Developing Land Registry and Cadastre Base Data Model for Land Management Applications

Arif Cagdas AYDINOGLU and Halil Ibrahim INAN, Turkey

SUMMARY

Content about land registry and cadastre data in Turkey is being developed based on the Land Registry and Cadastre Information System Project (TAKBIS). On the other hand, Turkish National GIS (TUCBS or TRGIS in English) is an e-government project aiming at establishing Turkish National Spatial Data Infrastructure that enables effective geographic data management and meets national level requirements and the INSPIRE implementation rules.

Designing Land Registry-Cadastre Data Theme (TRGIS.TK), one of the base data themes of TRGIS, is discussed in this study. TRGIS stakeholders conduct requirement analysis for TRGIS.TK. ISO 19152 Land Administration Domain Model (LADM) is used and discussed as the base international standard in developing TRGIS.TK data theme standard. In this context, spatial easement, basic land parcel types in Turkey, group of parcels surrounded by barriers, group of parcels as a project area, custom cadastral maps, cadastral maps in standard shapes and content, standard subdivision of space in 2D with special subdivision names, surveyed point type and monumentation type concepts were introduced within TRGIS.TK geo-data theme.

ÖZET

Türkiye'de tapu ve kadastro verisinin içeriği, Tapu ve Kadastro Bilgi Sistemi Projesi (TAKBİS) kapsamında geliştirilmektedir. Diğer taraftan Türkiye Ulusal CBS (TUCBS), etkin coğrafi veri yönetimini sağlamayı ve ulusal düzeydeki gereksinimleri ve INSPIRE uygulama kurallarını karşılayan Türkiye Ulusal Konumsal Veri Altyapısı kurulmasını hedefleyen e-devlet projesidir.

Bu çalışmada, TUCBS'nin temel veri temalarından biri olan Tapu ve Kadastro'nun (TUCBS.TK) tasarımı irdelenmektedir. TUCBS paydaşlarına gereksinim analizi uygulanmıştır. ISO 19152 Arazi İdaresi Temel Modeli, temel uluslararası standart olarak kabul edilmiş ve kullanımı irdelenmiştir. Bu kapsamda TUCBS.TK temasındaki; ada, irtifak ve kadastro çapı gibi konumsal birim, tapu tescili kavramları, tapu kişi kavramları, konumsal işlem belge ve nokta gibi kadastro orijinal verileri, pafta indeksi ve sınır gibi kadastro veri yapısı, vb. kavramlar açıklanacaktır.

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1. INTRODUCTION

Content about land registry and cadastre data in Turkey is being developed based on the Land Registry and Cadastre Information System Project (TAKBIS). In this project, software development and applications were performed for the automation of services served by central and local bodies of General Directorate of Land Registry and Cadastre (TKGM). But, this project has some deficiencies regarding managing geographic data because of the inclination of preserving traditional data management, poor quality of geographic data, and problems about temporal changes.

Turkey National GIS (TRGIS) is an e-government project aiming at establishing Turkey National Spatial Data Infrastructure that enables effective geo-data management and meets national level requirements and the INSPIRE implementation rules. Designing Land Registry-Cadastre Data Theme (TRGIS.TK), one of the base data themes of Turkey National GIS (TRGIS), is discussed in this study.

Specifications for base geo-data themes including land registry and cadastre were designed by considering all stakeholders of TRGIS. Requirement analysis for TRGIS.TK was conducted by TRGIS stakeholders including 10 of ministries, 24 of general directorates, 25 of departments. It was declared that land registry and cadastre data is used in 77 GIS-related works.

In developing TRGIS.TK data theme standard, ISO 19152 Land Administration Domain Model (LADM) which was accepted as international standard with the leadership of International Federation of Surveyors (FIG) is used as the base international standard. Features of INSPIRE Cadastral Parcels data theme were also taken into account. In addition, scientific studies (Kaufmann and Steudler, 1998; UN-ECE, 1996; van Oosterom et al., 2006; Inan et al., 2010) and data modelling foresights of TAKBIS were considered. To design geographic data model; temporal data management, topological data structure, administrative units, non-registered areas, etc. were added to TRGIS.TK data theme beside the contents of requirement analysis.

