REMOTE SENSING AND GIS INTEGRATION FOR LAND COVER ANALYSIS, A CASE STUDY: GOKCEADA ISLAND

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ABSTRACT:

In this study, remote sensing and geographic information system (GIS) integration were used in order to analyse land cover of Gökceada Island by using Landsat 7 ETM data with slope and aspect data. Digital image processing techniques were conducted for the processes of image enhancement, manipulation, registration and classification for land cover analysis. Digital Elevation Model of the island were performed by digitising 1/25000 scaled standart topographic map. Slope and aspect map were derived by using the DEM as layers in GIS. Previously derived slope and aspect maps were overlain on the classified image to delineate problamatic areas of island for urbanisation. Gokceada Island has been developing rapidly over the last decade, successful planning will require reliable information about land use/cover distribution. This study illustrates that integration of remotely sensed data and GIS techniques are effective in order to provide such information.

1. INTRODUCTION

Land cover is a fundamental parameter describing the Earth's surface. This parameter is a considerable variable that impacts on and links many parts of the human and physical environments (Foody, 2002). Remote sensing technique has ability to represent of land cover categories by means of classification process. With the availability of multispectral remotely sensed data in digital form and the developments in digital processing, remote sensing supplies a new prospective for land-cover/land-use analysis. Geographical Information Systems have already been used for assessing environmental problems, since they provides a flexible environment and a powerful tool for the manipulation and analysis of spatial information for land cover feature identification and the maps of all variables were combined to extract information to beter understand analysing (Weng, 2001). Satellite remote sensing, in conjuction with geographic information systems, has been widely applied and been recognized as a powerful and effective tool in analysing land cover/use categories (Ehlers et al., 1990; Treitz et al., 1992; Harris and Ventura, 1995; Weng, 2001). This study made use of remotely sensed data and GIS technologies; to evaluate qualitatively and quantitatively outcome of Gokceada Island land cover/use distribution. Obtained results were compared with each other, visualized and analyzed, in Geographic Information System.

2. STUDY AREA

The selected area of study was Gökceada Island of Turkey as shown in figure 1. Gökceada island located between latitudes 40^0 $05^{'}$ $12^{''}$ N and 40^0 $14^{'}$ $18^{''}$ N and longtitude 25^0 $40^{'}$ $06^{''}$ E and 26^0 $01^{'}$ $05^{''}$ E, is the most largest island of Turkey and comprises 289.5 km^2 and has a population of 8875. The terrain of the island is mostly hilly and the climate of it basically Mediterreanne and it is the 4th island of the world from the point of plenty of fresh water sources in the world. The economy of the island is based mainly on tourism. Gokceada Island is being developed, year after year, extending their infrastructure in order to cope to increasing number of tourist arrivals. Economic prosperity in the island has generated a significant demand for all forms of recreational activities.

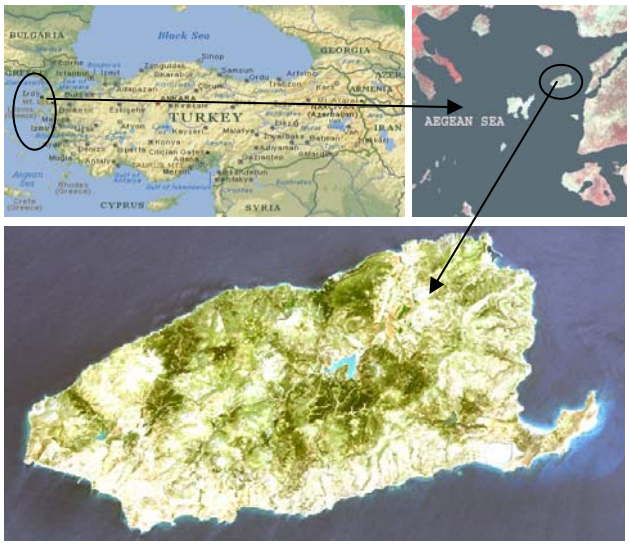

Figure1. Location of the study area

Subsequently, the island has been undergoing rapid development in terms of expanding road networks and the construction of hotels and holiday complexes.

