Optimization of Land Valuation Factors by GIS & SPSS

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Key words: Land Value, GIS, SPSS, Factor Analysis, Turkey, Trabzon.

SUMMARY

This study aims that the land-value maps are produced with less number of factors by limiting the factors affecting the value of land. In order to make adequate value estimation for a land parcel, there are many tangible and intangible land valuation factors that should be taken into account during the valuation process. The determination and classification of these valuation factors are difficult, because the characteristics of these factors can be objective and subjective, changing according to person's desires. Indeed, the number of land valuation factors cannot be limited. But, it can be limited depending on the aim and scale of the work. In other words, a land value map produced in a less accuracy level with less number of factors or with the factors changing according to the person's desire can be demanded. In this study, a land value map based on nominal valuation method is produced for Trabzon province by using 20 factors with Geographic Information Systems (GIS). SPSS statistical software is used to make a regression analysis between nominal and current values. The highest explanation value calculated in the model using 20 factors is R-square = 0.861 and it is obtained from the cubic curve. R-square = 0.734 when 8 factor is used for calculation.

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1. INTRODUCTION

Land value is essential in all sorts of decision relating to real estate buying, selling, financing, developing, managing, owning, leasing and trading. Land value is mainly depending on its location. A number of factors, such as social change and technological development, have affected location and these are considered. Locational influences on property value are widely regarded as the most important, yet their incorporation into valuation methodology is often implicit (Wyatt, 1995). In general, the most important physical factor affecting value is location. All the other factors are subordinated to, or considered in relation to, location. If location is not attractive and all other factors are positive, the property will probably have a negative value basis.

Assessment of the financial impact that physical and legal factors have on property value, using the comparison method of valuation, is relatively straightforward if sufficient data are available. This is not true for location influences and the development of a methodology that attempts to measure the impact that location has on value is an important addition to valuation theory. However, as Wyatt (1995) is mentioned, 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.

In this study, 20 effected land factors such as; Environment, Landscape view, Distance to car parking area and Distance to city centre etc. were determined for producing land value map and these factors evaluated in statistically by SPSS software and optimum factor number analysis were performed. In the first stage of the study, reliability of questionnaires data's were tested then normalize analysis were applied for each factors, and finally the factor analysis were carried out to determine the factors effected land values.

2. SELECTION OF LAND VALUE FACTORS & WEIGHTS

City of Trabzon where is selected as a case study area a historical city in the North East part of Turkey, and lies along Black Sea shores (Figure 1). Land is mountainous and rough. So, agricultural activity is limited. Because of topographic structure, housing areas are located closely, and state road lies through shore along which the city developed mostly linear. The study area is 28,3 km^2 has 43 district.

All valuation techniques rely on the collection and analysis of data; general data such as social, economic, planning and environmental attributes, and specific data including local market conditions, details of transactions such as location, physical and functional form and legal characteristics (Wyatt, 1995). The importance of the various location characteristics of a property is largely influenced by the use of the property, but there are other factors that apply

to all land use (access to transportation facilities and quantity and quality of municipal services) Table 1.

