CHAPTER 6

DESCRIPTION OF LARES

6.1   Introduction

The software design for the proposed land readjustment model was explained in the previous chapter. The main algorithms and their approaches were particularly discussed on the problem solving level. Based on the combinations of these algorithms a software suite which called LARES has been developed.

LARES is a menu-driven prototype software which performs the all requirements of a value-based urban land readjustment process. Its development procedures are mainly based on ARC/ INFO GIS system. This chapter overviews the prototype LARES. In order to fulfil the value-based land readjustment procedures, the requirements and functionality of LARES is described in detail. The file management procedures for data input, output, storage and spatial analysis functions are explained. The menu system of LARES is also illustrated with some examples.

6.2   Design criteria

LARES was basically designed to perform the needs of a value-based land readjustment process within an interactive environment which is user friendly. Using ARC/ INFO AML, a user interface was created. During the

design of this interface a number of criteria were considered to provide an effective user environment. These design criteria are given in the following sections.

6.2.1   Hardware

Hardware is the term used to describe the actual computer machinery itself including all of the attendant peripheral devices such as keyboard, printers, screens, digitiser, plotter, disks drivers etc. The choice of hardware for a GIS is optional (Dangermond, 1991). A typical standalone computer suitable for many GIS application would be a graphical workstation with about 16 megabytes of RAM and 600 MB of harddisk. Such hardware platforms include SUN, HP, IBM etc. Figure 6.1 shows a UNIX based SUN workstation which was used concurrently for this research.

6.2.2   Software

The functioning of the computer is controlled by specific coded instructions capable of performing a variety of tasks. These instructions are generally referred to as software. There are two categories of software which enable the computer hardware to perform. These are ;

(a)   Operating system ; makes the computer do what is required. These, together with executive programs, supervisors and monitor systems, control the running of the computer. The common operating systems are MS-DOS and UNIX. Based on these operating systems, the latest technology has provided the Graphical User Interface (GUI) systems such as MOTIF and OPEN LOOK that can easily be used by the user in program execution and file organisation requirements.

b) Application software ; is used by analyst and programmer to solve particular problems. GIS packages are part of the application software. Presently, there are many GIS packages in the market that perform various spatial analysis.   They include ARC/ INFO, INTERGRAPH, SLIMPAC, Smallword, System 9, etc.

In this study, the UNIX operating system and ARC/ INFO GIS application software were used for the software requirements.
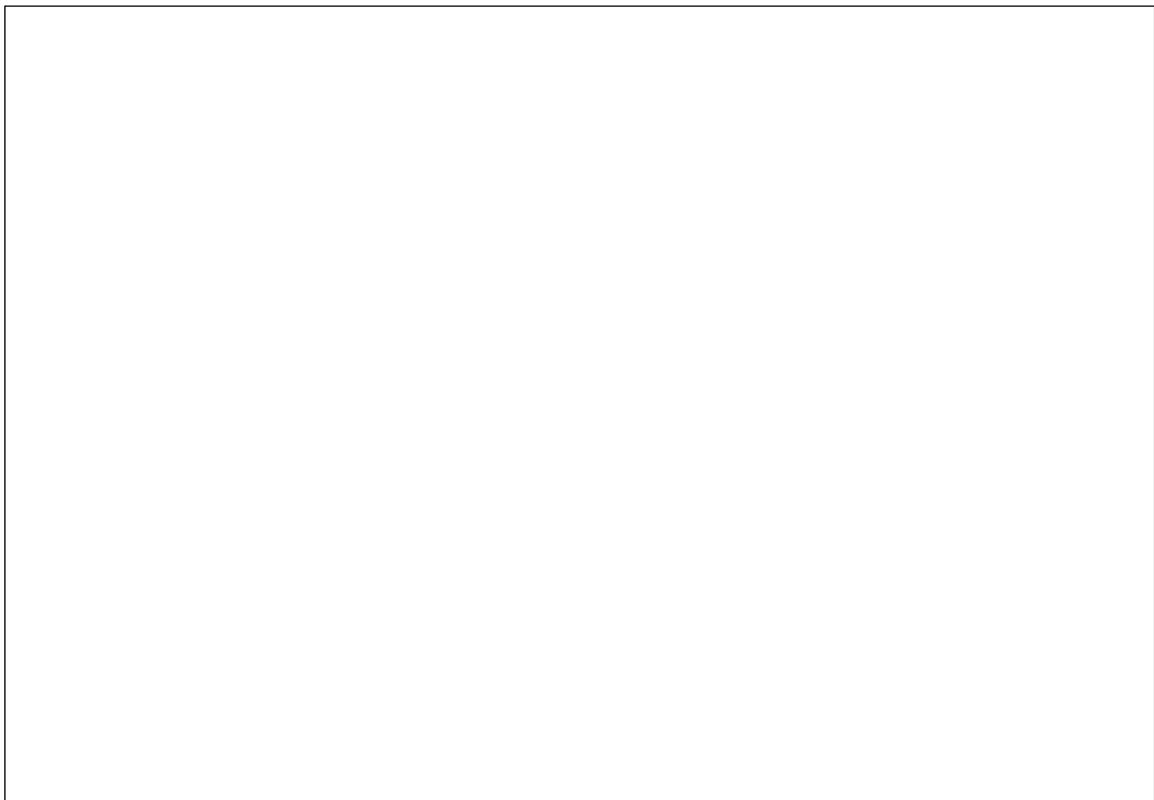
Figure 6.1 The view of hardware used for this study

6.2.3 Digitising

Digitising is one of the methods used for converting analogue or hard copy documents into computer readable format.   By digitising a paper map becomes in digital form. A digitising table equipped with a precise cursor is

commonly used as a device to operate the GIS. The digitising table electronically encodes the position of the pointing device with a precision of fractions of a millimetre. The most common table digitiser uses a fine grid of wires embedded in the table.

Other methods like scanning exist but manual digitising is the most commonly used method which was used in this study. In manual digitising the map is affixed to a digitising table and a pointing devices used to trace the map features. As the map elements are traced, the coordinate data are generated from the digitising table are either processed immediately by the GIS or are stored for later processing.

In a GIS implementation, the principal aim of the digitiser is to input quickly and accurately the coordinates of points and bounding lines. To do this, first, the map is secured is secured to the digitiser surface with tape. The scale of map must then be entered to the computer, followed by two digitises at the extreme corners (X_{min}, Y_{min}) and (X_{max}, Y_{max}) to define the area being used. Lines can be digitised in two ways, known respectively as stream and point digitising (Burrough, 1986). For a vector based process, the point digitising method is more preferable.

Thus, in this study, the point digitising method was used to digitise the required data layers such as cadastral and zoning maps. During the digitising of these maps, cadastral parcel boundaries, site blocks, roads, land use, buildings, public areas, contours are particularly considered. As illustrated in Figure 6.2, the other data layers such as environment, streams, soil condition, planned public buildings, and the other thematic data should also be digitised. On the other hand, the related attribute data were entered by keyboard in ARC/INFO.
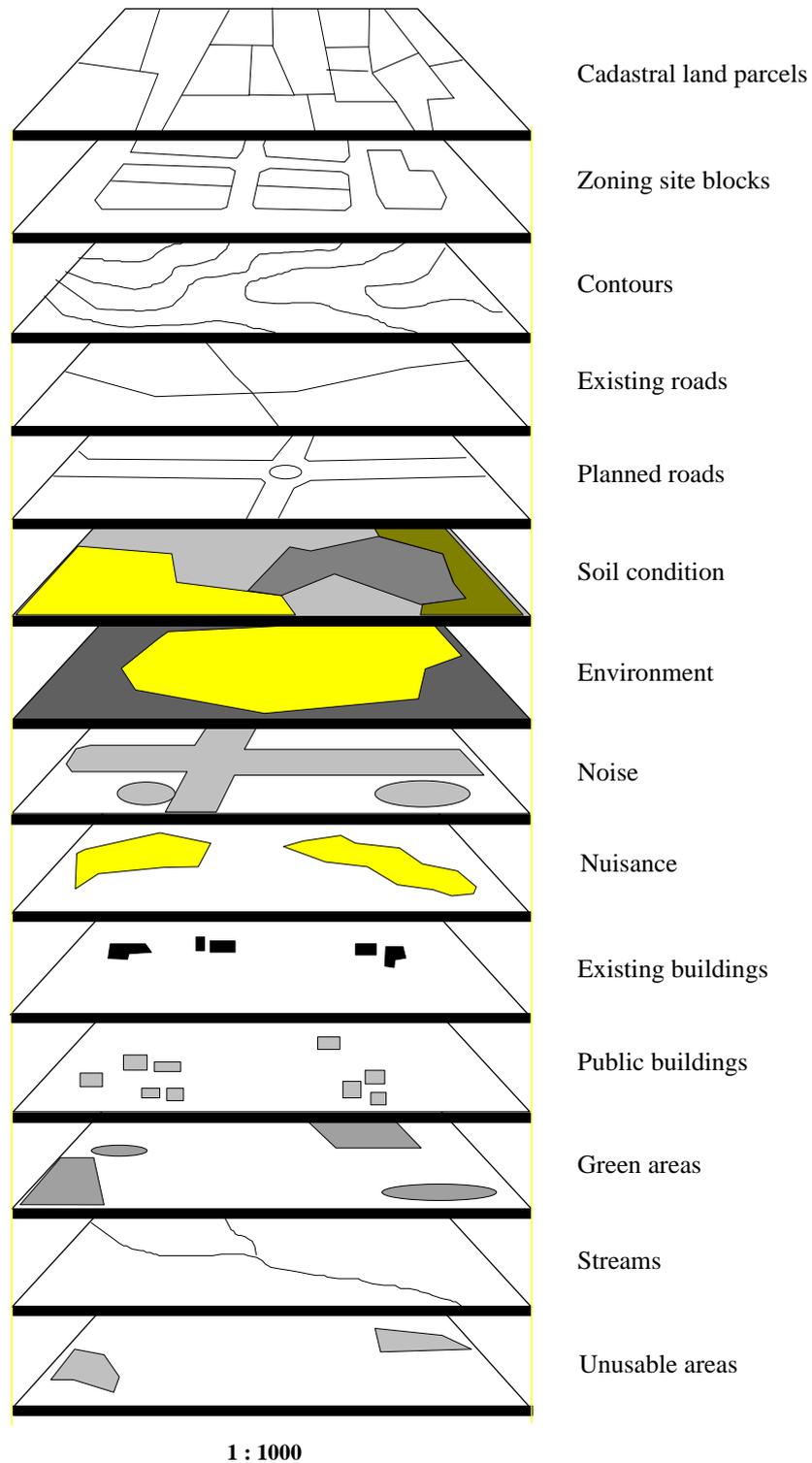
Spatial Data Layers

