**Advanced Remote Sensing**

http://publish.mersin.edu.tr/index.php/arsej

**e-ISSN 2979-9104**

# Evaluation of green areas with remote sensing and GIS: A case study of Yozgat city center

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Cite this study: Erdoğan, A., Görken, M., Kabadayı, A., & Temizel, S. (2022). Evaluation of green areas with remote sensing and GIS: A case study of Yozgat city center. Advanced Remote Sensing, 2 (2), 58-65

**Keywords**
Remote sensing
Green area
Classification
GIS

**Research Article**
Received: 05.09.2022
Revised: 28.11.2022
Accepted: 07.12.2022
Published: 28.12.2022

**Abstract**

Green spaces in urban areas play a critical role in the quality of life. The abundance of urban green spaces; They play an important role in the formation of quality living environments with their ecological, economic, social, physical and aesthetic functions. The fact that green areas or park areas in a city are at the level of human need have positive effects on the socio-psychological structure of the society living there, which has effects on the city in many dimensions such as physical, social, cultural and economic structure and livability, ecological sustainability, urban aesthetics, education, and recreation. makes an impact. It also has significant effects on the local microclimate and the regional climate of the city. In recent years, with the development of remote sensing technologies, many mapping techniques and analyzes have been developed. He has made great contributions to the analysis of urban green spaces. In this study, the direction of urban expansion and changes in urban open-green areas were investigated by using satellite images with high ground sample distance. Analyzes consist of satellite image classification, plant index generation and GIS-based analysis methods. The reliability of geospatial information from remote sensing data is often evaluated by actual verification or comparison with other reference data. In the study, active open green areas detected with the help of satellite images in the city center of Yozgat were compared with the data obtained in the field. More research is needed for thematic applications such as monitoring the changes in urban green spaces with remote sensing methods, assessing vegetation health, and carbon mapping.

## 1. Introduction

Remote sensing has long been an important and effective tool for monitoring land cover, with its ability to quickly provide broad, precise, unbiased and easily accessible information regarding the spatial variability of the land surface [1,2]. In remote sensing, the data source is an important factor for successful land cover classification. Landsat satellite data is widely used remote sensing data for land cover classification [2,3]. As a result of classification, by distinguishing land cover, roads, buildings and similar objects, thematic maps can be produced and transferred to geographic information systems (GIS).

People settled in certain places by forming social associations in order to survive on earth. With the increase in population and migration, these places have turned into urban spaces, which are accepted as the starting point of civilization. In the light of scientific and technological advances, the economic, cultural and social structures of cities and their physical appearance are changing day by day. With this change, open and green areas are neglected among the construction activities carried out by ignoring environmental principles in parallel with the rapidly increasing population, especially in developing countries. As a matter of fact, the impact of these areas on the psychological renewal and social and cultural development of urban people, who are far from nature and under the influence of urban life, is too great to be underestimated. Open spaces are very important factors for the mental and physical development of children and young people. While children develop their own physical strength with outdoor games, they are involved in social and psychological actions, even if not as much as cultural activities [4]. From a social point of view, green spaces are areas where individuals, each of whom forms a different texture of the urban mosaic, come together and share their social and cultural characteristics.

From a social point of view, green spaces are areas where individuals, each of whom forms a different texture of the urban mosaic, come together and share their social and cultural characteristics. The rapid increase in the urban population, economic and political conditions bring with it increasing building and structural masses on the city surface. As a result, we rarely come across nature and natural life in our living environment. “On the other hand, the ability of a person to adapt to the environment according to physical and psychological conditions can only be achieved by establishing harmony not only with her own species but also with all living creatures” [5]. Green areas are of great importance in balancing the deteriorated relationship between nature and people and in creating a healthy urban texture. The data layers created in this process become easier to understand thanks to the advantages of mapping [6].

Parks and gardens, where people used to have fun in the past, have become a necessity after the increase in vertical architecture and the concentration of population in certain regions. Urban green spaces are defined as the surface areas of existing open spaces covered or combined with vegetative elements. In practice, it is divided into two as active green areas and passive green areas [7]. Active green areas are children's playgrounds, park areas and sports fields and are important physical components of urban life quality [8]. It has many functions in terms of economic, ecological, social, and physical (in terms of planning) [9-13]. Especially geographical information systems have an important contribution here [14].

