Design and Determine 3D Cadastral Systems: A Case Study of Turkey

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Keywords: 3D Cadastre, Legal framework, Land title and cadastral data, GDLRC

SUMMARY

Our country cadastre has been carried out by different institutions with different organizational structures and legislative regulations from past to present. There are numerous laws, regulations, circulars, and directives are regulating land registry and cadastre activities in Turkey (Cete, 2008). However, it is seen that there are laws relating to 8 cadastre and 34 laws related to land registry. Besides, there are three statutes and 1000 circulars (Ercan, 2003). Taking into account modern trends in the world (such as 3D / 4D Cadastre), the structure of the cadastral system, as well as the legislation, should be arranged in such a way as to be able to respond to these trends. In this respect, many studies have been carried out on the legal, technical and institutional structure of our cadastral system.

Turkey's existing cadastral system consists of two primary components. These are deed recordings and cadastral recordings. Cadastral data, on the other hand, determines the location in a coordinate system and the shape of the estate. The immovables registered to the title as a result of the laws in our country are the land, the independent land section, and the permanent rights. Buildings, apartments, and business centers, which are registered to the land registry and are called "independent sections," are registered in the real estate registry. Besides according to article 683 of the Civil Code, a person who holds something has the authority to use it, to exploit it, and to make it available on his behalf, within the limits of the law.

The current status of the land in Turkey due to the current law on cadastre map cannot be fully reflected. The third dimension on land and real estate is shown in 2D on the map with permanent rights. Located underground car parks, underground tunnels, and some networks cannot be registered. In our country, the roads are informal. It is shown in the cadastral maps but is not registered with the title. Because of this, pipelines, tunnels, underground bazaars passing under the roads are not shown in the cadastral maps.

In this study, within the scope of the 3D cadastre, the cadastral system and projects in Turkey have been evaluated. Firstly, the immovables recorded in the existing system, and the relation with the three dimensions have been analyzed. In our country, we have researched what the objects that should be registered within the scope of 3D Cadastre in the direction of legal legislation. The legal obstacles to not registering these objects have been revealed. As a result, our cadastral system has been evaluated concerning three-dimensional cadastral development. Within the scope of the 3-dimensional cadastre, the country profile has been established, and the deficiencies in our current cadastral system have been identified. Also, an exemplary model of how to model the objects to be recorded in the 3D cadastral transition phase is presented.

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1. INTRODUCTION

An official cadastre has not been developed to date due to legal differences such as technical and economic impossibilities in every country. Various categorizations and definitions have been made for the cadastre taking into consideration criteria such as priority purposes, types of registered rights, techniques used for collecting data (FIG, 1995). However, the definitions of cadastre conflicts with existing surveying systems. Because of the physical world is four dimensions. These are horizontal (x), (y), vertical (z) and time (t) dimensions. However, today's cadastral systems are defined as two-dimensional and parcel-based. It is not possible to accurately model the physical world with the existing cadastral systems today. Regarding reality in existing systems, it reveals the lack of height and time dimension (Öztürk, 2007). Due to limited land resources, above and under of the earth must be planned and managed together. Because of this, the need for cadastral data is increasing. As a result of this need, demand has emerged which is a 3/4 dimensional cadastre that represents the real world. Institutions and academicians have intensively studied the concept of three-dimensional immovable property in the last decade (Fendel, 2002; Stoter ve V. Oosterom, 2006; Ploeger, 2011; Stoter vd. , 2012; v. Oosterom, 2013; Paasch ve Paulsson, 2014; Kitsakis vd. , 2016). As a result of the studies, different topics have come up within the context of 3D cadastre. These are listed in the five main headings in FIG.

- Legal foundations for 3D Cadastre
- Initial Registration of 3D Parcels
- 3D Cadastral Information Modelling
- 3D Spatial DBMS for 3D Cadastres
- Visualization and New Opportunities

Due to these shortcomings, some international studies have been done. These include the Bogor Declaration, Cadastre 2014, Bathurst Declaration, European Union Cadastre Congress and Cadastre 2034 Vision. These studies jointly emphasize the following issues.

- To be a property owner and create a cadastral system that is managed sustainably.
- A cadastre system that is accessible, easily visualized, easily understood and used will be created.
- It is to establish a cadastre system linked to wider legal and social interests on the land.
- A three-dimensional, dynamic and accurately measured digital cadastre will be introduced.
- An integrated cadastre system based on common standards will be established.

As can be understood from these reports, two-dimensional cadastral systems cannot respond to users' requests. Because two-dimensional cadastral systems are used for underground structures (subway, underground market, underground car parks, etc.), technical infrastructure facilities (pipelines, cables, telecommunication lines, etc.). They cannot be registered on it.

Therefore, taking ownership of the guarantee is a problem in two-dimensional systems (Karatas, 2007). Because of all these reasons, 3-4 dimensional cadastre concept has emerged, and studies for its development have been made. According to some researchers, the 3D cadastre is not just a parcel, but a system for digitally managing and representing layered rights, restrictions, responsibilities (legal models) and buildings, public services, and corresponding physical models (provision of registered rights above and below the 3D terrain surface) (Stoter, 2004, Papaefthymiou et al., 2004, Aien, 2013). In this way, 3D cadastre facilitates the management of property rights in the real world. It also enables a wide variety of applications that create a demand for detailed and integrated 3D legal and physical objects. These applications provide essential information for different applications such as urban planning management, land, and property management (Rajabifard et al., 2012). For example in dense urban areas, particularly bridges and tunnels that build above or under other structures giving constructions plan support of the land development process. It can also be integrated with other information layers for 3D city models (CityGML), Building Information Model (BIM), transportation, service networks, land use and different applications (Aien, 2013).