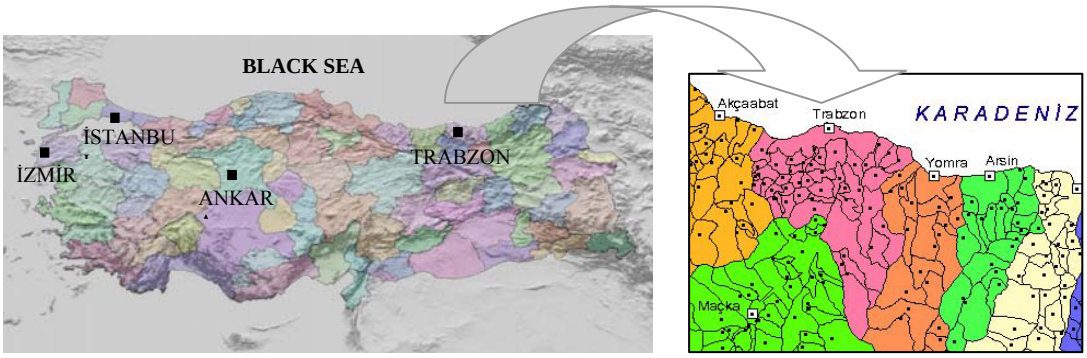

Figure1. Locations of the study areas on the maps of Trabzon Province and Turkey

The determination of land valuation factors is essential. For this purpose, a survey was carried out to classify and select land valuation criteria which can affect the total perceived value of a land parcel (see Table.2). Each land valuation factors does not have same effect on the total value. For instance, land parcel shape can have a different magnitude of effect to the topography. Therefore, a "weight" for the selected factors is also necessary. The weights for these factors have derived from the survey results. The important point is which methods are used for derivation of weight. The Average value of survey for weights can be used in the normal distribution. Otherwise different methods for example M-Estimators (Huber, Tukey, Hampel, Andrew), median, mode, adjusted mean, weighted mean are available (Table 2). Table 2 shows land value factors means calculated from different methods and The M-Estimators/Tukey method was used because of not having normal distribution data's for study area and its very prevalent in statistical working.

Table 1. Some location characteristics that affect the land value

RESIDENTIAL	COMMERCIAL	INDUSTRIAL
. Access to major sources of employment . Access to major shopping and service areas . Access to neighborhood shopping and service stores . Access to schools and religious places . Access to parks and recreational areas . Proximity from sources of safety and health hazards . Proximity from nuisances such as noise and smoke	. Proximity to prime shopping areas . Proximity to areas of heaviest pedestrian traffic . Proximity to parking facilities . Access to residential areas . Etc.	. Proximity to source of labour . Proximity to market areas . Proximity to sources of row materials and power . Access to adequate parking facilities . Access to transportation facilities . Etc.

Table 2. The factor means calculated with different statistic methods

Factor no_Factor name	MV	Md	Mode	AM	Huber	Tukey	Hampel	Andrew	WM
Fak01_ Environment	75.28	80.00	80.00	77.16	79.64	82.27	80.22	82.31	81.57
Fak02_Supplied basic services	81.73	90.00	100.00	83.80	86.76	88.47	86.40	88.51	86.60
Fak03_Landscape, view	74.87	80.00	90.00	76.96	80.96	84.95	82.32	84.98	82.85
Fak04_Distance from nuisance	63.93	70.00	100.00	65.33	67.83	68.69	67.18	68.66	77.29
Fak05_Land parcel shape	65.45	70.00	80.00	66.89	69.59	69.98	68.43	69.96	77.18
Fak06_Distance from noise	61.59	70.00	80.00	62.74	65.04	65.56	64.25	65.53	73.84
Fak07_Aavailable utilities	54.49	60.00	60.00	54.76	56.17	56.11	55.73	56.10	67.77
Fak08_Permitted construction area	78.27	80.00	100.00	79.87	80.97	81.23	80.13	81.27	83.12
Fak09_Access to street	72.49	80.00	100.00	74.90	77.22	78.51	75.95	78.59	82.79
Fak10_Currently usable area	62.82	70.00	70.00	64.08	68.02	68.71	66.56	68.68	76.61
Fak11_Street frontage	69.05	75.00	80.00	70.72	73.20	74.92	72.74	74.94	77.71
Fak12_Permitted number of floors	76.71	80.00	100.00	79.05	81.42	82.44	80.45	82.50	83.93
Fak13_Distance to city centre	67.76	70.00	70.00	68.73	69.48	69.36	68.88	69.35	75.52
Fak14_Soil condition	56.62	60.00	80.00	57.03	59.11	58.91	58.08	58.89	70.82
Fak15_Distance to shopping centers	58.91	60.00	80.00	59.44	60.58	60.54	59.89	60.53	69.61
Fak16_Distance to health services	60.03	60.00	70.00	60.48	61.46	61.30	60.82	61.30	70.44
Fak17_Parcel location within block	72.87	80.00	80.00	74.60	77.61	80.86	78.39	80.90	80.16
Fak18_Topography	56.89	60.00	70.00	57.64	59.99	60.81	59.32	60.82	66.62
Fak19_Distance to educational centers	61.46	67.50	50.00	62.37	63.71	64.40	63.35	64.40	70.65
Fak20_Access to highway	57.38	60.00	80.00	57.87	59.83	59.71	58.72	59.64	70.11
Fak21_Distance to recreational areas	56.12	60.00	60.00	56.44	57.86	57.64	57.00	57.64	66.65
Fak22_Distance to car parking area	50.41	50.00	50.00	50.57	51.54	51.23	50.93	51.22	62.60
Fak23_Distance to police station	39.72	40.00	50.00	38.92	39.26	39.02	38.80	39.04	56.94
Fak24_Distance to play garden	50.36	50.00	50.00	50.40	51.58	51.29	50.89	51.29	63.00
Fak25_Distance to fire station	39.11	40.00	50.00	38.21	37.71	37.69	37.83	37.70	57.16
Fak26_Distance to religious places	44.58	50.00	50.00	43.98	43.41	43.86	43.76	43.87	66.48
Fak27_Access to railway	38.67	40.00	10.00	37.89	36.47	37.08	37.36	37.10	56.66
Fak28_Access to waterway	35.54	30.00	10.00	34.22	32.75	32.56	33.37	32.58	56.95
MV: Mean Value, , Md: Median, Mode, AM: Adjusted mean, WM: Weighted mean M-Estimators: Huber, Tukey, Hampel, Andrew									

