Some Spatial Data Management Issues Towards Building SDI

Arif Cagdas AYDINOGLU, The Netherlands and Tahsin YOMRALIOGLU, Turkey

Key words: SDI, Spatial Data Management/Models

SUMMARY

Various Urban GIS projects have been produced by different public institutions in Turkey. But, coordination has not been provided among these public institutions that produce and use spatial data. Technical, Standard, and policy deficiencies result in time and effort losses on data production, management, and sharing. Spatial data users need to use the data collaboratively to provide noteworthy benefits to environmental, social, and economic context for sustainable management of urban areas. By this way, Geographic information strategy consistent with European Union INSPIRE and Turkey National GIS actions should be determined. As a preliminary work to build Spatial Data Infrastructure (SDI), before making the data enabled for multiple uses, Generic Conceptual Model components were determined to manage and harmonize spatial data and to produce application schemas of spatial data themes. These components were divided into two sections, Scope / Application Area and Technical Components. Scope / Application Area components include standard hierarchy, scale-resolution, generalization approach, and building province level SDI. Technical Components include principles, reference model, application schema rules, general feature model, spatial object identifier, spatial object versioning, and like this. As a case study, spatial data collected from different sources was managed for many applications from environment and land management to Urban GIS with Trabzon city example. As a result of this, these spatial data management issues were examined with the aim of using and sharing data effectively for managing a city and clarity the needs for building SDI.

Some Spatial Data Management Issues Towards Building SDI

Arif Cagdas AYDINOGLU[1] and Tahsin YOMRALIOGLU[2], Turkey

1. INTRODUCTION

Geographic Information (GI) has a major role to play in addressing societal demands and exploiting the opportunities opened up by policy and technology. GI has economic value as a major component of Public Sector Information and has social and policy value for providing the basis to integrate policies and to provide tangible benefits to citizens, business, and governments (Craglia, 2004). GI users need to use the data collaboratively to provide noteworthy benefits to environmental, social, and economic context for sustainable management of urban areas.

Information Systems (IS) that support information management in concerned working group have been re-conceptualized as Information Infrastructure (II) concept that supports effective and corporate decision making by various institutions in a large user community. While Geographical Information Systems (GIS) were largely designed to serve specific projects or user communities, the focus is now increasingly shifting to the challenges associated with integrating these systems into a society perspective. Similar to II, this can be explained with Spatial Data Infrastructure (SDI) concept. SDI encompasses policies, technologies, standards for the effective collection, management, and access of GI to stimulate better governance, and to foster environmental sustainability by reducing duplication and facilitating integration at different administrative levels (Georgiadau et al., 2007). SDI concept started to develop on a perspective starting at local level and proceeds through state, national, regional, and global levels. Most countries in developing world are in the process of building SDI at different administrative levels in order to enable effective spatial data management (Aydinoglu and Yomralioglu, 2006).

There are technical and non-technical aspects to realize SDI. Among non-technical aspects, legal and organizational issues, such as copyright, pricing policy, and access rights, are important. As technical issus, SDI needs metadata made described in catalogues and web based services besides data content. Open Geospatial Concortium (OGC) and ISO/TC211 have developed a variety of standards in this area. To manage spatial data, there is now a wave of attempts to agree on complete data themes, covering both the spatial and non-spatial aspects. For example, within INSPIRE, 34 different data themes, such as administrative unit, address, topography, will be first agreed on the harmonized models and delivered for 27 countries of the EU. US Department of Homeland Security (DHS) Geospatial Data Model also covers quite a broad number of data themes. Many countries are in the process to design and manage spatial data with sharing data models all over the world (Scarponcini, etc. 2008).

In this study, current situation on GI management is determined towards building SDI. Requirements are discussed to develop data sharing model of Turkey. By this way, some spatial data management issues such as standard hierarchy, object identity, and versioning are examined with some case studies.

2. CURRENT SITUATION ON USING SPATIAL DATA IN TURKEY

Information and Communication Technologies (ICT) started to be used commonly in 1990s. Public Institutions increased investments for ICT hardware and software since 1995s. The importance of GIS has been realized by many public and private organizations within Turkey since 1990s (Yomralioglu, 2004). Analog maps were converted to digital format and used as a base map in some specific projects. General Command of Mapping (GCM) pioneered digital map production especially. Standard Topographic Maps (STM), smaller than 1:5000, are produced by GCM. Large Scaled Maps, 1:5000 and larger, are produced by Land Registry & Cadastre Directorate (LRCD) and State Provincial Bank. Other public institutions and municipalities also produce maps serving their own needs. As time goes by, the needs and requirements for geographic information have increased in Turkey like all over the world.

