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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Arts.

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This is to certify that I have read this thesis and that in my opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Arts.

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ABSTRACT

Sümeyra KURT **August 2009**

COASTLINE CHANGES AND THEIR IMPLICATIONS FOR LAND USE IN COASTAL REGION OF İSTANBUL BETWEEN 1987 AND 2007

Having a very long human history, dating back to almost six thousand years ago, İstanbul has experienced enormous changes in its natural environment, especially after the second half of the 20th century. Rapid increase in population most of which is due to immigration, has caused an unplanned urban growth in many parts of the city with accompanied problems such as environmental degradation, pollution, traffic congestion, etc. Because the city mainly expanded along the coasts surrounding three parts of each peninsula in Asian and European side of İstanbul, the coastal regions were the most affected areas from the rapid urban and population growth. In this study, the changes in the coastline and land use were detected from 1987 to 2007 in coastal regions of İstanbul expanding from coast to one thousand meters inland.

Geographic Information Systems (GIS) and Remote Sensing (RS) techniques were used in the study. Two Landsat images acquired in 1987 and 2007 with 30m resolution were used by using Erdas Imagine. After the classification of the images, accuracy analysis was conducted by using the reference data obtained by hand. Classification results were then edited and converted to vector form by using ArcGIS. Vector data was then used to produce the coastline of İstanbul for 1987 and 2007. The changes in the coastline in a 20-years period were detected by using these two coastlines in İstanbul. In the following steps, a thousand meter zone of study area was drawn from the coastline to the inner lands using buffer and clip methods. The same technique was used to produce two different coastal regions for 1987 and 2007. Land use changes were detected in these two coastal regions from 1987 and 2007 by classifying the area into six land use classes.

These are urban areas, agricultural areas, forest, bare soil, brush/grassland and lake/pond.

The study provided an understanding of the changes in coastline and land use in coastal regions of İstanbul between 1987 and 2007. As the study revealed, the coastline of İstanbul has extended 33 km from 459 km in 1987 to 492 km in 2007 due mainly to the changes made along the coast. One of the most striking results of the study was about the filling areas along the coast. A total of 1223 hectares area which makes 3% of the study area was filled along the coastline in İstanbul within a 20-years period in order to gain land for different activities such as providing more land for outdoor recreational activities, transportation and building facilities such as quay and ports. Most of the changes in coastline was detected along the Sea of Marmara then Black Sea. As it was determined, 700 hectares area was filled along the coastline of Marmara Sea while the same figure was 502 hectares along the coastline of Black Sea. While the coastline moved towards sea in many parts of İstanbul, it has changed backward in local areas mainly along the Black Sea and in Haliç region. A total of 52 hectares of coastal areas were eroded due to different reasons such as removing sand or soil from the coast. As the study revealed, the changes in coastline along the Bosporus did not have significant changes.

The study provided an in-depth analysis of the land use changes in the study area between 1987 and 2007. As the results clearly revealed, agricultural and forest areas decreased while urban areas expanded within the 20-years time period. Urban areas have increased 29% most of which was observed along the Marmara Sea and Bosporus. Agricultural areas experienced a 35% decline while forest areas decreased 37% in the same time period. The study also displayed that almost half of the coastal areas (46%) were urban in İstanbul in 2007. The second important land cover class in the study area is grassland with 21%. Being located mainly along the Black Sea and Bosporus, forest areas covered only 12% in the study area. Agricultural areas occupied only 3% while bare soil made up 17% of the study area in 2007.

As the overall study revealed, rapid population and urban growth have caused significant changes in the coastline and land use in coastal regions in İstanbul. As population continues to grow, the coastal regions of İstanbul is most likely to continue experiencing more pressure from urbanization. Therefore, a sustainable coastal management plan should be prepared and put in action in order to preserve the coastal regions of İstanbul for the benefit of society. Since İstanbul was already declared as the cultural capital of Europe for 2010, coastal regions of İstanbul need to have a better outlook reflecting characteristics of modern cities by providing society with opportunities to participate in different recreational activities.

Key words: Coastline Change, Land Use Change, Remote Sensing, Geographic Information Systems (GIS), İstanbul.

KISA ÖZET

Sümeyra KURT **Ağustos 2009**

İSTANBUL'UN KIYI BÖLGELERİNDE 1987 VE 2007 YILLARI ARASINDA MEYDANA GELEN KIYI ÇİZGİSİ DEĞİŞİMLERİ VE BUNLARIN ARAZİ KULLANIMI AÇISINDAN DEĞERLENDİRİLMESİ

Yaklaşık altı bin yıldır insanlık tarihine sahne olan İstanbul, özellikle 20. yüzyılın ikinci yarısından itibaren doğal yapısında muazzam değişiklikler yaşamıştır. Nüfusun özellikle göçe bağlı olarak hızla artması şehrin bir çok bölgesinde plansız kentleşmeye ve beraberinde çevresel bozulmaya, kirliliğe ve trafik problemlerine sebep olmuştur. Şehrin büyük ölçüde Asya ve Avrupa yakalarındaki yarımadalarda bulunan üç bölgede yapılanması nedeniyle hızlı kentleşme ve nüfus artışından en çok etkilenen kıyı bölgeleri olmuştur. Bu çalışmada, 1987 den 2007 yılına kadar İstanbul' un kıyı bölgerinde kıyı çizgisinden başlayarak karaya doğru, zonlama ve kesme yöntemleri kullanılarak 1000 metrelik çalışma alanında meydana gelen değişiklikler saptanmıştır.

Bu araştırmada, Coğrafi Bilgi Sistemleri (CBS) ve Uzaktan Algılama (UA) teknikleri kullanılmıştır. 1987 ve 2007 yılı Lansat TM 30 metre çözünürlüklü uydu görüntüleri Erdas Imagine programı kullanılarak analiz edilmiştir. Görüntüler sınıflandırıldıktan sonra doğruluk analizleri elle toplanan referans veriler kullanılarak yapılmıştır. Sınıflandırılan sonuçlar düzeltilerek ArcGIS programında vektör haline dönüştürülmüştür. Vektör verileri 1987 ve 2007 yılları için ayrı ayrı İstanbul kıyı çizgisinin belirlenmesinde kullanılmıştır. 20 yıl içerisinde kıyı şeridindeki değişimler bu verilerin analiz edilmesi ile saptanmıştır. Devam eden aşamalarda, kıyı çizgisinden başlayarak karaya doğru zonlama ve kesme yöntemleri kullanılarak - 1000 metrelik çalışma alanı çizilmiştir. Aynı teknik 1987 ve 2007 için farklı kıyı bölgeleri belirlenmesinde de kullanılmıştır. Bu iki bölgede de 1987 den 2007'ye kadar arazi kullanımında değişimler saptanmıştır. Arazi kullanımındaki bu değişimler; şehir alanları, tarım alanları, orman, çıplak toprak, fundalık - çimenlik ve göl-gölcük olmak üzere 6 sınıfa ayrılarak incelenmiştir.

Araştırmalar sonucunda 1987-2007 yılları arasında İstanbul kıyı bölgelerinde oluşan kıyı ve arazi kullanımı değişimleri belirlenmiştir. 1987 yılında 459 kilometre olan İstanbul kıyı çizgisinin 2007 yılında 492 kilometreye ulaşarak 33 kilometre arttığı ortaya çıkmıştır. Bu çalışmanın en dikkat çekici sonuçlarından biri kıyı bölgelerindeki dolgu alanlarları oranının tesbiti olmuştur. Çalışma alanın % 3'üne tekabül eden toplamda 1223

hektarlık alanın 20 yıllık zaman içerisinde rekreasyon, ulaşım, iskele, liman vb. çeşitli etkinlikler için arazi kazanmak amacıyla doldurularak, kıyıların doğal görünümünün bozulduğu tespit edilmiştir. Kıyı çizgisindeki değişimin büyük çoğunluğunun Karadeniz kıyılarından çok Marmara kıyılarında olduğu saptanmıştır. Marmara Denizi kıyı şeridi boyunca 700 hektar alan doldurulurken, Karadeniz kıyı şeridinde 502 hektar alanının doldurulduğu belirlenmiştir. İstanbul'un bir çok bölgesinde kıyı şeridi dışarı doğru genişlerken, Karadeniz ve Haliç kıyı şeridinde bu haraketin içeri doğru ilerlediği gözlemlenmiştir. Toplamda 52 hektarlık alanının kıyıdan kum yada toprak alınması gibi değişik nedenlerle aşındığı tespit edilmiştir. Çalışmada, İstanbul Boğazı kıyılarında önemli kıyı değişimlerine rastlanmadığı ortaya çıkmıştır.

Bu çalışma, 1987 ve 2007 yılları arasında çalışma sahasında gözlemlenen arazi kullanımı değişimlerinin kapsamlı bir anlizini sunmaktadır. Sonuçların açıkça ortaya koyduğu üzere, 20 yıl içerisinde tarım ve ormanlık alanlar azalırken yerleşim alanları genişlemiştir. Yerleşim alanlarında çoğunluğu Marmara Denizi ve İstanbul Boğazı'nda olmak üzere %29'luk bir artış olmuştur. Aynı zaman diliminde tarımsal alanlarda %35'lik ormanlık alanlarda ise %37'lik azalma tespit edilmiştir. Çalışma aynı zamanda 2007 yılı verilerine dayanarak kıyı bölgelerinin hemen hemen yarısının (%46) yerleşim yeri olarak kullanıldığını ortaya koymuştur. Çalışma sahasındaki değişimin saptandığı ikinci önemli alan % 21'lik orana sahip fundalık ve çimenlik alanlardır. Daha çok Karadeniz ve İstanbul Boğazı kıyılarında yer alan ormanlık alan ise çalışma sahasının sadece %12' lik kısmını kaplamaktadır. Tarımsal alanlar çalışma sahasında %3'lük bir orana sahipken %17'lik alanın çıplak arazi olarak bırakıldığı gözlemlenmiştir.

Çalışma sonucunda görülmüştür ki, hızlı nüfus artışı ve kentleşme İstanbul'un kıyı bölgelerinde belirgin arazi kullanımı ve kıyı çizgisi değişimlerine sebep olmuştur. Nüfus hızla artmaya devam ettiği müddetçe, İstanbul'un kıyı bölgelerinde yaşanan kentleşme baskısı muhtemelen artarak devam edecektir. Bu nedenle, İstanbul kıyı bölgelerinin korunması ve halkın faydalanması için, devamlılığı sağlanabilir bir kıyı politikasının hazırlanarak yürürlüğe konulması gerekmektedir. İstanbul'un 2010 yılında Avrupa'nın kültür başkenti olacağı düşünüldüğünde, Modern şehircilik anlayışına uygun sürdürülebilir bir kıyı planlamasının yapılması ve kıyılardan faydalanmanın artırılması gerekmektedir.

Anahtar Kelimeler: Kıyı Çizgisi Değişimi, Arazi Kullanımı Değişimi, Uzaktan Algılama, Coğrafi Bilgi Sistemleri (CBS), İstanbul.

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GIS: Geographic Information Systems

RS: Remote Sensing

K: Kappa Statistik

TM: Tematic Map

ERTS: Earth Resources Technology Satellites

GPS: Global Positioning System

DN: Digital Number

SHW: State Hydraulic Works

OECD: Organization for Economic Co-operation and Development

BDZ: Bitlis - Zagros Zone

EAFS: East Anatolian Fault

ED: Eratosthenes Sea Mountain

FY: Florence Rise

SAA: South Aegean Arc

NAFS: North Anatolian Fault

RSR: Red Sea Rift

KY: Cyprus Arc

PST: Pliny-Strabo Trenches

DSFS: Dead Sea Fault

EEA: Environmental Protection Agency

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CHAPTER 1: INTRODUCTION

1.1. Goals and Objectives

Coastlines have become the mostly preferred places to be settled as they included a lot of benefits for human being. Coastlines are not only preferable as a sort of magnet for transportation, trade, industry and tourism activities; but also preferable in terms of esthetics. In the previous ages, to settle nearby the coasts was quite important in terms of ensuring some basic needs, making easy agriculture and easy transportation, and also safety reasons. Thus, Coasts have great importance for the coastal cities to be developed in many cases.

Coastal regions are home to approximately two-thirds of the world population by providing a lot of advantages to their habitants (Köksal, 2000). For this reason coastal regions are crucial in terms of human life. However, what brought some problems in this respect are increasing population depending on the industrial activities, people's desire to mobilize towards the coasts, utilizing the coast for recreational and touristic aims. While fast-growing population and urbanization change the coastal regions, it also caused to change the nature of coastlines by filling and construction activities. The physical interventions in the coastlines also led to destroy their biological, ecological and physiological characteristics. Because of that today it is seen that the changes at the lands of coastal regions are much more than other places.

Although the coasts provide many advantages to establish urban cities, today they are threatened by every kind of pollution resulted from fast-growing population and urbanization. Wastes of sea side cities are being (directly or by semi-refining) dropped off into sea since this is seen as the cheapest way. However, this waste management damages to the sustainability of natural life and utilization from the coastlines.

Sea routes became much more preferred than land routes since they are comparatively easier and cheaper. As the sea trade improves at international level the course of time, it led to development of port cities and their numbers. In this respect, it can be said that many coastal metropolis got developed via having useful seaports. İstanbul is one of these port cities. İstanbul is the only city in the world by being established at the conjunction of the two continents and on the Bosporus watercourse (Yenen et al. 1992). Being originally established at Kadıköy area, İstanbul enlarged through addition of Eminönü at Byzantium period and then through Beyoğlu, Üsküdar, Eyup and Bosporus during the Ottoman period (İBB, 2009). Being a meeting point for the eastern and western civilizations by its geographical location, İstanbul has a great historical and cultural heritage as it was the capital city of three of the biggest empires. It is still one of the most important cities in the world. There is no doubt that having the unique coastlines and the Bosporus, İstanbul is of international importance, too. When it is taken into consideration that the import-export in Turkey as of 95 (Ayat et al. 2007) percent of which is made via sea routes, the meaning of its location can be understood better. Since the Bosporus located at the springboard of the sea routes transportation, İstanbul is of crucial importance in conveying, especially Caucasus, petroleum to the world market. However, the coastlines of İstanbul with 450 kilometers length are under the pressure of the increasing population, industrialization, intense trade and tourism activities (Ayat et al. 2007). İstanbul is the most crowded city in Turkey in terms of growing population. Its population continuously increased in the last 50 years. During the last decade, the population rate is 33 percent (TÜİK 2002). Especially, after 1950 İstanbul became enlarged via fast-urbanization resulted from the industrialization and following in 1970s, and then 1990s reached at today’s form by the internal immigrations. This caused to unplanned and wrong use of the lands, especially around coastal regions.

Another coastal problem for İstanbul is the uncontrolled areas that were artificially filled.

Today, it is quite hard to keep the natural link between the coasts and public because of the wrong implementations. For example, it is really hard to watch the scenic view of the sea throughout a sea side walking, sometimes even in kilometres. Making coast-by buildings blocking the winds come from sea side and this negatively affects the usual cool atmosphere inside the city. In this regard, although İstanbul is water surrounded city, only 25 kilometers of total 75 kilometers coasts of Marmara is open to public utilization (Yenen et al. 1992).

Well- planning the coastal area is one of the most important issues of catching modern city standarts. When it is taken into account that İstanbul will be the cultural capital of Europe in 2010, the importance of utilizing the coasts can be clearly realised. This fact definitely requires an effective and strategic management which can be gained with the critical observations pertaining to the coast lines. The problems with respect to the coastlines in Turkey can be solved in accordance with the article 5 of the coast law numbered with 3621. İstanbul coastlines are changed by human interventions as the other coastlines in Turkey. This is why an effective observation needed in this context.

This study aims to answer the questions stated below;

1. In which extent the coastlines of İstanbul changed between the years 1987 and 2007?
2. How the change concerning the land use along İstanbul coastlines occurred between the years 1987 and 2007?
3. What kind of arrangements/legislations should be made in coastal land use in order to perform the urbanization activities according to modern urban criteria?

1.2. Methodology

Today along with the developing technology, many different methods are widely used in the use of coastal zones and determination of coastal line changes. Determining existing and potential natural resources, monitoring the temporal changes and updating the data is possible with comparing current data with past data, therefore in any selected region, the old and new air photos and satellite image comparison, determining the changes correctly, collection of quick and low-cost information available is very crucial. For this purpose, remote sensing and the photometry methods are two of the most preferred methods (Şeker and Kabdaşlı, 2002, Çölkesen and Sesli, 2007). Satellite images and air photos, using enrichment and classification techniques, are effective tools to reveal environmental problems in large areas. Using photometry methods, coastal line changes can be measured more practically than tellurian measurements. For this purpose, firstly to establish the relationship between photography and land terrain, a certain number of control points is created. A process called numerical photo directing is applied to convert used photos to photo shoot at location of the photo. Thus connection between land and images was established. In the second phase, the details were determined and other processes are applied (Sesli, 2006).

In below, general information about Photogrammetry, Geographic Information Systems (GIS) and Remote Sensing (RS) has been given and the processes under this study will be described.

1.2.1. Photogrammetry Method:

The rays are spread from objects and around their environments. The environmental science discipline known as Photogrammetry collects reliable data about objects and their environments with recording, measuring, and interpreting the beam of electromagnetic energy of the spread of the ray of these photographic images. With this technique, the shape, size and position of objects can be determined using one or several images. Since air photos and satellite images are used in photogrammetry, these photos can be in black and white (panchromatic) or color infra-red (color infrared). Air photos taken for photogrammetry can be increased at a rate of 60% in length and 25% are in wide. It is known that these are called photographic expand. This method is used in several fields such as Geology, Forestry, Agriculture, Urban Planning, Survey-Project, Archeology, Architecture, Space Research, Astronomy, Military, Criminology, and Medicine. Using Photogrammetry methods; preparation of land use maps, identification of coastal line changes, coastal planning, determination of changes in forest area, determination of urban areas, detection of illegal constructions, etc. can be done (Çölkesen et al. 2007).

Compared to terrain measurements, Photogrammetry methods are easier to determine changes in the coastal line. For this, comparisons of the region’s old and new photos from the air are good enough for measurements. After that, to obtain the relationship between images of land and photo, a certain number of control points are created. After the positioning of the photos in the location of shoot, which is called orientation method, process is completed. Process of orientation is composed of internal orientation, mutual orientation, absolute orientation, the process of numerical integration, retrieval of detail and questioning (Sesli, 2006).

• Internal orientation: Orientation between photos' coordinate system and pixel coordinate system.

• Mutual orientation: Determination of orientation parameters of more than one time taken photo or photos.

• Absolute orientation: Determining the connections between objects determined by photo coordinate system and terrain coordinate system.

• Numerical integration and retrieval of details: Made of the photogrammetric evaluation to get the details of each model converted to terrain coordinate system.

1.2.2. Geographic Information Systems (GIS)

GIS is the process of obtaining, storing, processing and presenting to the user, a non-graphic and graphic data obtained from one location with observations. However, the most important issue here is the existence of data which will be the foundation for information. Because, without the data existence of information systems can not be mentioned. Sustainable life can be continued in the triangle of nature, environment and people in the integrity. Destruction of polluting elements or reducing can be made easier by GIS (Sesli et.al. 2002).

GIS is known as effective method in coastal management, and determining coastal and coastline changes. Saving, analyzing, processing and visualization of spatial and temporal changes are easier using GIS technology. Importance of GIS increased due to possibility of taking early precaution with the determination and control of changes against the environmental degradation. For geographic-based information storage, analysis and use, GIS provides an important mechanism. Other than these; in urban and infrastructure information systems, applications, land use and planning applications, environmental applications, geological applications, forestry and agricultural applications, business applications and security applications, GIS is used as a reflection of transition to information age (Çölkesen and Sesli 2007, Doygun et al. 2003).

As long as geographical objects continue their existence, they are affected by many events. The geometry of geographic objects (position and form) and semantics (attributes) are constantly changing. Therefore geometrical and semantic features of geographic objects and their changes over time can be analyzed separately. Geographic objects' changes can be characterized as follows (Dal et al. 2004).

• Ongoing Change: Sea causes continuous but very slow changes on coastline.
• Discrete changes: Sudden changes such as forest fire, earthquake, landslide, and accidents.
• Oscillating changes: The tide, the front line of glaciers, fishing areas, seasonal events, such as vegetation.
• Temporary changes: a building or road construction, or icing on the road.

The foundation of GIS is the clear and price information of where, when and what kinds of change occurred.

1.2.3. Remote Sensing and Image Processing

It is technique to obtain information about the earth only through the use of sensor system. Remote sensing images are the generated digital images with bringing together the square shape of the image elements called pixels (Yang, et all. 1999). This technology is used during processing and analysis of information detected and saved from energy reflected spread from the earth. The most important factor in this system is the detection of electromagnetic energy spread from objects. The electromagnetic wave energy is the total of energy with the speed of light and energy with the form of harmonic motion. In the meantime, the energy obtained can be defined in the electromagnetic spectrum. Based on the characteristics of the wavelength, sections of spectrum are named. For example, the UV (Ultraviolet), IR (infrared), visible and micro-wave sections are some parts of the spectrum. The most widely used wavelength, extending up to 0.30 μm to 15 μm are the optical wavelength (Çölkesen et al. 2007, Tunay and Ateşoğlu, 2004).

Today, in a very short time, and with reliable and economical way the information requested can be reached with the help of available remote sensing data. Therefore, remote sensing is one of the most preferred and reliable sources in many areas (Tunay and Ateşoğlu, 2004). Remote Sensing (RS) is used in many applications such as monitoring arid and semi-arid areas, monitoring of agricultural areas and controlling the changes especially to help applying precautions against environmental degradation (Doygun et al. 2003).

Coastal areas annually, depending on seasonal and daily events is constantly changing and these changes require monitoring in specific locations and periods. During this process since the classical methods takes longer time, photogrammetry and remote sensing technologies are preferred as they are the most appropriate methods (Sesli, 2006).

Resolution, with the general description, is described as the capacity of the sensor to distinguish two objects on the surface very close to each other. There are four types of resolution; Spatial, spectral, radiometric and temporal resolution. Spatial resolution shows the size of the smallest detail can be distinguished by the sensor. For example, in the image of 4 m. tellurian resolution, 4 meters or larger objects can be detected. Spectral resolution shows the wavelength range of recorded electro-magnetic spectrum by sensor. Radiometric resolution is the number of digital data for saving the data collected. The data is shown with byte. For example, in the image of 11 bytes, there are 211 = 2048 different gray tones. Temporal resolution is defined as the time passed when the same area detected a second time with the same viewing angle (Büyüksalih, 2006).

Satellite images do not give any information any more than visual information as long as processed with the appropriate method. The displays will be used by different applications should be selected by taking into account of features of the images and the purpose of study and processed to be ready produce information. Satellite data analysis methods used in this study are listed below (Büyüksalih, 2006).

1.2.3.1. Geometric Transform

Data obtained with remote sensing are called the raw data. Unprocessed this raw data can be corrupted with the flight altitude in the sensor platform, changes in the speed and scan angle changes and the earth's global shape and rotation. This problem needs to be fixed with the geometric correction process (Büyüksalih, 2006).

Three processes are required for geometric correction.

1. Ground control points were selected and their coordinates were entered.
2. Transformation matrix calculation and testing.
3. With the new coordinates obtained, the image need to be defined again.

In the process of conversion, the selection of ground control points is very important. Control points are carefully selected from the locations which can be distinguished easily and these points need to be homogeneously separated on the image. After entering ground control points and available projection information, with the re-sampling, new pixel value of geometrically corrected data is calculated. In this calculation there are three different methods including the nearest neighborhood, bilinear interpolation and cubic interpolation (Onur, 2007 and Çelik, 2006).

The nearest neighborhood method, the pixel value of the image corrected with the geometric correction is calculated with assigning the nearest pixel brightness value in the original image. In bilinear interpolation method, values of pixels is calculated taking the average of the nearest four pixels in the shape of 2X2 matrix.

In the cubic interpolation method, using a 4X4 matrix, the brightness values of pixels is calculated. These three methods have their advantages and disadvantages. The satellite data analysis methods used in the work are listed below.

1.2.3.2. Classification

The classification process can be defined a grouping of the objects that have the same features on an image. In image enhancement, classification methods can be divided into two categories: controlled classification and uncontrolled classification. The purpose of these method is to reveal the most obvious differences in detail and to improve the ability to make visual interpretation. Thus, the image features that are outside the interest can be suppressed (Çölkesen and Voice, 2007, Tunay and Ateşoğlu, 2004).

During the classification process, we need to pay attention to the following issues (Tunay and Ateşoğlu, 2004);

- Spectral bands should be appropriate to the purpose
- Sensors and sensing time should be appropriate to the purpose
- The selection of the control area.
- Selection of the classification algorithms.
- Applying the identified features to the image
- Perform accuracy assessments on the image

1. Unsupervised Classification

This classification method is used to obtain preliminary information when there is not enough information in the field that we work. Pixels are beginning to be analyzed from the upper-left corner towards the lower-right corner. According to the parameters set by the user, the pixels are iteratively grouped and the average value for each set is calculated. After each iteration the average value for each set is calculated again and based on the new values pixels are continued to be assigned to sets. This cycle continues until the user ‘s specified number of iterations is reached or the pixels which are assigned to sets do not change. Clustering, ISODATA is the most popular known unsupervised classification method (Onur, 2007 and Steel, 2006).

2. Supervised Classification

In this method the feature files of pixel values are created by using an adequate number of samples that define the features of the earth in the working field. Each pixel is assigned to the most similar class according to the distance or likelihood values calculated by applying these feature files to the image data. There are four methods: The most probable, the shortest distance, the parallel side, and the Mahalanobis distance (Onur, 2007 and Steel, 2006).

1.2.3.3. Accuracy Assessment on Classification

Accuracy assessment is to compare results of classification process with geographic data which is assumed as correct results to determine the accuracy of the classification. In the evaluation process of classification accuracy, the error matrix is created using classified data and the corresponding reference data. Error matrix sets up correlation with known reference and their corresponding data. Reference data is in matrix's column and classes obtained from the classification results is located in the matrix's row. The error matrix can be statistically analyzed with kappa coefficient. This coefficient varies between 0 and 1, and is calculated using the sum of the rows and columns of the error matrix and the elements on the diagonal.

Overall accuracy is calculated with the total number of correctly classified pixels (the total elements along the main diagonal) divided by the total number of reference pixels. Moreover, the accuracy of each category is calculated with correctly classified pixels in this category divided by corresponding pixel number in rows or columns. Producer accuracy is the number of pixels correctly classified (on the main diagonal) in each class sample divided by the number of exemplified pixels number (total column) of the class section. This shows the accuracy of the classification of the sample given pixels (Onur, 2007 and Steel, 2006).

User's accuracy is calculated with correctly classified number of pixels in each class for each class is divided by total number of classified pixels (row total) in that category and these displays the possibility of representing the pixel of a given category with the real location of that pixel on the earth.

1.2.3.4. Detection of Change

After classification, the images taken in different dates are compared and the change in perception can be determined. During this time, the images taken in two different dates are classified and recorded. Then, the changed pixels were determined with comparing these two images. Accuracy of these depends on the accuracy of independent classifications (Onur, 2007 and Çelik, 2006).

