

# **An Implementation of Nominal Asset Based Land Readjustment**

**Tahsin YOMRALIOGLU, Recep NISANCI, Volkan YILDIRIM**

**Keywords:** Land readjustment, GIS, land value, nominal land valuation method

## **SUMMARY**

The land-use problems confronting urban areas are usually traced to rapid urbanization and massive urban growth in the recent decades. Such changes will result in a need for significant acquisition of urban land for public purposes such as, roads, schools, hospitals, parks. In order to provide new services as rapidly as they are needed to support rapid urbanization local government authorities apply Land Readjustment (LR) which is one of the most important tools in planning process.

The determination of land valuation factors is essential in a LR project. In a value-based LR project, the main aim is to give back a new land parcel to a landowner with the same value as that owned before the project. For this purpose, using GIS, some land valuation criteria which can affect the total perceived value of a land parcel are spatially examined and value parameters are determined from the combination of these criteria. This approach is called as “Nominal Asset Based Land Readjustment (NABLR)”.

In this study, NABLR approach has been applied and examined in a pilot project area in the city of Trabzon, Turkey. In this content value distribution of land is obtained with different parameters by formulating some criteria of land values, to find out the unit value of land using nominal land valuation method rather than the prices determined by market conditions. Nominal unit values determined as a function of the factors that affect the value of the land were dealt as pixel based and the implementation of the model was carried out for LR. The parametric criteria used in expression of land values in pixel units were obtained by choosing a combination of factors of land value by utilizing the characteristics of spatial analysis of GIS.

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## **1. INTRODUCTION**

Since land is a limited natural resource for human activities, it requires effective management systems. Especially, rapid urbanization requires serviceable land for public and private needs. Land Readjustment (LR) is a crucial planning tool in order to provide new settlement lands in urban and rural areas. Because a sustainable urban development cannot usually be reached within the existing plot boundaries, it often requires a total change in the situation of the land ownership. It is an effective method to transform irregularly shaped cadastral parcels to appropriate plots that can be used in more economical manner. The main advantages of the method are the reduction of project time and its application in large project areas (Doebele, 1986). LR is often used by municipalities in order to provide new built-up areas for urban development needs. Using this method, available zoning plans are reflected on to land and new lots are created in a short time.

In order to reduce the objections and to increase the productivity of LR, all land parcels within the project area should obtain the same advantages from the project. In other words, the land value profile before the project should be reflected in the same way even after the project. To provide this, instead of using unit area, parcel unit value should be used. Because of the difficulty of real estate market data availability, the unit value approach has to be re-examined. However, a numerical parameter can represent a land parcel value rather than a real market value. To achieve that, all land parcels before and after LR project, should be examined with selected valuation criteria. Because of the complexity of this approach, computer use is essential. Geographical Information Systems (GIS) have the ability to deal with such spatial data analysis. However, GIS have already been widely used in many urban planning applications (Maguire, 1991).

In this article, in order to maximize the benefits from the LR implementations, a value-based approach to LR system is explained. Using GIS, the analysis of spatial data and production of pixel based valuation maps of project areas are also included. In this approach, many factors defining the economical, environment and spatial value of land parcels are analyzed before and after reallocation to ensure equality in the re-distribution process of LR.

## **2. THE CONCEPT OF LAND READJUSTMENT**

Many countries use classic instruments like compulsory purchase or expropriation for urban development. But those instruments often cause the resistance of the landowners who do not want to lose their plots. Controversial negotiations, irregular demands on compensation as well as longsome court proceedings can follow. Those effects might cause an extreme delay in realization of sustainable urban development (Jokel, 2004). LR is a technique for managing the urban development of urban-fringe lands, whereby a group of separate land parcels are assembled for their unified planning, servicing and subdivision as a single estate, and

redistribution of new building lots back to the original landowners (Archer, 1992). The process primarily takes the unplanned urban land and reallocates it in a more effective use with respect to zoning planning needs (Yomralioglu and Parker, 1992).