When studies of other countries within the scope of the 3D Cadastre are examined, it appears that they have many similar characteristics by the studies. It seems that the solutions applied are not significantly different, although the different aspects of 3D features are taken into account, based on the structure of the cadastral systems, the types of recorded objects, and variations on other topics. There are regulations in Australia and Canada where detailed explanations of how to measure and register a parcel as 3D are available. Also, there are arrangements in these countries that determine the 3D coordinates with boundaries of ownership below or above the surface of the land. The Netherlands redefined ownership on the land in 2007 by amending the Civil Code and Cadastre Act. Thus, the 3D object designated by law paved the way for the registration from parcel independently.

There is a separate Line Cadastre for the registration of the underground networks in Switzerland while the Netherlands underground networks are displayed in the cadastral map with numbers like parcels. The registration of underground structures in Norway is not compulsory but is optional. On the other hand, the provinces of Victoria and Queensland in Australia are very interested in the long-standing, ongoing legislative work on the 3D immovable property in the field of 3D Cadastre, and the search for the establishment of 3D cadastral systems following the legislation. The study has been done to transform the existing cadastral database in Switzerland into 3D. A comprehensive plan has been prepared by the Swiss government covering the steps to transition to 3D Cadastre. In China, 3/4 dimensional cadastral surveying have gained speed with pilot projects which have been implemented in some city centers. Thus, within the scope of Cadastre 2034 vision, it was aimed to provide essential services expected from the cadastre such as knowing all rights, restrictions and responsibilities related to the real estates with these components, access to property and positional content and to direct the future cadastre with the developed policies, models and standards (Aien, 2013; Stoter, 2004). As a result of all these studies, cadastral data reflecting the real world shows the necessity of creating a new 3-4 dimensional cadastral model containing x, y, z and t components.

2. BACKROUND

2.1. General information about Turkey Cadastral System

The General Directorate of Land Registry Cadastre, which has a rooted institutional structure, has created the cadastral and topographic cadastral map of the country according to the country coordinate system by Law No. 3402. Besides, the subdivision of a spatial information system has been formed by specifying the boundaries of immovable properties on land and cadastral maps. Also, the cadastral system and cadastral data have been improved with many projects.

The purpose of cadastral data is to be able to reflect the real world of complete way. However, the present cadastral representation represents the four-dimensional world by reducing it to two dimensions. In this case, it causes the physical world not to be fully reflected. In particular, missing information about the third dimension is presented because the rights and objects cannot be registered independently of the two-dimensional parcels and are not adequately associated with physical objects in the real world. There are two main reasons for this. The first reason is that rights cannot be registered and represented from the independent parcel. The second reason is that the information below the parcel surface is inaccessible and the information on the parcel is inadequate. These obstacles in the current system cannot fulfill the reflection of the physical world, which is the primary objective of the cadastre.

In our country, although the horizontal limits of the right of property are clearly expressed in the law, the definition of the vertical limit is not sufficient. The use of the vertical limit of the right of ownership is determined by the establishment of the real rights and condominiums, the regulations of the public law. However, these arrangements cannot be enough. For this reason, the 3D spatial data related to the location where the rights are applied in the current cadastral system are not included in the cadastral records. Moreover, since the data belonging to the objects located under the parcel are not available in the cadastre, the relation of these objects with the parcels cannot be analyzed. Another obstacle is that in the registration of independent sections located on the parcel there is no data in the cadastral system about how the property units are located in the structure, although it is known who owns the apartment in the building. Another problem in the existing system is that the parcels affected by any object positioned below or above the surface of the land cannot be queried as a whole. Besides, the parcels that are traded at a particular time interval cannot be queried as a whole. (Doner, 2010).

2.2. Evaluation of Turkey Cadastral System concerning legal and cadastral objects

The concept of ownership can have differences within every legal system. Whose owners and domination degree in the object that will contain the owner's property is determined by the legal system. Besides, the authority of how to use the land is also determined by the legal system (Doner and Biyik 2007).

Today, in many cadastral systems, 2D cadastral parcels are the basis for the registration of rights. The legal status of buildings under and above the surface of the land is determined by rights registered on the parcel in the surface. The most comprehensive right that a person can have is the right to property (Biyik and Karatas, 2002).

In the historical process of the right to property and cadastre in Turkey, it has been many laws and regulations. Some of these laws are the milestone in the formation of the cadastral system. The following act-timeline emphasizes the significant law and objectives related to the development of the Cadastre. Following these laws, today's cadastral system has been developed (Figure 1 next page).

Article 35 of the Constitution of the Republic of Turkey have been identified can be drawn as to how to limit the use of property rights. According to this; "Everyone has the right to ownership and inheritance. These rights may be restricted by law for good public purposes only. The use of the right to property cannot be contrary to public interest". Thus, it is clearly stated that private property or the right to use can be intervened by the state when there is the public interest. In addition, the vertical limit on property according to the Civil Code covers all layers above and below the land, so long as the use of property in the land is beneficial. Besides, plants, facilities, and resources on the land are within the limits of the scope of ownership (Article 718 of the Civil Code). According to this definition, the scope of benefit in practice is related to the intended use of property: for example, electrical lines passing over a building puts the building in danger and restricts its use. The subway line may be outside the area that the owner will use in a useful measure, in which case there is no restriction, and no action is taken on the land registry and cadastral map.

