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# A VALUE-BASED APPROACH FOR URBAN LAND READJUSTMENT

# UNE APPROCHE VALEUR-BASE POUR LE REMANIEMENT URBAIN

EINE WERT-BASIERTE METHODE FÜR STÄDTISCHE FLURBEREINIGUNG

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#### ABSTRACT

Land readjustment (LR) is a planning tool to assist in orderly urbanisation. It aims to convert undeveloped land plots into suitable forms for public and private use according to town planning requirements. LR has great advantages in solving the land-use problem in urban areas but current LR applications are still limited in many ways. The paper explains these limitations and proposes an alternative LR approach which is based on a multi-criteria land valuation process.

#### RESUME

Le remaniement urbain est un outil de planning pour assister à une urbanisation régulière. Le but est de transformer des régions pas encore dévelopées à une forme convenable pour l'utilisation publique et privé. Le remaniement urbain a des grandes avantages en supportant le problème de l'utilisation du sol dans des régions urbaines, mais les applications utilisées aufourd'hui sont toujours très limitées. Cet article explique ces limitations et propose une approche alternative qui se base sur un procès de multi-critère.

#### ZUSAMMENFASSUNG

Die Flurbereinigung ist ein Planungswerkzeug, das die geordnete Stadtentwicklung Der Zweck ist noch nicht entwickelte Gebiete in geeignete Formen für unterstützt. öffentlichen und privaten Gebrauch gemäss städtebaulichen Kriterien umzuformen. Die Flurbereinigung bietet grosse Vorteile bei der Lösungssuche für Landnutzungsprobleme in städtischen Gebieten, doch sind heutige Planungsmethoden noch immer in mancher Hinsicht mit Limiten behaftet. Dieser Artikel bringt dem Leser einige dieser Limiten näher schlägt eine alternative Methode vor, die auf einem Multi-Kriterienund Landbewertungsprozess basiert.

### **1. INTRODUCTION**

The rapid urbanisation has dramatically and continuously occurred in most major cities in the developing world. Thereby, these cities are faced with a lack of readily available land and this causes public services to fall further and further behind the demands of urbanisation (Doebele, 1982). For a better urban development, there is a need for significant acquisition of urban land for public purposes such as roads, housing, schools, hospitals, parks, markets, and other public facilities. In order to provide these new services as rapidly as they are needed to support rapid urbanisation, local government authorities must contrive some efficient land acquisition strategies for new settlements and built-up areas.

Many methods, such as nationalisation of land, government ownership of peripheral areas, special taxation on the benefits received by parcels from the installation of public services, land compensation and others, have been practised to resolve the urban land problems (Dunkerley, 1983; Kitay, 1985). Among the most interesting known devices in this field is *land readjustment*. This paper, first, describes the land readjustment process including the current issues with its implementation, then explains a new approach to land readjustment. The integration of land readjustment with geographical information systems (GIS) is also included.

### 2. LAND READJUSTMENT METHOD

Land readjustment (LR) can be defined as an instrument for land organisation, which means both the provision of land needed for public purposes and the suitable formation of private land according to the rules of town planning (Seele, 1982). The process aims to take rural or unplanned urban land, usually irregularly subdivided, and reallocate it, in the required balance, for public and private use according to town planning requirements. In other words, all land 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 (Figure 1).



*Figure 1*: The calculation procedure in land readjustment method

LR is one of the effective urban land acquisition methods which is mostly practised in Germany, Japan, South Korea, Australia, and Turkey (Archer, 1992; Yomralioglu, 1992). Conceptually, it aims to control rural-to-urban land-use changes according to town planning requirements. It is a crucial land management tool in urban development when suitable reformation of private land is needed for residential purposes. LR is a method by which the city government, other designated public bodies, or even private associations can participate directly in the process of urbanisation and thereby share in its profits (Rainer, 1992). After a LR project, a city will be able to reorganise its urban development, and the private landowners will receive new lots nearby to their original location. LR projects also provide an opportunity for simply and inexpensively resurveying the land and demarcating new lines (Chou and Shen, 1982). In addition, some of the advantages of LR can be given as follows (Doebele, 1982);

- Land readjustment permits fragmented and scattered land holdings to be consolidated into a single unit for better planning, servicing, and subdivision,
- Land readjustment permits the public agency concerned to recover costs while private owners receive some of their land back, ready for building,
- A prerequisite and advantage is that it renew cadastral and land registration in those areas of a city under most pressure for development,
- Land readjustment permits an orderly and efficient method of obtaining sites for schools, parks, markets, and all other needed public buildings and facilities.

