Conformity of LADM for Modeling 3D/4D Cadastre Situations in Turkey

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Key words: 3D/4D Cadastre, Land Administration, LADM, Turkish Cadastre

SUMMARY

The increasing complexity of land use requires that cadastral systems as a core component of land administration need an improved capacity to manage the higher dimensions (third dimension for height or deep and forth dimension for time) of the land. Until today countries have developed several studies related to 3D/4D cadastre depending on mainly their legal systems and technical needs. In Turkey, it is now broadly accepted that the current cadastral data model should be improved and enriched to reflect all dimensions of the land. In current practice, temporal and multidimensional information are treated as attributive data. Previous studies have shown that this approach has some limitations to represent and register 3D/4D situations in Turkey.

On the other hand, one of the ongoing important projects in Turkey is the Land Registry and Cadastre Information System (TAKBIS in Turkish) which is mainly aiming at providing reliable and up-to-date land information required for all land and land-related activities, transforming cadastral data to a multipurpose land information system, accomplishing cadastral services within the scope of information technologies and providing standardization in cadastral services. TAKBIS could not exactly reach its goals because of some deficiencies in monitoring and modeling temporal changes of spatial data. Another important project is Turkish National Geographical Information System (TUCBS in Turkish). TUCBS is an e-government project aiming at establishing infrastructure which is suitable for national level requirements and the INSPIRE directive, creating a web portal for serving the information that public institutions and enterprises responsible to users over the common infrastructure, generating content standards that satisfy needs of the all user institutions and determining geographical data exchange standards.

In this paper, conformity of LADM for modeling 3D/4D cadastre situations in Turkey was evaluated compared approaches of TAKBIS and TUCBS. The paper commences with an introduction in section 1. In section 2, Turkish land administration system is introduced to understand cadastral recordings with a 4D component. Then, 3D/4D situations are presented that current cadastre has shown limitations in section3. In section 4, similarities and differences between LADM and TAKBIS/TUCBS are presented to evaluate conformity of LADM for modeling 3D/4D situations. This paper ends with a conclusions section.

SUMMARY (TURKISH)

Arazi kullanımının giderek artan karmaşıklığı arazi idaresi temel bileşenlerinden olan kadastro sistemlerinin araziyi çok boyutlu (yükseklik veya derinlik için üçüncü boyut ve zaman için dördüncü boyut) olarak yönetebilecek şekilde kapasitelerinin artırılmasını gerektirmektedir. Bugüne kadar ülkeler ağrılıkla kendi yasal sistemlerine ve teknik ihtiyaçlarına bağlı olarak 3B/4B kadastroyla ilgili çeşitli çalışmalar gerçekleştirmişlerdir. Türkiye'de günümüzde mevcut kadastro veri modelinin iyileştirilmesi ve arazinin tüm boyutlarını yansıtacak şekilde zenginleştirilmesi geniş kabul görmektedir. Mevcut uygulamada zamansal ve çok boyutlu bilgiler öz nitelik olarak kabul edilmektedir. Yapılan çalışmalar bu yaklaşımın 3B/4B kullanım durumlarını temsil ve tescil etmede sınırlamaları olduğunu göstermektedir.

Diğer yandan, Türkiye'de devam etmekte olan önemli projelerden biri Tapu ve Kadastro Bilgi Sistemidir (TAKBIS). TAKBIS'in temel amacı arazi ve araziyle ilişkili faaliyetler için güvenilir ve güncel arazi bilgisi sağlamak, kadastro verilerini çok amaçlı bir arazi bilgi sistemine dönüştürmek, kadastro hizmetlerinin bilgi sistemleri çerçevesinde yürütülmesini mümkün kılmak ve kadastro hizmetlerinde standardizasyonu sağlamaktır. TAKBIS, konumsal verinin zamansal değişimlerinin izlenmesi ve modellenmesindeki eksiklikler nedeniyle amaçlarına tam olarak ulaşamamıştır. Diğer önemli bir proje Türkiye Ulusal Coğrafi Bilgi Sistemleridir (TUCBS). TUCBS, ulusal düzeyde teknolojik gelişmelere ve INSPIRE Direktifine uygun coğrafi bilgi sistemi altyapısı kurulmasını, kamu kurum ve kuruluşlarının sorumlusu oldukları coğrafi bilgileri ortak altyapı üzerinden kullanıcılara sunmaları amacıyla bir web portalı oluşturulmasını, coğrafi verilerin tüm kullanıcı kurumların ihtiyaçlarına cevap verecek şekilde içerik standartlarının oluşturulmasını ve coğrafi veri değişim standartlarının belirlenmesini amaçlayan bir e-devlet projedir.

