Forming the Digital Cadastral Maps from Current Cadastral Data: The Importance of the Geodetic Control Points

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Key words: cadastre, Cadastral archive data, geodetic control point.

SUMMARY

The base cadastral maps have been produced on the 3^0 Universal Transform Mercator (UTM) systems in Turkey since the middle of 1990's. The base cadastral maps produced on the nation-wide coordinate system covering only %5 percent of Turkey cadastre. In Turkey, cadastral surveys have been completed up to %98 in cities with different survey methods and coordinate systems. Because of this, the current base cadastral maps could not be produced according to today's standards in Turkey. Thus, current base cadastral maps can be in digital form on the UTM system for modern cadastre. In order to carry out this, the authority determined three important stages for modern cadastre. These stages are forming the geodetic control points on UTM system, survey the parcel boundaries based on this system and transfer the current base cadastral maps which have been produced up to now on this system.

The first two stages can be formed correct and reliable by using today's technology. But transferring the current base cadastral maps on the 3^0 UTM systems has consisted very important cadastral problem in Turkey like the other countries. In Turkey, different methods are used in establishing digital cadastral maps. Some of these different approaches include coordinate transformations; regional zoning plan applications, revision of cadastral maps and zoning plan improvement applications. However, on an average, applications of these methods have not produced satisfactory results. In this point, it has become a current issue to use the cadastral archives data to form digital cadastral maps. But the cadastral data is very complex and some of them have not been updated up to now. Because of this, using the cadastral archives data for forming digital cadastral maps has been of secondary importance. But the results of studies on this subject showed that forming the digital cadastral maps from current cadastral data especially produced with orthogonal survey methods in cities has been very important and this data can not be neglected. In this point, determining the geodetic control points established in the cadastre works on the ground is very important stage. If these control points have been reestablished on the ground based on the current cadastral data, these control points could be resurveyed on the 3^0 UTM coordinate systems. After that, using the original cadastral data, digital cadastral maps can be reproduced on the 3^0 UTM coordinate system reestablished on the ground.

To implement this method, the geodetic control points established on the ground must be reestablished on the ground. But there has been a very serious problem in this stage. Because most of the geodetic control points' establishments have lost and their bench marks data has

not been updated up to now. This paper is released for reforming the digital cadastral maps on the 3^0 UTM coordinate systems from the base cadastral maps belonging the region, whose cadastre was done by the orthogonal survey method. Because of this, in our pilot area, geodetic control points, 95 percent of which have been lost, are reestablished using original cadastral data and cadastral area surveys. And then, we are going to propose a method to reestablish the lost geodetic control points on the ground.

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1. INTRODUCTION

Cadastre is the method of registering land, designed to ensure the rights of individuals and the state of their property (Dale, 1976; Dowson & Sheppard, 1952). In cadastre, is an important institution that it provides to be produced, hidden, submitted and followed variations continuously of lots of basic data which law, economy, social life, statistics and science need. Submitted as information systems and spatial and non spatial lots of information's basic base is information that cadastre and land organization produces them (Bıyık, 1999). This information is searched accuracy, precision and currency qualities because they register naturally. In Turkey, using technological instruments completes rural and urban fields great piece of cadastre working. When Turkey's cadastre's general structure has been evaluated up to now, completed cadastre's 42% in graphic method (independent from coordinates), 20% in classical polar, 17% in orthogonal and 5% in digital situations has been produced. But current cadastre bases need to be reviewed on account of many causes as first of all technical standards and land use, geodetic control points, content and accuracy.

