DETECTION OF WATER RESERVOIR ON ELMALI DAM OF ISTANBUL USING SPACE TECHNOLOGY

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PURPOSE:

One of the main problems of Istanbul is the development without any planning. Many plans have been designed for the city, but not many of them have been used in the application. For this reason, ecological balance in the city has been harmed. The city has been extended towards the water basins in the north. This extension has caused a shrinkage of agricultural land and forests, and has increased surface water pollution around the dams. In this study, the land use and temporal variation have been examined using the 1984 and the 1992 Landsat TM images. The area selected is located near Istanbul, Elmalı Water Basin Area, in which the land use has been changed due to the large scale migration.

1. INTRODUCTION

Istanbul is the largest city of Turkey, including the size of its population, population density, economic and social activities. Around the urban areas in Istanbul, land is being rapidly converted from rural to urban uses. The population of Istanbul increases by 500 000 people every year (note that this increase is equal to the population of Helsinki, Finland). This population increase has been located around water basin areas. Water basin areas are under serious threat of uncontrolled urbanisation.

Regional and municipal planners require up-to-date information to because of current status of the land and to manage land development and plans for change. It is difficult to maintain up-to-date information on new housing and industrial/commercial developments. The land use plans has been important compenent of urban and regional planning. Even with the availability of satellite imargery an computer storage of imformation, the stage has not yet been reached where up-to-date information can be rapidly and easily provided. (Treitz, 1992). Remote sensing is an efficient tecnique to be used to obtain information on the land cover and urban ecosystem. Remote sensing methods have become the fastest way to collect information about detecting the face and development of such problems.They help us to collect data rapidly about land use, to transmit data to the user via satellite, to identify problems and to work on solutions .

The main purpose of this study is establish a basis for examining the potentials of the use of satellite images as an information source for landuse mapping in the context of urban planning.

2. STUDY AREA AND DATA SOURCES

Istanbul's drinking water is provided by surface water resourses from seven water dams. The Elmalı Dam water reserve area is located on the Anatolian side and is approximately 15 km. away from Istanbul's city center.

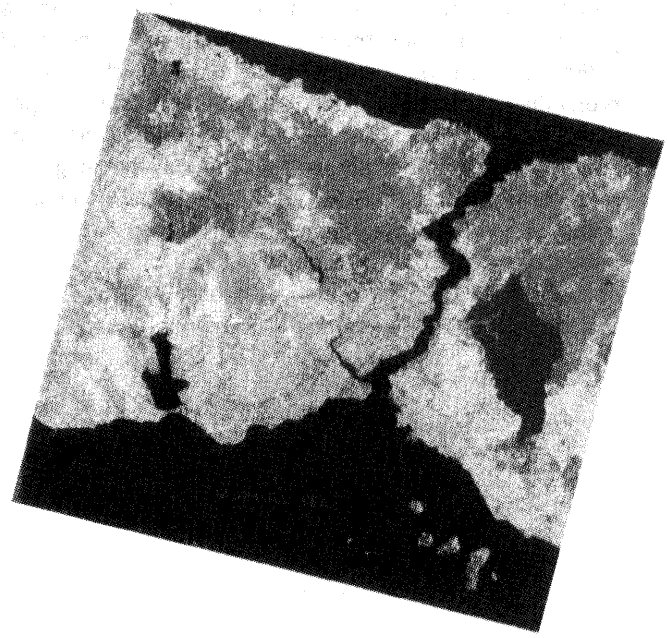

Figure 1: The study area Elmalı Water Basin

The second Bosphorous Bridge and Transit European Motor Way, which are located in the eastern part of the Elmalı, (TEM) have played an important role to encourage urban expansion and population increase in the water basins.

The population in the Elmalı water basins has shown a drastic increase from 1985 to 1990. This increase in Istanbul was around 5.3. % wherease the same rate for the Elmalı water basin area was 17.4 % for the period of 1985-1990. (Çetiner ,1994).