A typical LR process begins with the preparation of a zoning plan by the municipality. On the zoning plan, within the site blocks which formed by the streets, lots are allocated for private development. The area for public use are then determined by measuring the square meters in the planned streets, parks, and so forth and comparing it to the total area of project (Doebele, 1982). 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 blocks defined by the plan (Figure 1). To do this, first, each site block is subdivided into suitable new lots, and then land redistribution is carried out. The basic principle in the distribution is to keep land in nearby its original location, at least in the same block.

LR have notable advantages in solving land-use problems for urbanization but there are some issues which affect the adequate use of the process (Satoh, 1986). One effect of the planning system is that it can have a significant impact on land values (McGill and Plimmer, 2004). Land valuation for example has not been dynamically involved in the entire process. Many substantial criteria which may affect a land parcel's value are ignored during the process. As a result of this, inequitable land distribution occurs to the original landholders so that their benefits differ from the project.

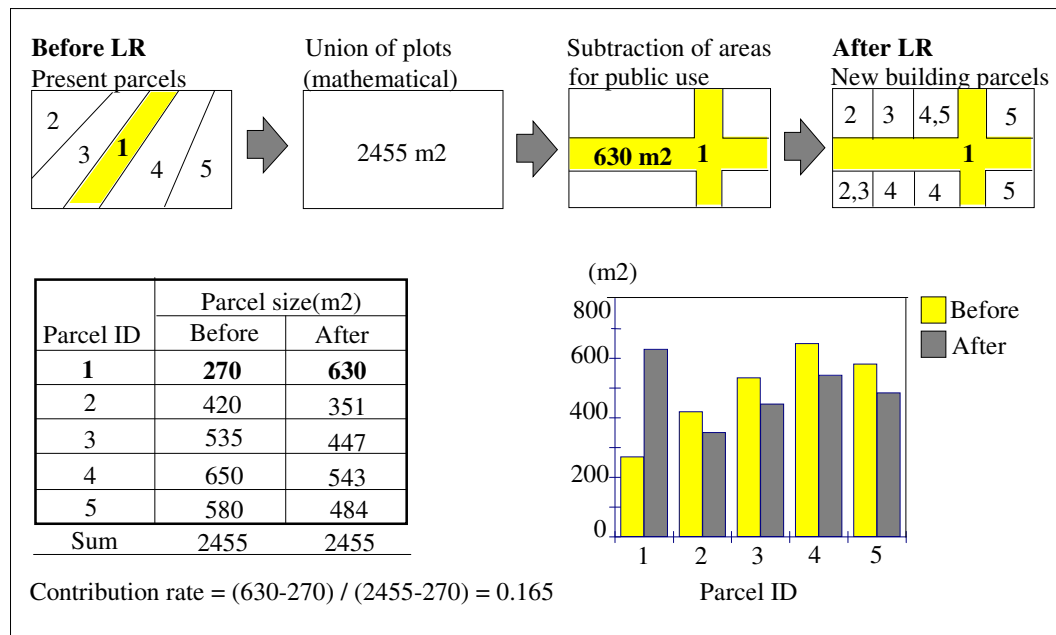


Figure 1. A land readjustment process based on parcel size

Due to there not being a standardized land distribution process, the planners have difficulty in making a decision about the new land parcel locations. Land redistribution itself is a very complex task which requires a massive spatial data analysis. In regard to the priorities of zoning plan and cadastral layouts, there are many questions that should be answered by planners. Such questions are, how will land be evaluated; what land characteristics should be considered; who will receive the lots; how will landowners be redistributed or be consolidated so that landowners be satisfied, and so on. Managing the data flow is also insufficient in the current applications. Because of poor information management processes the entire procedure is time consuming and error prone. This causes some undesirable duplication during the project adding to the expensive of the project.

