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Landsat Images Classification and Change Analysis of Land Cover/Use in Istanbul

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Abstract

This paper describes the methodology and results of classifications of Landsat TM data of the Istanbul for the years 1987 and 2007. Nine different land cover/use categories have been used, named built-up area, cropland, barren ground, grassland, scrub/brush, water, ever green, deciduous, cloud and others uses. When the obtained classification results are evaluated as a result of, the 1987 Landsat image overall accuracy of 79 % and a kappa value of 0.76, the 2007 Landsat image overall accuracy of 83.50% and kappa value of 0.81. Thus, Istanbul's change analysis was revealed that the 20-year period. The classifications have provided an economical and accurate way to quantify, map and analyze changes over time in land cover.

Keywords: Remote sensing; Land cover/Land use, GIS, Temporal Analysis, Landsat

Introduction

Remote sensing technology is used to determine the most intense land cover and land use. Monitoring the location and distribution of land cover change, to investigate the effects on people and the environment of the connection between future land use activities is very important to determine. Remote sensing has been an important source of earth at various time intervals on different spatial, spectral resolution and capable of view. Remote sensing and GIS plays an active role in identifying and monitoring the changes occurring in large areas of ecosystems such as forests (Erdin vd., 2002). The rapid increase in urbanization, infrastructure is often unplanned and uncontrolled urban growth areas such as green can lead to problems, such as the misuse of natural resources, agricultural land and water resources and may also cause damage. So especially the urban environment including natural resources must be constantly monitored and kept under control. Remote sensing data and technologies is an indispensable resource for decision-makers and managers in the monitoring of the urban environment.

GIS is the systematic introduction of numerous different disciplinary spatial and statistical data that can be used in inventorying the environment, observation of change and constituent processes and prediction based on current practices and management plans (Ramachandra and Kumar, 2004). Change detection as defined by Hoffer (1978) is temporal effects as variation in spectral response involves situations where the spectral characteristics of the vegetation or other cover type in a given location change over time. Singh (1989) described change detection as a process that observes the differences of an object or phenomenon at different times.

Study Area and Data

In this study, all of Istanbul is selected as the study area (fig.1). Istanbul is a megacity with over 15 million inhabitants (making approximately 20% of Turkey's total population) (OECD, 2008) and it is responsible for the 40% of Turkey's industrial activities. The megacity has a unique geographical location spanning on two continents, Europe and Asia (Fig.1) and according to latest investigations (Algan et al., 2001) its history has started approximately 8500 years ago. The climate of Istanbul is Mediterranean, characterized by warm/dry summers and cold/wet winters. Istanbul and its vicinity are considered to be the heartland of the

Turkish industry and there are over three (3) million vehicles on the road and around 1000 new vehicles entering the traffic every day (TUIK, 2012). Therefore it is a city that should be closely monitored for the planning of a city like Istanbul which has several tectonic risks (Alpar, et al., 2004 and Gazioğlu et al., 2010).

