A GML Application Schema for the Storage and Transport of Geo-Spatial and Non-Spatial Information of a Well-Functioning Cadastral System: A Turkish Case Study

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Abstract

It is widely accepted that cadastral data are one of the main pillars of national information systems. A good number of administrative and legal services are provided on the basis of cadastral plans and land registry. One of the geographic data layers used in INSPIRE (Infrastructure for Spatial Information in the European Union) is that of cadastre or land registry. It has recently become a common practice to use open source and interoperability technologies supported by XML (Extensible Markup Language). The Geography Markup Language (GML 3.2.1) is the XML grammar developed by the Open Geospatial Consortium (OGC) and supported by INSPIRE for encoding spatial and non-spatial data. The storage of available land registry and cadastral information only does not meet the multiple needs arising today. This paper outlines the development of a GML application schema for setting up cadastral information systems including real estate valuation and geological information.

***Keywords**:* GML application schema, cadastral system, land registry, immovable property

1. Introduction

As for the cadastre or land registry data, INSPIRE states that "cadastral parcel should be considered as a single area of Earth surface, under homogeneous real property rights and unique ownership." The cadastral data layer facilitates the smooth and rapid provision of a wide variety of administrative and legal services. These include utility management, real estate valuation, urban planning, and property taxation amongst others. Moreover, the number of the legal cases concerning immovable properties in Turkey is too high. Up-to-date and retrospective time analyses are highly significant for these cases. The existing National Data Exchange Format (UVDF) in Turkey encodes large-scale map data and cannot meet all the requirements of the services concerning land registry (Official Journal, 2005). Thus, it is important to encode land registry data using a format conforming to the requirements of INSPIRE, with the features of open source and interoperability technologies. The XML-defined GML displays these features. It is also functional to have an information system covering various types of cadastral data apart from land cadastre on both rural and urban areas, which can be used for a variety of purposes. For example, taxation-driven cadastre data has been examined in order to analyze the impact of pipelines running through agricultural land (Alas, 2016) and three-dimensional urban planning applications like CityGML have been created on the basis of data on agricultural land (CityGML 2.0, 2012; Cagdas, 2012).

The application schema presented in this paper will be able to encode all land registry data legally recorded in Turkey. Moreover, due attention was paid to the existing digitized cadastral map sheets at scale 1:1000 and parcel areas on these sheets. The Unified Modeling Language (UML) class diagram of the model that can encode all the existing registers was prepared, enabling time analyses and meeting the other relevant requirements as real estate valuation and geological information (Fowler and Scott, 2003). The GML application schema was designed in accordance with the UML class diagram. It was checked to see whether the GML application schemas conform to the rules specified in GML Encoding Standard Version: 3.2.1. The application was controlled on the basis of a specific part of the map sheet produced as a prototype (Alas, 2007; 2008; 2011).

The XML document was constructed for the concerned part of the prototype map sheet and checked if the document is well-formed and valid with respect to the GML application schema (Young, 2001; Stanek, 2003; Kilinc, 2004; Cicek, 2013; Alas, 2017). Furthermore, the necessary checks were made concerning the transformation of the XML document into HTML using Extensible Stylesheet Language Transformation (XSLT), the creation of an SVG map, and the facilitation of the queries with a software program developed by using .NET Framework (SVG 1.1, 2011; Gardner and Rendon, 2002; Pala, 2005; Karan, 2003; Inan and Demirli, 2003, 2004; Johnson and Skibo, 2004; Grimes, 2002; Fox, 2002; Yanik, 2004). This paper presents a GML application schema to enable the storage and transport of spatial and non-spatial data on immovable properties including real estate valuation and geological information in Turkey.

2. An Overview of the Cadastral System and Land Registry in Turkey

In Turkey, the cadastral plans and land registers are prepared and maintained by two separate public agencies. Moreover, according to the current legal regulations, land titles are registered only after cadastral plans become available. Cadastral plans are produced recording the boundaries of each property on the plot of land concerned and the locations of the buildings, annexes, and joint facilities therein. First of all, the general cadastre works are completed. Then, when the need arises, all changes such as land subdivision, uniting, or easement are recorded. Cadastral plans are used in the creation of cadastral digitized map sheets at scale 1:1000 based on the national coordinate system. When new zoning plans come into force, old map sheets are considered no longer in use, and new cadastral map sheets are produced.