Cadastral land parcels

Zoning site blocks

Contours

Existing roads

Planned roads

Soil condition

Environment

Noise

Nuisance

Existing buildings

Public buildings

Green areas

Streams

Unusable areas

1 : 1000

Figure 6.2 The digitised spatial data layers

6.2.4 Organising attribute data

Following the digitising procedure, additional information need to be specified before the analysis can be done. For example, zoning codes such as permitted number of floors, construction areas for the site blocks should be linked to the corresponding digitised polygons. To do this, the descriptive data need to be added to the zoning coverage.
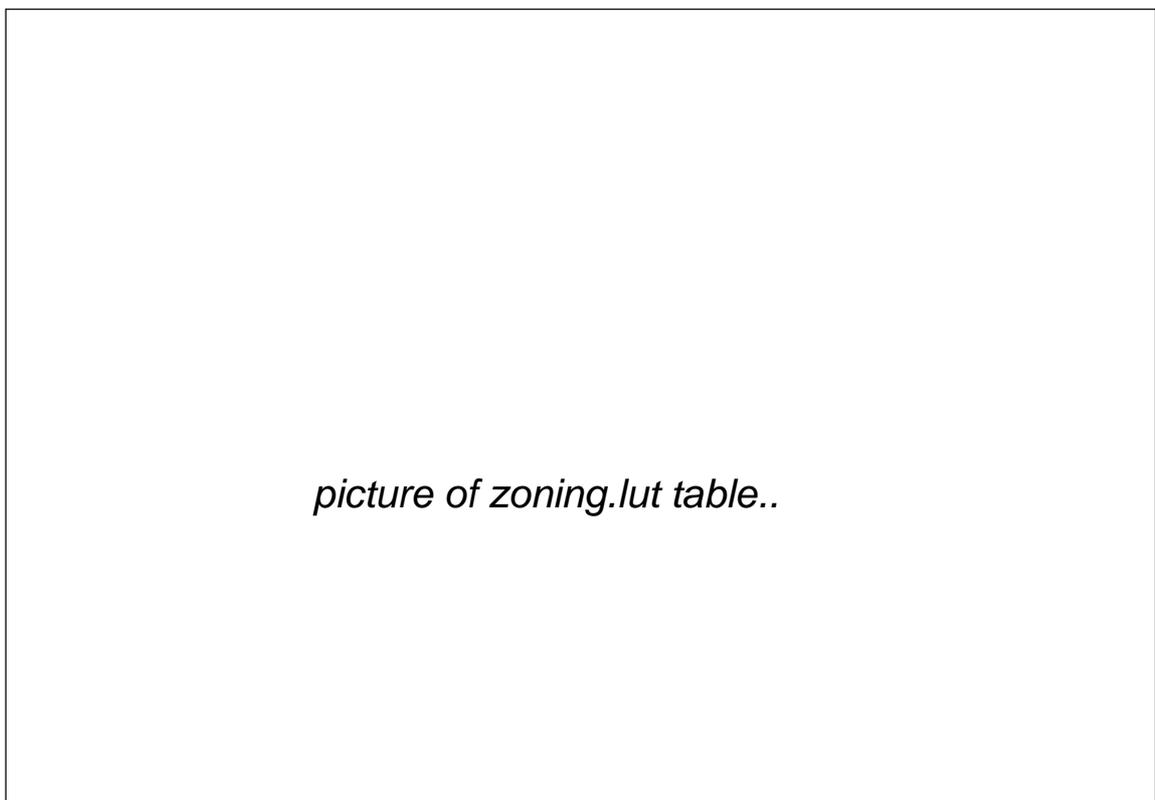
picture of zoning.lut table..

Figure 6.3 A view of standard feature attribute tables

However, when topology is created for a coverage the corresponding feature attribute table is automatically created by ARC/ INFO. This is a tabular data file storing standard attributes about the feature (Figure 6.3). To add a new attribute or item to a feature table, the following procedures are performed in the INFO subsystem in ARC/ INFO. Then the item values are added by typing them directly into the feature table.

```
Arc  : tables

Info : additem <input_info> <out_info> <item_name> .
```

Many feature attribute tables can be created for different purposes. These type of tables are created to hold a specific data such as soil type, land use and zoning codes. These tables are called Look Up Tables (LUT). Importantly, at least two attribute tables must have a common item as a key to link these two tables. An example of how these INFO tables were used to create an attribute table for a zoning coverage is given in Appendix C.

6.2.5   User interface

LARES has a menu-driven system for user interaction. This menu system provides access to implement the all requirements for the value-based land readjustment process, including the basic ARC/ INFO modules. Primarily, the main menu has some sub-menus which performs the individual procedures, such as subdivision, valuation. Figure 6.4 views the LARES menu. However, the components of the menu system is presented under section 6.4. The AML file that starts the process can be reached by following path.

```
>home/.../gis/lares.aml
```

To run LARES, the following commands are performed.

```
>login
>home/...
home/... > cd gis
home/.../gis > arc
Arc  : &r lares
...{ LARES menu appears }
```

Figure 6.4 A view of LARES interface

6.3   File organisation in LARES

To provide a more effective file management procedure, the data and other system files were organised for a particular land readjustment project. So, several sub-directories were created under a root directory which titled with a project name. When LARES is started then user is asked for the project name. Then the workspace is setup for this particular project. The file management process is presented below.

6.3.1   Directory structure

Directory organisation was based on a tree structure in the LARES. First, there is a parent directory which handles the starting up execution file an a

subdirectory which holds AML and FORTRAN source codes and the other execution files. Under this parent directory, there are also some other sub-directories which include particular project data such as coverages. These sub-directories were called project directories. The path for a project may be given as follow;

```
>home/.../gis/project1
```

The main objective of this directory organisation was to provide a manageable and accessible file processing environment. During the land readjustment analysis, many files are created under different names. Therefore, to reach these files may become very complicated for the user. To reduce this file complexity, a directory organisation was considered.

The fully directory structure of LARES is illustrated in Figure 6.5. However, more details on these directories including their particular files are given in Appendix D.

6.3.2   Data file management

Within a project directory there are three other main sub-directories which hold the input and output data files. These are;

```
>home/.../gis/project1/LR_COV
>home/.../gis/project1/LR_INF
>home/.../gis/project1/LR_RES
```

Figure 6.5 The directory structure of LARES

LR_COV directory holds the input coverages in ARC/INFO interchange formats. Before the entire process, the input coverages which topologically corrected by ARC/INFO are exported as interchange files. An interchange file contains all data source information in a fixed length ASCII format. These files are then stored in LR_COV directory for further use.

LR_INF directory holds the information files such as selected valuation factors, (*x,y*) coordinate lists, angle and distance measurements of land parcel boundaries. These files are created during the spatial analysis. Using some existing data, the new one is created for specific calculations and later use. Consequently, the information files contain the land surveying data that would be used by surveyors.

LR_RES directory holds the result files such as land distribution tables, old and new land valuation parameters, input data to created land valuation relief. After the land valuation analysis all results for each individual factor are stored within this directory. These files are named with related factor codes. The result files are then used as input data for land distribution process.