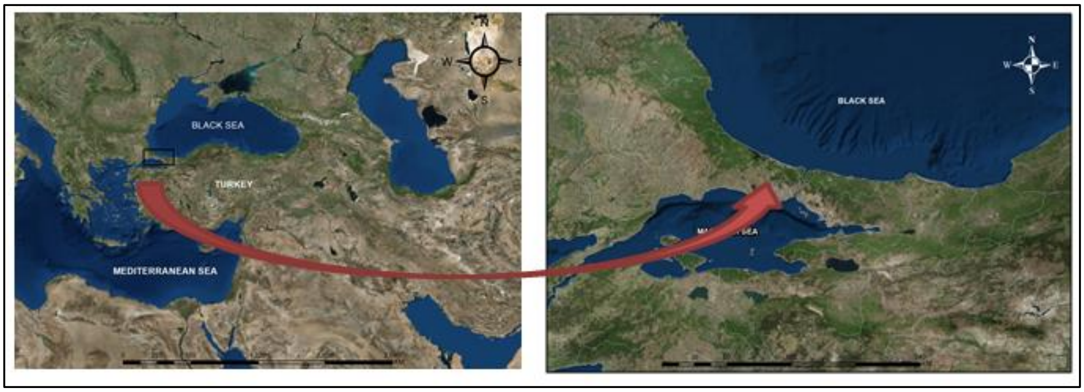

Figure 1: Locations of the sampling site

Methodology

The main goal of this study is reveal temporal changes using Landsat TM images data in Istanbul. Landsat data is the longest record of earth observation data to earth on a global scale and medium spatial resolution. The digital image-processing Erdas Imagine 2013 software was used for the processing, analysis and integration of spatial data to reach the objectives of the study. Supervised classification process has begun with the Principal Component Analysis process easier to distinguish between classes. Principal Component Analysis (PCA) process radiometric (spectral or color) transformation is performed on a statistical property. Collected signature on the predetermined range and the main reference data most suitable classified image data obtained is continued until the signature collection. After the signature collection process is complete, the classification process is beginning by the maximum likelihood method of the supervised classification. The most important stage of the classification process will begin with the analysis accuracy. After the classification process, ArcGIS 10.4 software from the median filtering the mixture would be minimized by making classes. It is then converted to raster format to vector format. Vector form data is controlled from the reference data and the large scale of the classes involved with editing process inherent factor and sorting out and eliminate the reasons that cannot be removed from the desired product cannot be obtained regions are corrected with the editing process. Thus the final product is obtained.

Analysis:

In the study, 30 m resolution Landsat imagery of 1987 and 2007 year the combination of the natural band (3-2-1) was used. For image classification, eight classes was defined which are; built-up area, cropland, barren ground, grassland, scrub/brush, water, ever green, deciduous in addition to contains cloud. The ship etc. other details also can be eliminated in the image because there was not need to create a class by editing. Our study; the analysis of the accuracy, the images classification and change analysis consists of three phases.

1- Image Classification of the 1987 and 2007 Landsat TM

Landsat has been providing a nearly continuous record of global land surface change since 1972. This record represents one of the most consistent available archives of recent earth history information, and its use has facilitated understanding of earth surface processes across spatial and temporal scales and disciplines (Cohen and Goward, 2004). The purpose of classification is to group objects with the same spectral characteristics. There is a need for reference data to classify the image of both periods. The classified image of 1987, the year that high-resolution satellite imagery is used ortho of the most recent in 1996 because it is not the actual image. The classified landsat geocover image of 1990 which is produced by NASA to be eliminated on a global scale is only used to determine the class. The following figure shows the state before the classification of landsat satellite images (Fig.2).

Signature gathering process should be continued until classes to separating. Particularly in the city containing many class structure like Istanbul is a need for a lot of signature collection (Fig.3).