Bu çalışmada LADM'in Türkiye'deki 3B/4B durumları modellemedeki uygunluğu TAKBIS ve TUCBS yaklaşımlarıyla karşılaştırılarak değerlendirilmektedir. Çalışma bölüm 1'de giriş ile başlamaktadır. Bölüm 2'de Türk arazi idaresi sistemi 4B bir bileşen içeren kadastro kayıtlarını anlamak için tanıtılmaktadır. Ardından, mevcut kadastronun sınırlamalar gösterdiği 3B/4B kullanım durumları bölüm 3'de verilmektedir. Bölüm 4'de LADM ve TAKBIS/TUCBS arasındaki bezerlik ve farklılıklar LADM'in 3B/4B durumları modellemede uygunluğunu değerlendirmek için sunulmaktadır. Çalışma sonuç bölümüyle sona ermektedir.

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Fatih DÖNER and Cemal BIYIK, Turkey

1. INTRODUCTION

The increasing complexity of land use requires that cadastral systems as a core component of land administration need an improved capacity to manage the higher dimensions (third dimension for height or deep and forth dimension for time) of the land (UN and FIG, 1999; Kaufmann and Steudler, 1998). Until today countries have developed several studies related to 3D/4D cadastre depending on mainly their legal systems and technical needs (Stoter, 2004; Döner et al, 2011). In Turkey, it is now broadly accepted that the current cadastral data model should be improved and enriched to reflect all dimensions of the land (Cete and Yomralioglu, 2013). In current practice, temporal and multidimensional information are treated as attributive data. Previous studies have shown that this approach has some limitations to represent and register 3D/4D situations in Turkey.

In the beginning of 2008 Federation of Surveyors (FIG) submitted a proposal to develop an International Standard for the land administration domain to the Technical Committee 211 (TC 211) on Geographic Information of the International Organization for Standardization. The Land Administration Domain Model (LADM) was approved as an official International ISO Standard on 1 November 2012, a milestone for FIG. LADM defines terminology for land administration, based on various national and international systems that is as simple as possible in order to be useful in practice. LADM covers the compete domain, surveying included. It is highly relevant that documented field surveys can be included, in combination with reconstructable adjustments to the spatial database (van Oosteron et al., 2013).

In Turkey, there are also attempts to achieve standardization in the area of cadastral and land related data. One of them is Land Registry and Cadastre Information System (TAKBIS in Turkish) which is mainly aiming at providing reliable and up-to-date land information required for all land and land-related activities, transforming cadastral data to a multipurpose land information system, accomplishing cadastral services within the scope of information technologies and providing standardization in cadastral services. TAKBIS could not exactly reach its goals because of some deficiencies in monitoring and modeling temporal changes of spatial data. Turkish National Geographical Information System (TUCBS in Turkish) is another e-government project aiming at establishing infrastructure which is suitable for national level requirements and the INSPIRE directive, creating a web portal for serving the information that public institutions and enterprises responsible to users over the common infrastructure, generating content standards that satisfy needs of the all user institutions and determining geographical data exchange standards.

In this paper, conformity of LADM for modeling 3D/4D cadastre situations in Turkey was evaluated compared approaches of TAKBIS and TUCBS. In section 2, Turkish land administration system is introduced to understand cadastral recordings with a 4D component. Then, 3D/4D situations are presented that current cadastre has shown limitations in section3.

In section 4, similarities and differences between LADM and TAKBIS/TUCBS are presented to evaluate conformity of LADM for 3D/4D situations. This paper ends with a conclusions section.

