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Coastline Changes and Inadequate Management Between Kilyos and Karaburun Shoreline

Kilyos-Karaburun Arasındaki Kıyı Çizgisinin Değişimi ve KıyınınKötü Kullanımı

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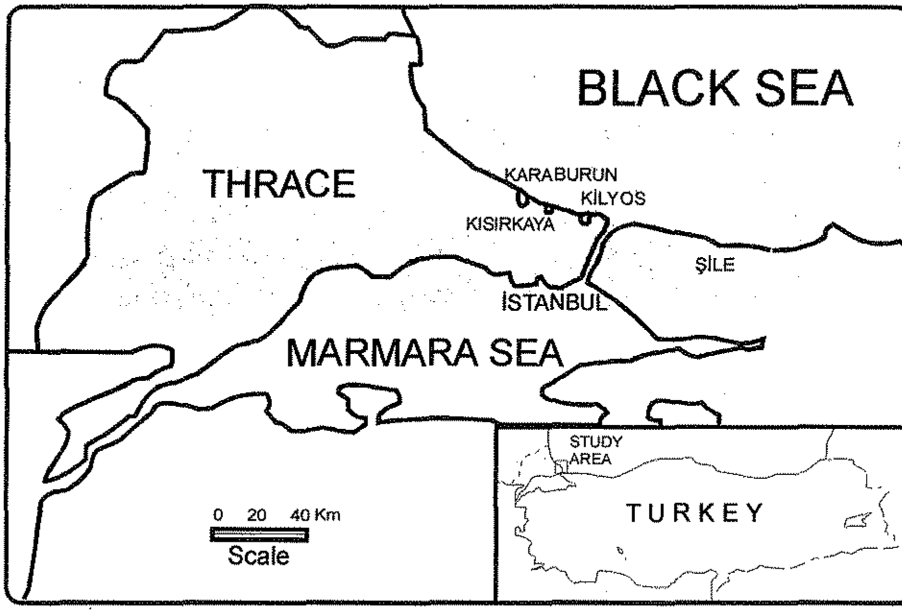
Abstract

The shoreline between Karaburun and Kilyos is fairly flat and mostly lined by beaches. The fact that sea water is shallow and the Belgrade Forest situated just behind the shoreline increases the touristic value of the area. However, coal, sand and clay are being produced at various quarries just behind the shoreline. As a result of open-surface excavations and mining, the accumulation of removed material has caused deterioration of the natural shoreline. During recent years depletion of coal reserves on land has caused mining activities to shift towards the shoreline. In this study based on the changes of the shoreline, the amount of area filled up with excavated material has been calculated by using remote sensing methods.

Keywords: coastal management, coastal usage, remote sensing, mining, İstanbul

Introduction

The study area is placed between Kilyos and Karaburun at the Black Sea coasts of the Trace Peninsula and approximately at the NW of the Strait of İstanbul (Figure 1). The coast line between Kilyos and Karaburun is 34 km. Even though the study area is rather close to the city centre and has natural beauties, it has recently lost its recreational and touristic characteristics due to the inadequate coastal management. The aim of this study is to expose the changes and destruction of



the coast line caused by the open-surface mining of coal, sand and clay. The planning and improvement of these mishandled areas for different demands is only possible by exposing the geologic, geomorphologic and geophysical characteristics of the area in detail.

Study Area

The Neogene formations take place along the coastline between Kilyos and Karaburun (Yalçınlar, 1976; Ketin, 1983). However, some Eocene formations approaches to seacoast at Karaburun and its environs (Oktay *et al.*, 1992). The Quaternary formations are mostly formed by beach sands, sand dunes and fluvial alluvium. Underneath these formations, Neogene deposits (white, yellow, green and grey clay) are situated around the elevations close to the present sea level. Quaternary sand dunes and sand deposits have overlaid all the coastal area and these are partially carried into the river valleys under the effect of northerly winds. Closely related to the subject, there are lignite series whose thickness varies between one and ten metres that are intercalated with conglomerate, sandstone and clay located at the upper layers of Neogene clay at some localities (Akpınar and Ağaçlı) between Kısırkaya and Karaburun.

