buildings must be registered on the land registry with all current details related to projects, management plans, independent sections, etc., in the name of 3D registration according to the 3D cadastre. Due to the transformation of the ownership type of these buildings into condominium, required data will be acquired to succeed the Turkish 3D cadastre.

MATERIALS AND METHOD

Property ownership can be defined in two ways according to the laws on the subject of land registry. The blue title deed form can be produced in two ways: one for unstructured properties, such as land (urban and rural), and one for the structuring but not the registration of condominiums. Condominium processes with a fresh example is seen in detail. First of all, a land registry or title deed for unstructured property (tapu senedi in Turkish) can be seen in figure 4 below.

Fig.4. the Display of property (unstructured) selected example

A condominium covers the independent units with additions and common areas in a building for the registration of property ownership. Independent units in a building or structure can obtain only its own title deed. Title deeds for both additions cannot be produced; they have to be matched with independent unit and common areas.

Property Law 634, article 1, explains that for departments of completed structures, such as floors, apartments, business offices, shops, stores, cellars and warehouses, which are separately used, the independent property rights can be established by owners or co-owners.

Subsequent articles explain that buildings, apartments, inns, building communities and other structures located in parcels on the land must be registered on a land registry legally to owners. In the Turkish Cadastral System, a parcel has one land registration page in the Directorate of Land Registry. In addition, if the type of ownership for a building is property ownership or condominiums, every independent section has its own land registration page on the same parcel. First, the owner of a structured property has to obtain permission for his/her property in the form of an occupancy permit given by public authorities according to legal regulations. An occupancy permit is a document given by relevant Municipality/Provincial Special Administration and ensures that a building or structure complies with the relevant bylaws and codes and is safe for people to live in or to use (URL-4, 2014). An occupancy permit indicates that the building was built according to a construction permit in acceptance of governmental institutions, such as a municipality in urban areas and a special provincial administration in rural areas.

It is one of the 35 title deed records (26 shops in A Block and 9 flats in B Block) from the constuctured buildings after that establishment of condominium. The building was constructed on the parcel as two blocks A and B with a total 35 independent sections. The ownership of the parcel was transformed into property ownership or condominium with 35 title deeds.

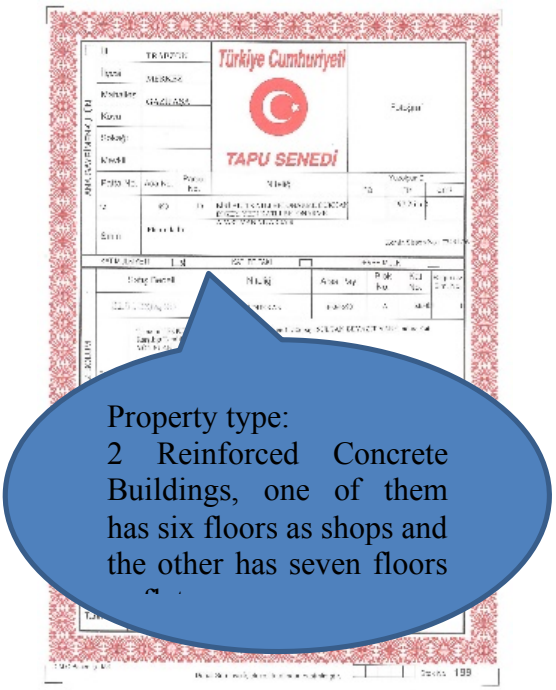

Fig.5. Title Deed of property selected example (structured)

FINDINGS

The current situation of all buildings in urban areas must be matched with the title deed registry record according to law 634. First, the status should be changed regarding the type of property, and the flat has to be registered in the records. After that, the ownership transformation process, from an unstructured property to a structured legal property, can be done perfectly. This process is also given via a graphical structure to be understandable for everyone who intends to comprehend this subject, as shown in figure 6 below.

