Need for Three-Dimensional Cadastre in Turkey

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Key words: 3D cadastre, land management, property, rights and restrictions

SUMMARY

Cadastral works in Turkey have been carried out in two-dimensional (2D) until 1987. With the Cadastre Law which was put into practice in 1987, it was aimed to produce cadastral data in three-dimensional (3D). Until 2004, cadastral bases could not been produced in 3D although the Cadastre Law. With the participation of private sector in cadastral works, merely corners of cadastral parcels have been surveyed in 3D as from 2004. However these surveys are not adequate to position the cadastral parcels and determine spatial relationships of them in 3D. Yet, registration and representation of an amount of space to which rights and restrictions apply should be understood from a real 3D cadastre. In today's modern world, it is great importance of determining and registration of different land uses locating top of each other in terms of sustainable land management. Thus, the term of land object was introduced to address future needs of cadastral systems. It is expected from future's modern cadastres to show complete legal situation of land including public rights and restrictions. Nowadays, all these rights and restrictions are often located top of each other. Therefore, 2D cadastral systems have shown limitations in some situations. In this context, content and scope of Turkish cadastre should be extended including registration and representation of space above and below the surface parcels. 3D modelling of Turkish cadastre has a great importance to be able to solve property problems in rural and urban areas which mainly arise from intensive use of land.

In this paper, it is aimed to examine aspects of 3D cadastre in Turkey. Current situation of Turkish cadastre is evaluated and cadastral recording with a 3D component are summarised. Then, some examples of 3D situations which current 2D cadastre has shown limitation are presented to determine actual needs for 3D cadastre. Finally, suggestions are given in conclusions to address problems facing in registering and representing of 3D situations.

SUMMARY (TURKISH)

Türkiye'de kadastro çalışmaları 1987 yılına kadar 2 boyutlu (2B) gerçekleştirilmiştir. 1987 yılında yürürlüğe giren 3402 sayılı kadastro kanunu ile kadastro verilerinin 3 boyutlu (3B) üretimi hedeflenmiştir. Ancak 2004 yılına kadar 3B kadastro verisi yasa da olmasına rağmen kadastro çalışmalarıyla üretilememiştir. Kadastro çalışmalarına özel sektörün katılımı ile 2004 yılından itibaren sadece parsel köşe noktalarında olmak üzere parsel ölçüleri 3B yapılmıştır. 3B kadastro verisi için bu çalışmalar yeterli konum verisini içermemektedir. Oysa üçüncü boyuttan kasıt arazinin yüzeyi, altı ve üstünde var olan bütün sınır ve detayların hassas bir şekilde 3B ölçülmesidir. Günümüz dünyasında sürdürülebilir arazi yönetimi açısından

arazilerin 3B kullanımı ve buna yönelik düşeyde mülkiyetin tespit ve tescili giderek önem kazanmaktadır. Nitekim bu amaca yönelik Kadastro 2014 kapsamında gelecek kadastral eğilimler altında arazi nesnesi kavramı geliştirilmiştir. Bu kavramın gelecek kadastral sistemler içerisinde çok önemli bir yer alacağı ve ülkelerin kadastro kapsam ve içeriklerini buna yönelik yeniden düzenlemeleri, modern kadastro için öngörülmüştür. Arazi nesnesinde ifade edilen araziye yönelik her türlü hak ve kısıtlamaların yanında arazi değerine etkiyebilecek bütün nesnelerin tespit edilerek tescil altına alınmasıdır. Bu bağlamda Türkiye kadastrosu kapsam ve içeriğinin, parselin yüzeyi, altı ve üstündeki bütün detayların 3B tespiti olmak üzere arazi kullanım kararlarına göre 3B tescillerini de kapsayacak şekilde zenginleştirilmesi gerekmektedir. Bu amaca yönelik kadastro verilerinin teknik standartlarının yanında zamansal verileri de içeren mülkiyet verilerinin 3B tescil sisteminin modellenmesi, özellikle kentsel ve kırsal arazi kullanımlarında genelde mühendislik faaliyetlerinden kaynaklı oluşan mülkiyet sorunlarının çözümü için büyük önem arz etmektedir.