In order to obtain sufficient sensitivity from images in remote sensing, a certain number of control points marked on the earth are needed [15]. These control points should be appropriately distributed over the terrain. In addition, it needs to be painted in certain dimensions in order to be visible in the satellite image [16-19]. At the beginning of the most important issues in which UA technology is used, agricultural ecosystem studies such as monitoring plant developments with the help of satellite images, tracking plant diseases and pests, biomass, evapotranspiration, product yield estimations, as well as land cover / land use types and especially agricultural product patterns.

It is necessary to analyze spatial, or in other words, geographical information in determining and solving problems that concern nature and natural life. As a result of developing computer technologies and sectoral demands, computer systems that collect, store, query and analyze spatial data have been developed. Thanks to Geographic Information Systems, different geographical formations and processes in the world can be mapped in the same environment and various analyzes can be made with these maps. Even the resulting maps can be presented in the WebGIS environment. WebGIS enables anyone to access geospatial data. It creates a fast and advanced environment without the limitations of space, time and high processing power and high client computer [20]. GIS technology greatly facilitates the inventory, evaluation, preservation, and documentation of sites and structures [21]. At the beginning of the most important issues in which UA technology is used, agricultural ecosystem studies such as monitoring plant developments with the help of satellite images, tracking plant diseases and pests, biomass, evapotranspiration, product yield estimations, as well as land cover / land use types and especially agricultural product patterns [22, 23].

The list of applications remote sensing and GIS is progressively growing; classification, visibility analysis, erosion modeling, surface hydrology, crop monitoring, watershed modeling, geomorphology, marine resource monitoring, land-sliding, and agriculture and ecosystem modeling, natural disaster warning, urban resource big data processing, land vegetation analysis, etc. are some examples [24].

This study was conducted to investigate the performance of Landsat 8 OLI data and to detect active green areas in Yozgat Center and to examine their changes compared to existing studies.

## 2. Material and Method

### 2.1. Study Area and Data

Yozgat (Figure 1) is located on the Bozok Plateau in the Central Central Anatolia Region. One of the trained classification methods on the satellite image dated 23/09/2020 08:21:21 of 176-32 path-row, which includes 34°03'-36°09' longitudes and 40° 15′-38° 57′ latitudes; It is classified by the closest distance and maximum probability methods. While the data consists of 7651x7781 pixels, its 915x580 pixel area covers the city center of Yozgat.

Landsat 8 Oli Satellite image bands and technical specifications of the study area are given in Table 1.