The cadastre does not deal with immovable properties that are not plotting to cadastral map sheet and not subject to property. Because of this, the measurement and mapping of underground facilities are not seen as a cadastral activity. If the underground lines pass through public roads, streets, parks, parking lots, green spaces, playground, they are only measured and made use of these maps when necessary. This is because they are places without a title under the decision and use of the State according to Article 715 of the Civil Code. Infrastructure facilities are only concerned with the cadastre when passing through the private-registered land. When the transit routes pass through immovables belonging to private or legal persons, either expropriation or easement is established (Civil Code 727; 744). Therefore, Infrastructure facilities are passed from public places (roads, squares, parks, green spaces, children's park, etc.), public land, private and legal persons.

Our Constitution is not as detailed as the explanation of the third dimension. In our country, there are some rights under the constitution relating to the implementation of the third dimension. These rights are classified as easement right, real servitude right, and private easement. The real servitude right is the right restricting the rights of the immovable to another immovable and determining the limits on how those rights are to be used. Types of real servitude right are right of passage, the right of superficies, right of the source and another easement.

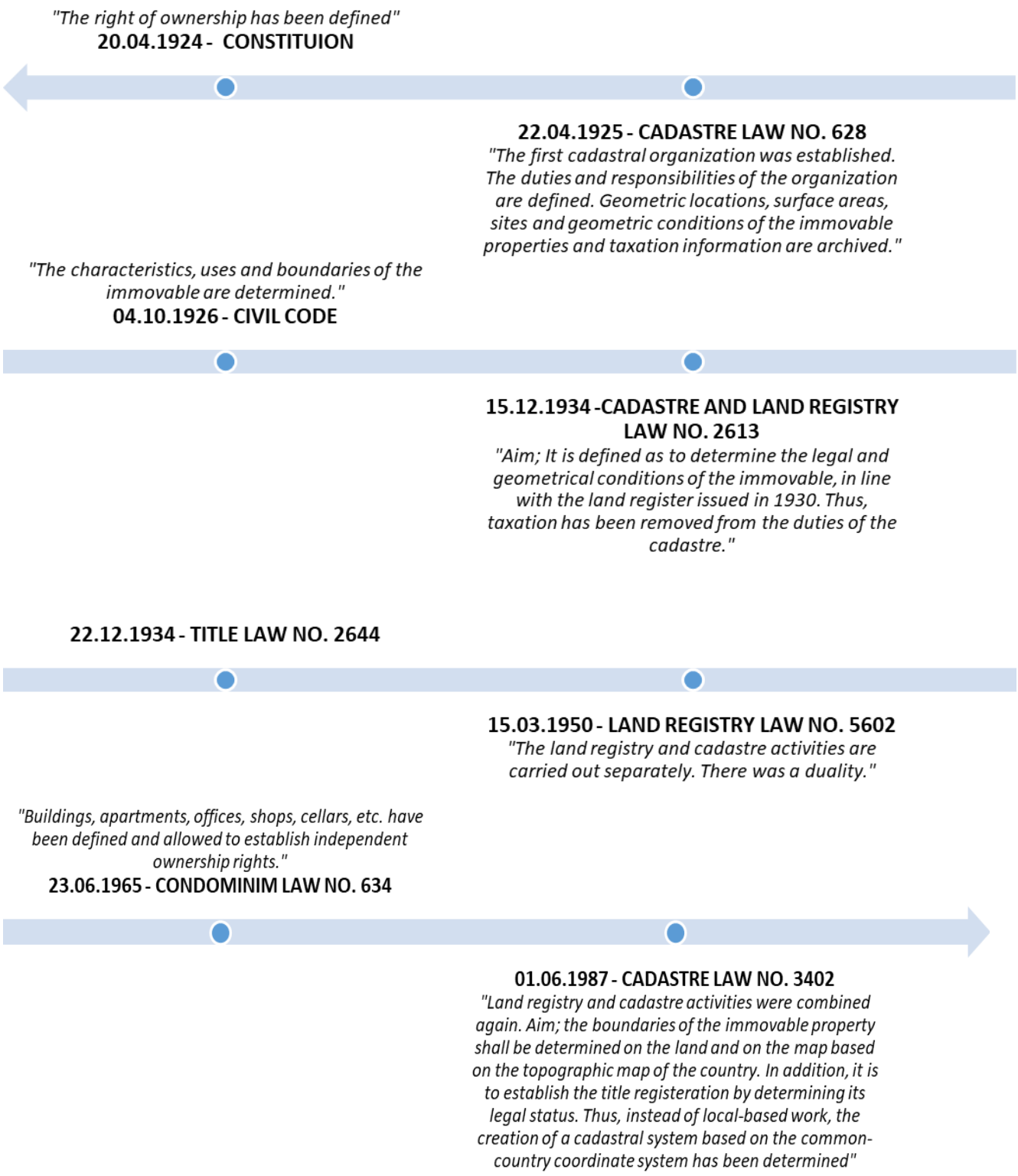

Figure 1. The historical process of essential laws in the development of the cadastral system

The private easement is a type of right that allows someone other than the owner of the immovable property to benefit from some of the property rights related to the immovable. The difference between private easement and the real servitude right is that a real estate is not provided a right by another real estate, but it is provided a right by a person. Types of private easement rights are right of usufruct, superficies (residence), the right of construction (construction), a right of resource and other rights.