In 1994 General Directorate of Land and Titles and Cadastre had made to formed digital cadastre maps in national coordinate system necessary so as to current service with healthy, quickly and economical and on the other hand to form safe base for spatial information system. In this stage for going to be done cadastre working standards are determined and formed digital cadastre base in this frame standards. Furthermore, cadastre bases which produced in differential coordinate systems, technological instrument, scales and measurement methods, needs to be reproduced from current archives data. Now all cadastral works carry out in digital form, in national coordinate system, present technical standards and wanted precision. Some cadastre organizations have carry out some works to transform the current cadastre bases into the digital form in national coordinate system using cadastral data digitized on maps. To do this they use transformations methods. But these digitized and transformed data caused very important boundary problems especially in fields where the real estates value is high and structuring is dense. At the moment cadastre geodetic control points lost their establishments on ground and current archives data belonging these points are not updated enough by now. And this situation is very big problem to solve in Turkey cadastre. But the results of doing studies especially cadastre covers our country's rarely 17% is valid in field formed orthogonal measurement methods. That losing geodetic control points will be reestablish with using archive data had been displayed. After reestablishing them on the ground, to be produced of these points can be performed from current archives data of digital cadastre base in national coordinate system. In this study selected a pilot region for the loss geodetic control points a method will be suggested to reestablish the lost geodetic control points and formed the digital cadastre, based on this point, in national coordinate system.

2. THE PILOT REGION'S CADASTRE DATA

Hızırbey quarter is selected as a pilot region. The Pilot region's Cadastre Data is shown at table 1.

Table 1: The Pilot region's Cadastre Data

Sheet number	The measurement method	The sheet type	Scale	Coordinate system
13,14,15	Orthogonal	Aluminum	1/500	Local

The cadastre works were carried out in 1955 at this pilot region. Now the building dense is quite many in this region. The suggested method is applied whole of Hızırbey quarter.

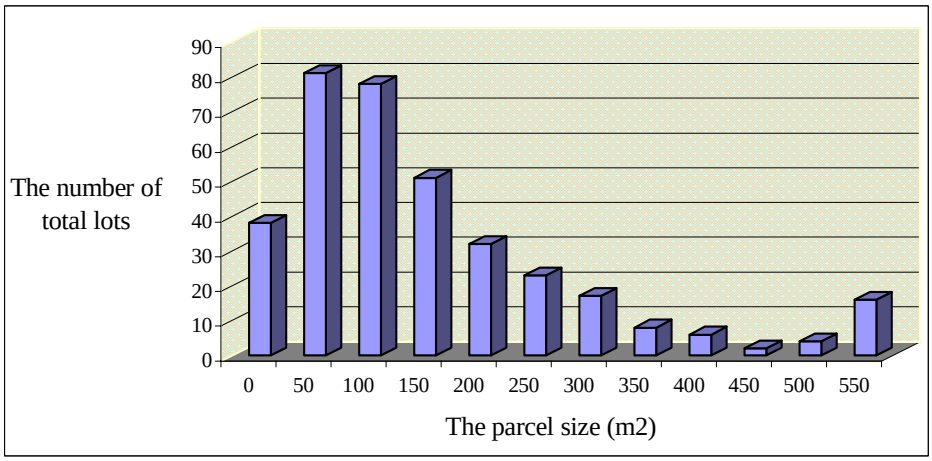

Figure 1: The avarage lot size of pilot region

The average size of parcel in the region is determined about 180.00 m^2 (Figure 1). Cadastral survey of the region was made with orthogonal measurement method. Cadastral parcel measurement was made by using local coordinate system and three cadastral map with 1/500 scale were produced (Demir, 2000).

There are some criterions that can be important for chosing the region;

- The property cadastre must have been made by orthogonal measurement method,
- A part of buildings and details available at cadastral base must have been still available on the land. (About 140 buildins and other details),
- Every kind of development applications must have been completed locally in the region,
- Map 1/500 scale must have been produced,
- The region must be near The Geodetic Network Points produced by Trabzon Cadastre Organization by using GPS in National Coordinate System.
- The region must have similar cadastral data characteristics with other wards of Trabzon.
- 95% of polygon points produced during cadastre must be lost today.

2.1 The Property Cadastre Geodetic Control Points Characteristics of Pilot Region

Table 2' shows characteristics of polygon points include whole Hızırbey Ward. According to that on workspace in 33 routes 149 geodetic control points were established.