The Turkish State keeps and maintains land registry, showing the owner of the rights of the immovable property in accordance with the principles of open access and registration. The registry system is made up of the primary and auxiliary components. The primary registers are the land book, the condominium book, official documents and the cadastral plan. The auxiliary registers comprise deed indexes, rectification registers, public property registers, and inventory registers. The information that has to be transported into the cadastral data layer is found in the land book, the condominium book, the cadastral plan and public property registers. The land register records ownership of immovable property, i.e. land, independent and permanent rights, condominium units subject to condominium ownership. The parcels in the cadastral plan are associated with the land register or the condominium book.

Cadastral work of forest land is carried out by forest cadastre committees, registering it to the State Treasury. In the areas where no cadastral records exist, a registry record (*zabit defteri*) or condominium registry record (*kat mülkiyeti zabit defteri*) is kept. Those immovable properties that are not private property and that are reserved for public use are not recorded in the land registry unless right in rem concerning them arises. As to all the cadastral changes concerning the plot of land arising from the fact that zoning plan is drawn up, the linkage between the old and new parcels is defined by recording the relevant pieces of information. Time analyses, which are particularly important in legal cases, can only be made on the basis of this information.

3. A Gml Application Schema Of A Well-Functioning Cadastral System: A Turkish Case Study

According to the Turkish Civil Code and other legal regulations, a land registry record refers to cadastral parcels, condominium units, and independent and permanent rights (Official Journal, 2001, 2008, 2013; Kizillot et al. 2005). All cadastral parcels are indicated in the cadastral plan. Those parcels of land on which no condominium units exist are recorded in the land book.

Table 1. First Page of a Land Book

page no:	map sheet no:	SURFACE AREA				REAL ESTATE CHARACTERISTICS			
	block no :	ha	m^2	dm^2	amendment				
	parcel no:								
former page no:	district:								
new page no:	neighborhood :								
cont. page no:	village:								
condominium unit page no:	location:					general no:	special no:	variety:	
	street								
NOTES	OWNERSHIP					ENCUMBRANCE ON REAL ESTATE			
civil code article 919-920-921	name, surname and owner's father's name	owner's register no:	reason for acquisition sale value	record date	day book no:	letter	R: right E:encumbrance	record date	day book no:

Table 2. Second Page of a Land Book and of a Condominium Book

STATEMENTS									
RIGTHS OF PLEDGE ON REAL ESTATE									COMMENTS (for rights of pledge)
letter	type of pledge	name, surname and owner's father's name	debt TL	interest %	priority claim	term	record date	day book no:	

Table 3. First Page of a Condominium Book

condominium unit page no:	CONDOMINIUM UNIT								
	according to building layout approved		owner's register no:		ownership share of the plot	type of use of the unit			insurance covering a specific unit
	story no:								no:
	unit no:								date:
	project no:								term:
	date:								amount:
former page no:	ENTIRE PROPERTY								
new page no:	neighborhoodor village: street:	map sheet no:	surface area			type of use of each unit in the building			insurance covering the entire building
cont. page no:		block no:	ha	m^2	dm^2				no:
land book page no:	building no:								date:
									term:
		parcel no:							amount:
NOTES	OWNERSHIP						ENCUMBRANCE ON REAL ESTATE			
civil code article 919-920-921	name, surname and owner's father's name	ownership share of the unit	owner's register no:	reason for acquisition sale value	record date	day book no:	letter	R: right O:obligation	record date	day book no:

Table 1 and Table 2 show the contents of the records on the first and second pages of a land book, respectively. The parcels on which there exist condominium units are recorded in the condominium book. For the first page of a condominium book, see Table 3, second page is identical to second page of a land book. Independent and permanent rights are recorded in the relevant sections of the land book and condominium book. Public property records are kept separately. Each record includes the information on the cadastral parcels. The UML class diagram and the GML application schema are designed in accordance with the forms of recording in the land and condominium books, showing all the relevant recorded information. The GML application schema includes real estate valuation data and geological information in addition to land registry records. By using the GML 3.2.1 version in the application, it is aimed that all spatial and non-spatial data of land registers are encoded in a single schema (OGC, 2007; XSD 1.1, 2012; XML 1.0, 2008). In addition to XML, the schema makes use of two other namespaces, i.e. "gml" coming from GML and "tk" which is employed for land registry records.