6.3.3   AML files

AML files provide the customisation for the model. The ARC/INFO commands were coded to execute some particular spatial applications such as topographical and network analysis. The AML files also provide the communication process to run a UNIX benchfile or to compile a FORTRAN program in the system. Data retrieval, storage and the other file management procedures are also accomplished by these AML files. Within the main

directory tree, all the AML files were kept together and located in the following directory.

```
>home/.../gis/lares/lr_aml
```

6.3.4   Menu files

The menu files which were written in AML provide a menu-driven interface for the user. The menu files were also located with the AML files. The main tasks such as the selection of land valuation factors and information query are operated by specific menus. Within the main LARES menu, there are seven titles. These titles are illustrated in Figure 6.6. The file which creates the main LARES menu is presented in Appendix D.
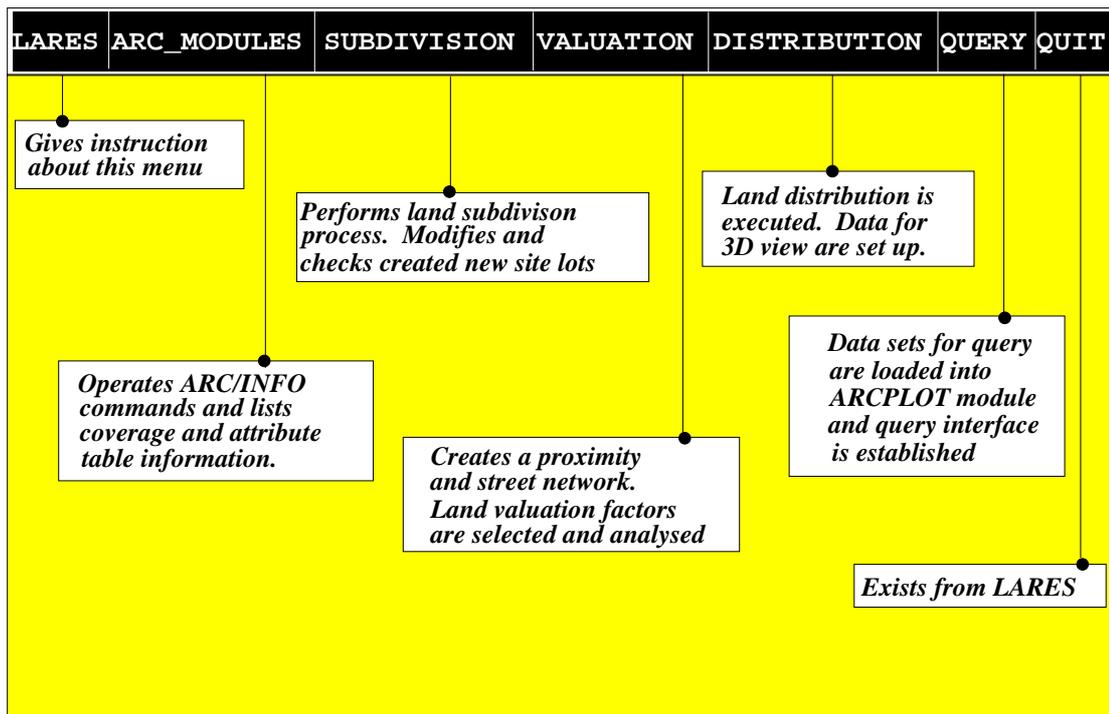

Figure 6.6 The menu titles of LARES

6.3.5   Execution files

During the entire analysis, some calculations are performed by external programs which were written in FORTRAN. When the AML was insufficient to execute a process, these external files were used. However, once a FORTRAN coded external program is compiled, an execution file is created and used for a specific task. Data input and output procedures during these execution files are provided by AML files. Therefore, AML provides the linkage mechanism between external files and ARC/INFO. The main advantage of using the execution files is to increase the speed of job execution. On the other hand, they need a permanent large space in the memory. The execution files were stored in the following directory;

```
>home/.../gis/lares/LR_EXE
```

However, the external files with FORTRAN source codes are kept in the following path;

```
>home/.../gis/lares/LR_F77
```

6.4   The components of LARES

The LARES menu has five basic components to complete the entire procedure of value-based land readjustment. These components are considered as the main modules of the model. The components of LARES are described in the following sections.

6.4.1   Arc modules

This module provides some functionality of ARC/INFO including ARCEDIT, ARCPLOT utilities.   Basically, file management, data input, editing, displaying data, and topology building are performed here.   The other functions of ARC/INFO are also executed without leaving the main menu. The menu title of arc-module is illustrated in Figure 6.7.

```
┌──────┬─────────────┬─────────────┬───────────┬──────────────┬───────┬─────┐
│LARES │ARC_MODULES  │ SUBDIVISION │ VALUATION │ DISTRIBUTION │ QUERY │QUIT │
└──────┴─────────────┴─────────────┴───────────┴──────────────┴───────┴─────┘
       │ go to ARCEDIT    >>  │
       │ go to ARCPLOT    >>  │
       │ EXTRACT COVER.       │
       │ CLEAN COVERAGE       │
       │ LABEL POLYGONS       │
       │ BUILD TOPOLOGY       │
       │ DESCRIBE COVERAGE    │
       │ LIST :NODE_ERRORS    │
       │  .   :LABEL_ERRORS   │
       │  .   :COVERAGES      │
       │  .   :INFO FILE      │
       │ KILL  : COVERAGE     │
       │  .    : INFO FILE    │
       │  .    : TIN FILE     │
       │  .    : COVERAGES    │
       │ ------------------   │
       │ ARC Command line     │
       │ ARC HELP             │
       └──────────────────────┘
```

Figure 6.7 The view of ARC-MODULE menu

6.4.2   Subdivision

This module performs the land subdivision process.   The required data are loaded into working workspace. Then, the site blocks on zoning coverage are automatically subdivided into the new patterns according to land-use planning details.   In this case, *zoning.LUT* tables are used to retrieve the

planning codes. Following the subdivision, some modifications may be required in the created layout plan. Especially, the subdivision of some geometrically complicated site blocks could be ignored during the process. In this case, the program lists the warning messages after the execution. The modification procedure can be done interactively through the LARES menu. ARCEDIT environment is however automatically set up with related coverages and attribute tables. The subdivision menu is illustrated in Figure 6.8.
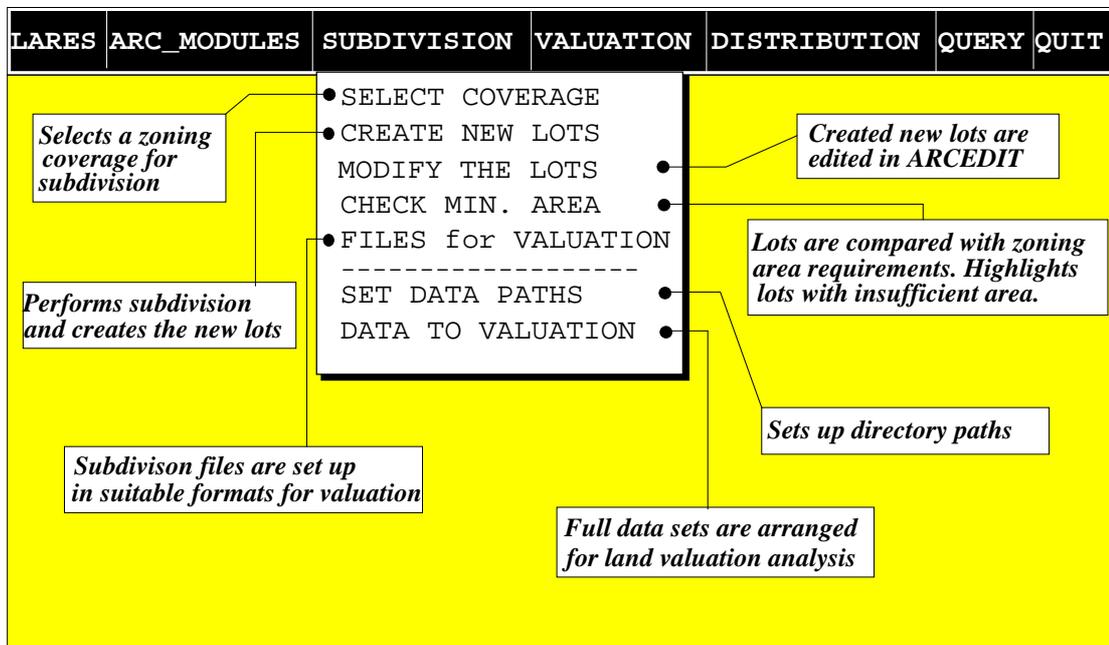
Figure 6.8 The view and functions of SUBDIVISION menu

6.4.3 Valuation

This module analyses the land parcels with selected land valuation factors. Before the factor selection, a street network is created. Then, using the factor selection sub-menu, land valuation factors are determined to analyse. Each selected factor is evaluated individually in both stages, before and after. When the valuation analysis is completed for the selected factors, then the process returns to the main menu. The final land valuation parameters are