Table 2: Hızırbey quarter geodetic control points data

	Connected line traverse	unclosed line traverse	Total
The points number	100	49	149
The route number	23	10	33

Problems about continuity of geodetic control point establishing of property cadastre affect these points negatively. So that in 1985 Cadastre Organization formed property cadastre geodetic coaster again in the same coordinate system by private sector for providing the continuity of geodetic control points and as coordinates with this for providing applicability of property cadastre coaster. It is obvious that coordinate discriminations among all of the polygon coordinates produced with this way are available (Figure 2).

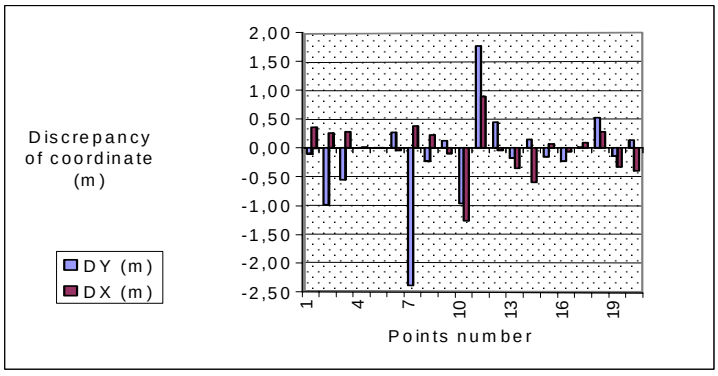

Figure 2: The dicrepancy of the same geodetic control points coordinate reproduced by the private sector on the local coordinate system

The boundary conflicts between ownerships have often occured using these geodetic control points in this cadastral area.

2.1.1 The Geodetic Control Points Benchmark Data

The geodetic control points bench mark data of the property cadastre in the pilot area had been done inadequate(Table 3). After the property cadastre the cadastral area has been changed by owenerships. These changes are not only influence the geodetic control points establishments but also influence their bench mark's points establishments with time. Therefore, property cadastre bench mark data has not updated till now. And then using these data to reestablish the property cadastre geodetic control points in the field wanted accurate has been rather impossible. Today it is determined that 95% of the property cadastre geodetic

control points bench marks can not be applied on the ground. A few parcellation works had been done in this study area by private sector.

With this parcellations works the property cadastre geodetic control points' bench mark data is updated by private sector. But some of these updated bench mark data is not the same data as the property cadastre geodetic control points bench mark data at the same geodetic control points. The discrepancy of this data is given on table 4.

Table 3: The current situation of the property cadastre geodetic control points bench mark

Bench mark data	(%)
From buildings	42
From wall and etc.	56
The others	2
From three points	97
From more than three points	1
From lest than three points	2
Changed	87
Indefinite	17
Updated	8
Applicable	5

As a consequence of a control process completed using 1400 stable objects such as parcel corners, building corners, wall sides in original measurement drawings formed during property cadastre, it was determined that parcel sides and two perpendicular lengths which originally form these sides had been measured correctly in the early measurement process. Therefore, it was reached that original measurement figures in the application area are proper to use.

Types and features of measurement stations used to determine parcel borders in application area during property cadastre are presented in Table5. As seen in table, many of parcel measurements were performed directly using traverse stations.

