A Case Study of Using Remote Sensing Data and GIS for Land Management; Catalca Region

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ABSTRACT

In this study Catalca region has been selected as study area. This region is one of the most developing and changing area around the Istanbul. This region is changing not only industrial but also planned residences. Main reasons of increasing in the residential area of this region are go away from the city life and threat of earthquakes. People whom live around the Istanbul, also like to improve their standard of living and live in small houses in garden instead of apartments. But this change causes decrease of productive agricultural land and increase of residential areas. There are many places in Turkey and Marmara Region has the same features likes Catalca.

IRS1C and LISS remotely sensed images in the years of 1996, 1998 and 2000 of the study area have been used together with ground measurements, digital terrain model and demographic data for analyse of change detection in the land use and impacts of this change on the environment. For the planning and direct of this kind change for future, satellite images have been referenced to the UTM coordinate system boundary of study area were determined on the images and classification algorithms have been applied to these data. Result data have been produced as polygon and transformed to GIS software. Benefits of these kinds of data in the planning phase have been analyzed.

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1. INTRODUCTION

Istanbul Metropolitan Area has attracted millions of migrants from other regions of Turkey over the past years. 25.8% of Turkey's population lives in the Marmara Region and 23% of Turkey's Gross Domestic Product is produce in the Istanbul, which is located on two continents, is the largest city of this region and Europe. It is a combination of a very rich historical background and a modern appearance.

As a result of the population growth and rapid urbanization, the city has expanded very fast causing many changes in land use. Urban planners and policy makers make strategic decisions on environmental protection, infrastructure development and maintenance, and land development. They need to access to up-to-date base maps and systematic information on the land use patterns environmental problems and infrastructure facilities. Urban land use planning can help guide's urban development away from vulnerable ecosystems. Many techniques have been used in identifying land use and land cover changes (Green et al., 1994, Forster, 1985)

In this study Catalca region has been selected as study area. This region is one of the most developing and changing area around the Istanbul. This region is changing not only industrial but also planned residences. Main reasons of increasing in the residential area of this region are go away from the city life and threat of earthquakes. People whom live around the Istanbul, also like to improve their standard of living and live in small houses in garden instead of apartments. But this change causes decrease of productive agricultural land and increase of residential areas. There are many places in Turkey and Marmara Region has the same features likes Catalca.

The aim of this study is determine land-use change in Buyukcekmece – Catalca region in Istanbul using remote sensing data and GIS. In the study different types of data were collected from various sources. The satellite images, standard topographic maps (1:5000 and 1:25000) and several photographs have been used. For this study, a post-classification comparison change detection technique utilizing Indian remote sensing data IRS 1C and LISS III data of three different dates were used to map land cover change in Istanbul.

The land cover change mapping involved following steps.

1. Accurate registration of 1996, 1998 and 2000 LISS III and IRS 1C data
2. Clustering of the data into 100 spectral classes using an unsupervised classification method;

3. Identification and labeling of spectral classes into seven land use categories using IRS 1C +LISS III merged data and other ground information;
4. Assessment of change detection accuracy.
5. Classified images were transferred into the Geographic Information Systems. Visual results and statistical reports expressed specific qualitative information related to satellite images. This study has focused on forestlands, open mining areas, agricultural lands and settlements.

2. STUDY AREA

Location of Catalca Region is given in figure 1. Surface water resources through seven water dams provide Istanbul's drinking water. Study area is lie on one of these reservoir basin called as Büyükcekmece Town. This area is located in long distance protected zone of water basin (2000m from water). Catalca is the largest township of Istanbul whose area is 1715 km^2. Catalca also contains water resources, which feed two other water basins in European side of Istanbul. Alluvion soils of these valleys are very convenient for the agriculture. On these productive soils different agricultural products are cultivated. Deforestation due to opening field for agriculture and quarries is becoming another danger for the study area.

Industry and trade are grown up mostly depend on agriculture. Catalca free trade zone is built in the medium distance protection zone (1000m-2000m) in 1994 and capacity of this zone is being increased day by day.

