Cadastre: The Key Component in Urban-based Information Systems

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Key words: Cadastre, Turkish Cadastral System, Urban Information System (UIS).

SUMMARY

The most important component needed in realizing a sustainable land development is a parcel-based data which acquired from the cadastral records. These data define not only size, shape, location, value of the real estate but also land-related rights, restrictions and responsibilities. While cadastre provides a guarantee and protects landowner's rights in many countries, it is also used for new land policy aims. Therefore, cadastre plays an important role on states in order to develop and supply new services such as spatial-based information systems in urban areas. Urban Information Systems (UIS) can be considered as an implementation of GIS in urban extent. It is an effective tool for local authorities with respect to manage urban relevant data and well-qualified service offer. Many geospatial data should be examined at the same time in UIS because of land planning, development and other decision-making procedures. However, land parcel-based information is very significant within this entire management task. From land taxation to environmental works in urban areas, cadastral documents are the main references which are always needed for a meaningful decision-making. Because cadastre is a methodically arranged public inventory of data concerning properties within a certain area, up-to-date cadastral data should be available for any time. If such data is in a digital form then it could be more valuable for an UIS application. But, the availability of cadastral data is also depending on the existing institutional structure and data use policy of a certain country as well. In this paper, firstly, the role of cadastral data in urban information procedures will be emphasized, and then the data quality and legal issues of introducing cadastral data to UIS applications of Turkey will be examined with regard to an organizational perspective.

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1. INTRODUCTION

Cadastre is a parcel based and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, ownership or control of those interests, and often the value of the parcel and its improvements (Enemark and Sevatdal, 1999).

The modern cadastre is primarily concerned with detailed information at the individual land parcel level. As such, it should service the needs both of the individual and of the community at large. Benefits arise its application to: asset management; conveyancing; credit security; demographic analysis; development control; emergency planning and management; environmental impact assessment; housing transactions and land market analysis; land and property ownership; land and property taxation; land reform; monitoring statistical data; physical planning; property portfolio management; public communication; site location; site management and protection (Dale and McLaughlin, 1999). As a result of understanding of these benefits, in recent decades, there have been many efforts to develop information systems based on the cadastral parcel which is the basic spatial unit of human activity (Dale and McLaughlin, 1999). In Turkey, the most common of these studies are known as Urban Information System (UIS) projects.

UIS can be considered as an implementation of GIS in urban extent. It is an effective tool for local authorities with respect to manage urban relevant data and well-qualified service offer. Many geospatial data can be examined at the same time in UIS. However, land parcel-based information is very significant within this entire management task. From land taxation to environmental works in urban areas, cadastral documents are the main references which are always needed for a meaningful decision-making. Because cadastre is a methodically arranged public inventory of data concerning properties within an area, up-to-date cadastral data should be available for any time. If such data is in a digital form then it could be more valuable for an UIS application. So, local authorities want to establish their cadastral data infrastructure in initial stage of their UIS study. However, there are important issues in realizing it with respect to cadastral maps, data quality, institutional and legal perspective.

2. TURKISH CADASTRAL SYSTEM IN BRIEF

2.1 The Process Followed by the Cadastral Studies

In Turkey, cadastre studies were started after the foundation of the Republic of Turkey. These studies have been realized in a manner that ownership of the lands were given to the people who use it. Firstly, in 1925, the process was started in municipal areas where one fourth of

the total population of the country live in. Because of the economical difficulties, technical deficiencies, personal insufficiencies, etc. these studies were realized only in cities within 25 year period of time (1925-1950). After the year 1950, they were also started in rural areas via an another legal regulation. Realized with different legal regulations in urban and rural areas, cadastral studies were combined with Cadastre Act in 1987.

From foundation of the Republic of Turkey to today, the aim of the Turkish cadastre have been defined as to define parcel boundries and their legal situations and to construct the land registry anticipated by the Turkish Civil Act. After the adaptation of the Switzerland Civil Act dated 1912 to Turkey conditions, the Turkish Civil Act accepted in 1926. Respect to the Act, the Turkish cadastre is named as "property cadastre" or in other words "legal cadastre". As seen in Table 1, between the years 1925-2001, 84,5% of the Turkey cadastre have been completed and almost 32.321.764 land parcels registered to the land registry (Kokturk, 2002). These studies are still going on under the management and supervision of the Land Registry and Cadastre Directorship. At the end of these studies, "Cadastre Map", "Land Registry Records" and it's related registries are producted (Biyik, 1999).