The coastline between Kilyos and Karaburun is interrupted by short and small streams. Most of the steams on the Çatalca (İstanbul) peneplane have their source in the hills covered by the Belgrat Forest, however, the fact that these hills are so close to the Black Sea means that those flowing northwards are short, while those flowing southwards are longer with a lower gradient. The streams flowing into the Black Sea between Kilyos and Karaburun have their source in hills at an altitude of 200 metres inside the Belgrat Forest. Since the valleys of these streams are embedded in soft Neogene deposits, they generally have gentle sloped banks. Consequently, there are small coastal plains formed by sand and alluvium at the river mouths depending on the length of the fluvial system.

The beach area runs in front of the valleys and coastal plains. When examined shoreline from east to west, the coast is flat from the western part of the cliff on which the settlement of Kilyos stands up to Kısırkaya. Here a beach covered with sand dunes extends fifty metres inland. The area between Kısırkaya and Karaburun has been cut by small streams more intensively. The valleys of the streams are deeper in that area because the cliffs become much more close to the Black Sea towards west. The area between Kısırkaya and Karaburun meanwhile has smaller coastal plains, behind which are cliffs. The nummulitic limestone forms fifty metre high cliffs particularly at Karaburun along the shore to the west. The short and narrow beaches along the shore between Kısırkaya and Karaburun lie at the edges of the stream mouths. There are islets, and rock debris at the foot of the cliffs as a result of the storm waves formed by strong northerly winds from the Black Sea. On the whole the sea is shallow off the beaches between Kilyos and Karaburun, with a gentle bathymetric slope.

Problems Created by Unplanned Coastline Usage in the Region

Mining has been continuing sporadically just behind the shore between Kilyos and Karaburun since the late nineteenth century. The introduction of excavating machinery on a large scale in recent times has resulted in intensive open lignite mining at many places on the coast here. However, the southern limit for mining corresponds to the southern boundary of the geological formations containing coal deposits. Mining is therefore expanding northwards by means of land reclamation, taking advantage of the region's bathymetry. The most significant cause of coastal deterioration is the fact that the lignite deposits continue underwater at a very shallow gradient.

As well as coal mining, industrial quality sand and clay deposits are exploited. All these mining activities cover an area of approximately 30,000 hectares. Soil and other material excavated from covering layers is heaped on the shore, disfiguring it for any other purpose. Since 1988 coal reserves on land have become depleted. So the companies, considering that the target layers are dipping towards the sea with gentle slopes, have begun to mine the areas of sea reclaimed by means of dikes constructed on the shore from excavated material. This has been made possible by the fact that the sea is extremely shallow in the area. A few mines continue to function on land, and these have expanded their activities into the forest behind, stripping away the soil to reveal the covering layer which is used to fill the sea. Damage caused to the shore by all kinds of mining activities have been evaluated as a whole (Figure 2). As it is seen, the coastline has been drastically altered from its original state.

Advantages of Remote Sensing Technology in Coastal Usage

Remote sensing enables the characteristics of objects to be identified and measured from a distance, by means of analysing electromagnetic energy emitted by an object without any physical connection (Örmeci, 1987). Remote sensing now permits hydrologic data to be collected on a spatial basis, thus overcoming the limitations of the traditional in-situ measurements. For this purpose artificial satellites which sense the electromagnetic spectrum on different wave lengths are used. Data obtained via these satellites belonging to various countries are converted into visual and digital images by image processing systems. Using image enhancement and classification techniques, these images can reveal the scale of environmental problems over wide areas. Furthermore satellite data can be used to plot the temporal (step by step) process of environmental damage in the past. This makes it possible to calculate the scale of change and its impact.