### **3. RASTERIZED LAND VALUATION PROCESS**

#### **3.1 Land Valuation**

Evaluation of real estates became last time a very important and indispensable element of real estates management. Consequently, new and improved methods of estimation are needed (Baranska, 2004). At present, the market value is estimated in two ways: by single valuation and mass appraisal. In the course of property valuation for taxation in most cases the single valuation is not applied since it is too time and work consuming, and in some way expressing a subjective opinion of a valuer; difficult to apply for valuation of many property objects, also the costs are too high (Bagdonavicius and Ramanauskas, 2004). Using the comparison method of valuation, physical, legal and market factors can be compared directly but every property are spatially unique, so spatial factors requiring an alternative method of adjustment. Such properties would be good comparable evidence, although rare in practice. Most enterprises consider location as the most important single factor when choosing the premises. The most essential factor in the location is good accessibility (Viitanen, 2004). Indeed, many factors that can influence land values and because of the different perceptions and interpretations that are made about how such capture can or should be undertaken (McGill and Plimmer, 2004).

Land valuation is a process of assigning values to land locations. Land value has to be determined in process of buying, selling, leasing or taxing it or when there is a need to calculate assets held by an individual or business (Dale and McLaughlin 1999). Three most commonly used methods of valuation are: sales comparison, income capitalization and cost approach method. Choice of method is greatly determined by property type and the purpose of valuation. Mentioned methods are most suitable for valuation of built-up land and professionals are still irreplaceable in a process of appraisal. However, fast and efficient information system could be a big help in the process (Tomic and at all, 2004).

Generally, real estate values which have same region or street are same. Whereas, each real estate can has positive or negative characteristics in economic perspective from neighbor real estates (Nisanci and Yomralioglu, 2002). For this reason, by evaluating in a region is existing properties, value dispersion between these properties under consideration should be determined. In this value dispersion process, base unit may be the real property value or parametric values obtained by grading effective factors on property. In this aim minimum and

maximum points are determined by formulizing value criteria taken into consideration, and a value coefficient representing each property is calculated. This value coefficient shows property situations between each other in respect of the value, and these values are easily converted to real value when needed (Yomralioglu, 1992).

The most significant process for land valuation is determined of the weighted factors effect real estate values. Thus, the value specified for a unit area can be reflected to all real estates with same proportions. This method is named as “*nominal land valuation method*”. Respect to this method, *nominal values of real estates can be calculated in a parametric way instead of definite value*. Objective and subjective criteria selected for this aim are evaluated one by one (Yomralioglu, 1993; Yomralioglu and Nisançi, 2004; Nisançi, 2005).

### 3.2 Raster Based Systems

Due to the complexity of land valuation process, providing property owners with an easy understood explanation of how their property has been valued is a continual challenge for planners and assessors. Today GIS is able to execute all these complex tasks. To deal with land valuation requirements, a value-based LR can also help by the provision of valuation maps of project areas. Thus, using ArcGIS Grid modules, a visual value model and required valuation maps are also created by the value-based LR system. The system especially provides a sophisticated mass appraisal analysis by considering selected tangible and intangible valuation criteria.

GIS provides a technological platform on which to base such an analysis and an initial stage is the spatial representation of property information in the form of value maps (Wyatt, 1995). GIS capabilities not only facilitate the organization and management of spatial data, but they also enable researchers to take full advantage of location information contained in these databases to support the application of geo statistical. Using raster based GIS; a pixel which represents unit land value is defined as a weighted average of the environmental quality notes according to the following figure 2 and equation [1]. This is fulfilled the entire parcel which is both LR project stages, before and after.

In a value-based LR process, the main aim is to give back a new land parcel to a landowner with the same value as that owned before the project. In other words, total land value of all the land parcels should be equal before and after the project. In reality, it is almost impossible to determine an exact value for a parcel but an estimation of value is conceivable in many ways (Dale and McLaughlin, 1988). However, in the development of a value-based LR model, using equation [1], the land parcel values are estimated in both stages, before and after. In the equation, the variable  $V$  represents the total value for a land parcel or a pixel while variable  $f$  represents the individual selected factor's value. For the calculation of a factor value, it assumes that each factor can be evaluated out of 100. However, land valuation factors were formulated and the results were derived from spatial analysis by raster based GIS.