3. DATA AND METHODOLOGY

In this study, analysing of Gokceada islands land cover by means of Landsat Enhanced Thematic Mapper (ETM) was aimed. Data acquired on Jun 14 2000 was used as remotely sensed data. Together with these satellite image, 1/25000 scaled topographic maps and existing land use maps were used for rectification and ground truth. Additionally, in order to produce digital elevation model (DEM) 1/25000 scaled standard topographic maps were used. Stages of digital image processing techniques were followed in order to obtaine land cover categories of study site.

In the first step, the simple image pre-processing was carried out including image enhancement, and geometric correction. Enhencement techniques were applied to satellite image in order to increase visual distinctions between features and increase the amount of information that can be visually interpreted from the data. These procedure includes various techniques. Landsat TM image was enhanced using high pass filtering and histogram matching (for minimizing atmospheric effects) enhancement techniques to improve interpretability of image.

Second stage is rectification process. To locate ground features on imagery, or to compare a series of images, a geometric correction procedure is used to register each pixel to real world coordinates (Jensen, 1996). Map to image registration was applied on image in order to prepare them for an accurate land cover classification. Landsat 7 ETM image dated 2000 was transformed UTM coordinate system by means of 1:25000 scaled standard topographic maps by using first order polinomial and nearest neighbour resampling method.

In the third phase, ISODATA classification technique was applied to classify the Landsat images of the island. The aim of the image classification process is converting image data to thematic data. ISODATA (Iterative Self Organizing Data Analysis Technique) which is clustering method, classify pixels iteratively, redefine the criteria for each class, and classifies again, so that the spectral distance pattern in the data gradually emerge (Goksel, 1998). Seven land cover types for Gökçeada are identified and used in this study, including: urban or built-up land, barren land, green areas, olive grove, forest, water and sand. Figure 2 showes the visual results of classified images in 2000 and table 1 shows the statistical results of classification.

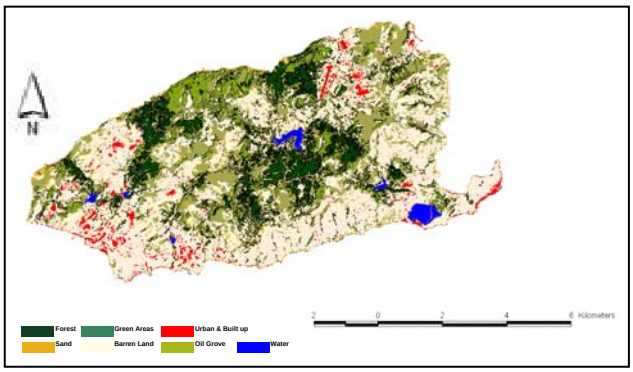

Figure 2. Classified 2000 date image

Classes	2000	
	ha	%
Water	379.13	1.31
Forest	3548.40	12.30
Green Areas	5416.64	18.77
Barren Land	9722.32	33.69
Olive Grove	6768.68	23.46
Urban & Build up (Mix)	2479.08	8.59
Sand	542,92	1.88
Total	28857.17	

Table 1. Results of classified images

At the last stage of image processing calculation of accuracy assessment of classification was performed. Accuracy assessment is an important feature of land-cover and land-use mapping, not only as a guide to map quality and reliability, but also in understanding thematic uncertainty and its likely implications to the end user. In this study, accuracy assesment of classification was calculated using a error matrix (Lillesand and Kiefer., 2000), which showed the accuracy of both the producer and the user. The classification accuracy in remote sensing shows the correspondence between a class label allocated to pixel and true class. The true class can be observed in the field, either directly or indirectly from a reference map (Janssen, and Vander Well., 1994). For accuracy assessment, 250 pixels were randomly selected from the ground truth coverage. Land use maps and photographs taken for documentary purposes were used as reference data to observe true classes. The overall accuracy and a Kappa analysis were used to perform a classification accuracy assessment based on error matrix analysis. For the 2000 dated image, overall classification accuracy for the seven classes was established as 87.5% and the Kappa coefficient was computed 0.863 (Bektas, 2003). A standard for land-cover and land-use maps is set between 85 (Anderson et al., 1976) and 90 % overall accuracy. The accuracy is sufficient for delineating of land cover in order to analyse.