In this study, data collected by the ERTS (Earth Resources Technology Satellites) was used initially, followed by data from the Landsat (Land Satellite) for 1986 and 1994. Of the five satellites put into orbit the first three are now disabled. Data used in this study was provided by the fifth satellite of this system. The Landsat-5 satellite carries out each sensing within a frame of 185 x 185 km from a height of 705 km and it passes over the same point every 16 days. This satellite has a scanner system known as the Thematic Mapper (TM), which can sense the visible, reflective infrared, medium infrared and thermal wave bands of the electromagnetic spectrum. Apart from the band which senses thermal wave length, the resolution of the other bands is approximately 30 x 30 m. Resolution of the thermal band is 120 x 120 m. By using band six it is possible to produce a thermal map of areas of varying temperature. (Jenson, 1986; Lillesnad and Kiefer, 1987).

In addition to satellite data the study has made use of the Digital Terrain Model (DTM) data for İstanbul, formed by digitisation from 1/25,000 scale maps of İstanbul and its environs. By using the appropriate transformation matrices, DTM data was converted into a format needed by the Erdas Imagine 8.2 programme (Erdas Imagine Field Guide, 1995).

Satellite data was rectified to allow measurements to be taken. Data provided by the Istanbul's DTM were evaluated in conjunction with the satellite data. So that the former and new shorelines could be shown in comparative form. The data from the DTM was delineated by means of contour lines and the resulting image is given in Figure 3. The natural appearance of the same area is shown in Figure 4. The lake which appears in the centre of the natural image shows an area where the sea is being reclaimed by land filling. The water trapped behind the dikes is pumped out, after which excavating machinery is lowered into the depression to commence mining.

An amount of approximately 100 million cubic metres of soil is moved as a result of mining activity every year (Kural, 1992). Most of this is used to construct dikes in the process of land reclamation. Changes which have taken place on the coast over time have been calculated using the Erdas Imagine 8.2 programme. The study commenced by identifying the areas of change in the region lying between 41°17'01"-40°52'47"N and 28°52'37"-29°13'11"E. The dimension of the altered areas was established by direct observation and measurement along the coast between Kilyos and Karaburun. The destruction of forest above the mineral layers was found to be another severe environment problem. When these areas of change were examined one by one, it was found that 160±10 hectares of sea had been filled in, and 590±10 hectares of forest destroyed. The data collected shows that approximately 44 million tons of coal have been extracted in the region between Kilyos and Karaburun as a result of excavation so far. Total reserves in the region are estimated at between 60 and 80 million tons.

The new image map of the study area (Figure 5), which was sensed by the IRS-1C satellite in 1996, was interpreted by Gesellschaft für Angewandte Fernerkundung mbH (Akgöz, 1997). Compared to our 1994 data (Figure 2), this new image shows an important increase in the excavated material and destroyed forests. It shows a new commercial harbour, one of the biggest ports in Turkey, as well. When carried out, it will be connected to the city centre by a highway.

All these adverse developments on land have affected the Black Sea, revealing the need to study water quality. In this context a study was carried out to measure the distribution of Chl-a concentration, one of the fundamental parameters in determining water quality, and a factor which can be measured by remote sensing technology. When the bands 2 and 1 of Landsat 5(TM) satellite are classified together thereupon the distribution of Chl-a concentration can be obtained (Muraklikrishna 1983; Gazioğlu, 1996). Figure 6 illustrates the result of this classification. It was found that Chl-a concentration was far higher between Kilyos and Karaburun, where there was a high level of mining activity, than in other parts of the sea in the same region. The reason for this is the nutrient salts in the soil which is dumped into the sea during land reclamation. These nutrient salts become part of the marine cycle and have a biological effect on the extant nutrient cycle. Excessive phytoplankton propagation has the effect of turbidity. When the phytoplankton die they precipitate to the bottom, in the process using dissolved oxygen in the environment.