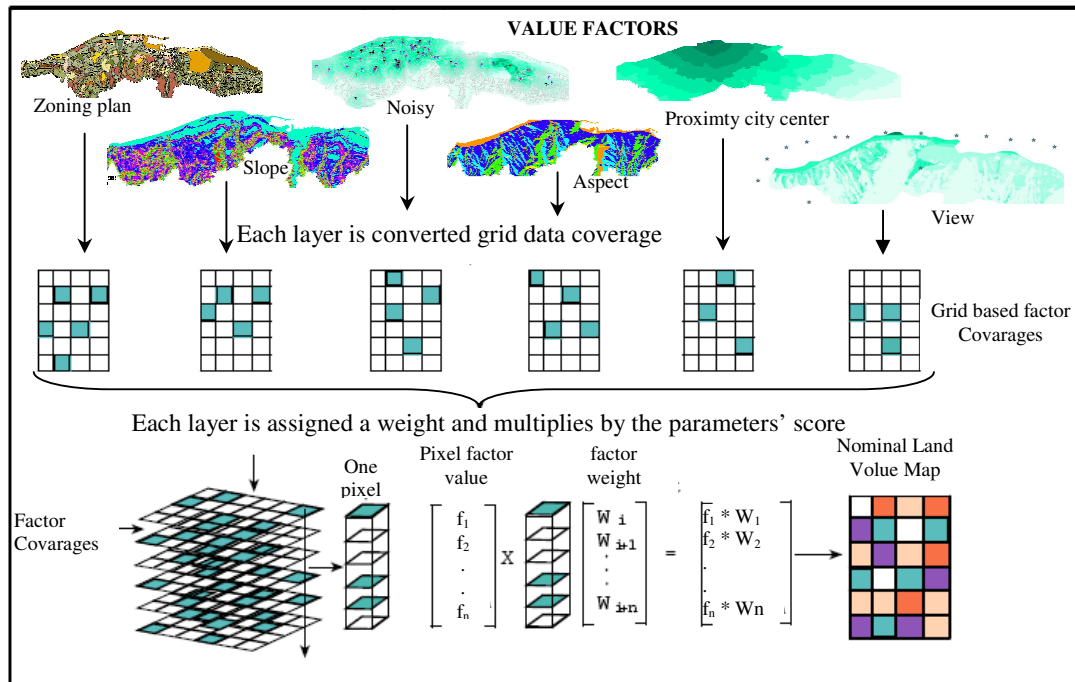


Figure 2. The Spatial analysis process of creating the raster based land value map

$$V_i = \text{AREA}(\text{pixel}) * \sum_{j=1}^k (f_{ji} * w_j) \quad [1]$$

<b>V</b> : Total nominal asset value of a pixel	<i>k</i> : Total number of factors
<b>Area</b> : Pixel size or Land parcel size	<i>n</i> : Total number of old parcels
<b>f</b> : Factor value	<i>m</i> : Total number of new produced parcels
<b>w</b> : Factor weight	( <i>i</i> = 1,2,..., <i>n</i> ) ( <i>j</i> = 1,2,..., <i>k</i> )

### 3.3 Calculation of the Nominal Asset Value

In a value-based LR approach, new parcels should be plotted before the project. In this stage, the maximum number of plots should be produced for optimum land-use. If a zoning plan exists for the project area, then subdivision can be performed according to this planning requirement. After that, parcel values are calculated for both old and new parcels. The main idea in the value-based approach is that total land values before and after must be equal [2]. Land values obtained to intersection of pixel based land value before and after.