1.2.3.5. Geometric Image Correction

Geometric Image Correction is the process of eliminatinating errors from systematic (inclination of the scan, scan speed changes, panoramic distortion, platform velocity, rotations in location, errors in altitude) and non-systematic (elevation changes, status changes) errors with the ground control points. The goal of this process is to use the new image which is corrected in a map (Tunay and Ateşoğlu, 2004).

1.2.3.6. Re-sampling

Firstly, control points with known coordinates are determined using GPS or topographic maps. The image is converted to a local coordinate system by the conversion method with the help of these determined control points with known coordinates. Then numerical values of pixels in the image (Digital Number-DN) is calculated again (Çölkesen and Voice, 2007).

Remote sensing satellites, LANDSAT, TERRA, SPOT, ESR, IRS, MOS, and JERS, Radarsat satellites and IKONOS and Quickbird are high-resolution satellites. In this study images of LANDSAT satellite were used (Nurlu, 2007, Büyüksalih, 2006).

Landsat:

NASA, ERTS (Earth Resources Technology Satellites) began to work in this project in 1967.In the first stage, ERTS-1 was sent to sky on 23 July 1972 and remained in orbit until 6 January 1978. Before sending ERTS-2, 22 January 1975, NASA changed the name to "Landsat" to separate this program from another other ERTS planned missions named "Seasat" oceanography satellite program. Therefore, the ERTS-1 was named as Landsat-1 and the name of all future satellites in this series were named Landsat. With Landsat satellites, 1 to 5 and 7 the missions were successfully placed into orbit but Landsat-6 mission has failed. Landsat 1, 2 and 3 is not used today, while the Landsat 4, 5 and 7 satellites still in orbit to provide data (Keskin, 2007 and Büyüksalih, 2006). The spectral and spatial resolutions of these systems are given in table 1.

TABLE 1: LANDSAT SENSORS USED IN MISSIONS

Sensor	Mission	Detection range	Resolution (m)
	1,2	0.475- 0.575	80
RBV		0.580- 0.680	80
		0.690- 0.830	80
	3	0.505- 0.750	30
	1-5	0.5- 0.6	79/82
MSS		0.6- 0.7	79/82
		0.7- 0.8	79/82
		0.8-1.1	79/82
	3	10.4-12.6	240
	4,5	0.45- 0.52	30
		0.52- 0.60	30
		0.63- 0.69	30
TM		0.76- 0.90	30
		1.55-1.75	30
		10.4-12.5	120
		2.08- 2.35	30
ETM	6	Over TM line +	30(120m thermal line
		0.50- 0.90	15 (pan)
ETM+	7	Over TM line +	30 (60m thermal line)
		0.50- 0.90	15 (pan)

Landsat 4 and Landsat 5 Satellites

Landsat 4 and 5 are placed in a similar way to previous Landsat series satellites as repetitive, circular, co-time with sun and near-polar orbits. However, the altitude of the orbit was reduced from 900km. to 705km. Low altitude has given a better opportunity to capture GSD images. It is higher quality sensor than TM, MSS based on the number of spectral bands with geometric and radiometric qualifications. There are 7 spectral lines instead of 4 lines and these lines includes visible spectrum (blue), mid-infrared and thermal parts. From the geometric perspective, the TM collects 30m GIS data (excluding 120m thermal line). Thus, the earth pixel size decreased 2.6

times, which increased the accuracy geodetic position. Table 2 reveals main features of TM' seven spectral lines (Büyüksalih, 2006).

TABLE 2: TM SPECTRAL LINES AND PROPERTIES

Line	Wavelength (μm)	Color	Main Applications
1	0.45- 0.52	Blue	This line can penetrate the water mass, this feature makes it useful for the analysis of coastal waters. This line can be also used in soil / vegetation separation, types of forest maps and to identify cultural description
2	0.52- 0.60	Green	The green reflection is used in vegetation image eparation. It is also useful in the description of cultural details.
3	0.63- 0.69	Red	It has been reserved to detect chlorophyll permeability line to ensure the separation of plant species
4	0.76- 0.90	Near infrared	It is useful in studies to determine soil moisture content and mapping plant species, freshness, bio mass content, and water ponds.
5	1.55-1.75	Mid-infrared	It is specified to measure soil moisture and plant moisture content is specified for. Also, it is used to distinguish snow from clouds.
6	10.4-12.5	Thermal infrared	It is used for plant stress analysis, to determine soil moisture, and temperature maps.
7	2.08- 2.35	Mid-infrared	It is useful for the separation of mineral and rock types. Moreover, it is also sensitive to plants' moisture content.

1.2.4. Study Report of Classification of Images Belongs to Landsat Satellite in the Years 1987 and 2007

Classification:

In numerical images, each object is expressed with different numerical values depending on its features. With classification process, the numerical values of the objects with similar features are grouped. In short, the aim of the classification is to grouping the objects which have the same spectral features.

In this study, 30 m. resolution satellite images come from Landsat satellite in 1987 and in 2007 classified with Erdas Imagine tellurian program and accuracy analysis have used the reference data in hand. Classification results are then edited and using ArcGIS program and converted to vector to be used in the GIS questionable analysis.

1. **1987 Landsat Satellite Image Classification**

In the first step of classification, image data has been subject to Principal Component Analysis. After the transformation process of main components is completed, the signature collection process is applied with checking the reference data. The signatures of previously designated classes are collected and continued to collection of signatures until reaching the most appropriate classified image data with reference data. After completing the signature process, classification process is initiated using controlled classification methods of the highest possibility method.

The signature in each data obtained as a result of classification is recorded. Thus, the classes of the image data are defined. With this process in Erdas program, obtained data is converted from the raster format to vector format with an ArcGIS program. Vector of the data is checked with the reference data, and for some areas confused in the first editing process have been corrected by editing methods. Results data have been obtained as a result of this process.

General Categories used in the Classification

1. Urban areas
2. Agricultural areas
3. Bare soil
4. Brush /Grassland
5. Lake/Pond
6. Forest
7. Cloud

In 1987 Landsat image, for cloud content, the cloud class was created. Since ships in this image were eliminated by editing method, there is no need to create a new class (Figure 1, 2, 3, 4, 5, 6, and 7).

FIGURE 1: LANDSAT 1987 AN IMAGE OF İSTANBUL (3-2-1 NATURAL BAND COMBINATION)

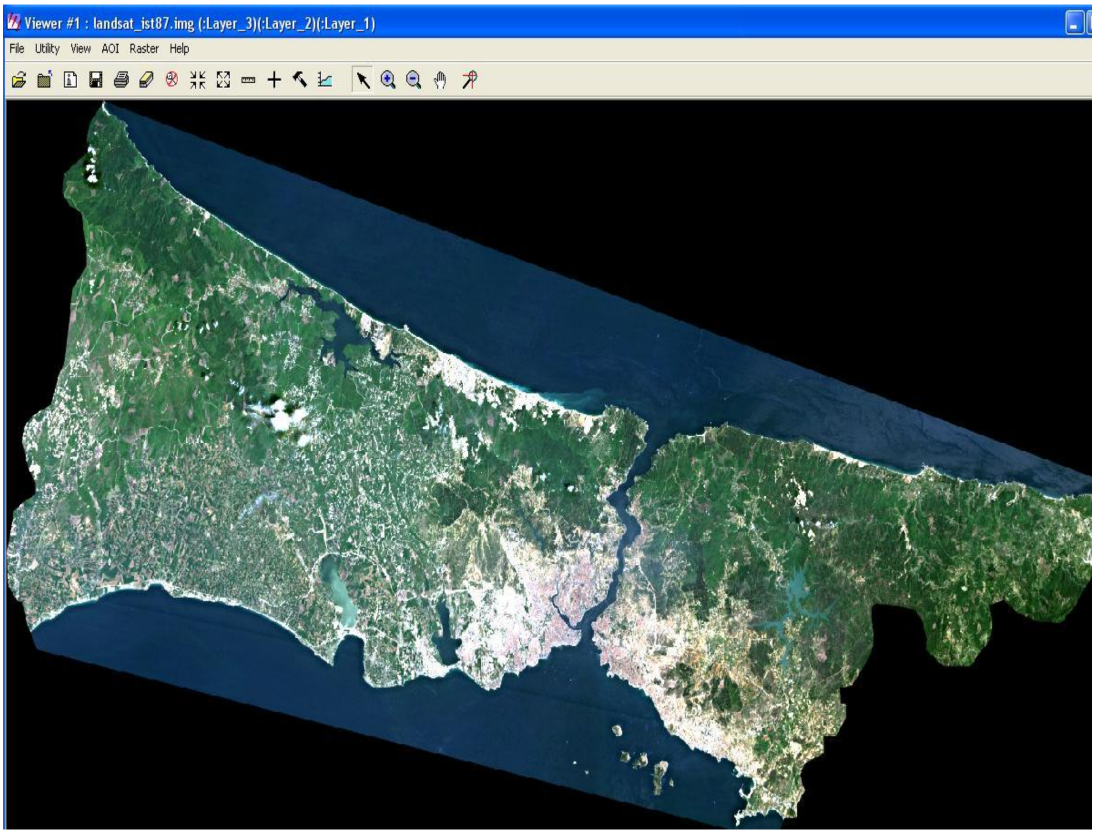


FIGURE 2: LANDSAT 1987 – AN IMAGE OF SAND AREA

FIGURE 3: MAIN COMPONENTS FOR THE CONVERSION DATA

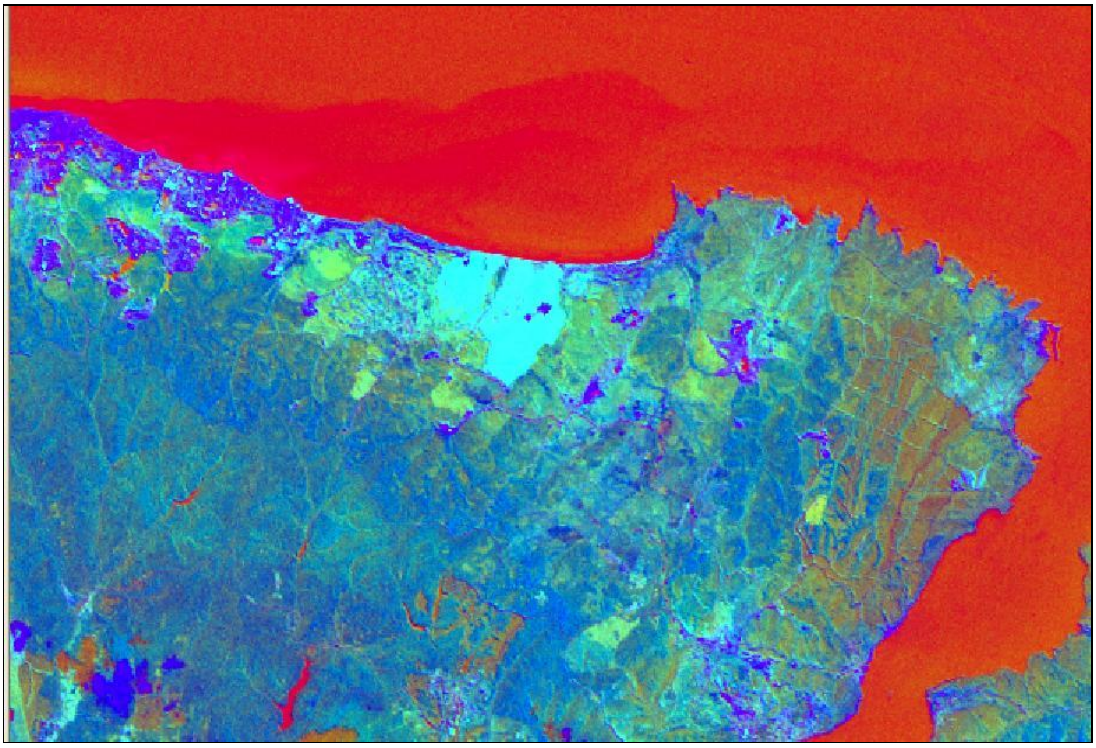


FIGURE 4: SIGNATURE COLLECTION IS BEING DONE

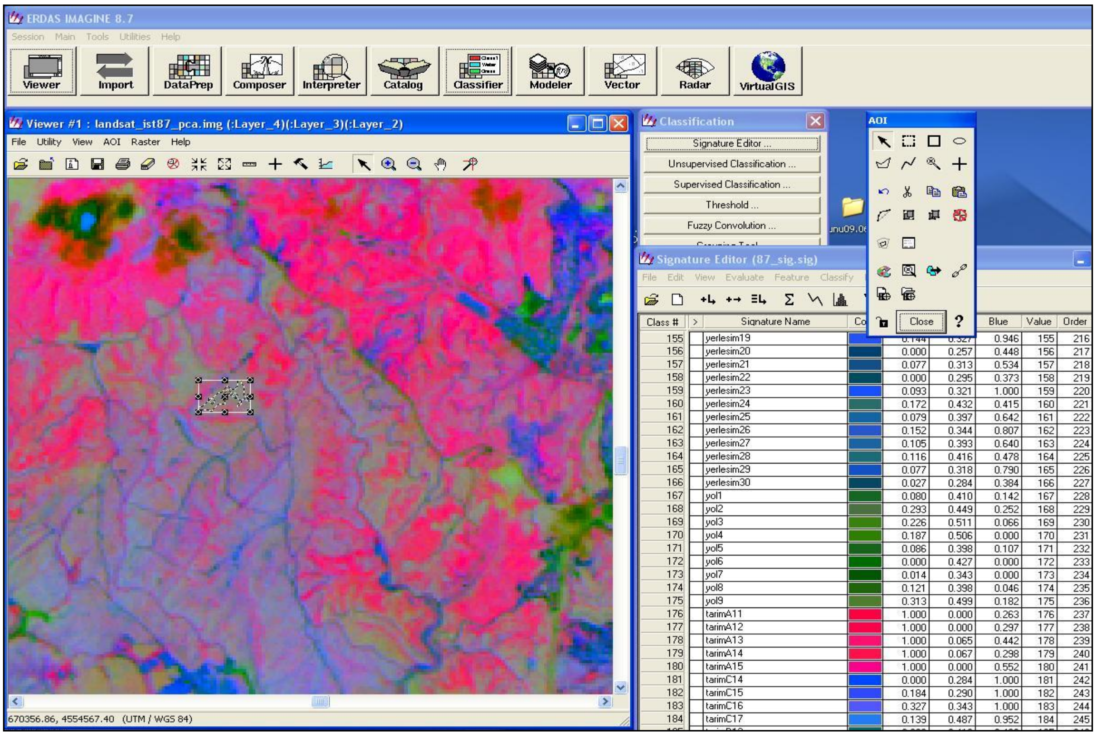


FIGURE 5: SIGNATURE A COMPARISON OF DATA WITH REFERENCE DATA COLLECTED

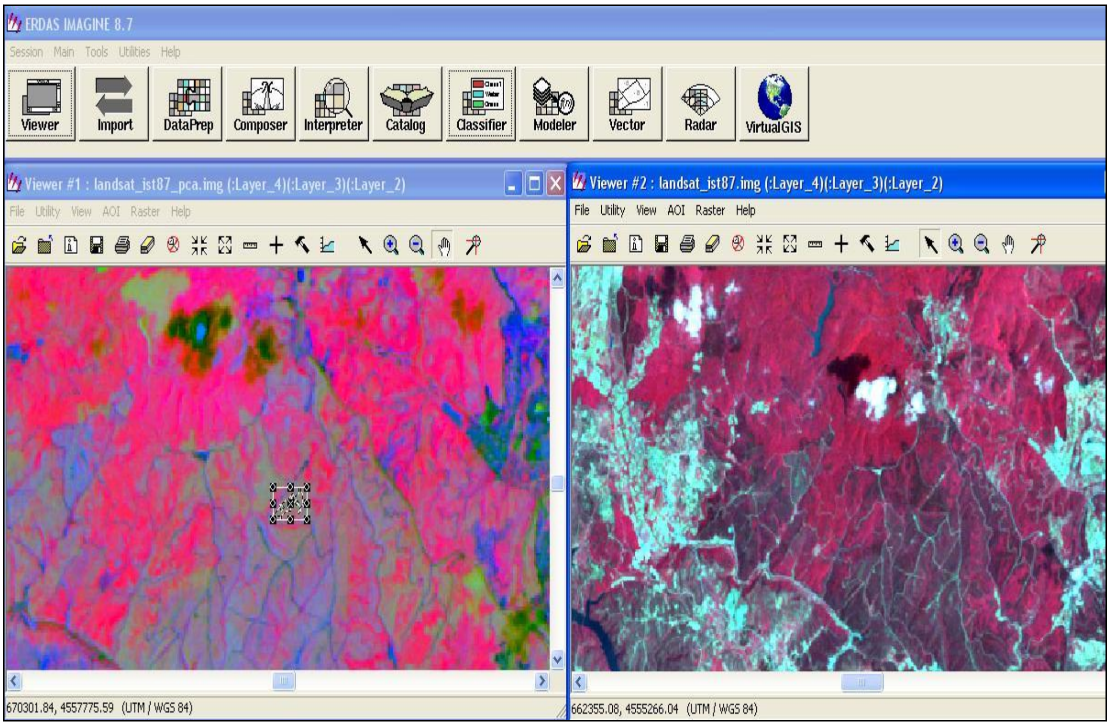


FIGURE 6: THE DATA OBTAINED BY RESULTS OF CLASSIFICATION

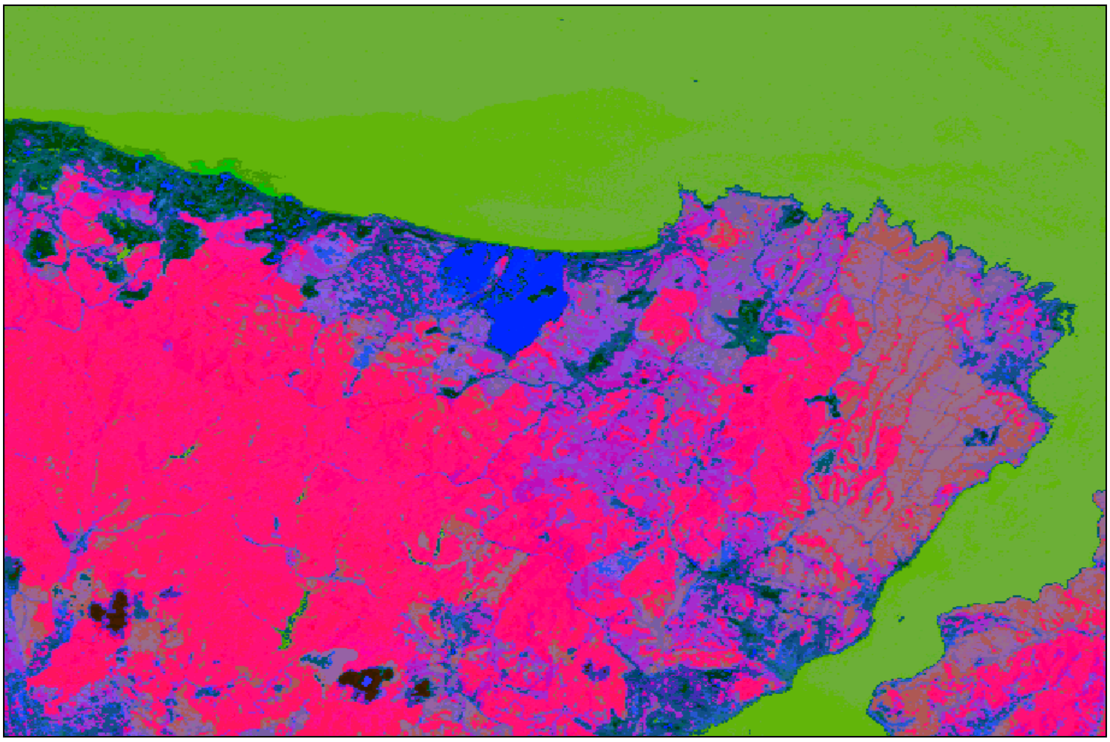
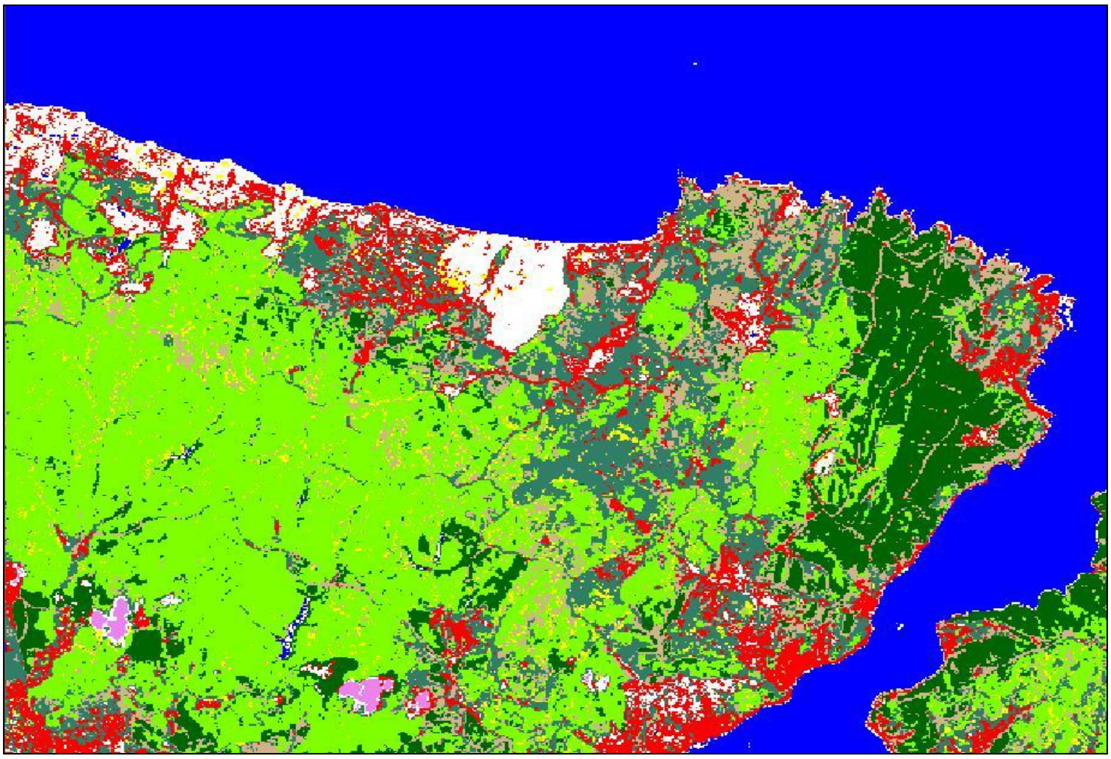


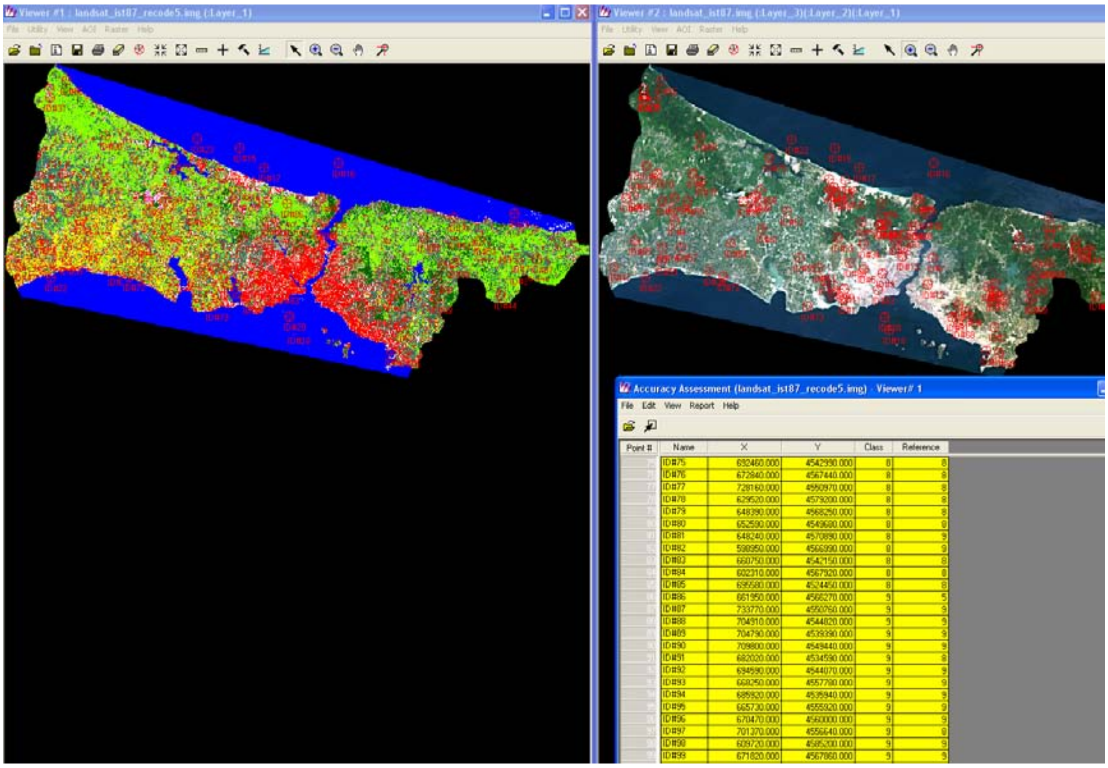
FIGURE 7: RECODED DATA



Accuracy Assessment of Landsat 1987 Image

Accuracy analysis of this application was done by Erdas 9.1 software. 100 points have been casted randomly at the areas that founded before filtered by using software (Figure 8, 9).

FIGURE 8: ACCURACY ASSESSMENT



Any point taken automatically has been controlled manually with information from the ground actuality before obtaining the accuracy analysis. Ground actuality information was obtained by using combination of Landsat image, natural band and recent ortofoto.