In this study, TRGIS.TK application schema compatible with the LADM was summarized and evaluated. Its similarities and differences and accordingly the basic contribution to further LADM development for Turkish land administration system were presented and discussed. Example feature types within TRGIS:TK data theme are spatial easement, group of full-partition parcels (surrounded by natural or man-made features) used for legal indexing or conventional data management, group of parcels for the designation of a land management activity, basic land parcel types and geodetic control points.

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2. RELATED DEVELOPMENTS IN TURKEY

2.1 Land Registry and Cadastre Information System Project (TAKBIS)

Data models on land registry and cadastre data in Turkey is being developed based on automation studies within the Land Registry and Cadastre Information System Project (TAKBIS). In the project framework, firstly software development and pilot application studies for automation of services served by central and local bodies of General Directorate of Land Registry and Cadastre (TKGM) were performed (Meshur and Turan, 2010). In the project there were deficiencies regarding modelling spatial data instead of traditional management approaches, improving content and quality standards of spatial data, monitoring temporal changes of the data, which made the extension of the project over the whole country impossible.

The project, initiated in 2000, aims mainly to transfer paper based land registry and cadastre data into a digital environment using a standard framework throughout the country. It is planned to be implemented in three phases consisting of the analysis, design, and test stages in TAKBIS-I, -II and -III;
− TAKBIS-I was initiated in 2001 and completed in 2005 as analysis phase.
− Then, the implementation stage, called as TAKBIS-II, was initiated in 2005. TAKBIS-II aims to expand the implementation of the project in predefined directorates of land registry and cadastre. The TAKBIS-II phase, which is still in progress, has shown that digitising land registry records is easy to implement. It is not easy to say the same thing for the existing analogue cadastral maps of the poor quality (Cete and Yomralioglu, 2013).
− The last stage, TAKBIS-III, aims to finalise the extension of TAKBIS to all TKGM units and enable cadastral data sharing with other organisations. Between the years 2002 and 2009 desired results were not achieved with TAKBIS due to the technical problems faced in cadastral data.

Numbers of parcels for which automation was realized in land registry and cadastre units within the scope of TAKBIS in 2009 were grouped. It is seen that automation of title deed information belonging to nearly 25 million parcels was carried out and on the other hand spatial information of cadastral parcels of 3.5 million can be transmitted to the system (TKGM, 2013). Therefore, the TKGM initiated a new project in 2009 called the Modernisation Project of the Land Registry and Cadastre. The main aim of the project is the renovation and updating of current analog cadastral maps as a base to TAKBIS and the National Land Information System.

2.2 Turkey National GIS (TRGIS or TUCBS in Turkish)

Public institutions in Turkey started investment for Information and Communication Technologies (ICTs) in the 1990s and recognized the necessity of GIS in these years. The General Command of Mapping (HGK) pioneered digital map production process. Standard Topographic Maps, smaller than 1:5000, are produced by HGK. Large Scaled Maps, 1:5000 and larger, are produced by the TKGM and local governments. Other public institutions and municipalities have produced maps for their working area.

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The e-Transformation Turkey Project aims to foster the evolution and coordination of information society actions. As an action plan of this initiative, building Turkish National GIS (TUCBS or TRGIS in English) was initiated under the responsibility of TKGM. In these actions;

– In 2004 with the National Action Plan No. 47, the current situation in relation to building TRGIS was examined. (TKGM, 2004).
– With the National Action Plan No. 36, TRGIS concept and implementation models were determined in 2005. It was emphasized that it is necessary to build TRGIS to efficiently share the geo-data produced by participating stakeholders (TKGM, 2006).
– According to Modernization in Public Administration Action Plan No.75 (KYM-75) starting in 2007, with feasibility study, current status, stakeholders of geo-portal, and international projects and standards were analysed under responsibility of TKGM.
– TRGIS geo-portal was built to serve geo-data sets and related content for public institutions.
– State Planning Organization (DPT) published Guide for Interoperability Principles in 2009 and updated in 2012 within the scope of E-Turkey Project. This guide suggests international accepted OGC standards about web services and access to geo-data.

