TURKGEO
TURKISH JOURNAL OF GEOSCIENCES

ISSN: *2717-7696*
Research Article
Vol; 4, Issue; 1, pp. 1-11, 2023
DOI: *10.48053/turkgeo.1213142*
Journal homepage:
https://dergipark.org.tr/en/pub/turkgeo

Real estate assessment of agricultural lands outside the zoning plan with artificial neural networks and multiple regression analysis methods: The case of Aksaray, Bahçesaray and Kırımlı rural districts

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Keywords
Agricultural land
Land valuation
ANN
MRA
GIS

ABSTRACT

This study aims to determine the market value of the agricultural lands in the rural Bahçesaray and Kirimli districts, which are outside the zoning plan, where agricultural production continues in Aksaray Province, Central District, in Turkey, by mass valuation methods. It is also aims to provide value estimation and value map production with the help of geographic information systems (GIS). Using the sales data from 125 parcels in the study area, the market value of the real estates for which the value is unknown in the region, was estimated. The most frequently used criteria in the assessment of agricultural lands were determined, and the valuation was carried out with Multiple Regression Analysis (MRA) and Artificial Neural Networks (ANN). By means of the assessment and the valuation study, the performance of the valuation methods was compared, and it was determined that the best result according to the test data was the valuation with ANN. In the performance analysis conducted with ANN, the Coefficient of Determination (R^2)=0.87, Mean Absolute Percentage Error (MAPE)=0.192, Mean Absolute Error (MAE)=0.047 and Root Mean Square Error (RMSE)=0.059 was found. Moreover, according to the proportional standards guide determined by the International Association of Assessing Officers (IAAO), the performance measurement, the values derived for the Coefficient of Dispersion as (COD)=19.58 and Price-Related Differential as (PRD)=1.02 were also found to be within acceptable limits. Since the valuation of agricultural lands is a less studied subject, there are few articles in the literature. For this reason, it will be useful to increase such as article and evaluate the results applying it region by region. In this study, estimates were found with MRA and ANN methods and value maps were created.

1. INTRODUCTION

Rural development studies are seen as a step towards becoming an influential renowned state at the global level, which is the fundamental long-term goal for Turkey. In rural development studies, the aim is to increase the contribution of the rural area to the country's economy and to reduce the development differences between the regions and the rural-urban by raising the living standard of the rural population (Karakayacı, 2011). Please rephrase this sentence like: Agricultural land prices have been risen in recent years not only in Turkey but also across the world. This situation can be regarded as positive as well as negative in terms of increasing the production cost for the farmers. (Lehn and Bahrs, 2018) In addition, changing consumer preferences and the effort of agricultural production to meet the demand have also increased the need for agricultural land (Çınar et al., 2018). This situation makes it necessary for countries to have the potential to meet their self-sufficient nutritional needs amidst the Coranavirus pandemic. Today, the fact that food security has a strategic significance increases the importance of agricultural lands and makes it necessary to evaluate the agricultural lands for different purposes and to have knowledge about their value (Akın et al., 2020).

The value of real estates is used for taxation, insurance, and expropriation etc. in addition to

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Received: 01/12/2022; Accepted: 14/01/2023

Cite this article

Karaduman, H., & Karataş, K. (2023). Real estate assessment of agricultural lands outside the zoning plan with artificial neural networks and multiple regression analysis methods: The case of Aksaray, Bahçesaray and Kırımlı rural districts. Turkish Journal of Geosciences 4(1), 1-11

transactions, it is also used for land management, planning, urban transformation, zoning applications, and real estate administration (Özdemir, 2019; Çosar and Engindeniz, 2013; İban, 2021). Although it is simple and feasible to make valuations in such transactions with traditional methods such as comparison and income, the valuations to be made in such transactions can be applied simply and quickly by comparison, cost, income method, which is considered among the traditional methods. However, it does not give healthy results in comprehensive and large-scale studies. It is possible to reach healthy results in comprehensive studies with many criteria that affect the value of the real estate, with mass valuation (Melón et al., 2008). The lack of an optimum number of criteria affecting land value that will serve as a base for mass valuation of real estates in Turkey and the lack of sufficient studies to establish a collective valuation system is a deficiency (Ünel, 2017). In this context, this study is important in terms of being an example for determining the values of real estates in rural areas according to objective criteria.

In this study, Multiple Regression Analysis (MRA) and Artificial Neural Networks (ANN) methods were used to evaluate the agricultural lands in the region, which is divided into two parts as Bahçesaray and Kırımlı Neighborhood, while Hamidiye-Alaca Village of Aksaray Province Central District still holds its rural characteristics. First of all, the criteria that are most frequently used in the studies on agricultural lands and that affect the value the most were determined. Necessary scoring and normalization processes regarding these criteria were performed. Prices are predicted was done with MRA and ANN methods, and a performance assessment was performed betweenmpredictions from these methods. Value maps were produced and drawn with ArcGIS 10.8, software.

2. MATERIALS AND METHODS

2.1. Real Estate Valuatıon Methods

Real estate valuation is a very complex process. The accuracy of the information obtained about the real estate depends on the knowledge and skills of the appraiser and the size of the errors caused by various factors in the valuation process (Choumert and Phélinas 2015). For this reason, subjective factors affecting the valuation and some specific factors cause errors in the valuation, while valuations done with statistical and modern methods can give objective and correct results (Cupal, 2014). The valuation of agricultural lands requires for expropriation, insurance, crediting, and taxation, etc. and are done for different purposes. (Çoşar and Engindeniz, 2013). For this reason, the valuation results are important for the land owner, the appraiser, and the relevant institutions.