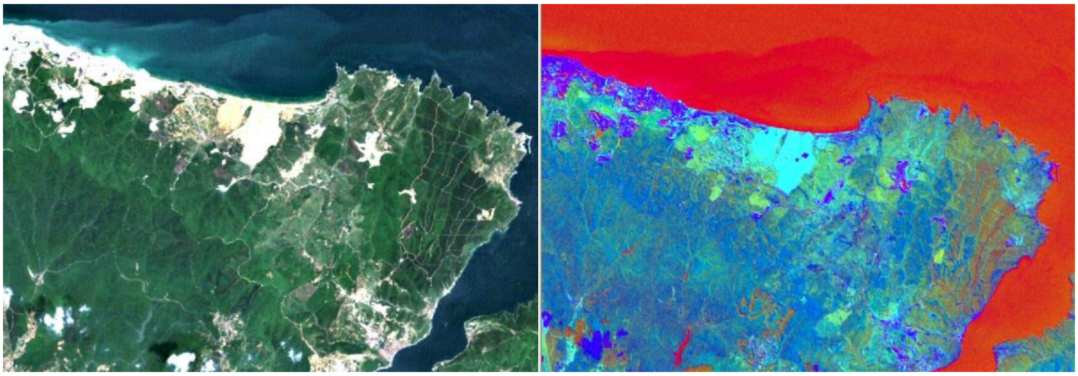

Figure 2. PCA process before classification

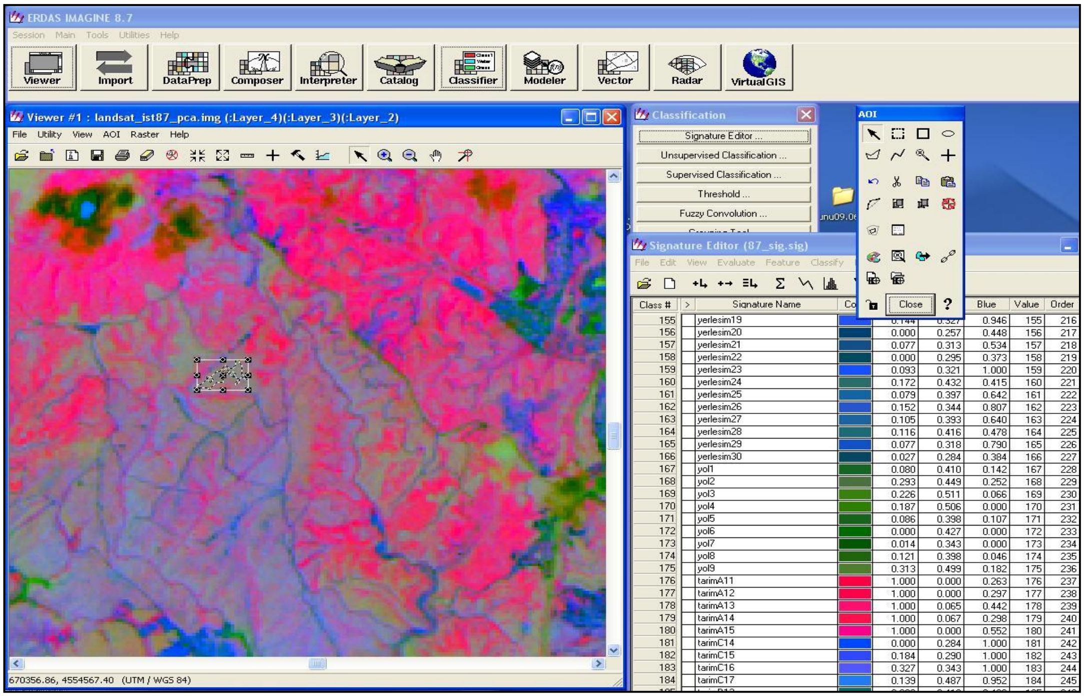

Figure 3. Signature collection process

After the signature collection process classified data shown in figure 4. After landsat satellite image classification process it can be easily identified classes obtained. This is resolved by making the median filtering. As a result, the thematic map of 1987 obtained from the floor section of the densely populated areas are given (Fig.5).

Image of 2007 compared to 1987 due to the 20-year difference from image quality and the ability to capture and classification are suitable for use in all kinds of analysis. As a reference in the classification process the landsat image of 2007, 1m resolution Ikonos imagery of same year and ortho image data is used. Figure 6 shows the vector data generated as a result of classification.