However, there were lacks of coordination among TRGIS stakeholders and technical difficulties for governing GIS projects. These factors cause inefficient collection of geo-data, impede the sharing of data on the GIS projects (DPT, 2006; Aydinoglu et al., 2008).

In 2011 within Ministry of Environment and Urbanization, General Directorate of GIS was established and started the projects about "Developing Turkey National GIS (TRGIS) standards" and "Developing Turkey Urban GIS (TRKBISS) standards".

TRGIS Conceptual model components, determined in 2012, provide general rules to create geo-data specification of TRGIS geo-data themes as a profile of ISO/TC211 and OGC standards. These components include principles, reference model, application schema rules, spatial and temporal aspects, general feature model, metadata, and etc. (GD-GIS, 2012a).

Geo-data specifications and exchange standards were developed for 10 base geo-data themes such as BI-Building, AD-Address, TK-Land Registry/Cadastre, IB-Administrative Unit, UL-Transportation, HI-Hydrography, AO-Land Cover, OR-Orthophoto, TO-Topography, and JD-Geodesy that meet national geo-data requirements to serve geo-data on TRGIS portal infrastructure (GD-GIS, 2012a). ISO/TC211 standards such as ISO 19103- 19107- 19109 support Model-driven Approach (MDA) for geo-data interoperability. Unified Modelling Language (UML) class diagrams express the structure and content of the geo-data for exchanging and multiple uses of geo-data. TRGIS geo-data themes using UML application schemas provide logical data structure for any geo-data theme, independent from platform and implementation. These UML schemas were encoded to Geography Markup Language (GML) accepted as a base of geo-data exchange format of TRGIS.

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3. TRGIS.TK MODEL DEVELOPMENT

Data specifications for TRGIS geo-data themes were based on the existing data analysis, international standard analysis, and data requirement analysis. TRGIS.TK Land Registry and Cadastre data theme standard is one of the base data themes. The following methodology was used in the analysis stage for TRGIS.TK;

- Existing Data Analysis was carried out by examining TAKBIS geo-database in TKGM and its sub-directorates.
- As a result of International Standards Analysis, ISO 19152 Land Administration Domain Model (LADM) was determined as the base international standard. In addition to this, features in INSPIRE Cadastral parcel geo-data theme were also taken into account.
- As a part of TRGIS data requirement analysis (GD-GIS, 2012b); It was determined that land registry and cadastre data is used/produced by 10 of ministries, 24 of general directorates, 25 of departments, and 77 of sub-departments. In addition, 77 map/applications were determined to use/produce land registry and cadastre data, 59 of them are existing applications and the others are suggested ones.
- For the development of TRGIS.TK application schema, a gap analysis was carried out which compares and evaluates the results of data requirement and existing data analysis.
- The data specifications of the TRGIS.TK geo-data theme were formalized from the results of the above defined analysis. DIS versions of the LADM were used as a template for model development.

As a basic international standard LADM meets common modelling requirement for the majority of land management applications that were determined as a result of TRGIS data requirement analysis. Therefore, extensions to LADM in terms of model development are focussed, discussed and presented with the help of diagrams together with explaining text. Because the original language of the modelling is Turkish, diagrams and all their content are also presented in Turkish. To increase the understandability of the presentation by wide range of readers, LADM related concepts explained in the text are presented with English translations.

The presented TRGIS.TK geo-data theme is not a Turkish Country Profile of LADM. It is only an extension of LADM for the implementation of TRGIS which is to meet all basic common needs of public and private sector in terms of Spatial Data Infrastructure development. It is developed by using DIS versions of LADM. It may be further refined using published final version of LADM in the future.