2. TURKISH LAND ADMINISTRATION

The Turkish land administration 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 (Ministry of Environment and City Planning) (Cete and Yomralioglu, 2013).

In spatial part of the cadastral database, the property boundaries, buildings and roads on land surface are maintained. With Cadastre Law entering into force in 1987, topographic data was also added to this content. However, up until today cadastre maps have been produced in two-dimensional manner. In the current application, only parcel corner coordinates are produced as three-dimensional in ITRF coordinate system (Doner and Biyik, 2007). In the maps, with the purpose of giving the third dimension, GDLRC is planning to establish the digital land model of whole Turkey until the year end of 2014 by realizing digital aerial videotape. Through this works, it is aimed to increase the production quality in cadastral renewal works, decrease the costs and establish up-dated and reliable sheets for information systems as well as to produce topographic map of the whole country.

With the development of technological tools and information technologies, some projects have been developed by the GDLRC to speed up cadastral works and also to improve and enrich content of the cadastral data. Purposes and calendar of some the projects of are summarized in Table 1.

From conceptual point of view, time is already a natural component of the recordings in Turkish land administration. However, main the main types of recordings with a 3D+time component can be listed as follows (the Turkish terms are added in italic, in brackets) (Doner and Biyik, 2007):

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

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. 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.

Table 1. Some of projects in Turkey, their purposes and estimated completion periods

Project	Purpose	Duration
Land Registry and Cadastre Information System (TAKBİS)	Carrying out the land Registry and cadastre activities over a computer system throughout Turkey; in this way ensuring the effective tracking and control of both private and public immovables, providing up-dated and reliable information in a quicker manner to state institutions and organizations and citizens.	2000 - in progress
Spatial Real Property System (MEGSIS)	Collecting CAD-base data on local computers of cadastre directorates digitally on a central system and mapping this data with land registry information that have been collected; and sharing this information with stakeholder institutions, organizations and municipalities.	2013 - in progress
Map Information Bank Project (HBB)	Giving opportunity for entry, updating and provision of meta data, over internet, which pertains to the information and documents belonging to the maps produced by the organizations.	2005-2008
Land Registry and Cadastre Modernization Project (TKMP)	Updating current land Registry and cadastre information as contemplated in Cadastral Law in a manner and form that will establish the base of spatial information systems.	2009 - in progress
Turkey National Geographical Information System Project (TUCBS)	TUCBS is an e-government project aiming the establishment of a Geographical Information System complying with International technological developments and INSPIRE Directive	2006 - in progress

Also, 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.

Another 4D 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.

Utilities are main objects in land administration with 4D characteristic. In Turkey, from legal point of view, utility networks are not considered as immovables and therefore are not registered in land administration as a separate object. Moreover, many utility networks are located under public lands (e.g. roads). According to the Article 16 of Cadastre Law (1987), public lands are not registered. Hence, the legal ownership situation of the utilities crossing these public lands remains unknown in the land administration unless they cross a private property (Döner et al, 2010).

3. 3D/4D SITUATIONS IN CURRENT PRACTICE

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 (Doner et al, 2011).

Another 3D use of land occurs in historical 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 partly 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 (Doner et al, 2011).

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 (Doner et al, 2011).

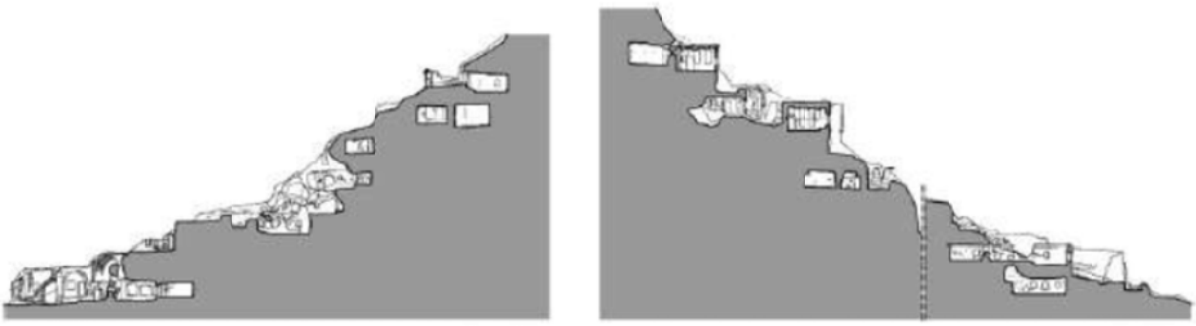

Figure 1. Typical sections of the settlement (Erdem, 2008)

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.