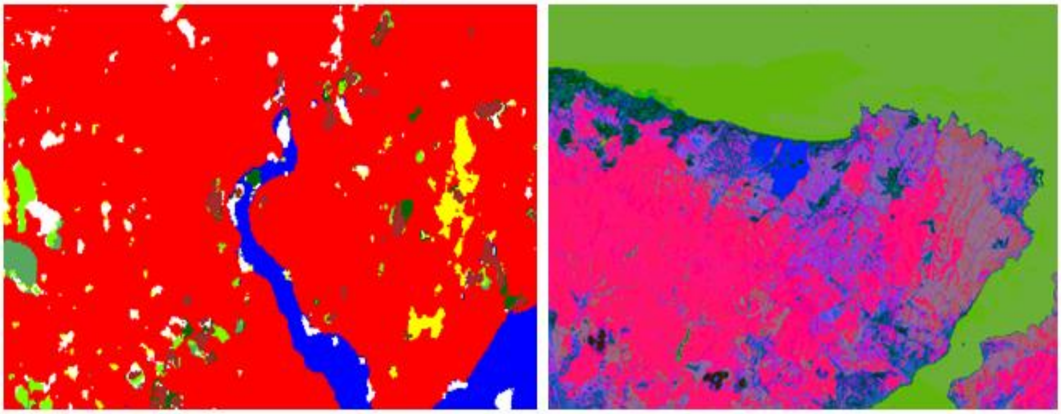

Figure 4. The view of classified area

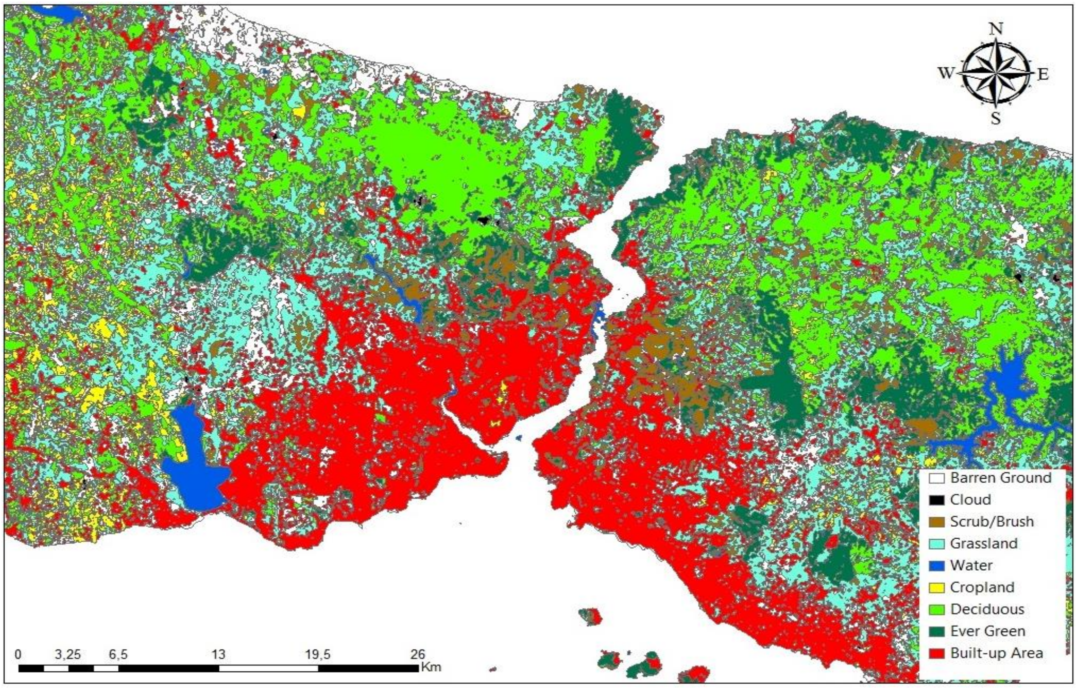

Figure 5. Tematic maps of 1987

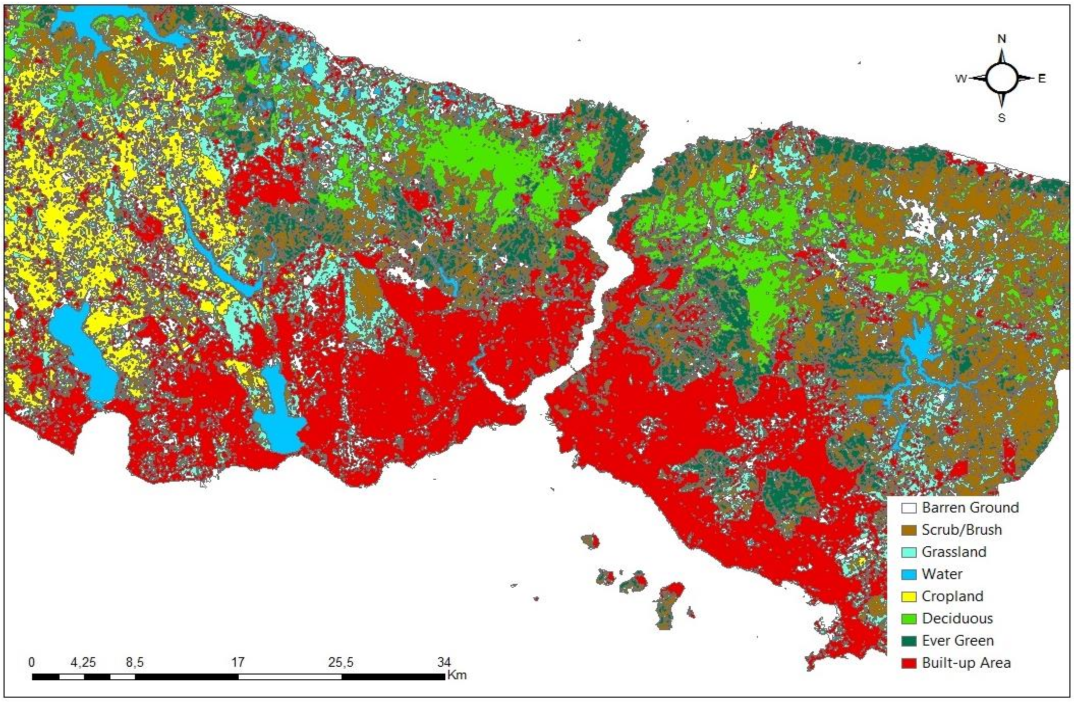

Figure 6. Tematic maps of 2007

Accuracy Assesment

Accuracy assesment was conducted with 100 points thrown at random are scattered throughout the study area (Fig.7). The accuracy assesmnet of the 1987 landsat satellite image analysis was performed using Erdas Imagıne 2013 software. Automatic thrown every point in the reference image was performed by manually check for accuracy. Accuracy of each class are given in table 1. In addition, the overall accuracy of 79.00 % was obtained.