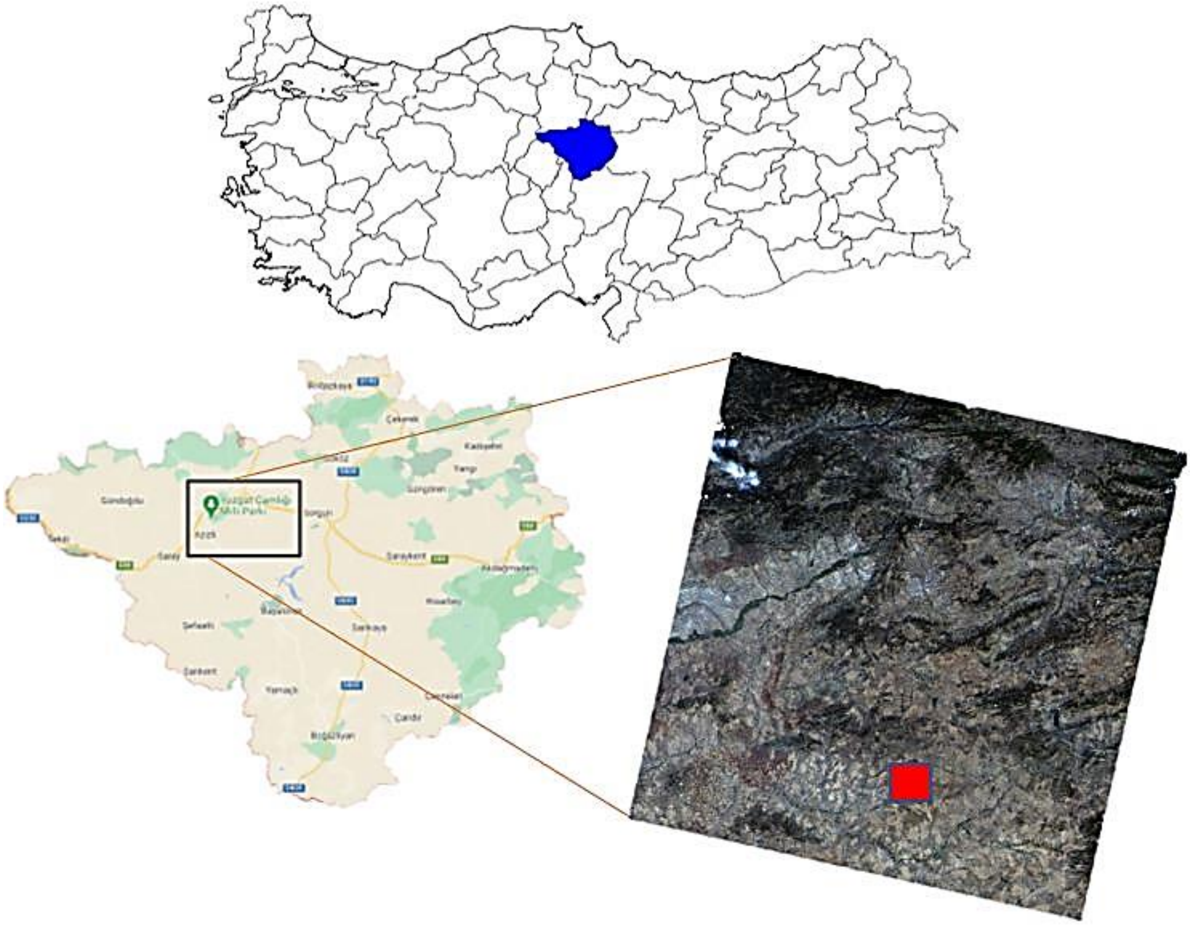


**Figure 1.** Study Area Turkey Map View

**Table 1.** Specifications of Landsat 8 OLI bands used

| Band | Wavelength (µm) | Resolution (m) |
|---|---|---|
| Band 1 Coastal Aerosol | 0.43-0.45 | 30 |
| Band 2 Blue | 0.45-0.51 | 30 |
| Band 3 Green | 0.53-0.59 | 30 |
| Band 4 Red | 0.64-0.67 | 30 |
| Band 5 Near-Infrared | 0.85-0.88 | 30 |
| Band 6 SWIR-1 | 1.57-1.65 | 30 |
| Band 7 SWIR-2 | 2.11-2.29 | 30 |
| Band 8 Panchromatic (PAN) | 0.50-0.68 | 15 |
| Band 9 Cirrus | 1.36-1.38 | 30 |

### 2.2. Classification of Images

Image classification refers to the classification of various objects in images, such as trees, people, crops, soil, minerals and bodies of water. Different objects or regions in the image must be identified and classified. The classification algorithm determines the accuracy of the result. It is usually based on a single image or sets of images. When image sets are used, the set will contain multiple images of the same object under different views and different conditions. Since the algorithm can accommodate a variety of conditions such as background differences, lighting or appearances, it will be more efficient at classification than with single images. It can also be invariant for image rotation and other transformations [10].

