

REMOTE SENSING APPLICATION IN A SPECIALLY PROTECTED AREA (SMALL PARADISE) IN TURKEY

Derya Maktav, Filiz Sunar, Sedat Kapdaşlı, Nebiye Musaoğlu

I.T.U. Civil Engineering Faculty, Remote Sensing Dept., Maslak 80626 Istanbul, TURKEY

Commission VII, Working Group 5

KEY WORDS : Remote Sensing, Hydrology, Landsat, Classification, Change-Detection.

ABSTRACT

Dalyan Delta, the Iztuzu Beach and the Köyceğiz Lagoon are declared as Specially Protected Area in Turkey. In order to protect these areas, regular monitoring is required on a yearly, monthly, weekly and even daily basis. In addition, the results from monitoring must be evaluated in order to determine the requirements for preservation. Satellite remote sensing with its synoptic view capabilities is a very useful tool for this purpose. In this study, multitemporal Landsat TM data were used to investigate the stability of the Iztuzu Beach, the changes of the Dalyan Mouth and the seasonal changes of some swamp areas in the Köyceğiz Lagoon.

1. Introduction

The rapid growth of urbanization, population, tourism, industrialization and the unplanned and unconscious use of earth resources are major sources of environmental pollution. The damaging effects of environmental pollution to human health necessitates the conservation of natural areas in some selected regions of the earth. Therefore, in many countries, some flora and fauna are protected by laws and regulations to ensure that these precious natural resources which support human health and maintain the ecological balance are preserved for future generations. For example, in Turkey there are more than 10 protected areas. There are an additional 637 suggested protection areas in the country.

The study aims to monitor the stability of the Iztuzu Beach and also some coastal areas covered by swamps and reeds in the Köyceğiz Lagoon, both being parts of one of the Specially Protected Areas in Turkey. It is based on the results of field measurements related to the water quality and GPS measurements done in this area and on the Landsat Thematic Mapper images acquired at different dates.

2. Study area

Köyceğiz Lake is a lagoon of tectonic origin extending in a N-S direction south of the Köyceğiz Town. It is located on the southwestern coast of Turkey and discharges into the Aegean Sea through an approximately 10 km long shallow meandering Dalyan Channel. At the sea coast it changes into a delta which has a high water storage capacity with numerous narrow channels bordered by reeds. Two other small lakes, Sülüngür and Iztuzu are also located here (Özhan, 1988, TÇV, 1993, Maktav *et al* 1994, Maktav *et al*, 1996). The inlet throat which is partly protected against the southwesterly waves by the Delikada Island located approximately 600 m offshore, is situated at the western end of a barrier beach called Iztuzu. This

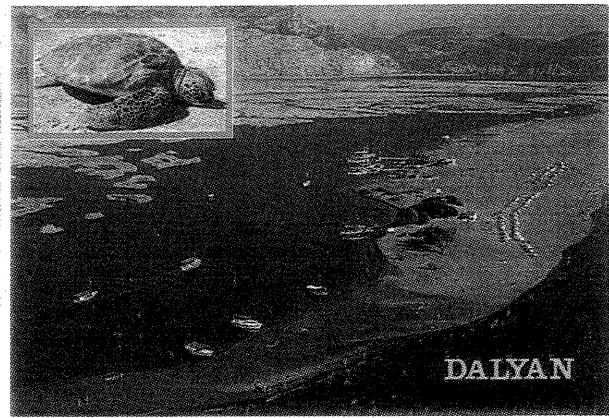
equilibrium beach of medium sized sand extends for approximately 5 km, bordered by headlands at both ends. About 3 km of the beach is tongue-shaped with water on both sides, where the beach width changes seasonally from 100 m to 250 m. At the northwest side of the inlet throat, there is a narrow beach at the foot of steep rocky hills (Figure 1)(Özhan, 1988).

Owing to the concern about excessive construction and the effects of tourism on the Dalyan Delta, especially at the point where the marine turtles (*Caretta caretta*) lay their eggs (Figure 1, b), the region (including the lagoon, the channel and the delta) was declared a Specially Protected Area on 1988 (TÇV, 1993).

3. Data and the field measurements

Landsat 5 Thematic Mapper image data of the study area in seven wavebands at a 30-m spatial resolution (thermal : 120 m) on 8 August 1984, on 19 August 1988, on 27 July 1991 and on 11 November 1995 were used in addition to an earlier mosaic of aerial photographs and topographic maps at a scale of 1: 25,000.