According to Turkey State Planning Organization (SPO) (LRCD, 2004), coordination has not been provided among public institutions that produce and use spatial data. Technical, Standard, and policy deficiencies result in time and effort losses on data production, management, and sharing. A variety of GIS Projects were produced by different public organizations. Public Institutions produce spatial data, depending on their responsibilities and rights legalized by the laws. E-transformation Turkey Project, following Europe+, triggered actions for building "Turkey National GIS" with participation of public institutions. With Action-47, current situation to build SDI was examined in 2004. In Turkey, It has not been determined which institutions produce which data on which standard or scale It was declared that 81 % of Public institutions have GIS software, but there is no a common use GIS software. There are no accepted international or de-facto standards in public institutions. 41% of Public Institutions use institutional standards in intra-organizations and only %19 of which use accepted national standards sometimes but base level (LRCD, 2004). Most municipalities in especially big provinces are trying to build Urban Information System (UIS) and e-municipality applications. According to UIS Survey executed by TURKSTAT (2007) to 3066 out of 3228 municipalities of Turkey, 18 % (543) of the municipalities have numbering unit and 4 % (126) of which work on Urban GIS.

According to 5216 numbered Municipality Law and 5272 numbered Metropolitan Municipality Law, municipalities are compulsory to build GIS and Urban GIS. Numbering and National Address Database Regulation (2006) supports numbering streets and buildings, forming address information, registering on the database, and relating with birth record. GIS projects of governorships and municipalities of each province need common GIS standards. This solves possible technical and administrative problems. Interoperability Circular (Off.Gaz., 2005) published by prime ministry of Turkey constitutes standards to build information systems in all central and local public institutions. On the scope of Turkish Standards Institute (TSE) Geographic Information Mirror Committee, it is emphasized to determine GIS interoperability standards. With Action-36, Turkey National GIS concept and implementation models were determined in 2005 (LRCD, 2006). According to Action-36's Data Standardization Commission (2006) report, building National SDI is required to share spatial data on different context and scale efficiently, produced by all public institutions,

organizations, companies, and universities that participates in Turkey National GIS. It is accepted to follow Infrastructure for Spatial Information in Europe (INSPIRE) Directive. By this way, first, spatial data should be produced on common data specifications from national to local level.

Examining data specification on GCM STM Data Dictionary, each feature was identified by NATO DIGEST feature code and grouped in feature classes. Feature classes are not defined with attributes and relationships for using in various GIS applications, but include information for presenting spatial data on the maps. Large Scaled Maps are produced, depending on Large Scaled Map Production Regulation (BÖHHBUY). BÖHHBUY was revised and enclosed with feature / attribute catalog in 2006. This catalog was not designed to solve application-driven requirements for various GIS projects. However, spatial data specification is required to support various GIS applications and decision making processes (Enem ve Batuk, 2007). And these specifications should enable harmonizing spatial data coming from different sources. GIS applications of local governments were developed, depending on GIS software and related companies. Therefore, spatial data is not interoperable because public institutions use different conceptual model and feature catalogs (LRCD, 2006). For example; Interior Ministry are in process to combine the databases of National Address Database (UAVT) and National Citizenship System (MERNIS). And, also Building Following System is being built to work with these systems (Atalay, 2006). Land Registry and Cadastre Information System (TAKBİS) was built in 2004 and are being activated in all cadastre directorate of Turkey.

Beside this, GIS projects executed in local governments, LRCD, municipalities, and public institutions were not designed to enable data interoperability. Local Governments need high resolution and large scaled spatial data and maps for applications like zoning plan, real property management, and infrastructure (Yomralıoğlu, 2004). For example; to get certificate of occupancy from the municipalities, the data collecting from different sources, like cadastral parcel, zoning plan, high-volume lines, preserved and restricted areas, is not harmonized. Land tax price can be determined with related road information through numbering and address information. Environmental data like hydrography, transportation, and topography should be harmonized to determine landslide and flooding risk. Statistics and Administrative Unit data should be combined to execute socio-economic and regional development analysis. Beside this, in various GIS applications, the users need accessing geographic information from a wide range of sources, but gaps in availability, lack of harmonization between datasets at different geographical scales and duplication of information collection.

INSPIRE (2007) emphasizes accessing spatial data, from the local level to the global level, in an inter-operable way for a variety of uses. Inter-Ministrial Map Progress Coordination and Planning Commission Report (2007), features and attributes required by institutions and organizations in their application should be determined. And, a common feature catalog should be produced and should provide generalization rules for using the data from local to national level. By this way, Data specifications that enable sharing and using the data coordinately should be provided. These specifications include coordinate system, attributes, geometry, topology, generalization rules, relations and like this. Firstly, data specifications were defined, compliant with INSPIRE Annex data themes and Action-75 including administrative unit, hydrography, transportation, geographic information, cadastre, and like

Arif Cagdas AYDINOGLU and Tahsin YOMRALIOGLU   4/14
Some Spatial Data Management Issues towards Building SDI

International Workshop on Spatial Information for Sustainable Management of Urban Areas
FIG Commission 3 Workshop 2009
Mainz, Germany, 2 – 4 February 2009

this. Applications Schemas of data themes should support updating National Data Exchange Format (UVDF) compliant with Geographic Markup Language (GML) 3.X.