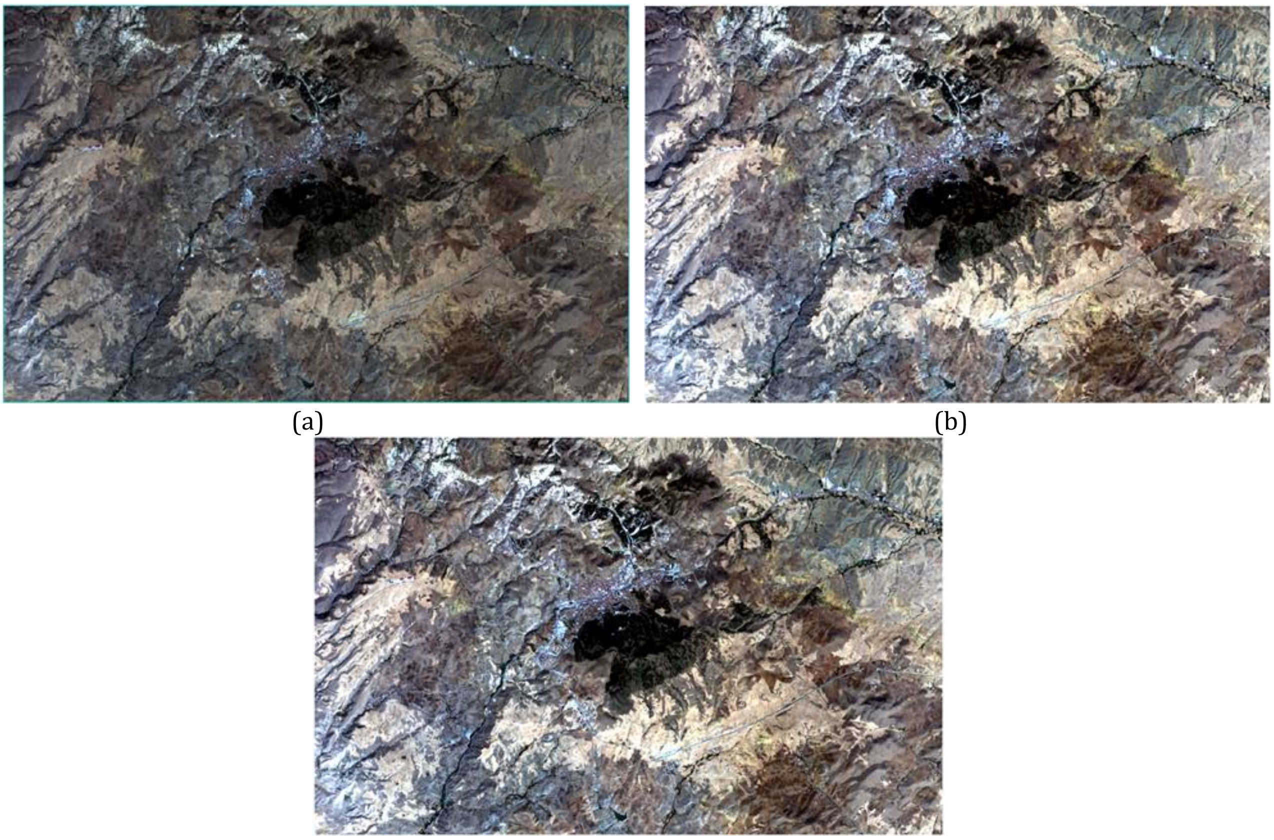
Using the spectral subset in ENVI software, selected regions of interest (ROI) were selected as training pixels. 6 classes were selected as park, national park (pine grove, road, structure, soil, high-speed train line) (Table 2).

**Table 2.** Pixel numbers and classes used as training data

| ROI Summary | Pixel Count |
|---|---|
| Park | 135 |
| Pine Grove | 184 |
| Structure | 153 |
| Soil | 405 |
| High Speed Train Line | 169 |
| Asphalt | 150 |

### 2.2.1. Atmospheric Correction and Radiometric Correction

Landsat image processing mainly includes radiometric calibration (Figure 2b) and atmospheric correction (Figure 2c). Landsat data radiometric calibration converts the value of digital numbers to luminance, and then atmospheric correction is performed to obtain the surface spectral reflection using the Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes (FLAASH) algorithm.



(a) (b) (c)

**Figure 2.** (a) Working area image cut from satellite image, (b) Radiometrically corrected image, (c) Atmospherically corrected image

### 2.2.2. Minimum Distance Classification (MDC)

It assumes that the statistics for each class in each band are normally distributed and calculates the probability that a particular pixel belongs to a particular class (Figure 3). Each pixel is assigned to the class with the highest probability (i.e., maximum probability) [11]. After applying the Minimum Distance Classification method, the image (Figure 4) was produced.

