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Sustainability in Urban Ecosystems and Detecting Urban Vegetation from Different Images Using an Object-Based Approach

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1. Introduction

Lexical meaning of ecology is “the study of the interrelations of organisms and their surroundings” (Odum and Barrett 2008). Every individual in the society must be aware of and know his surroundings, plants in his surroundings, other living beings and all the factors that affect the life in the nature in order to continue his life. Because of various opportunities provided by the success in technology for our lives, many of us are not aware of the fact that we depend on nature for air, water, and food, though indirectly. It is among the biggest misconceptions of developed societies of the present time that individuals perceive opportunities offered by technology as direct needs in addition to the basic needs provided by nature for us in daily life. Tangible value of services provided by nature for us both as a human being and as a society is very low. In this sense, we tend not to understand and comprehend the value of these services unless there is a problem (Odum and Odum 2000).

Association and living environments created by the societies have caused individuals of the societies to fail to adequately make use of advantages brought by nature in the course of time. Therefore, problems and solution offers concerning meeting the needs peculiar to nature in the urban areas are effectively discussed in scientific circles. The system formed by relationships between living beings and non-living things in nature is called ecological system or ecosystem (Çepel 1992). This system formed by living beings and non-living things tries to maintain its balance also in the environment where human beings live. Ecosystems which emerge through rearrangement of natural ecosystems based on human factor and which urban-industrial communities live on is defined as techno-ecosystems (Naveh 1982). It is possible to say that techno-ecosystems negatively change the balance in natural ecosystems. That is why, in order to continue their existence, urban communities have to establish an order based on mutual benefit with natural ecosystems within current ecosystem.

Looking at a piece of land (landscape) within a particular area as a whole, it is seen to have a heterogeneous structure peculiar to time and place. In such a structure, different developments, changes and dynamics appear depending on time and place. Landscape

ecology is the discipline which studies the characteristics of a landscape with a heterogeneous structure and reveals management policies of the land for benefit and life of the society (Risser et al. 1984). Principles and concepts in landscape ecology make theoretical and experimental contribution to many applied disciplines such as urban and regional planning and resource management. Calow 1999 defined landscape as “a term which unifies the human and the nature”. However, on the contrary, there also exist some landscapes designed by people as the ecosystems formed by human interference. Techno-ecosystems defined as cities and industrial districts result in ecological effects which are relatively small but highly strong. The majority of these effects are negative as well. The development of such districts is possible by interconnecting the urban ecosystem once more and the habitats surrounding it. The sustainability of the protection of the urban ecosystems is a problem whose solution is complex. The most prominent one of the main goals is the protection or to make the reconstruction of the natural potential of urban open green area systems possible. In order to do this, the necessary precautions within the scope of the sustainability have to be taken. The basis of the plan to be made is the detection of green area existence and the convenience of the vegetative form to the natural potential. The existence of urban open green areas is important in terms of urban climate, urban aesthetic, human psychology as well as ecological and economical aspects. One of the important research subjects for today's modern cities is to record the existence of the trees and green areas in the urban texture, to determine the amount of area it covers in the surface of the area and to set forth its temporal variations. In this context, the techniques of remote sensing technologies play an important role for the above-mentioned analysis to be carried out. As a result of these analysis, planning new parking areas in the urban texture and also being able to carry out new adjustments will be ensured (Bulut et al. 2010; Melchert 2005).

2. Urban ecosystem and the concept of green area

The rapid population growth, mechanization, asphalt and concrete housing in today's cities disturb the biological balance in the urban environment. As a result of this, the possibility for the urban people to lead an unconstrained and a secure life disappears. The environment created by human progresses in the opposite direction. The urban people are faced with the negative living conditions owing to the environment that has been destroyed. People form the type of a new (artificial) ecosystem by manipulating the natural ecosystem existing in the environment in which they live. Whereas the activities of people in the urban areas determine the land use, the outcomes of the industry improved by using the technology also determine the effect to the environment. In this context, the balance of the urban ecosystem depends on the interrelations of the factors composing this balance to offset in a renewable ratio (Yeren 1991). However the urbanization process has adversely affected the ecological systems. A healthy urban life and a sustainable urban ecosystem have to be integrated into the natural habitat because the city itself has to be a part of the ecosystem. Urban people live in small places, are enclosed in terms of indoor and outdoor, distant from natural beauties. As a result, a conscious physical and social planning is needed more in the urban environment.

The most important factor of the habitat is definitely its vegetal elements. The concept of green area is defined as the surface areas of the available open areas covered or combined with vegetal elements (wood and non-wood plants) (Bilgili 2009; Gül and Küçük 2001). The

urban open and green areas are gathered into two groups one of which is open green areas within the urban texture and the other is open green areas around the urban texture. Green areas composing a crucial part of the city in terms of area have to be in a certain structure within the urban texture. Since their usage is for social purposes, they are planned as expansive areas in a natural character within the city (Uzun 1990).

The contributions of green areas to the urban ecosystem can be enumerated as cooling of the air, increasing the relative humidity of the air, supplying clean air, infiltrating the air, absorbing the noise, producing oxygen, decreasing the greenhouse effect, and saving energy. Green areas serve like a respiratory organ especially in the urbanized areas as well as enabling a healthy development for people physically and psychologically through doing recreative and sports activities. In addition, by enabling people to recreate, green areas contribute to establishing social relations, maintaining these relations and developing the social solidarity (Aksoylu et al. 2005). In short, urban green areas are of great importance so as to bring about the three essential requirements: daylight, clean air and free motion opportunities. Moreover, green areas are needed in terms of many functions such as social, physical, and psychological. Figure 1 shows the classification of the functions of urban green area.

Ecological Functions	Economical Functions	Social Functions	Planning Functions
Real Natural function	Economic Value	Recreation function	Structural function
	- Production function	- Usage function	
Genetic Diversity function	- Service function	Aesthetic function	Interaction and Competition function
Life Support function	- Hedonic function	Cultural function	
		Historical function	
		Character Structure function	
		Therapeutic function	
		Social Interaction function	
		Substitution function	

Multidimensional Functions
Scientific Value
- Educational function
Political Value
- Financial function
- Public function

Fig. 1. The Classification of the Functions of Urban Green Area (Levent and Nijkamp 2005)

3. Remote sensing and extraction of urban vegetation

Open green areas in the urban ecosystem are the leading elements of the main life support systems in the urban life. The qualities of size, shape, texture, color of the plants in terms of light and shadow effects are recognized in the urban environment (Aslanboğa 1997). Plants used in landscape are classified according to their heights as brier, shrub and wood. As much as their forms are concerned, unique structure forms of each plant are one of their distinctive features. Leaf features are especially important for the recognition of the texture qualities of plants. Likewise, leaves and flowers are again the dominant organs of the plants in the color effect. Changes in the color of the leaves as a result of seasonal variations or problems arising from various causes offer important information extraction. Light and shadow effects are important for the textures of an object to be sensed, highlighted, and negatively masked as well. All these elements are keys to help the vegetation in urban area to be detected and the information related to it to be extracted. In

remote sensing technologies, detecting the difference between vegetation and urban texture is achieved through making use of the elements aforementioned.

