

# **Problems and Solution Proposals in Integration of Cadastral Data into Geographical Information System (GIS) in Turkey**

**Gülgün OZKAN, S. Savas DURDURAN, Ali ERDI and Bilal GIRGIN, Turkey**

**Key words:** Cadastre, GIS, Mapping, Data

## **SUMMARY**

Developing information technologies take place in all technical disciplines and they continue to support these disciplines in the meaning of time, labour, precision and cost.

Founding and applying Geographical Information System are the most popular working areas nowadays, in Turkey. Projects that are started by different institutions are developed rapidly and they are described as GIS and Urban Information System (UIS) like E-Government, MERNIS (Central Population Information System) project and TAKBIS (Turkish Land Registry and Cadastre Information System) project, etc.

In this study, problems in the entegration of cadastral data, that are considered by us based on GIS studies, in the system are determined and solution suggestions are given.

# **Problems and Solution Proposals in Integration of Cadastral Data into Geographical Information System (GIS) in Turkey**

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## **1. INTRODUCTION**

Being one of the outcomes of developing information technologies the Information Systems can be briefly defined as a tool that can be used in performing specified goals. The benefits of information system can be summarized as to be the more effective usage of spatial and non-spatial information that is included into the system to fulfill the specified goal for planning, service, management, control etc. subjects.

Both government and urban managers have accelerated the studies of system formation by thinking the benefits of it to the country with the usage of the mentioned system. The studies started by various institutions are called with different names and some of them are continuing independent from each other. They were generally not completed but in data collection stages as well.

As defined by FIG (International Federation of Surveyors), the cadastre should be the base of all planning and projecting studies. In other words, the main base of Geographical Information Systems (system based on position) that were planned to be formed should be the cadastral data. It is evident that the inclusion of a land whose owner is not known will not overlap with the goals of Information System (Yomralioglu 2003).

The integration of property data into the system is the biggest problem of the system that will be formed. Because the cadastral maps showing the geometrical position of property data were produced with different laws and regulations from past to today and they are still being used. In the study, benefiting from digitizing process in transferring cadastral data into the system was taken as the basic principle, however the possible problems to be met were determined and their solution suggestions were given.

## **2. A GENERAL OVERVIEW TO CADASTRAL STUDIES AND PRODUCED MAPS IN TURKEY**

### **2.1 Cadastral Studies in Turkey**

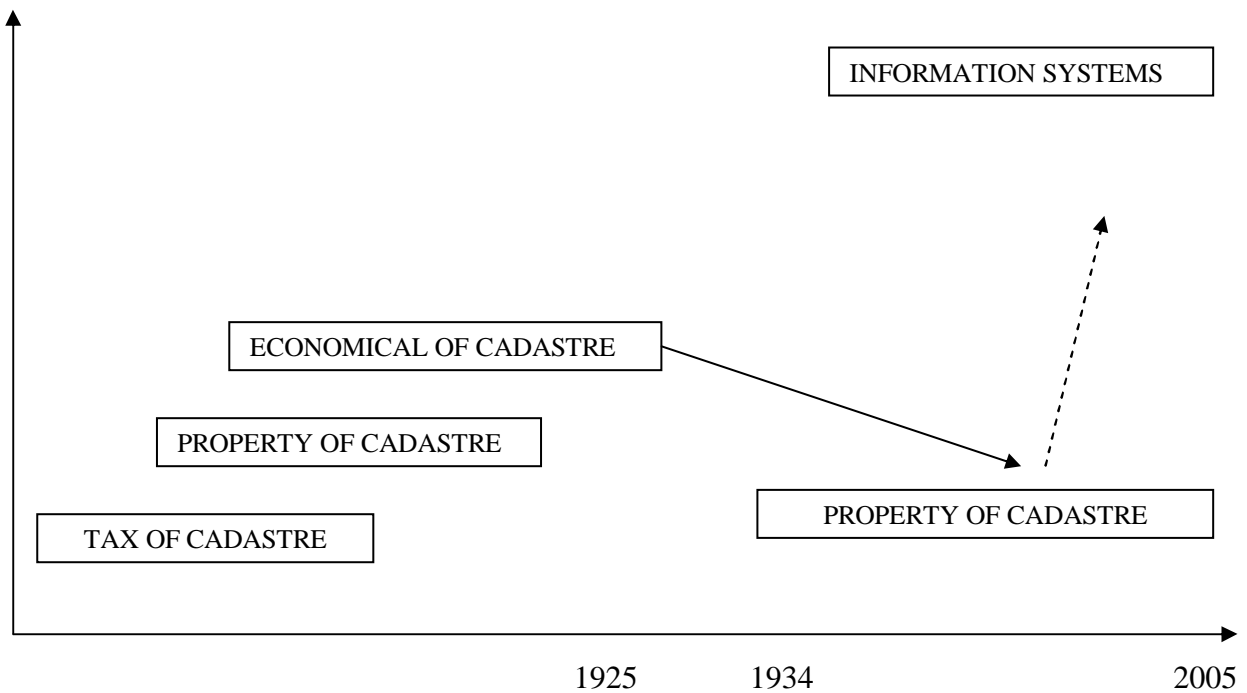
General Directorate of Turkish Land Registry and Cadastre performs the cadastral survey services in Turkey and fulfills its services as Central and Rural Organizations. The rural organization involves 22 Regional Directorates, 1003 Directorates of Land Registry and 325 Cadastre Directorates. The cadastral studies have been completed in 98 % ratio in urban areas and 65 % ratio in rural areas. The improvement studies are also in 15 % level. The condition of cadastral studies throughout the country is summarized in Table 1.

