CHAPTER 7

A Case Study: IMPLEMENTATION AND TESTING OF LARES

7.1 Introduction

As expressed by Taylor (1991), the correctness of a program when applied to its implementation is not a two-step process, and incorrect program does not suddenly become correct. The reliable implementation of a program, relatively a model, is achieved through a number of stages. According to Taylor (1991), these stages are:

- correct algorithm design,
- successful compilation and execution,
- production of correct results from valid test input data,
- correct behaviour from invalid input data,
- correct results from every possible combination of data,
- acceptance by end users.

For these, the entire functions of LARES were implemented and tested with a case study. Data processing throughout the LARES was illustrated with the examples of large scale maps. However, this chapter describes the qualification of the developed prototype model with a case study.

As a case study, a developing country which practices a land readjustment process was considered. Due to its rapid urbanisation and the present issues with the land readjustment system, Turkey was selected. Following the outline of Turkish land readjustment system, a pilot project area was described. The value-based model was applied to this project area. Finally, the results are discussed.

7.2 Implementation concerns

In chapter 2, the concept of land readjustment method was outlined with some of its present applications. Then, based on the technical matters of the method, a new value-based land readjustment model was described in chapter 3. In order to see the effects of such a model, it is so obvious that to implement the entire process is essential. Therefore, the developed prototype model was applied to a pilot project area. The description of the project area is given under section 7.4.

Following the required data installation, the prototype model was implemented for the selected project area. During the implementation, the LARES menu was redesigned and possible algorithms redefined. The linkages of execution files were tested. The testing of programs or procedures that directly manipulate spatial or textual data is achieved by using carefully selected test data sets, and checking results.

Another implementation concern is to show the applicability of the model for the developing countries. As explained by Doebele (1982), financial and technical limitations badly affect the urban land developments in these countries. However, as mentioned in the earlier chapters, the land readjustment method has many advantages to deal with the urban developments. On the other hand, land readjustment would also provide an opportunity for the establishment of a LIS in these countries, because with the method, the existing land tenure system can be changed and a new designed scheme is applied. During this process, a large amount of land-related information is newly created in a cadastral parcel base.

To see these possibilities, the Turkish land readjustment system is discussed with respect to a selected pilot project area. Among the developing countries, Turkey is selected because of the practice of the compulsory cadastral system and land readjustment process. Therefore, a previous land readjustment project which was carried out with conventional methods was examined. The developed model was applied to the same project area then the results were compared.

7.3 An overview of Turkish land registration system

7.3.1 General

Turkey is a country between Europe and Asia with 57.2 million population and 779,452 square kilometres. Population density is 73 persons for per square kilometres. Almost 61% of the people are living in urban area. (The Economist, 1992). According to 1988 figures, annual population growth is 2.1% in Turkey (EC, 1991).

Turkey has a republic system. The president, as head of state, is elected by parliament for seven years. The cabinet, headed by the prime minister, is appointed by the president. The one chamber Meclis (Grand National Assembly) has 450 members directly elected for five years. The local governments are also elected for five years, including city councils.

7.3.2 The cadastral system in Turkey

The root of the Turkish land registration system goes back to the age of Ottoman Empire. According to the archives which are kept by the cadastral head office, first land registration book is compiled in 1534, during the time of Magnificent Suleyman (Uzel, 1982). As in all other fields, the new changes were made in the system with the foundation of the Republic of Turkey in 1923. The Swiss Civil Code was primarily adopted in 1926. Based on the Swiss Cadastral System, the first regulation of land registration was acted in 1932. With this regulation, the modern cadastral system was adopted and the land registration became compulsory. In 1987, the regulations for the land title registration were enacted with respect to new developments.

Since the first cadastral law was legislated, almost 57% of the entire territory was registered by the cadastral offices. Cadastral maps at 1/ 1000 and 1/ 5000 are produced by using both the Geodetic and Photogrammetric methods. However, 86% of urban areas was completed and cadastral maps were produced at scales 1/ 1000 and 1/ 2000. The standard Topographical maps at 1/ 5000 scale is produced by both organisation General Commands of Map and General Directorate of Land Registration and Cadastre (Unal, 1990).

The land registration procedures are carried out by the Directory General of Land Registration and Cadastre under the related law and regulations. There are two main components for the cadastration. These are land registration book and cadastral map. Each surveyed land parcel is demarcated on the ground and mapped. Then, the land rights and ownership information are recorded on the registration book with a unique parcel ID. This ID provides the linkage between the registration book and cadastral map. After the registration of a land parcel, landowners receive a land title and use its property rights under the protection of the constitution.

In Turkey, the cadastral surveys are carried out by the public sector only. In recent years, the involvement of the private sector is being examined with the pilot project studies. The land registration process is done and updated manually. The use of computer aided surveying and drafting systems for the production of digital maps was started in 1986. In the province of Izmir, the computerisation of the land registration processes has began under a pilot project. It is expecting to extend this project to other provinces to establish a base for the national land information system.

7.3.3 Land acquisition methods and issues

As a result of rural-to-urban migration, urbanisation problems are created by rapid population growth in Turkey. Like many other developing countries, these problems have exerted a negative influence in the fields of human settlement and regular urban development. To provide these, land is acquired and developed with respect to master plans in a five year period.

Since the cadastral parcels were registered with their existing layouts, the implementation of zoning plans has became difficult in technical, economical and social senses. It is technical because most of the parcels were irregularly shaped. It is economical because of the budget limitations for land expropriation and developments. On the other hand, social issues have arisen when private landowner is compensated by the government. Landowners claim that this impairs the property rights of private land which are under the protection of the law.

The limitation of financial, human, and technical resources mostly restricts land development options. The government therefore has difficulty in controlling rural-to-urban land-use change to provide the appropriate land for both public and private sector requirements (Biyik and Uzun, 1990). Thus, as expressed by Dale and McLaughlin (1988), many squatters have established patterns of land use rights that operate outside of the national cadastral system. The land allocated for public-use has been partly occupied by squatters.

In order to provide urban land needs, some land acquisition methods are practised by the government. The objectives of these methods include the provision of basic public services and other aspects of infrastructure to urban areas undergoing development. However, most of the land-related developments are carried out by municipalities using master schemes and zoning regulations (Gurler, 1983).

The rapid urbanisation requires readily built-up areas in suburban areas. Hence, the provision of sufficient new lots, streets, roads, green areas, play gardens and parks are the main objectives of local land planning authorities. Controlling these urban land developments, three different land acquisition methods are basically performed by specific acts (Akyol and Tudes, 1987). These methods are;

(1) Land compensation method
(2) Voluntary method
(3) Land readjustment method

7.3.3.1 Land compensation

When the government urgently needs the land for public constructions, such as building a new highway, hospital, school, opening new green spaces, the compensation method is basically applied. All compensation procedures including land valuation are done in accordance with The Compensation Act, which was enacted in 1983 (Yildiz, 1987).