3.1 Information content and resolution

Remote sensing is the science of retrieving information about an object by means of the measurements performed in a certain distance from the object, that is, without actually contacting it (Maktav and Sunar 1991). The most crucial reason for the fact that the extensive use of remote sensing has begun in our day is because Ground Sampling Distance (GSD) of these images have been reduced. This fact enables an increase in the geometric resolution of the image and thus the extraction of the objects in a meaningful manner (Marangoz et al. 2006). In addition to GSD value, the radiometric and spectral resolutions of the images also affect the information content. Together with this resolution concept affecting the information content, other parameters which affect the information content are atmospheric conditions, sun elevation angle, incidence angle, the condition of the objects and the contrast among them while image acquisition (Marangoz 2009).

In today's world, depending on geometrical resolution, medium and high resolution satellite images have become a fast, accurate and economical source of data for producing vector maps. Besides, high radiometric resolution satellite images are effective on feature extraction of ground objects. This resolution facilitates image interpretation and by making use of such algorithms as automated feature extraction and matching, it promotes to obtain more efficient results. Whereas low resolution images were to be obtained in numerous bands with the previous satellite systems, generally high-resolution images are obtained contains visible and near infrared bands with the new satellites (Akdeniz and Erdoğan, 2005).

3.2 Image preprocessing

In order to facilitate the interpretation and the analysis processes of the image, image preprocessing procedures are carried out. Image enhancement algorithms are used with an aim to increase the display variation of the objects, whose visual interpretability is different, among each other (Lillesand et al. 2004). Ratio images are often used in order to enhance the images by the processes performed on several bands of multispectral images. By changing the properties of the original images with the arithmetic operations (addition, subtraction, multiplication, and division) carried out among bands, new images with a better visual interpretability can be obtained. Ratio images can be described as the transferring process as a new form of an image by adding, subtracting, multiplying, and dividing the pixel grey values belonging to two of the bands of an image data. These images are specifically useful in detecting spectral variations that have been masked due to low grey value changes in a single spectral band of image. For example, for an area having healthy green vegetation, the ratio of the band containing near-infrared to the band containing red color is normally very high. Thus, using ratio images obtained by the ratio of a near infrared-red band is very useful in the detection of green vegetation areas. Ratio images are especially used for information extraction about the vegetation from the various uses related to urban texture. The efficiency of any specific spectral rate depends on the actual application area and the spectral reflectance characteristics of the related objects.

Besides having some advantages based on resolution, satellite images also have color information, which is an element increasing the detectability of the object. Another image fusion technique, which is used depending on the superiority of the information content that can be obtained from multispectral image to the panchromatic, is Pan-sharp algorithm. In this algorithm which makes use of the color-geometry information in image bands, high-resolution panchromatic band is fused with color bands whose resolution is lower. The outcome is a high resolution multispectral image (Karakış 2005). Many pan-sharp algorithms are available nowadays. Some of those algorithms are Intensity Hue Saturation (IHS) Sharpening, Principal Components Analysis (PCA) Sharpening, Gramm Schmidt (GS) Sharpening, Wavelet Sharpening (WS), and UNB Sharpening.

The reflection of green areas in visible spectrum is low in contrast to their reflection being fairly higher in near infrared band. This high reflection for the near infrared band results high grey value of the pixels on the image. As a result, color noise values of the image increase. General disadvantage of all algorithms except UNB algorithm is that the green band cannot be obtained perfectly due to the causes mentioned above. However, the color transformation in UNB Sharpening Algorithm is perfect. In this algorithm which developed out of UNB by Dr. Yun Zhang, colors yield very close results as of the original multispectral bands (Padwick 2005). UNB Algorithm is a statistically-based algorithm. Least square method is used for determining the best alignment among the grey values of the image bands having fused, decreasing color distortion and calculating how much contribution will be made to the outcome by each different band. It includes some statistical approach to calculate the grey value relations among bands to eradicate the data set dependence problem and to automate the fusion operation process (Zhang and Wang, 2004; Cheng et al., 2003).

3.3 Image classification

The final phase of the analyses is the classification of the enhanced images. Generally, classification means including certain number of objects into a specific class with respect to class descriptions. For this reason, a class description is the description of typical properties and states that the intended class has. Then, objects are included to a class depending on whether they meet these properties or states. As a result, each object is included in a certain class or it is not included in any class. In the remote sensing applications, classical classifiers (for example with regards to the maximum likelihood, minimum distance or parallelepiped) assign membership to the objects as 1 or 0. Such classifiers are usually also called hard classifiers since they express the objects' membership to a class only in a binary manner. In contrast, soft classifiers (mainly fuzzy systems and/or Bayes classifiers) use a degree of membership/a probability to express an object's assignment to a class. The membership value usually lies between 1.0 and 0.0, where 1.0 expresses full membership/probability (a complete assignment) to a class and 0.0 expresses absolutely nonmembership/improbability. Thereby the degree of membership/probability depends on the degree to which the objects fulfill the class-describing properties/conditions (Baatz et al., 2004). Even though the probability value might change in the software using soft classification method, these values can be rounded up to the upper and lower limits by using crisp (rectangular) membership function.

In addition to pixel-based method, which is one of the classical classification approaches, object-based methods have also begun to be used in image processing and thus remote

sensing technologies of our day. Rich information content obtained by high resolution images could not be reflected precisely in the pixel-based classification approaches. The reason is that the basis for these classification approaches is the grey values of single pixel and consequently only spectral information has been used for the classification. Due to the structure of the pixel-based classical methods, this situation necessitates the use of the object-based classification methods. Algorithms used in this type of approach also use structural or textural supplementary information besides spectral information in forming classes so as to make the segments more appropriate. Classification phase in the object-based approach begins with grouping of adjacent pixels forming meaningful areas. Such kind of segmentation and topology formation should be arranged according to the resolution and the scale of the objects intended to be extracted. Whereas this segmentation can be applied in different resolutions, it also enables to detect the layer of object categories. With the object-based approach, the results from many image analysis applications are expected to be real classification and a real shape of the real-world objects (Hofmann, 2011 a, b, c).