FIGURE 9: ACCURACY ASSESSMENT

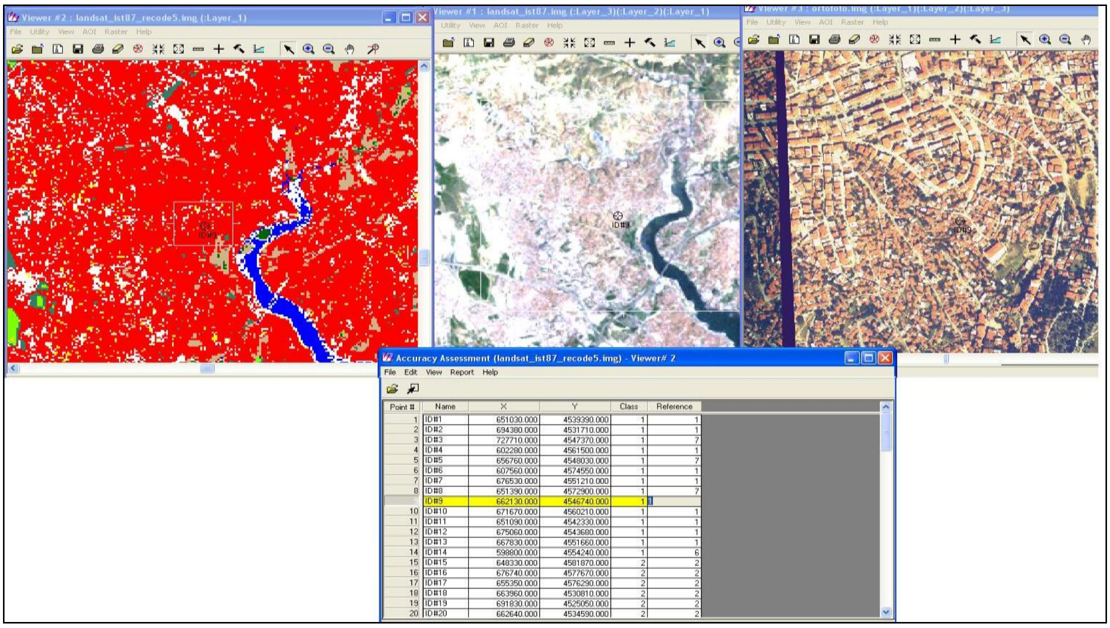


TABLE 3: ACCURACY ASSESSMENT

Class name	Total References	Total Classification	Number of correct	Producer Accuracy (%)	User Accuracy (%)
Urban areas	10	14	10	100	71.43
Lake/Pond	9	9	9	100	100
Cloud	8	8	8	100	100
Forest	19	22	15	79	69
Agriculturel areas	19	12	10	52.63	83.33
Bare soil	8	6	5	62.5	83.33
Bush/ Grass	27	29	22	81	76
Total	100	100	79		
General accuracy = % 79.00					

Kappa (K) Statistics

K statistics is an index which compares the agreement against what might be expected by chance. Kappa can be thought of as the chance-corrected proportional agreement, and possible values range from +1 (perfect agreement) via 0 (no agreement above that expected by chance) to -1 (complete disagreement). In Other words, the K statistic shows if the error matrix obtains the correct value by chance or with real concordance. Usually it's between 0 and 1. Value of 0.76 obtained in this application can be considered better then a probability of having a results of %76 by chance (Table 4).

TABLE 4: KAPPA (K) STATISTICS (1987)

Sınıf Adı	Kappa
Urban areas	0.6825
Lake/Pond	1.0000
Clouds	1.0000
Forest	0.6569
Agriculturel areas	0.7942
Bare soil	0.8188
Bush/ Grass	0,7218

Total Kappa Statistics = **0.76**

Based on international literature of production of land use map the results of 1987 Landsat image of the classification accuracy of 79% is sufficient. In terms of water and clouds classes value of reflection, 100% accuracy has been obtained without any confusion. It is usually mixed with class of bare soil because of roads were included in the settlement and its accuracy was 71.43%. This image has its own value in 3 different reflection in the result of seasonal differences in agricultural classes. Some of them are mixed with bushes and grass class. Similarly the accuracy result of 69 % of the forest class verify this hypothesis (Table 5).

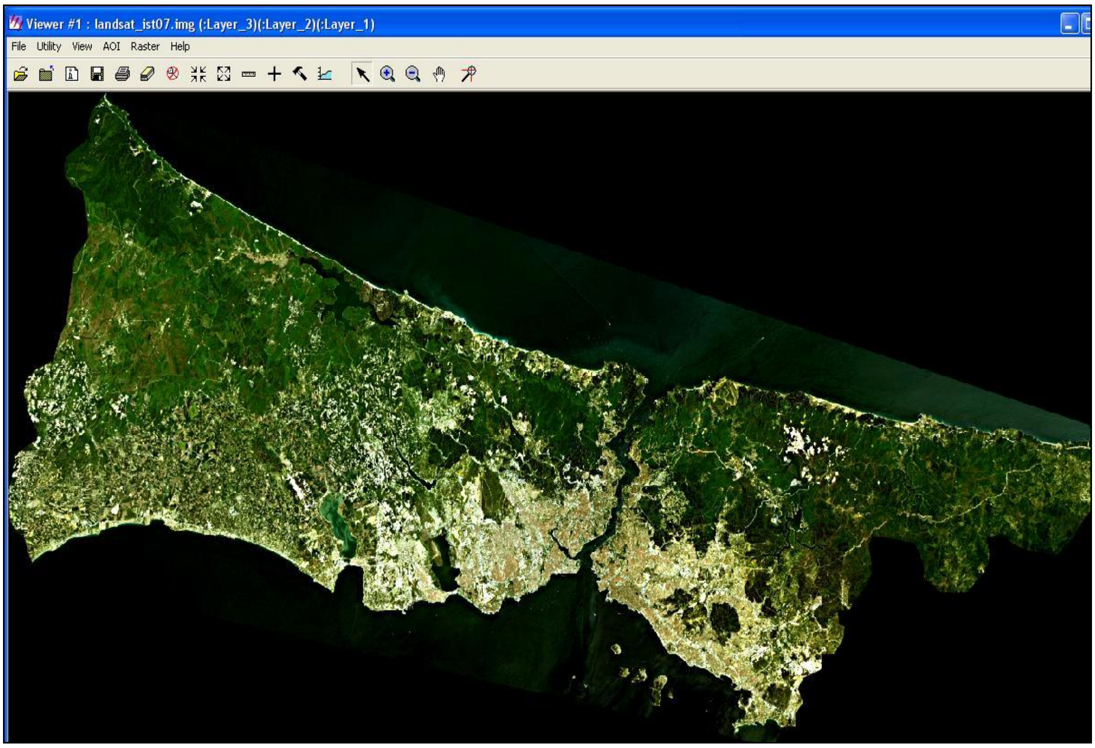
2. Classification of the Landsats 2007 Image

Classifications in Landsat Image in 2007:

1- Urban Areas Area
2- Bare Soil
3- Lake/Pond
4- Forest
5- Agricultural Area
6- Brush/Grassland

Landsat image in 2007 does not include clouds as images from Landsat images in 1987. Also, there is a 20-year time difference between these tow images, the 2007 image is more favorable to use for classifications and all kind of analysis because of the image quality and extra features from shooting. In the 2007 image classification, there is a lot of reference image data. For example; In 2007, the 1-m resolution IKONOS satellite image and orthophotos facilitated the process of categorization. During the classification of 1987 image, the most recent orthophoto was dated from 96; High-resolution satellite imagery is not available for that year. The classified Landsat Geocover image used in this research is produced by the NASA, it just gives some idea in classification (Figure 10).

FIGURE 10: LANDSAT 2007 IMAGE (3–2–1 NATURAL BAND COMBINATION)



During classification process and receiving signature, when (5-4-2) band combination tried as well as when using PCA processed image, separation in classes were easier (Figure 11, 12,13).

FIGURE 11: 5-4-2 BAND COMBINATION

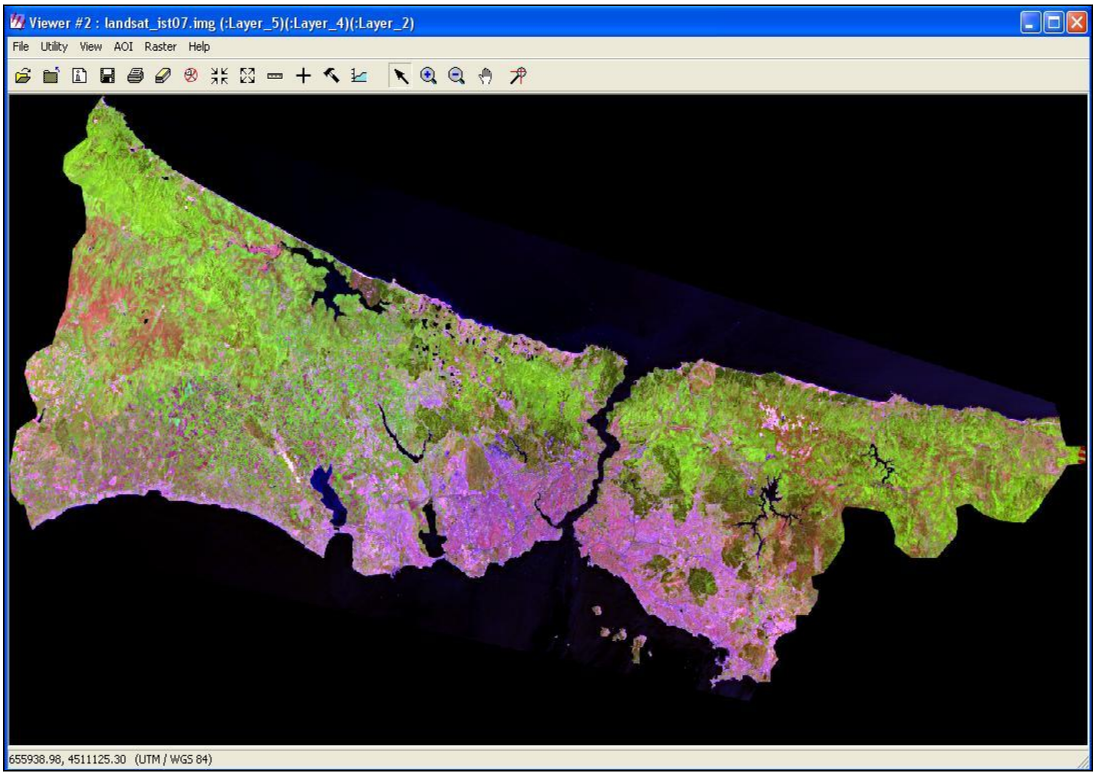


FIGURE 12: LANDSAT 2007 PCA APPLIED IMAGE

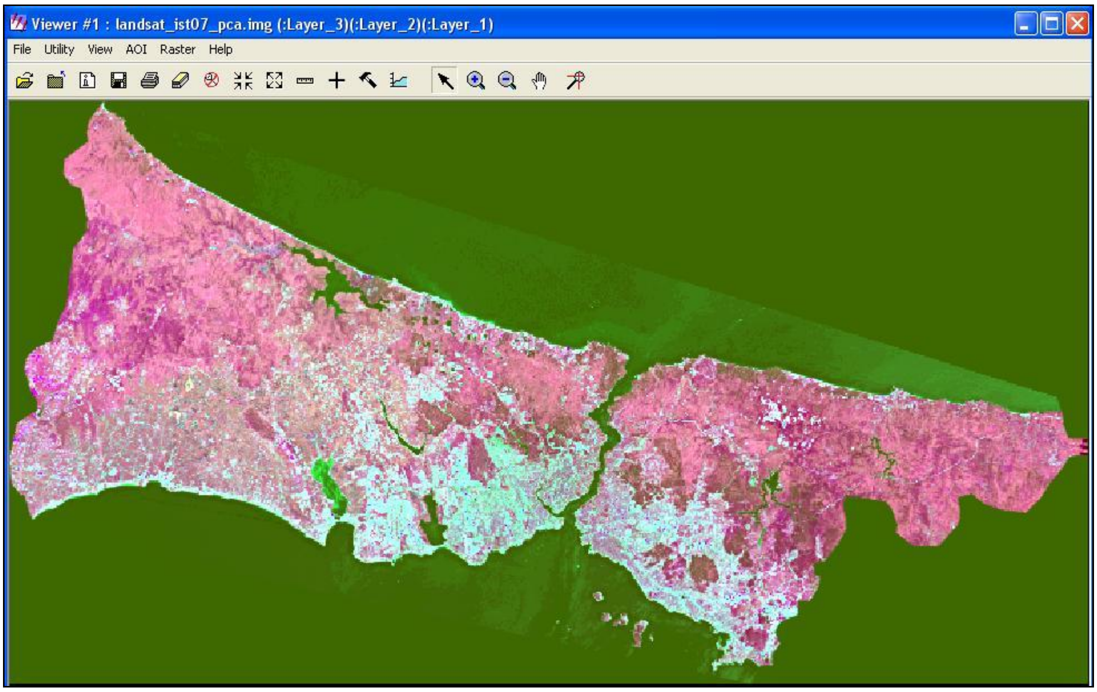
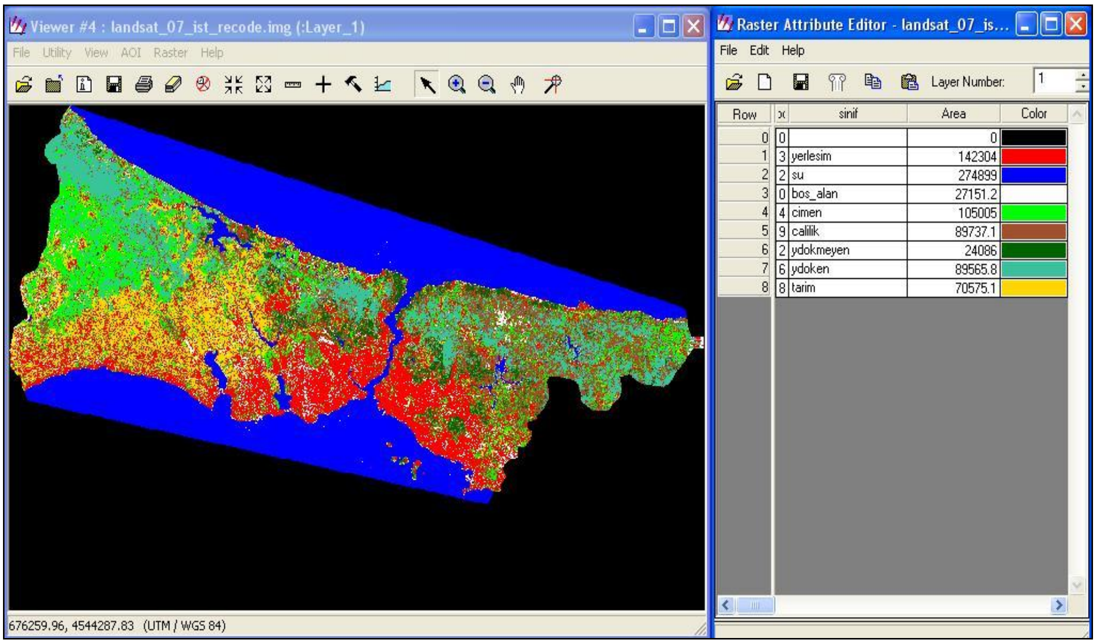


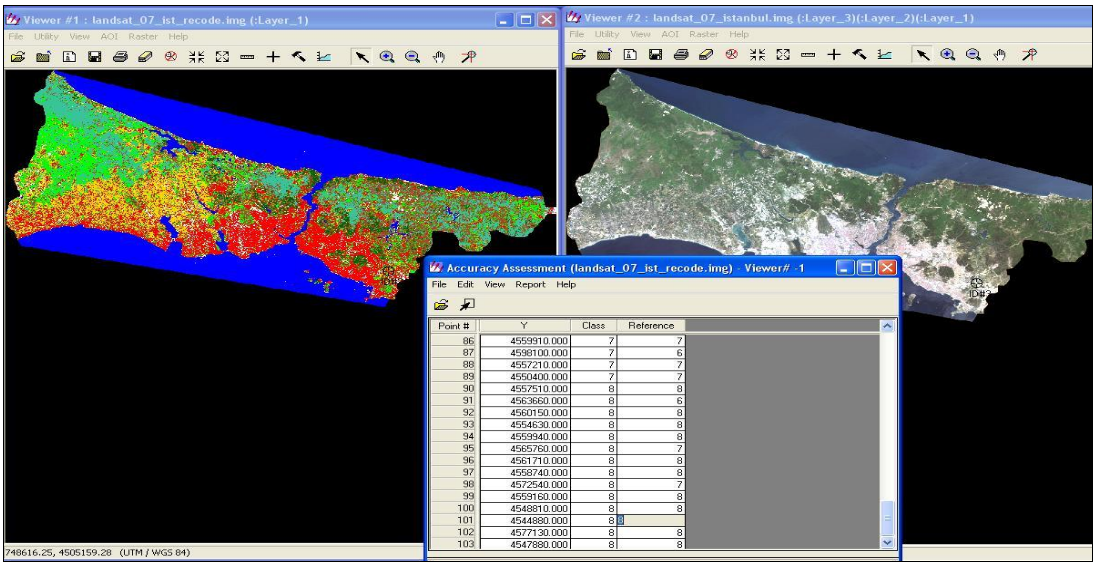
FIGURE 13: CLASSIFIED LANDSAT 2007 IMAGE



Accuracy Assessment of Landsat 2007 Image

In this application, accuracy analysis was performed with a Erdas 9.1 software. In the areas generated with classification, 100 points were added proportionally using the software (Figure 14,15).

FIGURE 14: DISTRIBUTION OF RANDOM POINTS



Manually for each point with checking earth real data, accuracy analysis has been performed. Earth real data were obtained using actual line combination of Landsat image and 2005 Ikonos image.

FIGURE 15: CLASSIFIED IMAGE, NATURAL BAND COMBINATION OF IMAGE, APPLICATION OF POINT ACCURACY ASSESSMENT ON JUNE 2005 IKONOS IMAGE

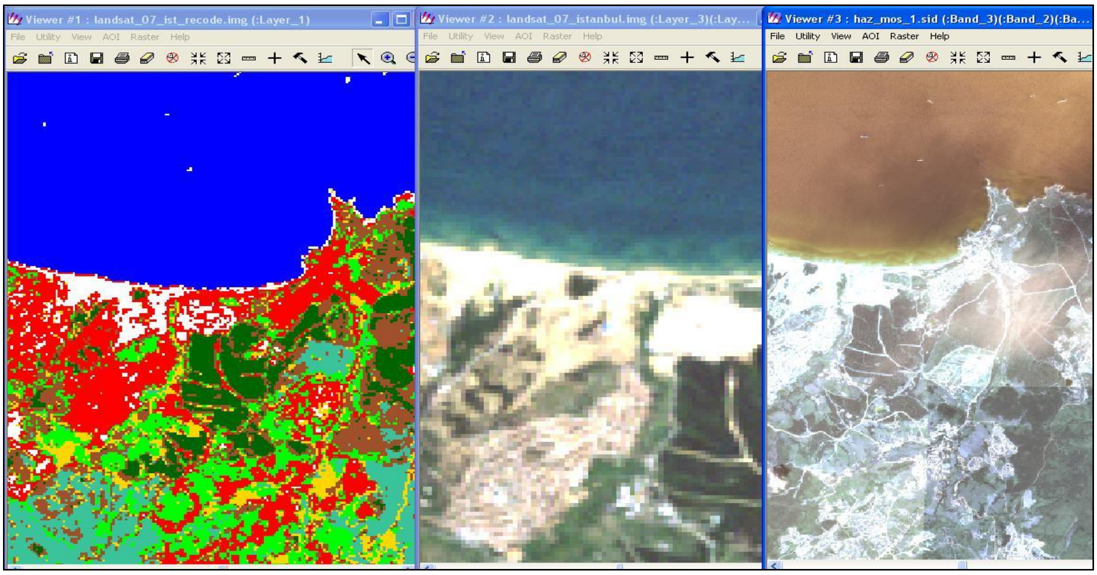


TABLE 5: ACCURACY ASSESSMENT

Name	Total references	Total classified	Number of accurate points	Producer accuracy (%)	User accuracy (%)
Urban areas	17	20	17	100	85
Lake/Pond	9	9	9	100	100
Bare soil	7	8	6	85.71	75
Forest	26	23	19	72,62	83,73
Agriculturel Areas	16	14	11	68.75	78.57
Brush/Grassland	28	29	24	86,46	84,62
Total	103	103	86		
Genaral accuracy = 83.50 %					

Kappa (K) Statistics

Kappa statistics can be defined as a criterion of alignment between reference data and automated classifier, and between the same reference data and random chance classifier. In other words, the kappa statistic shows either the error matrix correct value by chance or with real allignment. Usually it is between 0 and 1. A value of 0.81 in this application shows that the categories measured is better than 81% of randomly obtained values (Table 6).

TABLE 6: KAPPA (K) STATISTICS (2007)

Sınıf Adı	Kappa
Urban areas	0.8203
Lake/Pond	1.0000
Forest	81,31
Agriculturel areas	0.7463
Bare soil	0.7318
Brush/Grassland	74,96

Total Kappa statistics = **0.81**

An 81% of classification accuracy of Landsat images dated 2007 came out, keeping in mind the international literature, it is an important result in the production of the land use map. Since Landsat image in 2007 does not have the clouds and the shadow of clouds, and also has no corruption due to reflection, so results were clearer.

Change Detection Study

Spatial query for classes is made; Grass, bushes, deciduous, and evergreen classes were evaluated in the name of forest. Because to get the best results, signitures were collected with dividing forest class from different catagories. With this important detail, when results were evaluated, in the 20-year period, a natural increase in urban areas and decrease in the forest, bare soil and agricultural areas classes were observed.

After the geometric image correction of the satellite image was done, the borders of the study area were determined and a cut operation with the same coordinate image. To do this, on ArcMap, starting from the costline towards the inner lands, 1000 meters study area border was determined by buffer and clip methods. Then, maps inculiding 6 main land use classes about the features of a -1000- meters area towards the inner lands from the coastline, were produced. The buffer line for each year is taken separately, the difference between the two periods.

Evaluation of Classification Results and Discussion of Problems

Starting classification process in itself reguires a literature background and experience, the classification process and produced data includes some problems also. 30 m. Landsat-resolution images were used in classification are genarally used for the production of thematic maps. the classes in the proction of this thematic maps, for example, built-up areas as called urban areas in international articles were taken as class, during signature collection, not much problems were observed for tile roofed buildings, but many problems were experienced with brick buildings, asphalt roads, village roads, badlands known as the fallow fields, sand fields and quarries. They were mixed. Classified as agricultural land is also well characterized in 3 types of agricultural lands. During the instant of capturing the image from the satellite, ship, clouds, shadow of clouds, changes in the values of water reflection, and the quality of shooting affected the classification. After this process creates the general classification, more goal oriented studies can be performed. As an example, the barren ground areas can be classified as barren field, sand fields, stone quarries with chaging the vector data.

In general, the images subjected to classification were from the years 1987 and 2007 years and there is 20-year gap difference between the images. In this twenty - years period, an increase in the basins in the İstanbul Metropolitan area, the increase of settlement areas in this basin and the decrease of forest and agricultural land has been observed. Moreover, the accuracy of classification analysis is performed for any and all classes since it will not mean anything untill the accuracy analysis has been done.

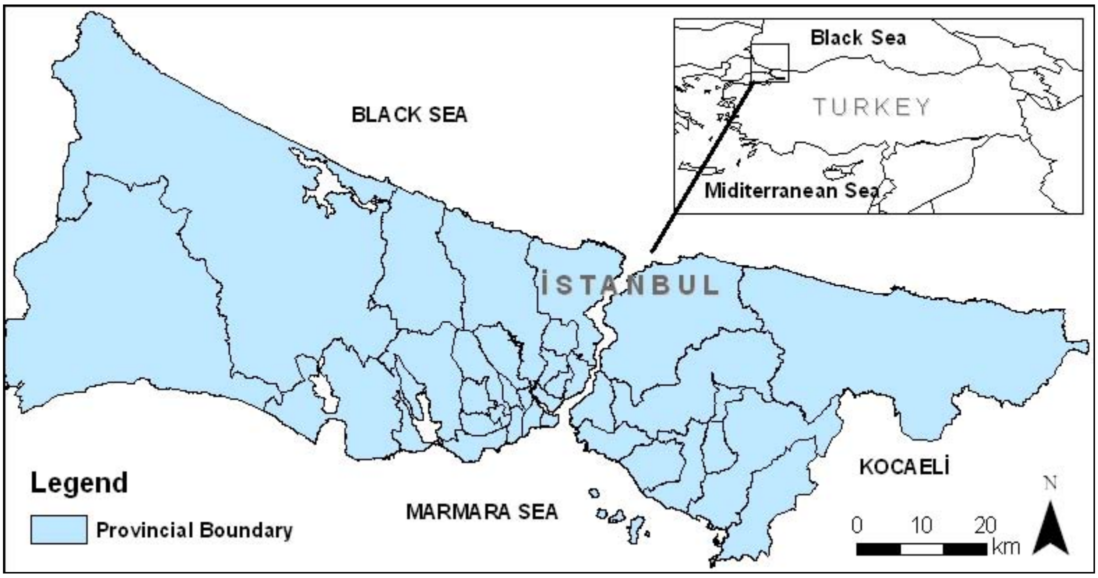
1.3. Study Area

İstanbul is located between 27° 58' – 29° 56' eastern longitudes and 40° 48' – 41° 36' northern latitudes. İstanbul is surrounded by the Black Sea at the north, Kocaeli mountain ranges at the east, Marmara Sea at the south, water line of Ergene Basin at the west (Figure 16). The city, which was established at the northwest of Turkey along Marmara Sea and Bosporus, is as a bridge connecting Asia and Europe. While the western side of Bosporus is known as Rumelia, It's eastern side known as Anatolia. With this characteristic it is the only metropolis established on two continents and including watercourse in the world. It has 32 districts (İBB, 2007). Having 5512 square meters area (İBB, 2009) İstanbul is like a peninsula since it is surrounded by Haliç, Bosporus and Marmara Sea. Being located on Çatalca and Kocaeli peninsulas, İstanbul was formed at the end of Miosen Period of III geologic time. Caming out after ebb tide lands corroded by external effect like winds and river İstanbul gained a large peneoplen image where the altitudes got lost. Meanwhile the valley stated at the Bosporus enlarged. Due to the increasing tendency at the river valleys, water corrosions also got increased and than the water corrosions at the eastern side flowed into Black Sea, while the ones at eastern side flowed into Marmara Sea.

There is no possibility to evaluate İstanbul's climate type under the frame work of a prominent category since it has a unique location. As it has different climate characteristics İstanbul indicates a transitory characteristic between climates of Black Sea and Mediterranean Sea. In this sense the natural land cover of İstanbul does consist of forest, Maquis, psodomaki (in line with the Black Sea climate and changed timely and coastal plants.

İstanbul has a continuous importance due to the Bosporus and its strategic location, at the conjunction of main roads and the sea, and also with unique climate characteristic. Due to these, İstanbul became the capital city of Ottoman and Byzantium empires in the past.

FIGURE 16: MAP OF İSTANBUL



Although it had a population of 1.078.000 in 1945, İstanbul reached 1.533.000 people in 1955 due to the immigrations after 1950 (İBB, 2009). According to TUIK data in 2008, İstanbul's populations increased as much as Bursa city in 8 years and reached 12.697.164 people (Table 7), (TÜİK, 2008). İstanbul received 11 million immigrants in last 50 years, and 2.5 million in last 7 years. 65 % of the residents live in the European side, while 35% live in the Anatolian side (İBB, 2009).