then calculated for cadastral and new site land parcels. All required information is stored in suitable formats for other uses, especially for land distribution. The valuation menu title with its sub-menus is illustrated in Figure 6.9.
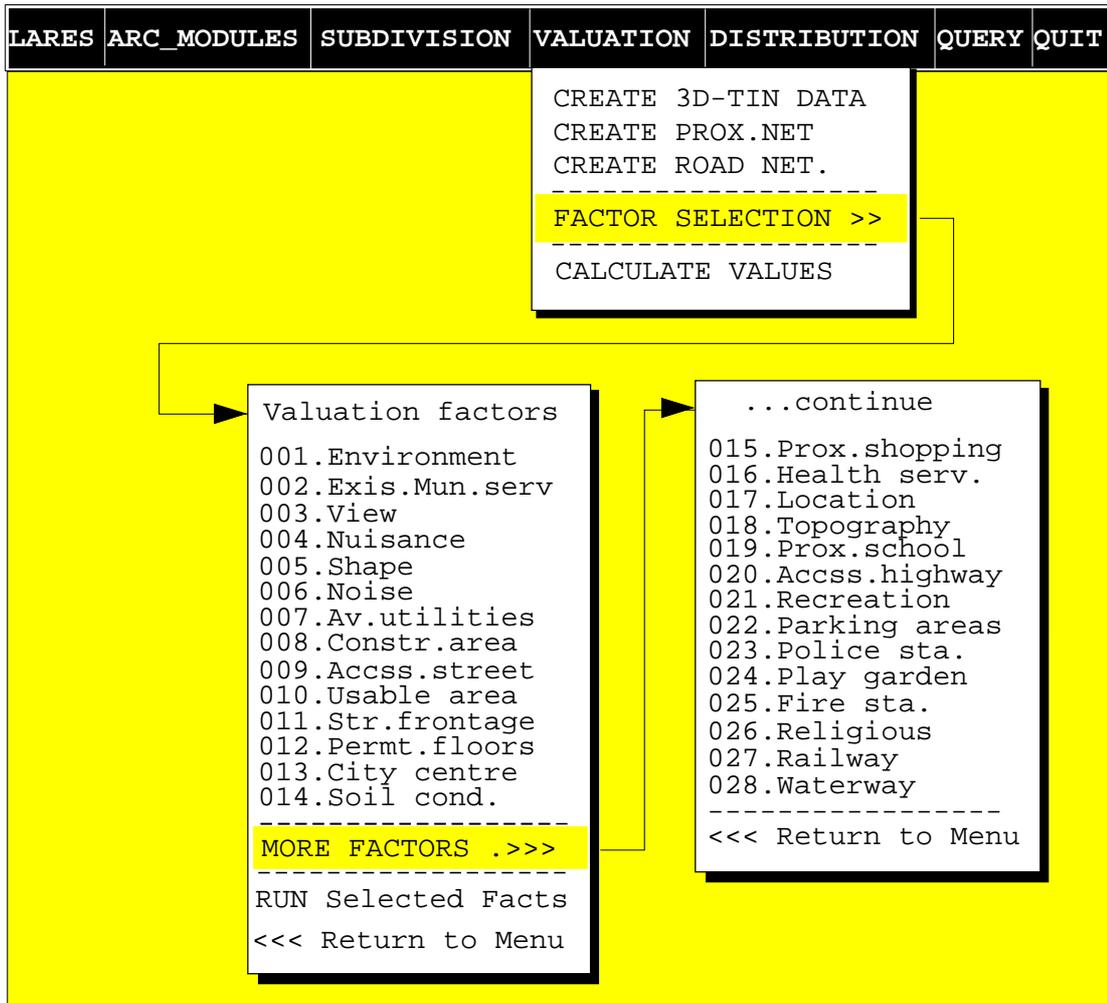
| LARES | ARC_MODULES | SUBDIVISION | VALUATION | DISTRIBUTION | QUERY | QUIT |

```
                              CREATE 3D-TIN DATA
                              CREATE PROX.NET
                              CREATE ROAD NET.
                              --------------------
                              FACTOR SELECTION >>
                              --------------------
                              CALCULATE VALUES


    Valuation factors              ...continue
                                015.Prox.shopping
    001.Environment             016.Health serv.
    002.Exis.Mun.serv           017.Location
    003.View                    018.Topography
    004.Nuisance                019.Prox.school
    005.Shape                   020.Accss.highway
    006.Noise                   021.Recreation
    007.Av.utilities            022.Parking areas
    008.Constr.area             023.Police sta.
    009.Accss.street            024.Play garden
    010.Usable area             025.Fire sta.
    011.Str.frontage            026.Religious
    012.Permt.floors            027.Railway
    013.City centre             028.Waterway
    014.Soil cond.              ------------------
    ------------------          <<< Return to Menu
    MORE FACTORS .>>>
    ------------------
    RUN Selected Facts

    <<< Return to Menu
```

Figure 6.9 The view of VALUATION menu

6.4.4 Distribution

This module performs the land redistribution using the results of land valuation analysis. All the cadastral land parcels are reallocated within the new site lots with respect to their determined parcel values. Since the valuation parameters are the main components for land reallocation, the

original location of cadastral parcels are also considered during the
distribution. So, an optimal solution is provided to consolidate, divide, and
redistribute the land parcels to minimise the number of shares within a single
land parcel. All these steps are carried out by the distribution algorithm.
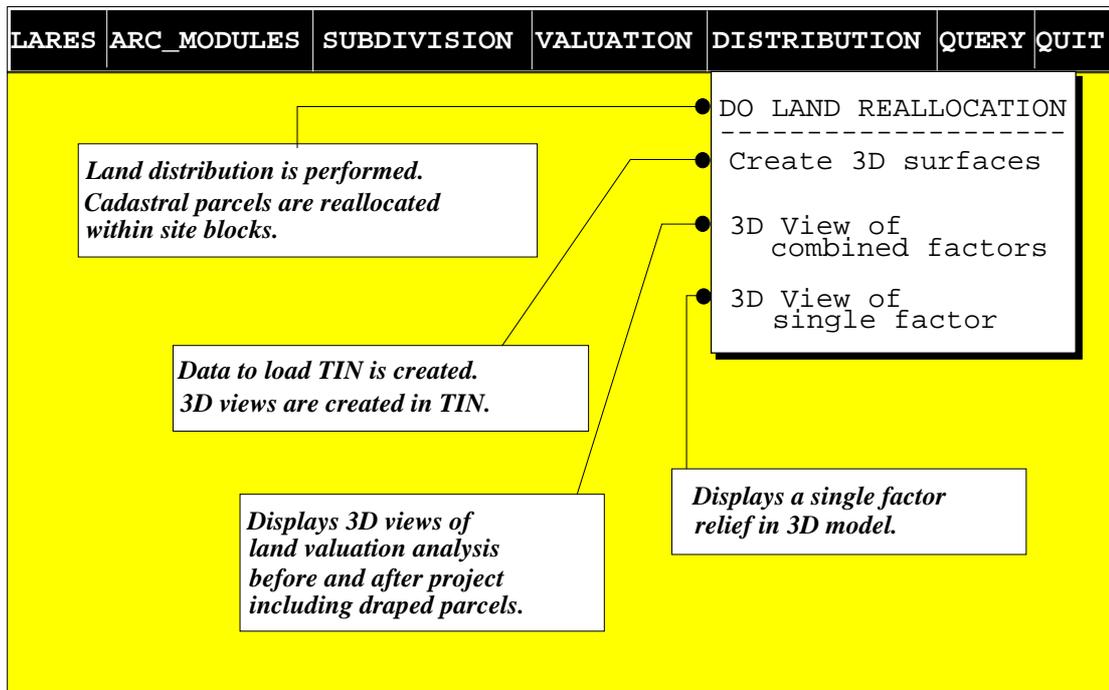However, Figure 6.10 illustrates the distribution menu title.

Figure 6.10 The view of DISTRIBUTION menu

6.4.5   Query

This module utilises the display of results for user's requirements. The
ARCPLOT is basically set up for the query requirements. All process results
both graphical and textual, including land valuation maps with 3D
visualisations, street networks, ownership records, and land-distribution
tables are loaded to ARCPLOT environment to display and query. Any
information about a land parcel can be easily queried. More details on the
query procedures are presented in the next section.

6.5   Attribute query

Query functions retrieve records in attribute data base according to conditions specified by the operator. The query of information is done either graphical or non-graphical or with the combination of both. Depending on the requirement, query can be very simple such as finding the class assigned to a selected polygon. However, complex queries involve selective searches of all the attributes for one or more data layers and the generation of a report that tabulates the results.

In LARES, the graphical data is displayed in ARCPLOT which allows the user to zoom in and display an enlarged part of the database. Textual information can also be displayed with these graphical data. However, to query more specific information may be required. Such information is land parcel identification, the relationship between old and new parcel, value and share distribution of land parcel. More details on the information query is given in following sections with some examples.

6.5.1 Coverage information

Using the arc-modules in the LARES menu, the coverages and their attribute tables can be displayed. These are the textual information that user may interest. Especially, PAT and LUT tables are listed to see the details on feature attributes of a coverage. Using INFO facilities, more specific data can be selected and listed. Figure 6.11 illustrates an example for this. In this example, the cadastral parcels which have value greater than 20,000 and less than 70,000 units are highlighted.