3. DEVELOPING GEOGRAPHIC DATA SHARING MODEL OF TURKEY

As a preliminary work to build SDI, before making the data enabled for multiple uses, GI sharing model of Turkey is designed. By this way, the base and harmonized geo-database model, named as National Geographic Data Exchange Model with UVDM acronym, can be accepted as a new approach on GI management in Turkey. This base model is a starting point to create sector models in different thematic areas. These sectors produce their data models depending on the rules described in the base model. Because all sectors share this base, interoperability between the sectors is greatly enhanced.

UVDM is a semantic model. Harmonized model provides common domain of interaction and the related information model. This interchangeable information results in semantic standardization. The model should explain objects with properties and relations semantically. That is, interchange of GI is also possible and a variety of different kinds of organizations can operate in the same GI.

UVDM is an object-relational model. This approach benefits from opportunities of relational and object-oriented data model, enables the users to store spatial data and their associated attribute data in a single database system. By this way, this model provides some advantages such as indexing, transaction management, and like this.

UVDM is compliant with ISO/TC 211 standards, expectations of INSPIRE data specifications that European countries follow to utilize in their country towards building European SDI, and Turkey National GIS actions.

UVDM is designed with Unified Modelling Language (UML) class diagrams, a graphical modeling tool with well defined semantics and an underlying computer model with a model driven approach (MDA). A Geography Markup Language (GML) application schema as an exchange format can be automatically derived from the UML model for harmonizing the data model.

UVDM data themes are Administrative Unit (IB), Address (AD), Land Ownership/Building (MB), Hydrography (HI), Topography (TO), Geodesy (JD), Transportation (UL), Land Cover/Use (AR), and like these. Application schemas of the themes define feature types with geometry, attribute, relationship, and constraints with documentation, catalogues, and schemas.

UVDM Conceptual Model specifies the components to determine application schemas of data themes. Conceptual Model components were determined to manage and harmonize spatial data and to produce application schemas of spatial data themes. These components were divided into two sections, Scope / Application Area and Technical Components. Scope / Application Area components include standard hierarchy, scale-resolution, generalization approach, and building province level SDI. Technical Components include principles,

Arif Cagdas AYDINOGLU and Tahsin YOMRALIOGLU   5/14
Some Spatial Data Management Issues towards Building SDI

International Workshop on Spatial Information for Sustainable Management of Urban Areas
FIG Commission 3 Workshop 2009
Mainz, Germany, 2 – 4 February 2009

reference model, application schema rules, general feature model, spatial object identifier, spatial object versioning, and like this. Some components are examined below to enable a spatial data sharing model.

Application driven modeling

An application-driven model based on an analysis of the intended GI uses is designed to serve a set of useful thematic applications. In other words, the design of UVDM follows the requirements of application algorithms and use of information, rather than a specific organization's workflow. According to the Field Work, information products and application needs relating to GI were determined for 37 of public/private institutions and organizations situated in Trabzon province of Turkey at local level. Because Provincial System is the main administrative system of Turkey, implementing SDI at province level can be model for all Turkey. These were summarized and combined in a list including 85 of functions that explain GIS activities at local level. User requirements of these functions were defined as the data content, the level of detail, relationships between objects, data consistency and updating, and the temporal dimension of the data. These data needs were combined with current feature/attribure catalogs. By this way, building this model meets GI needs from local to national level.

Standard Hierarchy

UVDM can be accepted as base and main data model for applications of different sectors. Sector models should be based on and compliant with UVDM base model. Land Ownership and Cadastre Information System (TAKBİS), State Hydro Information Systems (DSICBS), Urban GIS applications (KBS) of municipalities, topographic database applications, and like these should extend their geo-database from UVDM.

Figure 1. UVDM Base ans Sector Models

Arif Cagdas AYDINOGLU and Tahsin YOMRALIOGLU   6/14
Some Spatial Data Management Issues towards Building SDI

