CHAPTER 8

CONCLUSIONS

> " The land is man's most valuable resource. It is indeed much more than this: it is the means of life without which he could never have existed and on which his continued existence and progress depend."
>
> (Binns, 1953)

8.1 Introduction

This research was undertaken because it was felt that the current implementations of land readjustment have not been used totally effectively for improved land management. The benefits of land readjustment therefore cannot be shared sufficiently by both government and landowners. The controlling of the rural-to-urban land use change requires careful analysis of spatial characteristics of the land; particularly economical, social, and planning dimensions. It was also considered that the existing information technology has not been introduced to land readjustment adequately, so the benefits of the technology cannot be enjoyed.

Based on the objectives of this thesis, a new approach to land readjustment has been investigated. A land readjustment prototype model which deals with *land valuation*, *decision-making*, and *information management* issues of current land readjustment procedures has been designed, developed and implemented using GIS. This chapter, first, summaries the research and discusses the developed model itself. Then, following specific conclusions, some suggestions for further works are included.

8.2 Research summary

The work began with a review of related literature and the problem definition. The research objectives and methodology were defined in Chapter 1. In chapter 2 the land readjustment method was described with its potential use for urban land management. The current status of the method with its objectives, characteristics, and its role to monitor a rural-to-urban land use change have been outlined.

In Chapter 3 the important issues of current land readjustment applications were categorised. These issues were subdivided under the heading of *land valuation*, *decision-making*, and *information management*. The solutions for these issues were analysed and a new approach to land readjustment proposed. This new method has been designed to increase the qualitative and quantitative ability of the land readjustment process. The conceptual design of this proposed model was also set out in Chapter 3 along with its development requirements.

To implement the designed model a prototype, called LARES, has been developed using the currently available land-related information technology. In Chapter 4, to integrate the land readjustment process with the land-related information systems, GIS and LIS have been reviewed with their potential use.

In Chapter 5 the software development has been explained with particular algorithms such as land subdivision, land evaluation and the distribution of new land parcels. During the software development the functionality of Arc/ Info was used as a GIS tool for the spatial analysis, data manipulation, storage and display. Some external programs were also used to support the computing environment. A menu-driven system was developed to perform the process in an interactive way so that the main tasks of the prototype LARES were executed from the series of pull-down menus. The menu system including data flow, file structure and particular modules of LARES are described in Chapter 6.

Finally, a case study was carried out to test an implementation of the developed prototype model. For this purpose Turkey, which practices land readjustment, has been considered and a review of land readjustment in this country was made in Chapter 7. Using data from Turkey, the prototype model was tested on a particular project area. The case study results were statistically analysed in order to understand the relationship between the used land valuation factors and implementation validity of the model.

8.3 General discussion

Land readjustment is one of the land management techniques used in urban development. The main objective of land readjustment is to transform undeveloped land parcels, usually irregularly subdivided cadastral parcels, into appropriate forms according to the zoning planning requirements. For this, all cadastral parcels within a project area are grouped together and a percentage of each land parcel calculated to determine a contribution to public areas. This percentage depends on the size of the project area and the total size of required public-use areas. The remaining land is then reallocated within the site blocks defined by the zoning plan

As given in section 2.10, land readjustment has some valuable advantages in solving land-use problems in urban areas but current implementations are still faced with some problems. These included technical problems in handling the wealth of data, economical problems in funding compensation for acquiring land, and social problems in minimising the inconvenience and conceived injustices. These problems were discussed in sections, 1.2, 2.11, and 3.2.

It was considered that there was a need for a better land evaluation process because in many cases the most significant criterion by which land is redistributed is the parcel size. Based on the parcel size and the public-use land area required in the zoning plan, a single coefficient is calculated and applied to all landholders to reallocate their land and derive their contribution for the public areas. From the economical point of view, this process cannot guarantee fairness for landowners because it assumes that land unit values are the same within the project area and they do not change after the project. Thus, in current land readjustment applications, especially in Japan and Turkey, many objections arise from landowners. They claim that an equitable land distribution is not provided after a project, because many other economical and environmental factors which affect a parcel value are ignored.

Land valuation is therefore important in land readjustment. Using the market unit values, it is possible to implement such a project. But difficulty is to estimate the parcel values before and after the project. The conventional way to estimate the value is to use real-market data. If such data are available, this can only be used for the present cadastral parcels. The real-market data for the new land parcels are also needed but to collect such data requires the completion of the project which may take a long time. In Germany and Japan, for example, the assessment of the new land parcels takes more than five years to complete so that the projects are delayed (see sections 1.2, 2.13.4).