Besides the improving land utilisation for government, LR is also a significant method for landowners to economically improves the use of their land. In essence, some benefits of land readjustment for both government and landowners may be summarised as in Table 1.

### *Table 1.* The benefits of land readjustment

#### Land readjustment benefits for the government

- Compensation expenses for public-use land are greatly reduced so that the provision of public areas is captured in a more economical way,
- A zoning plan is realised in a short time, and urban land development projects are achieved rapidly,
- Tax revenue increases within project area. This provides an extra source to government,
- The land development programmes in urban fringe areas are systematically carried out,
- The existing cadastral records are updated, reorganised and cadastral administration is improved.

#### Land readjustment benefits for landowners

- After the project, land values increase very rapidly and land become more valuable for landowners,
- A cadastral parcel is re-shaped and transformed into a sufficient site lot that can be used more economically,
- Because of the effects of LR project are same for every landowners, disputes about land planning injustices are reduced,
- At the end of the project, basic public services are supplied to new lots, therefore the new social services are brought into to the project area,

#### **3.** The issues with current land readjustment applications

Due to the widely varying conditions in the cities of the world, in cultural attitudes toward land, and in political and institutional structures, no single form of LR can be universally applicable. While the main concept of LR has been maintained in all applications, current implementations are examined in different ways from country to country. So, while LR having great advantages in solving the land-use problems in urban areas, the process still faces with some common issues.

A significant criticism is that LR has succeeded in providing physical facilities, but that it neglected social aspects of urban life and failed to improve the community environment as a whole. An equally significant criticism is that the major beneficiaries are only large landowners. At the same time, landowners have protested at reduction of their land area without compensation through the readjustment process (Akyol and Tudes, 1987). It also experienced that a land readjustment project takes 5-10 years to complete as a result of some of social, political, economical, and technical requirements (Satoh, 1986). Considering the technical aspect of land readjustment, some of the common major problems with the present implementations may be classified as follows:

### 3.1 Land Valuation

During the project, there is no dynamic land valuation analysis. In most cases, land unit value is not involved 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. Redistributing land on an *area* rather than a *value* basis, does not provide an equitable approach for the landowners, because many other factors which affect a parcel value, are ignored. Such factors include, land-use, topography, shape, view, proximity to commercial areas, other public facilities, etc. However, during the project, each basic geographic unit of a land parcel should be characterised by a set of some economic, environmental, and spatial attributes.

#### 3.2 Decision Making

Land re-distribution is the most crucial part of the entire process. In this stage, cadastral parcel boundary locations are changed and landholders are moved to new locations by the planner's judgement only. Due to a non-standardised land re-distribution process, the planners often have difficulty in making a decision about the new land parcel locations. The landowners are, therefore, at risk, because different approaches provide different land locations and benefits to them. Land re-distribution itself is a complex task which requires highly specialised expertise because there are many questions that should be analysed. In regard to the priorities of zoning plans, the questions are, for example, who will receive the new parcels; how will land be evaluated; what criteria and land characteristics should be considered; how will landholders be redistributed or be consolidated so that landowners will be satisfied, etc.

# 3.3 Information Management

Analysing existing spatial information, searching legal land records and providing outputs for land readjustment applications are done with conventional manual methods which are time-consuming and error-prone. Sometimes, the information is not readily available for later use because of poor information management. Following the procedures in land readjustment calculations is a difficult task that requires great responsibility and accuracy. When any small mistake happens, whether technical or non-technical, it can mean repeating all the land readjustment processes. Sometimes unnecessary duplication can occur too. Therefore, information cannot be managed effectively and efficiently. In order to deal with all kinds of data within a considerable time period, a capable information management environment for land readjustment should be established with the aid of currently available spatial information technology such as GIS.

### 4. A NEW APPROACH FOR LAND READJUSTMENT

In order to deal with the current issues of LR process and improve the potential use of LR, a new model which is a nominal asset value-based land readjustment has been developed using the GIS (Yomralioglu and Parker, 1993). The main objective of this model is to determine the asset value of a land parcel before and after the project with possible land valuation factors, then give back a new parcel to the landowner with the same asset value as that owned before the project. In other words, a parallel condition between the land parcels asset value profiles before and after the project must be provided so that all landowners who are involved in the project are affected in the same way from the land-use plan.