3.1 Overview of the Application Schema

The content of TRGIS.TK covers in connection with the LADM (GD-GIS, 2012c);
- Spatial units registered for constituting immovable or a part of immovable even not registered (see KadastroKonumsalBirim package in Figure 1),
- Cadastral original data stored in cadastral archive (see KadastroOrjinalVeri package in Figure 1),
- Cadastral data structure that forms building blocks of the models (see KadastroVeriYapisi package in Figure 1),

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- Immovables registered in land registry that define rights on one, more or a part of whole spatial units (see TapuTescil package in Figure 1),
- Parties subject to property or responsibilities (see TapuKisi package in Figure 1),
- External data provided from other systems (see TKHariciVeri package in Figure 1).
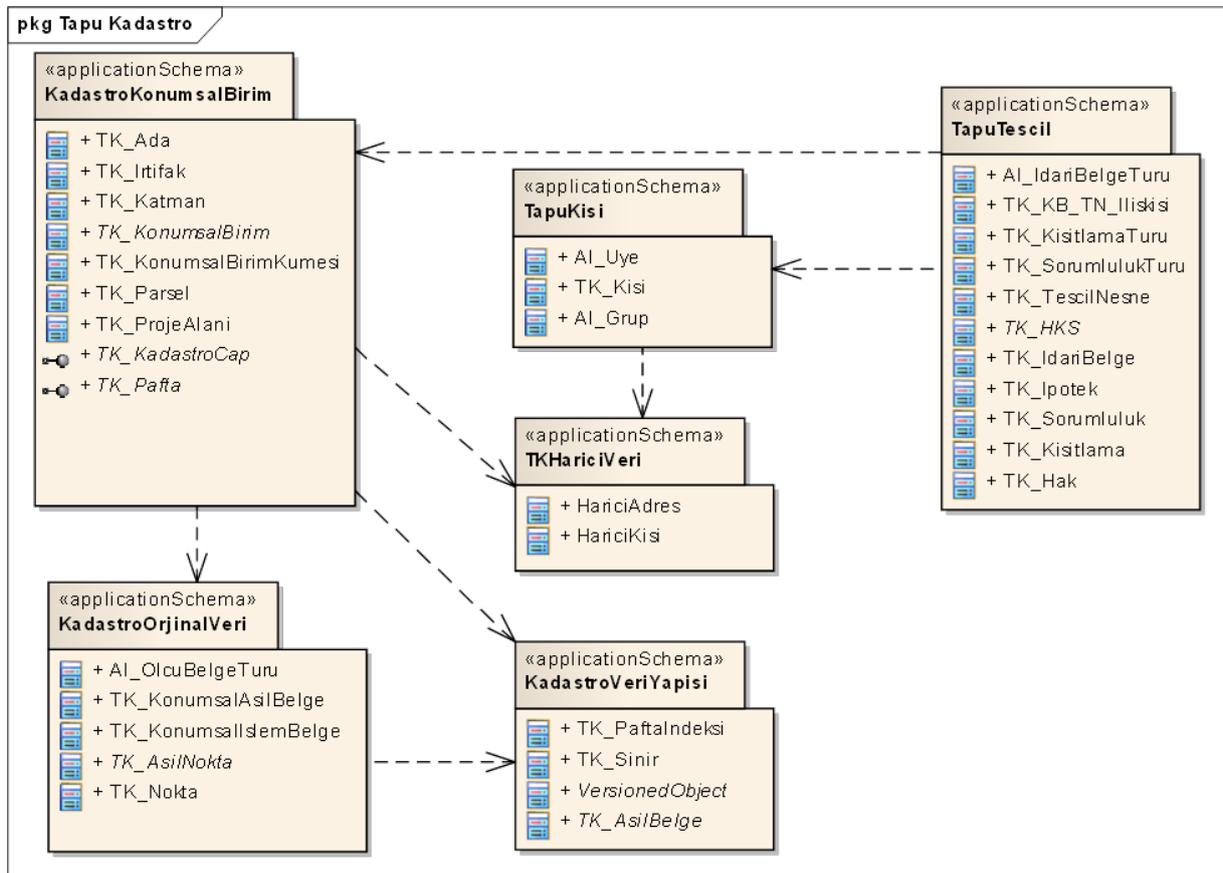
Figure 1. Data groups (packages) of the application schema