	PRESENT	FINISHED	EXPLANATION
NUMBER OF TOTAL CITY	81	79	
NUMBER OF TOTAL TOWN	950	794	127 CENTRAL TOWN

**Table 1:** Present Condition of Cadastral Studies in Turkey

The cadastral studies in Turkey are all property cadastre. The enacted and applied laws for cadastral studies from Ottoman time until today have determined the expectations and changed goals (Erdi, Ozkan, Cay, 1999). The goal variations in cadastral studies in our country are represented in (Figure 1).

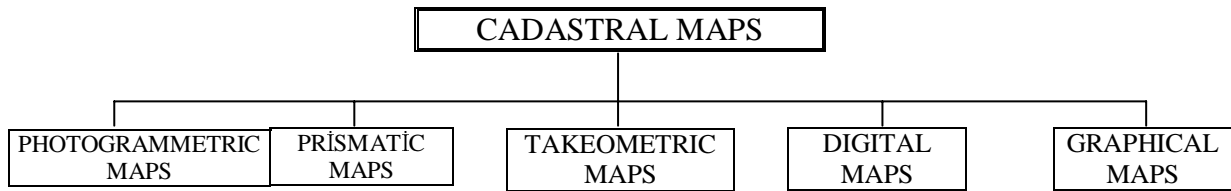
Automation is being used in 250 Land Registry Directorates that carry out land registry services of surface area, type and ownership characteristics of real estates besides showing the justices and obligations belonging to real estate like right of access, mortgage and explanation. Moreover, automation is aimed to be spread out all over our country.



**Figure 1:** Goal Variations in Cadastral Studies in Turkey

## 2.2 Maps Produced in Turkey and Their Characteristics

Maps produced as the outcomes of cadastral studies performed from past till today in Turkey can be classified as in Figure 2.



**Figure 2:** Classifications of Cadastral Maps According to Production Techniques

Number and base species of maps which are seen from the figure can be summarized like this:

According to producing methods ;

Produced with photogrammetric method	42374
Produced with prismatic method	45389
Produced with polar method	53318
Produced with digital method	12916
Produced with graphical method	110710
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TOTAL	264707

According to base species ;

Astrolon	65684
Diazo	444
Tracing Paper	632
Film	81012
Oilcloth	116935
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TOTAL	264707

Photogrammetric maps are the 1/5000 scaled maps produced due to national triangulation in order to perform cadastral studies in rural areas more quickly.

Prismatic maps are the 1/1000 scaled maps produced with prismatic method according to national or local coordinate systems and continued to be drawn after The Standards of Producing Large Scale Maps has become valid. They have been prepared for urban areas.

Tacheometric maps are the 1/5000 scaled maps produced due to national system. They have less accuracy and their production ended after The Standards of Producing Large Scale Maps has become valid.

Digital maps are the maps produced after The Standards of Producing Large Scale Maps has become valid for rural and urban areas consisting in the national coordinate system

Having extremely less accuracy, spatial maps are produced with no coordinates but based on polygon points only. They have become subjects of improvement studies.

Because of not being strengthened with photogrammetric method, photo plans are the maps that have no scale accordance in their all points. Their production has begun in our country to accelerate the cadastral studies in even areas in the years in which photogrammetric studies newly started. They have less number of maps whose production has ended in a short time period. (Girgin, 2004).