In equation [2], variable (*V*) which is derived from [3] represents the total value for a pixel. In equation [3], variable (*f*) represents the each individual selected factor's value. In the calculation of factor value, it assumes that each factor value has a maximum 100 value for a well developed land unit. Then, each factor is evaluated out of 100. It is also possible to formulate a valuation factor. Equation [3] is applied to all the old and the new parcels to determine the valuation parameters. Then, the total land parcel values are calculated before and after the project by equations [4] and [5].

$$\sum_{i=1}^n V_{(BEFORE)} = \sum_{i=1}^m V_{(AFTER)} \quad [2]$$

$n$  = Total number of old parcels

$m$  = Total number of new produced parcels

$$V_i = \text{Area}_i * \sum_{j=1}^k (f_{ji} * w_j) \quad [3]$$

( $i = 1, 2, \dots, n$ )

( $j = 1, 2, \dots, k$ )

$V$  : Total value of a parcel

Area : Pixel size or parcel area

$f$  : Factor value

$w$  : Factor weight

$k$  : Total number of factors

$n$  : Total number of parcels

$$\sum V_{before} = V_1 + V_2 + \dots + V_n \quad [4]$$

$$\sum V_{after} = V_1 + V_2 + V_3 + \dots + V_m \quad [5]$$

In order to accomplish equation [2] with the determined valuation parameters, a  $z$  scale coefficient is needed. Using equation [6] this coefficient is determined multiplied by the new parcel's valuation parameters to find the exact valuation parameters that are subject to distribution.

$$z = (\sum V_{before} / \sum V_{after}) \quad [6]$$

After all these calculations, land re-allocation is carried out by considering the calculated land value's figures before and after. The main objective here is to give back a new parcel to a landowner with the same value that owned before the project. So, besides the planners, this approach will be satisfactory to landowners as well.

In order to determine the land parcel values, each pixel can be characterized by a set of economic, environmental, and spatial attributes. To achieve this, some basic spatial analysis tasks such as overlaying, buffering and data extraction are highly required. Today, GIS has ability to do these requirements. A number of technical steps are however needed to carried out the process. Firstly, the required data are derived from the property, land-use, thematic, topographical maps, and from the other related textual records. Then, site blocks on the land-use plan are subdivided into new land parcels with respect to detailed zoning codes. Following the subdivision process, cadastral and created new parcels are individually analyzed by the selected land valuation factors. Using equation [1], each land parcel's value is determined for the parcels, before and after. Land re-distribution is then performed. Based on the calculated valuation figures, each old land parcel is finally re-allocated within the new lots.

In order to calculate to parcel value, the nominal asset value map is intersected with cadastral map or the map produced by subdividing land into the sufficient new land parcels. At the end of this stage, each parcel posses a nominal asset value. Figure 3 illustrates this method.

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. For the implementation of pixel based LR model, firstly, the required data are basically derived from the cadastral, zoning, thematic, and topographical maps, and from the other related textual records. Secondly, 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 analyzed. 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 analyze a parcel value. After the land valuation analysis, the nominal asset values of each land parcel are determined before and after the project. 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.