International Workshop on Spatial Information for Sustainable Management of Urban Areas
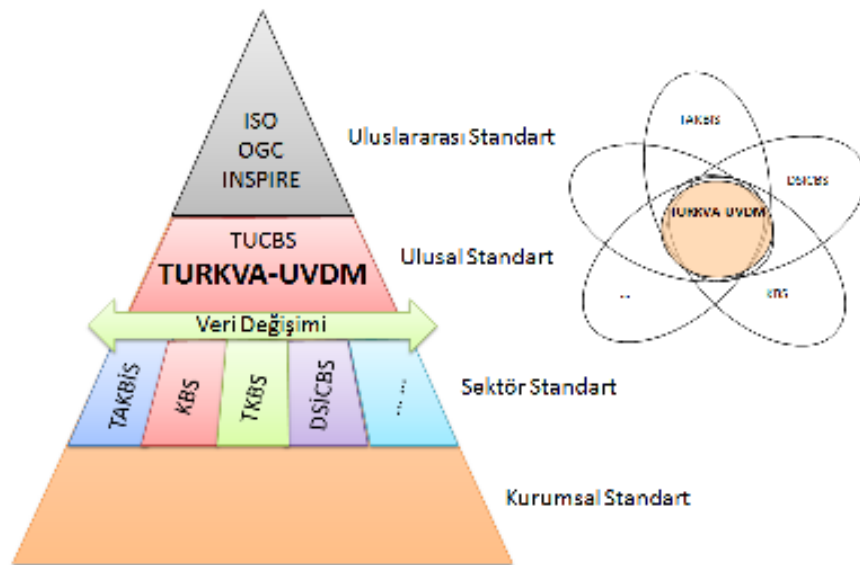FIG Commission 3 Workshop 2009
Mainz, Germany, 2 – 4 February 2009

For example, National Address Database (UAVT) and Census and Citizenship Database (MERNIS) are in the integrating process under responsibility of Ministry of Interior. On this scope, if National Address Code (UADK) determined on UVDM:AD model is used, data harmonization and exchange on various databases will be possible. As seen on example of Figure 2, address information for a person can be obtained easily with identity number. Urban GIS applications of municipalities can be harmonized to UAVT and MERNIS database. The example shows to reach location information from citizenship or identity number through relating database based on UVDM data model.
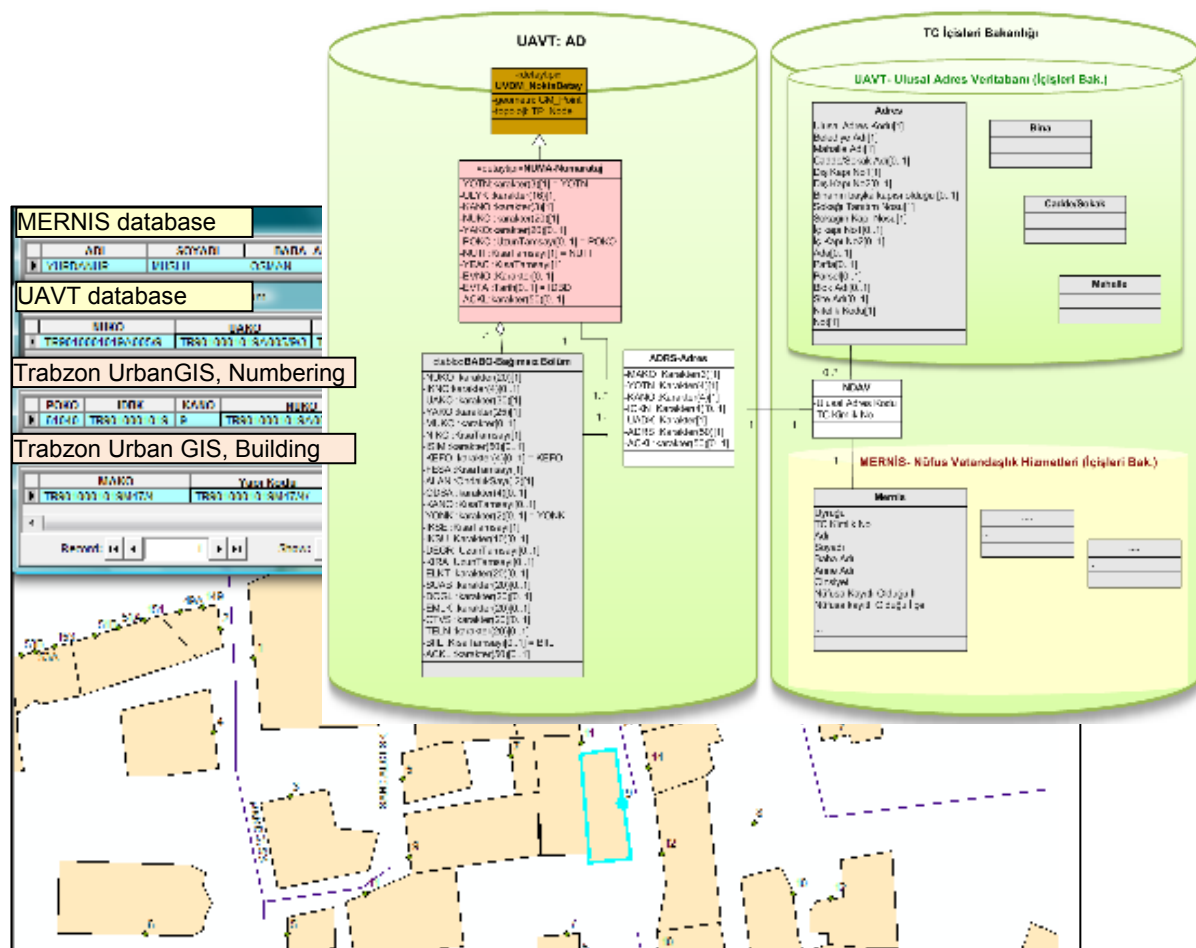

Figure 2.UVDM extension for UAVT / MERNIS database of Ministry of Interior of Turkey

Scale-Resolution and Generalization Approach

Spatial data should be maintained at a level where the data is managed effectively. Geo-database should be collected for a province and it can be combined and generalized from local to national level for all provinces of Turkey. The only way to have consistent and current national datasets is to have transactional updates penformed by local datasets. These data can be combined, transformed, and integrated into national datasets.