3.2 Spatial Aspects of the Application Schema

In Konumsal Birim (Spatial Unit) package, as sub classes of TK_KonumsalBirim (LA_SpatialUnit) class, TK_Parsel (LA_Parcel), TK_KonumsalBirimKümesi (LA_SpatialUnitGroup), TK_Ada (a group of land parcels surrounded by natural or manmade barriers), TK_ProjeAlani (a group of land parcels within a land management project) and TK_Irtifak (spatial location of an easement right within a land parcel) classes and also TK_Katman (LA_Layer) class are included. Bina (LA_Building) and BinaBlok (LA_BuildingBlock) classes come from a different TRGIS data theme (see Figure 2).

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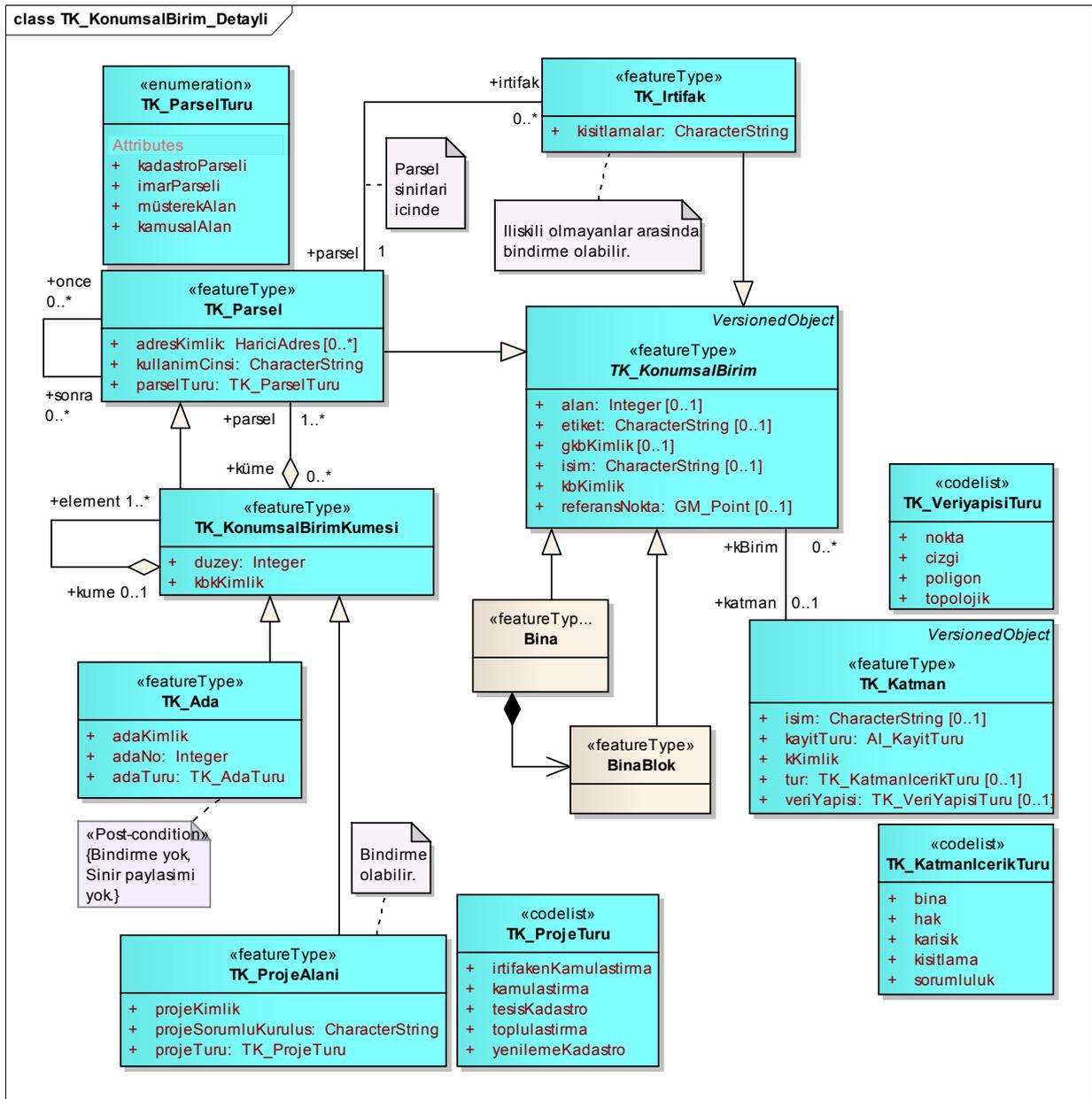
Figure 2. Feature classes of KonumsalBirim package and their relations