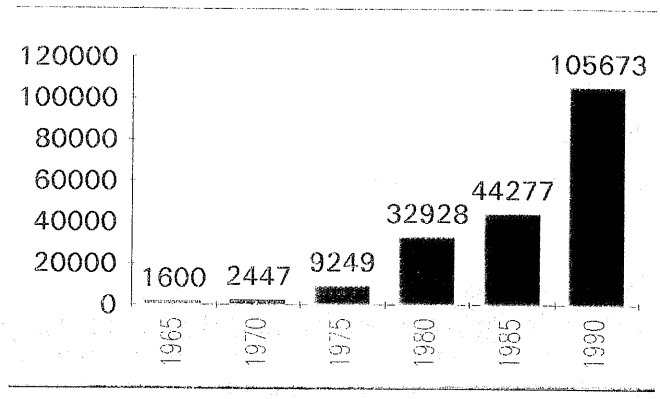

Figure 2: Population Distribution of Elmalı by 5 year periods

The regulations created by the Water Board Authority have determined four types of protected areas around dams: very near, near, medium and far distance protected areas. According to the regulations industrial activities, housing, and agricultural activities were prohibitied or resticted within the boundaries of four types of protected areas. Only in the far distance protected zone, a very low density of single family housing was permitted (Orhon, 1991). Today, several industrial activities and illegal housing are located within the protected areas of the Elmalı water basins. Figure 3 shows that digitized protected area borders and Table 1 indicates a list of their square kilometrage

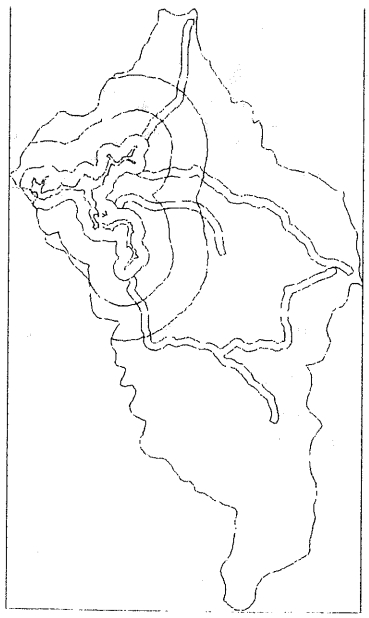

Figure 3: Digitized Elmalı Protected Areas

Table 1 : Protected Areas

Protected Area Tips	Width	Square Kilometrage (Area)
Very near protected Areas	0-300 m.	1.4 km^2
Near protected Areas	300-1000 m.	5.1 km^2
Medium protected Areas	1000-2000 m.	
Far distance Areas	2000 m.-	11.4 km^2
TOTAL		54.2 km^2
		82.4 km^2

2.1. Objectives

In this study, image processing and change detection analysis have been done by interpreting multitemporal images. The analysis consists of four major steps.

These are:

1- The Water Basin area protection zones have been digitized using 1/25000 scaled Standard Topographic Maps.

2- Satellite images have been registered to a known map coordinate system.

3- For the selection of the traning areas, a land study has been carried out and maps and plans belonging to the area utilisied. In addition, Merge images and aerial photographs have been used for this stage.

4- The supervised classification method has been applied to the Landsat images in order to determined the land use. In addition, temporal variations and accuracy assesments have been examined.

2.2. Material

The monitoring of changes of the Earth's surface through the use of images recorded on several different dates (multitemporal analysis) has been important for studies of landuse characteristics. (Durury 1987; Ormeci 1994).

The images and the necessary material used in this study are tabulated in Table 2.

Table : 2 Image and Map Data Used in Analysis

Source	Date	Resolution /Scale
SPOT-P	13.06.1993	10mx10m
Landsat 5 TM	06.09.1992	30mx30m
Color Aerial Photographs	April 1993	1/2500
Standard Topographic Maps.	1976	1/25000

The study reported here has been carried out by using the ERDAS V.7.5 in the laboratory of the Remote Sensing Division at the Istanbul Technical University.

2.3. Methodology

2.3.1. Preprocessing

The procedure to rectify the image data sets to the universal Transverse Mercator (UTM) coordinate system involved the following steps. ① Determination of Ground Control Points (GCPs) from 1/25000 scaled standard Topographic Maps and from the digital image data. ② Computation of least-square solution for a first order polynomial equation required to register the image data sets to the UTM coordinate system ③ Resampling of the data sets using nearest neighbor algoritm.(Ehlers, 1990). The explanatory information related with the geometric correction in this research illustrated in Table 3.