In this approach, due to the difficulty of collecting real-market value data, numerical parameters are intended to be calculated and used of for each land parcel rather than using the real-market value. To determine these parameters, each geographical unit of a land parcel is analysed with the selected land valuation factors. A land parcel value can then determined nominally which represents all factors effecting the land parcel as compared to others.

#### 4.1 Calculation of the land parcel's nominal asset value

In reality, the determination of an exact value for a land parcel is almost impossible but an estimation of the asset value can be conceivable. To estimate the value, some land valuation factors which can affect the total perceived value of a land parcel have been selected and spatially examined with the developed model. The list of considered land valuation factors are given in Table 2.

1)	SUPPLIED BASIC SERVICES	15) DISTANCE TO EDUCATIONAL CENTRES
2)	PERMITTED NUMBER OF FLOORS	16) DISTANCE TO HEALTH SERVICES
3)	PERMITTED CONSTRUCTION AREA	17) ACCESS TO HIGHWAY
4)	LANDSCAPE, VIEW	18) DISTANCE TO SHOPPING CENTRE
5)	ACCESS TO STREET	19) AVAILABLE UTILITIES
6)	ENVIRONMENT	20) DISTANCE TO RECREATIONAL AREAS
7)	PARCEL LOCATION WITHIN BLOCK	21) TOPOGRAPHY
8)	STREET FRONTAGE	22) DISTANCE TO RELIGIOUS PLACE
9)	DISTANCE FROM NUISANCES	23) DISTANCE TO PLAY GARDEN
10)	LAND PARCEL SHAPE	24) DISTANCE TO CAR PARKING AREA
11)	CURRENTLY USABLE AREA	25) DISTANCE TO FIRE STATION
12)	DISTANCE TO CITY CENTRE	26) ACCESS TO WATERWAY
13)	DISTANCE FROM NOISE	27) DISTANCE TO POLICE STATION
14)	SOIL CONDITION	28) ACCESS TO RAILWAY

*Table 2.* Land valuation factors which may affect a land parcel value

Using the selected factors, the parcel's asset values are estimated in both project stages, before and after. In the estimation process, first, the selected factor values are calculated. For the calculation of a factor value, it assumes that each factor can be evaluated out of 100%. Based on this idea, each land valuation factor has been defined by a specific equation. As an example, the determination of factor value for the soil condition, for example, is illustrated in Figure 2.

Following the individual factor value determination, the total value for a land parcel is determined by equation [1]. In this equation, the variable V represents the total nominal asset value for a land parcel while variable **f** represents the individual selected factor's value.

$$V i = AREA i * \sum_{j=1}^{k} (f_{ji} * w_{j})$$
[1]

**V** : Total nominal asset value of a parcel

- Area : Land parcel size
- **f** : Factor value
- w : Factor weight

k: Total number of factors n: Total number of old parcels m: Total number of new produced parcels



*Figure 2*: The factor value determination for soil condition

### 4.2 Land distribution

In a LR process, there are two main distinction stages that must be realised while performing the land valuation analysis. These stages are;

- (a) *Pre-project stage (Before)* which represents the current cadastral land parcels. These parcels are considered as the original input parcels of a LR project . In this stage, all land parcels are evaluated and classified by their existing suitability without referring to the urban land scheme.
- **(b)** *Post-project stage (After)* which represents the new site lots. These lots are created according to the detailed zoning schemes which are basically provide the planned roads, streets, residential areas and other public and private places. In this stage, all

given site blocks are carefully subdivided into suitable lots. The created new lots are then considered as the output parcels and evaluated with respect to the planning details as if these lots were fully developed.

The land valuation analysis is carried out differently in both these stages. Considering the suitable land valuation factors, the parcel values are calculated by equation [1]. Then, the total asset value of the project area is determined in both stages by following equations;

$$\begin{split} \boldsymbol{\Sigma} \mathbf{V}_{before} &= \mathbf{V}_1 + \mathbf{V}_2 + \dots + \mathbf{V}_n \\ \boldsymbol{\Sigma} \mathbf{V}_{after}^{} &= \mathbf{V}_1 + \mathbf{V}_2 + \mathbf{V}_3 + \dots + \mathbf{V}_m \end{split}$$
 [2]

n = Total number of old parcels
 m = Total number of new produced parcels

The main purpose in a value-based land readjustment is to provide the equation [4]. In practice, this may not always possible. Thus, to accomplish the equation [4] with the determined valuation parameters, a z scale coefficient is used. Using equation [5] the scale coefficient is determined and apply to all new land parcels which the unit values were initially estimated. As a result, the nominal asset values of the new land parcels are relatively changed and determined for the distribution.