Valuation methods are generally divided into three: traditional, modern, and statistical. The most used of these are the traditional comparison, income, and cost methods (Kontrimas and Verikas, 2011). Artificial neural networks, fuzzy-logic, and spatial analysis methods are classified as modern methods. Nominal methods, multiple regression and hedonic methods are stated as statistical methods (Yalpır, 2007).

Within the scope of the study, MRA and ANN methods were being used in the valuation of the agricultural lands. For this reason, information will be given about MRA and ANN methods.

2.2. Multiple Regression Analysis Method

The MRA model consists of dependent and independent variables. A linear regression model is used to detect the properties and relationships between both dependent and independent variables. A basic linear regression model contains only one independent variable, while a multiple linear regression model contains many independent variables. Linear regression analysis generates the linear equation by determining the function for the plane closest to each data point in a scatter plot (Ge et al., 2021). The MRA model is represented by the formula (1)

$$Y = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n + c \quad (1)$$

Y: Dependent Variable (Real Estate Value)
X_i: Independent Variables (criteria affecting the value of the real estate)
b_i: Variable coefficients (coefficients/weights of independent variables)
b_0: Constant coefficient
c: Real error

2.3. Artificial Neural Networks Method

Artificial Neural Networks (ANN) can be defined as a modeling system to perform basic functions such as producing new data from the data collected by the brain by learning, remembering, and generalizing by imitating the learning path of the human brain (Yalpır, 2007; Öztürk and Şahin, 2018). ANN is used as a solid and effective tool particularly in the field of engineering in the aftermath of the advancements in computer technology. Artificial neural networks are modeled based on the biological nervous system. Many artificial neural networks formed in the model have been developed to realize various features of biological neural networks such as learning and responsiveness. ANN contains an input layer, one or more hidden layers, and an output layer (Bilgilioğlu,2018).

Basic elements of artificial nerve cells are inputs, weights, addition function, activation function and outputs (Figure 1).

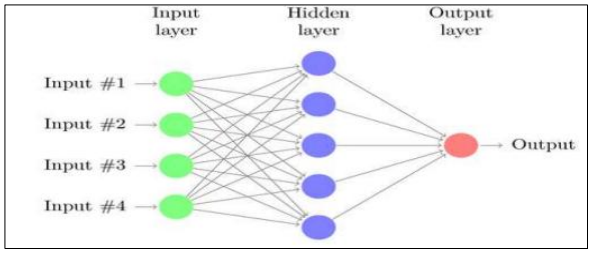

Figure 1. Artificial neural network cell (Soni and Sadiq, 2015).

Inputs is the information coming to the artificial neuron from the outside or from another neuron. Weights are coefficients that show the effect of the information coming to the artificial nerve cell on the cell. Each input is multiplied by the weight factor and then combined as a sum function. The addition function can be specified as a function that calculates the net input to a cell. The most common is the weighted sum. It is represented by the formula (2)

$$Net = \sum_{n=1}^{n}(W_i X_i + \mathrm{b}) \quad (2)$$

Here, X_i shows the inputs, W_i shows the weights, and n is the total number of inputs to a cell. (İlhan, 2019; Bilgilioğlu, 2018)

The characteristics of ANN can be listed as follows:

- It was developed with inspiration from biological neural networks. It mimics the human brain.
- It has non-linear characteristics.
- It can benefit from package programs.
- Learning is a method that can be adapted and generalized.
- It is necessary to work with healthy data. (Yalpir, 2007; Erdem, 2016).

2.4. Prediction performance analysis

An absolute error occurs in all operations performed with estimation methods. In order to compare the performances of the models made within the scope of the study, the accuracy of the estimated values is measured. The aim of all estimations is to create an estimation model with miniscule error values (Han, et al., 2022). The Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and Coefficient of Determination (R^2) results were used in the analyzes when comparing the comparable values and real estate values calculated according to the criteria in all transactions (Ünel, 2017).

$$\mathrm{RMSE} = \sqrt{\frac{1}{\mathrm{n}}\sum_{\mathrm{i}=1}^{\mathrm{n}}(\mathrm{yi} - \mathrm{yi}')^2} \quad (3)$$

$$\mathrm{MAPE} = \frac{1}{\mathrm{n}}\sum_{\mathrm{i}=1}^{\mathrm{n}}\frac{|\mathrm{yi}-\mathrm{yi}'|}{\mathrm{yi}} \quad (4)$$

$$\mathrm{MAE} = \frac{1}{\mathrm{n}}\sum_{\mathrm{i}=1}^{\mathrm{n}}|\mathrm{yi} - \mathrm{yi}'| \quad (5)$$

$$\mathrm{R}^2 = 1 - \frac{\sum_{\mathrm{i}=1}^{\mathrm{n}}(\mathrm{yi}-\mathrm{yi}')^2}{\sum_{\mathrm{i}=1}^{\mathrm{n}}(\mathrm{yi}-\bar{\mathrm{y}})^2} \quad (6)$$

yi: Precedent (market) value
yi': Estimated value
$\overline{y}$: Average value.