6.5.2 Query of two-dimensional information

The land parcels and the other factor coverages are basically displayed with their attribute data. Using ARCPLOT, a single or the combination of different map layers can be visualised (Figure 6.12). A particular land parcel and its related information can also be displayed by pointing on it (Figure 6.13). However, a specific query menu was designed for often information requirements. These are used to query the land valuation results for both cadastral and new land parcels. This query procedure was attached to ARCPLOT menu. Some tasks which perform by this query menu are;

picture of cadastral attr. table.
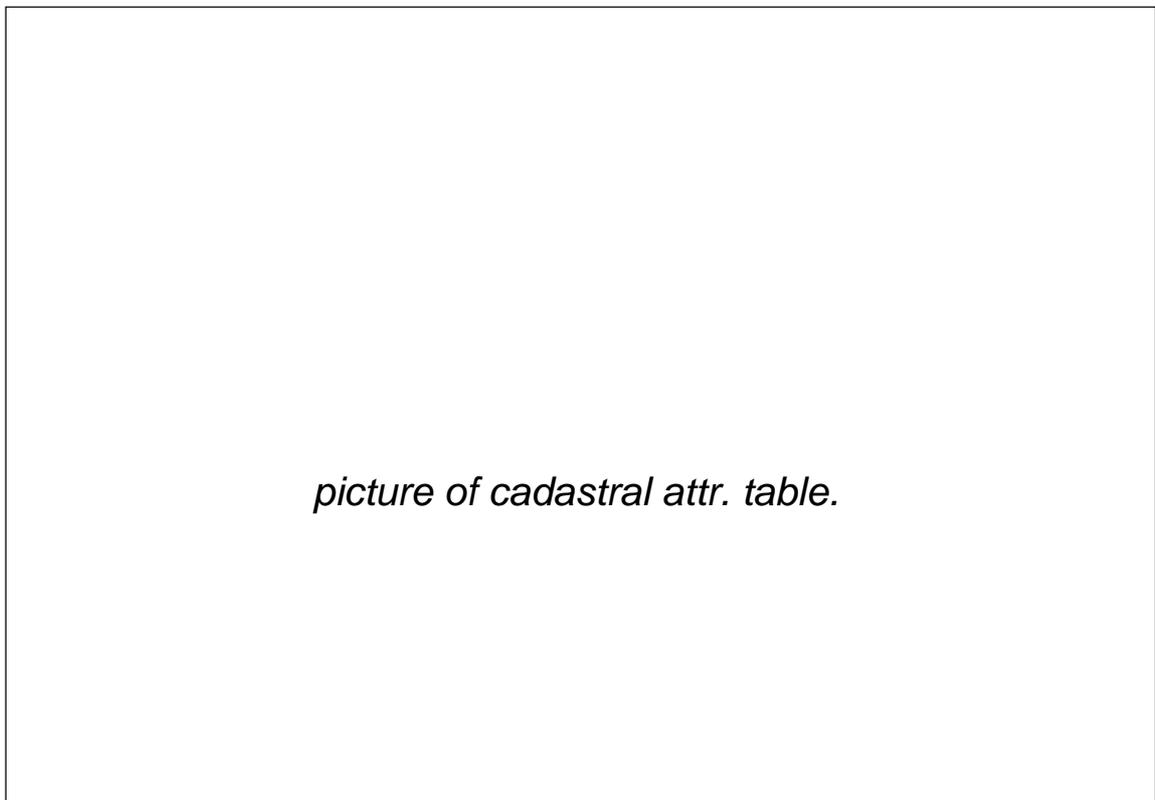
Figure 6.11 A list of cadastral parcels with selected value attributes

picture....
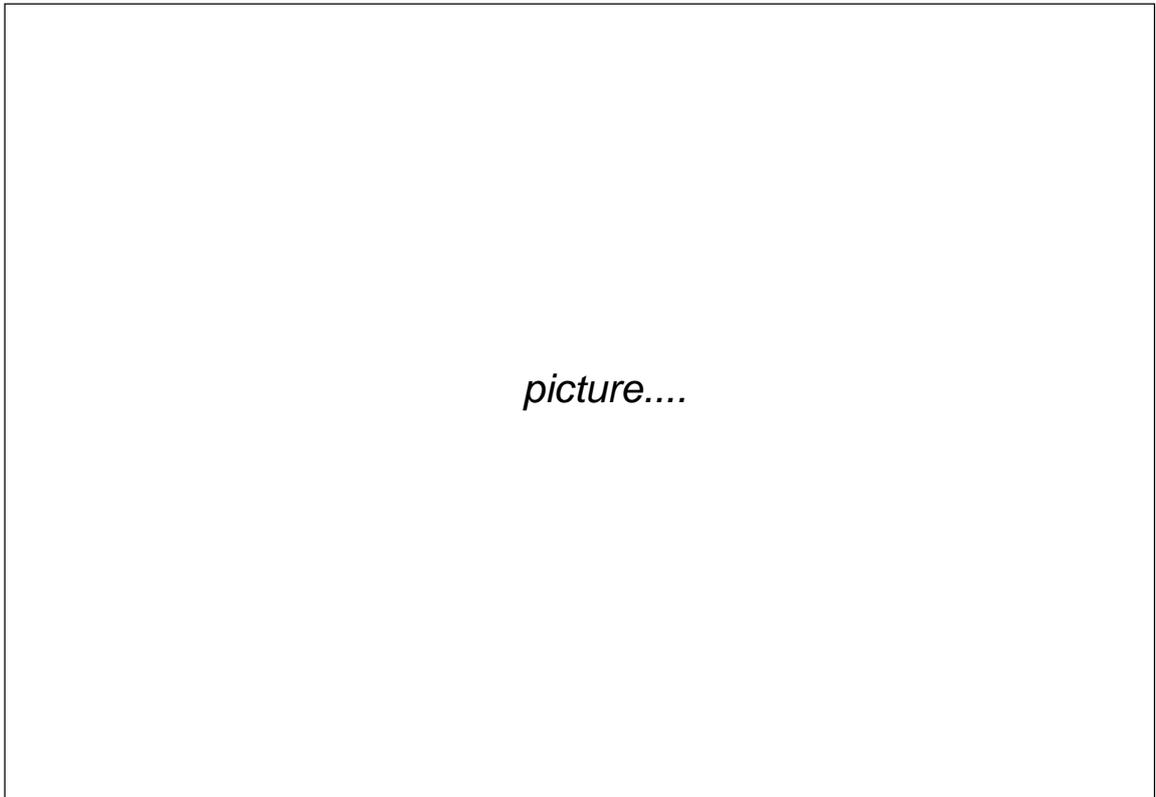
Figure 6.12   A view of layer combination

picture....
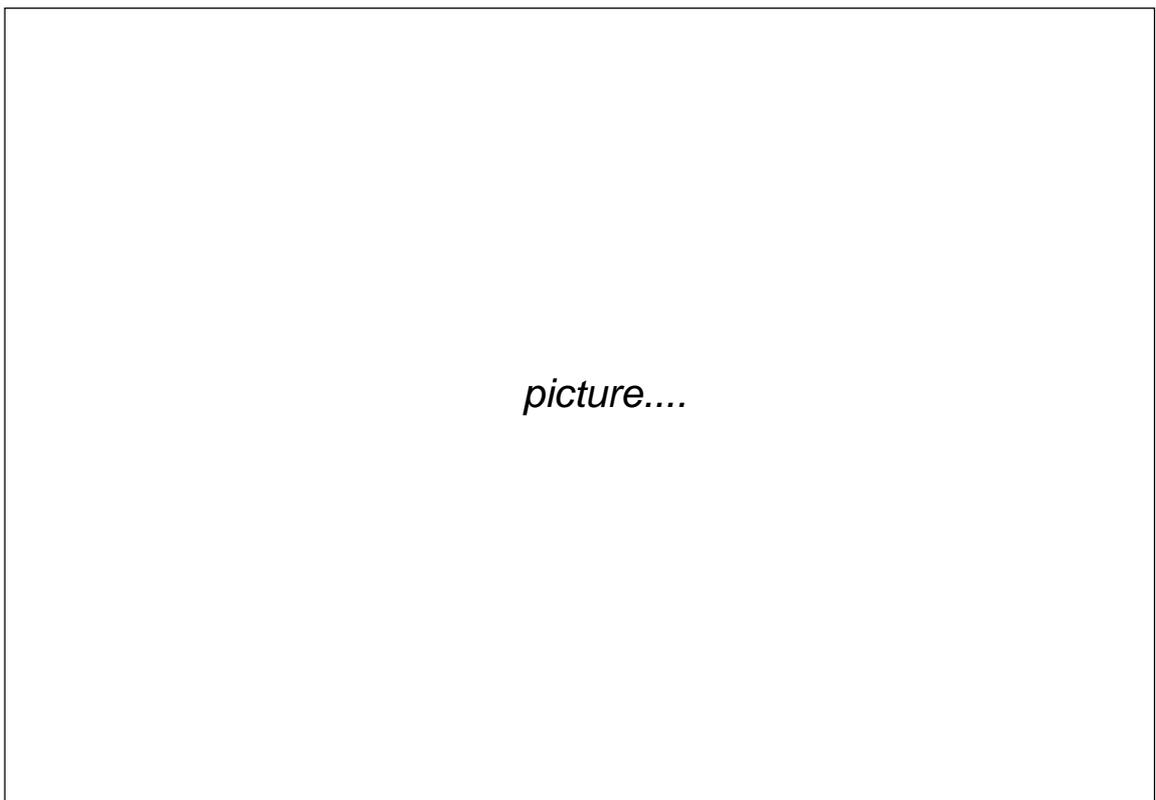
Figure 6.13   A view of cadastral parcel and its attached information

(a) Displaying land distribution information for cadastral parcels:

The cadastral parcels are displayed with their assigned new lots. Basically, the old and new parcel connection is presented. When a cadastral parcel is picked up by pointing on it, the new site lots that belong to this cadastral parcel is highlighted. So, the reallocation of cadastral parcel is shown. The distribution table with the valuation figures are also displayed. An example for the reallocation of a cadastral parcel is illustrated in Figure 6.14.

(b) Displaying land distribution information for the new site lots

This option presents the above option in a reverse way. This time, the new lots are displayed. Then, a lot is selected and the cadastral parcels which were assigned with this lot is highlighted. Figure 6.15 illustrates an example for this option.