Bu bildiride, Türkiye'de 3B kadastroya yönelik yapılan çalışmaların gelişim süreci incelenecektir. Türk kadastrosunun mevcut durumu değerlendirilerek 3B bileşen içeren kadastral kayıtlar özetlenmektedir. Bunun ardından, 3B kadastro için gerçek ihtiyaçları ortaya koymak için mevcut 2B kadastronun yetersiz kaldığı 3B kullanım durumlarına ait bazı örnekler sunulmaktadır. İncelemenin sonuçları ve 3B kullanım durumlarının tescil ve temsilinde karşılaşılan problemlere yönelik öneriler sonuçlar bölümünde verilmektedir.

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1. INTRODUCTION

Global economic, social, technological factors and need for sustainable development are having a substantial impact on cadastral systems. As a result of this impact, the content and role of cadastre have changed significantly during the last few decades. The increasing complexity of modern world requires that cadastral systems need an improved capacity to manage the third dimension. Traditional two dimensional (2D) cadastral systems have shown limitations to cope with increasingly complex rights, restrictions and responsibilities which occur in today's modern world. Although every country has its own laws and cadastral regulations and approaches, it can be generally said that access to information with respect to the third dimension of land is poor in land administration systems (UN and FIG**,** 1999; Van der Molen 2003).

From a conceptual point of view, one of the foundations of the 2D cadastre is that there can be no gaps or overlaps in the parcelation on which the rights are based, that is, a planar partition of the surface (implying property volumes defined by the space columns above and below the ground surface parcel). The same foundation (a partition of space with no overlaps or gaps) is also the basis of the conceptual thinking with respect to three dimensional (3D) cadastre (Stoter, 2004). This conceptual view is not per se directly translated into an identical 3D technical implementation. The most advanced translation would be to have a system based on a complete 3D topological structure based on volumes, faces, edges and nodes (as extension of the current systems based on a 2D topology with faces, edges and nodes). However, in the short term a practical technical solution for the implementation could be: use the 2D parcels as basis (with their implied column volumes) for the partition of space, but subtract from this the 'exceptional' cases of volume parcels with a complete 3D description (Döner et al., 2010).

In this paper, it is aimed to examine aspects of 3D cadastre in Turkey. Current situation of Turkish cadastre is evaluated and cadastral recording with a 3D component are summarised. Then, some examples of 3D situations which current 2D cadastre has shown limitation are presented to determine actual needs for 3D cadastre. Finally, suggestions are given in conclusions to address problems facing in registering and representing of 3D situations.

2. LEGAL ASPECT OF 3D CADASTRE IN TURKEY

The Turkish cadastral system includes land registration and cadastral mapping. Cadastral maps are part of the register and cadastral parcels are basic units in the maps. Land registration and cadastral mapping is maintained by one organization: The General Directorate of the Land Registry and Cadastre (GDLC). Responsibility of the cadastre belongs to the national government (The Ministry of Public Works and Settlement).

Cadastral works in Turkey was started after the foundation of the Republic of Turkey (1923). Early land records, however, existed in the Ottoman Empire period. During this period, lands were registered with detailed information and land boundaries were described in some books as written. This written period continued to the late nineteenth century. The land records which come from Ottoman Empire are still used to solve legal disputes on land (Biyik and Yomralioglu, 1994). After foundation of the Republic of Turkey, cadastral works began in 1925 based on the Cadastre Law (No. 658). Until 1950, cadastral works carried out only in urban areas. At the end of the World War II, the need for agricultural products and determination of agricultural lands increased the necessity for the cadastral surveys. Thus, the cadastral survey of the whole country was initiated in the early years of 1950's. Until 1987, cadastral works in Turkey were carried out in urban and rural areas based on different laws. In 1987, the Cadastre Law was put into practice and all the cadastral works and regulations were combined under the law (Demir et al., 2003).