TABLE 7: THE DISTRICT- BASE POPULATION OF İSTANBUL

District Name	Total	District Name	Total
Adalar	14.072	**Pendik**	541.619
Bakırköy	214.810	**Ümraniye**	553.935
Beşiktaş	185.373	**Bayrampaşa**	268.276
Beykoz	243.454	**Avcılar**	333.944
Beyoğlu	245.064	**Bağcılar**	720.819
Çatalca	62.339	**Bahçelievler**	571.683
Eyüp	323.038	**Güngören**	314.271
Fatih	443.955	**Maltepe**	417.605
Gaziosmanpaşa	460.675	**Sultanbeyli**	282.026
Kadıköy	533.452	**Tuzla**	170.453
Kartal	426.748	**Esenler**	464.557
Sarıyer	277.372	**Arnavutköy**	163.510
Silivri	124.601	**Ataşehir**	351.046
Şile	28.571	**Başakşehir**	207.542
Şişli	312.666	**Beylikdüzü**	185.633
Üsküdar	524.889	**Çekmeköy**	147.352
Zeytinburnu	288.058	**Esenyurt**	373.017
Büyükçekmece	163.140	**Sancaktepe**	229.093
Kağıthane	415.130	**Sultangazi**	444.295
Küçükçekmece	669.081	**İstanbul (Total)**	**12.697.164**

Source: TÜİK, 2008

The share of İstanbul in Gross National Product is around 23%, and its contribution to the state budget is 40%. The export rate constitutes 46% of national total and 40% of import. In İstanbul, the sectors such as managing centres, finance, turizm, service and banking came into prominence instead of the industry in the recent years (İBB, 2009).

In the study, the coastal changes due to land use depending on the time where the coastals of İstanbul with 450 kilometers length (Atakan, 2003) will be made up by different satellite images and by integrating the collected data into Geographic Information Systm.

1.4. Literature Review

Coast and coastal regions have great importance in human life as well as in respect of ecosystems. The coastal regions nowadays having 8 percent of human settlements have been constantly changing since the formation of the first coasts in the world up to today. The most important factors of the changes in the coastal areas from Precambrian to Quaternary's Holocene age were internal and external forces which were effective in the world's shaping. The factors such as epirogenic and orogenic movements, waves, rivers, glaciers, winds have formed the forces which are effective in changes of the coasts in the world for long years. As in the coastal line, there have been important changes in the geomorphologic structures of the coastal regions depending on these forces. From the 18th century in which the effects of human beings to the world became more evident to today, it has been observed that the human effects are more effective especially in the changes of regions in which human settlements take place, coastal line and coastal regions. The population increase and rapid urbanization have effects in changing of coastlines depending on different purposes and developing different land usage examples in coastal areas. An intense literature review has been realized in this study named examination of coastal line changes in İstanbul coasts depending on the land usage between the years of 1987 and 2007. In the literature review, firstly the concept related to the coasts are defined depending on different sources and then the reasons of changes occurring in coastal line and coastal regions are tried to be studied under separate subheadings.

1.4.1. Basic Concepts Regarding The Coast

1.4.1.1. Coast

The first legal definition of the coast the dictionary meaning of which is conjunction line of the land surrounding natural water bodies such as sea, lake and river with water was made in the 41st article article of the civil law that became effective in the year of 1926 (Atakan, 2003). According to the Coast Law number 3621 that became effective in April 17, 1990 and to the law number 3830 that was ratified in July 11, 1992 containing amendments; the coast is defined as an area located between sandy, gravel, stony and marsh areas going along the coastal line of sea, lakes and rivers and their natural lines in the direction of land (Figure 19), (Official Journal, 1990, Sesli, 2006 and Akça, 2008). This area, the area located between the lowest water level and highest water level changed according to tides and waves, is the region of drawdown (Atakan, 2003, Erdem, 2006). In another definition the coast is the area locating between the coastal line and coastal edge line (Sesli and Karslı, 2003). As in the past the coast and shore were used interchangeably, nowadays it has changed from the shore concept to the coast concept (Gülez et al. 2007).

As the borderline in which the sandy, gravel, stony, rocky, reedy and marsh areas ends at the land side determines the depth of coasts, the coasts can be examined in two groups as Low Coasts and High Coasts according to their general appearances. The coasts contain all coastal forms (such as seaside cliffs, shore terraces and all low areas locating on the coast) due to the fact that they cover a wider area when compared to the coast zone.

a) Narrow-High Coast; are the coasts which do not have beaches, generally end with cliffs and where the coast and coastal edge line collide (Figure 17), (Official Jurnal, 1990).

b) Low-Flat Coast: They are coasts going on after coastal line, containing sandbar which contains beaches, movable and stable sand dunes that the coastal movements form, lagoon lake, lagoon areas, reedy, marsh and sandy, gravel, stony and rocky areas (Figure 18), (Official Jurnal, 1990).

FIGURE 17: AN EXAMPLE OF NARROW-HIGH COAST

(ANTALYA-FİNİKE)

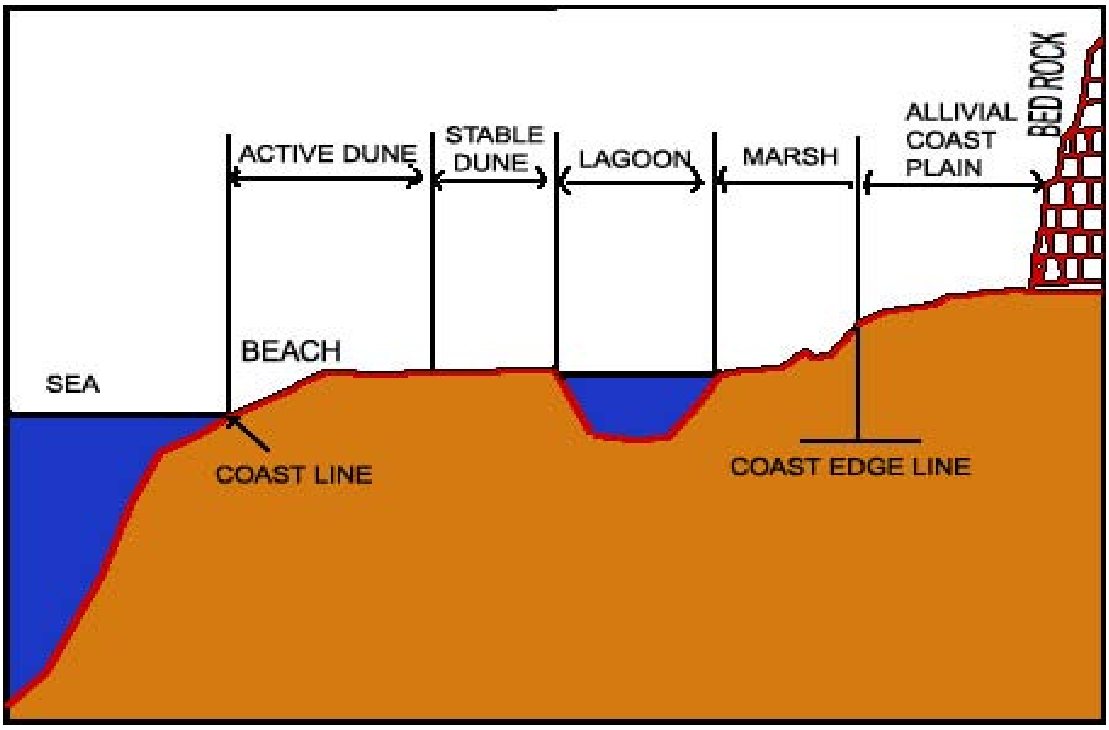
Source: Akça, 2008

FIGURE 18: TYPICAL EXAMPLE OF LOW-FLAT COAST

(MUĞLA-SARIGERME)

Source: Akça, 2008

FIGURE 19: AN IDEAL PROFILE OF LOW-FLAT COAST



Source: Akça, 2008

1.4.1.2. Coastline

According to the coastal law in effect in our country and application regulation number 3830 regarding making changes in some articles of the former, it is a natural line which is formed of the conjunction of the points on which the water touches to the lands apart from flood situations on seas, lakes and rivers and is changing according to the meteorological events (Figure 19, Table 8). In natural and artificial lakes, maximum water-level determined by the General Directorate for State Hydraulic Works determine the coastal line (Sesli and Akyol, 2002). The coastal lines which are natural borders between land and sea are constantly changing especially at the mouths of rivers and creeks due to natural and artificial effects (Boak and Turner, 2005, Alesheikh et al. 2007, Van and Binh, 2008).

TABLE 8: THE COASTAL WIDTH DISTANCES IMPLEMENTED IN VARIOUS COUNTRIES

Country	Coastline Width
Equator	8 m.
Hawaii	40 ft.
Philippines *	20 m.
New zealand	66 .ft
Indonesia *	50-400 m.
Mexico	20 m.
Brasilia	33 m.
Colombia	50 m.
Costa rica	50-200
Chili	80 m.
Uruguay	250 m.
Sweden **	100 m. (some plece 300 m.)
Norway **	100 m.
Denmark **	1-3 km.
France	100 m.
Spain	100-200 m.
Greece	500 m.
CIS (Black Sea coast)	300 km.

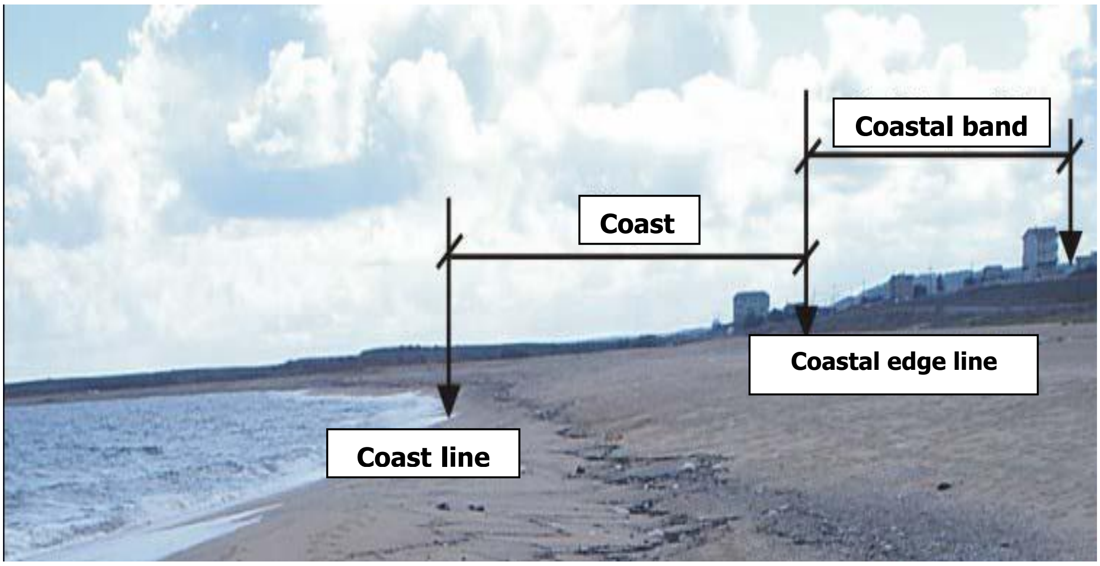
***Mangrov:** Mangrove areas allocated as green belt**.** Tree cutting ban 50 m. and green belt 400 m. (for Indonesia).
CIS: The Commonwealth of Independent States [composed of some republics which were formerly a part of the U.S.S.R.] 1 foot = 0.3048 m.
****Second housing construction ban.

Source: Sesli et al. 2003

1.4.1.3. Coastal Edge Line

According to coastal law published in the official journal dated 30.3.1994 and number 21890 and application regulation; it is a natural border of sandy, gravel, rocky, stony, reedy, marsh and similar areas composed of beaches and coastal sand dunes that the water movements form in the direction of land after the coastline in the regions of seas, natural and artificial lakes and rivers which show low flat coast characteristics; it is the upper bound of slope or cliff in the regions showing narrow-high coast characteristics (Figure 20). This bound is also not changed in case of gathering land through filling. However, in the regions showing narrow-high coast characteristics, the upper bound of slope or cliff is the coastal edge line (Official Jurnal, 1994). While determining this bound, the reedy, marsh, beach and lagoon areas are left on the coast. While determining the coastal edge line in the lakes, it is required to initially determine the coastal line which is the maximum water-level bound belonging to the lake. This level can be requested from the State Hydraulic Works (SHW) with an official correspondence. The coastal edge line is determined by an at-least-5-person commission composed of public officers by the governorships (Sesli et al. 2003, Sesli and Akyol, 2002, Gülez et al. 2007, Akça, 2008)

FIGURE 20: INDICATING WITH THE COASTLINE



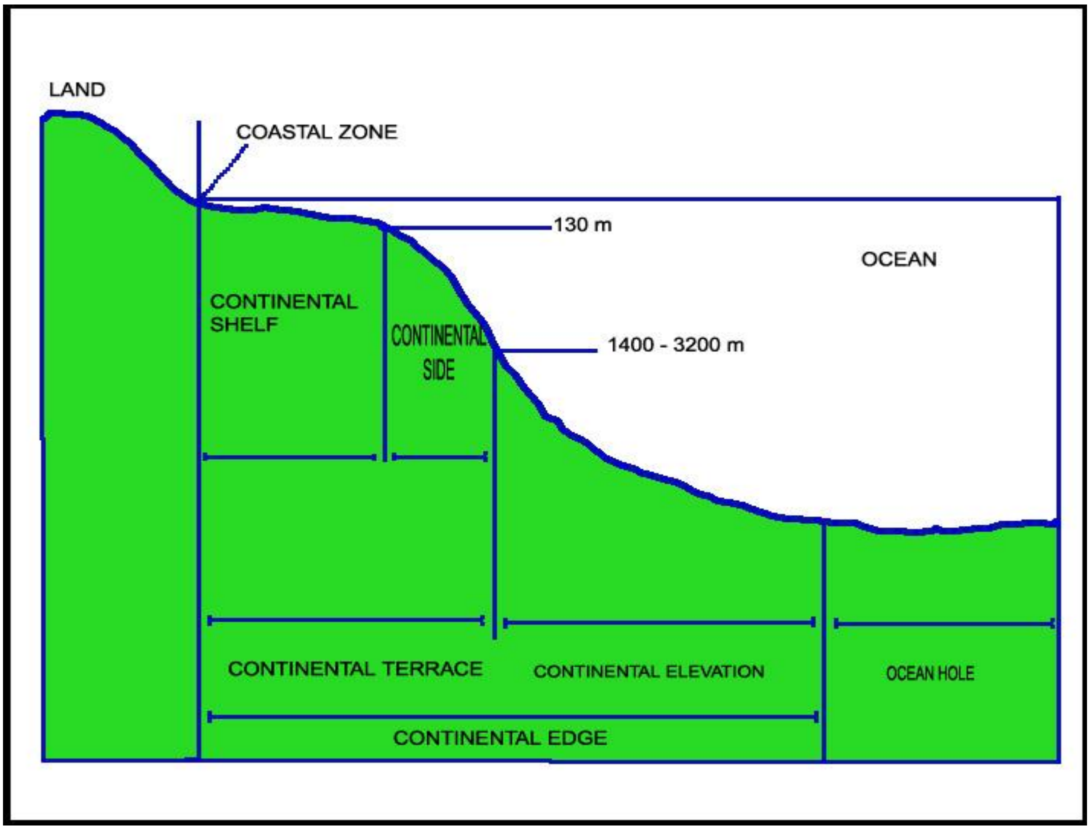
Source: Aykut et al. 2005

1.4.1.4. Coastal Region (Zone)

As in English there is a slight difference between the words of zone and area, the words expressing the coastal region have been used as being combined as zone. As the coastal region does not have a definite meaning, it is known as the land’s regions locating under the sea water and land side that the sea affects and area on the side of sea that the land affects (Erdem, 2006). This area contains coastline and beaches as well as the areas which are far away from the sea such as lagoon; bay and plain (Figure 21). In another words this area is a transition region between land and sea.

Therefore it is not a line, it is in a band structure and the width of this band is not equal everywhere (İncekara, 2001, Jayappa et al. 2006, Bayram et al. 2004). It is hard to determine exactly the borders of the coastal region due to the fact that its width changes according to its location and time. However, this border can be determined depending on the environmental factors. In coastal regions the average width of which is 60 kilometers and cover 15 percent of world's territorial surfaces (Erdem, 2006, Sesli, 2006).

FIGURE 22: THE SECTIONS FOR COASTAL REGIONS

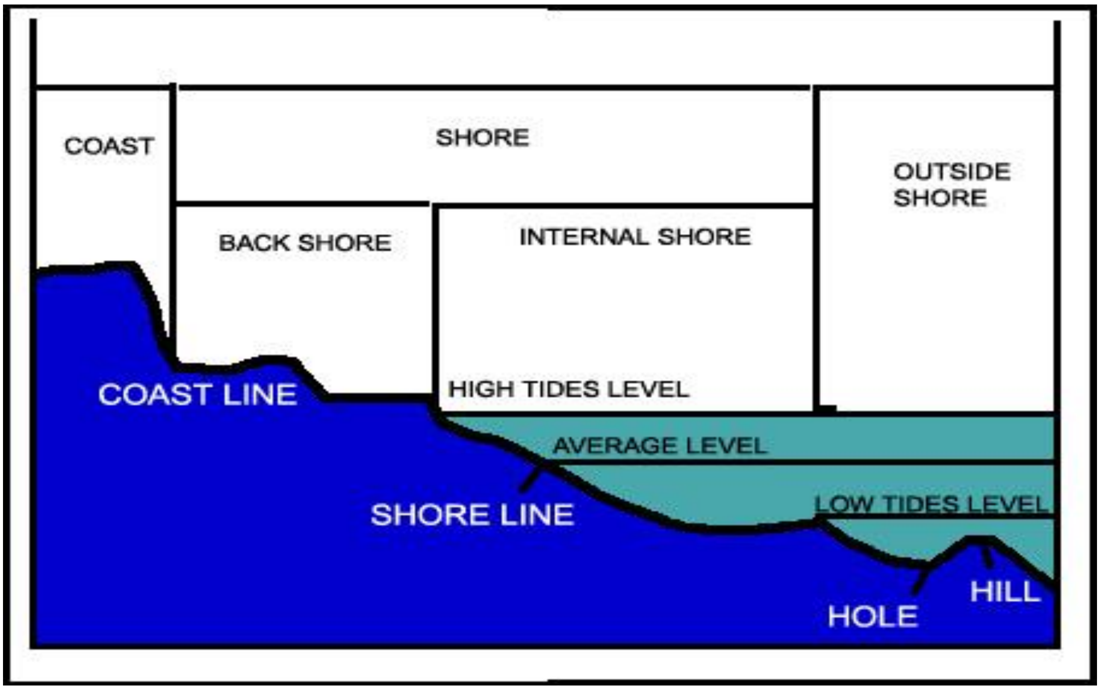


Source: Köksal et al. 2005

1.4.1.5. Shore (Beach)

The region in which the sand spreads between the period on when the water rises at most and lowers at the least due to most the wave motions is called "Shore (beach)" (Figure 23). As the shores are stable zones, their widths can change according to the geological structures. In these areas, waves, tidal movements, winds etc. are effective. Also, the shores can be destroyed by humans to build harbours and residential constructions (Özkan, 2000, Atakan, 2003, Köksal et al. 2005).

FIGURE 23: GENERAL CHARACTERISTICS OF COAST REGION



Source: Köksal et al. 2005

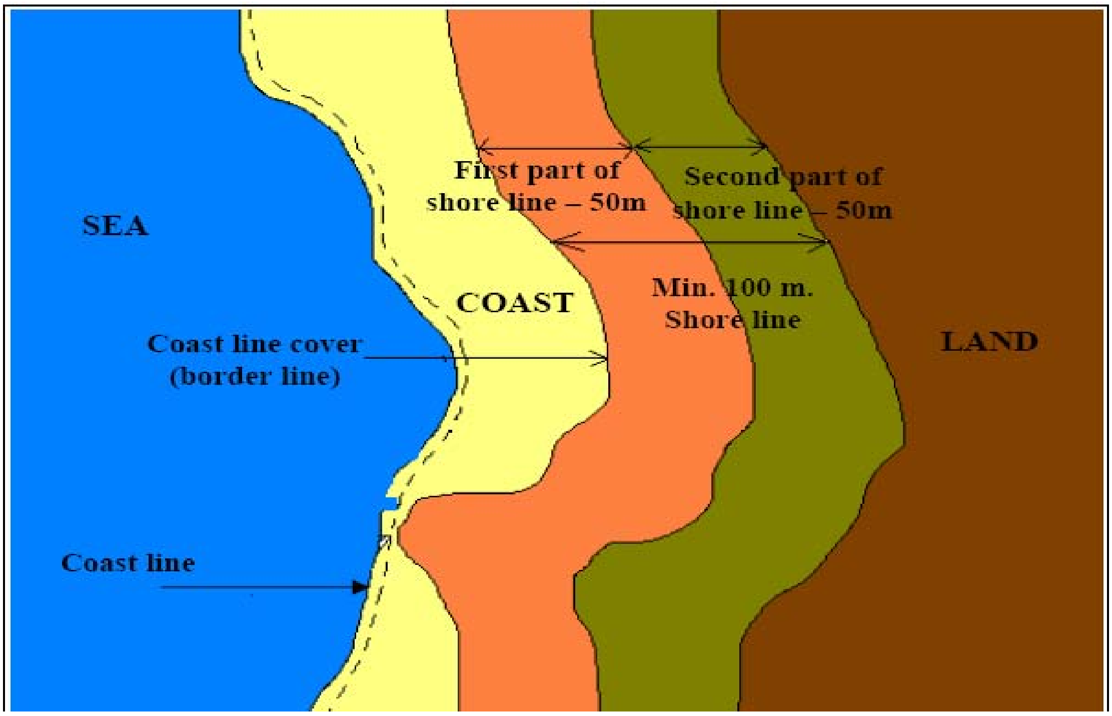
1.4.1.6. Coastal Band

According to coastal law published on the official journal dated 13.10. 1992 number 21374 and application regulation, it is a region which has horizontally at least 100 meters of width in the direction of land as of coastal edge line of the sea, and has natural and artificial lakes (Figue 24). This area is composed of two sections (Official Jurnal, 1990). In many countries the coastal band changes from 8 meters to 3 kilometers. This area consists of two sections: The First Section of Coastal Band and the Second Band of Coastal Band (Sesli et al. 2003, Gülez et al. 2007).

a) First Section of Coastal Band: Is an area in 50 meters of width in land side as of the coastal edge line. This section is only the area that can be used such as open areas, green areas, walking areas, children's playgrounds and any re-creative usages or pedestrian ways (Figure 24).

b) Second Section of Coastal Band: Is an area starting from the first section of the coastal band and going on in the direction of land for at least 50 meters of width. These areas which are open to the community's utilization according to the 8^{th} article of the law says these areas are the areas on which tourism establishment for excursionists, traffic ways, open auto parks and treatment facilities can be constructed (Figure 24).

FIGURE 24: A DIAGRAM SHOW THE COASTAL CONCEPTS



Source: Sesli et al. 2002

1.4.1.7. Continental shelf

It is the section on which the land extends to 130 meters of depth on average starting from the coastal region (Figure 22). However, it has been determined that in some places this section goes on up to 200 meters of depth. The approximate area of continental shelf having 400 000 length of kilometers of length and has been calculated to have 30 billion km^2. This area constitutes approximately 7.5 percent of whole ocean bottom (Köksal et al. 2005, Özkan, 2000)

1.5. Changes Occurred in Coastal Line in the World in the Past and Present and the Reasons of Coastal Line Changes

The coastal areas are important since the first ages of the history and have constantly changed as physically and ecologically depending on natural and human factors. Natural events such as winds, waves and streams are generally effective in the shaping of coasts and changes of coastline. The continents were formed due to the tectonic plates, this is the continents' movements for millions of years (Ersoy and Görüm, 2005). Natural factors in the coastal line changes have been evaluated in three different ways: Short term, long term and episodic changes (Tağıl and Cürebal, 2002). While the effects from the rising and lowering of the tide make the short term changes, the effects that climate changes, periodical storms and waves cause longer term and permanent changes. The short term changes are changes in a period of 10 to 100 years. During this time, coastal region can be affected at the same level. As the short term ones occur in a 5-10 year period, at intervals of a couple of kilometers on the same coast on one side a drawback is observed and on the other side expansion or steadiness of the land can be observed. The episodic changes are the changes that occur as a result of sudden natural events such as storms (Krueger et al 2008, Tağıl and Cürebal, 2002). In addition to natural attributions of the coasts, increase in the world's population every day and a dense pressure of the emerging activities also constitute human effects in the coastline change. These changes that occurre in the coastline and coastal regions generally continue to negatively have a negative affect on human lives, agricultural activities and marine transportation (Bayram et al. 2004, Tai-Wen Hsu et al. 2007).

One of the most important characteristics of the coastal regions is that these areas have change depending on the daily, monthly and seasonal events (Table 9). To determine the changes it is required to observed certain section of the coast at certain times and periods (Van and Binh, 2008).

TABLE 9: SOME CHANGES OBSERVED AT THE COASTS

Infinite Chronograph	Civil Chronograph	Coastal Changings
Millennium		Sea surface to be challenged by icing up
Centuries	Changes in habitation and industry	Historical coast changes. Destruction of the villages and towns
Decades	Coastal Engineering and Protection	Forming habitations, swamps, sand dunes and their destruction
Years	Coastal Engineering and Management Plans	Effects of Protection Activities
Months	Tourism Effects	Seasonal Arragements, forming the shore profile
Weeks	Tourism Effects, Emergency Activities for coastal protection, filling the sea sand out	Formation of the shore profile,Tides during spring time
Days	Emergency Activities to prevent floods	Wind weaves
Hours	Sewage, Garbage	Tides Activities
Minutes		Weaves and streams
Second		Sedimental movements

Source: Duru, 2001

On the coasts which are shaped through erosion and accumulation activities, estuaries, beaches, barrier-reefs, coastal marshes and deltas occur with the shaper forces such as waves, winds and tides (Özdemir, 2004).

In geomorphologic terms, the coasts change depending on the formation of lands. Therefore, the geological structure and morphological haracteristics of the lands have determined the first shape and coastline. In the changes of factors for changing the coastal shapes and coastline, the factors such as the kinds of rocks, type of the coast, tides, etc. are effective. These factors also cause the coastline to be irregular. The coasts can generally be separated into three groups: flat, notched and islander according to the extension of the coastline. The coasts which extend to sea coasts and on which there are plains are called as flat coasts: the coasts that go across long distances and edge inside the lands are called notched coasts: and the coasts formed as a result of sea's filling graves are called islander coasts. Also on the low coasts on which there are plains the coastline has been generally extended literally (Akdeniz, 2008).