On the other hand, growing pressure on land and rising land values have caused an increasing need for 4D (including 3D) information in management of utilities in land administration systems. These infrastructural objects are mostly located in a part of the parcel and may cross many parcel boundaries, although most of those parcels will be owned by parties other than the network manager. Furthermore, the utilities are often subsurface and have therefore a 3D characteristic. Finally, the cadastral registration of utility networks includes temporal aspects, which are (at a minimum) initial creation, changes during life time (including splitting and merging networks) and finally deletion.

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

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. For the representation of the legal status of utility networks crossing private property, the owner of the underground utility can be entitled to use the space above or below the surface parcel by means of limited rights such as superficies and easement rights. Also, 2D drawings can be added to the deeds to describe the location of the underground objects. However, these drawings are only available as separate documents and not digitally linked to records describing the associated rights in land (Döner et al, 2010).

4. CONFORMITY OF LADM FOR TURKISH LAND ADMINISTRATION

In this section, TUCBS-TK Application Schema" and its sub-sections are explained and elaborated.

Land Registry- Cadastre data theme (TUCBS-TK) is one of 10 TUCBS base geo-data themes that different users need to share. ISO/TC211 based UML/GML application schemas were designed for the geo-data themes to provide data interoperability. The content of TUCBS-TK covers (in connection with the LADM):

- spatial units registered for constituting immovables or constituting a part of immovables even not registered (Spatial Unit package in the LADM);
- cadastral original data stored in cadastral archive and based for technical studies (Surveying part of the Surveying and Representation package in the LADM);

- cadastral data structure that forms building blocks of the models (Representation part of the Surveying and Representation package in the LADM);
- immovables registered in land registry that define rights on one, more or a part of whole spatial units (Administrative package in the LADM);
- parties subject to property (Party package in the LADM);
- external data provided from other systems (External package in the LADM).

Fundamental operation of the data theme is defined by relation between four basic classes. These classes represent spatial units (*KonumsalBirim*) which are registered spatially, registration objects (-*TescilNesne*- real estate recordings), rights/restrictions/responsibilities on registered real estates (*HKS*-RRR) and persons related to the RRR (Figure 3) (Inan et al, 2013).