Table 5: Traverse – Parcel Relation in Hızırbey Quarter

Point type	Connected line traverse	Unclosed line traverse	other	Total
Parcel surveying (%)	67	3	30	100

Table 4: The discrepancy of property cadastre bench mark and updated bench mark data

The number of the point	Updated distance (m)	Original distance (m)	Discrepancy (m)
463	9,98	9,76	- 0,22
	4,44	4,51	0,07
	2,84	3,04	0,20

The number of the point	Updated distance (m)	Original distance (m)	Discrepancy (m)
	3,04	2,84	0,20
525	3,93	4,15	0,22
557	2,82	2,96	0,14
560	5,91	5,84	- 0,07
	8,04	8,14	- 0,10
	12,82	12,73	0,09
561	9,62	9,70	0,08
564	4,32	4,97	0,65
	6,90	7,58	0,68
	9,38	9,60	0,22
	10,32	10,43	0,11
569	3,87	3,78	- 0,09
	8,63	8,79	0,16
	10,00	9,71	- 0,29
570	1,74	1,88	0,14
	8,40	8,53	0,13
574	4,50	4,43	- 0,07

3. RENEWING STUDIES OF GEODETIC NETWORK

Obtaining the digital mapping data forms the bottleneck in the process of establishing the analytical cadastre. Several basic sources exist for obtaining such data: field measurements of land boundaries; digitizing existing maps; and processing the existing surveying data (Fradkin, K., Doytsher, Y., 2002). In our study area, by fallowing process steps as fallows, reconstruction of geodetic network of property cadastre was realized. These studies;

- Renewing process of reference marks of traverse stations established during property cadastre as a consequence of evaluating original measurement drawings with application data. To do this;
  - Determining stable stations currently available both measurement drawings and ground,
  - Testing compatibility of stable stations and measurement stations,
  - Determining the details capable of being reference mark in measurement drawings and having measurements directly to traverse stations.
  - Determining the details capable of being reference mark and not performed a length measurement to a traverse stations but being possible to calculate this length,
  - Determining final stable stations capable of being reference mark, and preparing final witness point reports,
  - Constructing new ground stations using new witness point report,
  - Final controls, and making definite ground positions of traverse stations using witness point reports;

- Using these newly prepared witness point report, constructing ground stations of traverse points,
- Preparing exact witness reports of traverse points having new ground stations using nearby details,
- Determining new traverse routes (former traverse net formed during property cadastre was considered in this stage),
- Performing and controlling length-angle measurement of traverse net,
- Constructing geodetic network in the study area by forming measurement routes depending on current triangulation and traverse points at UTM modified for Turkey,
- Performing control measurement (parcel, building and detail measurement), and forming final traverse witness point drawings were realized.

Coordinates of traverse stations constructed again in the ground are determined based on triangulation points formed in 1995 by Cadastre Organization via GPS measurements (Demir, etc. 1999). In forming traverse net, it was given special attention to forming same traverse net formed formerly during property cadastre as far as possible because of its easiness of control and calculation. After 23 traverse routes were formed considering mentioned criteria, modified UTM coordinates of a total of 149 traverse points were calculated. Ground construction of 11 traverse route out of these were performed with the help of former measurement drawings, and by performing new length-angle measurements their coordinates were calculated in the end of traverse net calculations. For other 12 traverse points, by using property cadastre data and newly collected data together, and with different alternative techniques, coordinates of traverse points were obtained. In exceptional situations, modified UTM coordinates of traverse points were calculated using common points determined parcel based or alternatively in a restricted area. As a consequence of this, 65% ground construction of traverse points in study area were made by evaluating measurement drawings of property cadastre and land. Thus, 90% of traverse stations of property cadastre were transferred into modified UTM system at the end of traverse calculation process. Features of newly formed traverse stations are presented in table 6.

Table 6: Data caracteristics of geodetic control points reconstructed in pilot region

Geodetic control points					
Bench marks			Coordinates, in national coordinate system		
Renew from current cadastral archive data	Not renew from current cadastral archive data	Total	Recalculated from current cadastral archive data	Calculated with coordinate transformation	Total
% 65	% 35	% 100	(%) 90	(%) 10	% 100

3.1 The Geodetic Control Points Test Result in the Pilot Region

Using parts of data in the selected district the suggested method was implemented and the obtained results are shown Figure :3 ,as follows(existing cadastre coordinates are labeled as k, the coordinates newly measured on suggested method as L.)(Demir, O., Bıyık, C. 2001).