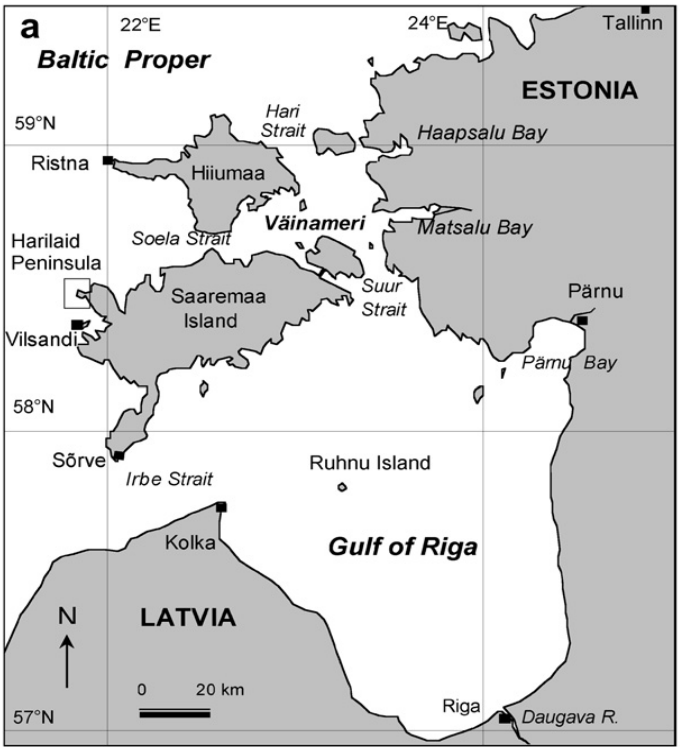
1.5.1. Changes Occurring In the Coastline Worldwide In the Geological Times

The sea levels and coastlines have been continualy to changing for millions of years as a result of the advancement or drawback of melting continental glaciers. The rising of sea level causes the coastline to change and advance towards the direction of land and this situation is more evident in low coasts. As a result, the coastal regions and coastlines have also been changing. The climate changed at the end of Pleistocene and at the beginning of Quaternary of the geological periods and this had had important effects on drawback on the melting of continental glaciers. This and changed the sea levels. Approximately 3000 years ago, the melting of glaciers in the oceans caused the sea level to raise and coastlines to advance towards the direction of land. The sediments belonging to the glacier period accumulated in the river beds in Quaternary period (in which the climate changes occurred at the highest level had caused the previously formed ice layers to enlarge and the sea level to decrease by the drawback of sea). As a result of this, approximately from 30 000 to 19 000 years ago, the sea level had decreased dropped 120-125 meters during the Last Glacial Maximum. As a result of this drop, the places which were previously continental shelves became lands and the rivers reached the sea (in kilometers away from the places that they disembogue today) (Atalay, 2005). For example, Gediz River in Turkey reached the Aegean Sea in the neighbourhood of Karaburun. At that time, the Black Sea with Aegean and Mediterranean Sea were connected and it was a freshwater lake. The glacier and river sediments also gathered in sea bases which are continental shelves now. Due to the fact that in the period of 120 thousand years from the Last Interglacial of geological periods to the beginning of Holocene the temperatures were 2-3 °C higher than today, it was observed that the global sea level was close to today’s sea level. Also, due to the fact that approximately 50 million km3 of water was transferred to the oceans from the end of the last Glacial Maximum in period when the sea level reached its acual position, these sediments nowadays are continuing to be effective in the coastal shaping by being activated with the tidal streams again (Özkan, 2000, Bekaroglu, 2008).

In the period glacier age up to today (approximately 15 000 years) the sea level has risen more than 100 meters. It is estimated that this rising sopped approximately 6000 years ago. The rising of the sea level has caused the shores to remain under water especially in low coasts.

It has been determined that there are changes in the coastlines especially in the regions close to the poles and that these changes depend on the sea level rises in the geological periods. For example it has been determined that as a result of melting of the glaciers in Saaremaa Island in Baltic Sea and in the west of Estonia during the glacial period, the sea rose 2 - 2.5 mms. and the coastline drew back (Figure 25), (Suursaar et al. 2008). Also, 18000 years ago the sea level increased 120 - 130 meters with the melting of glaciers in the Northern America and Northwestern Europe coasts. 12 000 - 10000 years ago, the Persian Gulf and Australia's Carpentaria Gulf was formed during the rising of water and advancing towards the land (Lambeck, 1996).

FIGURE 25: A COASTLINE IMAGE FROM SAAREMAA ISLAND



Source: Suursaar et al. 2008

1.5.2. Reasons of Coastline Changes

The coastline formed of the conjunction of the points on which the water touches the coast at the times when the sea is still have constantly changed through natural and human ways. The most important natural factors affecting coastline are composed of climate, waves and streams, tides, rivers, winds, erosion, tectonic events, and effects of landslides and glaciers. The human factors are fillings made for recreaction, tourism or road construction, breakwaters constructed with the aim of decreasing the wave effects, the harbours constructed for transportation, extracting sand from the coast for various purposes and construction of secondary domiciles and holiday sites (Table 10), (Boak and Turner, 2005).

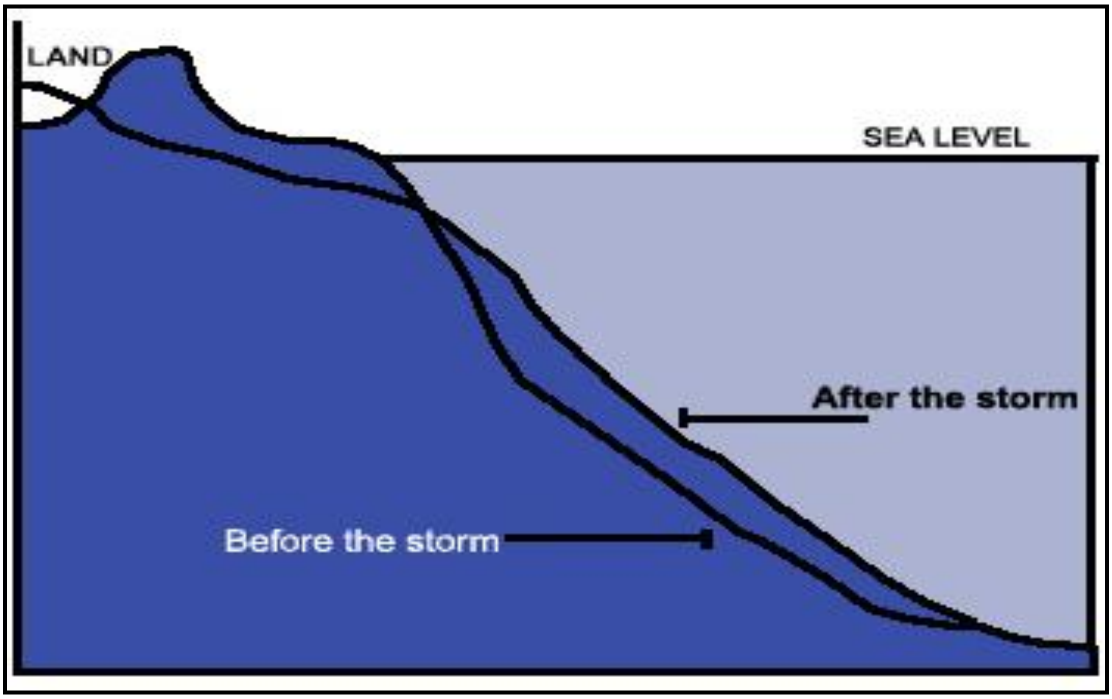
TABLE 10: FACTORS AFFECTING THE COASTLINE CHANGE

Natural factors	Human factors
• Erosion • Waves and Streams • Climate and Glaciers • Tectonic Movements • and Landslides • Tides	• Human activities

1.5.2.1. Change in the Coastline Due to Erosion

Coastal erosion is a global problem which is effective in 70 percent of the coast worldwide. In the last century, only 86 percent of American western coasts (out of coasts where barriers were constructed) were affected from erosion (Zhang et al. 2004). In searches related with the coastal erosion it has been determined that erosion is a threat for North Atlantic region where population is dense and where 85 percent of coastal line is private (Köksal et al. 2005). The storms and hurricanes are main factors for coastal erosions. These winds have destructive effects especially on the beaches with rocky coasts and gravel area formed by the beach sediments. Sediments in coasts are easily carried, abraded by streams and waves which are formed by strong winds and storms. However, there are significant differences between winter and summer months. Since coasts are covered by larger areas of sands the small summer waves make a vertical coast surface. Since the majority of sand is carried by bigger and stronger waves formed by storms, coasts have a smoother appearance (Valvo et al. 2005 and Köksal et al. 2005).

FIGURE 26: COASTAL CHANGES OCCUR BY LOCAL STORMS



Source: Köksal et al. 2005

Since the drift caused by the waves formed by the storms are vertical and towards the sea and leads to erosion, the coastline is drawn backwards (Figure 26, 27). The drawback of the coastline towards the land is important since it displays erosion in the coastal region.

While the sediment drift which is formed vertically to the coastline causes short time period differences in the coastline, the sediment drift along the coastline causes long time period abrasion in the coastal regions, and coastline changes due to filling (Kırkgöz, 2002).

In a researche made in Sagar Island of India, it has been determined that erosion which is effective in an area of 2.65 square kilometers and has increased to an area of 11.55 square kilometers. Natural events such as tides, waves, storms very common in this region have great effects on erosion. A sediment accumulation of 3-11 meters of height and 12 kilometers of area has occurred in the western and northern parts of the island (Jayappa et al. 2006).

During the investigations that was made with the Geographic Information Systems and Remote Sensing between years 1981-2002 in Kunduchi Manyema Bay which locates in northern part of Dar Es Salaam port in Tanzania, it was determined that 2.62 ha of land was abraded because of the tides and seasonal winds. Most effective erosion occurred in the mouth of a river in Kunduchi Manyema between years 1981-1992. While the width of the narrowest place in the mouth of the river was 79 meters in 1981, this value reached 325 meters in 1992. Because of effective erosion, the hotels in Silversands and Kunduchi shores were drawn 50 meters back from the coastal line (Makota et al. 2004).

FIGURE 27: ROCK AND SOIL FILLL MATERIAL ON THE ESPLANADE EXPOSED BY DUNE EROSION

Source: Epa, 2004

Recently, because of rise in the water levels, and storm formation; several methods have been developed against the wave effects and floods. As shown in the Figure 28, 29 the artificial beaches, coastal renewing structures such as breakwaters, shear walls, cutwaters, and coast walls constitute these structural solutions. For example almost 2000 square kilometers of area in English coasts are protected by such flood protection system (Turner et al. 2007, Yüksel et al. 2005).

FIGURE 28: COAST WALL


(

Source: Yüksel at al. 2005

FIGURE 29: Y-MAHMUZ

Source: Yüksel at al. 2005

1.5.2.2. Change in the Coastal Line Depending On the Waves and Streams

The waves, are important factors in the coastline change are formed by the winds. The waves' speed and height decrease when they go from deeper waters to shallower water. Waves are also not as large as the ones in the seas because of the distanceof the wind blowing. The larger waves occur in the oceans. The most important property of waves is that they break when they come closer to shallow water and coasts. Movement of water is toward beach in broken waves. While the drift towards the sea and vertical to the coastal line causes erosion, the drift towards the coastal line forms accumulation. However this effect decreases where there is breakwater and docks. Since the sand is carried from the water to the land by waves, the beaches are larger and longer in summer. The beaches become smaller and smoother in winters. The sand which is carried from the beaches is accumulated apart from the beaches. This situation causes seasonal changes in the beaches (Köksal et al. 2005, Türker and Kabdaşlı, 2002).

When waves become closer to the coasts, they break in different angles. The waves which break in parallel angle to the coast cause material drift along the coast, the waves that break with perpendicular angle with the coast cause solid material accumulation in a vertical angle with the coast (Arı et al. 2007).

The effects of waves in the coastal areas are different in sand dune and rocky areas. The changes in rocky coasts cause temporary changes in the morphological structures. However since changes caused by waves in sand dune areas formed by gravel and sand are not permanent they can return to their former situation (Türker and Kabdaşlı, 2002).

Waves that come in any angles to the coast form parallel or vertical streams. These are called limit streams and have a north-south direction. The limit streams in west direction are the biggest of surface streams. The limit streams have more variable properties than ocean streams. The tide streams caused by tides are horizontal water movements. However tide movement does not occur in every coast where tide occurs. These streams formed by the tides and waves carry sediment to the coasts and shallow waters, and shape and change coastlines. Since streams and waves move together in coastal regions sediments which were taken by waves are carried by the streams. Therefore 10^9 tons of sediment is carried by means of the waves and streams (Köksal et al. 2005, Türker and Kabdaşlı, 2002). According to researches, 42 percent of American coasts out of Alaskan coast are abraded by waves. The most abraded places are coast line of America where 85 percent of coastal line is personal estate (Özkan, 2000).

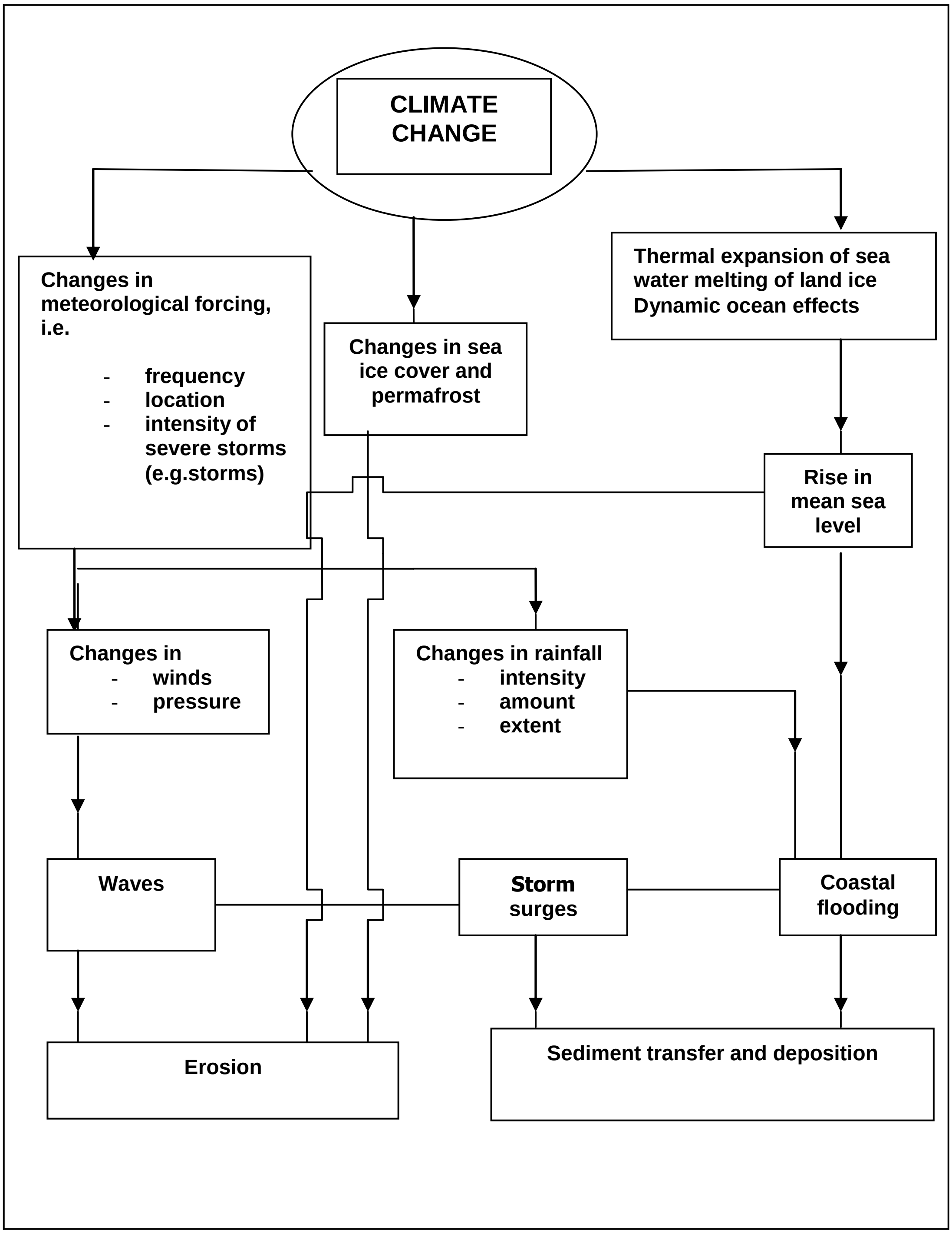
Notwithstanding, since the waves shape the surface in different ways like erosion and deposition, the coastlines and beaches are getting well without humankind interference.

1.5.2.3. Change in the Coastline Due To the Climate and Glaciers

From the beginning of humankind history up to now, the Earth was covered with glaciers and natural and human environments were majorly affected from this. For example, 20000 years ago the northern part of the European continent was covered with glaciers. Sea level was lower 125 meters converning the stream level. As a result of this Siberia and Alaska were joined and become one land. This period lasted 4000 years, then glaciers started to decrease and temperature started to increase. Recently world faces with global warming and climate changes because of gases released in the atmosphere by human kind. Effect of global warming is more than a geomorphologic event in sea level rise (Goudie, 2000). The effect of energy consumption and production over global warming is 36 percent, industrial activities is 24 percent, forestry is 36 percent, agricultural activities is 9 percent and other sources is 3 percent (Uğurlu and Örçen, 2007). These climate changes will cause changes in agricultural activities, natural living areas of animals and plant, and will cause negative effects especially in water sources and coastal regions (Öztürk, 2002). The coastlines which are most affected from climate changes change their location during the year due to sea level rise. When the sea level rises 1cm, the coastal line changes 100 cms towards the land. In recent years, the sea level rised due to the increase in global temperature and with respect to this a 50 cms rise in sea level is estimated by the end of 21st century. Also there will be 0.5 meters of rise because of melting in the Antarctic and Greenland caused by the sudden climate change. Because the sea level rose with a rate of 0.15 mms/year in the last 130 years. Increases in the rate of 5-30 % in the last 100 years is caused by melting in Greenland (Houghton, at al. 2001). Since the levels of lagoon lakes located on the coasts will raise 50 cms because of the rise in sea level, it is thought that the coastlines will advance 2500 meters towards lands. Meanwhile by joining of the adjacent lagoon lakes, bigger and deeper lagoons will form. It is predicted that grass areas and agricultural fields will be covered by water around the lakes in such places (Uzun, 2006).

The water in the oceans declined and sea level decreased because of cold in quaternary period due to climate change that occurred nearly 2 million years ago. As a result of this places which were continental shelves before have risen as lands in shallow seas. For example, 80000 or 20000 years ago, the sea level decreased 110-120 meters comparing to its former level. The glacier sediments which were formed during this process were accumulated under seas which are now continental shelves. These sediments move because of the storm waves and tide streams, and are effective in the coastal changes by causing erosion (Table 11), (Goudie, 2000, Özkan, 2000).

TABLE 11: THE RELATIONSHIP BETWEEN CLIMATE CHANGE AND COASTAL CHANGE

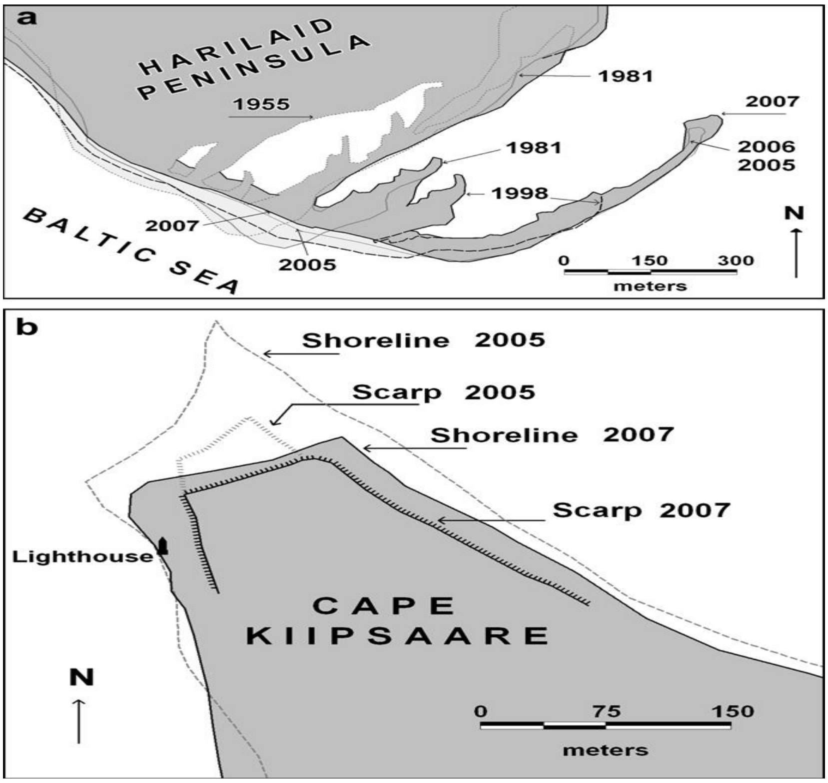


Source: Goudie at al. 2000

Recent, researches have been determined that there are changes related to the climateall around the world. The most significant of these can be seen near to the Polar Regions. In places near to Polar Regions and especially in the coasts of Baltic Sea, the sea level increased due to the melting of glaciers caused by temperatures increase bcause of climate changes when compared to the first periods. As a result of this, the coastline boundary changed in many places. As it can be seen in Figure 15, in the measurements taken in summer months between 2005 -2007, the drawbacks in the coastal lines have been obviously determined as 15 meters in the western side, 30-50 meters in the northwestern side, up to 130 meters in the northern side and 10-20 meters in the northeastern side of Cape Kiipsaare. The cliffed region, locates in the northern and northeastern part of the region, moved 35-50 meters backwards. The average height of the cliff is 1 meter and average sediment amount which subjected to erosion is 3000 or 4000 m^3 (Figure 30), (Suursaar et al. 2008).

The lower coasts and location places in these regions will be the places that immediately suffered from the probable sea level increase in the entire world. In a recent survey it has been determined that 17 percent of coastlines of Çanakkale will be affected from the probable sea level increase (Koç and Öztürk, 2007).

FIGURE 30: CHANGES IN COASTLINE AT CAPE KELBA

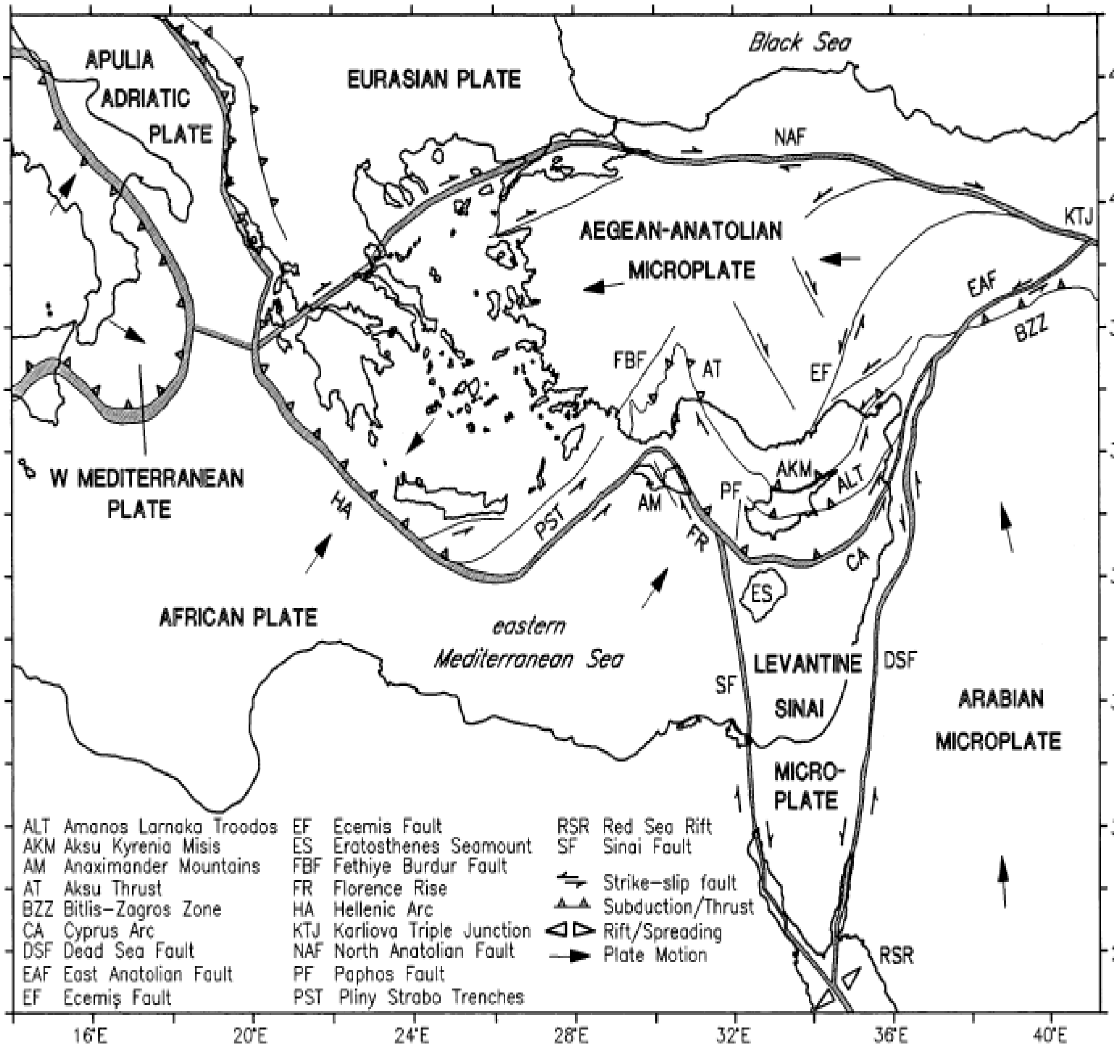


Note:Changes in shoreline and contours of old beach ridges at cape kelba (a), changes in shorelines and scarp contours at cape kiipsaare (b) between summers 2005, 2006 and 2007
Source: Suursaar et al. 2008

1.5.2.4. Coastline Change due to Tectonic Movements and Landslides

Instantaneous and vertical tectonic elevations on the coastal regions lead to vertical movements on the shorelines as well. Most prominent example for these movements took place on the East Mediterranean coasts, between 4th century AD and 6th century AD, during a 200 year period. According to the seismic data from the historical records and to the radiocarbon dating, carried out on the samples from elevated shorelines detected in certain coasts of Greece, Turkey, Syria and Lebanon, an area of at least 1500 km. long in East Mediterranean has elevated 0.5 - 1 meter due to a high seismic activity called Early Byzantium Tectonic Paroxysm. The maximum elevation in the shoreline was on the south west edge of Crete. The main factor is claimed to be the collision between African Plate and Aegean-Anatolian microplate (Fiure 31, 32), (Bekaroglu, 2008, Lambeck, 1996).