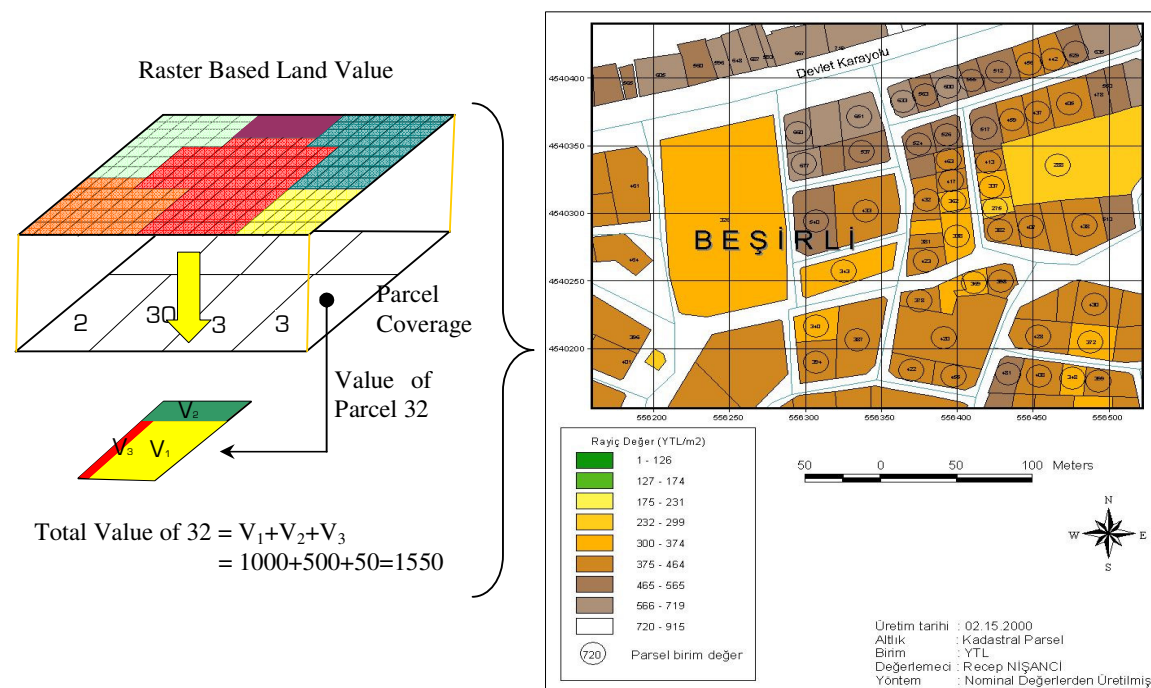


Figure 3. Calculation of Nominal Asset Value of Parcel

After all 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 parcels 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 is 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, then 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 by parcel.

#### 4. EXAMPLE

The sample study area selected for this study is in the city of Trabzon which is located on the Black Sea coast (Figure 4). Study area is 9.8 hectares with by 105 land parcels. The property map, the land-use plan and topographical maps were digitized. Land ownership records were also included in the database. Then, 19 site blocks were subdivided into 156 land parcels according to the plan's rules. Because of the nature of the LR concept, the total area of all land parcels was reduced to 6.2 hectares with the process. In another words, 3.6 hectares of public-use areas were gained by the contribution of the landowners. Including the previous public-user area of 0.8 hectares a total of 4.4 hectares of land was reserved for public-use after the project.