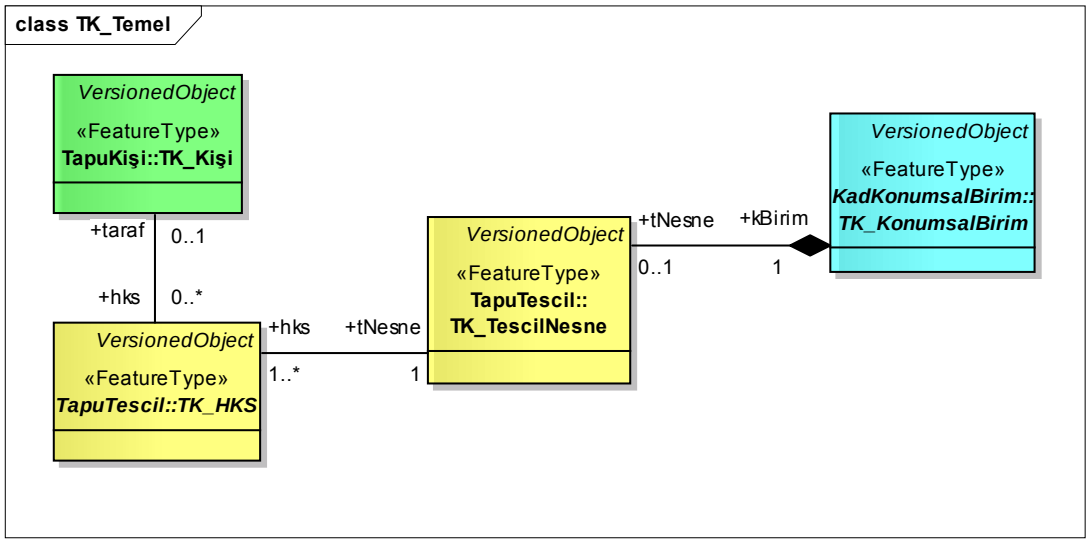

Figure 3. Basic classed of TUCBS-TK

Spatial unit basic class has area and volume geometries. This class defines basic properties of other types of spatial classes such as parcel (*Parsel*), building (*Bina*), building block (*BinaBlok)*, spatial unit cluster (*KonumsalBirimKümesi)* project area (*ProjeAlanı)*, easement (*İrtifak)* (Figure 4). In data structure (*VeriYapısı)* group, basic classes related to design are defined. To trace non-spa*tial* temporal changes, an abstract class (VersionedObject) is defined based on objects' start and finish of validity times. All classes are designed as specialization of the abstract class (Figure 5). In addition, to define basic properties of all technical and legal documents an abstract class (*AsılBelge)* is defined. *Sınır* class is designed to manage topological relations and to represent real estate boundaries which consist of point and line portions. *PaftaİndeksI* class is designed to determine boundaries of spatial subclasses of cadastral data. *The Sınır* class also manages direction information of real estates. In this way, complex areas (nested poligons) and topological operations can be handled.

Basic classes of *Tescil* group are *TescilNesne* and *HKS* (rights, restrictions and responsibilities). Any type of spatial unit represented with *KonumsalBirim* class has a character that direct registration is impossible. For example, a parcel and a building on this

parcel can be registered together with in the name of the same person. Or, a condominium can be registered with a part of parcel or can be registered with common areas of the building. To manage such combinations *TescilNesne* relation class is defined and the situation that registration depends on some conditions and time is taken into account with *TK_KB_TN* class (Figure 6) (Inan et al, 2013).