(c) Land owner sharing situation

The zoning limitations on new lot creation may cause the sharing of a new lot by more than one landowner. The sharing information in both old and new parcels can be queried by user. The parcels are basically highlighted with the number of landowners. Figure 6.16 illustrates an example for the sharing condition of new site lots after land distribution.

(d) Querying land parcel values

Land values in a given interval range are highlighted. This query option helps to user to find land parcels with a certain value. The maximum and minimum values are always listed. The user asked to enter desired interval ranges for value display. The valuation query can be done both old and new land parcels. An example for new parcels is given in Figure 6.17.
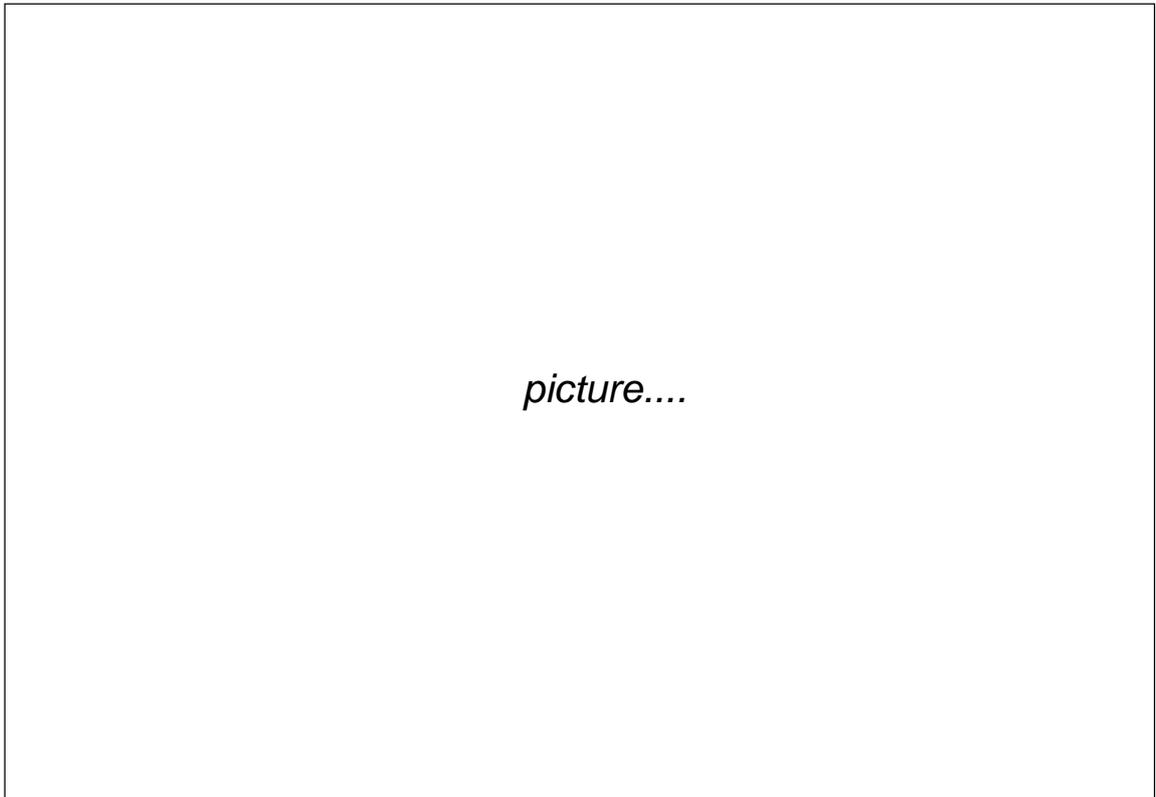
picture....

Figure 6.14   A cadastral parcel with its new site lots after land distribution
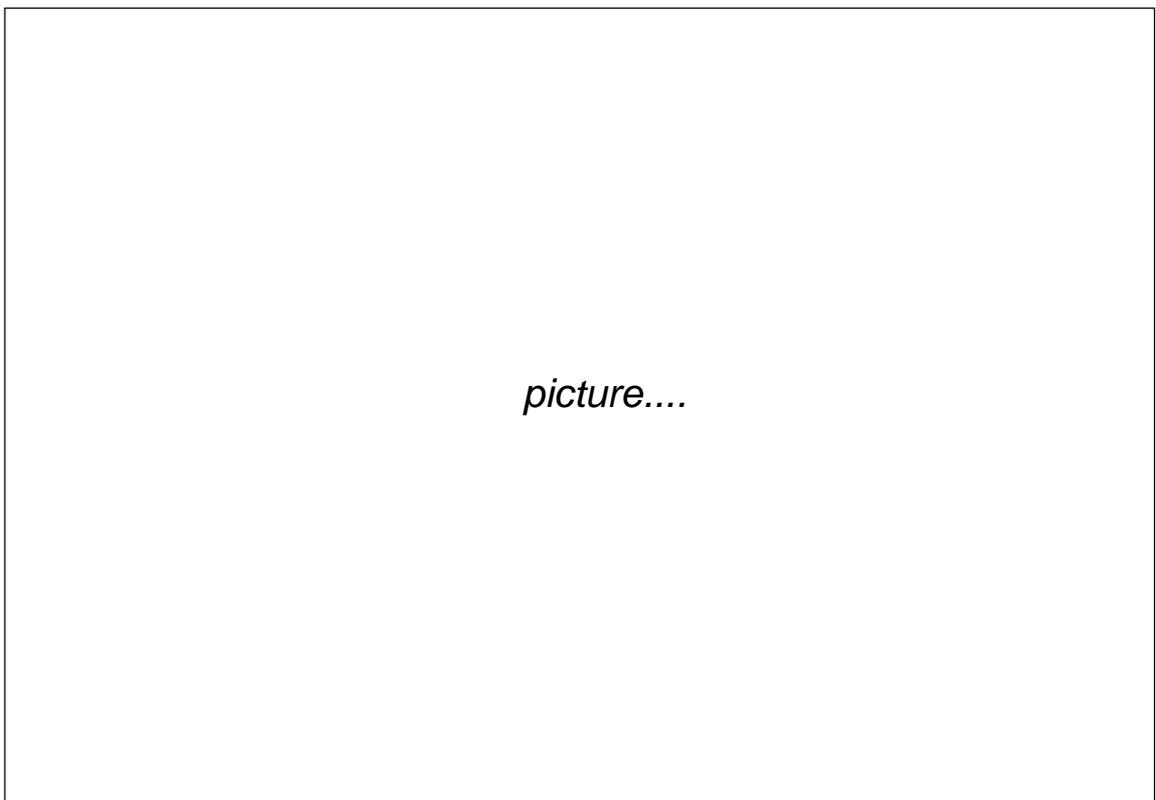
picture....

Figure 6.15   A new site lot with its related cadastral parcels
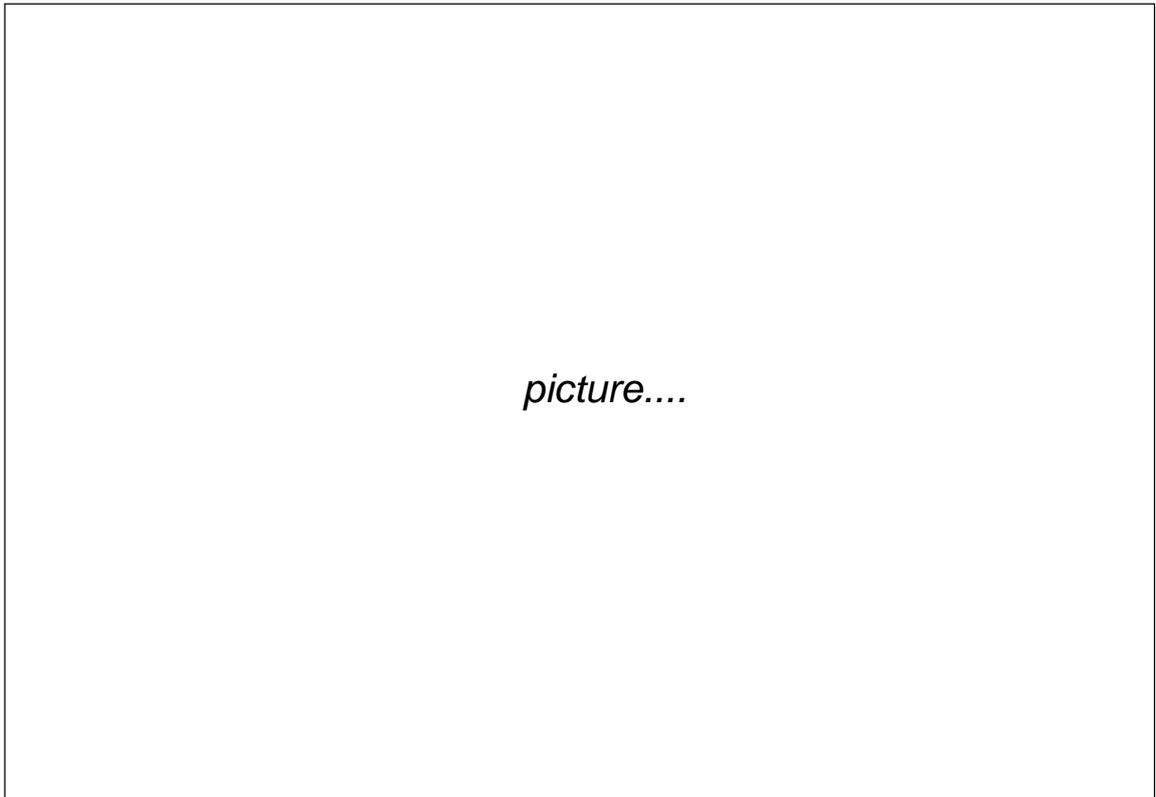after land distribution

picture....