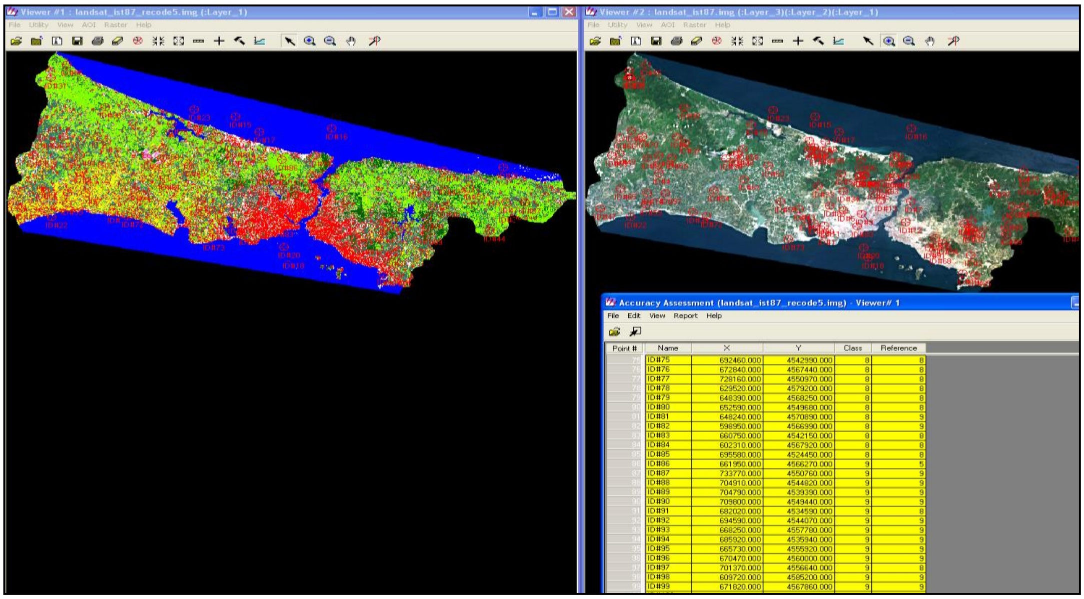

Figure 7. Accuracy analysis

Class	Reference	Classified	Correct number	Producers accuracy (%)	User accuracy (%)
Built-up Area	10	14	10	100	71.43
Water	9	9	9	100	100
Cloud	8	8	8	100	100
Ever green	6	7	5	83.33	71.43
Deciduous	13	15	10	76.92	66.67
Cropland	19	12	10	52.63	83.33
Barren ground	8	6	5	62.5	83.33
Grassland	13	14	11	84.62	78.57
Scrub/Brush	14	15	11	78.57	73.33
	100	100	79		

Table 1. The results of the accuracy analysis

The resulting accuracy of the overall accuracy, Kappa statistics (K) is expressed. K statistics shows that the true value of the error matrix are real or is it by chance while a consensus achieved. It is usually between 0 and 1. In the case of total Kappa statistics chance result of classification of 0.76 measured values obtained in this application it can be considered as 76 % better.

Landsat image classification accuracy of 79% if you take into account the international literature that is sufficient to produce maps for land use. The reflectance values of water and clouds are different from wavelengths of other classes and complexity is not mentioned therefore are obtained 100% accuracy. Road details in the built-up area class is confused with barren ground class and accuracy were obtained as 71.43%. Agricultural class has 3 different reflectance value in itself because of seasonal differences, some of which are mixed with bushes and grass class. Likewise, deciduous class is 66.67% of righting class shows that mix with grass and bushes class. Landsat image 2007 resulting in proportion to the area classification is determined automatically at random around 100 points (Fig.8).

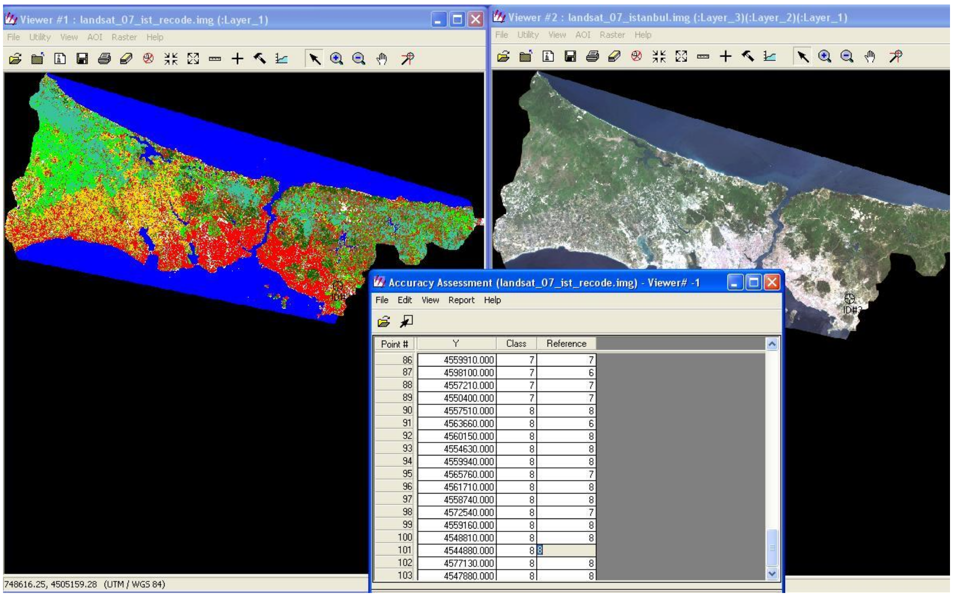

Figure 8. The distribution of the random point

Accuracy analysis process is performed automatically checked with ground truth information for each point selected manually. As a reference Landsat image natural band combination and Ikonos image 2005 was used (Fig.9). The accuracy of each class are given in Table 2. Also overall accuracy was obtained as 83.50%.