In Turkey, county level is the most effective level that produces and use spatial data in GIS applications. Municipalities and Provincial Administrations having high level Power/Interest and GeoICT/Data Requirements capacity, are managing the data between 1:1000 and 1:5000 scales. And, also BOHHBUY determines large scaled maps larger than 1:5000. Spatial Hierarchy Approach enables collecting the data at county (İlçe) level, larger than 1:5000 scale and 50 cm resolution once and then re-using at different level such as *Province* (İl), Region (*Bölge*), and Country (*Ülke*).

UVDM3 at large scaled county level (>1:5000) is the base geo-database level for UVDM. Produced and combined geo-databases at county level can be used in applications and information products with graphic and cartographic generalization. The geo-databases, at 3 numbered large-scaled level, can be converted to 2 numbered middle-scale level and 1 numbered small scale level with model generalization. Information Products and Applications of other levels can be produced inside these geodatabases with generalization.

For example, Trabzon geo-database named as TR90101 was built at large-scaled county level with UVDM3. As seen on Figure 3, the geo-database for Trabzon Urban Atlas was generated from TR90101 geo-database. To produce urban atlas geo-database, UVDM:IB, AD, UL, and AR data were extracted from the main database. Large scaled Trabzon Urban Atlas and Internet web atlas were produced based on this geo-database.
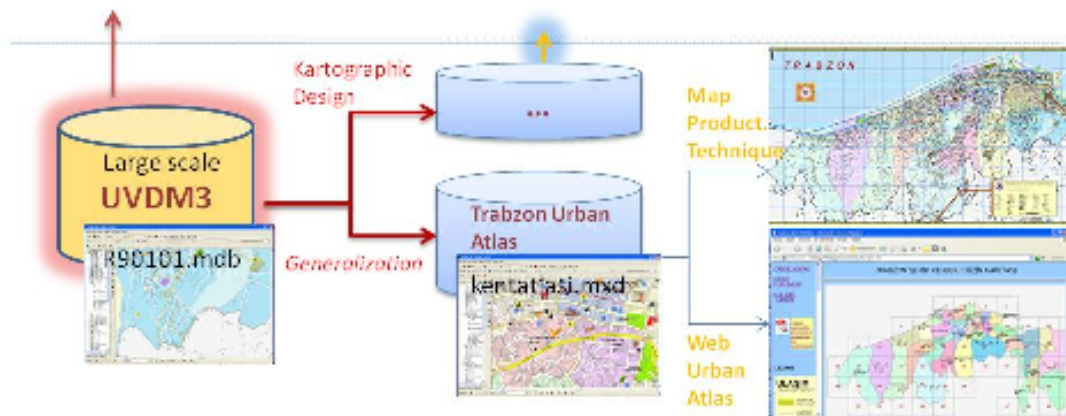
Figure 3. Urban Atlas production based on UVDM geo-database

Base Application Schema

Key properties of UVDM base application schema are explained on Figure 4;
• High level and base class of UVDM is *UVDM_CografiNesne* accepted as common and compulsory class.
• All spatial objects in feature classes have geometry and/or topology in a position.
• All spatial objects are referenced on a Geography Coordinate System named as *CografiReferans*.
• All spatial objects defined on feature classes of data groups are sub-class and specialization of *UVDM_CografiNesne*.
• *NesneTanımlayıcı* defines all spatial objects with unique identifier attribute.