The compensation method can be practised by any government department. As long as they prove that land is needed for public use, they can make any compensation decisions. These decisions must be approved by the city council. Landowners who have any property in designated areas are then informed about the compensation decision. These procedures are followed by other steps which include land survey, assessment, payment and registration. At the end of the process, the determined value is directly deposited in the landowner's bank account. However, in many cases, landowners object to the amount of compensation that in offered. They always argue that the determined value does not reflect the real value of their property. This has always resulted in prolonged litigation in courts of law (Akyol, 1987).

From the government perspective, the compensation method provides a practical solution to land acquisition, because it is a short-cut method that is easy to implement by the force of the act. Although the compensation method has great advantages for government, there are also some disadvantages with the method. Table 7.1 illustrates some of the advantages and disadvantages of the method.

Advantages • Land compensation is a rapid land acquisition method for government in urgent land provision, • The government has great power making decisions by the Act. This accelerates the land-acquisition process and project time positively, • The method is more efficient in small land development projects.
Disadvantages • Compensation is an expensive method for the government, • A readily available budget is always required, • It is a mandatory land-acquisition process which uses legal force. In many cases, landholders are not happy with the decision about the compensation for their land, • The process causes land valuation disputes between government and landowners. This delays the implementation of project, • Land speculation occurs in project areas.

Table 7.1 Advantages and disadvantages of land compensation

7.3.3.2 Voluntary Method

The voluntary land acquisition method is usually applied when a landowner wishes to obtain a construction permit, for example he wants to build an house. The basic principle with the method is to re-demarcate existing cadastral parcel boundaries according to the rules of zoning plans. In regard to zoning requirements, the suitability of a cadastral parcel is examined by the municipalities. If the checked land parcel does not provide the requirements, then the landowner should find out some alternative solutions to provide zoning requirements. In this case, there are a few options that can be followed by landowners in order to obtain have a construction permit. These options are as follows:

i) Private subdivision: If an existing cadastral parcel is adequately large, a special subdivision can be performed with respect to zoning requirements. A cadastral parcel is subdivided into two or more suitable new lots. During the subdivision, land which covers the public use area is contributed to public use. Subdivision procedures are carried out by a private surveyor. In order to register the new site lots, subdivision plans and all other related documents must be checked and approved by both the cadastral office and the municipality.

ii) Consolidation: When land parcels do not have sufficient area for the plan objectives, land holders can consolidate their parcels with adjoining land parcels. Before the consolidation of these parcels, an agreement between the interested landowners is required. It may not always be necessary to consolidate all the adjoined parcels entirely because some portion of land may be satisfactory for the zoning requirements. It should also be considered that after the consolidation, the rest of the consolidated parcels should certainly allow for further development.

iii) Boundary Exchanging: If an existing land parcel has an irregular shape, adjoined cadastral parcel boundaries can be re-demarcated or some land portions can be exchanged between landowners. The boundary demarcation and land exchange are done by the agreement of interested landholders only. Adjacent landowners make an agreement that their land parcel shapes can be modified, in order to give a regular shape to land parcels. If the agreement is satisfactory, then technical procedures are carried out only by the cadastral office, with no fee.

The voluntary method has also some advantages and disadvantages for land development process. These are given in Table 7.2.

Advantages • Voluntary method is inexpensive land-acquisition way for government, • Instead of the government, individual landowners are more actively involved in the land development process, • New site lots for housing purposes are produced, • A cadastral parcel is transferred to a site lot so that the legal position of the parcel changes. This increases tax revenue, • The government obtains land required for public use freely, without any compensation.
Disadvantages • It is a time-consuming approach to the land development process for a large project area, • The method works when a landowner needs a construction permit only, • Landowners are under an obligation that if the existing parcel covers a public-use area, the covered portion of land should be dedicated to public use. This results to lost of revenue to landowners, • Land exchanges between the owner require a legal agreement.

Table 7.2 Advantages and disadvantages of voluntary method

7.3.3.3 Land readjustment

Land readjustment is another land acquisition method that has more advantages when compared with the other land-acquisition methods. Due to the implementation difficulties with the other methods the government tried to set a more powerful and practical solution to the land development process by an act. In 1985, therefore, the Land Readjustment Act was passed in Turkey. It was the hope that, with this Act, the implementation of the zoning plans will be operated more effectively in the expanding project areas.

7.3.4 Land readjustment system

The first Land Readjustment Act was adopted in 1963. Then, in 1985, it was enacted with some new technical and administrative arrangements. The basic principle of the Act is that the local government has complete authority to apply the zoning plans within their district without the consent of owners. The main title of the Act which is no.18 states that landowners who have any parcel in the project area have to give up 35% of the total area of their land for public use. This percentage depends on the size of public area required including new roads, streets, green areas, play ground, religious places, parks and building area within the project area (IK,1985).

The Land Readjustment Act and related technical regulations guide the implementations. Before the beginning of such a project, all cadastral works and zoning plans should be completed in the project area. The city council then makes the implementation decisions on the project. The final project area is determined and voted by the council members. If the project is approved, the decision is announced publicly. The cadastral office is also informed about the project, so that any interested people are notified about the project during the cadastral transactions. No construction can take place within the project area until the rules have been fulfilled.

After the council decision, all required technical and non-technical procedures are carried out by the municipality. Following the land surveying, the basic calculations are made to determine the final distribution figures for the parcels. Then, land subdivision and reallocation are performed. The new layout plan and distribution tables are publicised for a month. During this period, landowners can make their objections. Following the consideration of the objections, the planning committee makes their final decisions. The new plan is then approved and the new parcels are registered by the cadastral office. The new land titles are prepared and posted to original landowners. Finally, the municipality begins the construction of the basic infrastructures in public areas.

According to a survey (KTU,1990), since 1985, area with 10,800 hectares has been developed by land readjustment process in Turkey. Figure 7.1 illustrates these project areas in the country. On the other hand, since the first land readjustment programme was enacted, some projects were found to be unsatisfactory or were not completed on schedule. The limitation of budget, poor land information management, and lack of public support have prevented some projects from achieving their objectives. Significantly, there have been many objections from landowners about the reallocation process. Particularly, the reduction of original land size and the changing of location have been the main issues in the project areas (Akyol, 1987). Some of these issues can be outlined as follows:

(a) Issues for landowners

In many cases, most landowners do not support the land readjustment project. They are aware of the fact that some parts of their land will be forfeited for public use without any compensation. However, some of landowners whose land is already fragmented and more or less useless do support land readjustment to gain from the project benefits.