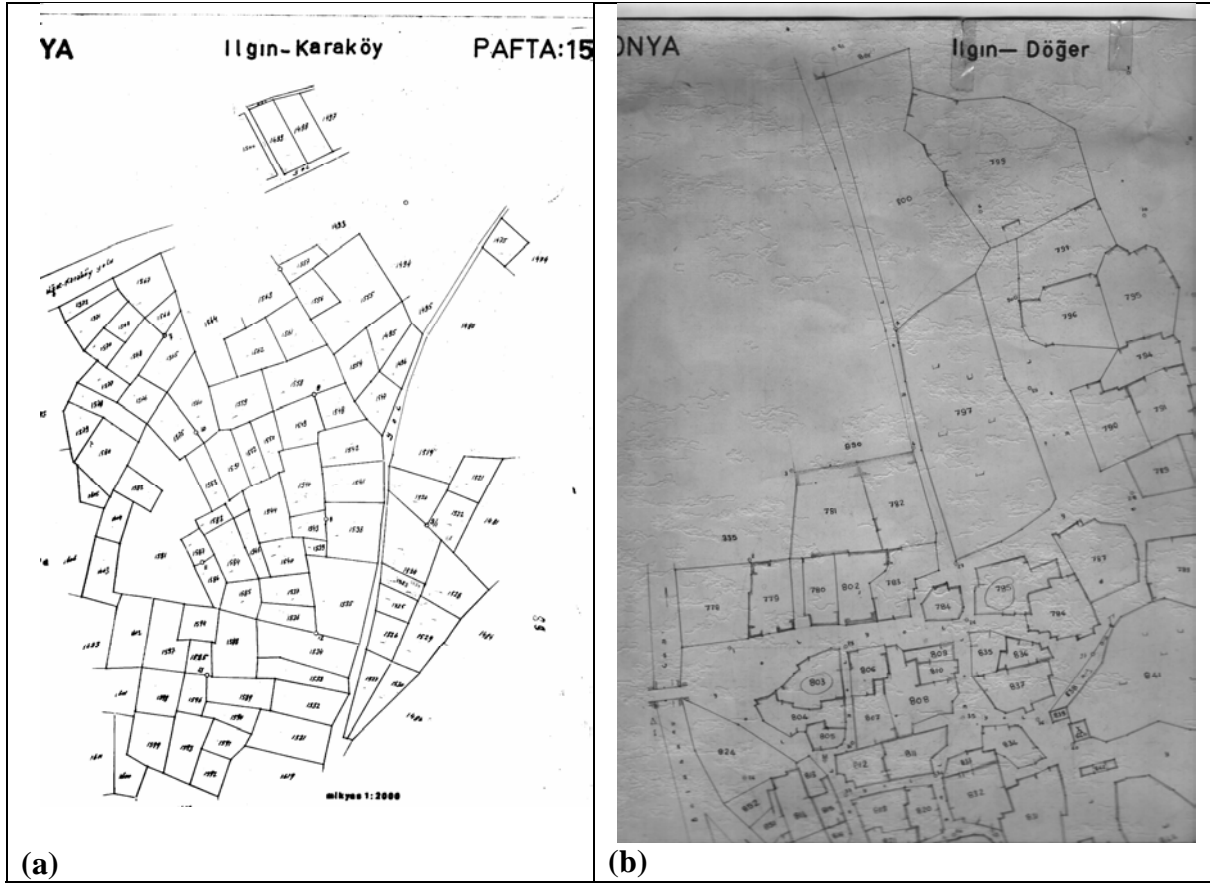
The possible errors in cadastral maps classified in five groups according to their production techniques are directly related with map production techniques, since the precision of measurement values that were taken as bases in map production will effect the position accuracy of measured detail points.

### **3. INTEGRATION OF CADASTRAL DATA INTO THE SYSTEM**

Transferring data into system in other words, database formation process is the most important process in GIS studies. This process takes more time and reaches the 65-70% of system cost. Cadastral data explains the digital and attribute information belonging to the earth. Spatial data can be included into the system with classical and photogrammetric measurements or by the help of the satellite views or digitizing processes from existing maps. In this study, digitizing process is taken into consideration

Property data should be accurately transferred into numerical format and integrated into the system for GIS systems. In Turkey, cadastral maps produced with various methods are still being used (Examples of spatial maps that produced for urban and rural areas are shown in Figure 3). In the maps produced with various methods, the determination process of geometrical conditions of real estates varies due to applied legal regulations, measurement devices used in measuring, method and technology used in calculation and drawing. Therefore, it is known that produced maps have technical errors besides differences in point position accuracy.