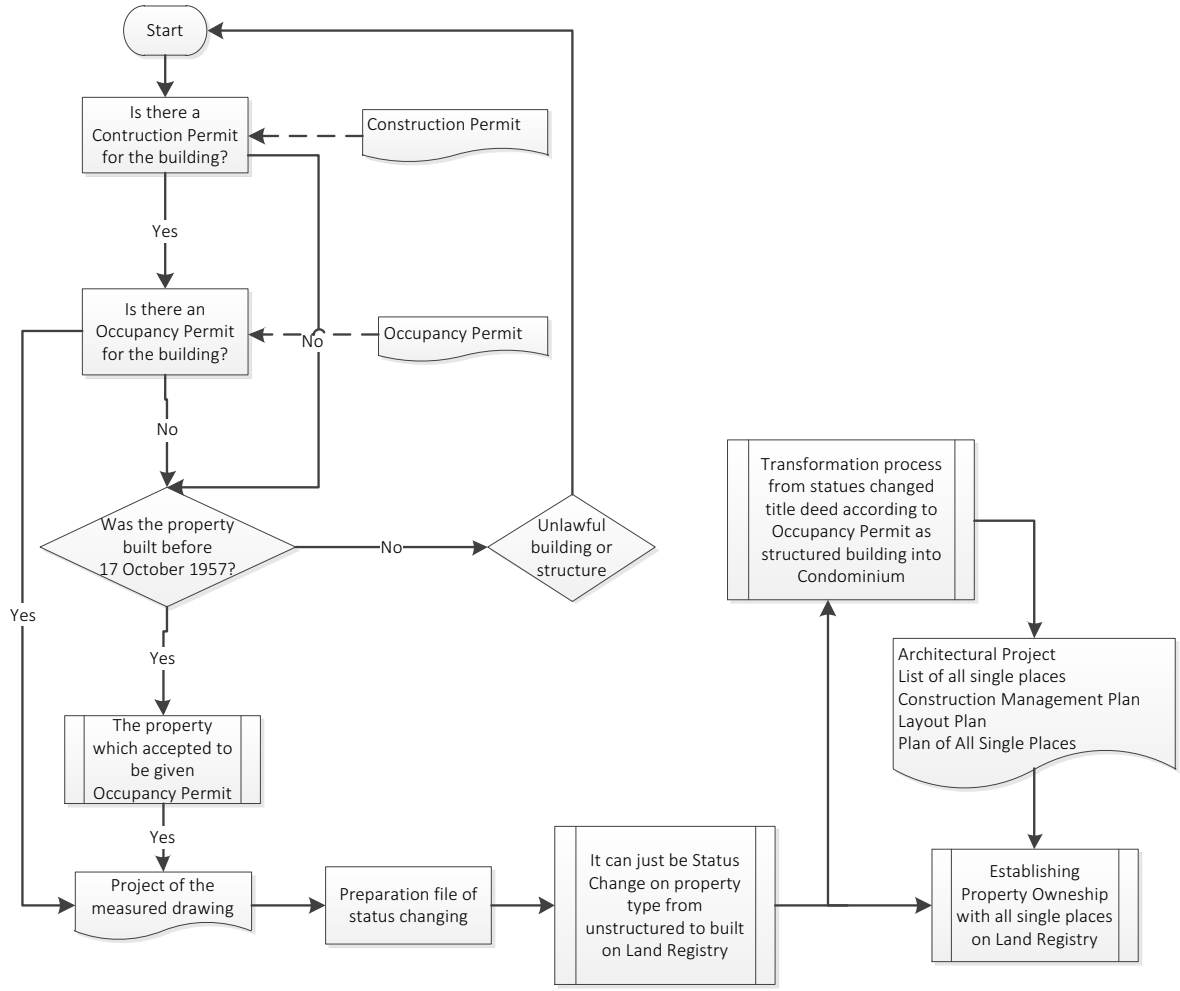

Fig. 6. Property (constructed) transformation process in terms of registration on title deed

It can also be emphasized in this paper that before constructing a building or structure, a construction permit has to be attained, which can only be given by governmental institutions, such as municipalities and provincial special administrations according to a zoning plan or regulations for planned and unplanned areas. A construction permit is composed of information about parcels and buildings to be built, such as parcel areas, parcel ownership, information about dimensional drawings, total construction area, number of floors, number of building (if more than 1), personal information of both the owner of the parcel and the governmental personnel (generally architects, civil engineers, mechanical engineers),

independent sections with land share, common spaces, and so on. The construction type, height, independent sections, common spaces, and additional places have to be drawn on paper with a defined scale in an architectural project of zoning plans or regulations for unplanned areas. Architectural projects are only allowed with construction permits; otherwise, they are not allowed. Construction can be started via the construction project under the control of governmental organizations that determine whether the construction is going well in terms of related regulations. Upon completing the construction, an occupancy permit can be attained. Then, thanks to this permit, it can be ensured that a building or structure complies with the relevant bylaws and codes and is safe for people to live in.