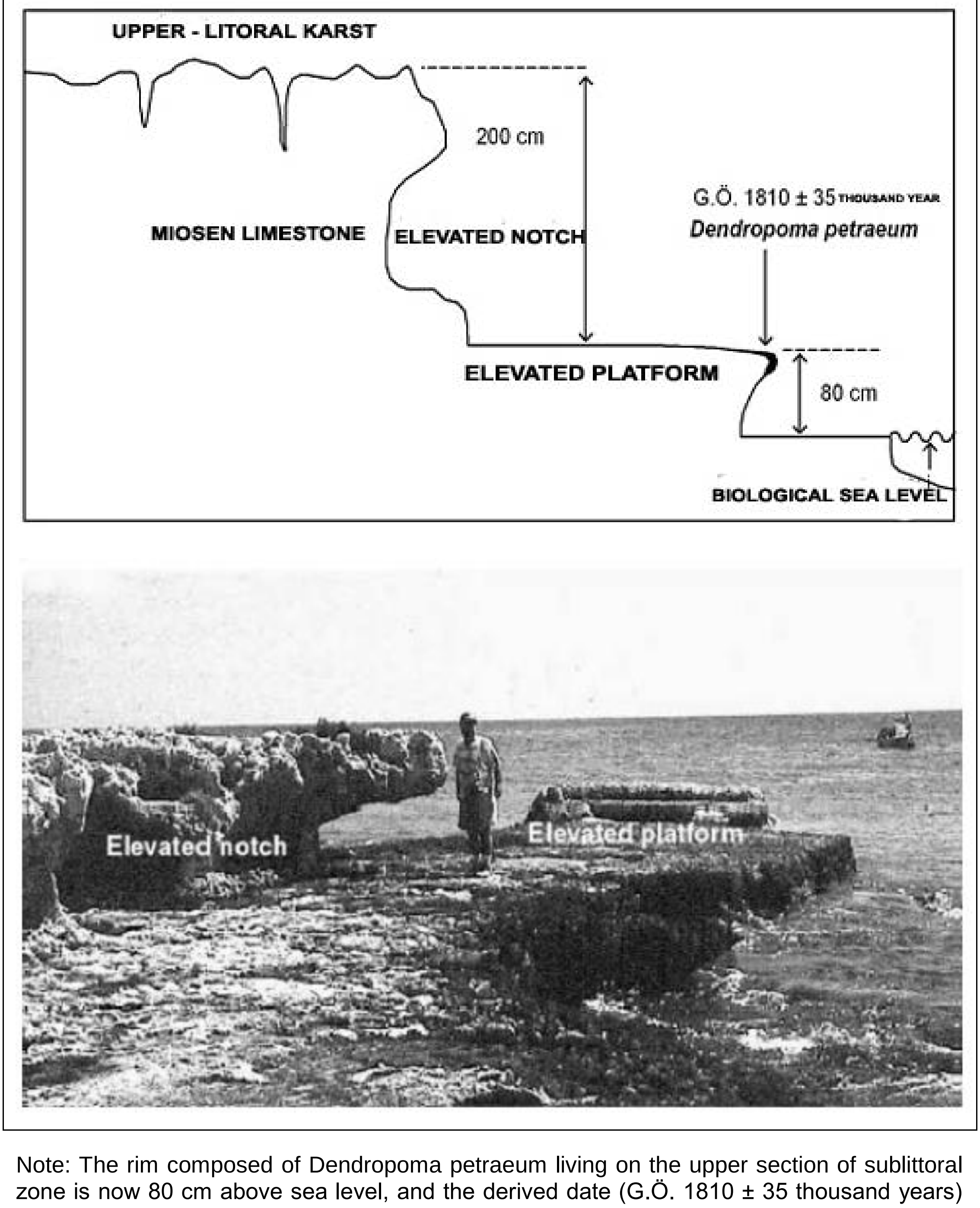
FIGURE 31: SIMPLIFIED TECTONIC MAP OF THE EASTERN MEDITERRANEAN SEA AND SURRAUNDING REGIONS



Source: Aksu, et al. 2005

Note: Localities (black points) of elevated shorelines during ebtp (according to various resources) and their elevation values (in meter). **AM:** Anaximander Mountains, **BDZ:** Bitlis-Zagros Zone, **EAFS:** East Anatolian Fault, **ED:** Eratosthenes Sea Mountain, **FY:** Florence Rise, **SAA:** South Aegean Arc, **NAFS:** North Anatolian Fault, **RSR:** Red Sea Rift, **KY:** Cyprus Arc, **PST:** Pliny-Strabo Trenches, **DSFS:** Dead Sea Fault. The larger arrows illustrate the movement direction of the plates, and the small arrows illustrate the pitch direction of the faults (Bekaroglu, 2008).

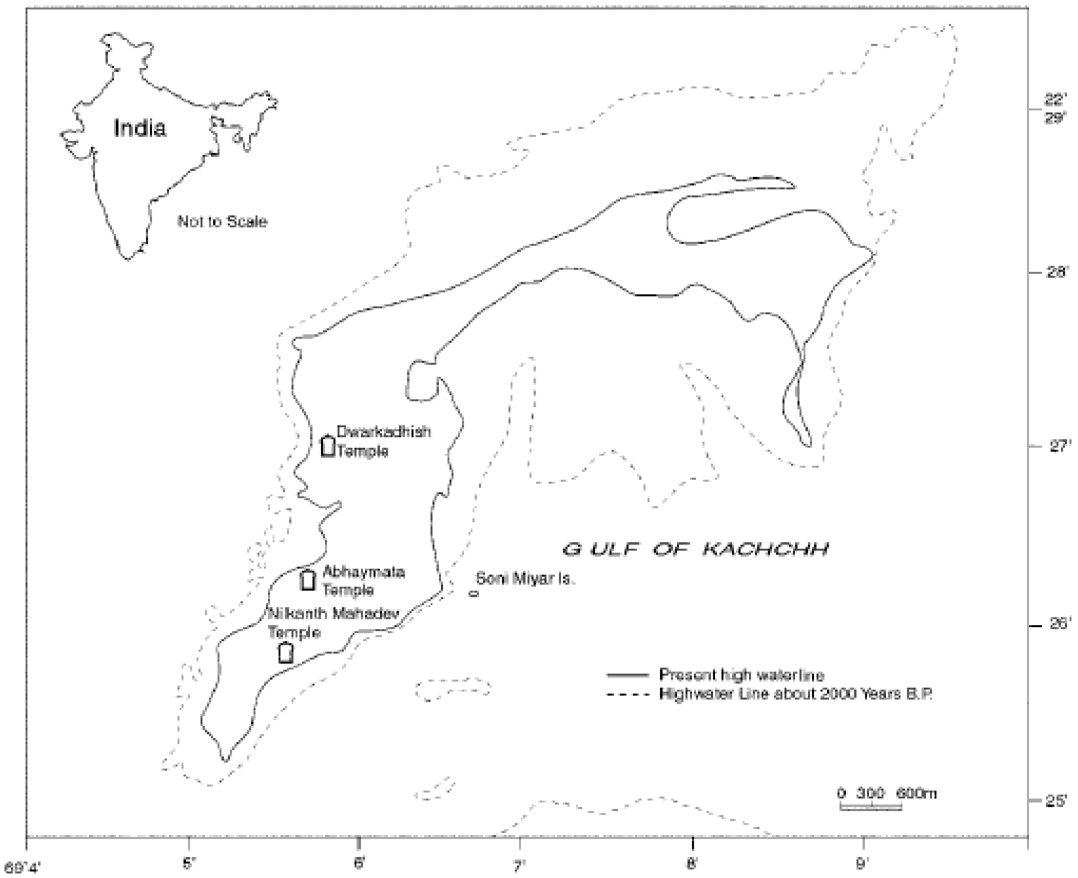
FIGURE 32: ELEVATED NOTCH AND PLATFORM ON LEBANON (TRIPOLI) COASTS



Note: The rim composed of Dendropoma petraeum living on the upper section of sublittoral zone is now 80 cm above sea level, and the derived date (G.Ö. 1810 ± 35 thousand years) indicates the elevation date of the shoreline (Bekaroglu, 2008)

According to data obtained from archeological excavations in many historical cities around the world, tectonic movements had an influence on changes of shoreline in many countries and human settlement in coastal regions. For example, Bet Dwarka Island on the west of India has changed, in the last 2000 years, being subject to erosion due to rise of the sea level caused by tectonic movements (Figure 33), (Gaur et al. 2007).

FIGURE 33: POSSIBLE OUTLINE OF BET DWARKA ISLAND DURING 2000 YRS BP



Source: Gaur et al. 2007

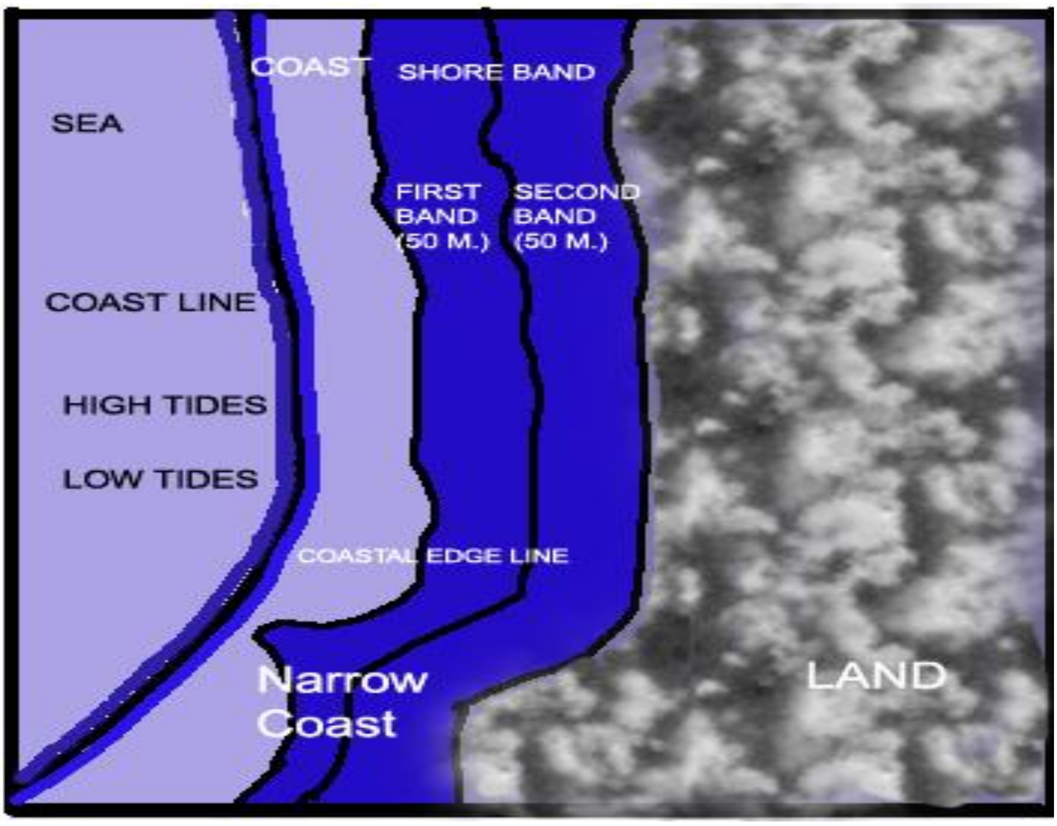
Moreover, in oceans and seas, huge waves, called tsunami, are formed due to tectonic movements. The term 'Tsunami' was first used after the tsunami event, which took place in Japan, in June 15, 1896 and caused 21,000 dead (Şeker and Kabdaşlı, 2002). Meaning 'harbor waves', tsunamis are formed due to collapses, landslides, volcanic movements, earthquakes and land slips at the bottom of the seas and oceans resulting in big vibrations or mass movements on the water surface, which in turn leads to huge waves on the coasts. This causes important damage on the coasts and changes on the coastlines (Gedik et al. 2005). For example; the tsunami, which occurred in December 26, 2004 in Indian Ocean, rised the Malesia coast in 3.5 meters length caused 68 dead and resulted in damages on coast structures, estuaries and facilities in various levels. In three regions where the total coastline length is 200 m, it caused 61 dead (of 68 in total) (Yalçıner et al. 2005).

Generally emerging in big seas and oceans, these waves may also occur in the inland seas such as Sea of Marmara, where the water mass is low. For example; the historical data shows that more than 20 tsunamis occurred in te Black Sea. The presence of land slips on the slopes close to the coasts, as indicated by the studies carried out in recent years regarding the subsoil of Sea of Marmara, confirms this argument (Gedik et al. 2005, Cığızoğlu et al. 2007). Kocaeli earthquake of August 17, 1999 in Turkey is one of the last examples for tsunami as a coastal region disaster. It has been detected that the fields previously filled in and shallow shores on the coasts of Sea of Marmara have been submerged in water, and that there have been important changes on the shoreline (Şeker and Kabdaşlı, 2002). According to the historical data, within the 3500-year period, from 1500 BC to today, the researches have detected the impact of more than hundred tsunami waves on Turkish coasts, 8333 km. in length (Alpar et al. 2005).

1.5.2.5. Coastline Change Due to Tides

Periodical and predictable eustatic movements of the sea level happening during a day in certain time intervals are called “tides”. The main that cause tides are; interaction of the sun and the moon, and rotation of the earth. Especially on low coasts, tidal movements cause the coastline to move meters inwards or outwards (Figure 34). For this reason, in many countries sensitive tide measurements are carried out continually on the coastal regions, and structuring on the coasts are executed accordingly (Köksal et al. 2005, Turner, 2006) Figure 43 illustrates coastline changes due to tides.

FIGURE 34: COASTLINE CHANGE DUE TO TIDES



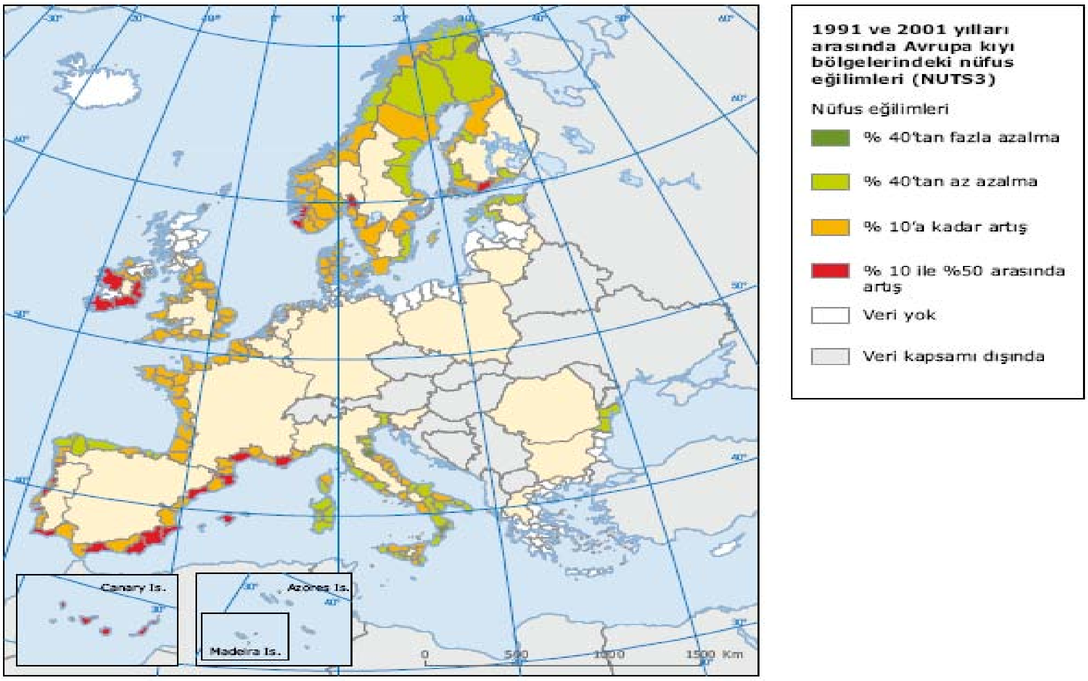
Source: Erdem, 2006

1.5.2.6. Coastline Change Due to Human Factors

Human beings have been most influential on the land utilization from the past years up to present days. Starting from the day when they passed to permanent settlement, the human beings have continued their transformation and evolution, accelerated by the industrial revolution in the 18th century, in especially in coastal regions due to the convenient resources they offer. As one of the most important areas for human beings since the first ages, the coastal regions change not only due to natural events but also due to the damages caused by human beings' utilization disturbing the natural balance (Gaur et al. 2007, Makota et al. 2004). Ecological structure of the coastal regions are disturbed by insensibly taking of sand from the sea, filling in for various reasons (residents, industry, commerce, agriculture, recreation, etc.), construction of breakwaters and coastal structures, etc. and these lead to coastal erosions (Aykut et al. 2005, Turan et al. 2008).

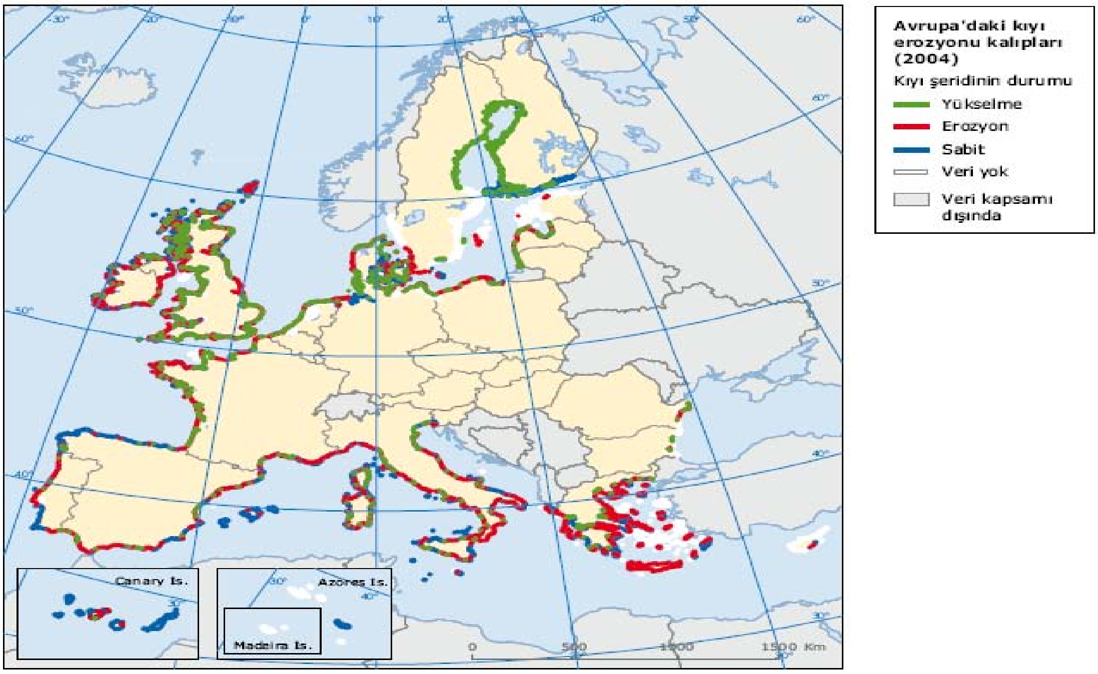
As approximately 1 billion of the world population (40 – 60 %) dwells in shorelines, amounting to 100 km in length, due to the convenient resources offered, many coast cities are confronted with intense coast utilization issue as a result of overpopulation (Mackenzie, 2003). In European countries, where the coasts are intensely used, the population density is 10% more than that of upcountry. This figure has reached up to 50% in countries bordering the Mediterranean Sea, such as France, Spain and Italy. Portugal, Netherlands and Belgium coasts are also regions where European population is dense. 61% of the coasts in European countries are used for residents, service and entertainment sectors and artificial sites, which cause the shoreline change (Figure 35, 36), (EEA, 2006).

FIGURE 35: 1991 AND 2001 POPULATION CENSUS



Source: EUROSTAT, EEA, 2006

FIGURE36: EROSION AS PER 2004



Source: EEA, 2006

1.6. The Importance and Utilization of the Coasts Today

Since the ancient ages, coasts and coastlines have always been the most dense and most important areas of the world with respect to economy and culture, and have provided resources for the economical and social development of societies and countries (Chen and Rau, 1998). For example; In European Continent, where the most developed settlement areas of the world are highly dense, the fact that the most distant point to the sea is 350 km. in Central Europe and 700 km. in Eastern Europe, has enabled to benefit from the natural resources and to easily conduct the sea commerce and transport (Duru, 2001).

Settlement areas are present on 60% (600 thousand km.) of world coasts, which in total is 1 million km (Özkan, 2000, Ergin, 2002). Approximately 2/3 of the world population dwells on the first 60 km. section of coastal regions, which are transition areas between sea and land (Sesli et al. 2006, Köksal et al. 2005). Taking into account that the world population will reach 8.5 billion in 2050, the density on the coastal regions is expected to be much higher (Sesli, 2006). According to the researches by United Nations Organization, in 30 years 3/4 of the world population, e.g. approximately 6.3 billion people, is expected to inhabit the coastal regions. Today, approximately 1 billion people populate urban settlement regions on coasts. The large part of this ever-increasing figure is composed of developing countries. For example, the coasts of Brazil, from Rio de Janeiro to Sao Paulo, are expected to be totally transformed into urban settlement areas by 2010. According to World Bank data of year 1994, 2/3 of the population of developing countries are estimated to inhabit coasts by the end of 20th century (Duru, 2001).

According to various researches, the population on coastal regions today equals to the entire world population in 1950. Total population of coastal regions constitutes 50-70 % of the world population. For example; the population density average of coastal regions in United States of America is calculated as 5 times higher than the other regions (Sesli, 2006). According to the research by National Oceanic and Atmospheric Administration regarding the population density on American coasts, the population on US coasts increases expeditiously. 30 of the 50 states in US are on coasts. The researches carried out have illustrated existence of a similar status in Europe. 200 million people out of 680 million in Europe dwell on a 50 km coastline (Duru, 2001). Evaluated in the light of these data; having provided nutrients and a secure environment for human beings at the beginning, coastal regions in the subsequent ages seem to have gained importance as well, with respect to industrial, commercial and residential considerations (Jayappa et al. 2006). Today, coasts became a focus area in the sense of vacation and protection. As it is seen, because the coastal regions provide natural habitat for many species and human beings, they always confront with intense demand and interest, and these regions continue to be the center for industry (refineries and power plants), commerce (harbors), fishery, shipping, tourism, transportation, agriculture, waste material disposal (municipal and industrial waste), raw material supply (mines, sand, aggregate), defense, recreation, health, energy and sport activities (İrtem and Karaman, 2004, Turan et al. 2008). This excessive number of activities related with coasts enables the coastal regions to develop very fast and causes, especially in urban regions, occupation of coasts.

Generally, the coasts bordering to seas, which cover 360 million km² of the world surface (Özkan, 2000), are directly or indirectly utilized; Industry, transportation and tourism are examples for indirect utilization, and utilization by every segment of society for recreation and entertainment purposes provides an example for direct utilization (Ergin, 2002, Atakan, 2003).

It is possible to classify the coastal regions into the following categories, depending on their potential values and utilization purposes.

1) Utilization of the Coasts for Industrial Purposes
2) Utilization of the Coasts for Tourism Purposes
3) Utilization of the Coasts for Recreational Purposes
4) Utilization of the Coasts for Residential Purposes
5) Utilization of the Coasts for Transportation Purposes

1.6.1. Utilization of the Coasts for Industrial Purposes

As a natural wealth resource, today coasts are the industrial and commercial centers. 50% of the world population employed in industry sector lives in the coastal regions. Every year this population grows by 1.5% (Turner et al. 1996). Given the fact that transportation facilities are critical for industrial activities necessary for the development of countries, as an intersection of marine and land transportation, coastal regions become preferred sites. Industry sector prefers immediate surroundings of harbors, due to the storage capabilities and ease of transportation. For this reason, most of the important industrial cities in the 19th century were on coastal regions, as it is the case today with İstanbul, Los Angeles, New York, Rio de Janeiro and Roma (İncekara, 2001). London, New York, Buenos Aires, Sydney are a few examples (Atakan, 2003). In addition, another reason why coastal regions are preferred sites for industry is the ease of raw material (aggregate, sand, etc.) provision and waste material disposal (Sesli et al. 2002). However, sea, land, air and coastal pollution substantially increase on coasts where industrial activities are dense.

Today, coastal regions are in serious danger due to industrial wastes, and rivers and streams transporting solid substances. These waste materials not only create pollution, but also cause the extinction of species in nature. For example, destruction of coral reefs causes devastation of living spaces of the fish species, which in turn diminishes calcareous sediments and leads to economical and social damages. According to recent studies, pollution as a result of excessive nitrogen and phosphor make up 70% of the total pollution (Mackenzie, 2003).

1.6.2. Utilization of the Coasts for Tourism Purposes

As the natural resources are the most utilized and consumed areas for tourism, coasts as natural resources are like the cornerstone of tourism. In general, tourism activities can be classified as activities for religion, health, science, nature, and recreational purposes. As in general coasts are preferred for recreational tourism, one of the most favorite tourism activities, tourism activities in coastal regions of developed countries constitute an important income resource and represent the fastest growing industry sector (Atakan, 2003, Alonso et al. 2008). Mediterranean coasts, South Florida and Caribbean Islands can be given as example. As the population increase rate in these coasts is much higher compared to other regions, every year new vacation sites are constructed.

The utilization of the coasts for recreational purposes dates back to 1800 (Turan et al. 2008, Atakan, 2003). After 19th century, meeting with larger masses, tourism activities substantially increased upon Second World War, especially in 1960s (Ongan, 1997), and became a major economical sector in 20th century with the help of the developments in communication and transportation technologies (Duru, 2001). Today, the most important recreation and tourism centers of the world are on the coasts. However, the fast increase rate of world population leads to the increase of interest in especially sea tourism and causes intense and sometimes uncontrolled utilization of the coasts. As a result, coasts change and lose their natural appearance. However, with the change in perception of tourism started in recent years, there is certain shift from classical tourism concept to the innovative tourism concept. It is observed that the tourists today mostly prefer innovative tourism concept, which represents the utilization of tourism regions in their natural state (Yüksel et al. 2005). As seen in table 12, because the natural habitat conditions are very fundamental in innovative tourism concept, utilization of coastal regions in their natural state is popularized.

TABLE 12: CHANGES IN TOURIST REQUIREMENTS

Understanding of Standard Tourism	Understanding of New Tourism
Air fields	Sand hills
Main roads	Water areas
Hotels	Clean water
Park areas	Birds
Eat to ready	Fish
Alcohol	Bike paths

Source: Yüksel et al. 2005

The regions presenting clean and healthy living conditions, in general are the areas where the natural beauties are preserved. As most of the regions where these conditions are met reside on coasts, these regions constitute the cornerstone of the tourism sector. For this reason, the coasts in countries which feature natural beauties, convenient climate and rich historical assets, have become points of attraction for tourism today. For example, in Turkey, one of the countries featuring the above mentioned characteristics, tourism activities are mostly coastal tourism. Coastal tourism in Turkey was especially encouraged after 1980, however today; excessive utilization and density on the coasts require new precautions to be taken (Kılıçaslan, 2006). As a result, whilst tourism can substantially contribute to the economy of the country, it can also cause various direct or indirect damages to the natural environment, in case no precautions are taken. However, as most of the tourism activities are on coastal regions, the damage in these regions are much more compared to others. For example, construction of hotels and other tourism related buildings along the coasts, development of the infrastructure to meet the needs of the increased population, works undertaken to fulfill basic necessities such as transportation and energy, cause the destruction of the natural structure of these regions (Duru, 2001).