Due to the increasing population rate in the world, intensive construction comes to before in the underground and aboveground. In our country, underground bazaars have been built under the non-registered places such as roads, squares, parks for reasons such as providing income for underground bazaars used for commercial purposes and underground passages being comfortable places.

As an example of showing underground bazaars in our cadastral system in our country, it is possible to give the Zafer Bazaar, which is registered under the name of Ankara Metropolitan Municipality with the date of December 11, 1974, and 9795 of document number (Figure 2). Zafer Bazaar is registered Ankara Province, Çankaya District, Zone 3, Volume 2, Pages 127, and is located 7547 cadastral blocks and number of 1 parcel. Figure 3 shows the information of the Zafer Bazaar from the screen of the parcel questionnaire developed by the general directorate of land registry cadastre in Turkey. Figure 4 shows the Digital Cadastral Map of Zafer Bazaar (Colak, 2016).

Figure 2. Zafer Bazaar in Ankara (Colak, 2016)

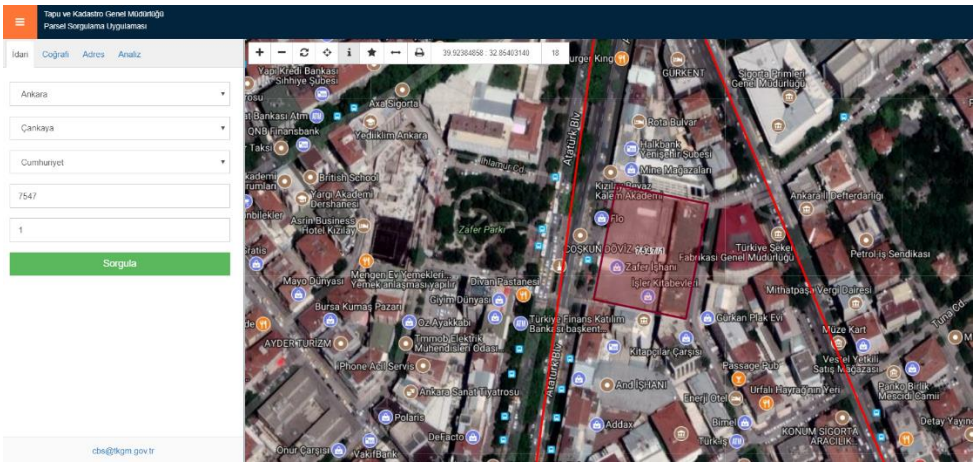

Figure 3. Screen of the parcel questionnaire for Zafer Bazaar

Figure 4. Digital cadastral map for Zafer Bazaar Digital (Colak, 2016)

General Directorate of Land Registry and Cadastre (GDLR) has been found in the scope of the legislation related to registration of underground markets to the title. According to this; if the shops are under the road, the part corresponding to the surface as the footprint of the shops is limited. Afterward, it is registered on behalf of the municipality by way of the road. Then a permanent and independent superficies is established. Finally, the condominiums are established on the superficies.

Another example is a workplace under the parcel number 125 in the cadastral block number 34 on the Çarşı district of Rize province (Figure 5). Firstly the workplace located under the land was registered as a road with the parcel number 125 in the name of Rize Municipality. After the completion of the construction of the workplace, this land was registered in the name of the municipality with the new parcel number 149 and rented to the business owner

for 49 years. The superficies was established for the workplace under the parcel, and this right was registered to the title (Colak, 2016).

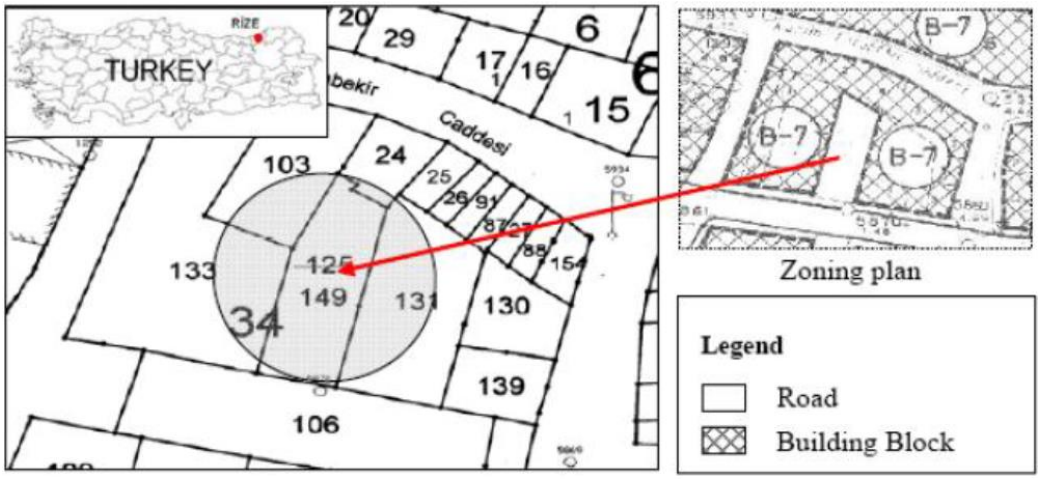

Figure 5. Underground market in Rize (Colak, 2016)

A similar example is available for the Municipality of Kastamonu. There are many shops under Mutaflar Street. The road to stay on top of the shops was registered with the municipality as was the case in the previous example, and then some shops are registered to the condominium registry with independent and permanent rights. Also, some shops under the cadastral parcel number 274 are represented in the records by establishing an easement right on this parcel (Figure 6) (Colak, 2016).