The design makes it possible that a GML document records a digitized cadastral sheet at scale 1:1000 produced according to the ITRF (International Terrestrial Reference Frame) coordinate system and all the data found in the relevant land register. The map sheet is the root node of the GML document, while digitized cadastral map sheet is the feature collection and the parcels on the map sheet are feature members. The parcel type is generated as a complex type from the abstract feature types of the GML schema. Surface property defined in the GML schema is chosen for the spatial data of the land parcel. While the types chosen from the namespaces XML and GML are used for the non-spatial data, those defined by the namespace "tk" are employed for land registry records. Thus, an application schema is generated that allows recording the coordinates of all the geometrical figures which are recorded on the cadastral plans and all the information found in the land book and condominium book. Some pieces of data are encoded both as an element and an attribute in order to make it easier for the user to carry out transformations through XSLT and to make the needed queries with a software program developed by using .NET Framework.

Within the "Parcel Type," some feature types, namely "parcel info" (parsel_bilgi), "owner info" (malik_bilgi), "value of property info" (deger_bilgi), "encumbrance on real estate" (irtifak_hakki), "rights of pledge on real estate" (rehin_hakki), "geologic info" (jeolojik_bilgi), "new parcel" (git_parsel) and "old parcel" (gel_parsel) are defined as complex types of the GML schema. "geologic info" presents pieces of information about the geological structure, those used in real estate valuation and those found in the public property registry. The GML schema also allows the user to define forestry parcels. The UML class diagram of the application schema is shown in Figure 1.