With the development of technological tools and information technologies, some projects have been developed in Turkey to speed up cadastral works and also to improve cadastral services and accuracy of the cadastral data. One important projects developed by GDLC is the Title and Cadastre Information System (TAKBIS in Turkish).The general objective of this project which was initiated in 2000 is to establish the Turkish Cadastre Information System throughout the country. The pilot area for the project was selected as two districts of the Ankara. The TAKBIS project is still in progress, and consists of three steps: analysis, design, and application development. The main purposes of TAKBIS are (URL1):

- to provide reliable and up-to-date land information required for all land and land-related activities and decision makers,
- to transform cadastral data to a multipurpose land information system,
- to protect the cadastral data in a secure environment and provide secure access the data,
- to accomplish cadastral services within the scope of information technologies,
- to provide standardization in cadastral services.

Like many other countries, civil law is the legal basis in Turkish cadastral registration. Regarding the Turkish Civil Code, the main types of cadastral recordings with a 3D component are (the Turkish terms are added in italic, in brackets) (Doner and Biyik, 2007):

- Property right (*mülkiyet hakkı*)
- Right of easement (*irtifak hakkı*)
- Right of superficies (*üst hakkı*)
- Condominium right (*kat mülkiyeti*)

2.1 Property right

From the legal standpoint, property on land has a 3D component in Turkey. Article 718 of the Turkish Civil Code (2001) describes the content of the property on land. According to the article, property in land reaches from the middle of the earth up to sky. Also this property comprises building, vegetables and mines. According to the Article 998 of the Turkish Civil Code, followings are registered in land registry as real estate:

- Land
- Individual and permanent rights on real estates
- Individual parts of the building that are subject to condominium

2.2 Right of easement

Article 779 of the Turkish Civil Code defines the right of easement (*irtifak hakkı*). According to the article an easement is charge imposed upon a real estate (serving real estate), in favor of another real estate (dominant real estate). This charge forces the owner of serving real estate to avoid using some benefits of the property right or forces the owner of dominant real estate to use the serving real estate in specific way. The right of easement can be transferred, that is, when the parcel is sold, rights and restrictions of an easement are taken over by the next parcel owner.

2.3 Right of superficies

In Article 726 of the Turkish Civil Code the right of superficies (*üst hakkı*) is defined as: property of constructions that are built permanently under or above of a land owned by someone else belongs to person who has right of easement. In the same article, it is defined that it can not be set a superficies on individual parts of the buildings subject to the Condominium Law. A right of superficies can be used when the owner of the construction is not the same as the owner of the parcel. In the cadastre, no geometry is maintained to reflect spatial extent of the right.

2.4 Condominium right

Another 3D use of space occurs in apartment complexes. From the point of legal context, in Turkey, every apartment owner has the full property of a part of the building (apartment). The communal areas of the building, such as staircases and elevators are held in co-property. According to the Turkish Civil Code, the registration of individual parts of a building is subject to Condominium Law (in Turkish: *Kat Mülkiyeti Kanunu*). In the cadastre, only the ground parcel of the apartment building is maintained and therefore the individual apartments can not be recognized on the cadastral map. Consequently apartment units cannot spatially be queried.

Another important issue is that underground objects aren't registered in Turkey. This is due to the fact that many underground objects related to infrastructure are located under lands owned by public (e.g. roads). According to the Article 16 of Cadastre Law (1987), these lands which are not subject to private property are only shown on maps and not registered (Tudes and Biyik, 2001).

3. TECHNICAL ASPECT OF 3D CADASTRE IN TURKEY

Cadastral mapping in Turkey has been implemented with using different surveying methods and standards so far. In addition, cadastral maps have been produced in different coordinate

system, scale and base types. Some of the surveying methods which are used for producing cadastral maps are: graphical, orthogonal, photogrammetric and digital (X,Y,Z). Besides, the obligation of producing cadastral bases in national coordinate system could not be put into practice until 1993 (Demir and Cete, 2004). As of 2010, %99 of cadastral surveying was completed in the country (URL-1).