Dividing the image into different subdivision is called segmentation (Baatz and Schäpe, 2000). Image segmentation procedures have been the main focus of research for years in the area of image analysis and various approaches have been followed for solution. Only some of these can be applied under operational settings and have given persuading results quantitatively. A great deal of degrees of freedom has to be reduced to one or several degrees of freedom which are able to meet the given requirements. Moreover, another difficulty is that the areas dealt with are, in many cases, heterogeneous. The case of heterogeneity results in uncertainties and the information needed and required to be understood cannot be extracted directly. What is longed for in image segmentation is that in many cases it is possible to extract the desired and intended objects automatically for a specific task. With a general overview, segmentation methods are divided into two main categories: information extraction methods (top to bottom) in one hand, and data extraction methods (bottom to top) in the other. Both approaches can be performed through applying the operations below (Baatz et. al. 2004):

- Creating the hierarchical structure of the image objects by using multi resolution segmentation operation. Whereas top layer image segments displays small-scale objects, the bottom layer segments display large-scale objects.
- The classification of the obtained objects according to their physical properties. This also means that class names and class hierarchies serve as an example when two features are taken into account: real world whose mapping has been carried out and the physical measurable size of the image object. Using other methods accelerate the classification process as well as sharpening it more.
- The definition of the semantic relations of the building objects when neighborhood or being sub or super object comes into question. This generally ensures the development of the physical classification resolution in class hierarchy.
- The fusion of the classified objects as meaningful groups that can be used for classification-based segmentation. The adjacent segments that are obtained can be used later after they were transferred to GIS environment. In addition, the semantic groups can also be used for other neighboring analyses.

Whereas carrying out the first two operations is obligatory, the application of the other two operations is recommended depending on the software user and the image content. The

segmentation itself is not an aim. The aim of image analysis can be land cover/land use classification or the retrieval of the related objects. Furthermore, in many cases the related objects might be highly heterogeneous. A segmentation operation carried out based on general homogeneity criteria in many cases will not directly retrieve the related result fields or objects. Moreover, individual methods giving a support for segmentation and classification, increasing its opportunities and enabling operation optimization have to be chosen. Various methods with the data input-output, vectorization, information interfaces, the analysis and statistics of accuracy complete the whole. The best segmentation result is the one which provides optimum information for next steps. The first segmentation constitutes the most important step of the application. The original image information is required to be retrieved in any resolution desired and as in object blocks which will be appropriate for the classification operations. A segmentation phase has to produce segments with high homogeneity for the optimum division and presentation of image areas. While every image analysis problem is dealing with data based on a specific data in a spatial scale, average dimensions of the image objects have to be suitable to the related scale. The properties of image objects such as grey value, texture, structure, and relations with the adjacent areas depend on the scale. Only the structures in similar scales have a comparable quality and they have comparable features. As a consequence;

- Result image objects have to be similar value.
- Segmentation phase has to be universal and it can be applicable to a large number of various images and problems.
- Segmentation results have to be able to reproduce.
- Segmentation process has to be as fast as possible.
- Human eye is a powerful and an experienced source for segmentation evaluation.

Segmentation replaces visual digitization by applying segmentation process to the automation of image analysis. None of the segmentation results are completely meaningful unless they satisfy the human eye sufficiently. Multi segmentation is a space fusion technique, to top bottom, starting with one-pixel objects (Benz et al. 2003) (Figure 2). In a large number of sub-levels, small image objects are fusioned with the bigger ones (Burnett and Blaschke 2003).

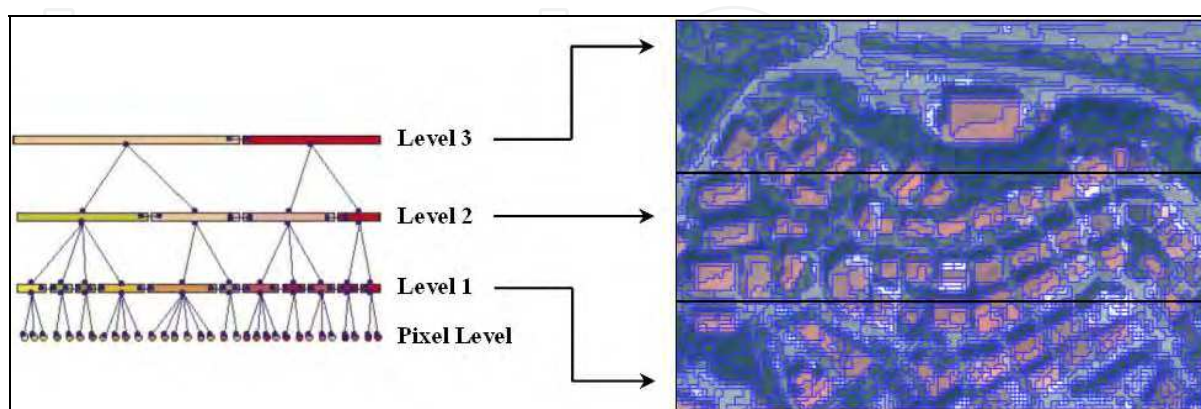


Fig. 2. Hierarchical Net of Image Objects Derived from Segmentation (Karakış et al. 2006).

In the segmentation phase, the parameters below have to be determined as close to the real world as possible.

- **Scale Parameter:** This parameter affects the average object size indirectly. In reality this parameter determines the maximum value which enables the heterogeneity of the objects. The bigger the scale parameter is, the bigger the objects are.
- **Color/Shape:** With these parameters, object production effect of the homogeneity of color and shape conflict can be adjusted. The higher the shape criteria, the less the object production effect of the spectral homogeneity.
- **Smoothness/Compactness:** When shape criteria is bigger than 0, the user can decide whether the objects should be more compact or more smooth (Hofmann, 2001a, b, and c).

The classification process of the images follows segmentation process. Based on the classification results, the statistical information produced for its users displays the accuracy values in addition to the confusion matrix.

The most important feature of the object-based classification is the mutual relation between the scale and the image objects in image interpretation. The scale is one of the important steps in understanding the image. Whereas the resolution usually expresses the area that a pixel occupies, the scale describes the size of extraction or the level that a phenomenon can be described. Thus, working on different scales rather than on different resolutions with an object facilitates the analysis. For example, in urban ecosystems when the high resolution image of the urban settlement, singular houses, buildings, roads, and other urban objects are recognized in detail. If the zoom distance is increased, then singular buildings are not viewed, but highly various settlements or neighborhood can be detected. They can also be detected by their different textures, different sizes and shapes. The neighborhood texture includes its sub objects and structures in a larger scale (e.g. Houses, roads, and green areas) and these are described in terms of grey value, shape and also topological relations. There is a kind of hierarchy in different phenomena and the structure real-world objects. This hierarchy is determined explicitly by the scale. For example when houses, buildings and roads are determined, by combining them together, settlements and neighborhoods are extraction as well. By combining many settlements together, town or city structure is achieved. Ecosystems show similar features: for example with regards to green areas, combination of several trees composes a group of trees, combining more trees composes the stand or combining many groups composes the forest.

What is important on the basis of the mutual relations among the image objects is contextual information. Two kinds of contextual information exist: the global context defining the state of the image (basically time, sensor, and spatial information) and the local context defining the mutual relations or the mutual meanings of the image areas. Processing the context information always exists in the human perception either conscious or unconscious. In order to extract meaningful context information, image areas in the correct scale have to be associated. This scale is determined by the integration of the resolution of the image data through the classification process. For example, in a high resolution image, the parks always compose of large and successive green areas. This different scale distinguishes between the park and the garden. Additionally, the parks are different from the meadows because of their locations in urban areas. Singular neighboring houses are not an enough condition to define parks. Nevertheless, being adjacent to singular buildings is a suitable criterion for the gardens to distinguish them from meadows. This simple example already shows how many

context information is available based on the scale of structures related to each other. In order for the image objects to detect their spatial context, associating them together is necessitated. For this reason, a topological network is created (Baatz et al. 2004).