(b) Issues for the municipalities

The municipalities have the greatest responsibilities throughout a land readjustment project. However, because the city council has power to allow the land readjustment applications, some projects can be delayed or cancelled for political reasons. Because the large number of people who are living in a project area can affect the local election results, therefore, the elected council members may not be positive about the implementation of the project. For this reason, the land readjustment projects fail very often, especially in small and non-powerful municipalities.

A part from the political reasons, the municipalities have also some technical issues with the project. In most cases, available municipal resources such as technical persons, budget, and equipment are not sufficient to carry out such a project. Due to the complexity with process, the availability of professional people is very important.

(c) Technical issues

Land value does not play a role in the calculation of the percentages to be contributed by each landowner for public areas. The only criterion is the parcel size, and the contribution factor is the public-use land area required in the zoning plan. This single coefficient is calculated and applied to all landholders in the project to derive their contribution to the public land. There is no parcel appraisal, before or after the project. The area method, instead of valuation, does not provide an equitable approach for the landowners, because many other factors which affect a parcel value, are ignored.

Analysing the cadastral information, searching needed records and providing necessary outputs are done with conventional manual methods. Sometimes, the information is not readily available for later use because of poor information management. Thus, following the procedures is a complicated task which requires great talent. The use of computers has not been introduced to the entire process yet.

Particularly, the land reallocation procedure has not been standardised. Therefore, the planners often have difficulty in making a decision about the new parcel locations. The parcel boundaries are changed and landholders are moved to new locations by the planner's judgement only, so that the planners make their own decision upon land distribution, as if they are the only ones responsible for the land reallocation and distribution. This also affects the landowners because different approaches provide different land locations and benefits to them.

As a conclusion, land readjustment is a powerful and economical way to acquire urban land in Turkey. But still some problems exist. To deal with these problems, a careful analysis of spatial characteristics of the land, notably economic, social, and planning aspects is required. With respect to these aspects, a new approach to land readjustment, which particularly deals with the land valuation process, would improve the functionality of the method.

7.4 The study area

Although land readjustment is a popular device for local governments for subdividing raw land in Turkey, small cities frequently do not implement many land readjustment projects, since demand for land is not very high.

Large metropolitan areas implement the process more frequently in the urban-fringe. The sample area was however selected from one of these urban-fringe areas. Ideally, the selection of several cities would have been preferred. But it has been limited to evidence in one project area because of a limited budget and time.

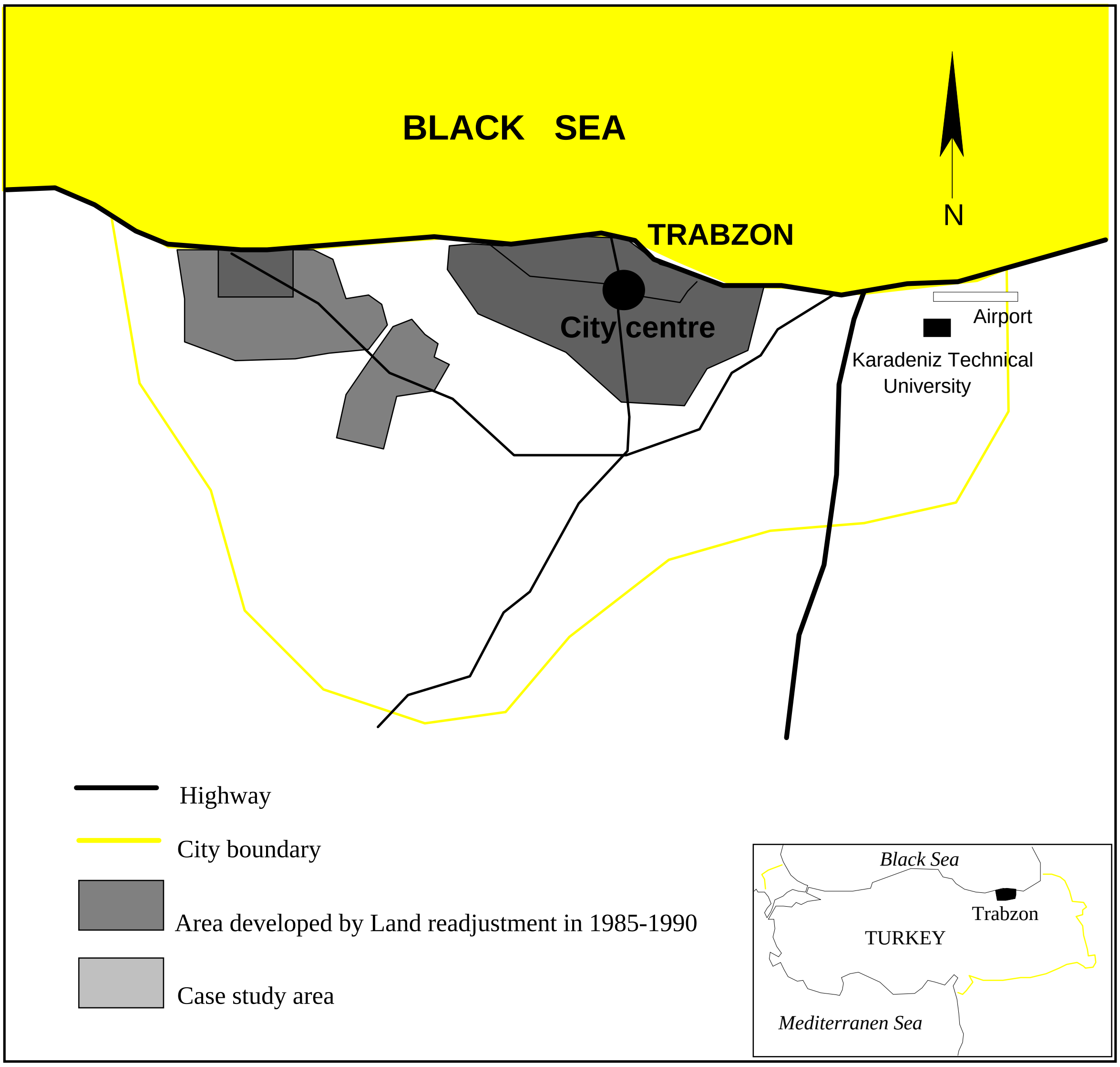

Figure 7.2 City of Trabzon

The sample study area selected for this study is in the city of Trabzon which is located on the Black Sea coast. It is an harbour city which provides the import and export requirements of the north-east part of Turkey. The city has a population of 100,000 and rough topographical characteristic. Since 1985 almost 500 hectares area has been developed by land readjustment process (KTU, 1990). The particular project site which illustrated in Figure 7.2 is an area with 700x700 meters in the west part of the city. Urban expansion occurs from the city centre to the western side because of topographical limitations in the other parts of the city.