3. LAND VALUATION METHODS

Each country will have a different culture and experience, which will determine the methods adopted for any particular valuation. The majority of all methods will rely upon some form of comparison to assess market value. This may be done, in its simplest form, by direct capital comparison or may rely upon a range of observations that allow the expert to determine a regression model. Any such method is referred to in this paper as “traditional”. Other models or methods try to analyses the market by directly mimicking the thought processes of the players in the market in an attempt to estimate the point of exchange. These models tend to be more quantities in method and will be referred to as “advanced” (Pagourtzi at all, 2003).

For each method that is described below, its theory is briefly explained together with an outline of how it is applied in the valuation process. The appropriate economic principles are also quoted with an explanation how they apply to each method (Pagourtzi at all, 2003).

Methods can be grouped as follows:

Traditional valuation methods:

- Comparable method;
- Investment/income method;
- Profit method;
- Development/residual method;
- Contractor's method/cost method;
- Multiple regression method; and
- Stepwise regression method.

Advanced valuation methods:

- Artificial neural networks (ANNs);
- Hedonic pricing method;
- Spatial analysis methods;
- Fuzzy logic; and
- Autoregressive integrated moving average (ARIMA).

4. USING GIS & SPSS in LAND VALUATION

While GIS can improve the measurement of location and access variables, namely by resorting to time, rather than mere Euclidean distances, their analytical capabilities are greatly enhanced where spatial statistics methods are integrated (Yomralioglu, 1993; Zeng and Zhou, 2001). Indeed, procedures such as spatial pattern analysis and autocorrelation analysis (Tiefelsdorf and Boots, 1997) as well as variography and Kriging techniques (Dubin, 1992) can help detecting additional neighborhood factors.