The object-based image analysis is extracting a great deal of additional information from the image objects. What lies behind this is the information elicited from shape, texture, neighboring and other object layers. Using this information, classification can be reached to improved semantic analysis and more accurate results. Baatz et al. (2004), with a conceptual point of view, have grouped the possible features as follows:

- **Basic features:** Physical features of the objects are determined by portraying the real world and imaging quality (simply sensor and illumination). These features define color, texture, and the structures of the objects.
- **Topological Features:** The features that define the geometrical neighborhood of the objects or the whole scene. E.g. being on the left or right, or being at a certain distance to a certain object, or being at a certain area within the image.
- **Environmental Features:** The features that define the semantic neighborhood relations of the objects. E.g. a park should 100% be surrounded by urban area.

The process of the image objects can be carried out by specific methods in the base of the classification. For example, when an object is classified as “green area”, from the moment on, artificial intelligence may locally be used, and in principle since then, everything performed with this object or its related environment is followed by using “green area” logic. Applying a modified process instead of processing all areas of an image with the same algorithm would be much more suitable. This is one of the prevalent features of the object-based image analysis. The final step in order to carry out the necessary analysis is the phase where the classification is applied to the segments. With this aim, slope or crisp functions can be used. Slope functions define the membership of the objects to a class between 0 and 1 by enabling the fuzzy classification. On the other hand, in crisp functions, the object is faced with the process of either full membership or removing from the membership. In the direction of all these mentioned above, such features as color and neighborhood are used with suitable functions to compose classes.

4. Applications of extraction urban vegetation using remote sensing data

In the first section of the application, the object-based classification results and accuracy values belonging to medium and high resolution satellite image data of the city of Bartın, located in the West Black Sea Region of Turkey, and its surroundings are stated and their final results have been evaluated. In the second section, the segmentation process has been applied to all bands of high resolution satellite image related to a different test area by both using an additional data and without using any additional data and their results have been interpreted. Finally, manual and automated object extraction approaches from high resolution image data have been comparatively analyzed. In addition, the information about the advantages and the capacity of this type of classification is given.

The first test area is the city of Bartın, located in the West Black Sea Region of Turkey, and its surroundings (Figure 3). Medium resolution Landsat 7 ETM+ and Spot XS images of the test area have been subject to the object-based classification (Büyüksalih et al. 2005).

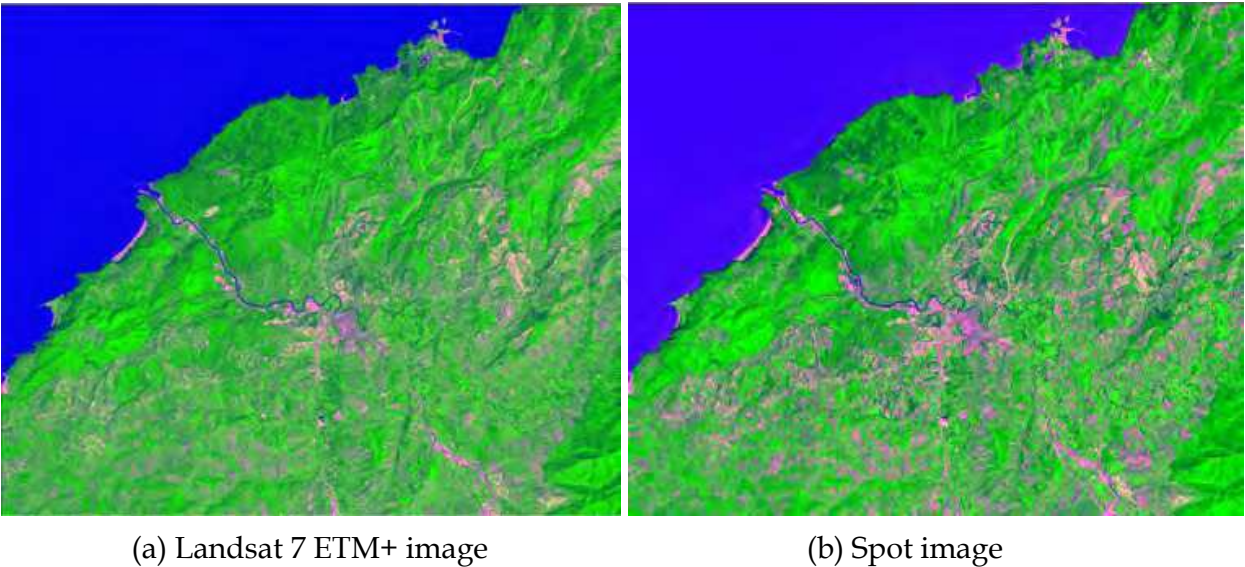


Fig. 3. Medium Resolution Satellite Images of the City of Bartın and Its Surroundings.

Segmentation parameters used for both satellite image data are given in Table 1. The classes created as a result of the classification consist of general classes such as settlement, cultivated area, forest etc. to represent a larger area (Figure 4). The evaluation results of the classification accuracy are given in Table 2 (Oruç et al. 2004).

Level	1	2	3	4	5	1	2	3	4	5	6
SP	1	5	1	5	10	1	5	1	5	10	15
Color	0.5	0.5	Spectral Difference	Spectral Difference	Spectral Difference	0.5	0.5	Spectral Difference	Spectral Difference	Spectral Difference	Spectral Difference
Shape	0.5	0.5				0.5	0.5				
Compactness	0.5	0.5				0.5	0.5				
Smoothness	0.5	0.5				0.5	0.5				
Segm. mode	Nor.	Nor.				Nor.	Nor.				
(a) Landsat 7 ETM+ image						(b) Spot image					

Table 1. Segmentation Parameters.

The user and the producer accuracy belonging to the forest and settlement class heterogeneity are high for both image data. In the evaluated results related to the cultivated areas, the classification accuracy assessment results from the Spot image were appeared to be higher. The geometric resolution of the Spot image data being high and the heterogeneity of the detail of the cultivated areas being higher than other classes have enabled the extraction to be better than the other classes (Tunay et al. 2007).

High resolution pan-sharp IKONOS satellite image data belonging to the city of Bartın downtown, which is located in the same test area, has also been subject to the object-based classification (Figure 5). The segmentation parameters used are given in Table 3.