### 2.2.3. Maksimum Likelihood Classification (MLC)

Among the pixel-based classification, the most frequently used and used method in the literature is the most similarity method. The main purpose of the method is to define the equiprobability curves for the classes and to assign the highest membership to the pixels to be classified [12]. After applying the Maximum Likelihood Classification method, the image (Figure 5) was produced.

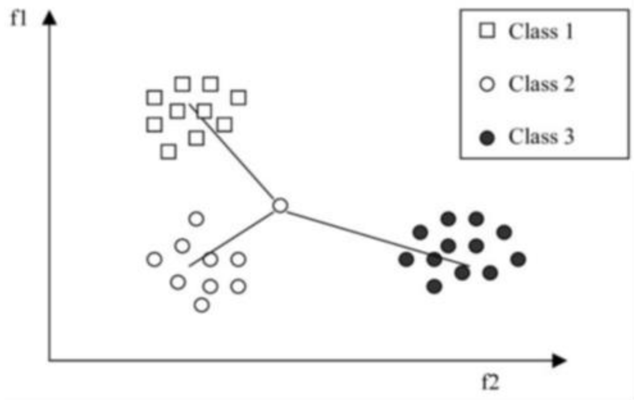



**Figure 3.** Minimum Distance Classification

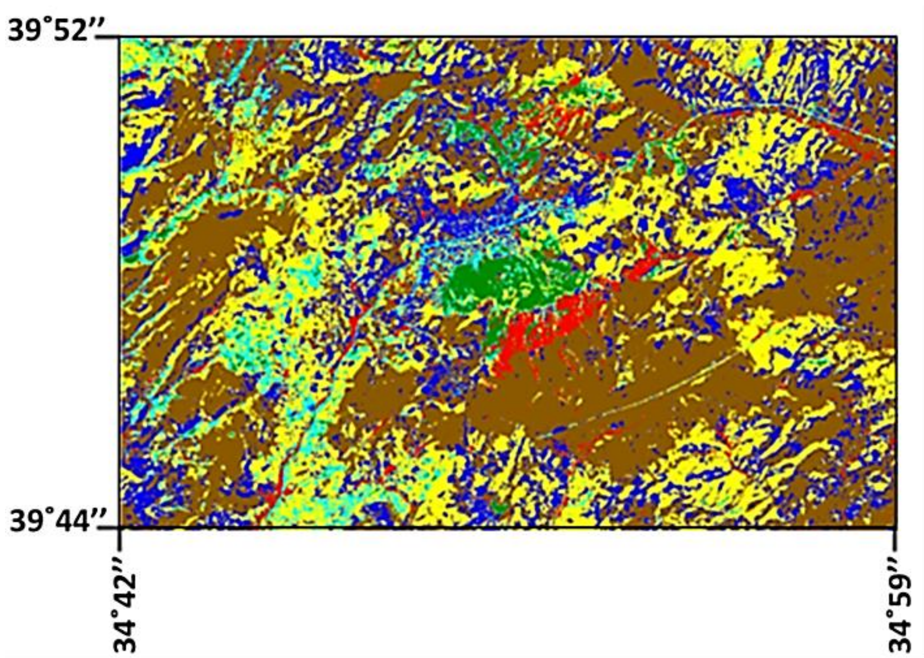



**Figure 4.** Thematic image formed after MDC

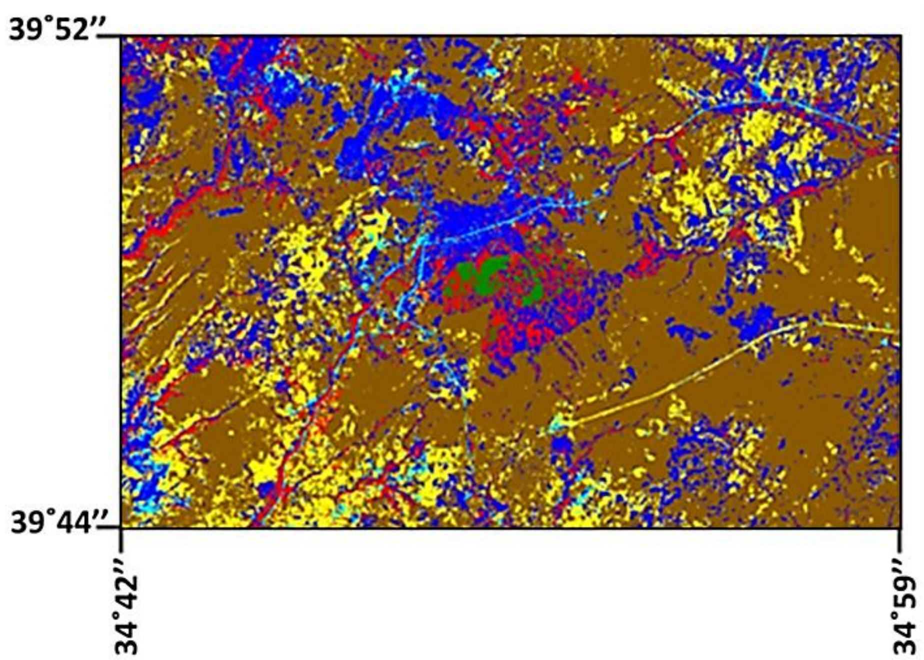