7.5 Data gathering

The type of information which could be useful for the study was collected in Turkey. The present zoning and cadastral maps and other relevant information to this study area were collected from the municipality of Trabzon. Data sources were available in 1:1000 scale. However, some required data were not available. Such maps soil, environment, available utilities etc. were created during this study.

The cadastral map shows the legal position of current land parcels, buildings, parcel IDs, and existing roads. The zoning maps on the other hand represent the combination of several maps such as topography, land-use, thematic map. The new land development plan is also drawn on the zoning maps. Basically, new site block patterns with designed roads, green areas, and public buildings are shown in the zoning map. The zoning codes are also given on the map.

7.5.1 Digitising of required map layers

Since geoprocessing requires information to be in digital format, existing maps were converted into digital format using the process of hand digitising. Since digitising facilities were not available for ARC/ INFO, AutoCAD was used to capture the data in digital form.

In Turkey, digital data are not available. Therefore, the map sheets were collected as blueprint copies. So, all required data layers were stored as vector data. Land parcels, site blocks, buildings and other polygonal areas were represented with closed chains of straight line segments. Linear features such as roads, contours, streams were recorded as *x,y* coordinate pairs of pivot points linking short straight line segments.

7.5.2 Data transfer from AutoCAD to ARC/INFO

Using AutoCAD, the required data on a map sheet were digitised under different map layers but saved as a single file. To use this data file in ARC/ INFO, first the AutoCAD file was converted into DXF format. The conversion of the AutoCAD file into DXF format was performed as follow:

```
Command: DXFOUT <file_name>
```

Following this command a DXF formatted file with **file_name.dxf** is created. Then this file is loaded into a project directory. Using ARC/ INFO, **DXFINFO** command is performed. This command reads any DXF formatted interchange file and displays information about the file. It lists all the layers in the file, the kinds of features contained in each layer, and length of character strings that may be converted into attributes or text strings of annotation. Then, **DXFARC** command is performed to convert an AutoCAD map layer to ARC/ INFO map coverage. When this command is issued, a dialogue is initiated and the layer names are entered interactively. However, it has be noticed that if a single layer wants to be converted to a single coverage, **DXFARC**command must issued for that layer only. Otherwise, all AutoCAD layers are combined in a ARC/INFO coverage.

A sample example use of **DXFARC** where the conversion parameters are specified through interactive dialogue is given below.

```
Arc :  DXFARC  CADASTRE.DXF CADASTRE.COV

Enter the layer names and options (type END or $REST when done) :
=========================================================
Enter the 1st layer and options: PARCELS
Enter the 2nd layer and options: END

Do you want to use the above layers and options (Y/N)? Y

Processing <SUPPORT>AI50>DXF>CADASTRE ...
Externalling BND and TIC...
      426  Arcs written.
       58  Labels written.
        0  Annotation written.
        0  Annotation levels.

Arc :
```

7.5.3 Topology creation

Before the spatial analysis, a correct topology must be provided for the available coverages. To create the topology, **CLEAN** command is issued in ARC/ INFO. This command builds polygon and arc-node topology by performing a geometric analysis on the coverage arcs and label points to identify coverage nodes and polygons. During **CLEAN**, two or more arc coordinates within the fuzzy tolerance of each other are snapped together and becomes the same coordinate point. The choice of a fuzzy tolerance is important because it affects the resolution of the output coverage. For this study, the fuzzy tolerances were determined according to the resolutions of the input coverages. The following **CLEAN** command was issued for a cadastral coverage to correct the topology.

```
Arc : CLEAN CADASTRE CADASTRE 0.02 0.02 LINE
Arc : CLEAN CADASTRE CADASTRE 0.02 0.02 POLY
```

The coordinate precision of output coverage is determined by the current processing rule as set by the **PRECISION** command. If the processing rule has not yet been established using **PRECISION** during current ARC/INFO section, then the processing rule will be HIGHEST. This means that **CLEAN** will create an output coverage in the same precision as the input coverage.

7.5.4 The correction of topology errors

To check out the topology whether it was built correctly or not, **NODEERRORS** and **LABELERRORS** commands are issued. **NODEERRORS** detects and lists all nodes of a coverage that represent potential errors. This command lists the information on type of node error, node number, and its *(x,y)* coordinate location. If a coverage being evaluated has no node errors, the following report must be received.

```
Total number of Dangling Nodes:  0
Arc :
```

On the other hand, **LABELERRORS** is used to identify label point errors for polygons. This command lists all polygons which have either no label points or more than one label point. If more than one label point is found in a polygon, the `User-ID` of each label point is listed. If a coverage being evaluated has no label errors, the following report must be received.

```
Polygon 1 has 0 label points
Arc :
```

If any errors are detected, both label and node errors are corrected by using editing facilities in ARCEDIT. After editing, the coverage topology is recreated. These editing and topology recreation procedures are repeated until node and label errors are provided in correctly.

7.5.5 Input of descriptive data

Besides the graphical information, additional information need to be specified for the special analysis. For example, the zoning codes such as permitted construction area, minimum street frontage, permitted number of floors for the site blocks should be represented with the coverage.

When topology is constructed for a coverage the corresponding feature attribute table is automatically created. This is a tabular data file storing standard attributes about the features such as area, perimeter, coverage-ID. It is also possible to add any additional information to a tabular data file by joining with different data sets. To add new attributes for each feature the following procedures were followed:

(1) Creating a new INFO data file to hold the attributes,
(2) Adding attribute values to the INFO data file,
(3) Joining the INFO data file to the feature attribute table for the coverage.

To add additional attributes to the feature attribute, another INFO data files were created to hold the new attribute values. These INFO files were named with corresponding coverages and LUT extension, such as *ZONING.LUT*. To create such a table, first an INFO file should be defined including its item names and formats. Then, the attribute values were added to the newly created INFO data file by typing them directly into the file. Appendix C shows an example of how the *ZONING.LUT* was created. The other LUT tables which were used in this study are also given in Appendix C.

The newly added attribute values to the INFO data file were attached to the feature attribute table for the coverages using common item. This is a joining process of two different tabular data files that is performed as follow:

```
Arc :  JOINITEM <in_file> <join_file> <out_file>
         <relate_item> <start_item>
```

7.5.6 Formulation of land parcel IDs

In Turkey, land parcels are coded with unique parcel IDs during the land registration. The ID coding for a parcel is based on the following procedures:

Parcel ID *= Name of city + Name of district + Block no + Parcel no*

An example of parcel coding system is illustrated in Figure 7.3 In this case study, a new type parcel coding system was used rather than using the current parcel IDs.