Figure 6.16   Share distribution of new site lots after land reallocation
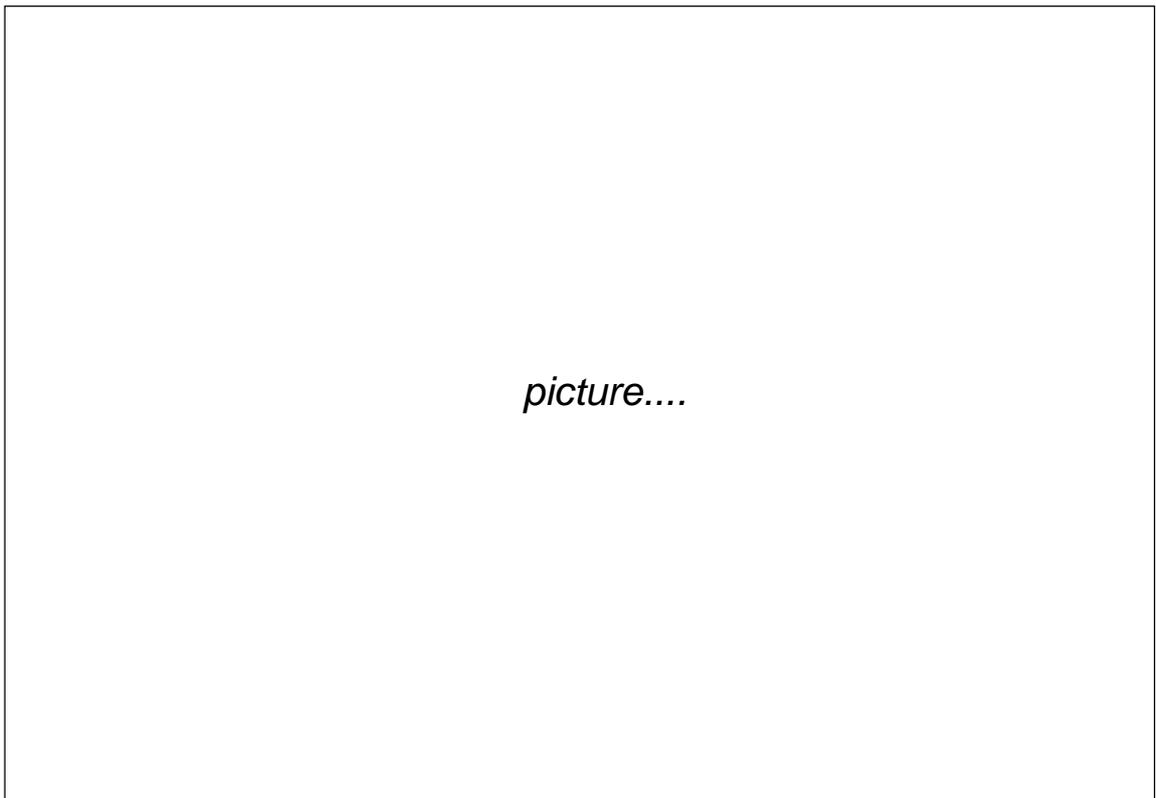
picture....

Figure 6.17   A view of new land parcel values
between 50,000 and 60,000 units

6.5.3   Displaying three-dimensional views

A three-dimensional model of surface is generated from a TIN or a lattice file. Both models are based on point data which associates a z value item with an x,y location. Although surface elevation is commonly used, alternative z values can be used to produce any three-dimensional models (Raper and Kelk, 1991). Using ARC/INFO TIN module in LARES, these values were used to represent the value measurements of land parcels. The valuation reliefs of project area for old and new land parcels are viewed in a three-dimensional model. Optionally the land parcel coverages are also draped on valuation surface. Figure 6.18 and Figure 6.19 show the examples of three-dimensional valuation models before and after project. As illustrated in Figure 6.20 and 6.21, any single land valuation factor can also be viewed.

Data for three-dimension visualisation are loaded from the LR_RES directory. The data file contains the x,y coordinates of a land parcel centroid and corner points and corresponding parcel value as z variables. To put this data file in ARC/INFO TIN module, there is a need for data conversion procedure. To accomplish this requirement a data conversion algorithm is developed. This algorithm is given in Appendix E.

When the data are put in TIN environment, the other utilities of the module can also be used for information query. Once a three-dimension surface is generated by **VIEW** command, it can be used for interactive calculation of value for a particular location. Using the **SPOT** command to select any point on the surface will return an interpolated value of that point's x,y and z location. If these points are saved after they have been selected, their value parameters are recorded as an INFO data item. A valuation profile graph can also be generated interactively using **PROFILE** command.
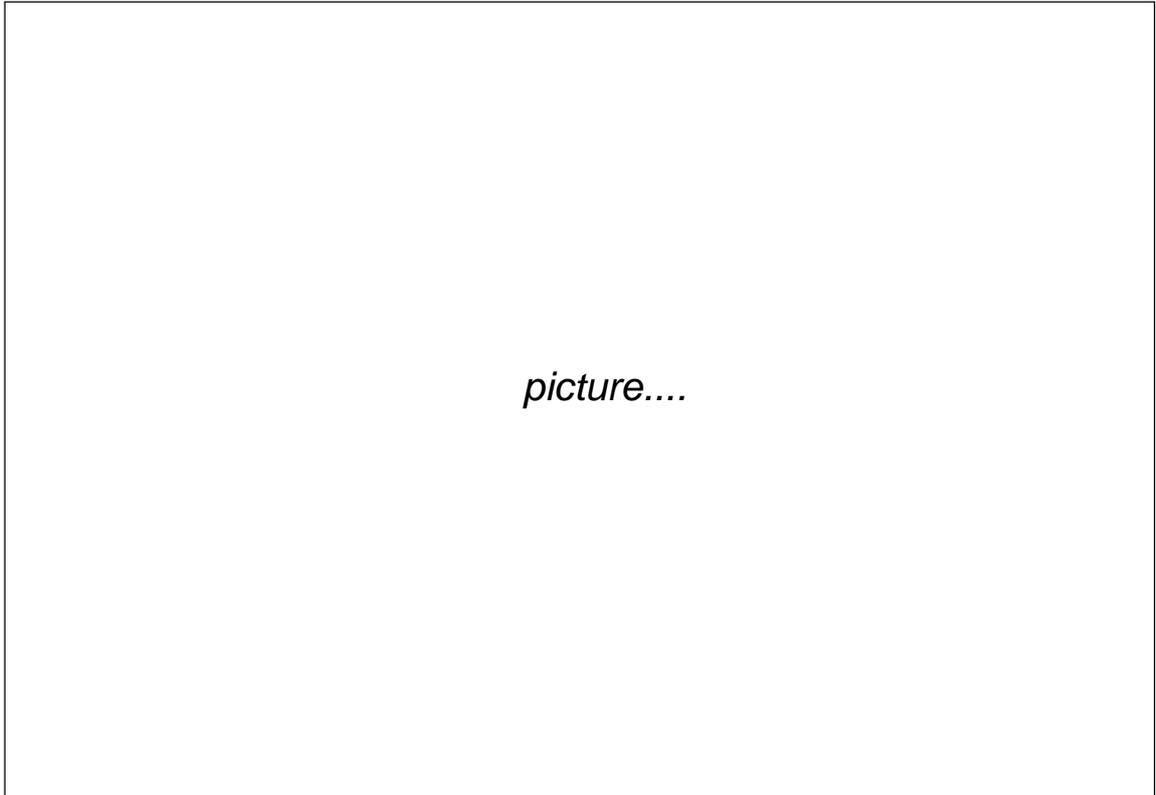
picture....