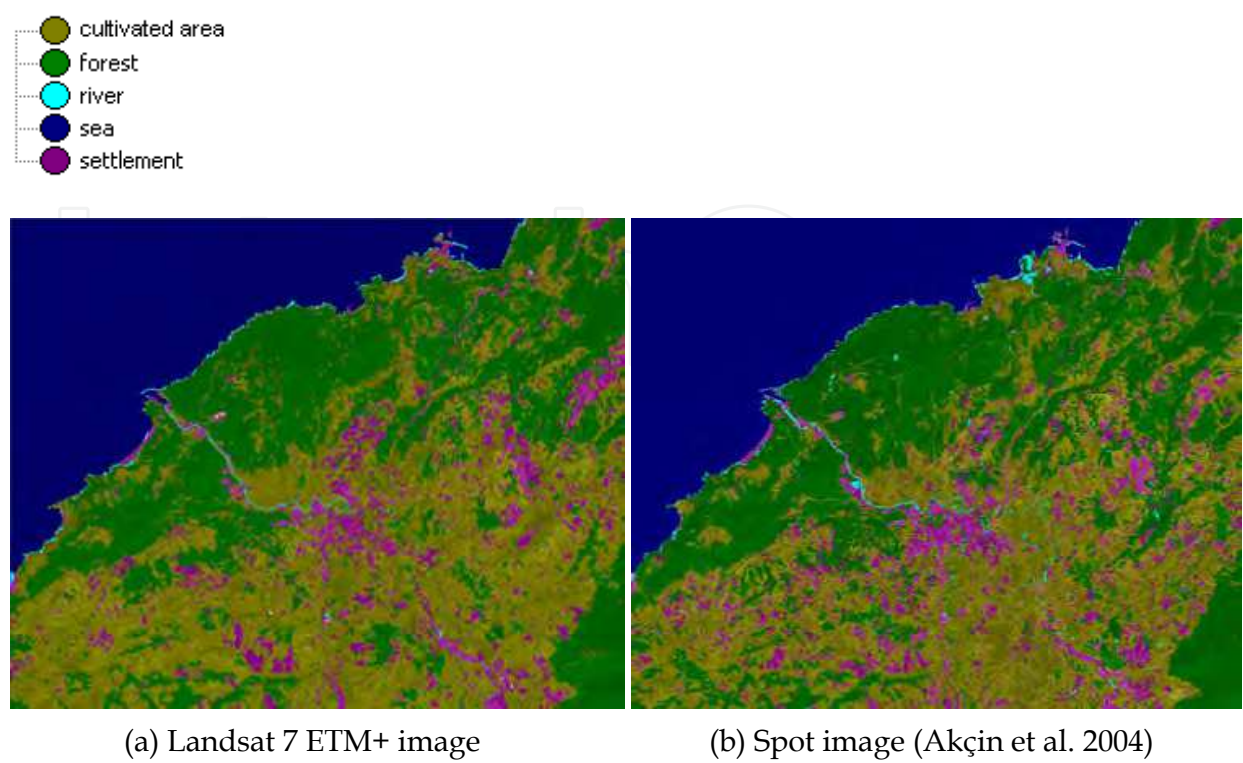




Fig. 5. Pan-Sharpended IKONOS Image (Marangoz et al. 2006).

Level	1	2	3	4	5
SP	10	20	30	40	40
Color	0.5	0.5	0.5	0.5	Spectral Difference
Shape	0.5	0.5	0.5	0.5	
Compactness	0.5	0.5	0.5	0.5	
Smoothness	0.5	0.5	0.5	0.5	
Segm. mode	Nor.	Nor.	Nor.	Nor.	

Table 3. Segmentation Parameters.

Classes created as a result of the classification have been separated more accurately thanks to the high resolution (Figure 6). Accuracy values of each class are quite high (Table 4). The efficiency rate of the extraction of objects about the urban vegetation has been 100%. The only disadvantage for the classification in general was that the extaction could not be achieved clearly due to the road structures and the homogeneity among urban open areas having no vegetation.

Class Name	Producer's Accuracy %	User's Accuracy %	Kappa Statistic
Agricultural	83	86	0.78
Buildings	84	89	0.75
Vegetation	100	100	1.00
River	100	100	1.00
Road	100	73	1.00

Tablo 4. Accuracy Assessment Results.



Fig. 6. Classes and Classification Results (Tunay et al. 2007).

In the application about the city of Zonguldak test area located in West Black Sea Region, Quickbird satellite image has been used (Figure 7). The technical features of the image have been given in Table 5. Quickbird image used has been enhanced by applying pan-sharp algorithm.

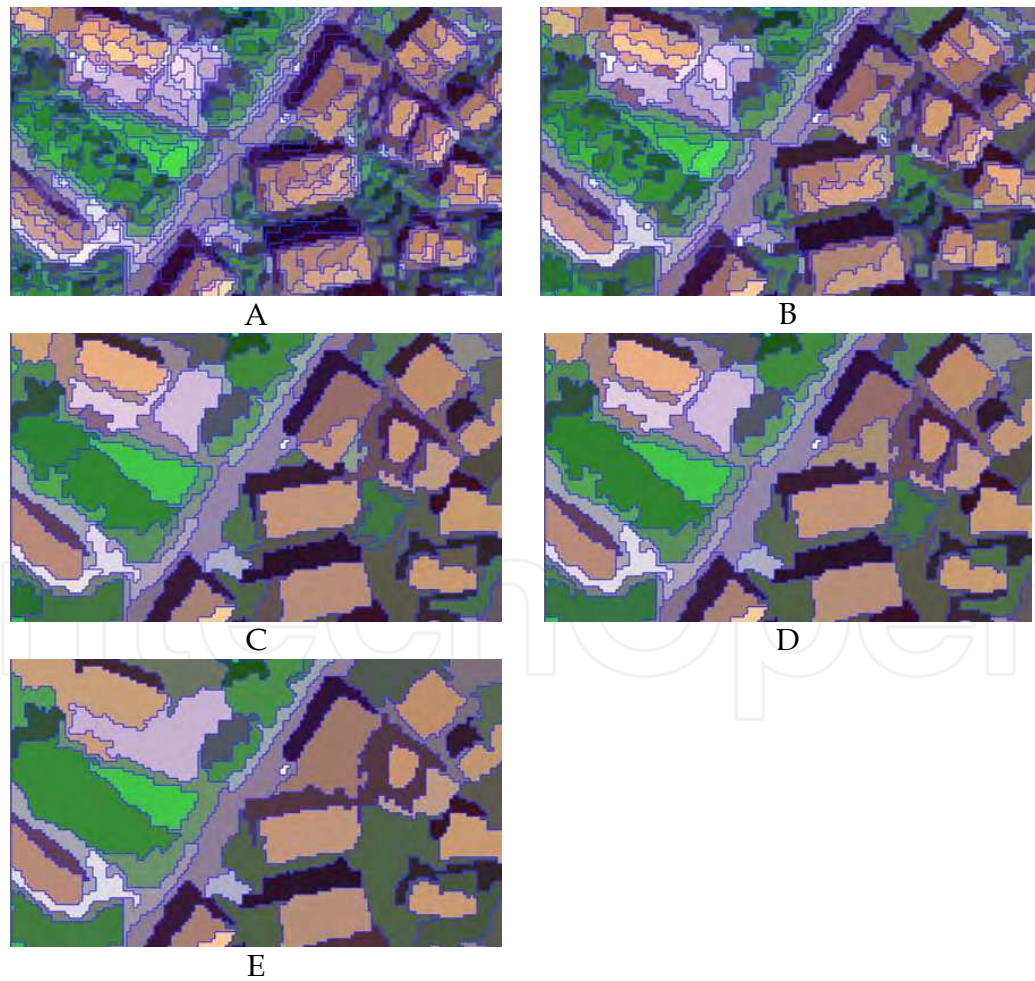


Fig. 7. Pan-sharpened Quickbird Image.