After the topology creation unique coverage-IDs are created for each land parcel. Based on these IDs and the block numbers, the new land parcel numbers were determined automatically by the system with following commands:

```
Arc : ADDITEM CADASTRE.LUT CADASTRE.LUT O-PARCEL-ID 15 15 N 5
Arc : TABLES
Tables :  SELECT CADASTRE.LUT
Tables :  CALCULATE  O-PARCEL-ID = (( BLOCK-ID * 100000 ) +
CADASTRE-ID) / 100000
Tables :  Q STOP
Arc:
```

End of this calculation, for example, a land parcel is represented with following form:

```
O-PARCEL-ID =  502.00018
```

In this representation, the first three digits represent the block number and rest of it represents the sequence number of parcel within the coverage.

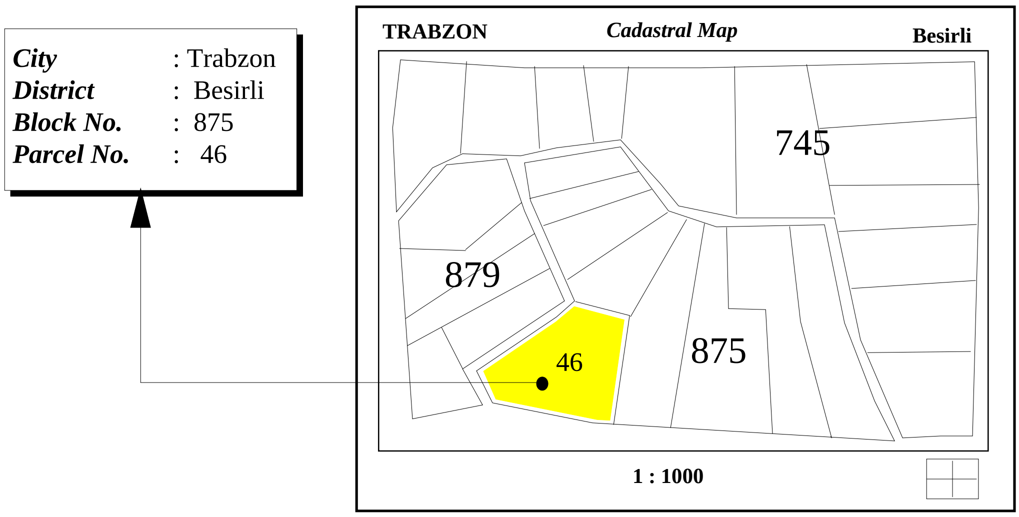

Figure 7.3 A land parcel identification

7.5.7 Exporting of input coverages

Before running LARES, the workspace should be emptied. Therefore all input coverages with their attribute tables were exported and stored under different file names in LR_COV directory. This is one of the requirement of LARES in order to control data flow during the process. So, after the topology creation and descriptive data input, the following commands were issued before the full process of LARES.

```
Arc :  EXPORT COVER ZONING CASE1.ZON
Arc :  EXPORT COVER CADASTRE CASE1.CAD
Arc :  .......
Arc :  EXPORT COVER CONTOURS CASE1.CON
Arc :  &system mv case1.*.E00  ~/gis/project1/LR_COV
Arc :  KILL ZONING ALL
Arc :  KILL CADASTRE ALL
Arc :  .......
Arc :  KILL CONTOURS ALL
```

7.6 Data Processing

Using LARES, the value-based land readjustment process was implemented for 185 cadastral parcels with 430,834 square meters (Figure 7.4). These parcels were reallocated within 68 site blocks. During the implementation some other new coverages such as slope, view, old and new network were derived from the input coverages. More importantly, the performance of LARES was tested and land related information was resulted. The entire procedures of this case study are presented in Appendix F. All related information such as input coverages, data, land subdivision, valuation analysis and outputs are also included to Appendix F. However, following sections give summary information related to the main modules of LARES.

7.6.1 Creation of new site lots

Based on the zoning coverage and its related attribute tables, the new subdivision coverage was created. After the first implementation of land subdivision program, some land parcels were edited to satisfied the zoning requirements. The main idea during the land subdivision was to produce the maximum number of new land parcels with respect to zoning restrictions. The new land parcel-IDs were also created similar to cadastral parcel-ID creation process which explained in section 7.5.6.

Figure 7.5 shows the input zoning coverage for land subdivision. Figure 7.6 represents the output coverage after the implementation of land subdivision process. The output coverage were considered as the final layout of the project area. This coverage which names as CASE1.LOT coverage was used as input coverage for land valuation analysis.

7.6.2 Land valuation analysis

Land valuation analysis was implemented for both cadastral and lot parcels. Different number of land valuation factors were selected to analyse. The results which named with the corresponding factor code IDs were stored under the LR_RES directory. These results represents the each selected land factor values for the land parcels. These factors were evaluated out of 100 with respect to their formulas. The factor weights were also considered during the calculation.

Figure 7.4 Cadastral coverage

Figure 7.5 Zoning coverage

Figure 7.6 Subdivision coverage

7.6.3 Determination of parcel values

For the implementation of the model, only 17 land valuation factors were examined because of computer memory limitations. The 15 of these factors were used for the evaluation of the old cadastral parcels and another combination with 15 factors were also used for the evaluation of the new lots. These different factor groups are given as follows;

No	CODE	USED VALUATION FACTORS	BEFORE	AFTER
1	001	ENVIRONMENT	*	*
2	002	SUPPLIED BASIC SERVICES	*	*
3	003	LANDSCAPE, VIEW	*	*
4	004	DISTANCE FROM NUISANCES	*	*
5	005	LAND PARCEL SHAPE	*	*
6	006	DISTANCE FROM NOISE	*	*
7	007	AVAILABLE UTILITIES	*	*
8	008	PERMITTED CONSTRUCTION AREA		*
9	009	ACCESS TO STREET	*	*
10	010	CURRENTLY USABLE AREA	*	*
11	011	STREET FRONTAGE	*	*
12	012	PERMITTED NUMBER OF FLOORS		*
13	013	DISTANCE TO CITY CENTRE	*	
14	014	SOIL CONDITION	*	*
15	015	DISTANCE TO SHOPPING CENTRE	*	
16	017	PARCEL LOCATION WITHIN BLOCK	*	*
17	018	TOPOGRAPHY	*	*

Using the results of these factor values, the nominal asset values of the land parcels were determined by equation [3.2]. Then, the final value figures were calculated as explained in section 5.5.3. The initial implementation outputs for the project area are presented below.

```
Total value before the project =  28,496,489  units
Total value after the project  =  31,041,087  units
The readjustment coefficient (z) =  0.918025
```

7.6.4 Distribution of new land parcels

Following the determination of parcel value, the cadastral land parcels were distributed with respect to their calculated nominal values. As explained in section 5.5.4, the value of old and new land parcels were compared in order to reallocate the cadastral parcels within the new lots. The general information about input and output parcels are given below.

```
===============================================
Input parcels  = 185
Output parcels = 506

382 parcels ; with  1  owner(s)    ( 75.5 % )
 83 parcels ; with  2  owner(s)    ( 16.4 % )
 29 parcels ; with  3  owner(s)    (  5.7 % )
  8 parcels ; with  4  owner(s)    (  1.6 % )
  2 parcels ; with  5  owner(s)    (  0.4 % )
  1 parcels ; with  6  owner(s)    (  0.2 % )
  1 parcels ; with  7  owner(s)    (  0.2 % )
===============================================
```

7.6.5 Final reports

At the end of the full implementation, the distribution results were reported as the final outputs. These outputs contain the information about the parcels including their old and new land parcel-IDs, assigned values, share percentages, etc. Some of the results of this case study are presented in Appendix F. However, an example for the land parcels in the site block no.111 is illustrated in Figure 7.7.

