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Using artificial neural networks in land use/change

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ABSTRACT

The aim of this study is to detect and control the land cover distribution / change with stylistic shaping based on the satellite images of different times by using remote sensing techniques. These images are used to obtain earth information from satellite images obtained in raw form. The most common method for converting data into information is the classification of satellite images. Different kinds of statistical analysis and interpretation techniques are used to get information regarding the Earth from the images in the raw form. In this study, it is aimed to determine land usage change in order to better understand the land structure by using Landsat 8 OLI satellite images in Çaycuma district of Zonguldak province including the time between 2015 and 2020. The QGIS program was used to determine the change of land usage. In the study, artificial neural networks were used on determining the change of land usage. The values obtained by this method are compared with the maximum likelihood of values and the speed and accuracy of artificial intelligence methods in creating the change of land usage are examined.

1. INTRODUCTION

With remote sensing techniques, it provides important opportunities to determine the changes in different scales and to be able to make comparative analysis through satellite images of different times in order to detect and control the change of land usage.

Land use studies are necessary not only for agriculturally dominant, overpopulated developing regions, but also for all over the world due to their relationship with different human phenomena. The terms land use and land cover change (LU / LC) describe any human activities that occur on the Earth's surface. Land cover refers to the physical and biological cover of the land, including water, vegetation, bare soil and / or artificial structures (Ellis and Pontius, 2006).

Remote sensing is the science of obtaining information about objects without physical contact, recognizing them, distinguishing them from their surroundings and turning this information into the form of images.

With remote sensing technology, the visual and statistical detection of land use and change depending on time and location is an important gain in terms of speed and economy. Thanks to its ability to produce a high rate of data, it can significantly increase the possibilities for analytical evaluation processes about the region and provide users with the opportunity to produce methods and models suitable for its purpose in the planning process (Hellawell, 1991; Banister et al, 1997).

The changes in land cover and land use increase the impact of environmental changes that lead to the change and transformation of the earth. These changes and transformations depend on time. The reason for the change is the decisions taken by local and regional governments in parallel with the economic, cultural, social and ecological processes (Aspinall,2006).

The various statistical analyses and interpretation techniques are used to obtain earth information from satellite images obtained in raw form. The most common method for converting data into information is the classification of satellite images.

Classification is the categorizaton of all pixels in one image nto different classes or themes. It is the creation of homogeneous classes of similar objects in the data, or the creation of previously defined classes using the property of the given object, obtained by mathematical and statistical methods. The purpose of the image

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classification process is to obtain the thematic map by assigning each pixel to one of the classes that makes up the terrain cover according to a specific rule based on the brightness values of the pixels that make up the image. In this study, it is aimed to determine land usage change in order to better understand the land structure by using Landsat 8 OLI satellite images in Çaycuma district of Zonguldak province including the time between 2015 and 2020.

2. METHOD

In this study, Landsat 8 OLI images from 2015 and 2020 were used in Çaycuma district of Zonguldak province. The following ways are briefly followed in the pre-processing of these images and obtaining a land use map: First, image preprocessing (geometric and atmospheric correction) was performed. The land classes to be used are designed. These classes are the forest area, water surface, structure, agriculture, bare land. Then, test sites that could reveal the earth characteristics in the image were determined and classified with appropriate algorithms. The controlled *classification* method was used in our study. Sample pixels were collected for each terrain class through the image before the classification was initiated. By analyzing the pixel values, the statistical characteristics of the classes were determined and the images were classified using the *Maximum Likelihood* method. In order to get used, artificial neural networks were used on land use change. The values obtained by this method were compared with the *maximum likelihoood* values and the speed and accuracy of the methods of creating classifications were examined. An artificial neural network model was created using Matlab. The results compared with the values obtained with the *maximum likelihood* method and the usability of the methods in the field of land use change are shown.

There are several methods and techniques for satellite image classification. Figure 1 shows the hierarchy of satellite image classification methods. Satellite image classification methods can be broadly classified into three categories: Automated, Manual, Hybrid (Abburu, 2015).