TK_ParselTuru definition list (enumeration) as the data type of the attribute parselTuru (parcelType) in TK_Parsel (LA_Parcel) class were defined to meet the needs of all TRGIS stakeholders. In the list, four basic (first order) parcel types kadastroParseli (land parcels in the areas without development plan; villages or suburbs of urban areas), imarParseli (land parcels produced in terms of a development plan), müsterekAlan (land parcels commonly serving for two or more land parcels; e.g. driveways) and kamusalAlan (publicly used areas; roads, parks etc. owned by the state or local government to serve for public) were defined (see Figure 2).

TK_Irtifak (easement) class was defined as a kind of spatial unit in order to represent an

easement right within a land parcel designated spatially with certain boundaries. It should exactly be within the boundaries of only one related land parcel (or a group of related land parcels called LA_BAUnit in LADM). This rule was added to the model with the note in Turkish "parsel sınırları içinde". Two or more such rights may be in a land parcel and they may spatially (in 2D and even in 3D for some rare case maybe) coincide because of their different relevance (see Figure 2).

As a kind of spatial unit group, TK_Ada class was defined in order to represent a group of land parcels surrounded by natural or manmade barriers as an area which is the basis for planning, application (land management) activities and also for unique parcel numbering. TK_ProjeAlani class was defined as another kind of spatial unit group in order to represent boundaries of different land administration or land management project areas. Kinds of project types (expropriation of easement right, expropriation of land, first cadastral surveys or renewal projects and land consolidation) were defined in TK_ProjeTuru definition class. The list of project type definition may be extended (see Figure 2).

Unlike LADM, Bina (LA_Building) and Bina Bolgesi (LA_LegalSpaceBuildingUnit) classes, as kinds of spatial unit, were defined outside TRGIS.TK geo-data theme as external data in another TRGIS geo-data theme called TRGIS.BI (see Figure 2).

TK_KadastroCap interface class was defined in order to represent the process of producing custom cadastral maps for specific cadastral lad parcels (see Figure 3). Custom cadastral maps, in this respect may be defined as an excerpt from an instance of TK_Katman (LA_Layer) class which was originally designed in LADM for the demonstration of an assortment of cadastral data as layers. Excerpts from cadastral map sheets are required in all land parcel related applications determined within TRGIS requirement analysis. Similarly, TK_Pafta class was defined in order to represent the process of producing cadastral maps in standard shapes and content (see Figure 3). Shapes of these cadastral maps (called as pafta in Turkish) are defined by TK_PaftaIndeksi (standard subdivision of space in 2D with special subdivision names) class which was designed as an extension to spatial representation package of LADM (see Figure 3). As required by the process of converting the application schema to GML application schema, two interface classes are presented as ordinary feature classes in Figure 3, additionally their relation with TK_Katman (LA_Layer) class are absent from Figure 3.