Problems in mapping and representing 3D situations in Turkey are most faced with underground utilities. Physical registration of utilities is not organized at national level in Turkey. Since underground network itself is not registered, cadastre does not provide geometric information for utilities. Several organizations and operators are responsible for installing and maintaining utility networks. In most situations, however, data sharing with respect to spatial information of the networks is weak. To provide coordination between different network operators within large 500,000+ cities, a law (number 3030) was put into practice and the Infrastructure Coordination Center, AYKOME, was established in 1984. It is the responsibility of the AYKOME to plan, coordinate and inspect the projects for water, electricity, tramway, subway, gas, telecommunication, etc. The registration of utilities is done by local governments through AYKOME based on the law which states that it is compulsory to establish AYKOME if population of the municipality is larger than 500,000; otherwise, each utility operator has its own registration. AYKOME does not access external utilities' databases, but maintains its own database of network data within the municipality. That is, it copies the data. The primary objective of the establishment of AYKOME is to determine how space is occupied by public infrastructure objects in cities. When a request for excavation is received by AYKOME, the area of interest is marked on a map to determine existing underground structures. In addition, depending of existence of data, depth information can be supplied to the excavator. AYKOME also determines if or when the excavation may take place and how much the excavator has to pay for information delivered. The whole process, from request to information delivery, takes around 2 weeks (Döner et al, in press).

4. 3D SITUATIONS IN TURKEY

In this section, some 3D situations from Turkey are shown to present the needs for 3D cadastre.

4.1. Underground shopping areas

One of the 3D situations which have been frequently faced in current practice occurs when underground properties such as shopping mall, parking places are partly or fully located under public lands (e.g roads). Since these kinds of lands are not subject to registration, legal situation has been disputed for a long time. General Directorate of Land Registry and Cadastre (GDLC) published an act for registration of underground shopping malls. The solution found was to register the road corresponding underground property in the name of municipality as 2D parcel and to establish right of superficies for the property located under the surface parcel. This type of 3D situation is common in big cities of Turkey. For example, number of the underground shopping malls is 260 in Ankara and 394 in Istanbul. Even thought the legal solution for shopping malls, most of the underground buildings have not

been registered in land registration. Furthermore, the registered underground property objects cannot be represented on cadastral maps (Karataş et al, 2010).

4.2. Historic sites

Property of the historical sites belongs to legal bodies such as municipality or related government departments. This kind of sites cannot be subject to private property. However problems occur if a historical site is located under surface(and the surface is used for different purposes by different owners). In this case, information about existence of the underground historical sites can only be found by examining notifications or limited real rights such as superficies and easements on surface parcels. Exact locations of the underground structure and space where the limited rights are applied remain unknown in cadastre. Examples for this 3D situation are Yerebatan Sarnıcı and Bindirek Sarnıcı in Istanbul. When examined records in land registry it was seen that Yerebatan Sarnıcı was registered in name of Municipality of Eminonu with parcel number 14. Actually the underground construction is also party located under many other parcels and this situation was explained with the notification on parcel 14 by giving numbers of intersecting parcels. However the cadastre map does not give information about location of the underground object. The situation is similar with the Bindirek Sarnıcı (Karataş, 2010).

An interesting 3D situation is from Cappadocia region in Turkey. Cappadocia, characterized by the natural features and rock architecture has been proclaimed a world heritage site by UNESCO in 1985. The story of this unique region covering almost 10,000 hectares goes back far in time to Neocene, around 25 million years ago. Yet, problems in registering and representing the subterranean settlement were faced about 40 years ago in Uçhisar, Nevşehir.