**Figure 5.** Thematic image created after MLC

#### 2.2.4. Normalized Difference Vegetation Index (NDVI)

The normalized plant difference index (NDVI), which is the most widely used vegetation index in the field of remote sensing, is an expanded version of the band ratio. The basic equation for NDVI is the combination of infrared (Nır) and Red (R) band [13].

$$NDVI = (Nır - Red)/(Nır + Red)$$

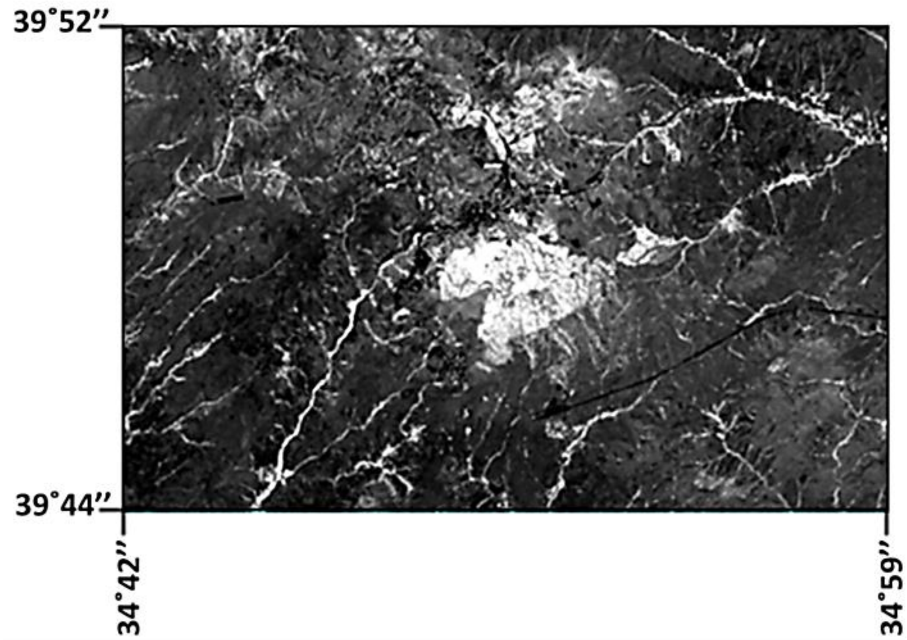



**Figure 6.** Thematic image formed after NDVI

## 3. Discussion

Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) images have a resolution of 30 m outside the panchromatic band in bands 1-9, reducing the classification success in residential areas. The file as a thematic map shape file obtained from the highest probability classification method with a higher accuracy rate was transferred to ARCGIS (Figure 7).