Date, Time	23/05/2004, 08:39:55 GMT
Nominal collection azimuth (deg.)	61.0
Nominal collection elevation (deg.)	85.9
Sun angle azimuth (deg.)	139.1
Sun angle elevation (deg.)	64.7
Nadir angle (deg.)	3.9
Image size (pixels in row, column)	24.572 x 25.500
Reference height (m)	265.66

Table 5. Technical Features of the Quickbird Image.

In this part application, two different approaches have been used for the segmentation phase. One of these approaches is subjecting all bands of Quickbird satellite image to the segmentation process without using any other additional data (Figure 8), the other is subjecting the all bands of the same image to the segmentation process by using vector maps of the test area created by photogrammetric methods in 1997 as additional data lying under this satellite image (Figure 9). Scale parameters and segmentation parameters used in both approaches have been given in Table 6 and 7.

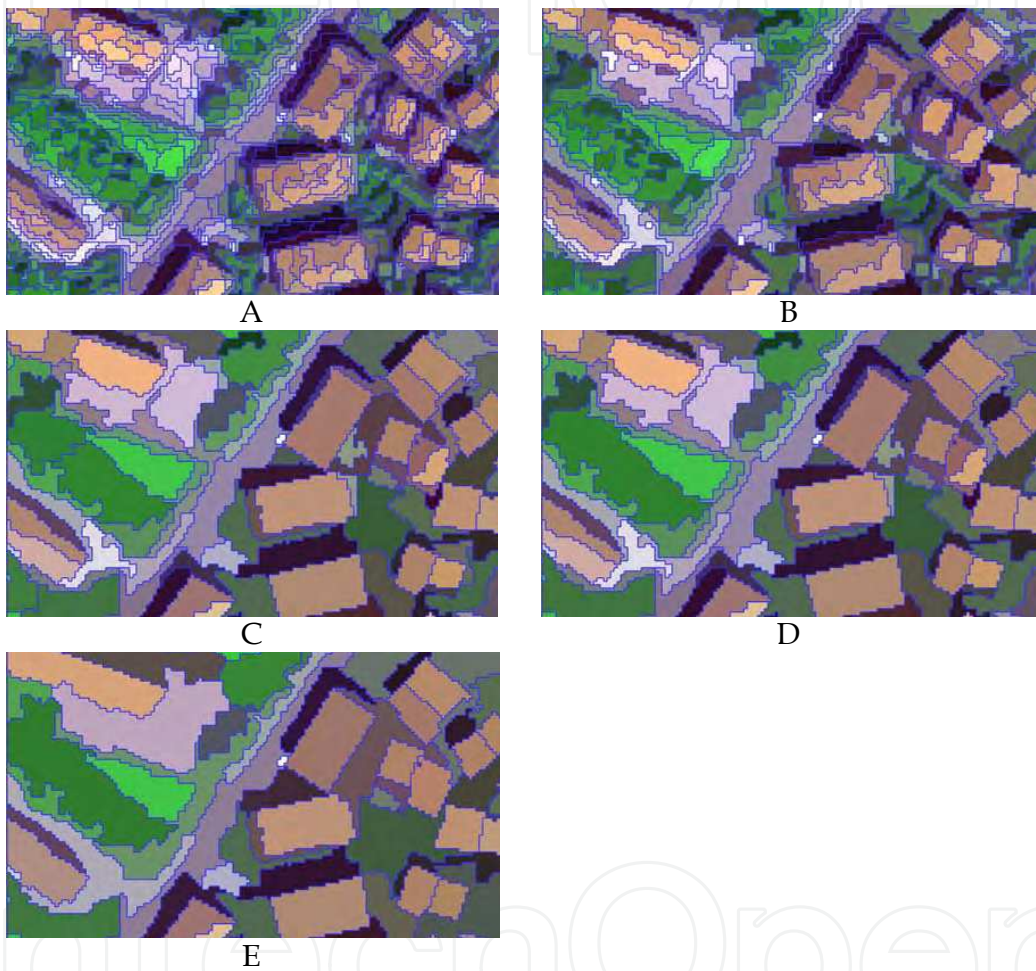


(The Scale Parameter: A = 10, B = 20, C = 30, D = 35 and E = 60)

Fig. 8. Image Segmentation Performed by Using Five Different Scale Parameters.

Level	A	B	C	D	E
SP	10	20	30	35	60
Color	0.5	0.7	0.3	0.5	0.5
Shape	0.5	0.3	0.7	0.5	0.5
Comp.	0.5	0.5	0.5	0.5	0.5
Smooth.	0.5	0.5	0.5	0.5	0.5
Segm. mode	N	N	N	N	N

Table 6. Segmentation Parameters.



(The Scale Parameter: A = 10, B = 20, C = 30, D = 35 and E = 60)

Fig. 9. Image Segmentation Performed by Using Five Different Scale Parameters.

Level	A	B	C	D	E
SP	10	20	30	35	60
Color	0.5	0.7	0.3	0.5	0.5
Shape	0.5	0.3	0.7	0.5	0.5
Comp.	0.5	0.5	0.5	0.5	0.5
Smooth.	0.5	0.5	0.5	0.5	0.5
Segm. mode	N	N	N	N	N

Table 7. Segmentation Parameters.

The parameters chosen in the segmentation process might change the accuracy of the classification. By using vector map, the heterogeneity has been balanced whereas in the application in which vector map was not used, the extraction of the details based on homogeneity have been problematic. This situation results in overlap in the segmentation phase when similar objects are close to each other (Figure 10) and has generally arisen in the building structures within urban texture. Extraction of green areas has been clearly achieved in both cases. Generally, some problems in feature extraction have come up based on the shadow effect. In addition, this situation results in the disappearance of green area objects between the building blocks in the cities in which dense housing are observed. For this reason, a segmentation to be carried out by using additional vector and the classification afterwards give a better result for the extraction of the vegetation in the urban area (Karakış et al. 2005).



Fig. 10. Segmentation With and Without Vectors Created by the Same Segmentation Parameters (A = Structured With Vector, B = Structured Without Vector).

The classification for the analysis processes has been performed after the segmentation phase. The results of the classification process carried out for the segmentation with vector have been shown in Figure 11.