When bands 4, 3 and 2 of the Landsat satellite are classified together using remote sensing technology, we can obtain the distribution of turbidity for areas under water (Pluhowski, 1973; Lillesnad, 1983; Müftüoğlu, 1995). Figure 7 shows turbidity distribution for the Southwest Black Sea and Marmara Sea. The results of many different remote sensing studies for the same region indicate that turbidity levels for this area are higher than those for neighbouring bodies of water (Doğan, 1996; Gönenç *et al.*, 1996). The principal reason for this is suspended sediment resulting from the process of sea fill. Even though the concentration of suspended sediment becomes less further out to the sea, it reaches the highest level just off areas of mining activity and in their close vicinity. The increase in concentrations of Chl-a and suspended sediment prevents sunlight from penetrating deep waters, thereby adversely affecting plants which rely on photosynthesis. To conclude, the mining activities between Kilyos and Karaburun are causing deterioration in water quality in the area.

Conclusion

The coastline is being altered dramatically by indiscriminate and uncontrolled open-surface mining. Although this study has not examined in detail the changes which have occurred along this coast between 1986 and 1994, its results have enabled us to calculate that 160±10 hectares of coastal water have been filled up with excavated material, and 590±10 hectares of forest have been destroyed. Damage due to intensive mining activity in this region is not only restricted the land but the deterioration also extends towards sea, where many biological, chemical and physical oceanographic structures are being adversely affected. As a result marine fauna and flora are suffering the most, although this is not visible to observers.

It appears impossible to rectify all the damage made to the environment. It is essential that further damage be prevented and remedial action taken as fast as possible. Ensuring that this work is based on reliable data depends on determining the general characteristics of the region, identifying areas where improvement is required, long term planning of investments, and the combined use of remote sensing technologies and oceanographic studies. In this way it will be possible to determine the extent to which land and marine life is being affected. This will facilitate the implementation of decisions relating both to the areas earmarked for improvement and their environs.

Özet

Karaburun'dan Kilyos'a kadar olan kıyı şeridi nispeten düzgün olup, büyük bir kısmı plaj karakterindedir. Denizin sığ olması ve kıyının hemen gerisinde Belgrat Ormanları'nın yer alması bölgenin turizm açısından değerini artırmaktadır. Ancak, kıyı kesiminin hemen gerisinde kömür, kum ve kil üretimi yapılmaktadır. Açık işletmeler şeklinde yapılan üretim sonucu ortaya çıkan örtü tabakaları ve toprak, kıyıya yığılarak doğal kıyı çizgisi bozulmuştur. Son yıllarda karada kömür rezervinin azalması, üretimi denize doğru kaydırmıştır. Bu çalışmada kıyı çizgisinin değişim aşamaları ele alınarak, denizin ne kadar doldurulduğu uzaktan algılama yöntemleri ile hesaplanmıştır.