In addition, another performance measurement method accepted according to the proportional standards guide of the IAAO is the coefficient of dispersion (COD) and price-related differential (PRD). COD measures the average % rate at which individual rates differ from the average rate (assessed value/selling price). The PRD measures the inequality between high and low value properties in the same land group with respect to price (Url-1). The performance standard for the COD distribution coefficient should be 15% or less for residential properties, 20% or less for commercial properties and 25% or less for agricultural land. PRD values for all kinds of real estates are considered appropriate when they are between 0.98-1.03. (IAAO, 2013)

$$\mathrm{COD} = \frac{100}{n} * \frac{\sum_{\mathrm{i}=1}^{\mathrm{n}}\left|(\frac{T}{S}-(\overline{T}/\overline{S})\right|}{(\overline{T}/\overline{S})} \quad (7)$$

$$\mathrm{PRD} = \frac{\overline{T/S}}{\sum T/\sum S} \quad (8)$$

T: Estimated Value
S: Sale price
N: Number of samples

2.5. Study Area

The Aksaray Province is located at the intersection of east-west, north-south main road connections in the middle of Central Anatolia. (Url-2). The area of the Aksaray province is 7659 km² and the area of the Central district is 3540 km² (Url-3,). The study area covers the Bahçesaray and Kırımlı Neighborhoods in the Aksaray City Center (Fig. 3.1). The province of Aksaray has a continental climate and generally wheat, silage corn, and sunflower are produced in their irrigated fields. On dry land, barley, and wheat are grown.

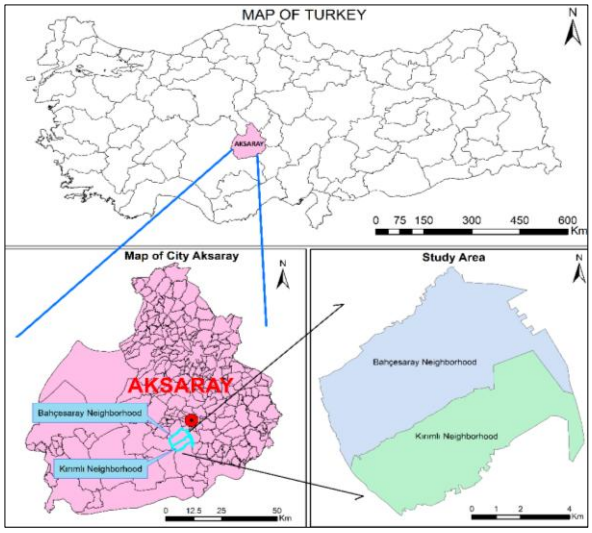

Figure 2. Study area.

2.6. Data Preparation

In the study, MRA and ANN methods were used for the collective valuation of agricultural lands. Before creating a model with these methods, the studies on valuation were examined and the most used criteria were determined (Table.1) (Ertaş, 2014; Koç, 2011; Karakayacı, 2011; Yiğit, 2019). The data set was prepared by scoring according to the importance of the sub-criteria used in the evaluation.

Table 1. Criteria used in the valuation of agricultural lands.

Criteria	Source/Author
Parcel Shape	Ertaş, 2014; Yiğit, 2019
Distance to city/district center	Ertaş, 2014; Koç, 2011; Karakayacı, 2011; Yiğit, 2019
Distance to neighborhood center	Ertaş, 2014; Karakayacı, 2011; Yiğit, 2019
Distance to main road	Ertaş, 2014; Koç, 2011; Karakayacı, 2011; Yiğit, 2019
Distance to pasturelands	Ertaş, 2014
Land Use Capability Class	Ertaş, 2014; Karakayacı, 2011; Yiğit, 2019
Possibility to generate new parcels	Ertaş, 2014; Koç, 2011
Parcel uniqueness	Ertaş, 2014
Irrigation	Ertaş, 2014; Koç, 2011; Karakayacı, 2011
Slope	Ertaş, 2014; Yiğit, 2019
Easement facility	

The price of agricultural land: The data regarding 125 parcels to be used in the valuation of the lands for which the market value will be determined consists of the values obtained from the sales works carried out by the Directorate of National property. The Bahçesaray and Kırımlı neighborhoods selected as the study area are outside the zoning plan and continue to be rural neighborhoods where agricultural production is made. However, due to the expectation that rural neighborhoods will be included in the development plan, the market value of the lands is constantly increasing. Therefore, since the sales values are estimated at different times, the value of the comparable properties was updated to September 2021, when the study was conducted, using the Wholesale Price Index (WPI) and Producer Price Index (PPI) rates published by the Turkish Statistical Institute (TUIK).

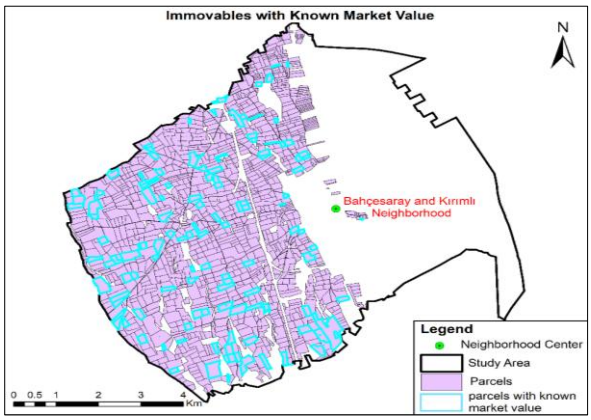

Figure 3. Precedent real estate.