TK_Nokta (LA_Point) class was designed to represent measured points in land administration system except for control points. Unlike LADM design, geodetic control points are regarded as outside the scope of TRGIS.TK. So, only two types of points are included TK_NoktaTuru (point type) definition class. For monumentation types of points, in TK_DetayIsaretTuru definition class, four types of monumentation (belirsiz: without any monumentation, digerDogalIsaret: existing natural monuments, digerYapayIsaret: existing man made monumentation, koseTasi: special monumentation for land parcel corner points) are listed (see Figure 4) (GD-GIS, 2012c).

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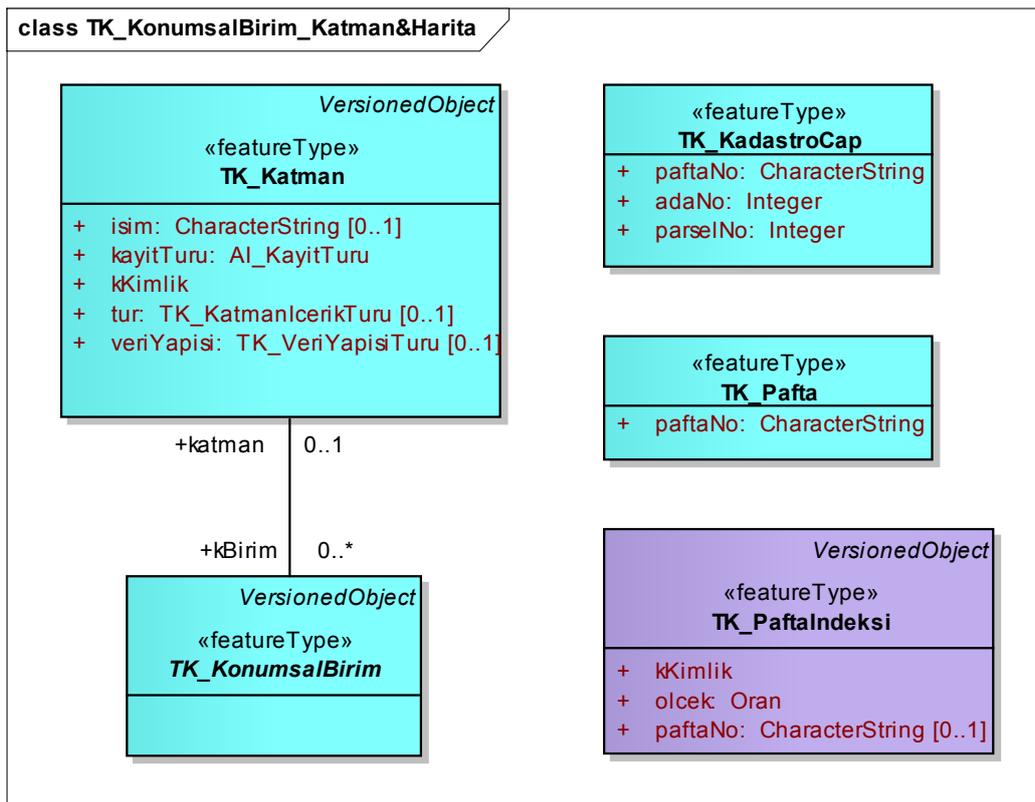
Figure 3. Cap and Pafta interface classes in relation with Katman (Layer) class, and the class PaftaIndeksi from KadastroVeriYapisi (Spatial Representation) package
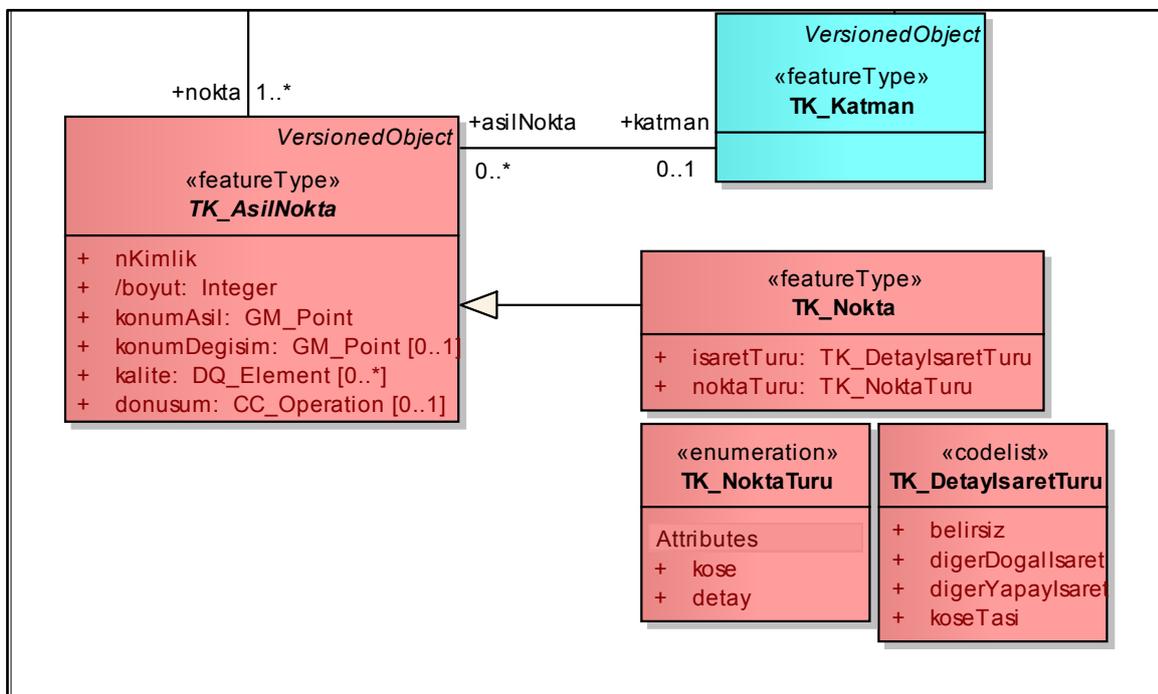