- *NesneVersiyonu* defines and controls changes of the objects through time with attributes.
- *KullanımHakkı* defines data accession permission and sources with attributes.
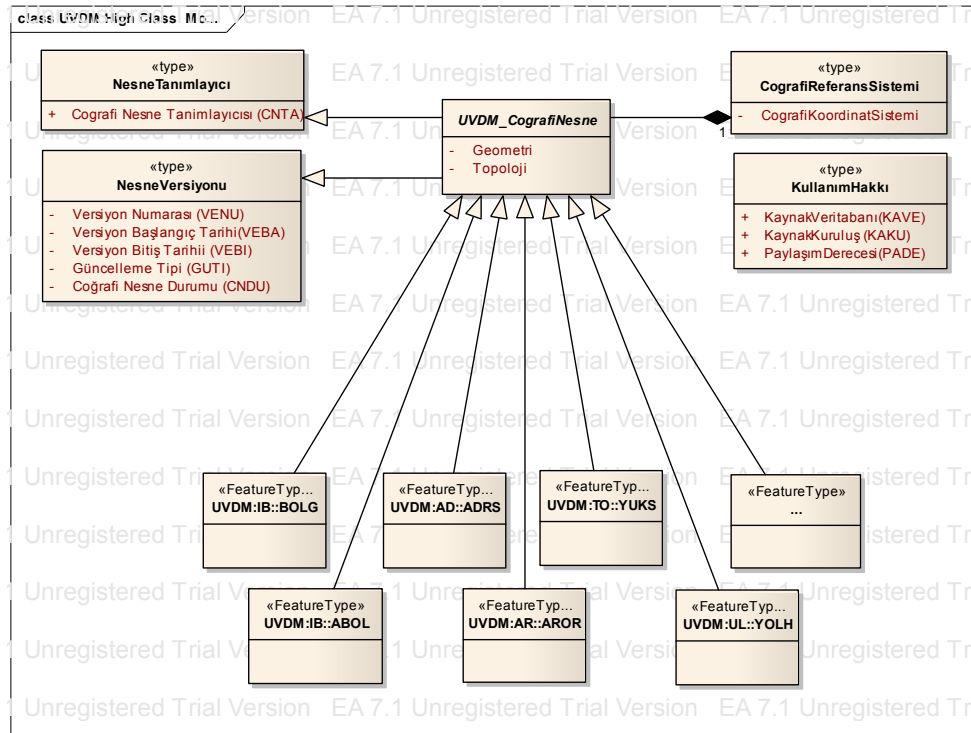

Figure 4. TURKVA:UVDM Base Application Schema

Spatial Object Identification and Versioning

A common framework is determined for the unique identification of spatial objects. These identifiers can be used to ensure interoperability among databases under national systems (INSPIRE Dir, 2007). This means all spatial objects shall carry a unique identifier property. In order for a unique identifier to remain meaningful, it must persist throughout the lifecycle of the object it refers to.

For example, Public Institutions such as Turkey Statistics Institute (TURKSTAT) and General Directorate of Local Governments use different hierarchical definitions related to administrative units. Therefore, IDBK should be produced in respect of country's administrative hierarchy. Because there is no IDBK that is defined from national to local level hierarchically, Administrative Unit definitions used in public institutions are combined. In Administrative Unit data theme (IB), Administrative Unit Code (IDBK) is produced to form relationship among databases representing administrative units. IDBK with 12 digits can be used on Administrative Unit Spatial Data Sets from national to local level. Hierarchical structure of Administrative Units is used to produce IDBK. Also, object identifier for cadastral parcels and addresses can be produced based on at the lowest level administrative unit code, Koy /Mahalle (Village /District) code.

Arif Cagdas AYDINOGLU and Tahsin YOMRALIOGLU   9/14
Some Spatial Data Management Issues towards Building SDI

International Workshop on Spatial Information for Sustainable Management of Urban Areas
FIG Commission 3 Workshop 2009
Mainz, Germany, 2 – 4 February 2009

Feature Types defined on different data themes support data sharing for applications. For example; as seen on Figure 5, spatial data sets presenting Region (BOLG), Sub-region (ABOL), Provinces (N3IL), County (ILCE), Municipality (BELD), and District/Village (MAKO) can be combined with CNTA attributes describing IDBK. Numbering data sets (NUMA) in Address Data group (AD) can be related to Building data sets (YAPI) in Ownership data group (MU) to support applications. And like this, similar combinations and data sharing possibilities provides opportunities to manage the data on Urban GIS applications.

Figure 5. Managing spatial data in sharable environment

In this model, basicly, temporal feature class is produced for each feature class including Geographic Data Identifier (CNTA), Versioning Number (VENU), Version Starting and Finishing Date (VEBA and VEBI). Old versions of an object can extract from temporal class, with the using of the same CNTA. In addition to this, life cycle of an object was defined with some rules.
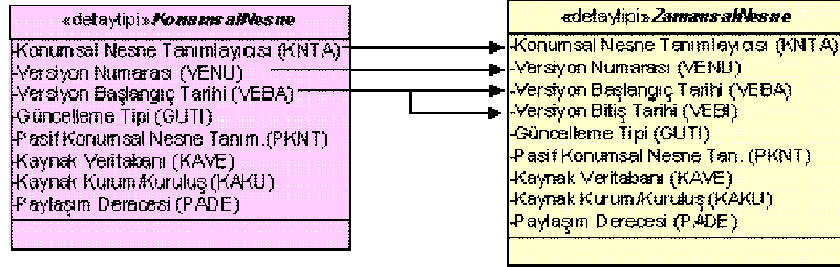

Figure 6. Feature and Temporal Feature Classes for Versioning

For example, Trabzon Urban GIS application was produced based on UVDM. This provides data harmonization to manage the data corporately. Also, all these data have unique object identity and versioning atttibutes. As seen on Figure 7, Numbering feature class (NUMA) in AD data group and building (YAPI), parcel (PARS), block (KAAD) feature classes in MB data group can be shared and it is possible to get versions on different time. For example; feautere and temporal features classes can be seen on Figure 7-1 for Trabzon City, Esentepe district, 397 block. As a result of data query of VEBA and VEBI attributes on feature and temporal feature classes; NUMA, PARS, KAAD, and YAPI feature classes can be get on specific data, like Figure 7-2 for 01.06.2008, Figure 7-3 for 01.01.2008, and Figure 7-4 for 01.01.2007.