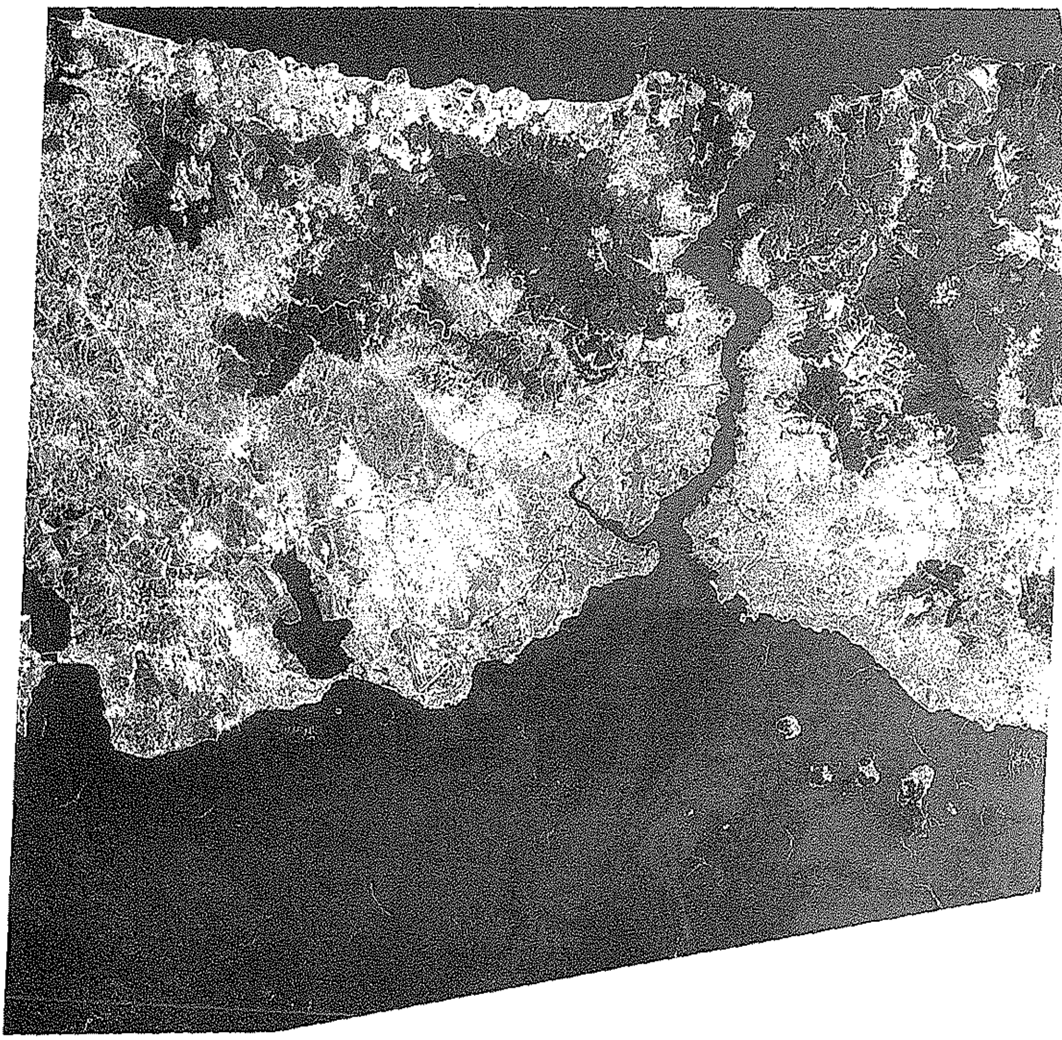


Figure 2. Image of Istanbul and its environs (after merging of Landsat of Spot data)

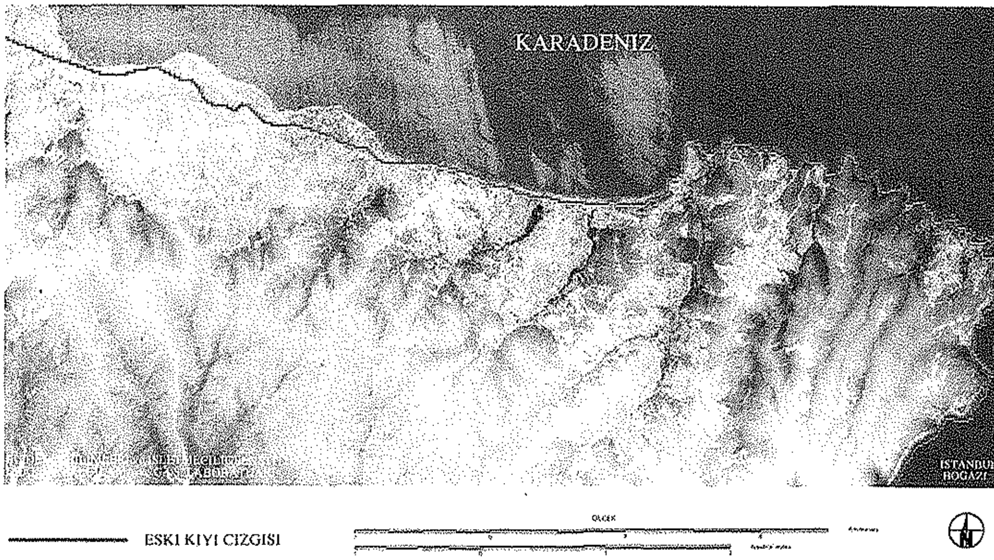


Figure 3. Merged view obtained from the Landsat data and Digital Terrain Model of the west of Kilyos.