Figure 4. TK_Nokta (LA_Point) class from OrijinalVeri (surveying data) package

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Classes which represent none-spatial aspects of TRGIS.TK geo-data theme are presented in packages in Figure 1. However, they are not presented in this study because of the fact that it was not required to do any remarkable extension to LADM in this respect.

4. DISCUSSION AND CONCLUSIONS

This study shows that LADM is a good template for further model development to meet county specific needs on land registry and cadastre related development issues. In fact, all LADM classes, properties, relations, and also methods were examined and adapted to TRGIS.TK geo-data theme, and only exceptional ones were presented in this study as original contribution to LADM. However, for some rare cases, LADM should be revised for the adoption of a specific country. In this context, LA_Building and LA_LegalSpaceBuildingUnit classes were replaced with external data sources. Similarly, LA_Point was revised in terms of included point types.

This study reflects contribution to LADM only in terms of the needs of TRGIS stakeholders. For full contribution, all land registry and cadastre process should be considered and presented as the Turkish country profile.

Easement as a spatial unit and group of land parcels surrounded by barriers (in Turkish Ada) may be considered as international contribution to LADM. Other extended contributions are specific to Turkey.

Application of TRGIS.TK geo-data theme is dependent on the application of both TRGIS and also accessibility of required quality data within land registry and cadastre organisation. In this stage, GML conversion of the model was carried out with some difficulties which cause the loss of some modelling content (e.g. relations between the classes TK_Katman/LA_Layer and TK_Pafta). Further refinement may be required for the conversion of a database schema, data loading and application.

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BIOGRAPHICAL NOTES

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