Arif Cagdas AYDINOGLU and Tahsin YOMRALIOGLU   11/14
Some Spatial Data Management Issues towards Building SDI

International Workshop on Spatial Information for Sustainable Management of Urban Areas
FIG Commission 3 Workshop 2009
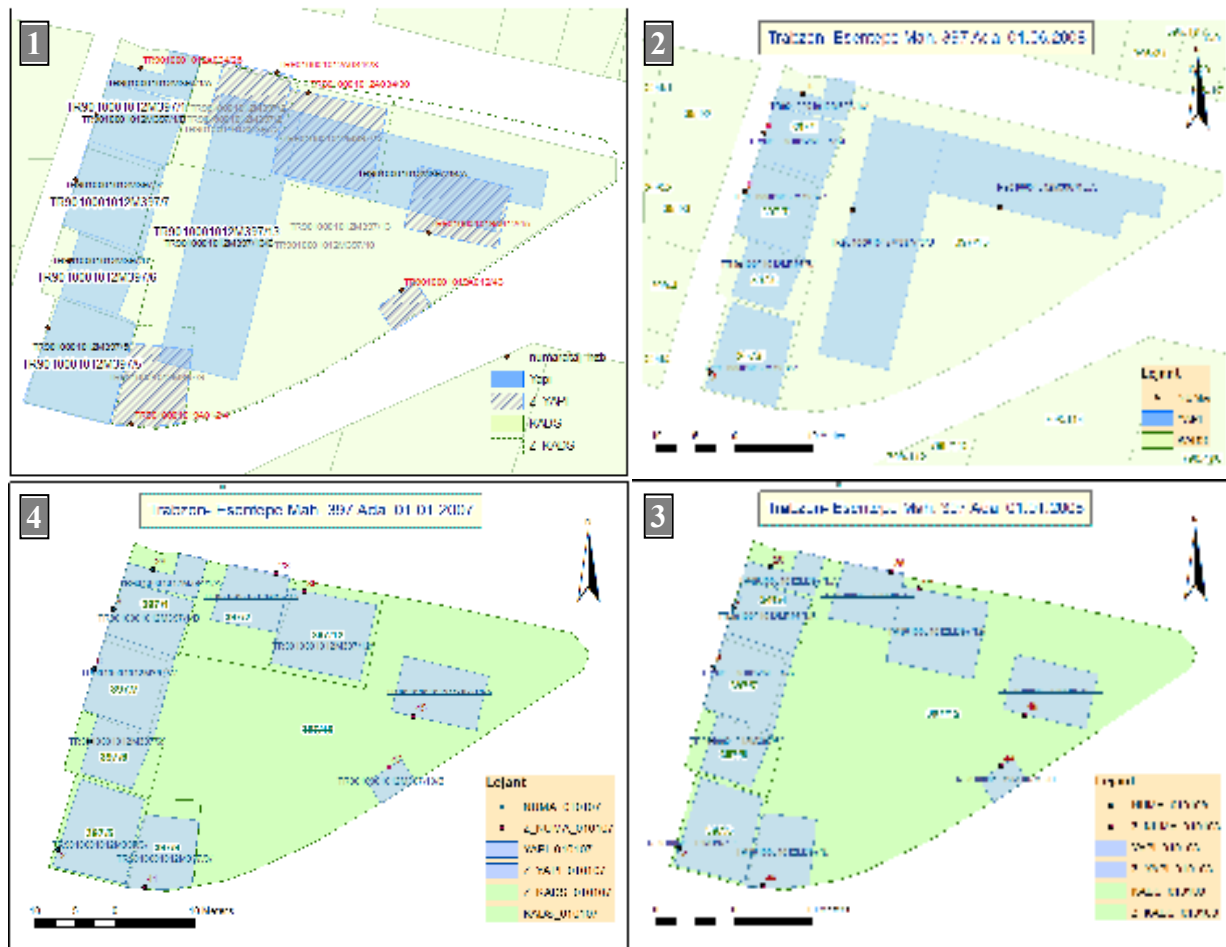Mainz, Germany, 2 – 4 February 2009

Figure 7. Versioning example for Numbering, Building, Parcel, and Block Data

CONCLUSION

Geo-database Model, called also Geographic Data Sharing Model or Feature/Object model, can provide an efficient approach on spatial data management with unique and persistent identifiers. UML is used to model spatial data, but it needs new tools to define spatial relations and constraints. That also supports inheritance, aggregation, composition, and association among feature types. Common terminology and definitions are key factor. These models enable to manage the data in terms of linking, sharing and reuse. Like other countries, Turkey needs to balance heterogeneity on spatial data management with this kind of common approach and national coordination.