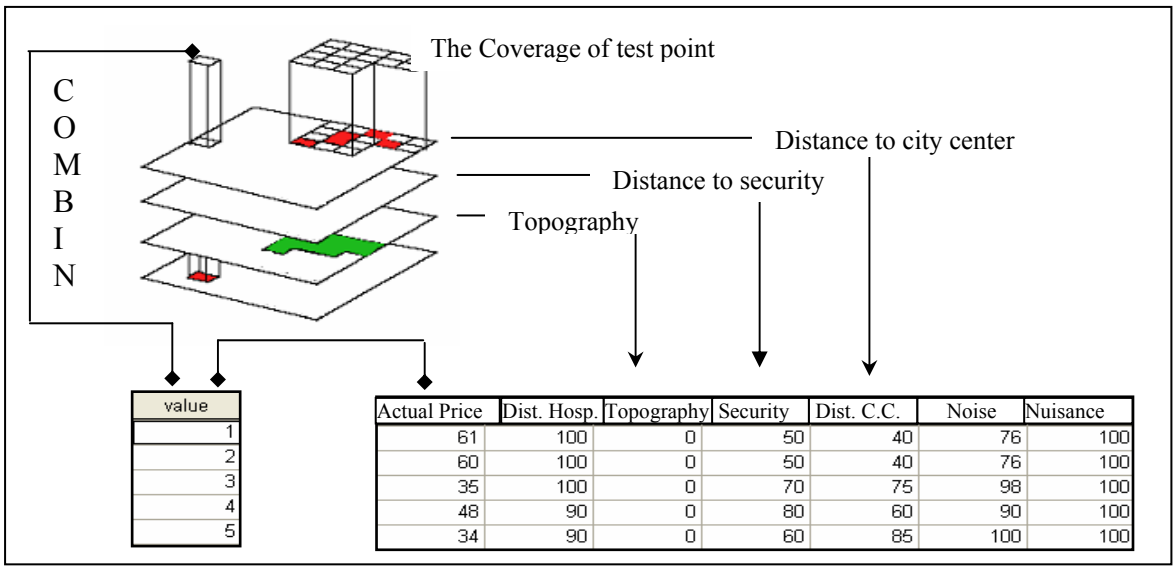

Figure 2. Relating actual price with value table

Within a GIS framework the use of surface response analysis techniques has been shown to provide a three-dimensional visualization of the value of location as it varies geographically. Using GIS functionality, spatial analysis is performed in order to determine land parcel values by the combination of mathematical analysis and subjective judgment. The statistic science is used for determining of land value factors and their weights. Especially statistic analysis is performed for testing results, regression analysis, reliability and factor analysis (Simons ve Saginor, 2006; Nisanci, 2005).

5. THE FACTOR ANALYSIS

Factor Analysis (FA), is a method which transform relational data structures into independent and less new data sets for making new sense. There are many methods for factor extractions. One of them is a principal component which is used in this study for 20 land value factors in 95 case points. Any case point is constituted with individual market value and each point represents a pixel (figure 2). Each pixels value was calculated by GIS capabilities for firming properties value tables. These tables are evaluated in SPSS software and results shown in Table 3.

Barlett Test of Sperhcity and Kaiser-Meyer-Olkin tests (Table 3) was applied on land value data's and Cattell Scree test was used in determining optimum factor number. As shown in Figure 3 scree plot starts to decrease after 6 components. 6 components can explain %75 and especially first component % 39 of total variance. Rotated Component Matrix was used to find out which factors affected the land value. Values bigger than 0.6 or 0.7 are selected. If 0.6 is selected 16 factors effect values and 4 factors are eliminated. If 0.7 is selected 13 factors are affected values and 7 of them are eliminated. On the other hand, 13 or 16 factors can be used for producing land value map with instead of using 20 factors.