7.7 Assessment of the implementation

To test the performance of LARES a land readjustment project area of 430,834 square meters with by 185 land parcels was examined. Data processing was began with digitising of the property map, the land-use plan, topographical maps and other required map layers. Land ownership records were also included in the database. Then, 68 site blocks were subdivided into 506 land parcels according to the plan's rules. The total area of the new land parcels is 247,400 square meters. Because of the nature of the land readjustment concept, the total area of old land parcels was reduced to 247,400 square meters with the process. In another words, 183,434 square meters of public-use areas were gained by the contribution of the landowners and reserved for public-use after the project. The rest of the land was then redistributed among the involved landowners.

The total value for the project area was estimated as 28,496,489 units by 15 land valuation factors in the post-project phase. These units were distributed to the landowners with respect to the their calculated old nominal asset values.

In Figure 7.7, for example, the land parcel no.14 within the block no.103, had a total of 306,635 units value before the distribution as a single parcel. With the process this total value was reallocated within five new site lots. These lots are no.36-41 within block no.111, and lot no.87-90-118 within block no.248. It must to be noted that after land distribution some new lots such as no.41 in the block no.111 can be shared by more than one landowner. This occurs because the limits of a new parcel size are given by the zoning plan that must be followed.

Figure 7.7 Land distribution for a site block

103.00014	*5*	*111.00036*	*111.00041*	*248.00087*	*248.00090*	*248.00118*
306634.98	*v*	*75214.16*	*29068.04*	*56723.69*	*45772.65*	*99856.43*
% OLD -->	*%*	*24.53*	*9.48*	*18.50*	*14.93*	*32.57*
% NEW -->	*%*	*100.00*	*38.66*	*100.00*	*100.00*	*100.00*
111.00036	1	103.00014	0.00000	0.00000	0.00000	0.00000
75214.16	v	75214.16	0.00	0.00	0.00	0.00
0.00	%	100.00	0.00	0.00	0.00	0.00
111.00041	3	103.00014	103.00019	106.00171	0.00000	0.00000
75183.24	v	29068.04	6805.69	39309.51	0.00	0.00
0.00	%	38.66	9.05	52.28	0.00	0.00
111.00045	1	103.00017	0.00000	0.00000	0.00000	0.00000
74910.19	v	74910.19	0.00	0.00	0.00	0.00
0.00	%	100.00	0.00	0.00	0.00	0.00
111.00049	2	103.00018	107.00170	0.00000	0.00000	0.00000
79439.51	v	34589.98	44849.53	0.00	0.00	0.00
0.00	%	43.54	56.46	0.00	0.00	0.00

7.7.1 The selection and implementation of different factors

The selection of land valuation factor is optional in LARES. When a different number of land valuation factors is selected, the parcel nominal asset values are subject to change after the project. In order to see the effects of the selection of different factors on the land distribution process, three different factor groups were applied to the same land parcels in the case study area. Table 7.3 shows the selected factor groups and related distribution results. As an example, the results of 10 land parcels are given in Table 7.4. The results shows that nominal asset values are different after the project. Figure 7.8 and Figure 7.9 illustrate the nominal asset value graphs before and after the project in accordance to the selected factor groups.

The selection of different numbers of the factors also affects the total land parcel area which a landowner will obtain after the project. Table 7.5. shows some of the land parcel sizes with the selected factor groups. The graph in Figure 7.10, indicates that there are significant differences (in square meter level) between the re-distributed land parcel sizes.

Table 7.3 The results of land distribution with three different factor groups

```
Total number of NEW parcels =   506
Total number of OLD parcels =   185


GROUP 1:

USED FACTOR ID's :  001 - 002 - 003
TOTAL of USED OLD VALUE  =     5922283.40
Initial NEW VALUE        =     7409981.71
z = 0.7992

Share Distribution...
--------------------------------------------------
    383 parcels ; with  1  owner(s)   < 75.6 % >
     85 parcels ; with  2  owner(s)   < 16.8 % >
     21 parcels ; with  3  owner(s)   <  4.2 % >
     13 parcels ; with  4  owner(s)   <  2.6 % >
      2 parcels ; with  5  owner(s)   <  0.4 % >
      2 parcels ; with  6  owner(s)   <  0.4 % >


GROUP 2:

USED FACTOR ID's :   001 - 002 - 003
                     004 - 005 - 006 - 007
TOTAL of USED OLD VALUE  =    10547366.14
Initial NEW VALUE        =    12744805.01
z = 0.8276

Share Distribution...
--------------------------------------------------
    381 parcels ; with  1  owner(s)   < 75.3 % >
     83 parcels ; with  2  owner(s)   < 16.4 % >
     34 parcels ; with  3  owner(s)   <  6.7 % >
      5 parcels ; with  4  owner(s)   <  1.0 % >
      1 parcels ; with  5  owner(s)   <  0.2 % >
      1 parcels ; with  7  owner(s)   <  0.2 % >
      1 parcels ; with  9  owner(s)   <  0.2 % >


GROUP 3:

USED FACTOR ID's :  009 - 010 - 011
TOTAL of USED OLD VALUE  =     7218810.73
Initial NEW VALUE        =     8140748.95
z = 0.8867

Share Distribution...
--------------------------------------------------
    383 parcels ; with  1  owner(s)   < 75.7 % >
     84 parcels ; with  2  owner(s)   < 16.6 % >
     24 parcels ; with  3  owner(s)   <  4.7 % >
      8 parcels ; with  4  owner(s)   <  1.6 % >
      7 parcels ; with  5  owner(s)   <  1.4 % >
```

Table 7.4 The calculated parcel unit values for the selected factor groups

Table 7.5 The land parcel sizes which landowners obtain after the project

7.7.2 Statistical analysis of the case study results

To examine the developed model itself, the case study results have been statistically analysed using SPSS-X. Basically, the following questions have been investigated.

(1) Is there correlation between the selected land valuation factor's value? If so, how are these factors are correlated to each other?
(2) When a parcel nominal asset value is determined, are there any significant differences between the selected factors?
(3) What factor or factors have most effect on the estimation of an individual land parcel's nominal asset value?
(4) What is the achievement validity of the developed model if different land parcel groups are implemented?