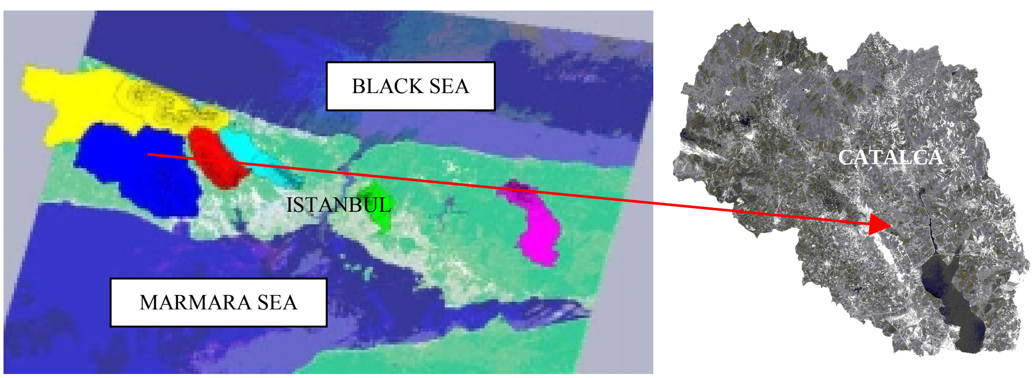


Figure 1. Study area.

3. METHODOLOGY

For analyzing land-use changes for different period remote sensing data was used. The characteristics of the satellite images have shown in table 1.

3.1. Remote Sensing Data and Image Processing of Study Area

3.1.1. Georeferencing

The image data sets were geometrically corrected to the Universal Transverse Mercator System (UTM) coordinate system involved the following steps:

- Map to image and image-to-image methods have been used in rectification process.

- Digitized of ground control point's coordinates from standard topographic 1/25000-scaled maps and 1/5000-scaled orthophoto maps. Twenty-five ground control points used in this step.

- Computation of least square methods solution for a first order polynomial equation required to register the image data sets.

- For the resampling method of geometric correction using cubic convolution algorithm.

Total root mean square (RMS) error 0.5 pixel (2.9m) for the IRS 1C images and 0.55 pixel (13m) for the LISS III image.

Table 1. The characteristics of satellite images that were used in the study

Image	Date	Resolution	Number of bands
IRS 1C	06.24.1996 10.18.1998 05.09.2000	5.8m x 5.8m	1
LISS III	06.24.1996 10.18.1998 05.09.2000	23.5m x 23.5m	4

The registration of satellite images is relatively straightforward. Positional accuracy defines the relationship between the registered image and the applied source map. The spatial resolution of the present land observation satellites circumscribes the identification precision of Geometrically Correction Procedure and therefore the potential accuracy. A registered image should be labeled with information on the following items, source of reference Geometrically Correction Procedure's number of Geometrically Correction Procedure's type of information, RMS error or standard deviation, and, if necessary resampling method (Jansen and Vander Well, 1994) In the light of these explanation we can say that georeferencing is a technique, which has high probability.

3.1.2. Merge

Rapid advances in computer image analysis have allowed for greater flexibility and the use of new techniques for combining and integrating multi resolution and multispectral data such as the 5.8m single-band IRS 1C Pan image data with the 23m spatial resolution LISS III multispectral data. In figure 2, merged images taken in 1996 and in 2000 have been given. The enhanced detail available from merged images was found to be particularly important for visual land-use interpretation and urban growth analysis (Ehlers et al., 1990). LISS III 2,3,1 band combination have been taken as RGB and Brovey transformation was applied. After this process IRS 1C panchromatic data was manipulated and obtained image was transformed to RGB system.

Figure 2. Merged images of study area.