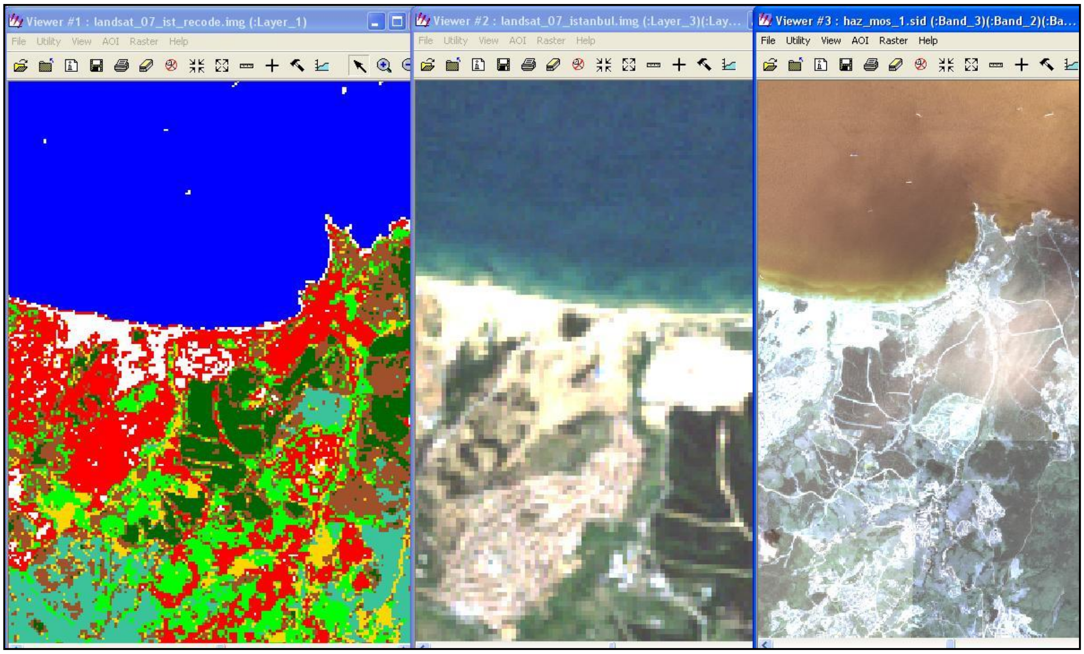

Figure 9. The using reference data for accuracy analysis

Class	Reference	Classified	Correct number	Producers accuracy (%)	User accuracy (%)
Built-up Area	17	20	17	100	85
Water	9	9	9	100	100
Barren Ground	7	8	6	85.71	75
Ever Green	12	9	8	66.67	88.89
Deciduous	14	14	11	78.57	78.57
Cropland	16	14	11	68.75	78.57
Scrub/Brush	12	14	11	91.67	78.57
Grassland	16	15	13	81.25	86.67
	103	103	86		

Table 2. The results of the accuracy analysis

Determination of the 2007 Landsat image classification accuracy of 81%, it is important to produce a land use map product at the point of considering the international literature. The lack of clouds in the Landsat image in 2007, as well as a lack of natural cloud 's shadow and a reflection of the lack of any value impairment results were positively influence the image.

Temporal Analysis

When 20-year change analysis for Istanbul; grass, shrubs, deciduous, evergreen classes should be considered under the name of the forest, because the forest is divided into grade class in itself to give the positive results of the classification signature collected. When the results were evaluated, the increase in built-up area, forests and agricultural areas in the decrease are identified. The fields of each class of the classification results obtained are given in table 3. Figure 10 can be made to review and change between classes.

