Geoinformation for European-wide Integration, Benes (ed.)

Analyzing features obtained from satellite data by means of GIS

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Keywords: remote sensing, land-use/land cover, water basin area, GIS

ABSTRACT: In this study land use and temporal changes in land cover of the Alibeykoy basin have been analysed by using LISS III and IRS 1C satellite data dated 1996 and 2000. Land use changes obtained from classification results have been generalised to transform into polygons in vector format. These polygons have been integrated with relevant attributes and transferred to GIS. An analysis using GIS functions such as overlay analysis, statistical analysis and producing digital terrain model was conducted.

1 INTRODUCTION

Parallel to the improvement in the computer and space technology, remote sensing technology developed rapidly. One of today's main research areas is finding new resources to solve problems caused by population. Many people are trying to find urgent and reliable solutions. Migration from rural part to the urban area brought many different problems with it. Because of these rapid changes, several factors such as transportation, shelter, recreation and feeding have to be established and associated problems have to be solved. This can be using remote sensing data, which offer high precision, economy, and detailed and wide range information.

Life sources of Istanbul have been focused on the green belt that covers forests, recreation areas and surface water reservoirs. Usage and drinking water are supplied from seven different reservoirs and dams. Local and regional administrators and governors need land use information, which is very important for decision-making to prepare and execute application plans. Land use information is used in these plans either directly or indirectly.

Controlling of environmental problems requires collection of data from different sources. Data collected by different institutions, individuals and organizations are not homogenous and not in the same quality. Because of above mentioned reasons benefits of these data is minimum in view of the global perspective.

Land use information is also very important for scientific studies. Regional and national land use reflects characteristics of interaction between human and environment together with fundamental economical functions.

Rapidly increasing population caused by migration cannot find a chance to settle in the cities and move to the rural areas around the cities. Reservoirs and water dams were covered with forests in the past but now there are lots of industrial plants and residences. Opened agricultural areas without control caused a change in the forest density. These uncontrolled agricultural activity around the lakes and reservoirs protection areas causes erosion and pollution. Istanbul's water supply sources have been endangered by the increasing pollution caused by the changing land use. One of the main reasons of these increasing undeceivable parameters is a highway newly built passing through the basin.

Migration rate is much higher in the basin compared to other parts of the city because of the attraction of water and green areas located in the basin. Increasing population around the water collection reservoirs and further factors including fast industrialization and mining activities nearby these sources are lowering the water quality (ISKI project report).

The main determinant for mankind to select a site for settlement is water. The densely populated new settlement centers of Istanbul and the inefficient control mechanism clash with the water resources. Water quality is interrelated with the

area's accessibility for human settlement. The buildings and roads form the impermeable surface and certain ways of usage and industrial premises as well as settlement areas with inadequate purification facilities make up the sources of pollution. Urban expansion is also threading the local watershed: an estimated 1 million squatters now live in protected watershed areas, and wetlands located next to the rivers are covered by streets and housing.

The use of remotely sensed data for monitoring and management of water resources is basically for mapping, flood monitoring, wetland monitoring, lake and reservoir volumes, irrigated land assessment. Remote sensing is a valuable source of data for periodically assessing existing and future water requirements of irrigated croplands. Water resource management is a major importance to the economics of arid and semi arid regions (Engman and Gurney, 1991).

2 STUDY AREA AND SATELLITE IMAGES

There are seven water dams and reservoirs providing drinking water to Istanbul. Alibeykoy basin, which has been chosen as the study area is shown with the rectangle in figure 1. This basin has been affected very much from the enlargement of the residential areas. Land use classes of this basin have been examined by means of satellite data and GIS.

Alibeykoy basin is located about 25 km's away from the city center. It is located between Terkos water reservoir and Kagithane township. Some of the residential areas belong to different townships also located in this basin. There are 1 settlement in the definite protection area and 5 settlements in the long distance protection area of the basin. Population of the basin has been counted as 7372, 84706 120000 and approximately 300000 respectively in the years of 1975, 1990, 1993 and 2000.

Protected zones of the basin have been digitised by using standard topographic maps scaled 1:25000 (Figure2). Calculated areas of protection zones have been given in Table 1.

In this study LISS III (spatial resolution: 23.5 m) and IRS 1C (spatial resolution: 5.8 m) satellite images have been used and all imagery belong to date June 1996 and June 2000. Other data sources are the 1: 5000 scale orthophoto maps.