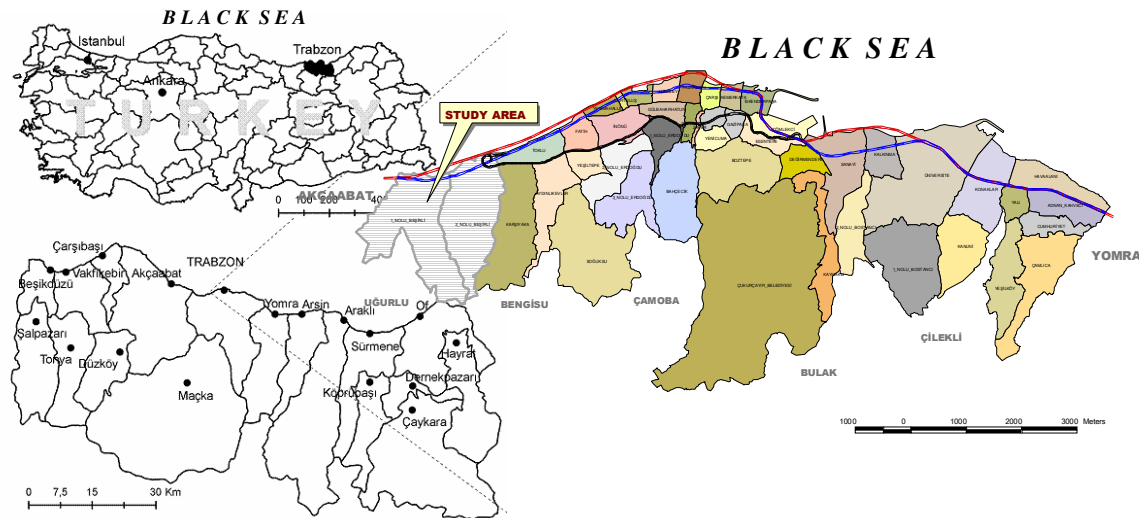


Figure 4. Study Area in Trabzon, Turkey

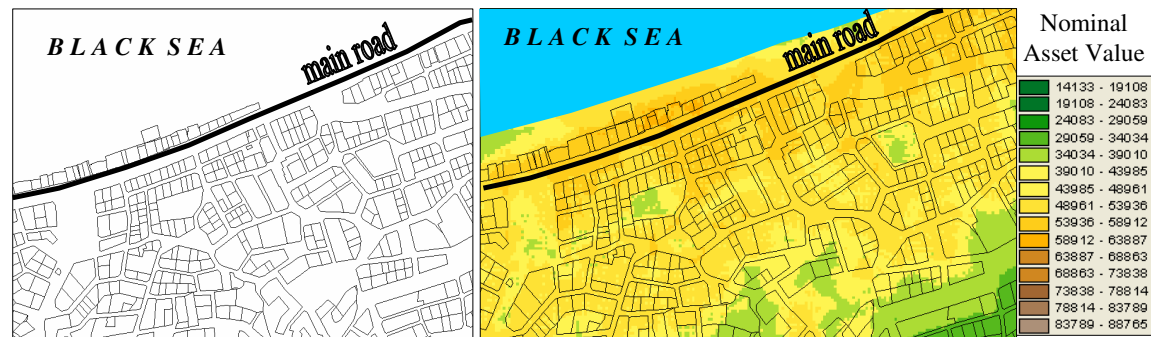


Figure 5(a). Study area subdivision map; (b) Subdivision map overlayed with value map

The rest of the land was then redistributed among the involved landowners. The total value for the project area was estimated as 5 687 024 units by 28 land valuation factors. Figure 5-a illustrates the situation after the LR project on a sample part of the study area, and Figure 5-b shows the study area valuation map in which the raster valuation coverage overlay subdivision coverage. So each parcel has got a value. With the help of this method required balancing between cadastral parcels (before LR) and subdivision parcels (after LR) for each parcel could be arranged. This process is shown in Table 1 in the form of a sample application.

Table 1. An example of new parcel ownerships in the study area.

Parcel ID	New Parcel ID	Input size: m2	Input value: \$	Allocated size: m2	Allocated value \$	Money balance
500-1	100-1	1,175	21,500	590	16,500	+5,000
550-2	100-2	1,085	25,450	650	15,000	+10,450
500-3	100-3	795	10,900	650	14,900	-4,000
500-4	100-5	900	13,800	650	14,850	-1,050
500-5	100-4	783	15,500	580	15,400	+100
600-1	200-1	1,270	24,850	590	18,000	+6,850
600-2	200-2	480	8,200	650	16,300	-8,100
600-3	200-3	1,185	17,000	650	16,100	+900
600-4	200-2	462	9,000	650	15,900	-6,900
600-5	200-4	765	14,100	580	17,350	-3,250
			160,300		160,300	0

## 5. CONCLUSIONS

To increase the effectiveness of land readjustment method, a nominal asset value-based land readjustment approach 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 an 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.

The performance of the LR process was increased by the use of GIS and raster function. Many complex tasks, such as land valuation analysis and land redistribution have been accomplished within a short time. Especially, GRID functions of GIS provide considerable flexibility and facility in land valuation process. So, raster based valuation technique is a more effective approach compared with iterative approaches as a result of computing pixel based values and overlaying this data set with parcels. Because, each pixel is considered to be a parcel, and valuation process can be performed using selected factors.

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## BIOGRAPHICAL NOTES

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