The coordinates of the selected stations where sea-truth measurements were made in the lagoon were measured by a single channel Raystar 390 GPS Receiver for navigators with the memory capacity to store 300 waypoints. Microprocessor Oxygen-meter OXI 196 was used for oxygen measurements. Salinity and temperature measurements were made by Microprocessor Conductivity Meter LF 196. Depth measurements were accomplished with the FMV-603 Video Sounder which determines the distance between its transducer and underwater objects and displays the results on a screen. For turbidity measurement the Secchi Disk was used.



(a) (b)
Figure 1. Study area. (a) Map. (b) Ground photograph.

4. Methodology

The nature of the Dalyan Wetland is dominated by the barrier beach Iztuzu located between the Aegean Sea and the Dalyan Wetland. This beach consists of quite homogenous fine sand, and the nearshore characteristics of the sea bottom in front of this beach are highly complex. The sea bottom slope is relatively mild (approximately %1) and the bathymetry is unstable due to the different wave conditions. The significant wave direction is SSW which is obstructed by the headlands located at the west side of the bay. Because of the mild bottom slope, the incident waves break quite far from the beach. Therefore, the surfzone is relatively wide in this coast. In the surfzone, particularly near the wetland mouth, some offshore bar formations can be seen.

The wetland front of the sandy barrier beach is affected by freshwater flow from the Köyceğiz Lagoon. During the dry season, water levels at both sides of the beach are almost equal whereas the water level in the wetland is higher during the wet season which causes a considerable amount of fresh water discharge from wetland to the sea. Therefore, particularly in wet seasons, the beach stability is sometimes in a rather critical stage. This means, that the beach is under pressure of the freshwater from the wetland side, and is under effects of the strong waves from the sea side. Because the freshwater level is higher than that of the sea, there must be a groundwater flow beneath or through the beach causing some parts of the beach getting wet so that the sand will be more movable in comparison to dry conditions. In addition, the significant waves generated by strong storm can arrive at higher points on the beach even sometimes overtopping occurs. As a result of all these, the beach became narrow. However, there are two safety points which control the conditions above mentioned. The first is the wetland which became wider due to the higher discharge capacity (erosion of the mouth) and the second are the wetlands and the small lakes adjacent to the beach. These areas act as a flood defense system which observes the freshwater and balances the increase of the freshwater level in the wetlands.

The eastern part of the Iztuzu Beach was monitored by using satellite images. For this aim, four different dated Landsat TM images were used (August 1984, August 1988, July 1991 and November 1995). This part of the barrier beach is mostly under effect of comparatively strong wave actions during the significant waves generation. Therefore, the sea water can climb over the beach almost up to the beach crest. This means that the sand on this part of the beach is mostly wet which can be seen in all of the four masked satellite images (Figure 2, a). Areal extent of the total sandy beach area also changes seasonally between max. 45 ha and min. 33 ha. (Figure 3).

The mouth, located at one end of the barrier beach, is also a morphologically dynamic part of the beach acting as a discharge and water level regulator system. The change of the mouth from 1984 to 1995 can also be monitored in the four masked satellite images in Fig. 2. Here, in dry seasons (July and August), the mouth is narrower due to the sand accumulation. In the wet season (November), however, enlargement of the mouth due to the sand erosion caused by seaward freshwater flow can also be seen (Figure 2, 1995b).

The seasonal changes of the swamp areas at some coasts of the Köyceğiz Lagoon using multitemporal Landsat TM data were also investigated. Change detection method involves the use of multirate data sets to discriminate areas of land/water cover changes between dates of imaging. Data from the Landsat Thematic Mapper with its synoptic and regular coverage offers potential for detection and inventory of changes that occur in the environment. A change in reflectance often indicates a physical change on the ground. The changes in reflectance of an area registered in different times provide a key information on land/use cover changes. Considering the swamp areas in the Köyceğiz Lagoon, as a first step, all image data set were registered geometrically to each other and treated as a single 28 (4 x 7) dimension data. A photographic comparison of a single band of data from the two (or more) dates, a simplest change detection procedure was produced. The colors (the gray tones) of each pixel in the resulting image indicate the changes in reflectance values between these different times (Virag, 1987). The success of this method mostly