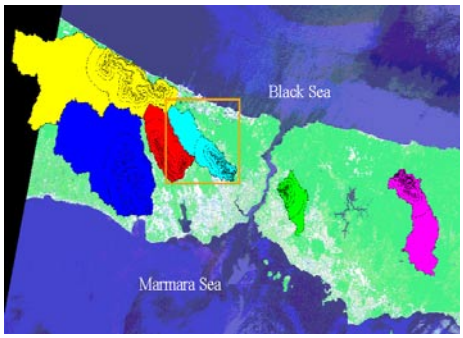


Figure 1. Location of the study area

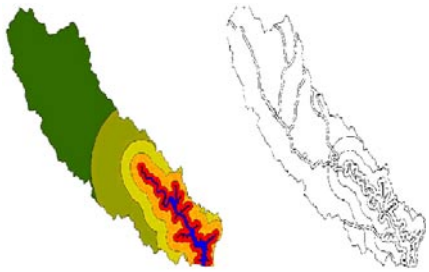


Figure 2. Protection zones of Alibeyköy basin

Table 1. Protection zones area values

Protected Area Types	Width (m)	Area (km^2)
Reservoir Area		4.60
Definite protection zone	0-300	13.45
Short distance protection zone	300-1000	19.02
Medium distance protection zone	1000-2000	16.48
Long distance protection zone	2000- Water Basin Area Border	105.96
Total		159.87

3 METHODOLOGY

3.1 *Geometric Correction*

First, topographic maps covering the study area were scanned and georeferenced to Universal Transverse Mercator Projection System (UTM). Second, The IRS 1C-1D Panchromatic Image was registered to using maps with a root mean square (RMS) error of 0.5 pixels. The registration of each image was performed using the nearest neighbour resampling algorithm (Figure 3).

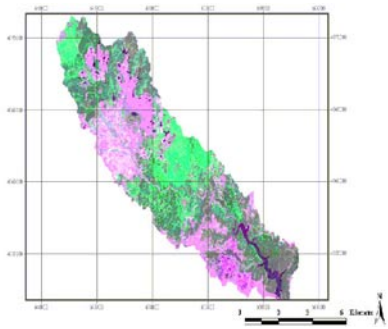


Figure 3. Study area in UTM coordinate system

3.2 *Classification*

An unsupervised multitemporal classification was performed on this data set using the ISODATA algorithm (Menz and Bethke, 2000). The LISS III data of 1996 and 2000 are classified into 40 spectral classes and these classes generalized to 9 classes. Field studies have been done for controlling classification results. Also various maps (orthophoto maps and land use maps) and photographs were used to control classes. For transforming classified satellite images to meaningful vectors generalizations is necessary. For this purpose, 5*5 neighborhood algorithm has been applied to satellite images dated 1996 and 2000. Selected layers are; urban, quarries (open mining areas), water, forest, agricultural land, bare land and wetland. After this, each class has been transformed to vector layer.

4 REMOTE SENSING AND GIS INTEGRATION

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. Land cover data generated by a classification might be used as well as the other layers, in subsequent queries and manipulations of the GIS database (Musaoglu et al, 2002).

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. 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.

5 RESULTS

Alibeykoy basin has wide urban and industrial areas. This basin is under the serious threat of massive urbanization. This area, which is developing in an unplanned way, will in the course of time lead to pollution of the basin. As a result of the increase in urbanization, 20 % of the agricultural land, forests and shrubberies have decreased. When Alibeykoy basin is examined one of the most attracttive attention feature is extension of quarries in timing. One of the classification problems is mixing a little bit of residences and quarries. For this reason quarries have been digitised with merged IRS 1C and LISSIII. Destruction of quarries on the environment can be seen in the merge images given in Figure 4. Photograph taken during the ground truth in the Cebeci quarry area is given in figure 5. Figure 6 shows differences within a 4 years period.

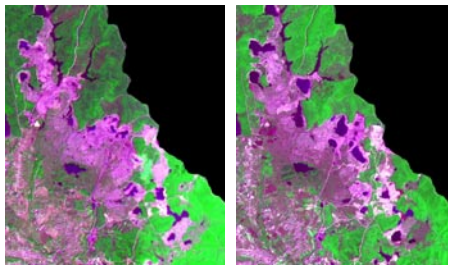


Figure 4.Quarries on the Merge images of the year 1996 and 2000.