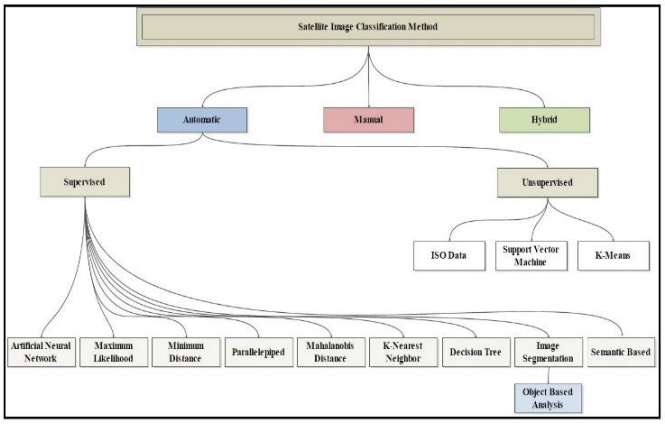


Figure 1. The hierarchy of Satellite image classifications methods (Abburu, 2015)

The controlled classification map for 2015 created with the QGIS program is given in Figure 2.

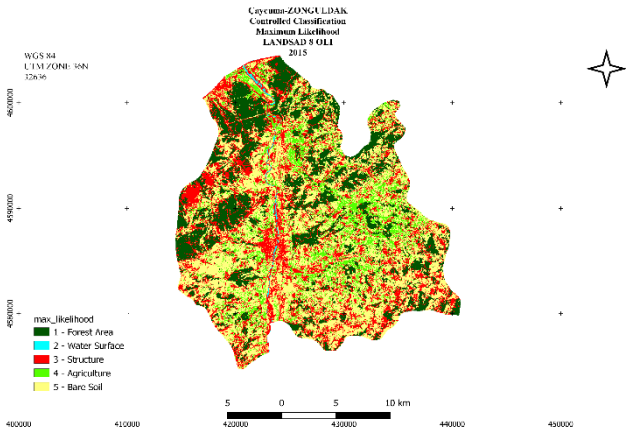


Figure 2. Çaycuma district controlled classification in 2015

The controlled classification map for 2020 created with the QGIS program is given in Figure 3.

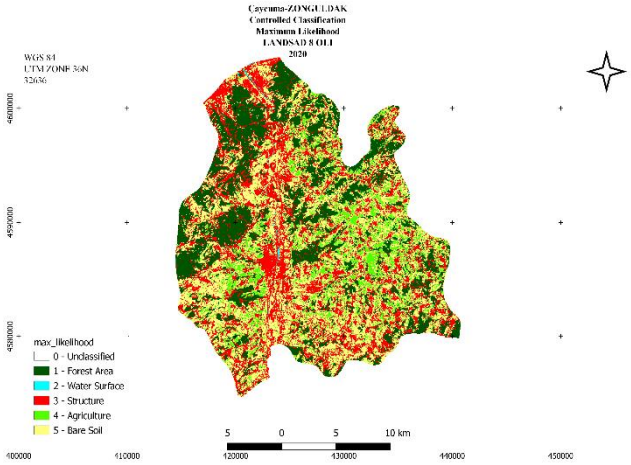


Figure 3. Çaycuma district controlled classification in 2020

The data were obtained as a result of the controlled classification with *maximum likelihood* technique. Classification results for 2015 and 2020 are given in Table 1 and Table 2.

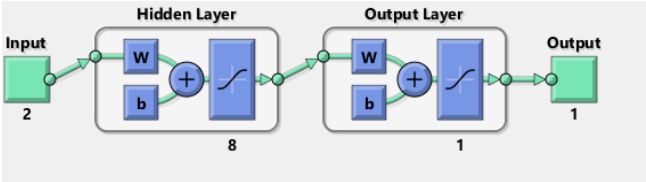
Table 1. Classification results for 2015

Class	PixelSum	Percentage (%)	Area [m^2]
1	130305	23.82676431	117274500
2	2373	0.433912066	2135700
3	130639	23.88783748	117575100
4	63952	11.69386617	57556800
5	219616	40.15761997	197654400

Table 2. Classification results for 2020

Class	PixelSum	Percentage (%)	Area [m^2]
1	144960	26.5063898	130464000
2	1269	0.372040623	1892100
3	146468	26.78213232	131821200
4	65197	11.92147555	58677300
5	188993	34.5579617	170093700

Artificial Neural Networks is an often preferred method because it is successful in learning nonlinear relationships by generalizing with samples. It is a method created based on strong and complex nerves in the human brain (Tabar,2020). It is used to classify complex relationships and nonlinear states. The data is divided into units. Each unit consists of inputs and outputs generating a function that determines the relationship between them. To start the application, the data must first be recognized and the network must be created. After the input and output values are determined, the training phase of the network should be started. The model of artificial neural networks obtained by input and output values is given in Figure 4.