As it is observed from Figure 4, the integration process of cadastral data into the system can be sorted as error investigation of cadastral maps, digitizing process and providing coordinate accordance. During digitizing of cadastral maps, the determination and correction of technical errors will affect the accuracy of digitizing process. Providing coordinate accordance and transforming into national coordinate system after digitizing process is necessary for integration.

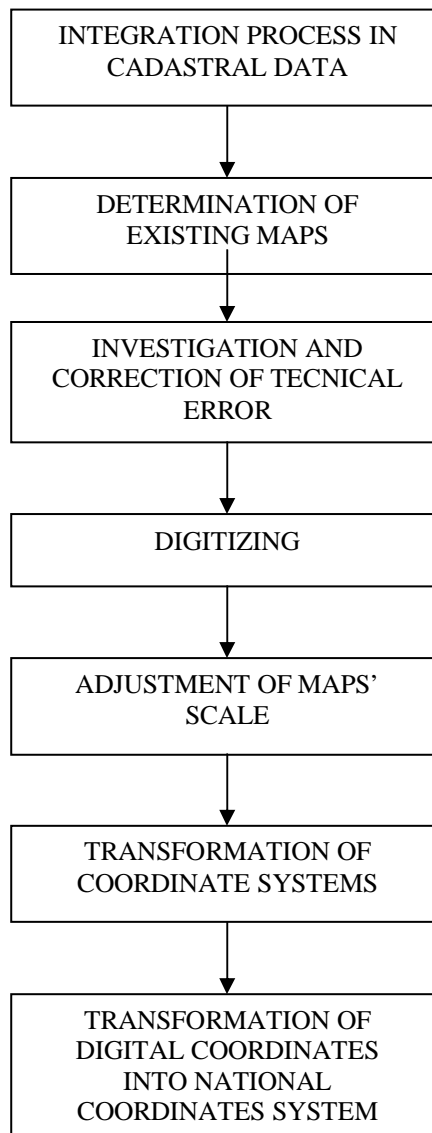


**Figure 3:** Examples of graphic maps that used for rural (a) and urban (b) areas

### 3.1 Presence Investigation and Elimination of Technical Errors

Cadastral studies are carried out with classical and photogrammetrical measurement methods. The classical method process is formed from bounding and measurement stages. The technical errors that can appear during and after measurement can be classified in three groups;

- Measurement Errors
  - Prismatic measurement errors,
  - Tacheometric measurement errors,
- Digital measurement errors
- Drawing Errors
- Calculation Errors



**Figure 4:** Integration Process of Cadastral Data into the System

Measurement errors are caused from devices (for ex: prism, tacheometry, electronic telemeter, etc.) that will be used in the method. In prismatic method, measurement sketches should be controlled in order to determine the measurement errors. Side controls should be made by prismatic measurement method applied on the lines formed between polygon points.

The determined errors should be corrected according to the 41<sup>st</sup> clause of Cadastre Law. The measurement sketches cannot be used in determining measurement errors in tacheometrical method. With the help of bounding sketches, the boundaries of the area should be controlled whether they changed or not. There are met no measurement errors in the digital method (with electronic telemeter) when some rules like collimation test, scale coefficient input, determining verticality of reflector during measurement, etc. are obeyed.

The drawing errors are caused from incomplete or wrong points during the drawing of measurement values into the sheet. They are being corrected according to 41<sup>st</sup> clause.

The calculation errors are generally met in area calculations made by planimeter. There occur errors due to carelessness in area calculations that are made digitally or with Thomson Formulas. The elimination of this type of errors is made with 1458 and 1994/5 numbered regulations.

The measurement studies in photogrammetric method process are performed independent from bounding studies. Measurement, evaluation and drawing processes in photogrammetric method are carried out different from classical method and the precision of produced maps changes due to the experience of the operator.

The frequently met error in photogrammetric method is making confusion between land boundary and contour line. In addition, boundary lines not adaptable with the land due to vegetation can be seen on the sheet. Complementary studies with classical method are appropriate for this type of conditions during control works.

In order to eliminate the errors mentioned above, 3194/18 numbered Reconstruction Law, 2981-3290-3366 numbered Reconstruction Forgiveness Law and Land Consolidation studies can be used.

### **3.2 Digitizing Process**

Information system functions are seen in data collection, processing and presentation manners. Data should be integrated into the system digitally.