Buildings have been accepted as legal buildings according to laws related to property ownership in Turkey. The difference between these structures and modern construction is only these permits, in addition to architectural projects. Whereas modern buildings or constructions have to be designed and plotted on paper or CD via architectural projects to get permits, cultural assets like these bazaars do not. Therefore, building survey projects for all structures have to be designed and plotted on paper for the transformation process to occur from property ownership into condominium.

CONCLUSIONS

Whenever normal buildings or structures are constructed on parcel(s), which must be registered on title deeds, the property ownership of these structures must be transferred into condominiums with defined documents and projects. These are construction projects, occupancy permits and construction management plans approved by the relevant institutions, such as municipalities, provincial special administrations, and the Union of Chambers of Turkish Engineers and Architects, indicated in laws 634 and 3194, which are needed for ownership transformation. The ownership transformation can be carried out according to these projects and documents by the Directorate of Land Registry. Then these projects and documents can be stored by GDLRC in the Land Registry Offices and Municipalities.

The cadastral map cannot be reflected in a 3D perspective for the structures with a plan and its project stored in the Land Registry Office so that all these projects and documents can reflect the real situation with a 3D perspective. Nevertheless the transformation process from property ownership to condominium on a title deed can be evaluated to be acceptable as 3D cadastre registration in Turkey. Therefore, this transformation process is also important in the name of the transition to 3D cadastre from 2D cadastral maps, 2D projects, and other documents. The required documents and projects should be obtained by owners so that correct registration can be accomplished by the Directorate of Land Registry on the title deed.

According to all information detailed above, first, the type of building registered on the title deed must be transformed into the type of building in the real world and then written in the table. Thus, the construction type of the building can represent its true form. Altough all these buildings are 3D in the real World, why are they registerdc on the title deed and cadastral bases or maps in 2D? Is registration and presentation of these buildings in 3D, especially related to condominium events possible?

There are a lot of documents related to the registration and visualization of structured properties in Cadastral Offices and Land Registry Offices and Municipalities in Turkey. But, all of these documents are taken just only in paper format. Turkish Land Registry and Cadastral Systems have been carried out as e-governance applications like TAKBİS and MEGSİS via the internet. But, these systems are not yet ready in the name of registration and visualizaiton for most particularly structured immovable properties. Turkish Cadastral and Registrial Systems should be converted from clasic format into the digital format. Particularly, if the transformation process is to be accomplied carefully for structured buildings, all these documents and projects related to them would be seen in e-govrenance applications in 3D format.

REFERENCES

Aien A., Kalantari M., Rajabifard A., Williamson I. and Wallace J., 2013. Towards integration of 3D legal and physical objects in cadastral datamodels, *Land Use Policy,* 35, 140– 154

Dale, P. F. ve McLaughlin, J. D., 1999. Land Administration, Oxford University Press, New York, ISBN: 0-19-823390-6, 169 pages.

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

FIG, 1995, FIG Statement on Cadastre, Publication No. 11, Fédération Internationale des Géomètres http://www.fig.net/commission7/reports/cadastre/statement_on_cadastre.html.

Henssen, J., 1995. Basic Principles of the main cadastral Systems in the World, Proceedings Seminar "Modern Cadastres and Cadastral Innovations" in Delft, FIG Commission 7, Melbourne.

Jazayeri, I., Rajabifard, A., and Kalantari M., 2014. A geometric and semantic evaluation of 3D data sourcing methods for land and property information, Land Use Policy 36 (2014), 219–230.