To convince landowners that fair land distribution has taken place, the asset value profiles among the landowners before the project should be the same after the project. To achieve this, based on a wide range of significant criteria, the nominal asset values of land parcels can be derived before and after the project. Then, the land distribution is performed with respect to the derived asset values. In this case, regardless of the new land size and location, a landowner would obtain the land with its derived value that was the same before the project. So, based on this idea a new model has been designed and developed.

In this research, rather than dealing with the real-market data, the qualitative and quantitative characteristics of individual land parcels have been examined before and after the project. To estimate the parcel nominal asset value, 28 land valuation factors were selected and formulated (see section 3.3.2.3.1). In the assessment of importance of these factors, it was assumed that each factor value could have a maximum value of 100 for a fully developed land unit. In other words, each factor was evaluated out 100% (see section 3.3.2.3). Then, a land parcel value was determined with the combination of these factors. In here, as mentioned in section 1.4, the term *value* was used as a *nominal asset value* which represents a land parcel's worth when compared to others.

As mentioned above, there is a need to estimate the parcel values in both project stages, before and after. The cadastral parcels are available in the pre-project stage but the new land parcels are not. For the post-project phase the only available document is the zoning plan which represents the designed roads, public areas, and the bounds of site blocks. Therefore, first, the zoning site blocks need subdivision. During the subdivision process the new land parcels are created according to the given zoning data only. The subdivision process was discussed in section 5.5.1.

Following the land subdivision, both the old and new land parcels are analysed to determine the nominal asset values. Using these determined values, the total value before and after the project is calculated. The case study demonstrated that overall asset value in the post-project phase is greater than that in the pre-project because of upgrade in the whole area by applying the new plan (see section 7.6.3). But in order to achieve the equation [3.1] in section 3.3.2.3, the total asset value *after* was scaled down to match total asset value *before* (see section 3.3.2.3.2).

After the determination of the land unit values, land distribution is carried out block by block. As explained in section 5.5.4, first, the cadastral and new parcel are overlaid. The cadastral parcels which overlapped in a common zoning block are reallocated within the same block in accordance with their original location and the determined asset value. The main idea here is to fill a zoning block with the corresponding cadastral parcels with regard to their asset value and original location. This land distribution process was automated.

Land valuation analysis and the land distribution require an effective computing environment. Land valuation analysis, for example, deals with some land valuation factors which should be spatially examined in a defined geographical unit. In addition, data input, basic calculations, data extraction, manipulation and provision of all necessary information should be done precisely in a short period of time. Querying and display of any graphical or textual information are also important user requirements. To provide these, a GIS was used.

Using GIS technology, the designed model was computerised and a prototype called LARES developed. GIS provided a great advantage in the land valuation analysis. Some algorithms which perform particular tasks such as land subdivision, land distribution, the proximity analysis were also possible with GIS. More importantly, a user friendly computing environment was created for land readjustment application (see Chapter 6).

The functions of the developed model were implemented and tested with a case study. While the linkage of execution files were being tested, the model was modified. Finally, the case study results were statistically analysed and some remarks on the implementation validity of the model have been made in section 7.7.2.

Using 15 land valuation factors, the test result shows that most of the land valuation factors are significantly different at the 0.01 statistical level (see sections 7.7.2.1, 7.7.2.2). It was found that the factors *access to street*, *environment*, and *usable area* have higher effects on the asset land value than the other land valuation factors. On the other hand, the factors *utilities* and *distance to noise* have the lowest effect on the asset value. In addition, the validity of the model were tested with different land parcel groups. The test results indicate that when the model is applied to other land parcel groups, 95% of the results will be the same (see section 7.7.2.3).

Due to the time and financial limitations it was not possible to implement this land readjustment model on a current project. For a better assessment of the nominal asset value-based land readjustment model, some pilot projects are necessary. Such projects would help the evaluation and modification of the developed model. However, some suggestions for further work have been given in section 8.5.

8.4 Results and conclusions

The following conclusions can be drawn from this research project:

1. ***A new approach to land readjustment was proposed, designed and developed.*** To maximise the benefits from the land readjustment process the current land readjustment applications were evaluated (see chapter 2, section 3.2) and a new approach for the process was designed and developed (see sections 3.3, 5.2, 5.5).

2. ***A land valuation analysis was involved in land distribution***. To provide a fair land distribution process for landowners, the significant tangible and intangible land valuation factors were spatially analysed and the nominal asset values of land parcels were determined with the combination of these factors (see section 3.3.2.3.2). Then, based on the calculated land valuation parameters, land distribution was achieved so that while the original location of a cadastral parcel is changing, its asset value is maintained after the project (see sections 5.5.4, and 7.7). In this way, all landowners are treated in similar fashion.

3. ***A survey was carried out to give priority to the selected land valuation factors with respect to their effects on the total perceived value of a land parcel***. The survey results with 202 responses showed that the factors;

supplied municipal services, permitted number of floors, permitted construction area, view, environment, location within site block, and access to street are more important on the total perceived value of a land parcel than the factors; *distance to fire station, police station, religious places, access to waterway, and railway* (see section 3.3.2.3.3. a, b and Appendix B).