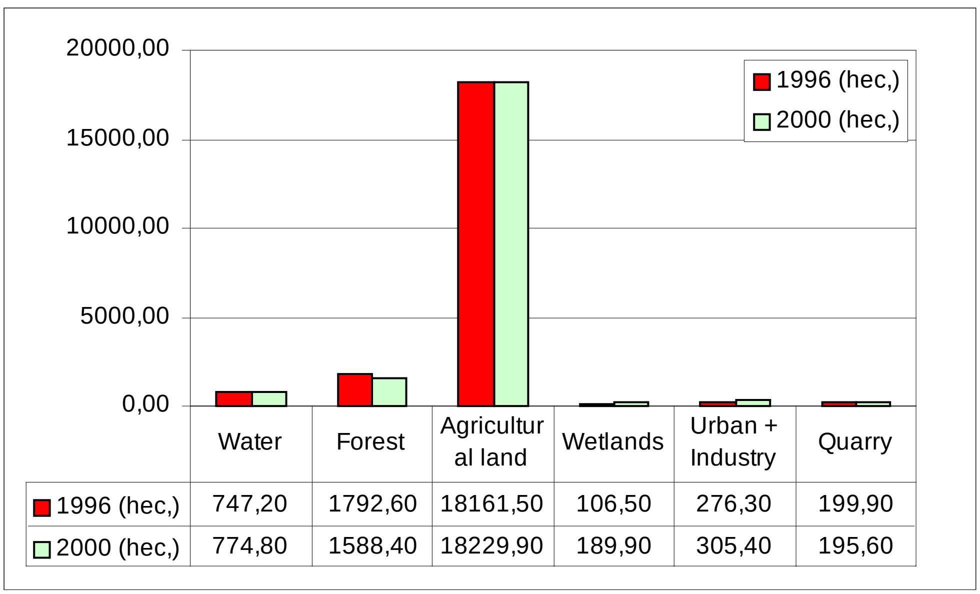
3.1.3. Classification

Unsupervised classification process ISODATA (Iterative Self Organizing Data Analysis Technique) has been applied image data sets. The advantages of ISODATA were the reason for the selection of this algorithm. A preliminary thematic raster layer is created which give results similar to using a minimum distance classifier on the signatures that are created. This thematic layer can be used for analyzing and manipulating the signatures before actual classification take place (Erdas Field Guide, 1991, Ormeci et al, 1996).

ISODATA algorithm produced 100 spectral clusters, which after generalization on fieldwork, were aggregated to seven land-use land cover classes. Forest, bare soil, settlement, wetland, open mining area, agricultural land and water. One of the photographs taken during the fieldworks, which show the open mining areas, is given in figure 3.

Figure 3. Field work at open mining area.

Fieldwork was an integral part of this study. Many kinds of reference data, field map and photographs were used in this section. The thematic maps, which were provided on earlier works, other source maps, and ground truth works in the field supported the research. Panchromatic images were used as aerial photographs in the classification process. Classification results shown on the figure 4. Total study area is calculated as 21284.0 hectares. In this study images dated 1998 has also been evaluated. Even it has been seen the increasing at the settlement but for the analysis this data was not used.



	Water	Forest	Agricultural land	Wetlands	Urban + Industry	Quarry
1996 (hec,)	747,20	1792,60	18161,50	106,50	276,30	199,90
2000 (hec,)	774,80	1588,40	18229,90	189,90	305,40	195,60

Figure 4. Classification results and changes in the six different classes.

3.1.4. Accuracy Assessment

Accuracy in Remote Sensing Classifications shows the correspondence between a class label allocated to a pixel and "true" class. The true class can be observed in the field, either directly or indirectly, from a reference map (Janssen and Well, 1994).

For the accuracy assessment, 100 pixels were randomly selected from the ground-truth coverage for comparison purposes, and error-matrix. The results tabulated in table 2.

Table 2. Accuracy assessment.

Image	Number of Pixels	Overall Accuracy
1996- LISS III		81%
1998- LISS III	100	81%
2000- LISS III		83%

3.2. Integration of GIS and Remote Sensing Data

Remote sensing data can be readily merged with other sources of geo-coded information in a GIS. This permits the overlapping of several layers of information with the remotely sensed data, and the application of a virtually unlimited number of forms of data analysis. On the one hand, the data in a GIS might be used to aid in image classification. On the other hand, the land cover data generated by a classification might be used in subsequent queries and manipulations of the GIS database.

As the use of geographic information systems is expanding, the availability of timely and up-to-date spatial data in digital format is an essential requirement for its success. For the user, it is a requirement, which is expected to be easily fulfilled. Satellite imagery combined with the increased processing capabilities of current image analysis systems have made it possible to generate meaningful data sets which represent new knowledge not available with previous technologies (Palko et al, 1995).