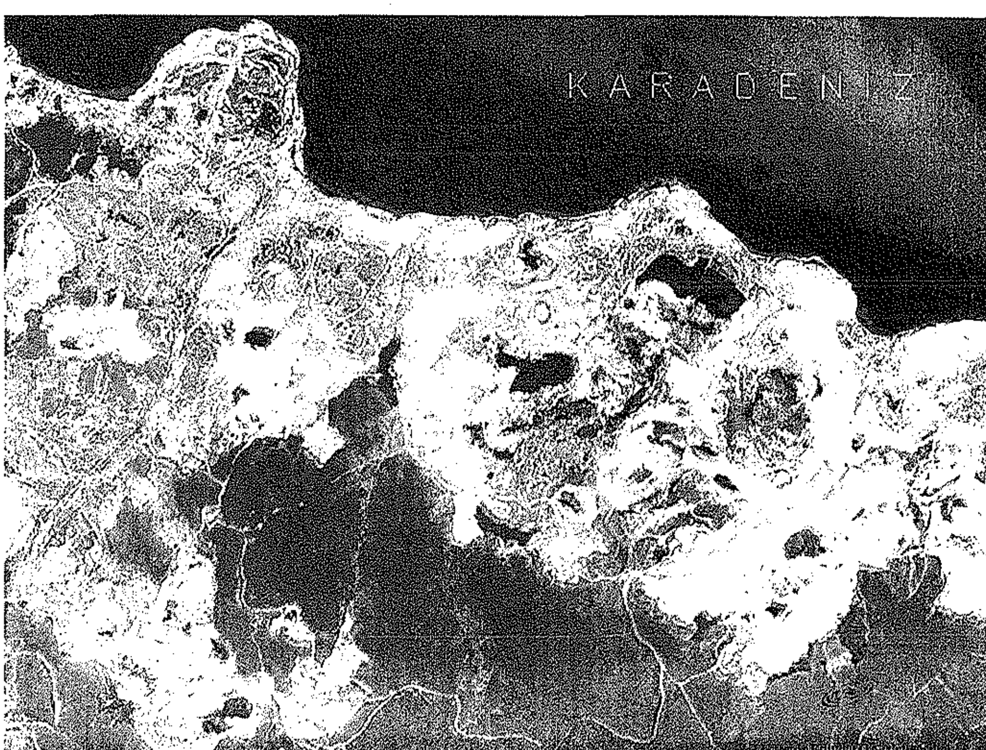


Figure 4. The natural image (1992) of the west of Kilyos from Landsat data.