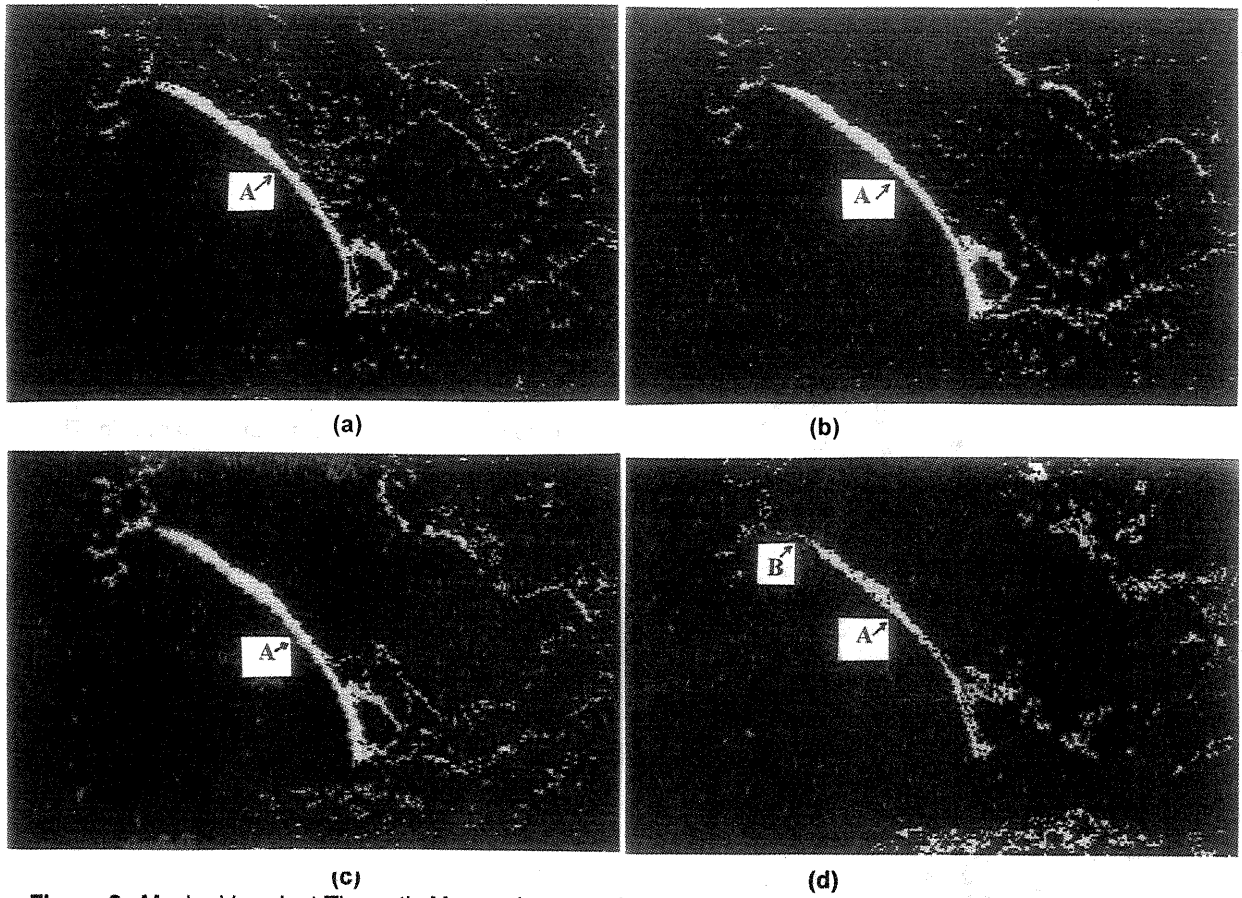


Figure 2. Masked Landsat Thematic Mapper images of the beach (a-1984, b-1988, c-1991 and d-1995).