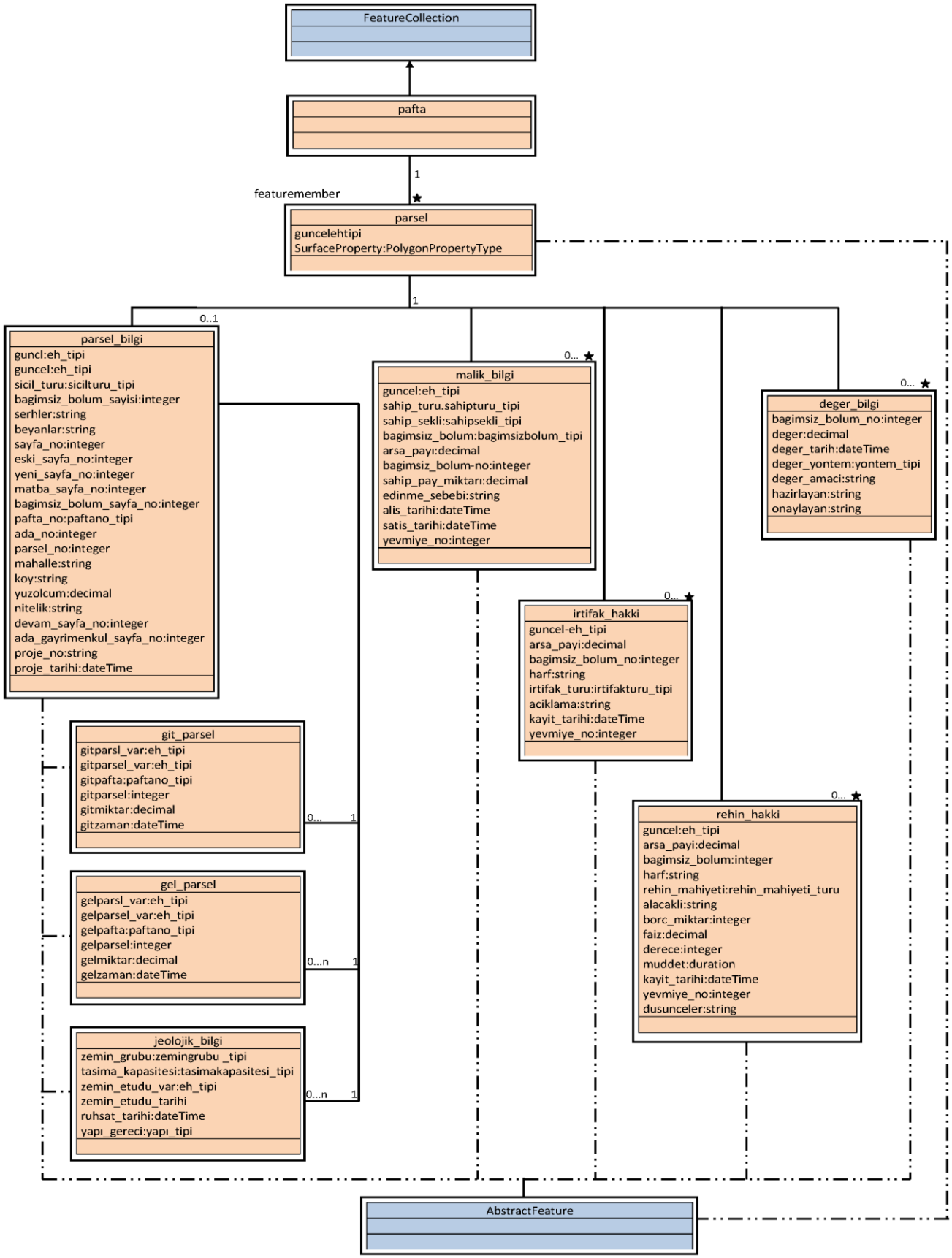

Figure 1: The UML Class Diagram for the GML Application Schema

A part of codes of the GML application schema concerning geological information is given in Annex A. A part of the coding of non-geographical parcel features is given in Annex_B. The application schema was developed on the basis of a specific part of the cadastral map sheet produced as a prototype and the relevant information on the title register. Each prototype is conceived as a cadastral map sheet.

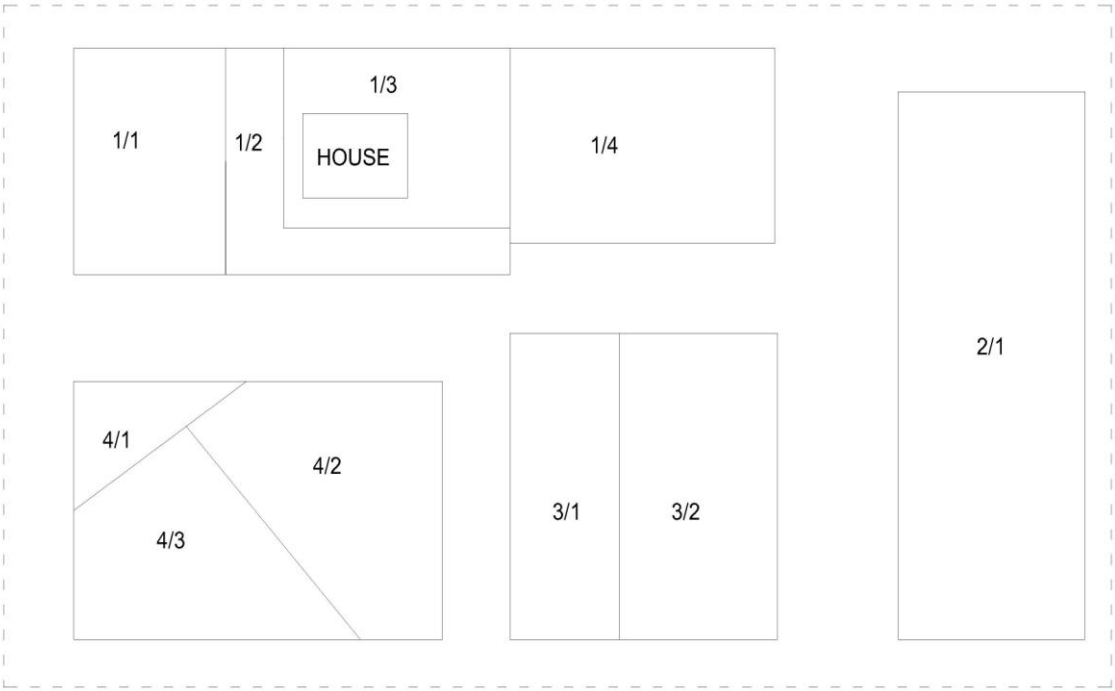

Figure 2: The Prototype produced for the General Cadastre.