Table 3: Geometric Correction Information

Sattelite Images	Selected GCP	Used GCP	X RMS (m)	Y RMS (m)	Total RMS (m)
LANDSAT TM	45	9	8.73	11.19	14.19

2.3.2. Data Merging

Landsat TM image data and SPOT P image data can be merged to effectively create enhanced multispectral images of high resolution. The resulting multiresolution images retained the spatial resolution of the 10m. SPOT Pancromatic referance of the Landsat multispectral data. Merge images can be shown in Figure 4. The enhanced detail, available from merged images has been found to be particularly important for visual Landuse interpretation.

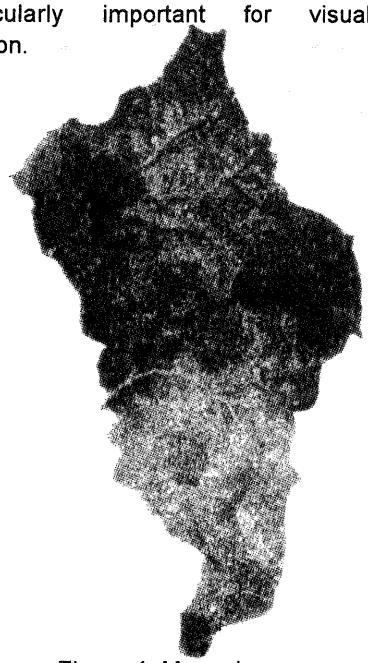

Figure 4: Merge images

The aerial photographs covering the area have been obtained from the Istanbul Water Board Authorities (ISKI). The aerial photographs of the TEM motorway area located in the very near protected land are shown in Fig.5.

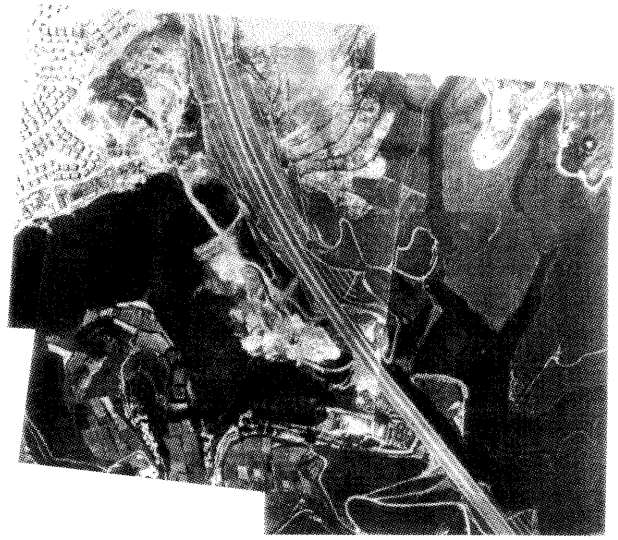

Figure 5: Aerial photographs

2.3.3. Classification

In the classification procedure involved classifying the Landsat TM data sets using the convential supervised maximum likelihood classification algoritm. This study has been carried out with the seven classes level. These are water, forest, green area, bare soil, industry, road and urban. The training areas have been selected on the base of the information obtained from the field surveys, merge images, aerial photographs and existing maps and plans. For the signature evaluation, the mean and the standard deviation of every signature are used to represent the histogram in each Landsat Band of each potential class. By analyzing the ellipse graphs for all band pairs and then Landsat TM (3. and 4. Bands) selected for provide accurate classification results. The classified images are illustrated in Figure 6. The statistical results of the classified images for urban, roads, industry, forest, green area are classes according to the protected areas are tabulated in Table 4. Table 5 gives the multitemporal land use statistics of the Elmalı Water Basin and their percentages.