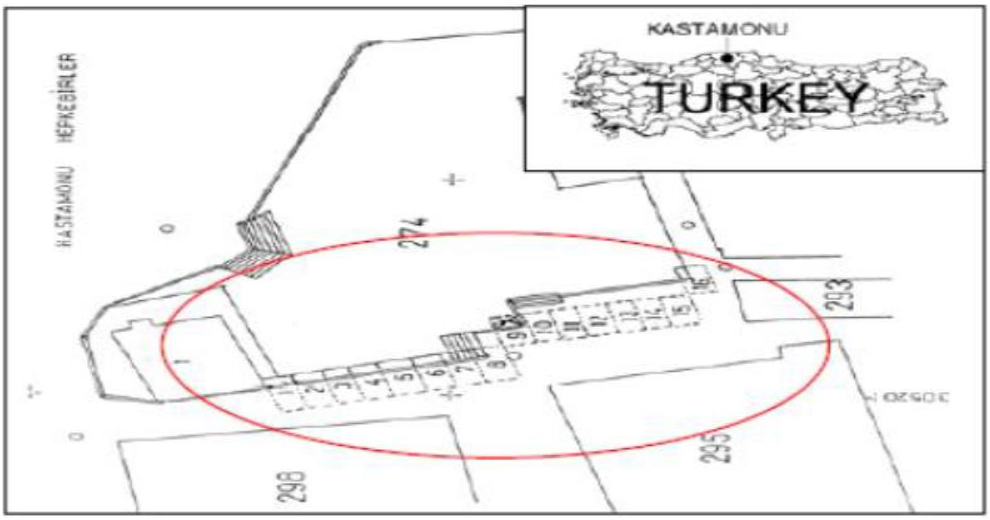

Figure 6 Underground market in Kastamonu (Colak, 2016)

As can be seen from the examples given, there is no standard method for registering properties belonging to different properties in the vertical dimension. This causes complications in the registration process. Also, the geometrical states of the structures above and below the land and the associations with the parcels are unknown in the cadastre.

The legal definition of 3D objects: 3D objects subject to registration are recorded with easements. The type, scope, and application of 3D RRR's are defined in the Civil Code and Cadastre Law. Although it is possible to register some 3D objects, there is no necessary explanation for 3D objects in the law as a whole. 2D registration is done in the Cadastre Map. Immovables, built on and their rights are registered. Property ownership is registered. Registration is mandatory.

Rights that can registered in 3D: Land, parcel, buildings, independent sections and built on are registered. RRR's on the registered objects are recorded. Registered RRR's are represented as 2D in the Cadastral Map. The altitudes are represented as 2D in the cadastral map. Architectural plans have 3D information.

Existing 3D objects: Buildings and extensions, Parcels, Servitudes, Condominiums, High voltage lines, Oil and gas pipelines, Pylon sites, Water channels.
Registered 3D objects: Buildings and extensions, Parcels, Servitudes, Condominiums, High voltage lines, Oil and gas pipelines, Pylon sites, Water channels.

Presentation of 3D objects to cadastral map: 2D.

2.3. Evaluation of existing projects in Turkey

In Turkey, the six main project is developed under GDLRC have the fundamental purpose for providing a share of common standard data to other public institutions. Initiatives projects are developed for providing integration to vision on the future of cadastres. These are namely, Turkey National GIS (TUCBS) and as an information system the Land Registry and Cadastre Information System (TAKBIS in Turkish) (Nisanci and Ozcelik, 2015).

2.3.1. Turkish Land Registry and Cadastre Information System (TAKBIS in Turkish)

Started in 2005, TAKBIS is the most basic e-government project aiming to transfer property information to the computer environment and to carry out all kinds of inquiries. The target of TAKBIS project is to create the Turkish Land Registry and Cadastre Information System across the country. Also within this scope, the problems will be determined, and the solutions will be found. The title deeds and cadastre services will be conducted as standard and electronic way, and right, secure and updated data will be submitted to the Local Governments, the public institutions and organizations by analyzing the title deed and cadastre services within the scope of the Geographical Information System (GIS) and the Land Information System (LIS) (TKGM, 2015). As of the date 2012, all title deed directorates have started to give services. With the system working successfully, the data share is practicing as online with 17 institutions. Many services such as fee interrogation, title deed interrogation are presented to the public as online with TAKBIS that is ensured its integration with E-government.

2.3.2. Spatial Property System (MEGSIS in Turkish)

The Spatial Property System (MEGSIS) is an opensource application prepared by the General Directorate of Land Registry and Cadastre. MEGSIS is conceptualizing the project in order to match the data with cad format in the local computers of cadastre directorates with the title deeds data by collecting on a central system that is to share this data with shareholder

institutions, organizations and municipalities and mapping services. Also, it works in the international standards and to submit the public with e-government application. Studies conducted under MEGSIS are collected as three main headings: i) Web-based application software, ii) the international standards map service, iii) e-government services. Web-based application software is composed of modules consisting of the data entrance of internal and external users to the system. The system concerning the data downloading, the title deeds data and the integration processes and interrogations, the control and follow-up of conducted works within the framework of the identification/authorization which ensures and directs the application to use in the different levels and needs. International standard map services, the cadastral data collected within MEGSIS is shared in standard format and its conformity to the standards specified in the Guideline of Principles of Workableness Together prepared by Open Geospatial Consortium (OGC) and DPT Information Society Department and institutions, organizations, municipalities requesting under protocols is tested with open source and commercial products. E-Government Services collected cadastral data combined with land registry data as a map service is offered to the citizens for information purposes. These services offered by the www.turkiye.gov.tr internet address have the characteristic to be the only geographical service.