New houses, schools and administrative buildings were built above ground relevant to the master plan of the late 1960s. According to the municipality archives, until early 1960s a detailed cadastral plan of the area did not exist and the existing properties were registered according to the owner's declarations. The subterranean entities expanded when necessary and divided among the heirs when the title deed owner passed away. When a particular property changed hands the boundaries were determined by mutual consent. Potential problems faced during transactions were handled either by arbitration or according to the relevant sections of property law. Due to emerging safety issues stemming from geological conditions and wear and tear factors; following the initiatives defined by the central government; local administrators initiated plans for evacuation of certain areas within Cappadocia in late 1960s. In 1970s, a comprehensive survey aiming to map and complete the land registry documentation of the residential areas has started. The existing settlement characteristics of Uchisar set an example to the symbiotic relation of man and nature common to many settlements in Cappadocia. Horizontal and vertical sections from the settlement represent the complex relations of subterranean spaces and entities. As can clearly be followed in the sections, the pattern of underground development is not constrained by property lines or other abstract boundaries. Contradictory to the common urbanization patterns, the settlement developed organically, independent of any guiding regulations or principles. (Erdem, 2008). Figure 1 and Figure 2 show sections of the underground settlement

and locations of the sections, respectively.

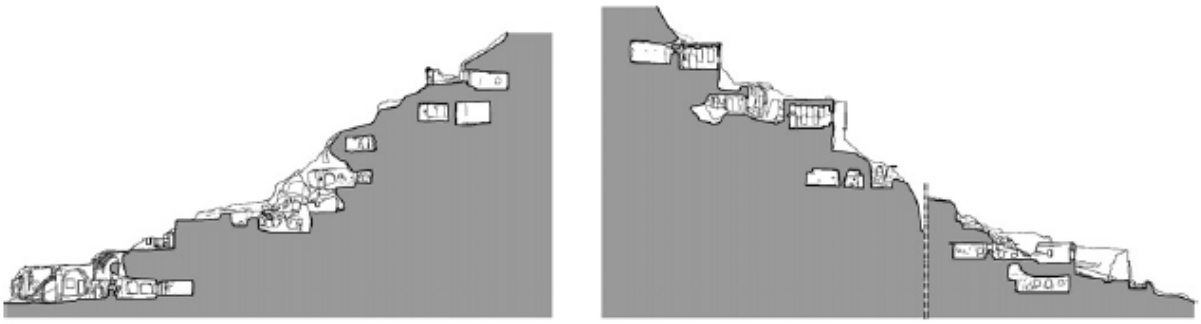

Figure 1: Typical sections of the settlement (Erdem, 2008)

Figure 2: Location of the sections (Aslan et al, 2002)

Legal registration problems could be solved by establishing rights such as easements, superficies. However, it was not possible to represent all the properties on cadastre map because of complex configuration of the situation. Therefore, the properties located tops of each other are currently displayed on the cadastre map with their approximate location as written.

5. CONCLUSION

Due to the complex management tasks, modelling multi-dimensional spatial information has become one of the challenging topics in current cadastres. In this paper, legal and technical aspects of 3D cadastre in Turkey were examined to present needs and opportunities of the cadastre in current practice. Then, some of 3D situations which current cadastre has shown limitation to register and represent were given.

Like many other countries parcel is the basic registration unit for cadastral in Turkey. Property on the land parcel is defined by boundaries on the surface and is not explicitly limited in the vertical dimension. In general, the property on land includes all space above and below the parcel, as well as all constructions that are permanently fixed to the land. The consequence is that property to land is very well registered in the cadastral registration by means of 2D parcels, while 3D situations described above are defined and registered by means of limited rights and other restrictions on intersecting parcels.

As seen from cases, different solutions have been produced based on current legal framework to establish rights in case of 3D situations. There are no rules or standardization for 3D situations. Furthermore, currently, it is impossible to view the 3D property units interactively in Turkey because geometric information of the 3D situation either is not available or only available as paper format. Therefore, spatial part of the cadastral database does not give information about the 3D situations.

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BIOGRAPHICAL NOTES

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