DEM is defined as any digital representation of the continuous variation of relief over space (Burrough, 1986). By means of digitized contour lines of 1/25000 scaled topographic maps in every 20m interval, DEM of the study area were performed by using interpolation procedure. The classified image dated 2000, superimposed with DEM in order to obtain better visualization that are impossible by means of two-dimensional analysis are given in figure 3. Reliability of data sources, frequency of the points selected on the land and the mathematical method used in conversion are important for the quality and accuracy of the digital elevation model.

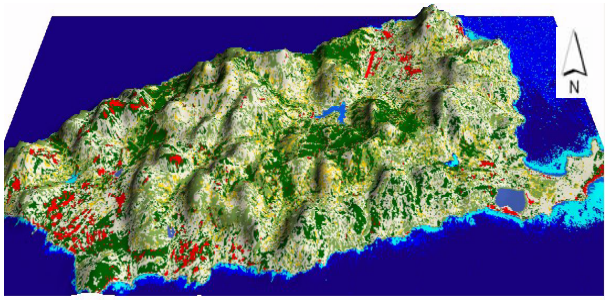

Figure 3. Digital Elevation Model (DEM) of the Gokceada

The DEM was used to create aspect map and a slope map in order to use as a layer in GIS. Slope and aspect values of land are particularly important, for determining how suitable land is for development and what impact development on land is likely to have on the environment. A slope of %20 and more and aspect of north, north east and north west mean that this part of land is not suitable for building. This information can be linked to other GIS layers such as slope and aspect to analyse land cover categories especially urban & built up class.

The slope and aspect data were calculated in degrees and were attached as the modal slope and aspect to give the dominant orientation of the surface within the island.

Raster data were translated into vector format before it used as a layer in a vector GIS. The result of digital satellite image classification is a pixel by pixel labeling of the entire image. Raster data was pre processed to reduce the large amount of data. Before conversion to vector format, the image was simplified to reduce the pixel by pixel classification to some smaller number of polygons. Raster to vector translation was occured for the purpose of presentation and analysis in a GIS layer.

4. DISCUSSION AND RESULTS

This paper indicates that how remote sensing and GIS techniques are integrated in order to establish land cover analyses in the Gokceada Island, Turkey, in the year of 2000. GIS techniques have been used to analyse and visualize urban planning of Gökçeada from the point of the criterias of slope and aspect. Map overlaying technique was applied to describe the quantitative relationships between urban and built up category of land cover classes and slope and aspect criterias. As a result, map of the islands showed in figure 3 with the threshold for discriminating criteria of two of them, for suitable urban planning were produced and interpreted to identify problametic areas of the Gökçeada Island.

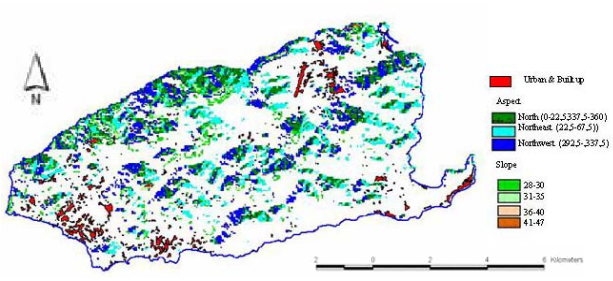

Figure 3. Analysis result of slope, aspect and urban-built up.

The result of GIS analyses showes that Gökçeada island is in good condition from the point of the view of urban planning. The relationship between slope, aspect criteria and urban built-up categorie is acceptable. The integration of remote sensing and GIS provides an efficient way to detect suitability and to evaluate its impact on environment. The digital image classification coupled with GIS has demonstrated its ability to provide comprehensive information on the nature, rate and location of urban planning.

5. CONCLUSION

Within the framework of this study, for the detection of possible land cover in Gökceada using Landsat TM data was realized. The results showed that integration of remote sensing and GIS was found to be effective in monitoring and analysing land cover patterns, and in evaluating urbanization impact for future land development project of study areas. The use of GIS in combination with image analysis in the application of the Gökçeada will depend on mostly availability and quality of the imaging data. However, the issue of class uncertainties in image classification has not been examined in this study. Although the land-cover maps of the Gokceada Islands have a high overall accuracy. Accuracy of different classes varies each others. Due to similar reflectance values of Urban and built up class was mixed up with the sand and barren land classes.

Increasing human activities causes some changes on the environment of Gokceada Island. Because of these reason, the obtained results integrated with the data for effective planning of urban area suitable for the development of the island.

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