Kalantari, M., Rajabifard, A., Wallace, J., Williamson, I., 2008. Spatially referenced legal property objects. Land Use Policy 25 (2), 173–181.

Şahinalp MS and Günal V., 2012. Spatial Analysis Of Bazaar Systems: Their Location and Forms in the Ottoman Urbanism Culture, MILLI FOLKLOR, 93, 149-168.

Official Gazette, 1934, Land Law, Başbakanlık Basımevi (2892), 1458-1435. http://www.mevzuat.gov.tr/MevzuatMetin/1.3.2644.pdf

Official Gazette, 1965, Property Ownership Law, Başbakanlık Basımevi 2412038, 5, 4, 413-4177. http://www.mevzuat.gov.tr/MevzuatMetin/1.5.634.pdf

Official Gazette, 1982a, Constitution of Republic of Turkey, Başbakanlık Basımevi 17863, 129-182. http://www.mevzuat.gov.tr/MevzuatMetin/1.5.2709.pdf

Resmi Gazete, 1982b. Dünya Kültürel ve Doğal Mirasının Korunmasına Dair Sözleşmeye Türkiye Cumhuriyetinin Katılmasının Uygun Bulunduğu Hakkında Kanun, Tarih, 17670.

Official Gazette, 1983a, Code of Protection of Cultural and Natural Properties, Başbakanlık Basımevi (18113), 5879-5900. http://www.mevzuat.gov.tr/MevzuatMetin/1.5.2863.pdf

Resmi Gazete, 1983b, Milletlerarası Sözleşme, Bakanlar Kurulu Kararı, Karar Sayısı: 8/4788, 17959.

Official Gazette, 1985, Zoning Law, Başbakanlık Basımevi (18749), 6677-6698, http://www.mevzuat.gov.tr/MevzuatMetin/1.5.3194.pdf

Official Gazette, 2001, Turkish Civil Code, Başbakanlık Basımevi 24607, 8049-8210. http://mevzuat.basbakanlik.gov.tr/Metin1.Aspx?MevzuatKod=1.5.4721&MevzuatIliski=0&sourceXmlSearch=&Tur=1&Tertip=5&No=4721

Official Gazette, 2008, Land Plans Regulation, Başbakanlık Basımevi (12038), http://www.resmigazete.gov.tr/eskiler/2008/08/20080827-1.htm

Official Gazette, 2012. Regulation Related to Determination and Registration for Immovable Cultural Heritage Needed Protection and Protected Area, Başbakanlık Basımevi, 28232.

Tanaç Zeren, M., 2012. Understandıng qnd Re-Usıng The Cultural Herıtage Buıldıngs, *Structural Analysıs of Hıstorıcal Constructıons*, 1, 3, 2800-2808

Tüdeş, T. ve Bıyık, C., 1997. Information of Cadastre, Karadeniz Teknik Üniversitesi Basımevi, 2.Baskı, 518 Sayfa, Trabzon.

URL-1, 2014. http://kvmgm.kultur.gov.tr/TR,44798/turkiye-geneli-korunmasi-gerekli-tasinmaz-kultur-varlig-.html. 18.09.2014

URL-2 2014. http://whc.unesco.org/en/conventiontext/

URL-3. Universal Declaration of Human Rights, All Human Rights for All, Fiftieth Anniversary of the Universal Declaration of Human Rights (1948-1998), http://www.un.org/en/documents/udhr/index.shtml, 18.09.2014

URL-4. Convention for the Protection of Human Rights and Fundamental Freedoms, Council of Europe, Registry of the European Court of Human Rights, Rome, http://www.conventions.coe.int/Treaty/en/Treaties/Html/009.htm, 18.09.2014

URL-5, 2014. http://vancouver.ca/home-property-development/occupancy-permit.aspx. 18.09.2014

URL-6, 2015. [44] URL-10, http://www.tkgm.gov.tr/tr/TAKBIS, 11.02.2015.

URL-7, 2015. http://cbs.tkgm.gov.tr/uygulama.aspx. 11.02.2015

Uysal M., 2010. A Spatial Analysis of Traditional Konya Bazaar from a Historical Perspective, MILLI FOLKLOR, 86, 149-162.