Shape of the Land: There is a linear relationship between the shapes of the plots and the agricultural income. The uneven shape of the plots affects the net agricultural production area in the plot where direct cultivation is done. This situation causes losses in the net agricultural production area due to the maneuvering of agricultural tools used in agricultural activities such as planting, fertilizing, spraying and harvesting, resulting in a decrease in agricultural income. In addition, it directly affects the irrigation efficiency by negatively affecting the irrigation works of the parcel where agricultural production is made. In this case, more labor and materials will be required, independent of the irrigation method, to irrigate an irregularly shaped parcel. Planting-harvest operations and irrigation works will cause more uncultivated land to remain in amorphous agricultural lands and decrease irrigation efficiency. This will increase production costs and reduce revenues (Küsek, 2014). In this context, it would be appropriate to use the golden ratio, which is encountered in nature and in many areas, to determine the best geometric dimension of the parcel. In mathematics, the golden ratio is approximately equal to 1.618. The shape of the lands will be dealt with on a golden rectangle with a ratio of its long side to its short side of 1.618 (Ertaş, 2014; Selçuk et al., 2009). Between the rectangle and the edges of the land, a ratio was taken as approximately 1.60 (Ertaş, 2014).

$$K = \frac{5.2\sqrt{\frac{f_p}{1.60}}}{C_p} \quad (9)$$

K: Golden ratio coefficient of the parcel
f_p: Area of the parcel
C_p: Perimeter of the parcel

According to the formula, as the result becomes closer to 1, it will provide the best parcel size according to the golden ratio. Accordingly, the golden ratio coefficient of the parcel is 0 provided that K ≤ 0.7 and K ≥ 1.3, 1in case the golden ratio coefficient is between 0.7-0.8 and 1.2-1.3, 2 in case the golden ratio coefficient is between 0.8-0.9 and 1.1-1.2, and finally the golden ratio coefficient is arranged as 3 points between 0.9-1.1.

Distance to City Center: The market situation and transportation to the city play an important role in delivering the products to the consumption areas of the districts (Odabaşı, 2020). When the products obtained from the agricultural production districts are evaluated in terms of reaching the market and transportation cost, the scoring was made according to each 8 km, 2 points were given between 0-8 km, and 1 point was given between 8-16 km.

Distance to highway: Scoring was done according to the Aksaray-Adana State Highway, which is one of the most important main roads in Turkey and Aksaray passing through the outer border of the study area. According to the distance to the highway, it was determined to be 4 points between 0-1 km, 3 points between 1-3 km, and 2 points between 3-5 km, and 1 point between 5-7 km (Figure 4).

Status of Easement Right in the Land: The right of easement is a limited real right that grants some or all of the powers related to use and exploitation on an item to the right owner or prohibits the use of some of the rights of the owner of the item for the benefit of the right-holder (Yalpır, 2007). The establishment of an easement right on a real estate may affect the owner's right of use, income, and value of the land. In the study area, the parcels that are in the projection of the energy transmission lines are given 0 points, while the ones that are not in the projection are given 1 point (Figure 4).

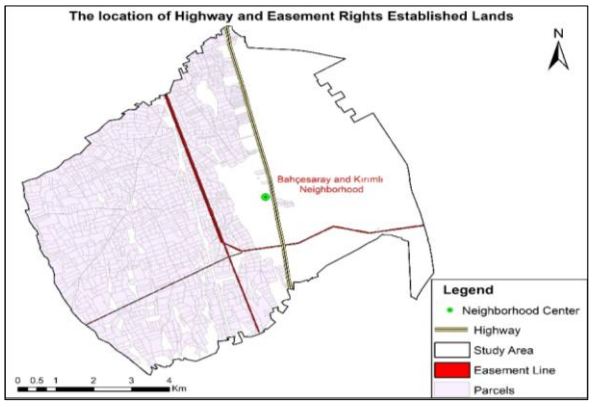

Figure 4. The location of the highway and Easement Rights Established Lands

Distance to Neighborhood Center: The village of Hamidiye-Alaca, where agricultural production continues, it was divided into two: The Bahçesaray and Kırımlı Districts. Today, the neighborhoods maintain their rural characteristics and continue their agricultural production activities. Rural neighborhoods outside the zoning plan have a single center. For this reason, by scoring according to a single center, 4 points were given between 0-1 km, 3 points were given between 1-3 km, 2 points were given between 3-5 km, and 1 point was given between 5-7 km.

Irrigation Opportunity: Scoring was done according to the irrigation status of agricultural lands. Irrigable agricultural lands were given 1 point and non-irrigated agricultural lands were given 0 points (Figure 5).

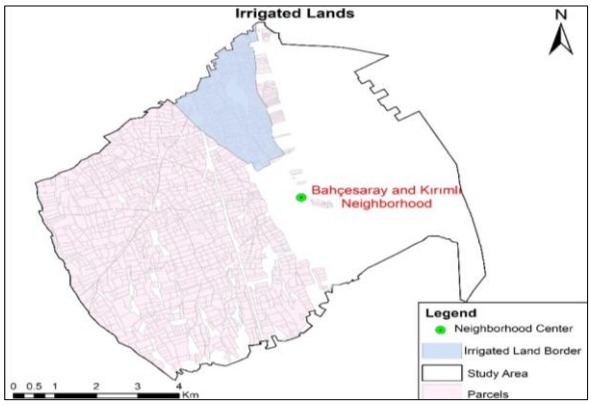

Figure 5. Irrigated lands

Land Use Capability: Land Capability Classification (Land Use Capability Classes) is the physical determination of agricultural lands according to their suitability for tillage agricultural production, their characteristic features, and the number and type of problems limiting tillage agriculture (Doğrama, 2020). According to the technical instruction of soil and land classification standards, land use capability starts from the first (I) class suitable for agriculture and continues until the eighth (VIII) class, where no agricultural activity can be processed.