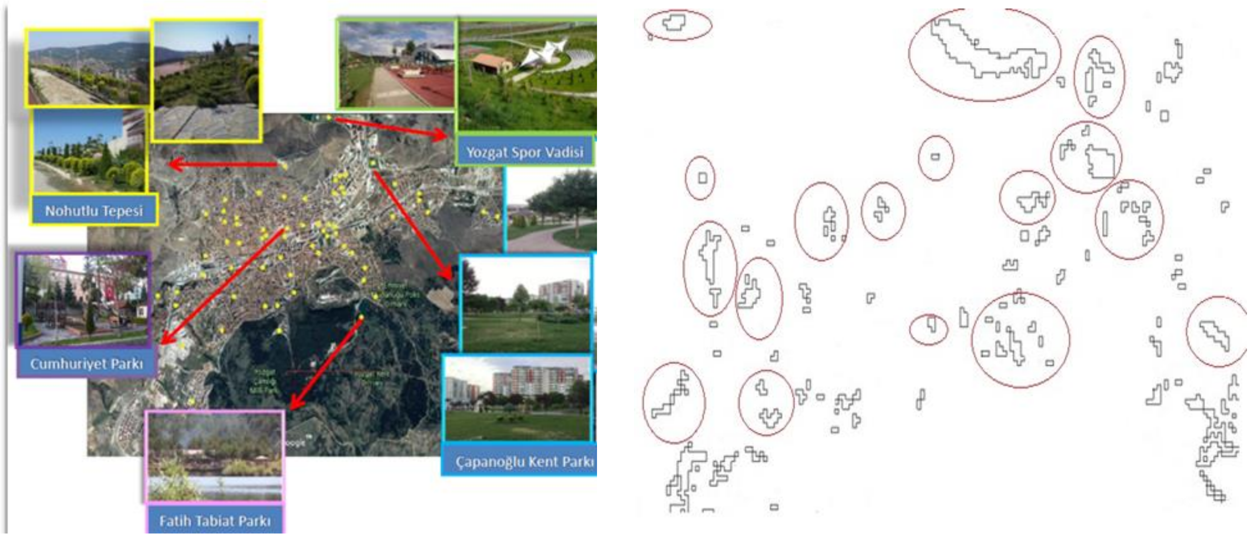



**Figure 7. (a)** Image with active green areas marked, **(b)** Vector map produced from thematic maps

## 4. Conclusion

Accuracies of the produced thematic maps were calculated with the Confusing Matrix Using Ground Truth ROIs module in Envi 5.3 Program. In this module, comparisons of test data and training data are made.

Classification accuracy and kappa statistics were calculated based on validation samples. The overall performance of the MLC classifier (overall accuracy 80.4%; kappa coefficient: 0.71) was slightly lower than the MDC classifier (overall accuracy: 79.3%; kappa coefficient: 0.69). Since the building class and roads, Park and Çamlık classes have spectral signatures that are very close to each other, the most errors occurred in these two classes. All other class types have been observed to separate better from each other and have higher user and producer accuracies.

In this study, which was carried out in Yozgat city center, the total of active green areas was 627073 $m^2$. In the study, it was calculated as 680045 $m^2$. However, in the classification, a part of the Provincial Directorate of Agriculture, TOKİ garden and Governor's garden and Çamlık National Park located in the city center are classified as parks. These green areas cannot be considered as active green areas.

The social and demographic structure of the urban people must be taken into account in the planning and applications for green areas. According to the population projections to be made, green areas should be designed to meet the needs. Especially for the elderly, children and disabled people with walking distance limits, the standards should be taken into consideration in the planning.

Transferring green areas to future generations is as important as designing them. In this context, it is necessary to raise awareness of people about the protection and continuity of planned areas and natural greenery. Local government and non-governmental organizations should also take an active role in informing and raising awareness about green areas and their protection.

**Funding**

This research received no external funding.

**Author contributions**

**Alperen Erdoğan:** Data, Methodology, Software, Visualization. **Mahmut Görken:** Conceptualization, Data curation, Visualization. **Adem Kabadayi:** Writing-Original draft preparation, Software. **Selin Temizel:** Investigation, Writing-Reviewing and Editing.

**Conflicts of interest**

The authors declare no conflicts of interest.

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