1.6.3. Utilization of the Coasts for Recreational Purposes

Recreation is all the activities performed by human beings for relaxation, refreshment and entertainment purposes in leisure times (Özdemir, 2004). Today, recreation activities are very important for people working in intensive tempo in cities with high population. Issues of the urban life such as noise and environmental pollution, due to technological developments, lead the people to communal areas in coastal regions, which in turn decrease the natural recreation resources on the public shorelines (Alonso et al. 2008).

Favorable climate, attractive aesthetical characteristics, positive impact on the human health and ease of transportation play a great role in why the coastal regions are preferred for recreational purposes (Atakan, 2003, Gülez et al. 2007). Activities such as swimming, fishing, sunbathing, reposing by the sea are also influential on utilization of coasts for recreational purposes. As the coastal regions in all over the world are excessively utilized for these attractive characteristics, Sweden was the first in Europe to legislate a law to protect coasts. Then a coastline of 300 m. is provided for public utilization. Moreover, as awareness of recreational potentials is very important in order to ensure utilization-preservation balance for the coasts, in New York, the largest city of United States of America, a detailed work has been carried out for land utilization along the 578-mile coast, taking into account the value of the natural resources (Özdemir, 2004).

As the most important aesthetic and visual point in recreational activities is water, the users select water as primary visual and aesthetical value. In addition, as special coast arrangements are carried out in coast utilization for recreational purposes, the land in the coastal regions are changed in order to provide more regular shorelines. For example; Kuching coast in Malaysia Saravak, Parc Del Litoral in Barcelona (Figure 37, 38), (Özdemir, 2004).

FIGURE 37: AN IMAGE OF PARC DEL LITORAL, BARCELONA

Source: Özdemir, 2004

FIGURE 38: KUCHING COAST, SARAVAK MALAYSIA

Source: Özdemir, 2004

1.6.4. Utilization of the Coasts for Residential Purposes

As water and coast have always been very important for human life since the ancient ages, most of the ancient civilizations are built in regions bordering to water. Rich resource potential, convenience of transportation and climate made the coastal regions points of attraction as residential areas for centuries. In ages where living conditions were severe, irrigated farming and animal breeding activities and defense capabilities provided by seas have made the coasts as preferred residential areas (Gülez et al. 2007, Atakan, 2003). The researches indicate that the majority of the cities in ancient Greece have developed on coasts, and that cities in Roman Empire have been accumulated on the coastal regions according to the maps (Duru, 2001).

Today the coastal regions are still the most important and utilized areas; because they provide a favorable habitat, present convenient opportunities for industry and commerce, act as a storage for waste disposal, because of their convenience for food production, their natural beauties and that they can be used for various purposes such as education, defense. For example; Whilst the total population of Mediterranean and surrounding cities including Turkey was 212 million in 1950, this figure has reached up to 356 million in 1985. This figure is expected to be 547 million in 2025. In 1992, 38% of the population of these countries inhabited 15% of the Mediterranean coasts. Featuring one of the most important coasts of this region, in Spain, the population living on the coastal regions has increased from 12% in 1900 to 35% in 1992. The population and settlement in the coastal regions of Mediterranean is expected to increase in a fast rate, in the future as well (Duru, 2001). Many issues arise in coastal regions of many countries due to excessive utilization. Main issues are;

a) Unplanned and dispersed settlement
b) Negative impacts on the natural view
c) Infrastructure issues
d) Land occupation
e) Construction of residents, roads and touristic sites by land filling

As the coastal regions experience a high rate of growth, 34% of the coasts confront a high-level risk of damage and 17% confronts a medium-level risk of damage as per the World Resources Institute. The coasts under risk are mostly in North Equator and in temperate zones. 86% of European coasts and 69% of Asian coasts are under risk (Mackenzie, 2003).

Consequently, as a result of the dense and unplanned utilization of the coasts, which are the most important part of the urban settlement, today they lose their natural appearance.

1.5.6. Utilization of the Coasts for Transportation Purposes

As an intersection point between sea and land, the coasts are highly convenient areas for transportation. For this reason, the roads constructed along the shoreline have a great influence on the development of cities. However, the coastal roads destruct the natural state of the coast by reducing the city-sea relation with a barrier between them. For this reason, one of the ideal ways to provide solution for transportation issues in coastal cities is sea transportation. Sea transportation has also been influential on foundation of coastal civilizations providing commercial and cultural interactions. Harbors constitute the base of sea transportation. Development of sea transportation as a result of industrial revolution lead to an increase in the number of harbors. The low cost of sea transport compared to land transport, expanded the construction of harbors and increased the utilization of coasts for industrial purposes. As transport, loading and unloading processes are the most important points in sea transport, the harbors play a great role in the development of the cities. The foundation of inter-country relations has led to port cities on the coasts. It is possible to state that many commercial and cultural cities have developed thanks to the harbors. As the main issue posed by the harbors on the coast ecology is pollution, harbor areas should be constructed away from the public sites in order to prevent their negative effects (Atakan, 2003).

Many port cities are important income resources for the economy of the country. As one of these countries, in Turkey the contribution of harbors to the economy is very low due to the investment deficiency, though the harbor activities continue with military ports, dockyards, commercial harbors, fishing ports and submarine pipelines. Though 73% of the foreign trade and 90% of the domestic trade is carried out by sea, and 200 million tons of freight passes through the harbors, the investments are not sufficient (Ergin, 2002).

1.7. General Characteristics of Turkish Coasts and Changes on the Coastlines

The importance of the coasts and coastal resources depend on several criteria. These are; the ratio of the coast length to the surface area of the country and the ratio of coast length to the total borderline of the country (Ünal, 1997). A long shoreline is an important natural and economic resource for the country. The production as a result of favorable exploitation of the coast resources and the income by exporting these products, the income from tourism, and direct and indirect contribution of the coasts to the labor force are the most significant indicators to what the coast mean for a country's economy (Sesli et al. 2003).

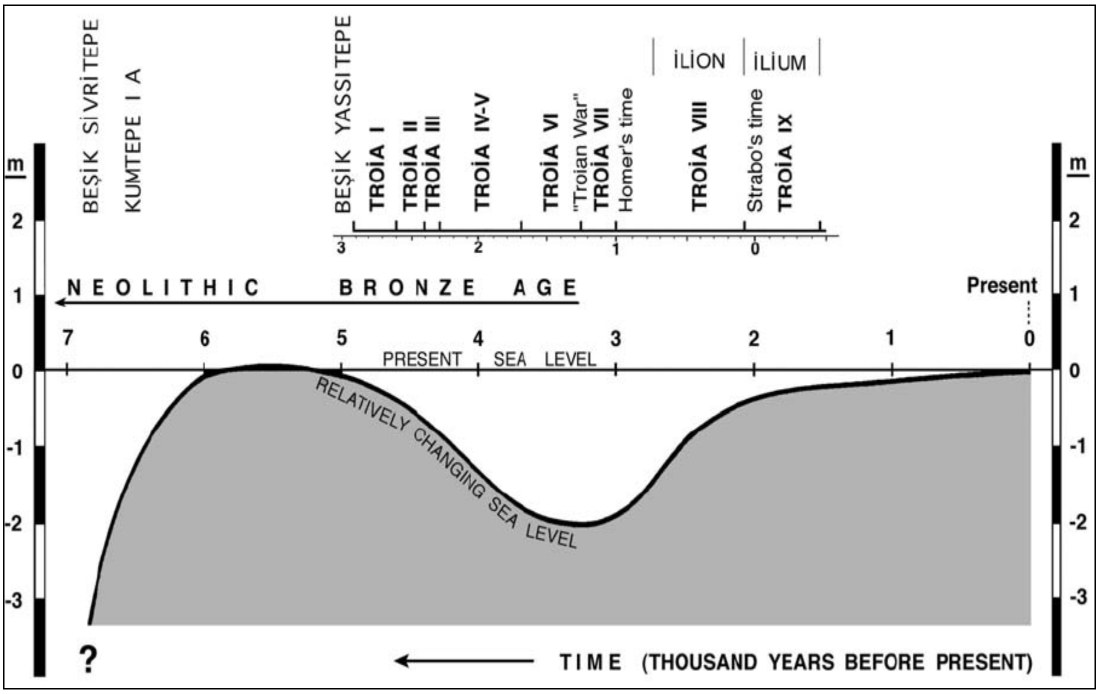
Surrounded by Mediterranean, Black Sea, Marmara and Aegean Seas, Turkey has a total coastline of 8333 km. With this shoreline length, which constitutes 75% of its borders, Turkey is one of the countries with the longest shoreline in OECD (Organization for Economic Co-operation and Development) countries (Akça, 2008). Turkey has 1701 km of coastline in Black Sea, 1441 km in Sea of Marmara, 3484 km in Aegean Sea, 1707 km in Mediterranean and 1067 km in islands (Bayram et al. 2008, Özkan, 2000, Sesli, 2006)**.** In addition, with a continental shelf of 154,080 km^2, Turkey is a sea country featuring various fertilities, hydrographic, geographical and climate characteristics (Erdem, 2006).

1.7.1. Physical Geographical Characteristic of Turkish Coasts and Coastline changes

Starting from geologic period, the coasts of Turkey have continually changed under the impact of natural factors, to become in the end what it is today. From the ice age to present time (approximately 15,000 years) the sea level has risen more than 100 meters (Atalay, 2001). This rise is predicted to have ended approximately 6000 years ago. The rise of the sea level caused especially low coasts to submerge. As the sea level rised to the actual level, tectonic grooves and broad base valleys have become bays and gulfs as in Aegean coasts and Taşucu-Erdemli coast of Mediterranean. Sea level changes during the quarterner period had major impact on the modeling of the coasts of Anatolia. Especially, sea level changes play an important role in the development of coast lowlands. As a result of the level changes, the coast shapes of many port cities in Mediterranean and Aegean coasts have changed. The deltas formed in this period are today under the sea, mostly on continental shelves. For example, whilst coasts of Tarsus plain were lower when the sea level was lower in the late ice age, today they are submerged under the water and covered with delta debris with the stream activity on the coast. With the expansion of the delta on the coast, the shoreline drew back to the sea to its current position (Öner et al. 2005, Atalay, 2001).

With the Holocene transgression 10,000 years ago on Çanakkale coasts, the sea reached to the lower section of Karamenderes River. With the impact of the alluvial accumulation, coastline drew back to north. The 2 m setdown of the sea level approximately 5000 - 3500 years ago, in the Bronze Age, accelerated the progression of Karamenderes delta and caused the regression of coastline (Figure 39), (Kayan, 2001).

FIGURE 39: SEA LEVEL CHANGE CURVE ON AEGEAN SEA COASTS OF WEST TROY AND ANATOLIA DUE TO MID-LATE HOLOCENE



Source: Kayan, 2001

Another example for shoreline change in the geological period can be seen on Antalya coasts. With the melting down of glaciers in the post glacial age, the sea level started to rise, and the sea level, which was -2 meters 7000 year ago reached to 0 meter 6000 years ago. 7000 years ago, the sea infiltrated to 400 m. - 1.4 km. inside on Karpuzçay coasts of Antalya. Though the sea level was on the peak point, the deltas, which were on the shoreline 4000 years ago, continued to progress towards the sea. The researches indicate that the coastlines regressed (Çiçek et al. 2008). The front side of the gulf, which was formed 15,000 years ago on Eşen brook delta in South West Anatolia (West of Teke peninsula), was filled with alluviums transported by the river, and the coastline progressed towards the sea (Öner, 2001).

Along with the sea level changes in geological periods, erosion factors have also been influential on the coastline changes in Turkey. For example;

Payas town coasts near Iskenderun, Turkey, are an example for these erosion effects. As seen on Figure 40, as a result of the erosions in the coastal region, the coastline has progressed towards the land and caused the formation of a cliff 10 meter in height (Arı et al. 2007, Kırkgöz, 2002).

FIGURE 40: GENERAL IMAGE OF THE COAST IN PAYAS SUBJECT TO EROSION

Source: Kırkgöz, 2002

Solid substance transports formed in vertical to the coast, cause long-term impacts on the coasts. As the transports towards the coast rebuild the accumulation and coast bench, they regenerate the coasts. Karaburun Fishing Port on Black Sea side of Bosporus became unusable due to sand accumulation in the port opening as a result of the solid substance transport on east-west direction. In 2 years, a change of 10 meters is detected on the coastline near the fishing port. This change indicates that the port opening is filled (Arı et al. 2007).

After the ice age (würm) of the late geological period, the improvement of the climate caused the acceleration of erosions in river basins, and the amount of substances transported to the sea increased. Despite the rise in the sea level in this period, deltas expanded due to the increase of sediment amount transported by rivers. For example; İkiztepe settlement built on Kızılırmak opening is today 15 km inwards from the coast. The expansion of Kızılırmak delta continued until the construction of Altınkaya and Derbent dams on the river. Similarly, it is detected that Yeşilırmak delta has progressed approximately 3km. and expanded 2,617 km² until the construction of Hasan Ugurlu and Suat Ugurlu dams (Figure 41), (Uzun, 2006).

FIGURE 41: COASTLINE CHANGE AT YEŞİLIRMAK COASTS

Note:The sandbank on the east side of yeşilirmak delta (north of Çaltı Cape) has disappeared due to erosion, and the shoreline has reached to the afforested area.The photograph illustrates the roots of the trees which have been knocked down by the waves (Uzun, 2006).

Whilst the width of the beach in front of Side Perissia Otel on Side Coast of Antalya, Turkey, was 50 meters before 1999' a regression on the coastline is detected in the recent years due to undercuts by waves. Thus, the usability of the beach has also substantially decreased (Güler et al. 2008).

1.7.2. Anthropogeographical Characteristics of Turkish Sea Coasts and the Coastline Changes

There are 28 littoral cities in Turkey (Figure 42). Their total territorial area is 221.414 square kilometer. This area equals to 28.76 % of the country's total area. According to the census dated with 31 December 2008, 38.610.347 people live at these littoral cities. This means 54 % of the country population, which is 71.517.100, is located at the aforementioned area (TÜİK, 2008).

FIGURE 42: COASTAL PROVINCES OF TURKEY

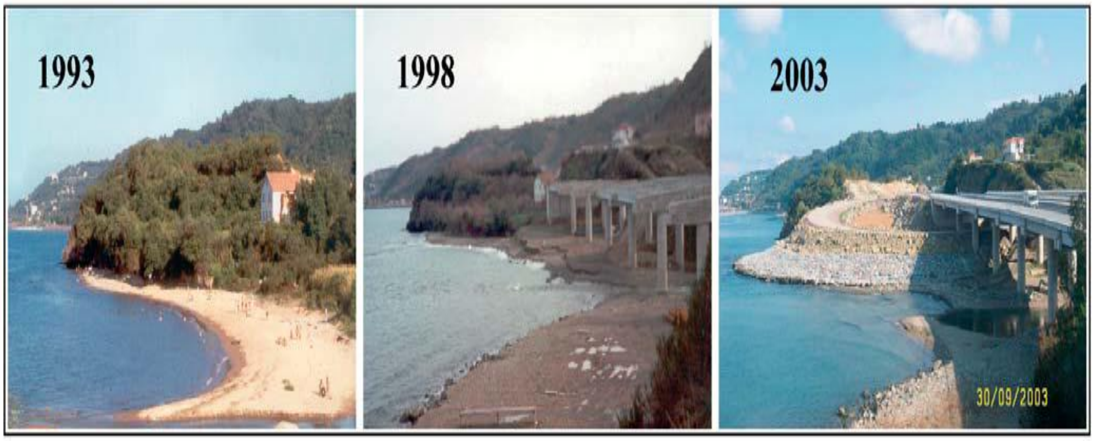
Note: The twenty-eight coastal provinces of Turkey (Priority Actions Programme Regional Activity Centre, 2005)

Why the population densifies at the sea coasts is because of such opportunities like trade, political linkages, climate, fishery, fertile agricultural areas and recreation. The researches indicate that the population at the sea coasts is three times crowded than the internal cities (İrtem and Karaman, 2004). Since 1985, the population of the littoral cities has been increasing via new tourism and encouragement policies (Sesli et al. 2006, Özkan, 2000). However, being, Turkish coasts, that are unrenewable natural sources, have been negatively affected by industrialization which results population growth and unplanned building as it is in many littoral countries (Sayıştay, 2006). Since some implementations in the recent years did not take the characteristics of the sea coasts into consideration, this caused to serious damages throughout the coast lines. Because of that, some protective plans are in the process in this respect (İrtem and Karaman, 2004).

Turkish sea coasts are challenged by touristic villages, illegal filling at coasts, highways, water pollution by waste water, disposing of garbage, etc. Where the sea coasts are filled in order to solve transportation problems, gigantic buildings rise instead of beaches (Sesli et al. 2002, Çölkesen and Sesli, 2007).

Since 1960, constructing highways throughout the sea coasts has been rapidly continued as it is reasonable in price and promotes touristic booms in Turkey. As it is seen at the picture below, the scenic beauty is unfortunately demolished in many places (Figure 43, 44), (Sesli et al. 2002).

FIGURE 43: YANBOLU VILLAGE OF TRABZON, BEFORE AND AFTER HIGHWAY CONSTRUCTION 1993, 1998, 2003



Source: Sesli, 2006

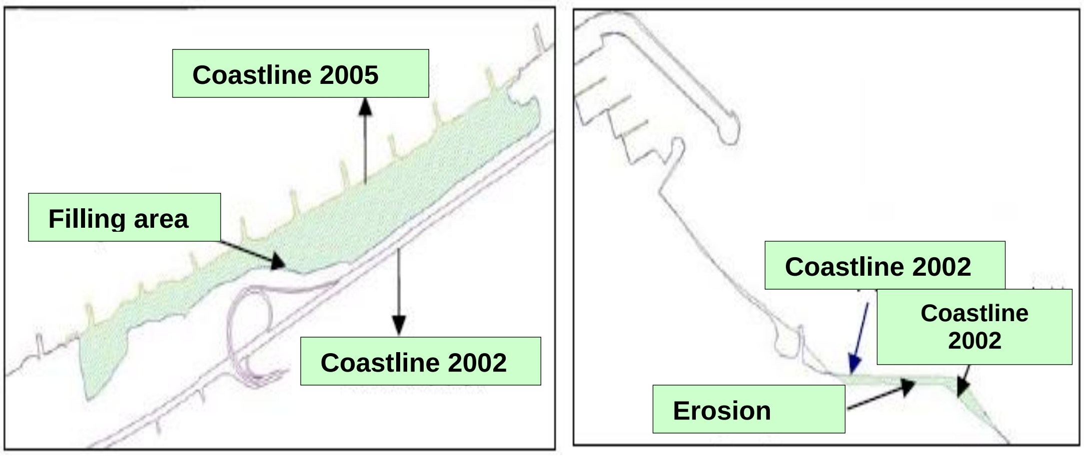
FIGURE 44: COASTAL ZONE CHANGES AFTER AND BEFORE HIGHWAY CONSTRUCTION (TRABZON)

Source: Sesli, et al. 2003

These kinds of sea side constructions do negatively change the natural aspects. In addition to this, mining, energy lines and also advirtesement billboards cause to undesired landscape not in line with the scienic perspective. Moreover, this sort of highways split the sea and the neighbouring area as if it’s an inhibitive border. Insomuch that sea-side roads create uncontrolled rise in current business values. In connection with this fact, all-related activities around sea coasts are undergoing a change (Atakan, 2003).

It is clear that since 1960, fastly increasing road constructions to develop tourism in Turkey, destroyed the sea-coasts and surrounding natural spheres. By making transportation facilities easier, a lot of uncontrolled buildings came out during this period (Sesli et al. 2002). For instance; it is ascertained via aerial photograph and satellite that between the years 2002 and 2005, a coastline of 60 hectares in Trabzon has been changed for transportation, tourism and reaction reasons. During these years again, an area of 6.7 decares has been lost depending on taking sand out of the sea and soil erosion (Figure 45), (Çölkesen and Sesli, 2007).

FIGURE 45: A COMPARATIVE DATA REGARDING THE SOIL EROSION IN COASTLINE OF TRABZON CITY



Source: Çölkesen et al. 2007

Having the largest sand dune, Turkey's coastlines comprises 845 square kilometer of shore sand dune. This is of 10 percent of the total coastline which is 8333 kilometers (Ongan, 1997). Nonetheless, the sand dune of Turkey has is not seen as geomorphologic and ecologic values, yet. For that reason, ravage still goes on in this regard. As Sea-side road constructions, touristic facilities, summer residences and other buildings affect the coast line in long-term, sand dune area is being dissolving. Because of this, sand dume areas can not be fed by natural ways and thus soil erosion comes out at sea side (Ongan, 1997).

Drawing attention at international level with its sand dune and natural vegetation the Eastern Mediterreanian Sea side of Turkey is one of the coastlines which have being destroyed by human intervention. This unique region faces with such a great risk because of intensive agricultural use, exceed buildings, and summer resorts. Since 1970s, via continuous industrialization, construction, and agricultural activities there is a certain decrease is observed at sedgy and sand dune areas. For example, around 46 percent of the Seyhan Delta was transformed to agricultural areas in last 76 years (Table 13) (Doygun et al. 2003).

TABLE 13: THE CHANGES PERTAINING TO THE SAND DUNE CAPACITY OF BURNAZ/HATAY BETWEEN THE YEARS 1972 AND 2000

Land cover types	**The areas covered by yeears (da)**		
	1972	**2000**	**The amount of change**
Coastal dunes	6040	6445	+405
Dune vegetation	1100	2045	+945
Reedy- Marsh	6320	2665	-3655
Plantation	19325	21660	+2335
Settlement	30	353	+323

Source: Doygun et al. 2003

The coast lines in Turkey are not only filled for transportational aims, but also reactional usage. The clearest example for that is seen in İstanbul sea coasts. Till now, in Anatolian and European side of İstanbul coastlines, 2.102.465 square meters area is filled for reactional reasons. While Asian side consists of 57 percent of this area, European part does 43 percent as well (Atakan, 2003).

In particular the Bosporous coast lines and in general İstanbul, which is one of the most important metropolitans of the world with its cultural and historical values, is under the pressure of intensive construction. Hence, the people who live in İstanbul are deprived of reactional use of the coastline and sea. To make the people benefited from the coasts as possible as, İstanbul Municipality made some arrangements just after 1984. In line with this objective, the coastal areas which are gained by filling have been opened to potential reactional use. This progress still goes on even nowadays (Atakan, 2003).

In today's world, the residences built at sea sides became a much advantaged investment option as the people prefer leaving the crowded metropols to be able to settle in more natural and healthier areas. What increased the number of residences at sea side is given governmental support to recreational activities at coastal regions. Nonetheless, second-buildings constructed at sea side draw attention, eventhough they are used only for a short period of the year. The clear example of this fact is the waterside houses built at İstanbul Bosporus. Another example also is fast-growing construction throughout the coastlines of İzmir-Çeşme, Bodrum, Marmaris mostly after the 1950s (Table 14), (Kılıçaslan, 2006, Akdeniz, 2008).

TABLE 14: THE COMPARATIVE DATA CONCERNING THE SEA-SIDE CONSTRUCTION FOR BODRUM AND MARMARIS FROM 1959 TO 1995

Bölge Adı	1959	1959-1978	1978-1995	Toplam
Bodrum	1,76 km²	3,23 km²	12,73 km²	17,72km²
Marmaris	0,66 km²	1,72km²	5,64 km²	8,02m²

Source: Akdeniz, 2008

Since it is considered as a way to reap easily a profit, many fruitful agricultural areas were transformed into second-house and/or touristic services in the recent years. This is rather because of making the local governments authorized in preparing reconstruction plan in 1985. As a consequence, agricultural productivity has been discredited (İncekara, 2001).

In terms of second-house issue, the residences and/or areas which are sold to foreigners is of crucial importance in this sense. When the legislation dated with 3 July, 2003 and numbered 4916, which allows non-Turkish to buy real estate property in Turkey, entered into force under the framework of harmonization with European Union; foreigners bought over 15.000 properties till this legislation would be cancelled on 15 March, 2005. Thus, by April 2005, the total area of properties bought by foreigners reached at 272.511.493 square meters in Turkey (Mutluer and Südaş, 2005). They are mostly stated around İstanbul and Antalya coastlines. By being used during only a short period of the year creates not an optimum economic value since they are stated as stagnant buildings. In consequence, the natural beauties of the coasts are being lost (Kılıçaslan, 2006)

The total area of the coastal cities in Turkey is 226.843 square kilometers. This area is equal to 29.2 percent of the country. But, the population in the cities of especially Egaean and Mediterreanean regions increase mostly in summer period. This situation is of vital importance in terms of being an indicator for the second-houses are not frequently used.

One of the settling preferences at coastal regions is seen as multiple-storey buildings. Negatively affecting the biological life, these buildings cause to block cool weather since they are obstacle for air circulation coming from sea side. Additionally, as it is seen in the picture 30 below, since the buildins are constructed as parallel to coast line, they not only prevent freash air from reaching inside the city area, but also interrupt the linkage with the neighbouring area. Hence, the current sand dune area is being lost out and the beaches are at least viasually being disqualified (Figure 46) (Sesli et al. 2002, Atakan, 2003).

As a consequence of these negative booms, Turkish coastlines have been damaged during the past 25 years.

FIGURE 46: A CONSTRUCTION VIEW FROM TRABZON COASTS, NOT IN LINE WITH THE LEGISLATION

Source: Sesli et al. 2002

1.8. General Characteristics of İstanbul Coasts and the Changes Happened Where in During the Geologic Times

Connecting the Europe and Asia continents with the Bosporous to each other, İstanbul is one of the greatest metropolises in the world having 450 kilometers coastline. İstanbul is surrounded with Ağva at Nort-East, with Yalıköy at Nort-West, with Tuzla at South-East and with Silivri at South-West. Being surrounded by sea from six directions, İstanbul is one of the precious of the world (Ayat et al. 2007, Atakan, 2003). From the past to modern times İstanbul became the capital city of Byzantium Empire and Ottoman Empire; by being so, it is also a unique water city carrying their cultural beauties to nowadays. In the meantime, İstanbul has the important caharacteristic of connecting the Black Sea and Mediterrenean Sea to each other as a water channel (Atakan, 2003). The Bosorous and Golden Horn as an internal sea port are the main factors to make İstanbul natural water route (Özbakır et al. 2007). İstanbul's connection with water is pretty different than the cities divided by channels like Venice and Amsterdam; and also different than river-side cities like London, Paris, and Frankfurt. What makes İstanbul distinguished is the Bosporus splitting the city into two parts. This waterway connecting the Mediterreanean Sea and Black Sea has been gained importance at all the time period (Özdemir, 2004). Nevertheless, only 25 kilometers of its total 75 kilometers coastline is used for the activities apart from industrial and transportational ones, although it has a unique water location. When the population of İstanbul is taken into consideration it becomes clear that this is definitely not enough (Yenen et al. 1992).