2.3.3. Turkey's National Geographic Information System Project (TUCBS in Turkish)

TUCBS is an e-government project aiming at establishing the infrastructure for Geographical Information System following the technological developments at the national level (Turkish National Geographic Information System-TUCBS). Besides being created a web portal by public institutions and organizations to provide the geographic information they are responsible for on a shared infrastructure (Figure 8), creating the content standards in the manner that geographic data can meet the needs of all user institutions and be determining the standards of geographic data interchange. It was conducted under the responsibility of the General Directorate of Land Registry and Cadastre.

2.3.4. Land Registry Archive System (TARBIS in Turkish)

With the realization of the project, its aims such as scanning archival documents stored at Department of Land Registry Archive and Istanbul TKBM (except for foreign records). Furthermore, it is ensuring easy access to scanned documents linked by index system of people authorized to access to archive information and documentation within the security framework of persons authorized. Also developing reporting functions of the information entered into digital media by the user by reviewing the original document in the archives within the scope of Title Deed Archive Automation were carried out.

2.3.5. Land Registry and Cadastre Modernization Project (TKMP in Turkish)

This project aims to update the data of title deeds and cadastre as being a base for the spatial information systems as set out by the Law on Cadastre and to bring it into use by transferring in the electronic environment in the numeric and legal form. In 2008, the budget of the Project of Title Deeds and Cadastre Modernization signed by the World Bank and the Republic of Turkey was determined as 35 million Euro (Approximately 203 Million $).

2.3.6. The Map Data Bank (HBB in Turkish)

It is a Spatial Information System developed for entering the metadata related to information and documents of maps created by using the developed technologic opportunities by institutions which practicing maps or have maps practiced for forming large-scaled spatial information systems across the country, updating them, submitting on the internet and therefore preventing the resource waste with the repeated map production.

The TAKBIS and TUCBS include attempts to achieve standardization in the area of cadastral data based on international standardization approaches. The land registry data related to parcels are held in Land Registry and Cadastre Information System (Coruhlu et al., 2015). Therefore, all title data in our country are on e-government, but all parcel data not transferred at present. Turkey's National Geographic Information System Project (TUCBS) has been designed according to the infrastructure of the ISO standard and compatible to Cadastre 2014 perspective (Alkan and Polat, 2017).

3. THE TURKEY CADASTRAL SYSTEM PROFILE, BASED ON LADM

LADM is identified to be an International standard organization of ISO 19152 under technical committee TC/211 for Geographic Information/Geomatics (Lemmen et al., 2010; Paasch et al., 2013; Tjia and Coetzee, 2013; Van Oosterom, 2015). LADM has a clear relationship with familiar aspects of land administrations all over the world (Tjia and Coetzee, 2013; Van Oosterom et al., 2013). It should also follow the international ISO and OGC standards (Kaufmann and Steudler, 1998; Tjia and Coetzee, 2013). Many countries have considered the adoption and application of LADM to their local needs in land administration. This study aim is not to develop a new model for the intended Turkey cadastral system but to analyze the existing cadastral system with the LADM based situation.

It is a class of ownership that corresponds to LADM Party class in Turkey Cadastral System. TC_ Ownership class contains the ownership information about the owner of the immovable property. Primary attributes of TC_Ownership class are The Full Name of the Owner, Father's Name, Legal Entity Name, Owner's Registry Number, Reason of Acquisition, Sales Fee, Register Date and Per Diem Number.

Servitudes, restrictions, responsibilities of real property in our system and corresponding with LA_RRR class. The mortgage rights and amenabilities and easement on real estate are recorded in the title deed. The features about easements and real estate ownership are Right, Liability Type, Description, Register Date and Per Diem Number. Real estate mortgage right features are Type of Mortgage, Letter Order, Full Name of Claimant, and Father's Name of the Claimant, Amount of Claim, Interest, Grade, Duration, Register Date, Per Diem Journal and Considerations.

Finally, the immovable class is corresponding to the LA_SpatialUnit class. According to Article 998 of Turkish Civil Law, 'land, independent and continuous rights recorded in title deed on a separate page, and the independent units recorded in the property ownership deed' are recorded as immovable in the title registry. Parcels and limitations on parcels and the

easement rights are recorded to the title deed. Any building on the parcel and the independent units on this building are recorded in property ownership deed (Alkan and Polat, 2016). All diagrams about Turkey Cadastral System based on LADM shows Figure 7.

4. CONCLUSION

The General Directorate of Land Registry Cadastre, which has a rooted institutional structure, has created the cadastral and topographic cadastral map of the country according to the country coordinate system by Law No. 3402. In addition, the subdivision of a spatial information system has been formed by specifying the boundaries of immovable properties on land and cadastral maps. Also, the cadastral system and cadastral data have been improved with many projects.

The 2D cadastral parcel is the primary registration unit in Turkey, while some 3D/4D situations given in the text are defined and registered through limited rights, condominium rights, time sharing and other restrictions on intersecting parcels (Doner and Biyik, 2013). In Turkey, the current cadastral data model should be improved to reflect better all dimensions of the land (Doner and Bıyık, 2013). In this context, In Turkey, initiatives projects are developed for providing integration to vision on the future of cadastres. A 2D cadastral system with developed e-government projects has been introduced to excellent condition. However, the present cadastral representation represents the four-dimensional world by reducing it to two dimensions. In this case, it causes the physical world not to be fully reflected. In particular, missing information about the third dimension is presented because the rights and objects cannot be registered independently of the two-dimensional parcels and are not adequately associated with physical objects in the real world.