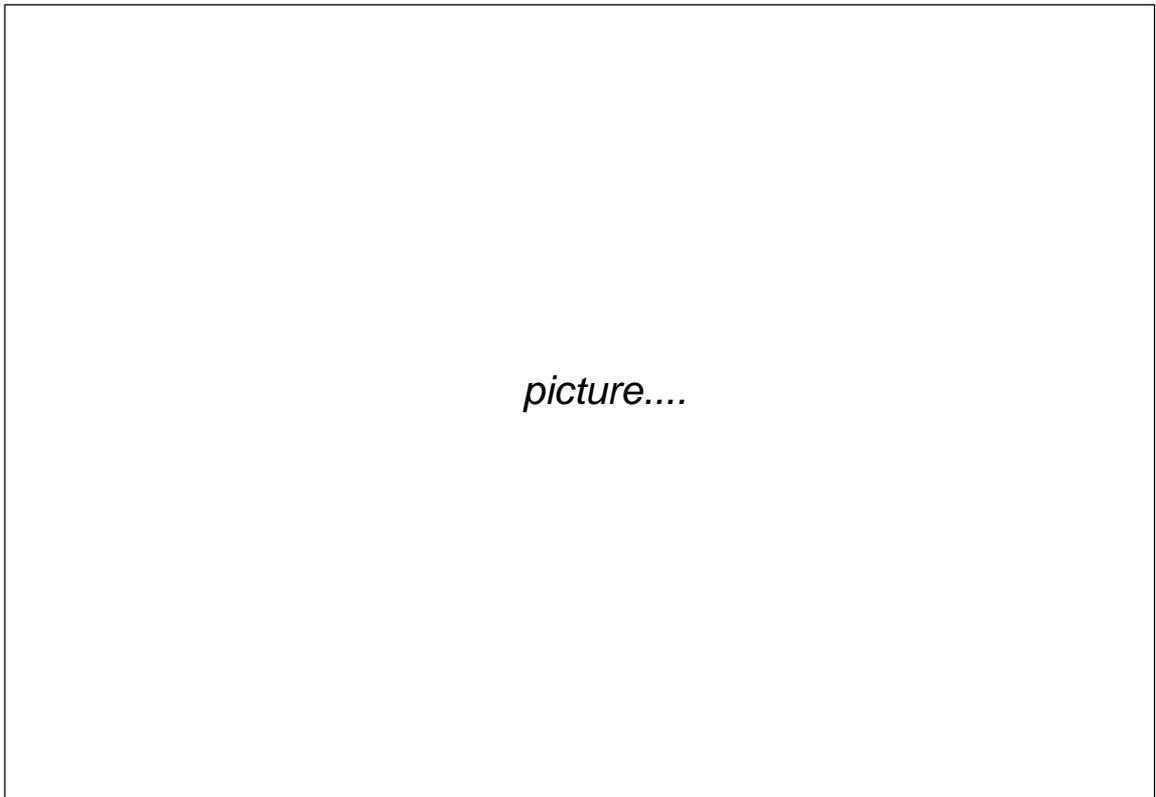Figure 6.18   A three-dimensional view of land valuation relief
with cadastral parcels before project.

picture....

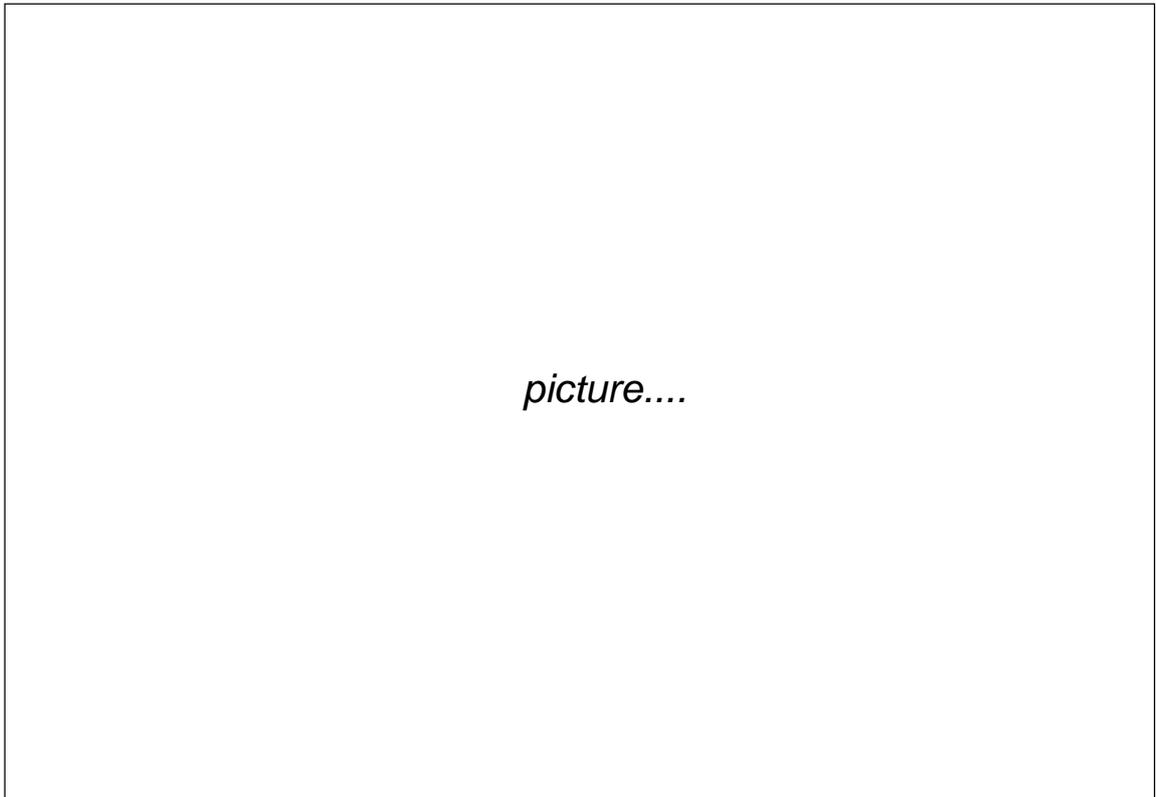Figure 6.19   A three-dimensional view of land valuation relief
with site lots after project.

picture....

Figure 6.20   A three-dimensional view of available utilitiy land valuation
factor relief with cadastral parcels.
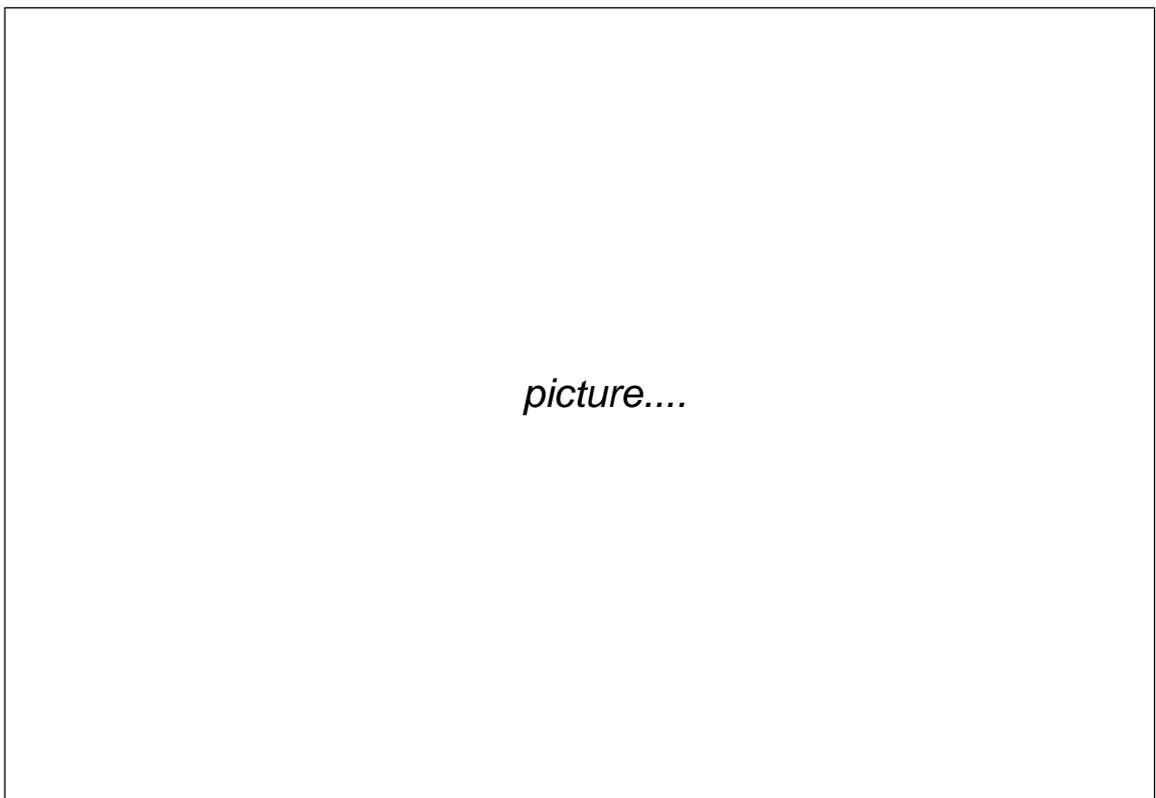
picture....

Figure 6.21   A three-dimensional view of permitted number of floor
land valuation factor relief with site lots.

6.6   Chapter summary

In order to perform the spatial analysis and display requirements of value-based land readjustment process, a prototype model called LARES has been developed. This chapter has described the main functions of LARES with illustrated examples. The development of LARES was mainly based on ARC/ INFO GIS system. Using ARC/ INFO functions, a menu-driven system was designed to provide a friendly user environment.

LARES has five main modules to perform the certain tasks. *ARC* module, for example, provides all functionality of ARC/ INFO including Arcedit, Arcplot, Tin and Network utilities. *SUBDIVISION* module performs the land subdivision process. The site blocks are automatically subdivided into the new patterns according to land-use planning details. *VALUATION* module analyses the land parcels with selected land valuation factors in property map and subdivision layout. Each selected factor is evaluated individually in both stages, before and after. All required information is stored in suitable formats for other uses, especially for land distribution. *DISTRIBUTION* module performs land redistribution using the results of land valuation analysis. Finally, *QUERY* module utilises the display of results for user's requirements. All process results both graphical and textual, including land valuation maps with 3D visualisations, street networks, ownership records, and land-distribution tables are stored for further use.