Land cover/land use categories	**1987 (ha)**	**2007(ha)**	**Changes**
Built-up Area	74196	130341	increase
Cloud	1580	-	-
Barren Ground	39288	28363	decrease
Grassland	129304	112671	decrease
Scrub/Brush	16748	100243	increase
Ever green	32365	25004	decrease
Deciduous	166461	91848	decrease
Cropland	85885	57309	decrease
	545827	**545779**	

Table 3. Land cover changes from 1987 to 2007.

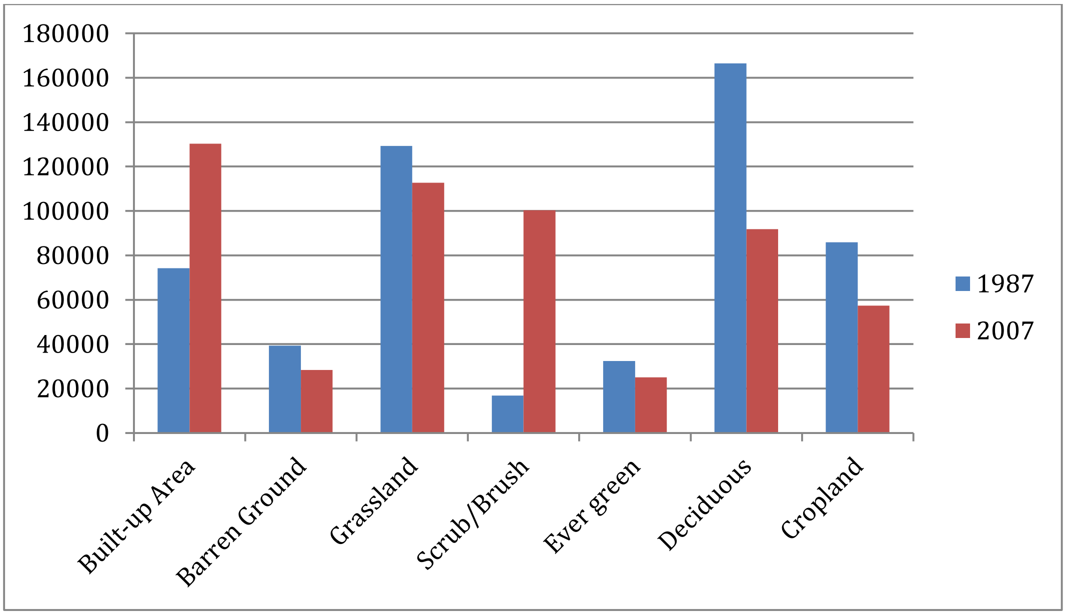

Figure 10. Changes in the seven categories between 1987 and 2007

Conclusion

Remote sensing technology in combination with GIS can render reliable information on land cover. The results demonstrate that Landsat classifications can be used to produce accurate landscape change maps and statistics. Information from satellite remote sensing can play a useful role in understanding the nature of changes in land cover/use, where they are occurring, and projecting possible or likely future changes. The growth of the size of cities, often at rates exceeding the population growth rate, and the accompanying loss of agricultural lands, forests and wetlands, escalating infrastructure costs, increases in traffic and degraded environments, is of growing concern to citizens and public agencies responsible for planning and managing growth and development. Metropolis in a controlled manner of selection decisions to date and the cost of failing to do in a rational way, drinking water basins and especially in forest areas, mostly in the direction of the north, where the area to be protected growing problems come to the fore. The importance to be indispensable to a high quality of life in Istanbul and the water is absolutely necessary to ensure the sustainability of forest resources. In the coming year, instead of creating favorable areas to new urban in Istanbul, it is necessary to improve the current situation. At the same time, ensuring the quality of growth, the implementation of environmental sustainability, it is necessary to diminish the pressure on natural resources formed.

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