The purpose of our study is to analyze the situation of our current cadastral system. The historical process of the law enacted for the development of cadastral systems in Turkey is explained. Besides, the cadastral system was analyzed with the developed e-government projects. The Turkish cadastral system has taken its final form with enacted laws and developed project. However, due to increasing population and intensive construction, the current cadastre system is also inadequate. We need to integrate our existing cadastral system with land management in a universal standard with developing technologies and software.

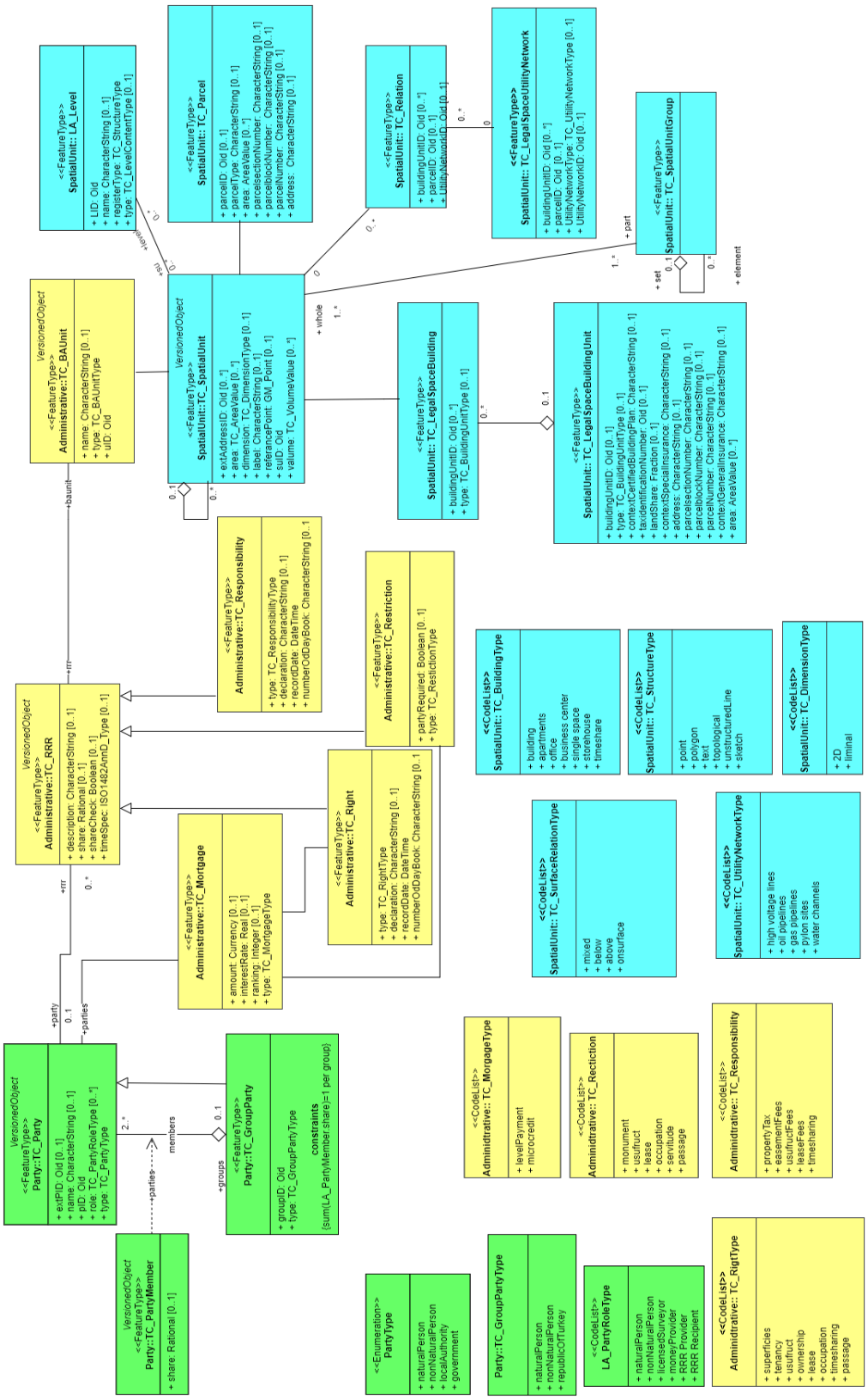

Figure 7. The relation of Turkey Cadastral System with the LADM

REFERENCES

Aien, A. , 2013. 3D Cadastral Data Modelling. PhD Thesis, Melbourne University, Victoria, Australia.

Alkan, M. and Polat, Z.A. , 2017. Design and Development of LADM-Based Infrastructure for Turkey. Survey Review 49:356, 370-385,

Cete, M., 2008. Türkiye Için Bir Arazi Idare Sistemi Yaklaşımı. PhD. Karadeniz Technical University.

Colak, H.E. , 2016. Lecture Notes of Infrastructure Cadastre. Karadeniz Technical University.

Doner, F. ve Biyik, C. , 2007a. Kadastronun Gelişimi Sürecinde Üç Boyutlu Kadastro.