Figüre 4. Artificial Neural Networks Model

Learning-status and test graphs are given in Figure 5.

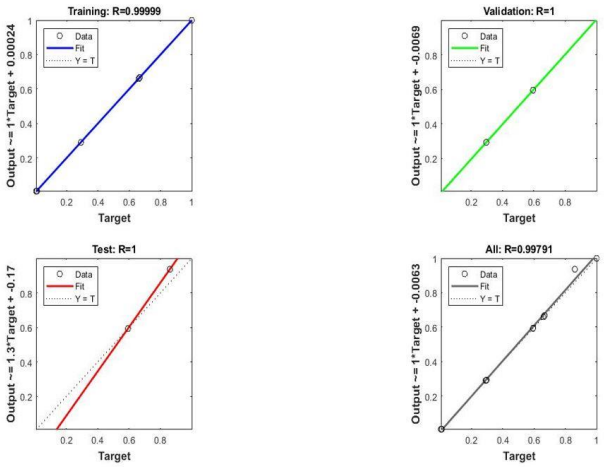


Figure 5. Learning-status and test graphs

Field data and artificial neural networks model were created and then the values of the test result data were compared (Figure 6).

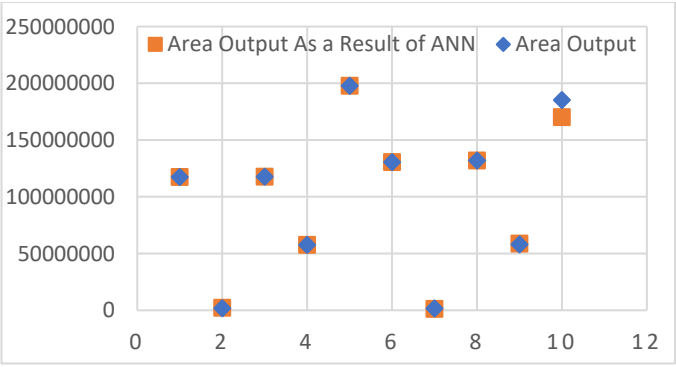


Figure 6. Creating a model of artificial neural networks with field data and then comparing the values of the test result data

Table 3. Artificial neural networks test output for 2015

Class	2015 Area (m^2)	ANN Output
1	117274500	117289335
2	2135700	1779324.79
3	117575100	117589375
4	57556800	57556920.5
5	197654400	197651065

Table 4. Artificial neural networks test output for 2020

Class	2020 Area (m^2)	ANN Output
1	130464000	130463798
2	1892100	1712896.95
3	131821200	131821412
4	58677300	57996906.5
5	170093700	185149415

3. RESULTS

The visual and statistical detection of land usage and change depending on time and location with remote sensing technology provide the possibility of high speed, economy and producing data of higher accuracy. It also contributes to the analytical review processes about the region. This technology is one of the most suitable choices to conduct them. In this study, Çaycuma district of Zonguldak province was examined with satellite images. For this purpose, Landsat 8 OLI satellite images were used. In the working area, there are classes of forest areas, water surface, structure, agricultural land, bare lands. In order to distinguish these classes, controlled classification techniques were applied using satellite imagery. At the same time, it has been investigated whether there will be similar results with artificial neural networks. When the results were examined, it was seen that the data obtained by the maximum likelihood method and the data obtained by artificial neural networks are compatible.

4. DISCUSSION

In the study, the use of artificial intelligence methods in land usage was investigated. Artificial neural networks toolbox was used in Matlab program for application. According to the application results, it was seen that the value obtained from the model established with artificial neural networks was very close to the actual report values. Most methods that use artificial intelligence, such as artificial neural networks, can be used in the change of land usage as it can be used in any field.

5. CONCLUSION

The study based on the change of land usage using Remote Sensing technology is important for numerical analysis with the plans. In addition, the effective analysis of land features involved in planning and the ability to do it quickly and at low costs increase its availability. In this respect, it has been used more frequently in recent years. Artificial neural networks, which are now used in every application, have been shown to give accurate results in

the studies. It should be noted that the number of data should be increased in order for artificial neural networks to give better results.

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