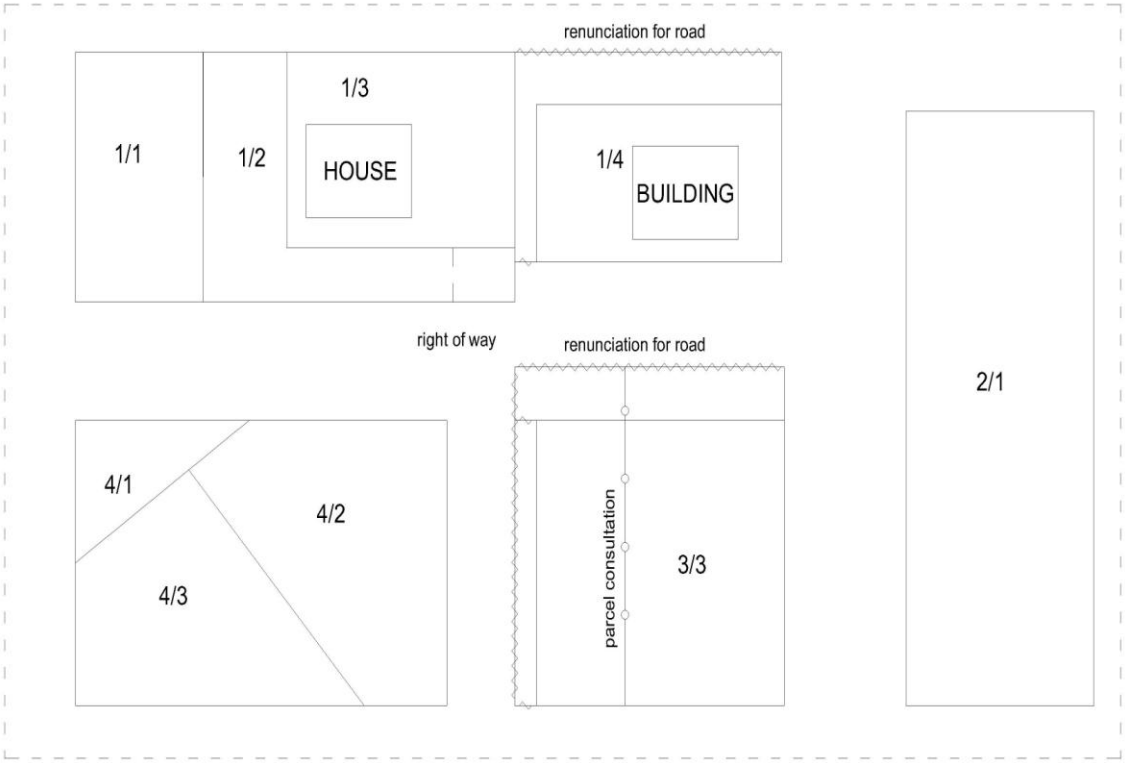

Figure 3: The Prototype produced for the Changes on the General Cadastre.