Starting from the first (I) class, the use of agricultural land decreases as the class rises. It is suitable for agricultural culture by cultivating the lands in the first, second, third and fourth classes, provided that good soil management and some soil protection measures are taken. Fifth, sixth, and seventh class lands, on the other hand, are not suitable for agricultural culture by cultivating the soil, but have the appropriate ability for meadow, pasture and tree cultivation. Some special types of fruit and vegetables can be grown in the fifth and sixth grades. VIII. On the other hand, no plant products can be obtained on the lands of the 2nd class (Bilal. et al., 2022). In this context, according to the land use capability data obtained from Aksaray

Provincial Directorate of Agriculture and Forestry, the first class where the is done best agriculture is given 8 points, the second class is given 7 points and the score of the eighth class is determined as 1. Since there was no eighth class land in the study area, scoring was made according to the seventh class land. (Figure 6).

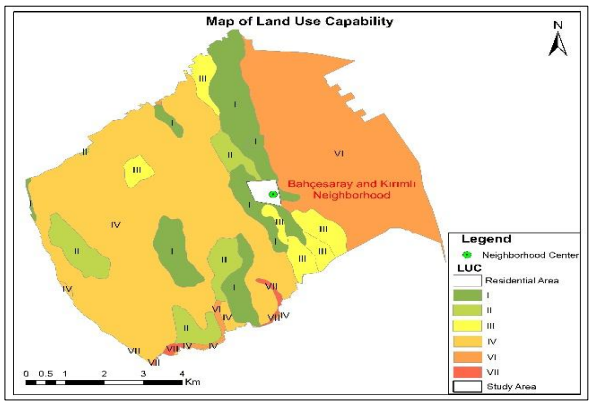

Figure 6. Land use capability.

Bordering the Pasture: In addition to agricultural activities, stock-breeding is also carried out on the lands in the study area. Pasture areas are important places for stock farming. In this context, the fact that agricultural lands are bordered by pasture, makes it easier to carry out stock-breeding activities together. (Ertaş, 2014). Within the scope of pasture information obtained from the Aksaray Cadastre Directorate, 1 point was given to the parcels bordering the pasture, while the score of the parcels not bordering the rangeland was determined as 0. (Figure 7).

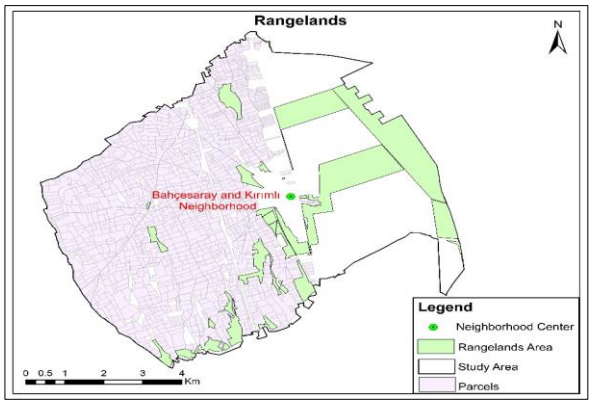

Figure 7. Rangelands in the study area

Average Slope: The slope of the land is an important criterion for the cultivation of agricultural products. Since sloping lands are often exposed to erosion, it is a factor that makes it difficult to grow agricultural products. The slope map of the study area was created using the data obtained from the website of the United States Geological Survey (Url-4). The slopes of the land up to 6% are considered as flat or nearly flat. Since this slope will not hinder agricultural production, it is considered as a non-slope in the classification of sloping land. Generally, agricultural productivity decreases on lands with a slope of more than 6% (Başer, 2015). Accordingly, lands with a plot slope between 0% and 2% were given 3 points, those with a plot slope between 2% and 4%, were given 2 points, and 1 point was given for a plot slope between 4% and 6%+ (Figure 8).

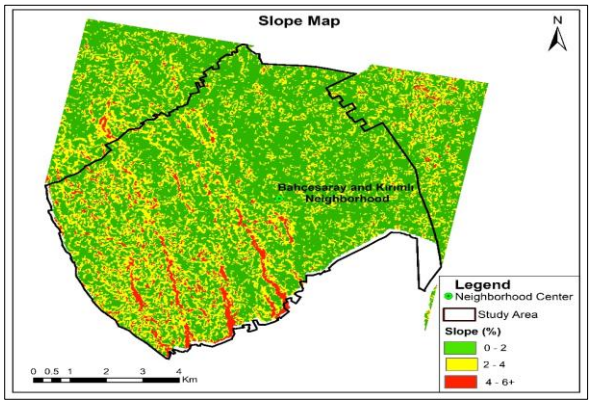

Figure 8. Slope map.

The Possibility of Being a Single Piece of Land and Generating New Parcels: The possibility of generating parcels is directly proportional to the size of the land. Since agriculture is a field of occupation made with the economic and physical contributions of family members, it is necessary for the owners of the lands to have the opportunity to generate large and new parcels (Ertaş, 2014).

According to the Soil Conservation and Land Use Law No. 5403, the criteria are that the minimum agricultural land size cannot be less than 2 hectares in absolute agricultural lands, marginal agricultural lands and special crop lands, 0.5 hectares in planted agricultural lands, and 0.3 hectares in greenhouse cultivation lands. exists. Furthermore, the size of agricultural land with sufficient income for the Central District of Aksaray Province, which is included in the Law No. 5403, is determined as 75 decares in irrigated land, 185 decares in dry land, 10 decares in planted land, and 3 decares in greenhouse land. While the minimum parcel size determined in this law and the parcels on subsistence land are 1, those below the specified criteria are given 0 points. 8 points are given for each divisible piece of eight or above that can be produced in multiples of the size as prescribed in the law numbered 5403, 7 points for seven pieces, 6 points for six pieces, and 1 point for one piece.

The boundary value scores of the criteria determined for the valuation of agricultural lands are shown in Table 2.

Table 2. Limit values and scores of the criteria used in the valuation.