High resolution satellite images of our day are organized to include panchromatic, multispectral and near infrared bands for the users. The application of these images is essential in the determination of green areas especially about the urban vegetation. The success level of panchromatic images in the automated extraction of the objects is low whereas the success level of these images in the extraction of the objects with the help of an analyst is intermediate. The success level of multispectral images in the automated and manual extraction of image is higher. However, for the green area texture, the distinction between biological and synthetic green cannot be achieved and detection of green areas in shaded areas is problematic. The success level is higher in multispectral images having added near-infrared bands and there is a significant increase in the success level of automated and manual extraction of the objects (Marangoz 2009).

In this context, the object extraction of the city of Zonguldak test area has been performed by using analyst. By the help of the software used, the related objects on the satellite image can be monitored on the screen; the vectorization process is performed using the cursor. All in all, quantitative object extraction which consists of many layers created by the user can be produced easily by setting up the desired topology and editing it. With regards to urban vegetation, using band combinations on Quickbird satellite image, the display of



Fig. 11. The Results of the Object-based Classification Performed by Using Classes and Vector Map.

near-infrared band has been made dominant over the real green band and the most suitable environment has been provided for the vectorization process. The extraction of green areas has been achieved on this image by minimizing the shadow effect and other detail losses and by drawing vector on the edges of the related objects (Marangoz et al. 2007) (Figure 12).

The parameters for the segmentation have been chosen in the first place in the automated object extraction approach carried out for the test area (Table 8). The segmentation has been performed in five different levels, and it has been concluded that the third level has given the most suitable objective form. At this phase, only the green area class has been created and the suitable membership functions have been assigned. In Figure 13, the membership functions have been given. In the designation of these functions, crisp functions have been used to clearly illustrate the areas. In addition, the grey values sensitive to red and blue have been used for the lower and upper limits of the functions. The reason is to reduce the reaction of the other groups of objects given against this function, in addition to the reaction of the objects related to the vegetation given against the function chosen for the near-infrared band.

Green area class created automatically by these segmentation parameters and membership functions has been given in Figure 14.



Fig. 12. Real and Artificial Near-Infrared Images of the Test Area and Manual Extraction of Green Areas on the Test Area (Marangoz et al. 2007).

Level	A	B	C	D	E
SP	10	20	30	40	60
Color	0.5	0.5	0.5	0.5	Spectral Difference
Shape	0.5	0.5	0.5	0.5	
Compactness	0.5	0.5	0.5	0.5	
Smoothness	0.5	0.5	0.5	0.5	
Segm. mode	N	N	N	N	

Table 8. Segmentation Parameters.

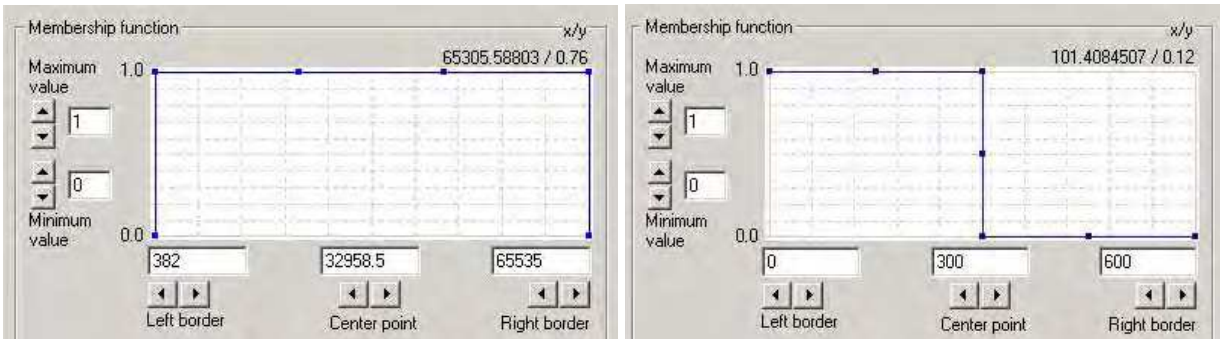


Fig. 13. Membership Functions for Classification; A) Inclusion of the Objects Sensitive To the Near-Infrared, B) Exclusion of the Objects that Are Not Supposed to Be Included in This Class Such as Roads, Buildings, etc, Together with Their Other Spectral Reflection Information.

By evaluating the results of CAD based manual object extraction and automated object extraction in the GIS environment, the amount of the area covered by the related objects on the test area has been calculated. From the analysis conducted, the amount of green area is 340827 m² (approximately 34%) out of the manual extraction of the whole test area whose surface area is 1 million m². In the automated extraction, these areas have been calculated 315301 m². According to the results, it has been concluded that 93% of the result created by the analyst could also be obtained automatically about extraction of green area. In Figure 15, the overlapping image of manual and automated extraction is given in GIS environment.

Furthermore, 7% of information loss has been the case in the automated object extraction according to manual extraction. Limiting the membership functions to the certain values to

prevent confusion of tree and green areas with the shading and other object groups causes problem mentioned above. In order to compensate this deficiency, the automated segmentation that has been performed could manually be interfered in the classification phase. (Figure 16).



Fig. 14. Automated Extraction of Green Areas on the Test Area (Marangoz et al. 2005).



Fig. 15. Overlapping Image of Manual and Automated Extraction in GIS Environment (Red in the below: manual extraction, green in the above: automated extraction).

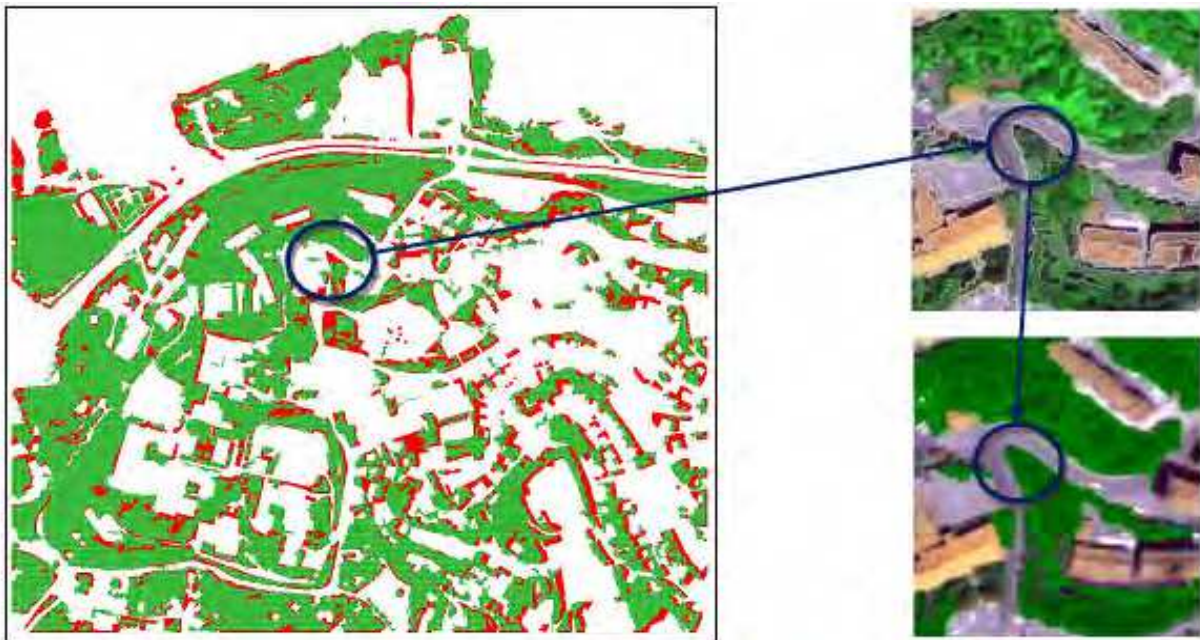


Fig. 16. Creating Natural Class Object Resulting from Manual Interference to the Object Class Which cannot be extracted by Automation (Marangoz et al. 2005).