Table 1: Realization of the Turkish cadastre (1925-2000).

Period	Total Area of Turkey (km^2)	Production of The Turkey Cadastre			
		Total Target (km^2) (A)	Completed Area (km^2) (B)	B/A (%)	Producted Parcel Number
1925-1984	780.000	430.000	226.522	52,7	22.458.928
1985-1989			26.220	6,1	3.100.502
1990-1994			52.537	12,2	3.473.851
1995-2000			57.838	13,5	3.288.483
Total	780.000	430.000	363.116	84,5	32.321.764

2.2 Existing Situation of the Cadastral Maps

Until now, cadastral works have been constructed with lots of different laws, rules and regulations put into force in different periods. Therefore, different surveying methods, coordinate systems, base types and sheet scales have been used in producing cadastral maps. In below, these differences will be explained in shortly.

2.2.1 Used methods

At the cadastral studies of Turkey, five different surveying methods have been used. These are graphical, polar, orthogonal, photogrammetric and digital (X,Y,Z) methods. The number of the maps produced with these methods and their percentages are given in Table 2.

Features on cadastral maps producted with graphic method have not a coordinate value. They were produced with angle-distance values. Because accuracy of the digitizing these maps are expressed with meters, they can not meet the today's information system needs.

Cadastral maps produced with polar method have coordinate values. However, sheet accuracy, especially producted for rural areas, is very low. This situation causes for many issues in areas which were rural areas when surveying and mapping but now is tranformed to urban areas.

Table 2: The cadastral maps of Turkey with respect to production methods (Kokturk, 2002).

No	Production Method	Number	%
1	Graphic	113.499	36.51
2	Polar	63.733	20.50
3	Orthogonal	62.846	20.22
4	Photogrammetric	46.191	14.86
5	Digital	24.585	7.91
Total: 5 different map production methods		310.854	100.00

Accuracy of the cadastral maps produced with orthogonal method is very high. However, determining of geodetic points as traverse stations on land is difficult task. Because, the majority of the features used in referencing marks have been disappeared in time. At the study realized by Demir (Demir, 2000) on the sheet produced with orthogonal method, these maps were digitized in a needed accuracy. Cadastral-based photogrammetric maps have been produced in 1990's and in 1/5.000 scale. These maps are accepted in low accuracy.

Producing and updating of cadastral maps digitally was introduced into Turkey legislation in 1988. According to this regulation, digital studies have to be applied not only in producing new maps but also updating of some changes on the old non-digital maps (Kocak, 2000).

The researches done about location errors up to now indicated that some points on the bases have many location problems. One of these studies results is given in Table 3. On the other hand, some renovation works have been continuing according to detailed programs to solve this kind of issues. Table 4 explains these renovation works in Turkey (Demir et al., 2003).

Table 3: The accuracy criterion used in digitizing cadastre maps

Measurement Method	Scale	Test Points-Parcel Numbers	Mean Root Squared Error (m_p) m
Orthogonal	1/1.000	225-42	0,37
Graphic	1/5.000	87-34	2,79
Photo plan	1/5.000	187-59	13,30
Photogrammetric	1/5.000	384-59	1,52
Digital (X,Y,Z)	1/1.000	412-88	0,32

Table 4: Distribution of cadastral parcels to be renewed across the country.

Settlement Unit	Total Unit	Total Parcel	Total Decar	A Section of a Map
District	359	421.825	3.288.764	4.938
Village	4.310	4.732.503	45.242.481	80.758
Turkey in General	4.669	5.154.328	48.531.245	85.696

2.2.2 Coordinate Systems

While majority of the cadastral maps produced in Turkey are in local coordinate system, some of them are in national coordinate system. Since the introduction of digital cadastre in Turkey, the maps have been produced and updated in national coordinate system.

2.2.3 Base Types

Bases of the cadastral maps of Turkey can be classified in three main groups: transparent, aluminium and paper-carton maps. The percentage of these bases is shown in Table 5.

Table 5: Existing situation of the cadastral maps with respect to sheet bases (Demir, 2000).