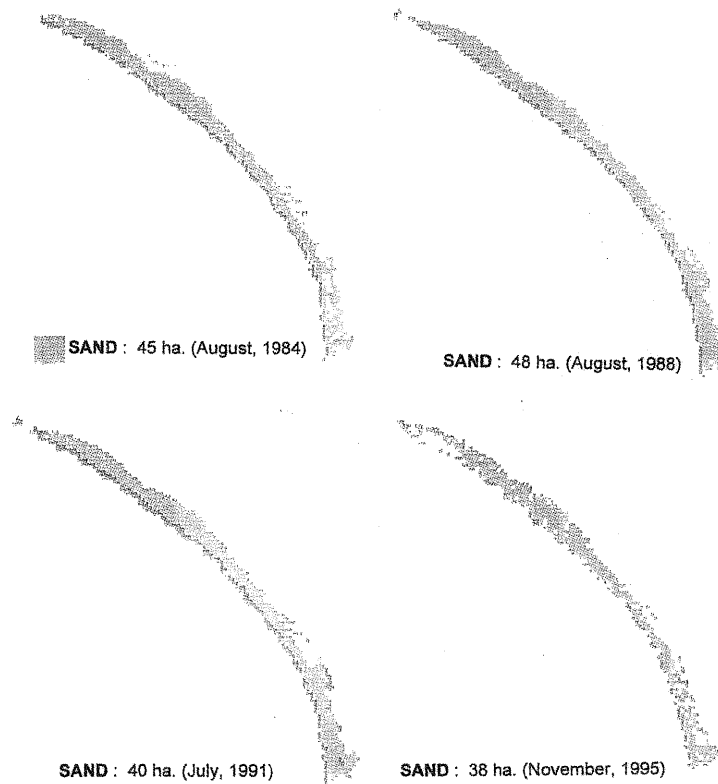


Figure 3. Areal changes of the barrier beach Iztuzu (in hectares).

depends on dissimilar responses of the change end points. In this study, the single band change image was prepared by color coding TM band 5 data from the 1995 as red, from 1984 as green and from 1991 as blue. From Figure 4, the temporal changes in swamp areas (A and B) of the lake coast can easily be seen and delineated. This change can be interpreted as a seasonal change since it occurred only in November 1995 data.

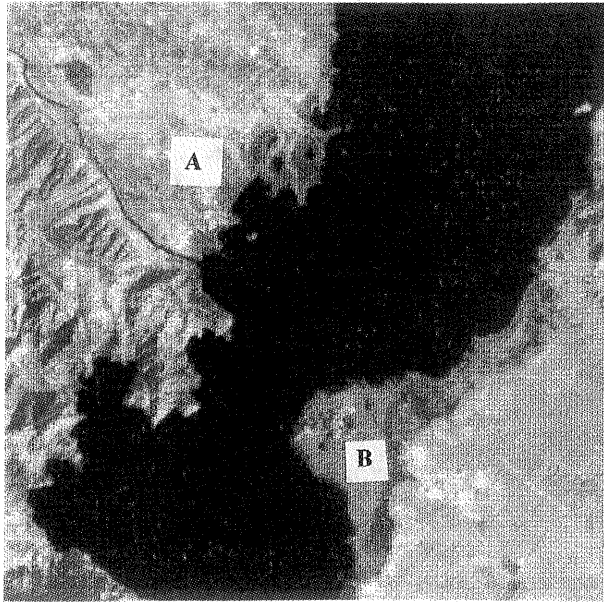


Figure 4. 1984-1995-1991 false color composite of the study area (Band 5).

5. Conclusion

The conclusion is that the stability of a beach like Iztuzu strongly depends on the hydrologic and hydraulic conditions of the land side and on the wave climate and morphology of the nearshore zone of the sea side. The stability of the beach can be on a critical stage during some seasons of the year. For this reason, any artificial change of the effective parameters mentioned above can cause unexpected and extremely reverse results which can destroy the natural system. For this reason, it should be avoided any man-made activities such as constructing coastal structures (seawall, grains, etc.) or moving the sea bottom sand for any use.

REFERENCES

Özhan, E., "Flow Regimes and Dynamic Equilibrium of Morphological Changes at Köyceğiz Lake Inlet", Turkey, Coastal Engineering, 12, Elsevier Science Publishers B.V. 1988.

Maktav, D., Sunar, F., Kapdaşlı, S., and Musaoğlu, N., "Use of Remote Sensing for Monitoring the Lagoon Köyceğiz and Its Environment", AGARD meeting on Remote Sensing : A Valuable Source of Information, 22-25 April, Toulouse, 1996.

Maktav, D., Kapdaşlı, S., "An Engineering of Landsat Data to Wetland Investigations in Turkey, 10th. Thematic Conference on Geologic Remote Sensing, San Antonio, Texas, USA, 1994b, pp. 515-520.

TÇV, Turkish Environmental Foundation, Wetlands of Turkey, Önder Publication, Turkey, 1993.

Virag, L.A. and J. E. Colwell, " An Improved Procedure for Analysis of Change in Thematic Mapper Image Pairs", Twenty-First International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan, October, pp. 26-30, 1987.