In both object extraction approaches, the object extractions from the image enhanced by near-infrared band so as to achieve the recognition of biological and synthetic green forms as well as minimizing the information losses. For example, the recognition of a soccer field covered with synthetic turf from the other green objects has been achieved by this means (Figure 17). If the object extractions are to be from a normal color image, to achieve this kind of recognition especially in automated extraction is out of question.

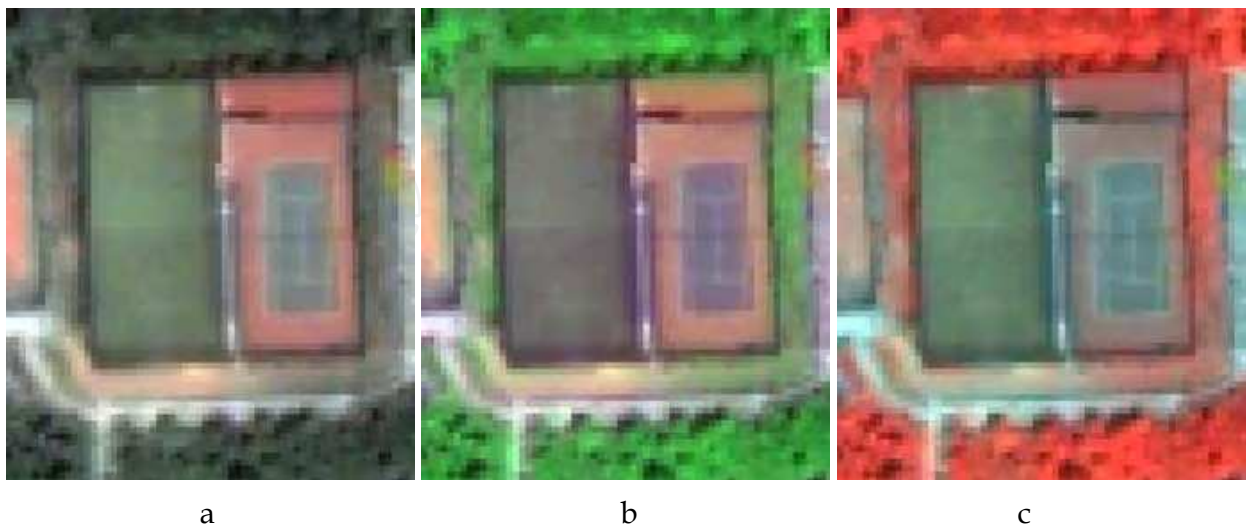


Fig. 17. Of an Area Including Soccer Field Covered with Synthetic Turf and a Green-Painted Tennis Court; A)Normal Color Image, B)Normal Color Image Enhanced by Near-Infrared, C)Artificial Color Image Enhanced by Near-Infrared (Marangoz et al. 2005).

5. Conclusions

This chapter provides information about urban ecosystem, urban vegetation, remote sensing, extraction of urban vegetation and object-based classification approach. The research focused on the object-based classification approach method with regards to the extraction of urban vegetation, and its results. The detection of the vegetation texture within the urban structure is important for planning and analyses to be carried out. In this context, the resolution qualities of the images and enhancing images suitable for use have been quite beneficial in the selection of the satellite image data. Despite an excessive information content of the image data that is used, the pre-processing and enhancement processes on the raw image are definitely needed for a thorough extraction of this information. The most important stage before the classification is the segmentation phase. The most prevalent parameters in this phase are scale, color and smoothness. Depending especially on the geometric and radiometric resolutions of the satellite image data, the acquisition time also influences the accuracy in the segmentation phase.

The object-based classification results carried out for medium resolution satellite image data achieve high producer and user accuracy values in the extraction of heterogeneous classes such as forest, habitat etc. Increasing heterogeneity on the geometric resolution and details of the satellite images contributes positively on the result of the classification process, in which land use classes are determined in general terms. Another source of data which promotes the accuracy of the segmentation process to be carried out for the high resolution satellite image data is vector maps. By using the vector map as an additional data, the heterogeneity between the objects is balanced and this affects the accuracy of the classification in a positive way. The coverage ratio of the results by automated object extraction of the vegetation related to urban area from high resolution image data to the results by the manual extraction is quite high. Generally, the reasons of inaccurate classification can be given as the conditions of the objects in the used image and the contrast values among them, the existing shadow problem and the inconsistent topography of the test areas. Moreover, it is a known fact that in the eCognition software, worked in the object-based approach and using Region Growing algorithm more success is achieved in the region-based object extraction. In this context, it can be said that not many problems have been encountered in the automated extraction of region-based objects such as vegetation in the test area.

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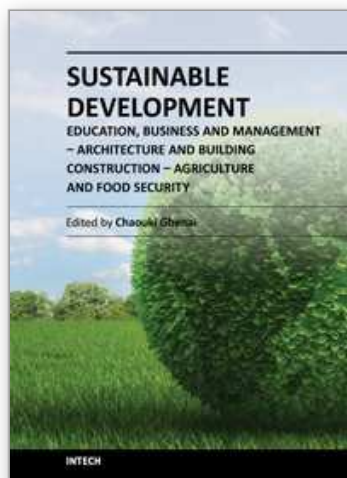
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Securing the future of the human race will require an improved understanding of the environment as well as of technological solutions, mindsets and behaviors in line with modes of development that the ecosphere of our planet can support. Some experts see the only solution in a global deflation of the currently unsustainable exploitation of resources. However, sustainable development offers an approach that would be practical to fuse with the managerial strategies and assessment tools for policy and decision makers at the regional planning level. Environmentalists, architects, engineers, policy makers and economists will have to work together in order to ensure that planning and development can meet our society's present needs without compromising the security of future generations. Better planning methods for urban and rural expansion could prevent environmental destruction and imminent crises. Energy, transport, water, environment and food production systems should aim for self-sufficiency and not the rapid depletion of natural resources. Planning for sustainable development must overcome many complex technical and social issues.

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