Table 3. The test results with KMO and Barrtlett's

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.850
Bartlett's Test of Sphericity	Approx. Chi-Square	1168.039
	df	190
	Sig.	.000

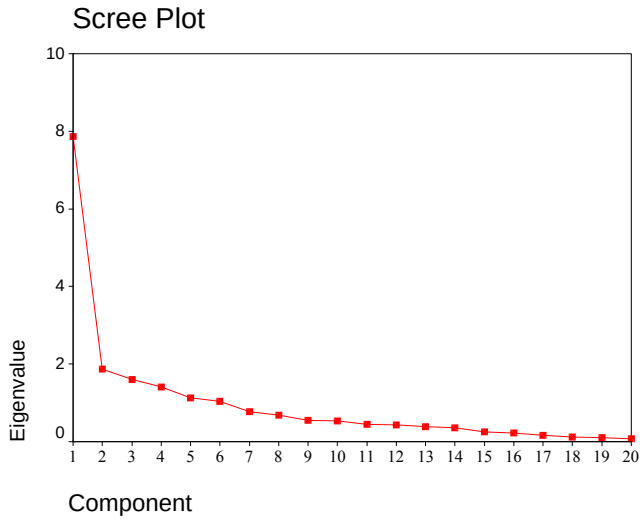

Figure 3: Cattell Scree graphic of factor component calculated by FA

Table 4. Total variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.865	39.326	39.326	7.865	39.326	39.326	4.515	22.576	22.576
2	1.876	9.379	48.705	1.876	9.379	48.705	4.179	20.895	43.470
3	1.596	7.978	56.682	1.596	7.978	56.682	2.061	10.307	53.777
4	1.410	7.049	63.731	1.410	7.049	63.731	1.586	7.931	61.707
5	1.129	5.647	69.378	1.129	5.647	69.378	1.419	7.096	68.803
6	1.038	5.191	74.570	1.038	5.191	74.570	1.153	5.767	74.570
7	.775	3.875	78.445						
8	.680	3.400	81.845						
9	.548	2.739	84.584						
10	.529	2.646	87.230						
11	.441	2.205	89.435						
12	.428	2.138	91.573						
13	.392	1.961	93.534						
14	.357	1.785	95.319						
15	.249	1.243	96.562						
16	.227	1.136	97.698						
17	.158	.790	98.487						
18	.123	.617	99.104						
19	.100	.502	99.606						
20	7.884E-02	.394	100.000						

Table 4 indicates that 6 main groups are determined and then it is observed that same type of factors take place in same groups. As a result of the factor analysis first component called "environmental" is determined as an important one and consist of distance to city center, distance to car parking area and attractive areas. Other results were explained in table 5.

Table 5. Main components with FA

Component	Factors	% of Variance
1	Distance to city center, distance to car parking area and attractive areas	39.3
2	Distance to educational centers, distance to fire station, distance to religious places, Distance to health services	9.4
3	Access to waterway and Landscape, view	8.0
4	Distance from nuisance	7.0
5	Permitted construction area and number of floors	5.6
6	Distance to play garden	5.2

In addition, in this study, using different number of factors regression analyses were implemented, and different regression equations were calculated. Equation 1 shows the linear curve equation calculated for study area.

$$LogAP = -7.1376 + 3.3782 * LogV \quad \text{(for linear curve equation)} \qquad [\text{Equation 1}]$$

AP: Actual price, V: Nominal Value which is determined from land value factor

In table 6, R-square figures of regression curve calculated using different number of factors are shown.

Table 6. R-square figures of regression equations calculated with different number of factors

Factor numbers	R-square Values of regressin equation	
	Lineer R^2	Cubic R^2
20	0.850	0.861
16	0.828	0.846
13	0.742	0.777
11	0.733	0.748
8	0.639	0.734

6. CONCLUSIONS

Economic changes are seriously affecting real estate marketing and land values are fluctuated. So, a land valuation method which has spatial abilities must be developed to prevent this fluctuation. Today, all spatial factors effected land values can be collected, classified, analyzed and presented in GIS and statistical capabilities. In this study, it has been concluded that less land value factors for evaluating large areas and also provide time consuming and economy with meaningful results too. As a result it can be said that the environmental factors have great potential to effect a whole land value.

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BIOGRAPHICAL NOTES

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