To answer the first question, the factor correlation matrix has been created and examined. For the second and third questions the *one-way* variance analysis has been applied to case study results. The final question was also investigated with *one-way* analysis by creating different number of data sets. The statistical analysis has been applied to the land parcels with 15 land valuation factors in both project stages, before and after. The following sections discuss the statistical analysis.

7.7.2.1 Correlation between the factor values

In order to see the relationships between the land valuation factors the correlation matrix of the estimated factor values can be examined. Based on the case study results, a correlation matrix was created with the correlation coefficients (see Appendix. H). The correlation coefficients can provide a quick way of indicating whether or not two land valuation factors are related at all in the given data and the numerical size of coefficient value reflects the amount of scatter in the data. A correlation near +1 means high values of *y* mostly occur with high values of *x*, and low with low. A correlation near *0* implies little or no special tendency for high *y* to occur with high *x*. A negative correlation arises when high *y* tend to go with low *x* and vice versa. A general limitation of the correlation coefficient is that it does not say what the relationship actually is. i.e. how *y* varies *x*. It only indicates the relative amount of scatter.

Table 7.6 represents the correlation matrix of the calculated nominal asset values before the project (n=185). According to this correlation matrix, the following land valuation factors are highly correlated (*r: correlation coefficient*);

Environment and distance to nuisance (r=0.78)
Environment and distance to noise (r=-0.53)
Environment and soil condition (r=0.77)
Environment and distance to shopping centre (r=0.58)
Distance to noise and distance to nuisance (r=-0.57)
Distance to noise and soil condition (r=0.76)
Access to street and distance to noise (r=-0.60)
Access to street and street-frontage (r=0.52)
Distance to shopping centre and distance to city centre (r=0.89)

On the other hand, according to the correlation matrix, it has been found that there is no correlation between the following factors (r<0.009):

Distance to city centre and distance to nuisance
Distance to noise and land parcel shape
Available utilities and soil condition
Access to street and soil condition
Location within the site block and topography

correlation matrix

7.7.2.2 Test of the significance on asset value

It can also be analysed whether each land valuation factor contributed significantly to the determined land parcel nominal asset value. To examine this, one-way of variance analysis was used. One-way can analyse several independent variables (in this case independent variables are land valuation factors) by one dependent variable (in this case dependent variable is the parcel nominal asset value) with one specification of the procedure.

One-way analysis, first, produces a table which shows how the selected land valuation factors are significantly different at the selected confidential level. In our example, 15 land valuation factors which have been used for the old cadastral parcels in the case study were tested at the 99% and 95% statistical confidence levels. In Table 7.7, the test result shows that most of the land valuation factors are significantly different at the 0.01 (99%) level (the '*' mark in the table indicates that there is a significant between the cross-variables).

Referring to this table, it is possible to say more about the significance of a factor. For example, there is a significant variance between the factor *street frontage* and the factors *utilities*, *noise* at 0.01 level, in favour of the factor *street frontage*. It indicates that the factor *street frontage* has had significantly higher effect on the parcel nominal asset value than the factor *utilities* and *noise*. Similarly, it can also be said that there is no significant variance between the factor *topography* and *soil condition*. This indicates that both factors have had same effect on the parcel nominal asset value.

Table 7.7 One-way test for the selected factors (before)

```
      MEAN    GROUP   FACTOR NAME               FACTOR-ID

     .3419     007  UTILITIES                   007
     .6646     006  NOISE                       006
    1.7216     011  STREETFRONTAGE              011
    2.7928     003  VIEW                        003
    4.2467     005  PARCEL SHAPE                005
    4.3292     002  MUNICIP.SERVICES            002
    4.4158     017  LOCATION IN BLOCK           017
    4.9069     015  DISTANCE TO SHOOP           015
    5.0101     013  DISTANCE TO CITY CNT        013
    5.4318     014  SOIL CONDITION              014
    5.5005     018  TOPOGRAPHY                  018
    6.5520     004  NUISANCE                    004
    6.7135     009  ACCESS TO STREET            009
    6.9463     001  ENVIRONMENT                 001
    7.3773     010  USABLE AREA                 010



THE RANGES ABOVE ARE TABLE RANGES.
THE VALUE ACTUALLY COMPARED WITH MEAN(J)-MEAN(I) IS..
        0.9814 * RANGE * DSQRT(1/N(I) + 1/N(J))

                          0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
                          0 0 1 0 0 0 1 1 1 1 1 0 0 0 1
                          7 6 1 3 5 2 7 5 3 4 8 4 9 1 0
     Mean     Factor ID's

      .3419       007
      .6646       006     .
     1.7216       011     * *
     2.7928       003     * * *
     4.2467       005     * * * *
     4.3292       002     * * * * .
     4.4158       017     * * * * . .
     4.9069       015     * * * * . . .
     5.0101       013     * * * * . . . .
     5.4318       014     * * * * * * * . .
     5.5005       018     * * * * * * * . . .
     6.5520       004     * * * * * * * * * * *
     6.7135       009     * * * * * * * * * * * .
     6.9463       001     * * * * * * * * * * * . .
     7.3773       010     * * * * * * * * * * * * . .


(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.010
LEVEL

(.) DENOTES PAIRS OF GROUPS SIGNIFICANTLY NOT DIFFERENT AT THE 0.010
LEVEL
```

One-way test also gives information on the variable groups. The analysis produces homogeneous subsets from the given variables (see Table 7.8). Each subset consist of some variables which have similar effect on the independent value. In our example, we can group the land valuation factors in accordance with their effect on the land unit value.

Based on the Table 7.8, it can be said that the *subset 7* has had the highest effect on the land unit value. In other words, the factors *access to street*, *environment*, and *usable area* have had the highest effects on the land unit value than the other land valuation factors. On the hand, the *subset 1* indicates that the factors *utilities* and *distance to noise* have had the lowest effect on the land unit value.

Table 7.8 Homogeneous subsets (before)

```
(SUBSETS OF GROUPS, WHOSE HIGHEST AND LOWEST MEANS
DO NOT DIFFER BY MORE THAN THE SHORTEST
SIGNIFICANT RANGE FOR A SUBSET OF THAT SIZE)

SUBSET  1
GROUP       007          006
MEAN        0.3419       0.6646
- - - - - - - - - - - - - - - - -
SUBSET  2
GROUP       011
MEAN        1.7216
- - - - - - - - - - -
SUBSET  3
GROUP       003
MEAN        2.7928
- - - - - - - - - - -
SUBSET  4
GROUP  005          002          017          015          013
MEAN   4.2467       4.3292       4.4158       4.9069       5.0101
- - - - - -- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
SUBSET  5
GROUP       015          013          014          018
MEAN        4.9069       5.0101       5.4318       5.5005
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
SUBSET  6
GROUP       004          009          001
MEAN        6.5520       6.7135       6.9463
- - - - - - - - - - - - - - - - - - - - - - - -
SUBSET  7
GROUP       009          001          010
MEAN        6.7135       6.9463       7.3773
```

The same test also applied to the new land parcels. Table 7.9 shows the factor significance for the nominal asset values of the new land parcels. Homogeneous subsets for the new parcels are also given in Table 7.10. According to the Table 7.10, the *subset 10* which consists of the factor *usable area* and *street frontage* has had the highest effect on the land unit value. The *subset 1* indicates that the factors *utilities*, *distance to noise*, and *construction area* have had the lowest effect on the estimation of new land parcel nominal asset value.