Criteria	Limit Values and Scores
Irrigation Possibility	Available [1], N/A [0]
Land Use Capability	1st Class [8]
	2 st Class [7]
	3 st Class [6]
	4 st Class [5]
	5 st Class [4]
	6 st Class [3]
	7 st Class [2]
	8 st Class [1]
Distance to main road and Distance to village center	1 km [4]
	3 km [3]
	5 km [2]
	7 km [1]
Distance to city center	8 km [2]
	16 km [1]
Bordering pasture and forest areasland class	Available [1], N/A [0]
Right o easement facility on the land	Available [1], N/A [0]
Shape of the real property (Golden ratio rule)	0.1-0.7 [0]
	0.7-0.8 [1]
	0.8-0.9 [2]
	0.9-1.1 [3]
	1.1-1.2 [2]
	1.2-1.3 [1]
	1.3-2.0 [0]
One Piece of Land	Plot area > Subsistance Land Area [1] Plot area < Subsistance Land Area [0]
New Parcel Generation Opportunity (For each piece generated on subsistence land)	For 8 +piece of land [8]
	For 7 piece of land [7]
	For 6 piece of land [6]
	For 5 piece of land [5]
	For 4 piece of land [4]
	For 3 piece of land [3]
	For 2 piece of land [2]
	For 1 piece of land [1]
	For 0 piece of land [0]
Average Slope	0%-2% [3]
	2%-4% [2]
	4%-6+% [1]

2.7. Normalization of Data

In the analysis process to be performed with MRA and ANN, dependent and independent variables were normalized between 0.1 ≤ X ≤ 0.9 using Equation (10).

3. IMPLEMENTATION

3.1. Agricultural Land Value Estimation with Multiple Regression Analysis:

To be used in the model, sales data of public institutions regarding 125 parcels with a known value in the study area were obtained. 70%(87) of this data was used as training data and 30% (38) was used as test data. MRA was performed with the help of the Statistical Package for The Social Sciences (SPSS) 26.0 program, and an R^2= 0.892 value was obtained as a result of the analysis. Since the R^2 value found is very close to 1, it was determined that the model is well explained by the independent variables. It was seen that the criteria that had the most positive effect on the value of the parcel and deemed as significant were the distance to the city center, the possibility of irrigation, the distance to the neighborhood center, and the main road (Tables 3, 4, 5, 6).

Table 3. MRA R^2 and adjusted R^2 values.

Model	R	R Square	Adjusted R Square	Standart Error of the Estimate
1	0.952	0.906	0.892	0.05909

Table 4. MRA variant analysis (ANOVA) table.

Model	Sum of square	df	Mean Square	F	Sig.
Regression	2.513	11	0.228	65.425	,000[b]
Residual	0.262	75	0.003		
TOTAL	2.775	86			

Table 5. MRA performance analysis.

Model	PERFORMANCE ANALYSIS			
	R^2	MAPE	MAE	RMSE
MRA Training	0.91	0.195	0.044	0.055
Testing	0.87	0.277	0.056	0.072

□□: Represents the input value,
□□□□: Represents the smallest number in the input data,
□□□x: Represents the largest number in the input data (Han, et al., 2022).

$$\text{Normalization}=0{,}8*\frac{\text{Xi}-\text{Xmin}}{\text{Xmax}-\text{Xmin}}+0{,}1 \qquad (10)$$

Table 6. Table of MRA criteria coefficients.

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Variance increase Factor
	B	Std. Error	β			VIF
Constant	-0.102	0.052		1.961	0.054	
Shape of the real property	0.051	0.026	0.072	1.933	0.057	1.113
Distance to city center	0.389	0.061	0.261	6.351	0.000	1.347
Distance to main road	0.147	0.059	0.192	2.498	0.015	4.690
Distance to neighborhood center	0.246	0.063	0.270	3.908	0.000	3.791
Irrigation possibility	0.292	0.030	0.481	9.813	0.000	1.907
Land Use Capability	-0.029	0.053	-0.022	-0.552	0.583	1.318
Proximity to do rangelands	0.039	0.025	0.067	1.567	0.121	1.445
Average Slope	0.071	0.035	0.089	2.037	0.045	1.526
Easement facility on the land	0.055	0.038	0.058	1.448	0.152	1.263
Land as one-piece	-0.024	0.020	-0.050	1.209	0.230	1.379
Possibility to generate new parcels	-0.097	0.066	-0.061	1.463	0.148	1.368

The F test value and R^2 value found from the model as a result of the analysis are among the important values that should be checked first. The F test is a test conducted with ANOVA to examine the significance of the regression model. The significance level corresponding to the F test value obtained as a result of the ANOVA test helps in the decision of the suitability of the created model. It was interpreted that the result of the F test is significant ($p<0.05$) and that the model makes a significant contribution to explaining the dependent variable. The R^2 value indicates that the % of the variance in the dependent variable is explained by the independent variable. The closer this value is to 1, the better the model is explained by the independent variables (Ünel, 2017).

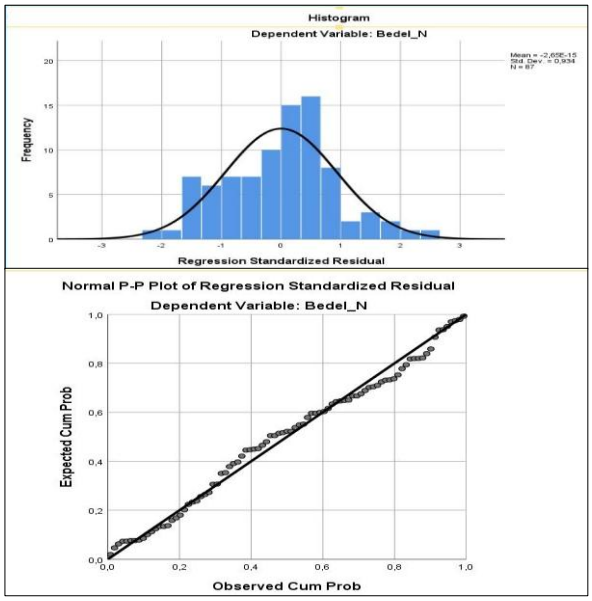

Figure 10. MRA results.