Figure 5. Photograph of Quarries in Cebeci

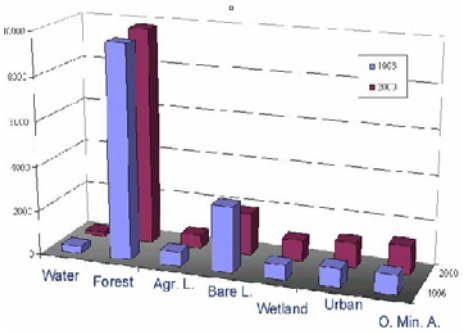
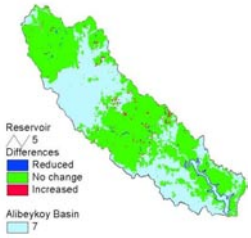


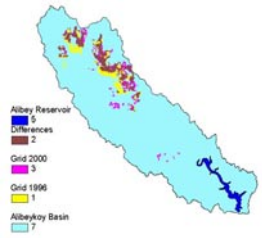
Figure 6. Differences in a 4 year period

In this study number of grids has been evaluated from existing polygons themes obtained from satellite images. These grids were standardized on their maximum and minimum values and then weighted map overlay has been produced to determine study area for different purposes. This process is one of the most effective ways to visualize statistical information that changes over distance are via a map that expresses values with a color gradient.

This process is called map calculator in ArcView. It is done combining the various criteria in the layers. It enables the user to produce a map that shows the distribution of values and express the results in terms of a percentage. In Figure 7a, one of the obtained map result has been given. This map shows the differences in the forest area in a 4 year period. In this map unchanged areas has been shown with green, reduced areas with blue and increased amount of forest has been indicated with red. Another example done with the same method is presented in Figure 7b.



(a)



(b)

Figure 7. Map calculation results.

In this example open mining areas (quarries) have been considered. Open mining areas in the year of 1996 are represented with yellow, and the year of 2000 are represented with pink color. Results of analysis are given with brown color. During this process, some problems have been encountered. As a matter of fact, the Map Calculator does not recognize normal mathematical syntax in some cases.

6 CONCLUSION

In this study, use of three-dimensional models prepared by considering the conservation areas for monitoring the basin brought a new dimension to the evaluation. By means of three-dimensional and multi-temporal analysis of the Alibeyköy Basin, an important database has been established for planning, protection and monitoring of the basin. In addition to three-dimensional modeling on the basis of the basin conservation belts of the land-use and land cover types, integration of data such as the soil type, slope, geological, hydrological, meteorological and climatic conditions and use of lakes within the established GIS must be ensured.

In order to provide safe water today and in the future from the surface water resources such as lakes, reservoirs and dams, it is necessary to protect the water in the reservoirs and basins against all sorts of pollution. The said contamination is generally caused by human elements, further aggravated by the increase of population. This is a very important problem almost for every major city around the world, notably Istanbul as well.

At present, institutions and establishments concerned with the evaluation, conservation and planning of the water resources need data that enable them to work safely, economical evaluation possible, temporally and in a multi-disciplinary. Therefore, integration of remote sensing data with GIS made rapid and economical evaluation possible during such studies.

Water has vital importance in human life. Land use evaluation results done for an eight years period pointed out the danger of water surface resources because of unsystematic urbanization. Together with this reality ISKI (Istanbul Water Board Authority) changed the regulation of surface water resources in 1996 and opened the short distance and medium distance protection zone for urbanization. This caused massive migration to these parts of the city. This regulation should be considered one more time without commercial expectation for the sustainable protection of the basins.

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 Alibeyköy basin. By means of integrated use of remote sensing and GIS data, timely decisions could be taken to both control the development and prevent the unfavourable 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 sources in preparing and applying the land management plans, executing the decision-support mechanism, monitoring the application, determining the course of urbanisation, taking necessary measures and making investments.

Another major problem related to study area is, the existence of more than one decision makers about the basins in Turkey. There should be one institution or organization, which takes all responsibilities.

ACKNOWLEDGEMENT

The authors would like to thank Dr. Cem Gazioglu for his technical support.

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