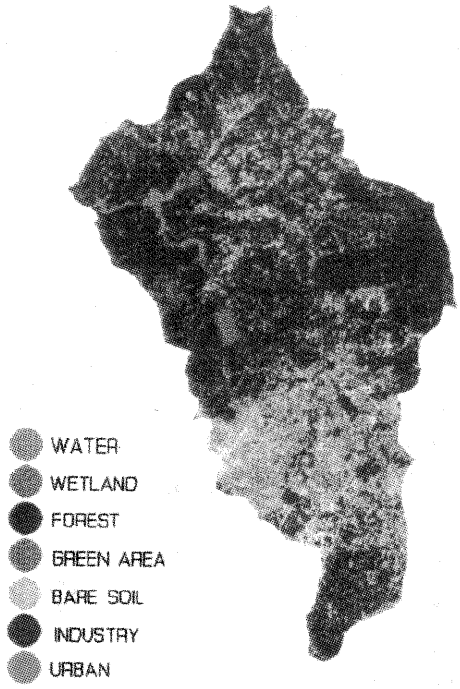

Figure 6a: Classified images (1984)

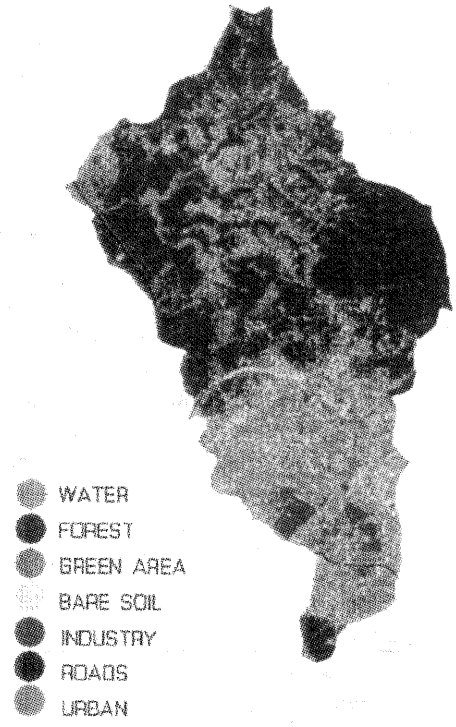

Figure 6b: Classified images (1992)

Table 4: Temporal Statistics of Protected Areas

Class Tips	Very Near Protected Areas		Near Protected Areas		Medium Protected Areas		Far Distance Protected Areas	
	1984	1992	1984	1992	1984	1992	1984	1992
Urban	8.10	14.49	33.48	73.08	41.58	86.31	358.83	1090.26
Roads	-	6.21	-	17.37	0.09	4.14	5.13	15.75
Industry	-	0.54	0.45	0.45	1.26	1.80	36.45	148.50
Forest	387.72	356.22	672.30	548.55	685.71	581.76	2697.57	2018.70
Green Area	79.74	95.76	197.64	262.53	228.6	293.58	876.42	958.77

Table 5: Results of the classified images

Class Tips	1984		1992	
	ha	%	ha	%
Water	67.32	0.82	63.81	0.77
Wetland	64.62	0.79	-	-
Forest	4455.81	54.10	3520.53	42.74
Green Area	1392.39	16.90	1636.65	19.87
Base Soil	1729.71	21.00	1556.28	18.89
Roads	5.22	0.06	43.74	0.53
Industry	38.25	0.46	151.29	1.84
Urban	441.90	5.36	1264.68	15.36
Building in Processess	41.76	0.51	-	-
Total	8236.98		8236.98	

In Remote Sensing Classifications, accuracy refers to the between the class label assigned to a pixel and the "true" class. The true class can be observed in the field directly or indirectly; for example, from a reference map or merge images (Janssen,1994). In this study classification accuracy has been assigned by selecting 500 pixels randamly for both images. As a result the total accuracy has been calculated from the error matrix. The accuracy of the 1984 classified Landsat images is 90% and it is 92% for the 1992 images.

CONCLUSION

This study provides a current investigation in the monitoring of water basin area using multitemporal images. It has always been a big problem to derive land use information using spectral data.

The classification results obtained in this study have shown that high resolution Landsat images can be effectively used for the study of land use-cover. In addition, it has also pointed out a large scale urbanisation from 1984 to 1992 in the Elmalı Water Basin.

Therefore, water basin areas in Istanbul should have the first priority for the environmental protection. Current status analyses and updating of these should be carried out by using remote sensing data.

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