Parcel boundaries, buildings and other details were measured in the field and their coordinate calculated from current cadastral archive data in national coordinate system. Then the obtained coordinates were compared. Table : 7 shows the average mean errors for a number of 125 points.

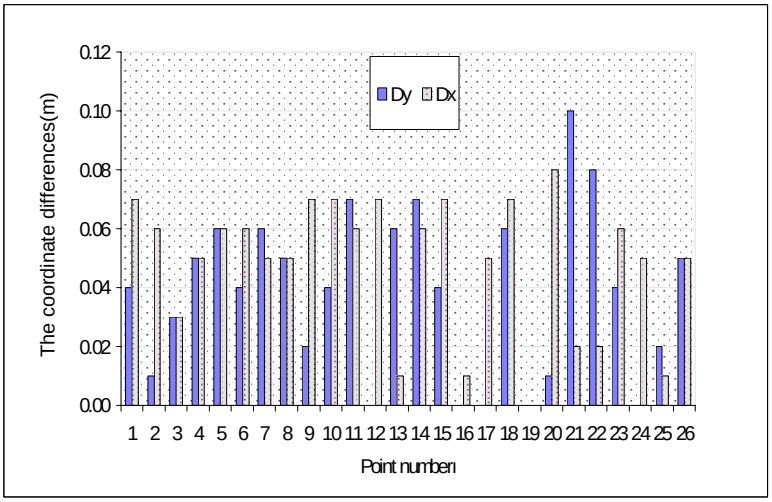

Figure 3: Differences between K and L type coordinate in Hızırbey Quarter

Table 7: Mean square errors of K and L type coordinates in pilot region

District	Method	m_y(m)	m_x(m)	m_p(m)	Point number
Hızırbey	Suggested	0,03	0,04	0,05	125

As can be seen in this table mean point error is mp=+/- 0.05m. Given this test results we can use this suggested methods to form the digital cadastre bases from current cadastral archive data, surveyed with ortogonal method, in national coordinate system.

4. CONCLUSION

Lost geodetic control points on the ground, insufficienct or unupdated surveying bench mark data are run into the practicers in applying the cadastre maps to the ground as a big problem. It has been resulted from this study that in the areas whose cadastres were made with orthogonal surveying method, the Geodetic base can be reestablihed on the ground with using surveying sketch of the original property cadastre.

Digital cadastre bases must be accuracy and updated for Cadastre-Based Geographical Information Systems. In the areas whose cadastres were made with orthogonal surveying method, measuring surveying value of the every lot makes the property cadastre data usable inside error boundaries in graphical meaning. When the property cadastre data are taken into account as graphical lot by lot, there are differences between ground and surveying plan that exceed error boundaries. But when we begin to give coordinates from property cadastre

geodetic control points data to the corner points of the cadastral lot, transitions, rotations and edging problems are resulted in the lots that do not have problems as graphical. In such areas, the data of the orijinal surveying plans and the newly-built ground control points can be built accurately in national coordinate system again by using the recent technology. In that way, the digital cadastre bases can be rebuilt in national coordinate system by using the surveying skecth of the property cadastre.

Transforming current cadastre data to digital form with transformation parameters formed in different scales is known as the method that is generally used in the steps of building cadastral bases. At this point, at last of our studies the method that we have suggested firstly to generate digital cadastral bases in the areas whose cadastres were done by orthogonal surveying method has been determined as the most convenient method to form a cadastral base that is reliable and accurate to use.

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BIOGRAPHICAL NOTES

Osman Demir is a research assistant at the Karadeniz Technical University (KTU), Turkey. He graduated from the Department of Geodesy and Photogrammetry Engineering at KTU in 1989. He received his MSc degree with thesis "An investigation on the current statues of the river basins ownership" in november 1993. He recieved his PhD degree with thesis " Forming the bases of cadastre information system in the area its cadastre was done on the orthogonal method" in september 2000. His research interests are cadastre and cadastre information system.

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