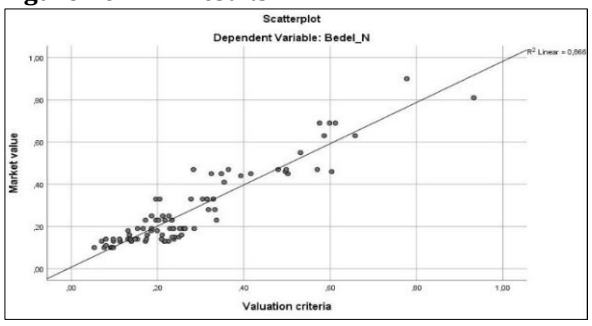

Figure 10. MRA results (continuation)

3.2. Agricultural Land Value Estimation with Artificial Neural Network Method

According to the data used in Multiple Regression analysis, ANN analysis was performed based on the Matrix Laboratory (MATLAB R2016b) program. 65% (81) of the sales data obtained from public institutions regarding 125 parcels in the study area were used as training data, 30% (38) were used as test data, and 5% (6) were used as validation data. Levenberg-Marquardt algorithm is selected as default in MATLAB R2016b program and ANN is used as backward feed. Whether the model is significant or not can be decided by looking at the R^2 value (Er, B. et al., 2022). The training data has shown the model at the level of 95%, and the validation data confirms the model at the rate of 95%. In addition, the test data finds the model was significant at the rate of 87%. The significance and error rates of the created ANN model are shown in Table 7. According to these ratios, it can be interpreted that the performance of the ANN model is quite accurate and successful.

Tablo 7. ANN Performance analysis

Model	PERFORMANCE ANALYSIS				
		R^2	MAPE	MAE	RMSE
ANN	Training	0.95	0.126	0.032	0.043
	Validation	0.95	0.120	0.020	0.027
	Testing	0.87	0.192	0.047	0.059

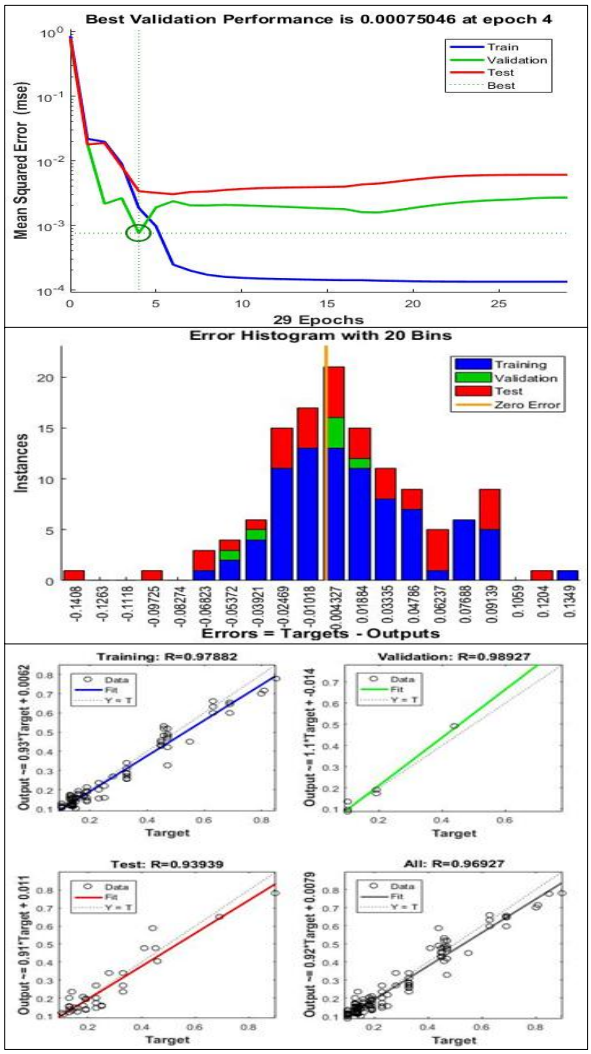

Figure 11. ANN results.

3.3. Comparison of MRA and ANN Application Results

R^2, MAPE, MAE, and RMSE are shown in Table 8 in the study to determine the value of agricultural

lands with MRA and ANN. When these values are examined, it is understood that the most significant and the lowest error rate is according to the results obtained with the ANN method. In this case, it was concluded that the most successful model in the estimation of agricultural land was ANN properties

Table 8. ANN ve MRA performance analysis

Model		PERFORMANCE ANALYSIS					
		R^2	MAPE	MAE	RMSE	COD	PRD
MRA	Training	0.91	0.195	0.044	0.055	19.49	1.04
	Testing	0.87	0.277	0.056	0.072	26.63	1.10
ANN	Training	0.95	0.126	0.032	0.043	12.77	1.02
	Validation	0.95	0.120	0.020	0.027	12.73	0.99
	Testing	0.87	0.192	0.047	0.059	19.58	1.02

One of the accepted performance measurement methods according to the proportional standards guide of IAAO is the coefficient of distribution (COD) and PRD value. The dispersion coefficient (COD) will give better results as it approaches 10 (ten). The performance standard for the COD distribution coefficient should be 15% or less for residential properties, 20% or less for commercial properties and 25% or less for agricultural land. (IAAO, 2013). PRD is an indicator of vertical equality. It is calculated by dividing the mean by the weighted average. The closer the value is to 1, the better the result will be. PRD values for all kinds of real estates are considered appropriate when they are between 0.98-1.03. (IAAO, 2013). If the PRD value is greater than 1, it indicates that parcels with higher values are undervalued and pull the weighted average lower. If the PRD value is less than 1, high value parcels will be proportionally more valuable. This indicates that the weighted average has been pulled higher (Url-1).