Table 7.9 One-way test for the selected factors (after)

```
    MEAN   FACTOR ID'S   FACTOR      FACTOR-ID

      .5885   008   CONSTRUCTION AREA     008
      .6281   007   UTILITIES             007
     1.0848   006   NOISE                 006
     3.2983   012   PERMITTED FLOORS      012
     4.4498   003   VIEW                  003
     5.9431   005   LAND PARCEL SHAPE     005
     7.5500   002   MUNICIP. SERVICES     002
     7.8207   018   TOPOGRAPHY            018
     8.4241   014   SOIL CONDITION        014
     9.1704   017   LOCATION IN BLOCK     017
     9.4361   009   ACCESS TO STREET      009
    11.3502   004   NUISANCE              004
    11.9060   001   ENVIRONMENT           001
    12.7370   010   USABLE AREA           010
    12.9740   011   STREET FRONTAGE       011

                          0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
                          0 0 0 1 0 0 0 1 1 1 0 0 0 1 1
                          8 7 6 2 3 5 2 8 4 7 9 4 1 0 1
     Mean     Factor IDs
      .5885     008
      .6281     007       .
     1.0848     006       . .
     3.2983     012       * * *
     4.4498     003       * * * *
     5.9431     005       * * * * *
     7.5500     002       * * * * * *
     7.8207     018       * * * * * * .
     8.4241     014       * * * * * * * *
     9.1704     017       * * * * * * * * *
     9.4361     009       * * * * * * * * * .
    11.3502     004       * * * * * * * * * * *
    11.9060     001       * * * * * * * * * * * *
    12.7370     010       * * * * * * * * * * * * *
    12.9740     011       * * * * * * * * * * * * * .

(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.010
LEVEL
```

```
(.) DENOTES PAIRS OF GROUPS SIGNIFICANTLY NOT DIFFERENT AT THE 0.010
LEVEL
```

Table 7.10 Homogeneous subsets (after)

```
(SUBSETS OF GROUPS, WHOSE HIGHEST AND LOWEST MEANS
                         DO NOT DIFFER BY MORE THAN THE SHORTEST
                         SIGNIFICANT RANGE FOR A SUBSET OF THAT SIZE)

SUBSET  1
GROUP       008           007           006
MEAN        0.5885        0.6281        1.0848
- - - - - - - - - - - - - - - - - - - - - - - -
SUBSET  2
GROUP       012
MEAN        3.2983
- - - - - - - - - -
SUBSET  3
GROUP       003
MEAN        4.4498
- - - - - - - - - -
SUBSET  4
GROUP       005
MEAN        5.9431
- - - - - - - - - -
SUBSET  5
GROUP       002           018
MEAN        7.5500        7.8207
- - - - - - - - - - - - - - - - - -
SUBSET  6
GROUP       014
MEAN        8.4241
- - - - - - - - - -
SUBSET  7
GROUP       017           009
MEAN        9.1704        9.4361
- - - - - - - - - - - - - - - - - -
SUBSET  8
GROUP       004
MEAN       11.3502
- - - - - - - - - -
SUBSET  9
GROUP       001
MEAN       11.9060
- - - - - - - - - -
SUBSET 10
GROUP       010          011
MEAN       12.7370       12.9740
- - - - - - - - - - - - - - - - - -
```

7.7.2.3 Testing the validity of the developed model

To test the developed model the best way is to use real-world data which produced the use of similar land valuation factors. But such data were not available during this study. Another option is to use real-market data but this cannot provide the efficiency of the model because it has not been intended that the model fit the calculated unit value to the market value.

Table 7.11 Testing the model (Rank of the 15 factors at 0.05 level)

(old)				(new)			
set-1 n=185	**set-2 n=60**	**set-3 n=65**	**set-4 n=60**	**set-1 n=506**	**set-2 n=247**	**set-3 n=259**	**set-4 n=188**
007	006	007	007	008	008	007	007
006	007	006	006	007	007	008	008
011	011	011	011	006	006	006	006
003	003	003	003	012	012	012	012
005	005	017	005	003	003	003	003
002	002	002	015	005	005	005	005
017	017	005	013	002	002	002	002
015	014	015	002	018	018	014	018
013	015	013	017	014	014	018	014
014	018	018	014	017	017	017	017
018	013	014	018	009	009	009	009
004	004	009	004	004	004	004	004
009	010	004	001	001	001	001	001
001	001	001	009	010	010	010	010
010	009	010	010	011	011	011	011

However, the validity of the model with 15 factors can be tested using a different number of land parcels. For this purpose, four different data sets were considered with respect to different number of parcel groups. The first data set represents the factor values for whole cadastral land parcels. The last three data sets were randomly picked from the whole data set. By applying the one-way analysis on these four data sets, the mean values of the land valuation factors and the rank of these factors between the selected data sets were examined. Table 7.11 shows the test results with the selected land valution factor ID's. It has been found that the rank of the land valuation factors remain almost the same for each data sets. In other words, the variance of land valuation factors on the land unit values are the same when different numbers of land parcels are considered. The data sets were tested at the 0.05 level. So, the test result indicates that when the model (with 15 factors) apply to other land parcel sets, 95% of the results will be the same.

This gives an evidence that the developed model is adequate. The details about the statistical tests are given in Appendix H.

7.8 Chapter summary

In this chapter, a case study was examined in order to implement and test the developed prototype LARES. A land readjustment project area in Turkey has been considered as a case study. First, land registration system and land readjustment applications in Turkey have been outlined. Then, using data from Turkey, the value-based land readjustment process was carried out. Following the land subdivision, land valuation analysis was performed and tested with different numbers of land valuation factors.

The results of land valuation analysis showed that the nominal asset values of the land parcels are relatively different before and after the project. Based on the calculated land valuation figures, land distribution was then performed. The distribution tables, all attached textual information and land valuation maps were produced as final outputs.

Finally, the case study results have been statistically tested. The correlation between the determined factor values and the significance of the selected factors have been examined. The developed model itself has also been tested with the different land parcel groups. The discussion about these tests have been given in this chapter. However, the test results are presented in Appendix H.