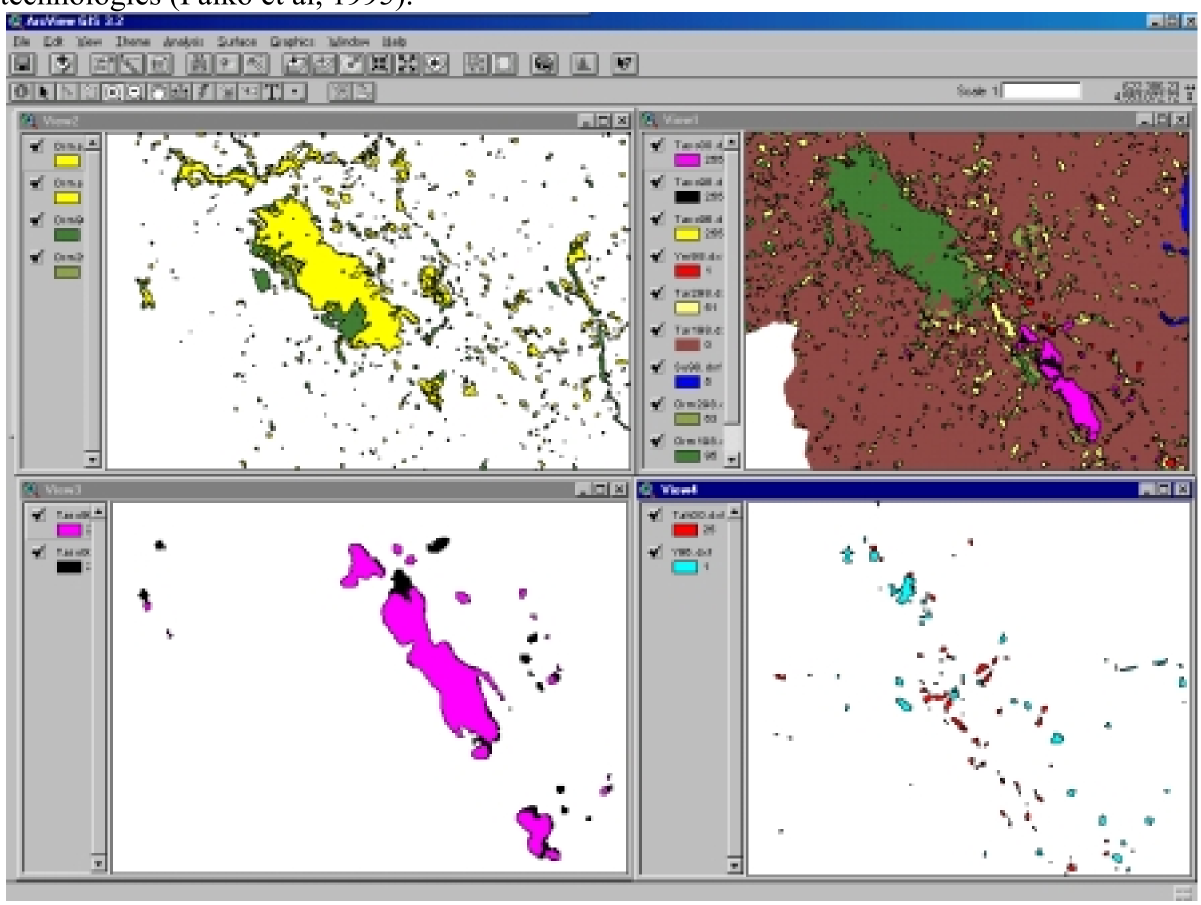


Figure 5. Analysis results obtained by GIS software.

For transforming classified satellite images to meaningful vectors generalizations is necessary. For this aim, 5*5 neighborhood algorithm has been applied to satellite images dated 1996 and 2000. After this, each class has been transformed to vector layer. Obtained layers imported to GIS media and used for the area analysis. ArcView desktop GIS has been selected as GIS software and one of the analysis results have been given in figure 5.

4. CONCLUSIONS

Classification and then temporal analysis of remote sensing data will help solve the problem concerning numerous land changes. As the remote sensing data to be used in GIS media are of raster data format, they are of limited use in certain applications. Use of vector data besides the raster data in making the analyses needed especially in land management studies and production of purpose-oriented data will serve for more and diverse purposes.

In this study, each class obtained by means of classifying the satellite images dated 1996 and 2000 have been transformed into vector data and transferred to GIS media, and then, area related queries were made. Results of the study revealed the existence of urbanization that could endanger especially the forestlands in and around Çatalca, located in a major water basin of Istanbul. By means of integrated use of remote sensing and GIS data, timely decisions could be taken to both control the development and prevent the unfavorable features in this area.

Data obtained by combining the capability of remote sensing in eliciting the desired type of data within a short time and the analysis capability of GIS are used as important source in preparing and applying the land management plans, executing the decision-support mechanism, monitoring the application, determining the course of urbanization, taking necessary measures and making investments.

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BIOGRAPHICAL NOTES

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She has graduated from Istanbul Technical University, Civil Eng. Faculty Dept. of Geodesy and Photogrammetry in 1989. Following her start as Research Assistant in 1989 and having completed his PhD in 1999 on Remote Sensing, worked in the same department as Research Assistant till 2000 and now she is still working in the same place as Associated Professor Dr.

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