In this context, when comparing the ANN and MRA models according to the COD and PRD values, it was seen that the estimation results made with the ANN model were within acceptable limits according to the proportional standards guide of the IAAO.

The value estimation maps of the agricultural lands in the study area were drawn from the data obtained according to the model created by ANN and MRA methods (Figure 12). According to these maps, it was observed that the value of irrigated lands and the value of lands close to the main road is higher. In dry lands, it can be understood that there is a gradual decrease in the value of agricultural lands as they move away from the neighborhood center and the main road.

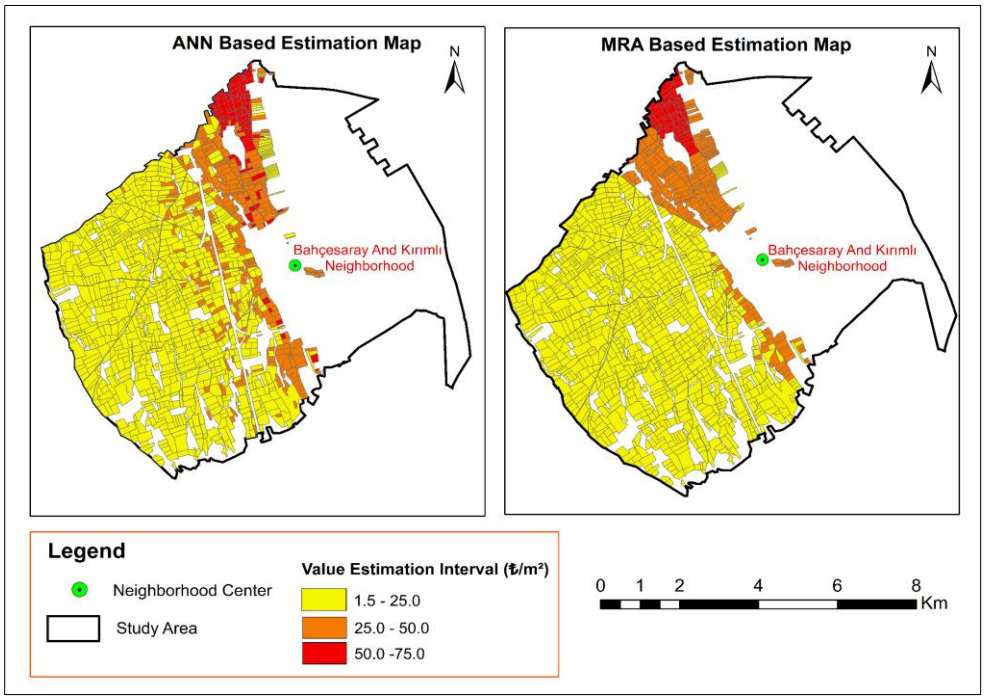

Figure 12. ANN and MRA based estimation maps.

4. CONCLUSİONS

While the Aksaray Province Merkez (Center) district was the Hamidiye-Alaca Village, it was divided into two to be Bahçesaray and Kırımlı Districts in 2014. However, the neighborhoods maintain their rural characteristics as a function and continue their agricultural production activities and are outside the scope of the zoning plan.

According to the sales data made by public institutions in the Central district of Aksaray province, the Bahçesaray and Kırımlı neighborhoods agricultural land valuation was carried out with ANN and MRA methods. A data set was created according to the sales values of 125 parcels obtained from

public institutions. Using this data set, an algorithm for valuation was created with respect to the MRA model with the help of the SPSS program and the ANN model with the help of the MATLAB program. It was determined that the analysis with the most significant and least error yielding concerning the R^2, MAPE, MAE and RMSE results were derived by the algorithm as a consequence of the analysis with ANN. The COD and PRD values produced by the model algorithm created with the ANN were found to be within acceptable limits according to the proportional standards guide of the IAAO. Furthermore, it has been seen that the value maps drawn according to ANN give more accurate results and better reflect the value of the real estate.

Real estate valuation is carried out for various purposes such as expropriation, purchase and sale, crediting, taxation, and bank mortgaging. The valuation procedures for agricultural lands are generally carried out in the form of determining the capitalization value according to the income method. When a valuation is conducted according to the income method, the valuation process is carried out without considering the spatial criteria (distance to the main road, distance to the village center, and distance to the city center) and some of the productive criteria (the shape of the land, the easement on the real estate, etc.) where the agricultural land is located. Under these circumstances, this situation may not give accurate results in determining the values of agricultural lands. For this reason, it would be appropriate to use modern and statistical methods in valuation according to all criteria affecting the value of the real estate.

Acknowledgement

This article is produced from Hakan KARADUMAN's master's thesis work.

Author Contributions

Hakan Karaduman: Conceptualization, Data curation, Methodology, Software, Writing-Original draft preparation. **Kamil Karatas**: Supervision, Methodology, Writing, Reviewing and Editing.

Conflicts of Interest

The authors declare no conflict of interest

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