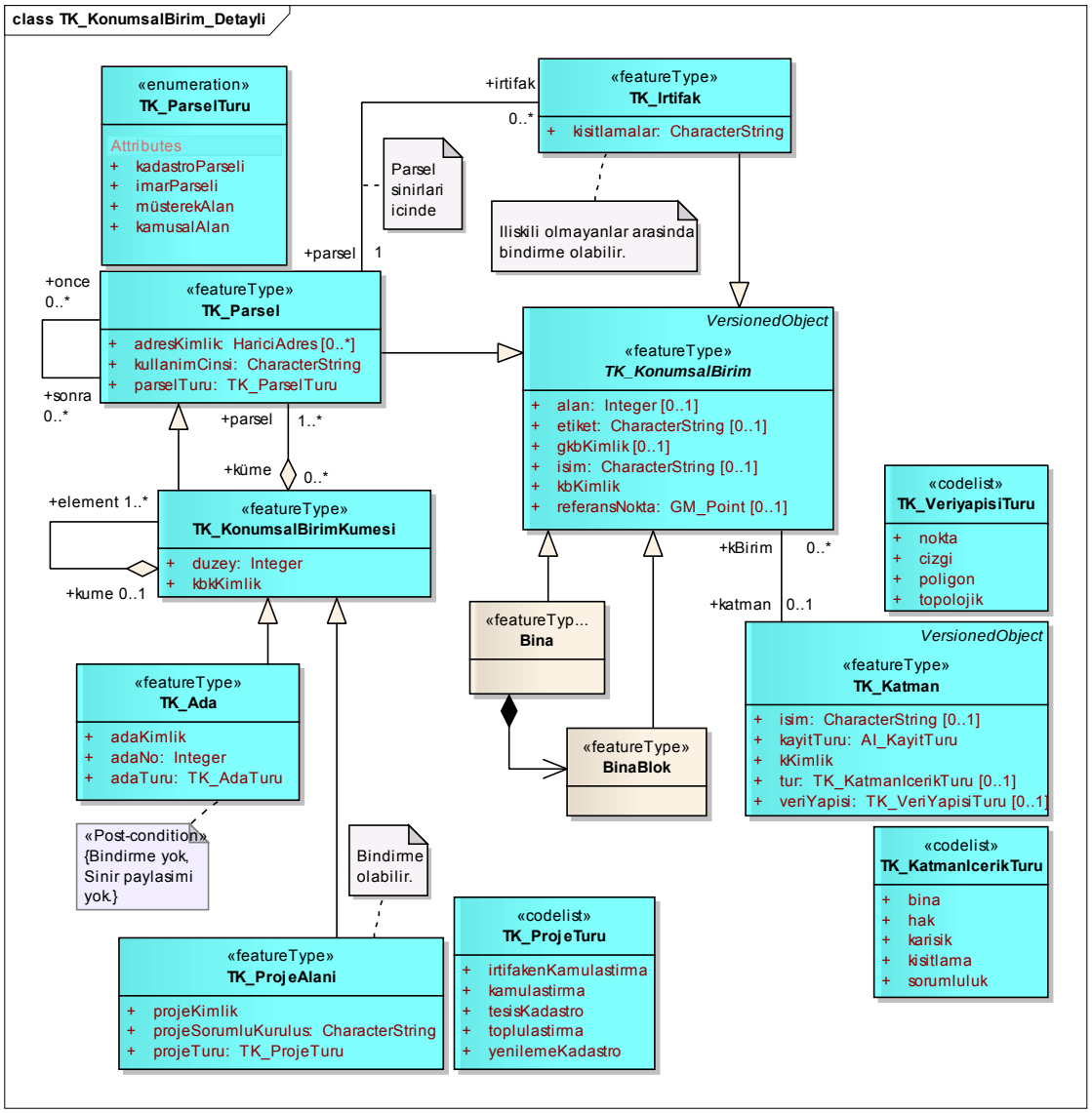

Figure 4. Spatial unit classes and relations

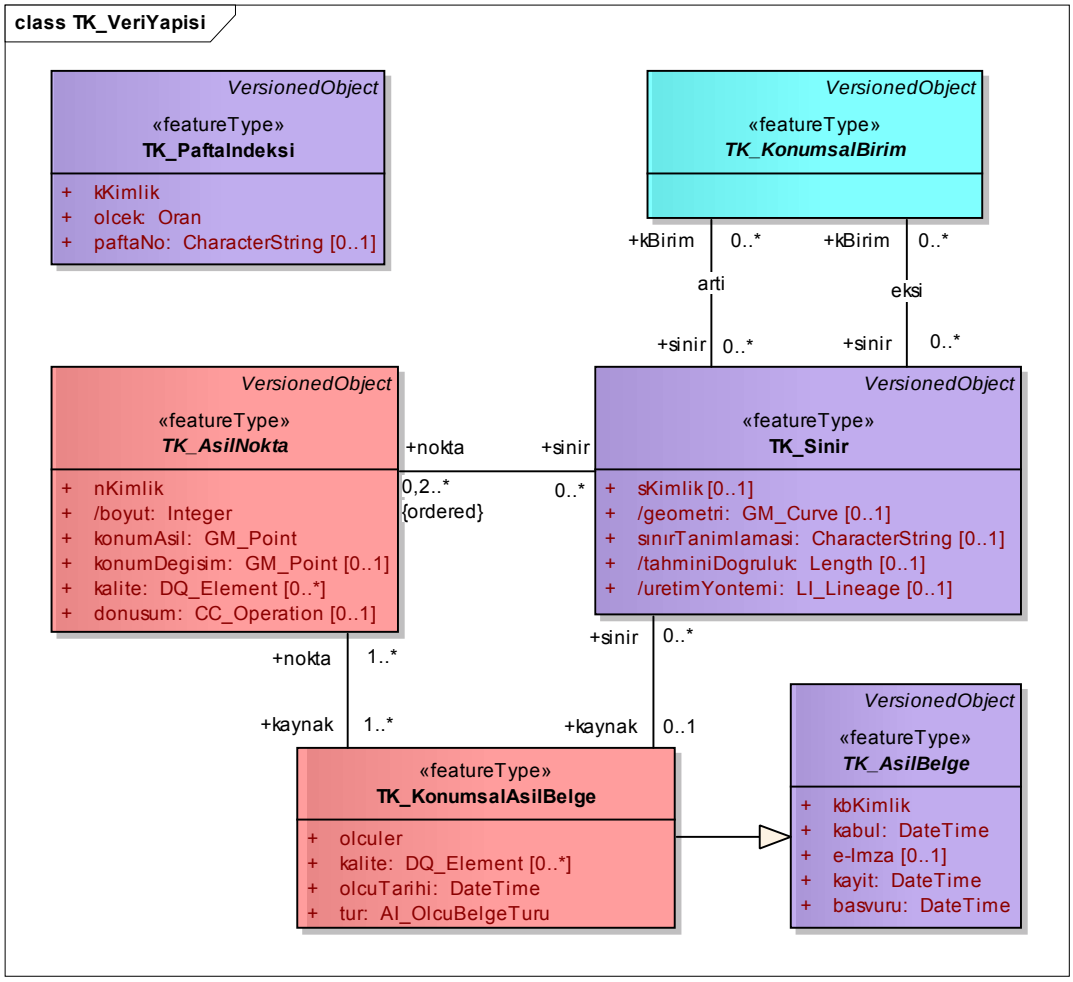

Figure 5. Data structure group classes

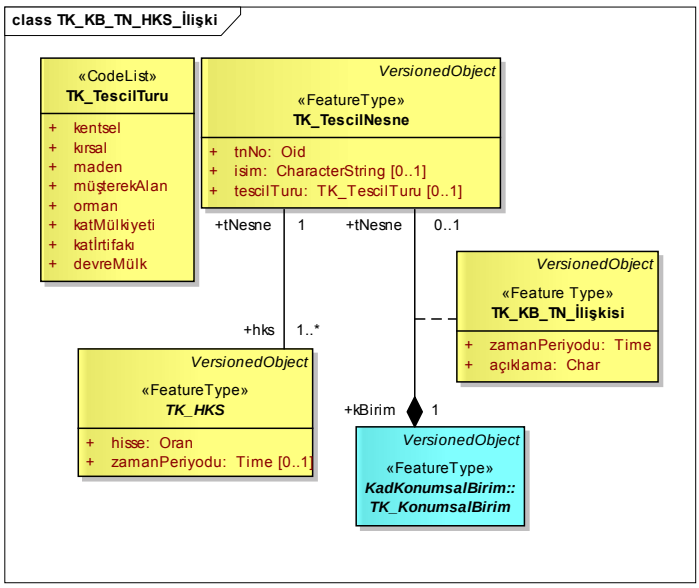

Figure 6. Relation between *KonumsalBirim* and *TescilNesne*

CONCLUSIONS

Resolution of problems in society requires more information than provided from one single data set, and this is equally true for problems with a spatial concept. To address these problems availability of well-maintained links between spatial data sets and other basic or key data sets, for example, on addresses, persons, companies, buildings, land rights, etc. is inevitable. Nowadays, different organizations perform applications to representations of the same objects. This requires further on standardization which enables these involved parties to communicate describing digital data and services.