Arif Cagdas AYDINOGLU and Tahsin YOMRALIOGLU   12/14
Some Spatial Data Management Issues towards Building SDI

International Workshop on Spatial Information for Sustainable Management of Urban Areas
FIG Commission 3 Workshop 2009
Mainz, Germany, 2 – 4 February 2009

REFERENCES

Atalay, B., 2006, Adrese Dayalı Nüfus Kayıt Sistemi, Bilgilendirme Toplantısı Konuşması. 18.08.2006, Ankara.

Aydınoğlu, A.Ç., Yomralıoğlu, T., Information Infrastructure Approach: Spatial Data Infrastructure Implementation Issues in Turkey. XXIII. International FIG Congress, October 8-13, 2006, Munich, Germany.

BHIKPK- Inter-Ministrial Map Progress Coordination and Planning Council, 2007, Standardization Commission Report. HGK.

Craglia, M. etal., 2004, Introduction and Overwiew, Section1 of GINIE book: Geographic Information Network in Europe.

Emem ve Batuk, 2007. Modern CBS yaklaşımlarında ve Ulusal Mekansal Veri Altyapılarında Web Servislerinin yeri ve OGC Mekansal Web Servisleri Kullanımının İncelenmesi. TMMOB HKMO, Ulusal CBS Kongresi, 30 Ekim –02 Kasım 2007, KTÜ, Trabzon

Georgiadau, Y., Puri, S.K., Sahay, S., 2005, The Rainbow Metaphor: Spatial Data Infrastructure Organization and Implementation in India. Submitted to Int. Studies of Management&Org. on Cultural Metaphors, Symbols, And Paradoxes. 06.03.2005.

INSPIRE, 2007, A Directive Of The European Parliament and of The Council Establishing An Infrastructure For Spatial Information in The Community (INSPIRE). 14.03.2007, EC JRC, Brussels.

LRCD-Land Registry and Cadastre Dir., 2004, A Preliminary Report to Build National GIS- Action 47. The Registry and Cadastre Directorate of Turkey, E-transformation Turkey Project, Ankara, Turkey

LRCD-Land Registry and Cadastre Dir., 2006, A Preliminary Report to Build National GIS- Action 36. The Registry and Cadastre Directorate of Turkey, E-transformation Turkey Project, Ankara, Turkey.

Official Gazette of Rep. of Turkey, 2005, Interoperability Circular. Issue:25897, Date:05.08.2005.

Official Gazette of Rep. of Turkey, 2006, Numbering and National Address Database Regulation. Issue:26245, Date: 31.07.2006.

Scarponcini, P., Camateros, S., Custers, O., Zlatanova, S., Oosterom, P.V., Introduction. Chapter in Creating Spatial Information Infrastructures towards the spatial semantic web edited by P.V.Oosterom and S. Zlatanova, Taylor&Francis Pr., 2008.

TURKSTAT-Turkey Statistical Institute, 2007, Demography Statistics. web: www.tuik.gov.tr available on 01.06.2008.

Yomralioglu, T., 2004,: Developing Infrastructure Potential in Turkey with GI. GEOInformatics, Volume.7 Apr/May 2004, p.52-55, The Netherlands

BIOGRAPHICAL NOTES

Arif Cagdas AYDINOGLU works as a research assistant at the Department of Geodesy and Photogrammetry Engineering at Karadeniz Technical University (KTU), Turkey. In 2003, he completed his MSc study and started his Phd study at KTU. He is following his researches in Technology University of Delft / The Netherlands since 2008. His research interests are GIS, SDI, Semantic Interoperability of spatial data.

Arif Cagdas AYDINOGLU and Tahsin YOMRALIOGLU   13/14
Some Spatial Data Management Issues towards Building SDI

International Workshop on Spatial Information for Sustainable Management of Urban Areas
FIG Commission 3 Workshop 2009
Mainz, Germany, 2 – 4 February 2009

CONTACTS

Arif Cagdas AYDINOGLU
Delft University of Technology
OTB Institute
Section GIS-technology
P.O. Box 5030, 2600 GA
Delft, The Netherlands
Tel: +31 (0) 15 278 56 60
e-mail:arifcagdas@gmail.com
(AAydinoglu@tudelft.nl)

Arif Cagdas AYDINOGLU and Tahsin YOMRALIOGLU   14/14
Some Spatial Data Management Issues towards Building SDI

International Workshop on Spatial Information for Sustainable Management of Urban Areas
FIG Commission 3 Workshop 2009
Mainz, Germany, 2 – 4 February 2009