4. ***It has been demonstrated that it is possible to implement the land readjustment model using GIS techniques.*** It was only conceivable to handle such a large quantity of spatial data using GIS. During the development of the model, the map overlaying, buffering, data extraction were made possible by GIS (see section 5.5.2). To automate the model a menu-driven module called LARES was developed using the GIS tool Arc/ Info (see chapter 6). This provides a user interface for data input, storage, manipulation, and output. Querying land readjustment results, particularly the relationship between the old and new land parcels, was also provided by pointing to the required land parcel (see section 6.5.2).

5. ***An algorithm for the automation of land subdivision process was developed.*** A site block was automatically subdivided with the given zoning codes such as minimum street frontage and area (see section 5.5.1). To modify the created land parcels a *subdivision* module was developed with the aid of ARCEDIT (see section 6.4.2).

6. ***An algorithm automating the connection of land parcels to roads was developed.*** The linkage of a land parcel to road is essential for the proximity analysis within the land valuation analysis (see section 3.3.2.3.1.p). To create and extend a street network, the new line segments from the parcel's centroid points to the closest road points were

automatically created. This provided a geometrical and topological connection between land parcels and the road network (sec section 5.5.2.i)

7. ***The developed model has been tested with a case study.*** The value-based land readjustment procedures have been implemented with a case study to examine the effects of the process. The results showed that individual land parcel values are relatively different and the total asset value of the project area increases after the project (see section 7.6.3). When the unit value is concerned, even a small land parcel can be more valuable than a large one (see section 7.7.1).

8.5 Suggestions for further investigations

The previous section in this chapter has summarised the main results and conclusions from this work. There are however more analyses and development work that could be carried out in this area. This section will summarise some suggestions for further work:

1. ***Evaluation of the value-based land readjustment model.*** To evaluate the developed model more implementations are required. For this, the model would apply to a project area where land readjustment has been already implemented. Then, the land distribution results can be compared in terms of parcel size and value. However, it could be difficult to compare the estimated land parcel values with the real-market value because different valuation criteria may be taken into account to determine the parcel value. However, it should be considered that even the real-market value does not reflect the exact value because it is also an estimation process. Nevertheless, the developed model and

real-market value profiles among the land parcels can be examined. To provide a trusty value profile for real-market data, some long term observations on the market would be needed. Thus, it may possible to compare the current cadastral land parcel values. But the assessment of the created new site lots is difficult in a short time because it requires to observe the situation, at least, after the initial land developments in the project area. So, the evaluation of the developed model, with respect to real-world, requires some long term iterative investigations with the pilot projects.

2. ***An effective land valuation analysis***. The analysis of land valuation factors is the most important part of the value-based land readjustment process. Land parcel asset values are determined with the combination of some objective and subjective valuation criteria. However definition and representation of these factors is unclear because these are the tangible and intangible factors that depend on the project type, location, and the desire of landowners. Better formulation for the individual valuation factors and weights for these factors would be achieved with a more organised and iterative survey methods such as *Delphi Method.*

3. ***Investigating and collecting of different types of data for land valuation procedure.*** Data sources are different for a value-based land readjustment process. Considering the selected land valuation factors, different types of data with different quality are required from different organisations. Field survey may also be required for a particular land valuation factor. Therefore, a procedure for data collection and distribution of the produced information can be investigated. This would increase the efficient use of the land-related information.

4. ***Full automation for land subdivision.*** Land subdivision process works with more regular geometrical figures. The subdivision of a polygon which can fit in a rectangle is done easily. But the polygons with more complex shapes are difficult to subdivide. Thus, the subdivision algorithm stops if the polygon is not subdivided after an iteration process. The full automation of land subdivision can be achieved by the examination of the different geometrical figures. The positions of the polygon line segments with arcs, node, and angle should be analysed.

5. ***The use of expert system in land readjustment***. Information technology is changing very rapidly. Today artificial information systems are used in the decision-making procedures. To provide an optimisation procedure in land distribution process, an expert system could be introduced to land readjustment. The expert system rules which concern how to distribute or consolidate landowners shares and how to find the suitable locations for the new site parcels can be written.

8.6 Concluding remarks

The initial aims of this research have been achieved. A new prototype model which provides a nominal asset value-based approach to land readjustment has been designed and developed. GIS was used to capture, manipulate, analyse and display spatially referenced data during the development. The prototype model specifically deals with the land valuation, decision-making, and information management issues of the current land readjustment applications. It is hoped that the developed model not only improves the qualitative and quantitative ability of current land readjustment applications but also increases the speed of urban land planning activities in developing countries.