Doner, F. , 2010. Türk Kadastro Sistemi Için Üç Boyutlu Yaklaşım. PhD. Karadeniz Technical University.

Ercan, O. , 2003. TKGM'de Jeodezi ve Arazi Bilgi Sistemi Faaliyetleri, TUJK 2003 Yılı Bilimsel Toplantısı, Coğrafi Bilgi Sistemleri ve Jeodezik Ağlar Çalıştayı, Sayfa: 7582, Konya.

Fendel, E. , 2002. Registration of Properties in Strata. Report on the working sessions. International workshop on "3D Cadastres", Delft, the Netherlands,

ICSM. , 2015. A Vision for Cadastre 2034.

Kaufmann, J. and Steudler, D. 1998. Cadastre 2014, A Vision for a Future Cadastral System. Copenhagen: International Federation of Surveyors.

Karatas, K., 2007. Kentsel Teknik Altyapı Tesisleri, Kadastrosu ve Türkiye'deki Uygulamaların Organizasyonu, Doktora Tezi, K.T.Ü., Fen Bilimleri Enstitüsü, Trabzon.

Kitsakis, D., Paasch, J., Paulsson, J., Navratil, G., Vučić, N., Karabin., M., Tenorio Carneiro, A., El-Mekawy, M. , 2016. 3D Real Property Legal Concepts and Cadastre - A Comparative Study of Selected Countries to Propose a Way Forward, In: v. Oosterom, P., Dimopoulou, E., Fendel, E. (Eds.), Proceedings of 5th International FIG 3D Cadastre Workshop, 18-20 October 2016, Athens, Greece, pp. 1-24.

Kokturk, E., 2003. Türkiye Kadastrosunun Tarihsel Görevi, HKM Jeodezi, Jeoinformasyon ve Arazi Yönetimi Dergisi, Yıl: 2003, Sayı: 89, Sayfa: 29–41.

Lemmen, C. H. J., Van Oosterom, P. J. M., Eisenhut, C. and Uitermark, H. 2010. The Modelling Of Rights, Restrictions And Responsibilities (RRR) İn The Land Administration Domain Model (LADM). FIG congress 2010 facing the challenges — Building the capacity, Sydney, Australia, 11–16 April 2010.

Nisanci, R. and Ozcelik, A. E. , 2015. An Assessment Towards to Innovative Cadastre Integrated with Cadastre 2034 Vision. The world cadastre Summit, Congress & Exhibition. Istanbul, Turkey, 20–25 April 2015.

Ozturk, R. , 2007. Üç Boyutlu Kadastro'da Yeni Yaklaşımlar. Master Thesis, Yıldız Technical University, Graduate School of Natural and Applied Sciences, Istanbul.

Paasch, J. , Van Oosterom, P. and Lemmen, C. H. J. 2013. Specialization of the LADM — Modelling of non-formal RRR. 5th Land Administration Domain Model Workshop, 24–25 September 2013, Kuala Lumpur, Malaysia.

Paasch, J.M. , Paulsson, J. 2014. Legal Framework 3D Cadastres – Position Paper 1. In: van Oosterom, P., Fendel, E. (Eds.), Proceedings 4th International FIG 3D Cadastre Workshop, 9-11 November 2014, Dubai, UAE, pp. 411-416.

Papaefthymiou M., Labropoulos, T., Zentelis, P. , 2004. 3D Cadastre in Greece, Legal, Physical and Practical Issues. Application on Santorini Island, FIG Working Week 2004 Athens, Greece, May 22-27, 2004.

Ploeger, H. , 2011. Legal Framework 3D Cadastres Position paper 1, In: van Oosterom, P., Fendel, E., Stoter, J., Streilein, A. (Eds.), 2nd International Workshop on 3D Cadastres, 16-18 November 2011, Delft, the Netherlands, pp. 545-550.

Stoter, J. ,Van oosterom, P. , Ploeger, H. and Aalders, H. , 2004. Conceptual 3D Cadastral Model Applied in Several Countries. FIG Working Week 2004 Athens, Greece, May 22-27, 2004.

Stoter, J. E. and van Oosterom, P.J.M., 2006. 3D Cadastre in an International Context: Legal, Organizational and Technological Aspects, Taylor & Francis, CRC Press, 323 s.

Stoter, J., van Oosterom, P., Ploeger, H. , 2012. The Phased 3D Cadastre Implementation in The Netherlands. In: van Oosterom, P., Guo, R., Li, L., Ying, S., Angsüsser, S. (Eds.), Proceedings 3rd International Workshop on 3D Cadastres: Developments and Practices, 25-26 October 2012, Shenzhen, China, pp. 203 – 218.

Tjia, D. and Coetzee, S. , 2013. Application of The Land Administration Domain Model to The City of Johannesburg Land Information System. South African Journal of Geomatics, 2(3), pp.260–79.

Van Oosterom, P. , 2015. Why and What to Standardize in Land Administration. The world cadastre summit, congress & exhibition. Istanbul, Turkey, 20–25 April 2015.

Van Oosterom, P., Lemmen, C. and Uitermark, H. , 2013. ISO 19152:2012, Land Administration Domain Model published by ISO. FIG Working Week 2013. Environment for Sustainability. Abuja, Nigeria, 6–10 May 2013.

Yildiz, O. ,2013.Türkiye Kadastrosunun Mevcut Durumu ve Çok Amaçlı Kadastroya Yönelik Yeni Yaklaşımlar. Doktora Tezi, KTÜ Fen Bilimleri Enstirüsü, Trabzon.

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