Digitizing process can be used in transferring cadastral data that is aimed to be the basic map of the system. While the information on the map is being digitized spatially, one of the methods from automatic or semi-automatic methods or manual digitizing that varies in precision, speed and production cost can be used.

The digitizing process is generally performed manually because of base quality differences (astrolon, tracing paper, film, etc.) in maps of existing cadastral maps and having erasures and scrapings on the maps, etc. The method is preferred since it needs less number of qualified people and requires cheaper and easier devices (Baz, 1999).

The digitizing process will be performed due to 1999/1 numbered regulation appendix. The regulation prefers the original sheet or the land control of the sheet that will be formed with temporary numerical values determined from digitizing process or measurement values used in the sheet formation.



### 3.4 Providing Coordinate Accordance

Present cadastral maps are produced in various scales with various coordinate systems. Providing scale and coordinate accordance between maps is extremely important. The coordinate values obtained by digitizing process are local coordinate values determined on digitizer. During digitizing process, although partial transformation is made with the help of grid lines of the sheet, the integration process will be completed after connecting all the spatial data that is collected in the database to the national system then the spatial data will become meaningful.

## 4. PROBLEMS DURING INTEGRATION PROCESS AND SOLUTION SUGGESTIONS

The determination of problems met during the integration process of cadastral data into the system and investigation results directed towards solutions are given in the following;

- In order to be successful in Information System studies in Turkey, present conditions of cadastral studies and problem resources in cadastre should be improved before all else by making investigations.
- Especially for permanent and reliable solutions of technical problems, existing network should be improved and the obligation of connection to TUTGA Network (Turkish National Fundamental GPS Network) should be provided. The transformation parameters that will provide transformation between ED-50 (Europe Datum 1950) and TUTGA-99 with sufficient accuracy should be obtained.
- The digitizing process should be accelerated throughout the country for the integration process of Information System, since huge amount of cadastral data is not in digital format in Turkey.
- During digitizing process, it should be decided whether cadastral data would be transferred into the system according to temporary coordinate data or national coordinate system that will be obtained by making land investigation with the help of these data.
- The regulation should be reviewed since performing digitizing process according to existing laws is far from being practical.
- There should be made legal regulations to provide easiness to applicants while regulating the technical errors that will be met during digitizing process of cadastral data.
- The truly determination of technical error regulations of property position carries the mean of eliminating wrong presentation caused from administration (Cadastre Law 41<sup>st</sup> clause) and since this contradicts with clause 645 of Civil Code, it should be reviewed.

- The error limit of The Standards of Producing Large Scale Maps should be re-determined after reviewing the coordinate and position tolerances given to the contractor and position error caused from prismatic measurement.
- Map production precision should be 0.2 mm. according to The Standards of Producing Large Scale Maps. Changing this precision as 0.5 mm by thinking map production techniques will contribute to perform the processes faster.
- The point position error of  $\pm 10$ cm determined in The Standards of Producing Large Scale Maps is found to be satisfied only in the maps produced with digital method.
- The calculations should be controlled in the 2<sup>nd</sup> coordinate system due to the precision expected from the study, since there can occur errors during the transformation of local coordinate values in various systems into another system.
- Helmert coordinate transformation is determined to be more appropriate for not large areas in Turkey in making transformation between coordinate systems of cadastral studies.
- The coordinate transformation with single parameter is found to be unreliable for transformations of coordinate systems in large areas like urban areas, since error ratio increases when going away from the center of gravity of common points and it is concluded that different parameters should be used in different regions.
- The usage of Affin transformation method will be useful for the transformation of coordinate values obtained from digitizer table or scanners into local coordinate values.

## 5. CONCLUSION

The cadastral studies in Turkey are continuing and the completion period of them cannot be indicated definitely. In order to complete the cadastral studies, the usage of Digital Photogrammetry and GPS (Global Positioning System) measurements in detail measurement will accelerate the studies especially in rural areas. It is known that cadastral data does not have the same standards since they were obtained from the maps produced with different techniques and methods in the regions where cadastral surveys were completed.

Well perception of existing condition of cadastral data group necessary to be integrated into the system, determination and elimination of possible errors and providing coordinate accordance are extremely important in the formation studies of Information Systems. New legal regulations are required to accelerate the digitizing studies and elimination of technical errors.

Without eliminating problems, the National or Urban Geographical Information Systems will not reach its goals as it is planned to be established.

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## BIOGRAPHICAL NOTES

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