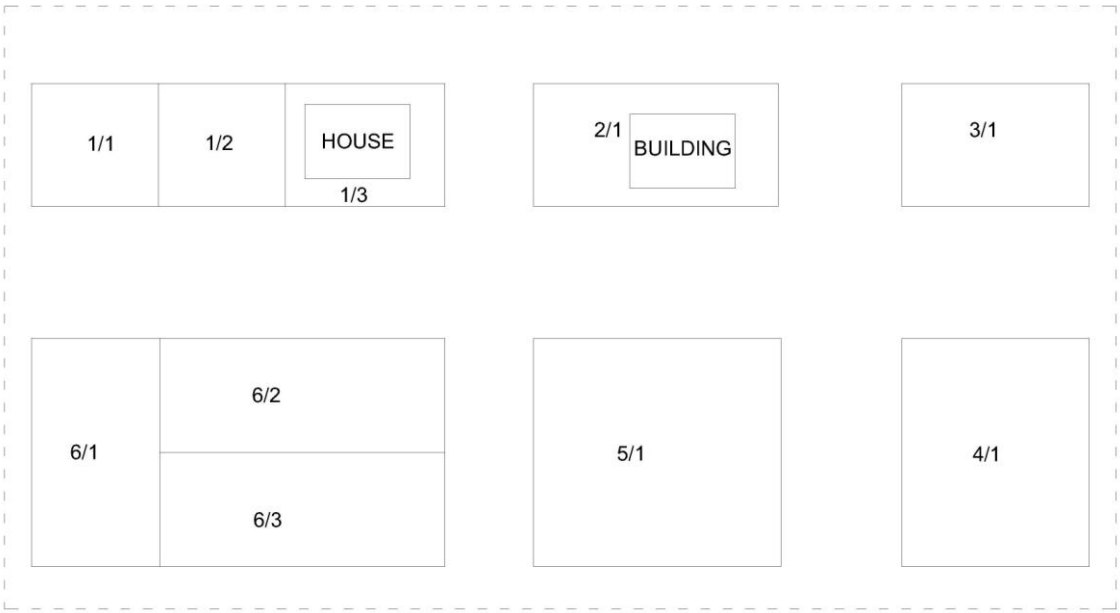

Figure 4: The Prototype produced for the Zoning Plan.

Figure 2 shows the prototype produced for the general cadastre. It is assumed that the changes on the concerned map sheet gives rise to the formation of the prototype in Figure 3. The changes are encoded on the same GML document. Figure 4 shows the prototype that comes into being when the zoning plan is drawn up. After the former GML document, which is based on the earlier cadastral map sheet, is marked as "not up-to-date," the new case is saved as a new GML document.

Each GML document generated from the XML has been checked to see if it is well-formed and valid with respect to the GML application schema. Furthermore, the necessary checks have been made concerning the transformation of the GML documents into the HTML format using XSLT, the creation of an SVG map, and the facilitation of the queries with a software program developed by using .NET Framework (Alas, 2007).

4. Conclusion

Land registry records are one of the main pillars of national information networks since a large number of administrative and legal services are provided on the basis of them. Cadastral or land registry data are amongst the specified spatial data layers of INSPIRE. It has recently become a common practice to use interoperability and open source technologies for the storage and transport of data, such as the XML (Extensible Markup Language), created by the World Wide Web Consortium (W3C), and the GML (Geography Markup Language), which is the XML grammar defined by the Open Geospatial Consortium (OGC). Encoding Turkey's cadastre and land registry records through the GML, which is supported by INSPIRE, will facilitate the easy storage, use, and transport of the data on the national and international platforms. Thus, this paper presents a GML application schema developed in order to facilitate the creation of a cadastre and land registry information system. It is argued that the application schema will be quite functional in the establishment of a cadastre and land registry database, a more effective performance in time analyses for legal cases, urban planning, and the provision of the relevant for other municipal services. Moreover, the GML application schema facilitates the storage of the values of immovable properties and that of geological information—the former might be used for a variety of purposes, especially for taxation studies, while the latter might be of benefit to researchers examining earthquake risks. This schema can be further developed in accordance with the needs of any related organization by a study group. The model developed here rests upon the legal regulations in Turkey, but it can be adapted into other countries where similar legal concepts are employed (Alas, 2007).

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ANNEX-A

```
<?xml version="1.0" ?>
<xs:schema id="pafta" targetNamespace="http://tempuri.org/belge_duzenleme.xsd"
xmlns:mstns="http://tempuri.org/belge_duzenleme.xsd"
  xmlns="http://tempuri.org/belge_duzenleme.xsd" xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:msdata="urn:schemas-microsoft-com:xml-msdata" attributeFormDefault="qualified"
elementFormDefault="qualified">
  <xs:element name="pafta" msdata:IsDataSet="true" msdata:Locale="tr-TR"
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        <xs:element name="featuremember">
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ANNEX-B

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  <xs:element name="mabat_sayfa_no" type="xs:integer" minOccurs="0" maxOccurs="1"/>
  <xs:element name=" bagimsiz_bolum _sayfa_no" type="xs:integer" minOccurs="0" maxOccurs="1"/>
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       <xs:enumeration value="yuksek" />
       <xs:enumeration value="cokyuksek" />
   </xs:restriction>
 </xs:simpleType>
```