The LADM is an attempt to achieve standardization in the area of land administration following conceptual framework of Cadastre 2014. The standardization of the land administration domain provides common definitions for land information and facilitates the effective use, understanding and automation of land related data thereby enhances data sharing. The LADM is developed according to the rules for application schema as defined by ISO 19109. The geometry and topology (2D and 3D) are based on the ISO/TC 211 standard classes. The model is specified in UML class diagrams and it is indicated how this UML model can be converted into an XML schema, which can then be used for data exchange. There are two different approaches when modeling temporal changes: event and state based modeling. The LADM covers both event (via the SourceDocuments) and state based temporal modeling (via VersionedObject). In event based modeling, transactions are modeled as separate entities within the system (with their own identity and set of attributes). When the start state is known and all events are known, it is possible to reconstruct every state in the past by traversing the whole chain of events. In state based modeling, on the other hand, the states (that is the results) are modeled explicitly: every object gets (at least) two dates/times, which indicate the time interval during which this object is valid. Via the comparison of two succeeding states it is possible to reconstruct what happened as a result of one specific event. It is easy to obtain the state at a given moment in time, by selecting the object based on their time interval (tmin-tmax). In the LADM, every object class that needs versioning inherits from VersionedObject class. Therefore, it is not needed to explicit add the tmin and tmax attributes to the main classes RegisterObject, RRR and Person.

2D cadastral parcel is the basic registration unit in Turkey. Property on the land parcel is defined by boundaries on the surface and is not explicitly limited in the vertical dimension. Property on land includes all space above and below the parcel, as well as all constructions that are permanently fixed to the land. Property to land is very well registered in the cadastral registration by means of the 2D parcels, while 3D/4D situations give in the text are defined and registered by means of limited rights, condominium rights, time sharing and other restrictions on intersecting parcels. It can be concluded from the cases presented here that like many other countries, traditional cadastre has shown some limitations in Turkey to register and represent 3D/4D situations. It is accepted that the current cadastral data model should be improved to reflect better all dimensions of the land. The TAKBIS and TUCBS include attempts to achieve standardization in the area of cadastral data based on international approaches. Land registry and cadastre data model of TUCBS is compatible with LADM. However, in case of managing multidimensional and temporal aspect, further studies are needed to meet expectations.

REFERENCES

Aslan, S., Orbay, A. and Cansever, F., (2002), Architectural Documentation of a Typical Cappadocian Settlement: Uchisar, Turkey, In: Proceedings, September, Berlin.

Cete, M., and Yomralioglu, T., 2013. Re-engineering of Turkish land administration, Survey Review 45 (330), 197-205

Döner, F., Biyik, C., (2007), "Defining 2D Parcels in 3D Space by Using Elevation Data", TS8G.3, FIG Working Week 2007, May 13-17, Hong Kong SAR, China.

Döner, F., O. Demir and C. Biyik, "Need for Three-Dimensional Cadastre in Turkey", FIG Working Week 2011, May 18-22, Marrakech, Morocco, 2011.

Döner, F., R. Thompson, J. Stoter, C. Lemmen, H. Ploeger, P. van Oosterom and S. Zlatanova, "Solutions for 4D cadastre – with a case study on utility Networks", International Journal of Geographical Information Science, 25(7), 1173-1189 (2011).

Döner, F., Thompson, R., Stoter, J., Lemmen, C., Ploeger, H., Van Oosterom, P., Zlatanova, S., (2010), 4D Cadastres: First Analysis of Legal, Organizational, and Technical Impact-with a Case Study on Utility Networks. Land Use Policy 27 (2010) 1068-1081.

Erdem, A., (2008), Subterranean Space Use in Cappadocia: The Uchisar Example, Tunnelling and Underground Space Technology, 23, 492–499.

Inan, H. I, Aydınoglu, A. C. and Doner, F., (2013). Developing Turkey's Land Registry and Cadastre Base Data Model in accordance with LADM, International FIG workshop on the Land Administration Domain Model, 24-25 September 2013, Kuala Lumpur, Malaysia.

Stoter, J.E., 2004. 3D Cadastre. PhD Thesis. TU Delft, September 2004.

UN and FIG, 1999. The Bathurst Declaration on Land Administration for Sustainable Development. Report of the Workshop on Land Tenure and Cadastral Infrastructures for Sustainable Development. 18-22 October, Bathurst-Australia.

Van OosteroM, P., Lemmen, C. and Uitermark, H., (2013). Land Administration Standardization with focus on Evidence from the Field and Processing of Field Observations, International Federation of Surveyors, Article of the Month – February 2013.

BIOGRAPHICAL NOTES

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