Base Type	%
Transparent	25
Aluminium	31
Paper-Cartoon	44

2.2.4 Scale

Cadastral maps are in 10 different scales range from 1/200 to 1/10.000. These scales, their sheet numbers and percentages are seen in Table 6 (Kokturk, 2002).

Table 6: Cadastral maps in according to scales

Number	Scale	Sheet Number	%
1	1/200	206	0,07
2	1/250	7	-
3	1/500	26.688	8,59
4	1/1000	90.648	29,16
5	1/2000	101.584	32,68
6	1/2500	17.890	5,75
7	1/3000	30	0,01
8	1/4000	397	0,13
9	1/5000	72.430	23,30
10	1/10000	974	0,31
Total: 10 different scales		310.854	100

3. CADASTRE-BASED INFORMATION SYSTEM STUDIES IN TURKEY

3.1 Cadastre-based Information System Studies in Urban Areas

Today, one of the most common usage type of Geographic Information Systems is Urban Information System (UIS). In most cities like Istanbul, Ankara, Izmir and Bursa UIS studies have been started in Turkey. However, there are important problems in digitizing of cadastral data which is one of the most important stage of the studies (Yomralioglu, 2000). The main causes of these problems, as stated above, production time of the cadastral maps, legislation acpects to the maps, surveying and map production methods, used coordinate systems, scale

factors, base materials and their changes. Nowadays, some local authorities are solving these issues via special protocols with cadastre directorships in a partnership manner. However, this situation is still a problem where cadastral maps can not be digitized in required accuracy.

3.2 Cadastre-based Information System Studies in National Perspective

In Turkey, various project studies have been undertaken for implementation of the cadastral activities in digital environment. While some of them were completed, the other are still going on. Turkish National Fundamental GPS Network which called TUTGA and Turkish Land Registry and Cadastre Information System which named as TAKBIS projects are the most important ones.

TUTGA project: Because existing fundamental geodetic network is inefficient, this network was constituted. TUTGA is in ITRF coordinate system and has ±1-3 cm accuracy. It is formed with 594 points which have three dimensional coordinates. The distance between these points is about 25-30 km but in the areas where geoid changes rapidly this value decreases to 15 km. This project was realized in three stages by Turkish Commander of Mapping and completed in April 2001 (Ercan, 2003).

TAKBIS project: It is aimed with this project that General Directorate of Turkish Land Registry and Cadastre (TKGM) studies are realized in an effective way and these studies are converted to Multi-purpose Land Information System.

The general objective of this project is to establish the Turkish Cadastre Information System through out the country. The pilot area of the project is the city center of Ankara and its vicinity. The Marmara Earthquake Region will be the first implementation region that covers an area of 9.351 km² and is an intensive settlement and industrial region. Cadastral renovation methods will be used both in urban and rural areas (Ercan, 2003). The TAKBIS project is still under development, and consists of three steps: analysis, design, and application development. The main purposes of TAKBIS are:

- to provide reliable land information required for land and land-related activities and decision makers,
- to regulate such activities in accordance to the principles of GIS/LIS in frame of standards of OpenGIS Consortium,
- to maintain information updated and re-evaluating them within the scope of information technologies,
- to provide spatial data for use in central and provincial public organizations.

Without completely realizing the TAKBIS project, effective resolutions can not be realized in some issues. Some of them are determining of unproductive areas, inventory analysis of public and management real estates, land readjustment, supervision of land use, developing of land-based credit market, inquiring of land-based conflicts, realizing rational investment plannings, fair taxation, preventing of tax loses, increasing revenues of real estate, fair and rapid expropriation, improvement of the shanty areas, turism planning, coastal use, determination of administrative boundries (Ercan, 2003).

4. CONCLUSION

When considered that cadastre is a fundamental data source for many information systems, it is obvious that forming and sustaining of systems in an effective structure depends on construction of the up-to-date and accurate cadastral data in digital environment. Therefore, in the areas where this can not be realized with existing cadastral maps, there is a need for the re-cadastre in digital format. However, while current legislation is permitting renovation of the cadastral bases, it does not allow the re-cadastre. So, there is a need to re-arrange current legislation with spatial information system requirements.

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BIOGRAPHICAL NOTES

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