$$\sum_{i=1}^{n} V (BEFORE) i = \sum_{i=1}^{m} V (AFTER) i$$
[4]

$$\mathbf{z} = \left( \Sigma \mathbf{V}_{before} / \Sigma \mathbf{V}_{after} \right)$$
[5]

After all these calculations, land distribution is carried out with respect to the estimated asset values before and after. The main objective in the land distribution is to give back a new land parcel to a landowner with the same nominal asset value that had before the project. Land distribution is done block by block. First, the cadastral and new parcel are overlaid. Then, the cadastral parcels which match a zoning block are grouped and reallocated within the same block in accordance with their old location and the input value. In this process, the total value of the grouped cadastral parcels are compared with the total value of the new lots within the block. If the total value of the cadastral parcels is not sufficient for the zoning block, than the closest parcel or parcels to the block are included in the cadastral parcel's group. The main idea here is to fill a zoning block with the corresponding cadastral parcels regarding the value and their original location. When sufficient value is provided for the whole block, then land distribution is accomplished within the block parcel.

#### 5. INTEGRATION OF LAND READJUSTMENT WITH GIS AND ITS IMPLEMENTATION

The land valuation analysis and land distribution are the most complex procedures of the entire process. These procedures require an effective computing environment which has the ability to make spatial analysis. In addition, data collection, handling, manipulation, display and production of all necessary information should be done very quickly and accurately. Querying and display of any graphical or textual information is also important for the users. Therefore, the use of some spatial analysis tools such as a GIS was essential.

GIS has the ability to handle all required graphical and textual data within a computer system so that any desired new information can be reached and derived from that which exists (Maguire, 1991). GIS also provides great functionality to deal with complex spatial data analysis that the value-based land readjustment requires. Using the capability of **Arc/Info** GIS system, a menu-driven prototype model called **LARES** (**LA**nd **RE**adjustment System) has been developed. The *Arc Macro Language* (AML) and *Fortran* are used for the programming requirements. The implementation is based on the land valuation analysis idea detailed above. LARES has a friendly user interface with its main functions within the process so that a user can interactively and easily perform the required procedures. In LARES, all the technical tasks are executed from series of pull-down menus (Figure 3).



*Figure 3*: The LARES menu interface

For the implementation of the prototype model, the required data are basically derived from the cadastral, zoning, thematic, and topographical maps, and from the other related textual records. The first stage after capturing all necessary data into the system is land subdivision. In this stage, site blocks delimited on the land-use plan are subdivided into the sufficient new land parcels.

Then, the cadastral land parcels on the property map and the newly produced site lots are analysed. Factor values for those parcels both before and after are determined with the selected land valuation factors. In this phase, the selection of a land valuation factor is optional. More than a factor can be selected to analyse a parcel value. After the land valuation analysis, the nominal asset values of each land parcel are determined before and after the project (Figure 4). Land distribution is then executed. Based on the calculated nominal asset value figures, each land parcel is reallocated within the site blocks in an optimal fashion. (1994) - YOMRALIOĞLU, T., A Value-Based Approach for Urban Land Readjustment, FIG.XX International Congress, Commission 8, Paper no:805.4, p.1-10, Melbourne, Australia 805.4/9



*Figure 4*: The data process in the value-based land readjustment model

### 6. **CONCLUSIONS**

Land readjustment provides a practical approach to rural-to-urban land-use transformation by dealing with economical, social, and planning characteristics of land. It is a great planning tool to assist in systematic urban land development. Land readjustment also increases land utilisation to meet the ideal of *best possible use of land* saving government a great deal of money, project time, and creating or updating all land-related records.

Despite the fact that land readjustment is an effective approach to provide new built-up areas there are still some issues by the process. Land valuation analysis, for example, has not been dynamically involved in current implementations. Many substantial factors which may affect land parcel's value are ignored during a project. Therefore, planners have difficulty in making decision about the new parcel locations and landowners become dissatisfied because different approaches provide different land locations and benefits to them.

However, to increase the effectiveness of land readjustment, a nominal asset value-based land readjustment model has been developed using GIS. The main objective in this model is to determine *the asset value* of a land parcel before and after a project, then giving back a new parcel to a landowner with the same value that owned before the project. For this purpose, different land valuation factors are formulated and spatially examined. Then, based on the determined nominal asset values, land distribution is accomplished. Using such a approach, the nominal asset value profiles among the landowners are preserved after the project so that the planning effects can therefore be shared similarly by all the landowners who are involved in the project.

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