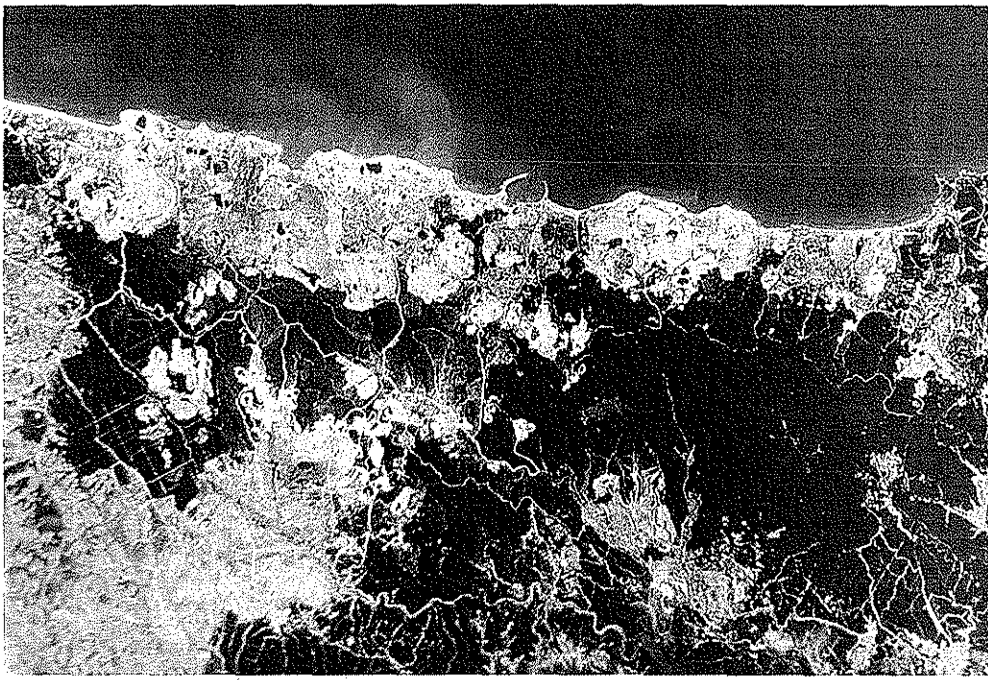


Figure 5. Image (1996) of Kilyos - Karaburun (Akgöz, 1997)

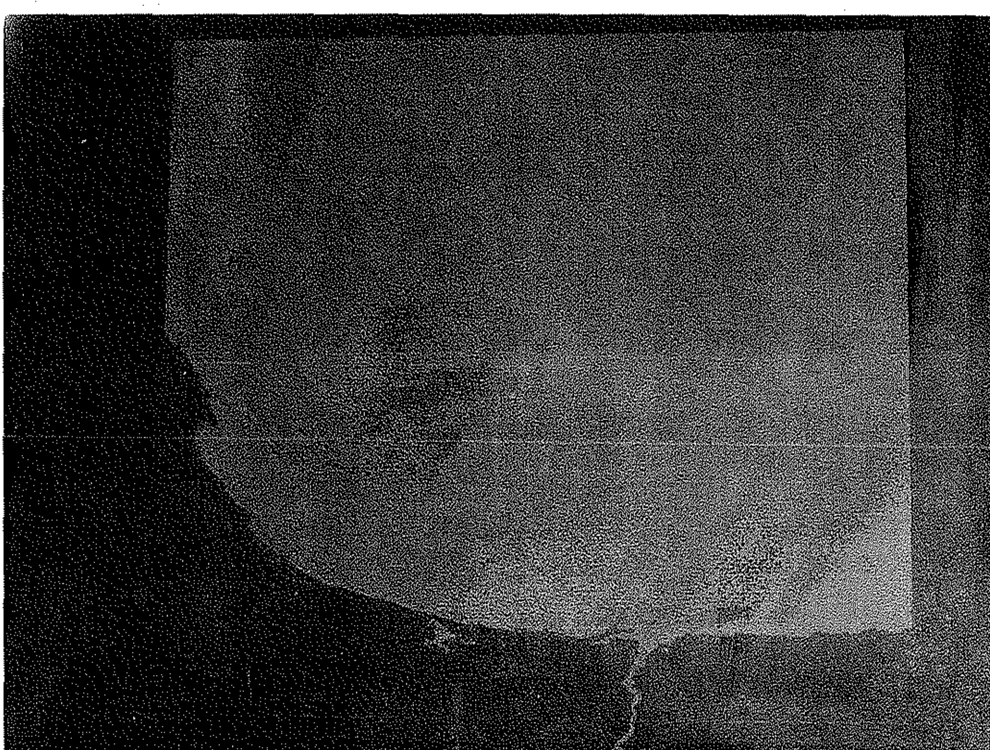


Figure 6. The distribution of Chl-a concentration (1992) at Southwest Black Sea.

Figure 7. The turbidity distribution (1992) at Southwest Black Sea and Marmara Sea.

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