1.8.1. Physiographical Characteristics of İstanbul Coastlines

What consist of İstanbul territories are plateaus of 75 percent, mountains and tablelands of 16 percent and savannas of 9 percent. The average height is 117, 55 meter. A great part of the plateaus are stated at Çatalca-Kocaeli regions. In fact, İstanbul Bosporous is an old valley flooded by the sea approximately 7000 years ago. The rivers, located at each side of the Bosporus and met with main watercourses, are stated toward Northwest-Southeast direction. The width of the İstanbul Bosporus which connects Marmara Sea and Black Sea changes between 0.7 and 3.5 kilometers, and the average width are around 1.3 kilometers. As to the depth, it changes between 30 and 100 meters. The deepest point is stated between Arnavutköy and Vaniköy as (-) 92 meters. Between Ortaköy and Kuzguncuk the lowest value of depth is known as (-) 30 meter (Ayat et al. 2007).

Beginning from Asian and Europe fortresses, Bosporos reaches at Üsküdar at Asian side and at Tophane in European side by forming valleys, savannas, bays and capes (see the picture 47). The width of Bosporus is 3600 meters between Asian and Europe phenars, and is 760 meters between Anatolian and Rumeli castles. This is the closest location between Asian and Europe sides of Bosporus. While the inclination at the western side of the Bosporus changes from 10 % to 30 %; it begins from 5 % at the Anatolian side. The Haliç called “Golden Horn” is 500 meters in breadth till Beyoğlu; and 5 kilometers in length as an internal port area (Özdemir, 2004).

FIGURE 47: A LANDSCAPE OF SERPANTINE TOPOGRAPHY OF İSTANBUL BOSPORUS

Source: Özdemir, 2004

Having lagoon characteristics, there are Küçükçekmece Lake (16 square kilometer) and Büyükçekmece Lake (11 square kilometer) located just nearby the Marmara Sea in İstanbul. Apart from these, the Riva, Ağva and Çanak rivers flowing into the Black Sea; Kağıthane and Alibeyköy rivers flowing into the Haliç, Sazlıdere river flowing into Küçükçekmece lake; Karasu river flowing into Büyükçekmece lake; and also Istranca river flowing into Terkos lake do all consist of the most important water resources of İstanbul (Özdemir, 2004).

It has crucial importance of filled areas which are effective in both territorial and sea side direction at İstanbul's phsysical and coastals changings. Because of this, it is seen that the coasts are being filled by either natural or artificial ways beginning from the Roman period up to nowadays. For instance; Üsküdar, Yenikapı, Kumkapı, Langa, Kadırga, Eminönü and Sirkeci ports are formed by filling in the past. At the Marmara and Haliç coasts of İstanbul, many ports were formed over the Byzantium period like

Ahırkapı port which is the first of that time, as well. However, only few of those are exist today as wall signs (Özdemir, 2004).

1.8.2. Anthropogeographical Characteristics of İstanbul Coastlines

As happened in many coastal cities, the coasts of İstanbul are also under the charge of fast-growing population, industrialization, trade and tourism as well. While the Marmara, as an internal sea, coasts becomes industrially polluted by surrounded industry companies; the Black Sea coasts are the other hand being negatively affected by pollution carried with Tuna River. Thus this pollution is conveyed via the streams between each Sea; and than it becomes a challenge to all the coasts of İstanbul (Ayat et al. 2007, Bayram et al. 2008).

Because the natural balances at the coastlines are destroyed by humanbeing, as a natural restitution, seas itself carry the sand dunes inside the sea to refill the underwater sands taken out by the people. This situation leads to decreased sand dunes at sandy sea coasts and then loosing in course of time. Resulting from the similar implementation, sand dune areas become notably narrow, during the recent years. The reason for this situation is waves carry the sands at seahore into the sea which was drained by human intervention. On the other hand; the aggregation, gathered via argillaceous rubbles carried by winds from the lignite operating companies at the northeast of İstanbul, is dragged through the sandy seashores by waves. This is offcourse an ongoing damage for the coastlines (Özkan, 2000).

Depending on the over population in Turkey, İstanbul, as one of the big cities where the shores intensively used, have been changed by filling to gain new lands in accordance with the intensive transportational, constructional and touristical necessities. With this aim, 2.102.465 squaremeter area of İstanbul coasts which has 450 kilometer length, were changed by filling (Table 15, 16), (Atakan, 2003). What is seen at İstanbul coastline is the topographical change in the length of 50 kilometers since

1983, because of these sorts of filling activities. Incentive Tourism Law dated 1982 and numbered 2634, and also Housing Exemption Law dated 1983 and numbered 2805 have important effect in this situation (Özdemir, 2004).

The filled area at Asia and European sides of İstanbul are detailed at the table below (Atakan, 2003).

TABLE 15: THE DATA REGARDING THE FILLED AREA AT THE EUROPEAN SIDE OF İSTANBUL

Coastal Filling Areas of the European Side	Organized Coastal Filling Areas (m²)	Population	Green Area per capita (m²/person)
Eminönü	67.073	55.548	1,2
Fatih	107.118	407.991	0,3
Zeytinburnu	177.276	244.062	0,7
Bakırköy	343.551	208.223	1,6
Avcılar	200.000	235.113	0,8
Total	895.018	1.150.937	0,7

Source: Atakan, 2003

TABLE 16: THE DATA REGARDING THE FILLED AREA AT THE ASIA SIDE OF İSTANBUL

Coastal Filling Areas of the European Side	Organized Coastal Filling Areas (m²)	Population	Green Area per capita (m²/person)
Üsküdar	63.000	496.402	0,1
Kadıköy	381.343	661.953	0,6
Maltepe	296.762	358.231	0,5
Kartal	295.581	407.034	0,7
Pendik	199.795	382.936	0,5
Tuzla	71.316	123.716	0,6
Total	1.207.447	2.430.272	0,5

Source: Atakan, 2003

Some sand dune areas of İstanbul become narrow because of getting the sands inside the sea out. Because, waves carry the sands at seahore into the sea in order to fill the discharged internal ground (Özkan, 2000). Terkos Lake, that is one of the most important water sources of İstanbul, is also faced with a similar case. Taking sands out and erosion make the coast line which separates it from the Black Sea, highly narrowed (Özdemir, 2004).

Although the coastline of İstanbul is quite long, it is somehow interrupted by the sea side roads for a long time. Moreover, it is not possible to uninterruptedly go over two points between Beşiktaş-Ortaköy throughout the coast line, and so it is extremely hard to see the beautiful perspective of the sea. In addition to this clear reality, through the coast line beginning from Balat to Yeşilköy, the sea side roads exist as a block hardening the connection between the shore and the neighbouring area (Demirdizen, 2008).

The intensively used shores are stated in the İstanbul Bosporus side. The waterside residences built around the Bosporus are the first examples of the second-houses in Turkey. Because, these kind of seaside constructions played great role in constructioning the İstanbul coasts, in course of time. Especially after 1950, it led to charging the coastlines via the fast growth resulted from urbanization and industrialization (Kılıçaslan, 2006, Bayram et al. 2008).

1.8.3. The Changings Happened At İstanbul Coastlines during Geological Times

İstanbul coastlines have been a ground for many changings beginning from the geological period to the present time. Whilst the Marmara Sea was a lake area like the basins of Ergene, Ulubat and Manyas lakes; it was formed by felling down through the fault lines at coasts. After the melting of ices in the the long run, the Marmara Sea and the Bosporus were formed by the Black Sea and the Mediterranean Sea waters which fill the downed ground, at the end of the last geological term. In the mean time, a great part of the deep valleys caused by the watercourses went under water. The Golden Horn near the Bosporus is one of these examples.

Having 15-20 meters height, there are some cliffs (guessed to be belonged to carbonifer period) happened by shield and grit stones which are corroded via the waves at the eastern side of Üsküdar-Harem dock. There are also some cliffs in fron of Moda cape located at the southern of Kadıköy with 5-6 meters height. What took shape in front of the Moda cape is a sort of wave-erosion plain which continues into the underwater along 300-400 meters. Since the shapes are not so prominent and high, it is estimated to be occurred in approximately 8-9 thousand years (Yalçınlar, 2001).

Around the İstanbul Bosporus, there are some series and depots belonging to the third geological period. What is more, some incorrodible quartzites exists Çamlıca and other hills. It is determined that schists and blue limestones exist in the Bosporus and Golden Horn regions by making sounding at the area. What is seen nearby the shores that the limestones are in density while the rate of the schists increases as being far from the coastline (Özdemir, 2004).

CHAPTER 2: COASTLINE CHANGES IN İSTANBUL BETWEEN 1987 AND 2007

It is noted that some major changes were made on the coastline of İstanbul from 1987 to 2007. In the end of these changes the coastline lenght of İstanbul changed as well, mainly extending towards the sea. As shown on table 6, from 1987 to 2007 on the coast of İstanbul, an area of 1223 hectares was filled and transformed to land extending to the sea. However in this period an area of 52 hectares transformed to sea from land. Consequently, in these areas the coastline was shifted inland. Because of the changes that occured on coastal areas between 1987 and 2007 the distance of coastlines also changed. The total coastline lenght rose to 492 km in 2007 which was only 459 km in 1987. Obviously the coastlines got longer by 32 km between 1987 and 2007.

Coastal areas are the most essential recreational areas for people. On the other hand, as it is seen on chapter 3 which depicts the utilisation of İstanbul coastlines, rapid urbanization caused intensive construction of buildings starting very close to the coastline during 20 years from 1987 to 2007. Although the regulation 13 of the law 3830 allows constructions to be built on coastlines providing that they will be for public use and will not pollute the environment, it is seen that constructions started on the coastline in some parts such as Bosporus area. However most of the buildings on the İstanbul coastlines are personal properties and prevent the public from connecting to the sea directly. That is why the Municipality of İstanbul having created filled areas, tried to meet the public demand for recrational areas. Such works both relieved the coastlines and caused the coastline borders to change. Especially the roads that were recently built on Marmara Sea coast of

İstanbul altered the coastlines. Removing sand from the coasts, building ports and piers, creating beaches have also contributed in changing of the coastlines.

Generally the filling areas that appeared on the coasts are of two kinds in terms of the way of formation; artificial and natural. Just as people make artificially filled areas to meet their needs for leisure activities, the rivers also flow some materials that accumulate on the river banks and lakesides to form natural filled areas like deltas. Such arificially filled areas are built mainly for the construction of piers, docks, parks and for recreational purposes. Such lands are widespread in many countries that have coastlines. Filling activities for recreational areas are in progess even now in İstanbul. These filled areas that were made in the frame of the project of redesigning the coastlines are in Fatih, Eminönü, Zeytinburnu, Bakırköy, Ataköy, Florya, Küçükçekmece, Avcilar and Büyükçekmece on the Coast of Western Marmara, and in Üsküdar, Kadıköy, Maltepe, Kartal, Pendik and Tuzla in Anatolia. On the Black Sea coast of İstanbul most fillings seem to be resulting from natural forces and enlargement of the beaches and filling seashores for ports and piers. There are not any other forms of filling activities. On the Bosporous coastlines there are no filling areas since there are many personal properties.

Some of the filling areas on Istabul coastal areas are used mainly as clearances for traffic while some others are parks and recreational. Some parks an carparks that are on the coasts are on these filling areas (Figure 48, 49)

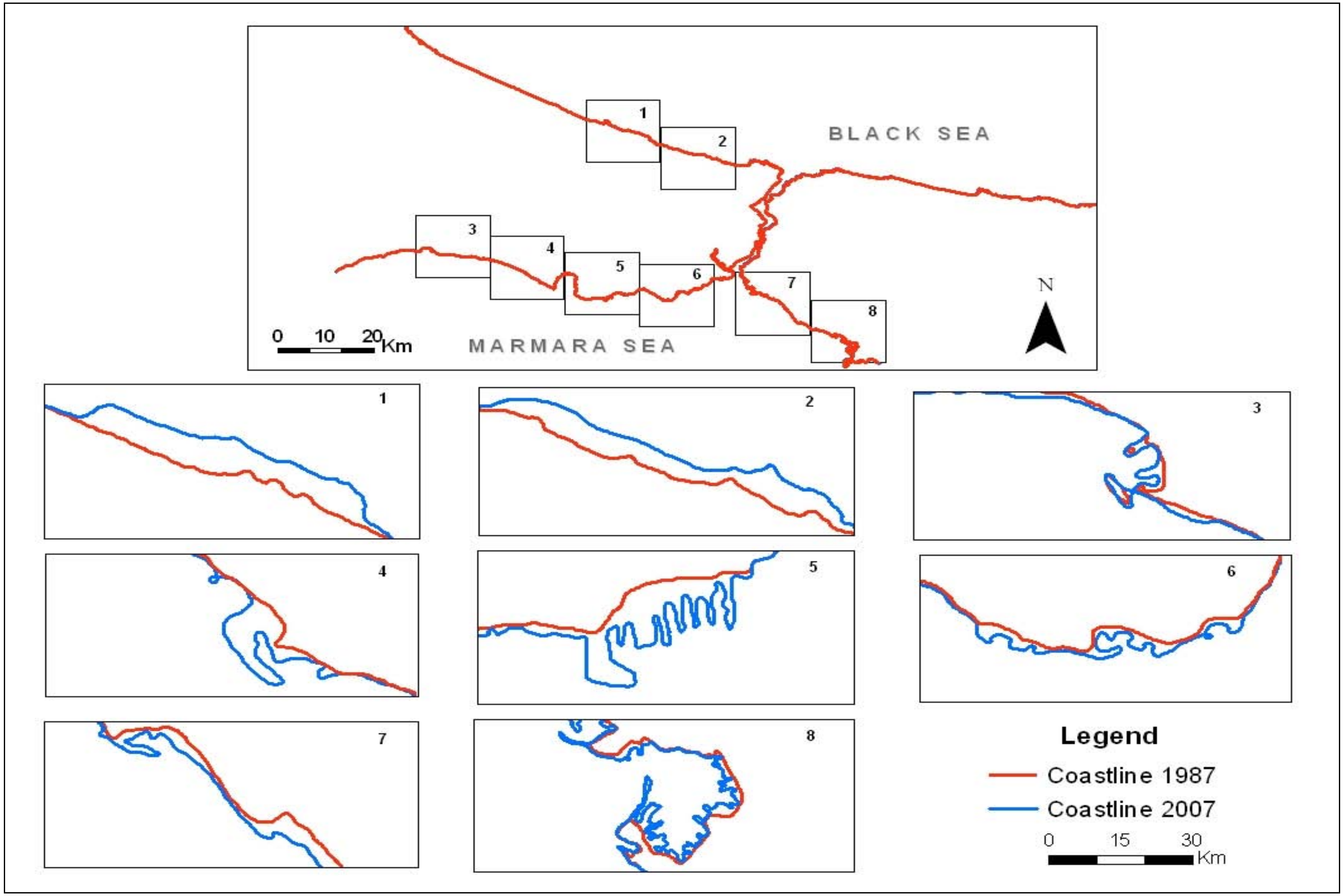
FIGURE 48: COASTAL FILLING AREA AND PORT OF PENDİK

FIGURE 49: COASTAL FILLING AREA AND ÇETİN EMEÇ BOULEVARD

One of the factors that cause the coastline to change towards inland is the removal of sand and soil for different reasons and the cliffs that are formed by waves and similar corrosions. Both of them are observed on the Black Sea shores of İstanbul effectively. As a result of removing sand from the sea from the coast of Black Sea and near Lake Terkos, it is risked that the waters of the lake and sea mix. Apart from this, on these shores between Eyüp and Yenikoy and at Haliç, the coastline shifted inland approximately by 52 hectares because of human factors and natural forces.

The coastline in İstanbul changed substantially especially on Black Sea coast and Marmara Sea during 20 years from 1987 to 2007. However the coastline of the Asian side and both sides of the Bosporous, the coastline seem to be stable (Figure 50).

FIGURE 50: COASTLINE CHANGE IN İSTANBUL



The coastline changes have been observed under three headings so that they could be well displayed; Black Sea coasts, Bosporous coasts and Marmara coasts.

2.1. The Coastline Changes on the Marmara Coasts of İstanbul

Approximately 722 hectares of area on the Marmara coasts of İstanbul were filled toward the sea from 1987 to 2007. These filled have been used mainly as places of recreational facilities, roads and the construction of ports. Around an area of 389 hectares was filled and changed to the use as ports, recreational areas (Figure 55, 56). In the district of Üsküdar, Üsküdar – Harem coastline was designed by filling an area of 2.5 hectares. (Atakan B., 2003) There are carparks, playgrounds for children and paths for pedestrians. In the filled areas between Kadıiköy and Maltepe there are Moda Inciburnu park, Kurbağalıdere Park, Kalamış Marinası Park, Fenerbahçe-Cadde Bostan and Caddebostan parks. Around 5 km from Bostancı to Maltepe and 6 km from Maltepe Kartal were filled for recreational purposes (Atakan B., 2003). A coastline road to Tuzla which is the eastern border of İstanbul after Pendik, about 5 km of distance was filled for a coastline road and recreational purposes (Figure 51, 52). Most filling areas are in the frontiers of Pendik. If the Anatolian coastlines are observed in terms of the rate of filled areas, it is seen that Kartal is the province which has the highest rate of change and Üsküdar is the lowest (Figure 55, 56).

At areas where coastal line changed, generally recreational parks, autoparks, and ports were constructed (Figure 53, 54). Forest, bush/grassland and bare soil areas decreased at areas where constructions increased. In Chapter 3, use of land in the area of 1000 meters from coastline to landward is described in detail.

FIGURE 51: THE COASTAL ROAD ON THE FILLED AREA BETWEEN MALTEPE AND KARTAL

FIGURE 52: COAST FILLING AREA BETWEEN KADIKÖY AND MODA

FIGURE 53: FERRY DOCKS AT KARTAL

FIGURE 54: PARK AND THE WALKING PATH ON THE MALTEPE COASTAL FILLING AREA

FIGURE 55: SATELLITE IMAGES OF FILLING AREAS AND COASTLINE ON MARMARA COASTS (1987 - 2007)

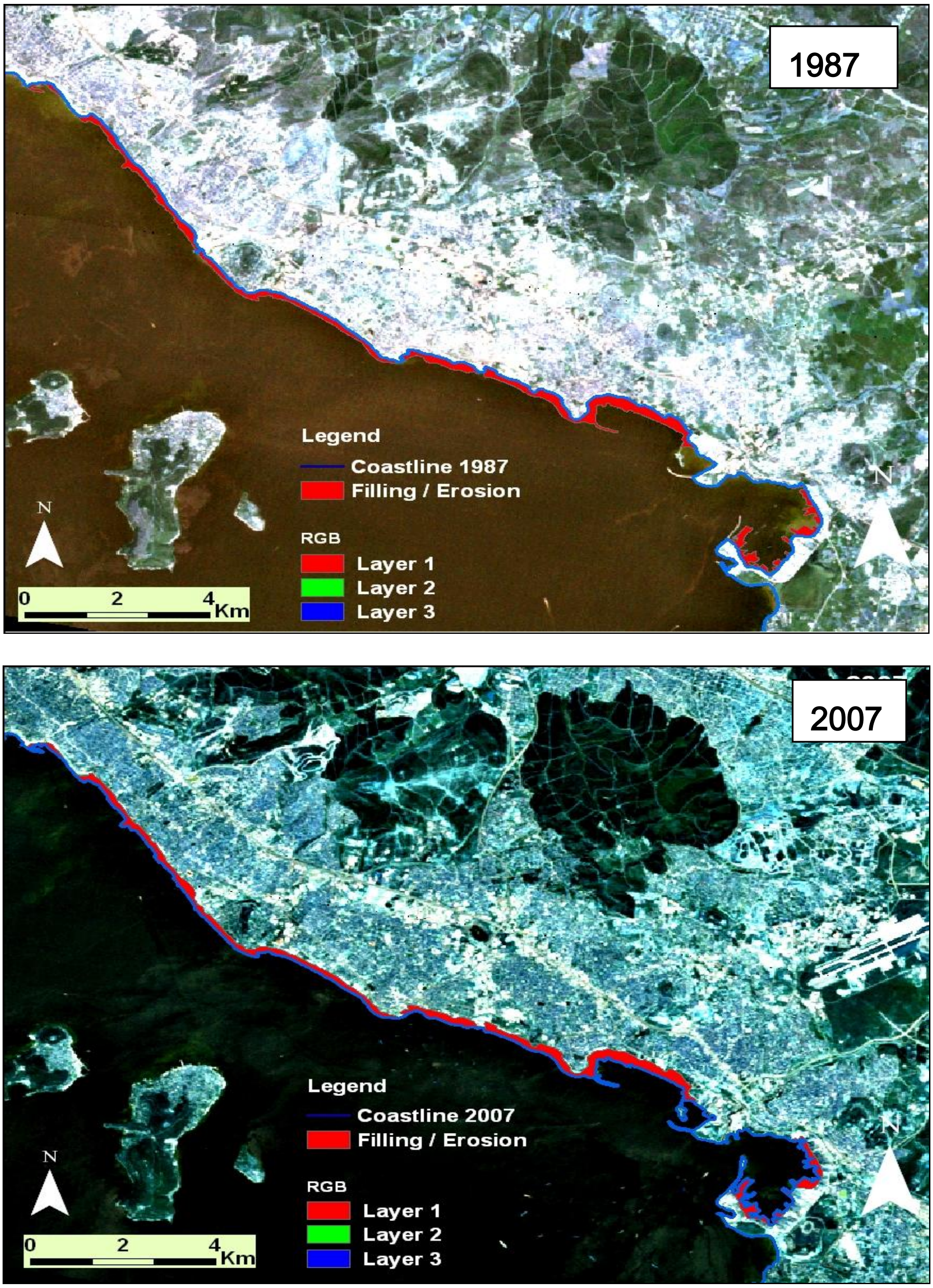
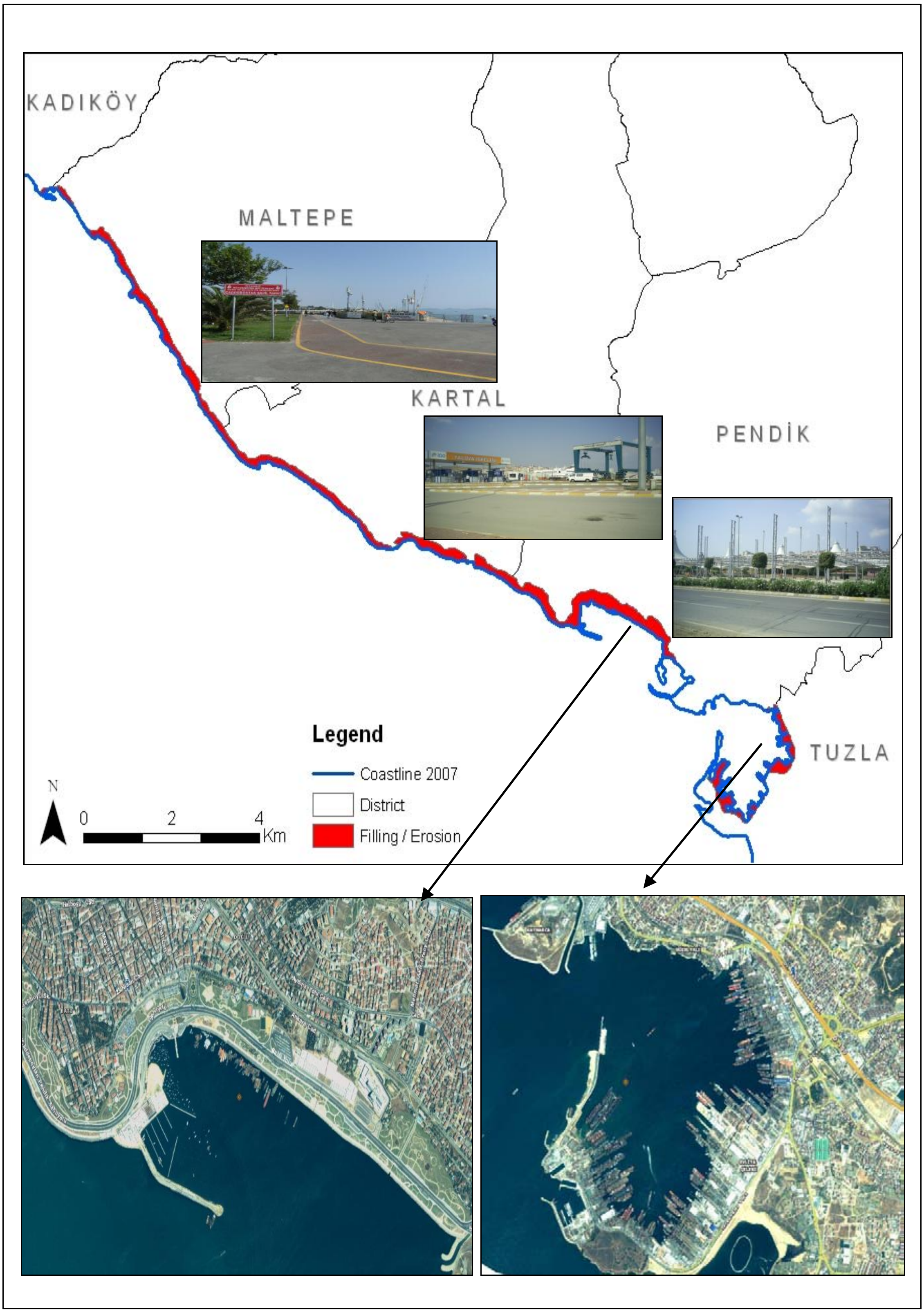


FIGURE 56: FILLING AREAS AND COASTLINE IN KARTAL AND PENDİK DISTRICTS ALONG MARMARA COASTS (2007)



Filling of coastal area of 307 hectares from Eminonu to Büyükçekmece caused the coastline to advance seaward. Yenikapı and Türkmenistan Parks of Fatih district are located on coastal fill areas. Kazlıçeşme ve Mermerkule Parks are located on coastal fill areas of Zeytinburnu district (Figure 57, 58). Aytekin Kotil Park (spanning 1.5 km. of coastal line), Facilities of Bakırköy Sea Buses, and Yeşilköy coastal park (spanning 3.5 km. of coastal line) are located on Bakırköy coastal fill areas. In Avcılar district, it can be seen that most of the coastal area is filled (Figure 59).

FIGURE 57: SPORTS ACTIVITIY FACILITIES ON ZEYTİNBURNU COASTAL FILLING AREA

FIGURE 58: RECREATIONAL PARKS ON ZEYTİNBURNU COASTAL FILLING AREA

FIGURE 59: PLAY GORUNDS FOR KIDS AT YEŞİLKÖY COASTAL FILLING AREA

Avcılar Dock of Sea Buses ve Petrol Ofisi Filling Plants are located on this coastal fill area (Figure 61, 62 and 63, 64, 65, 66). This coastal filling and reorganization activities have been continuing since 1992 (Figure 60) (Atakan, 2003).

FIGURE 60: FILLING AREAS AT DENİZ KÖŞKLER (AVCILAR) COAST

As can be seen in the satellite image from 2007 in figure 61, coastline between Eminonu and Ahırkapı is parralelle to the coastal. However, it was understood that this coastline is different form the one from 1987. It can be concluded that coastal filling in this line happened after 1987.

FIGURE 61: SATELLITE IMAGES OF FILLING AREAS AND COASTLINE ALONG MARMARA COASTS (1987 AND 2007)

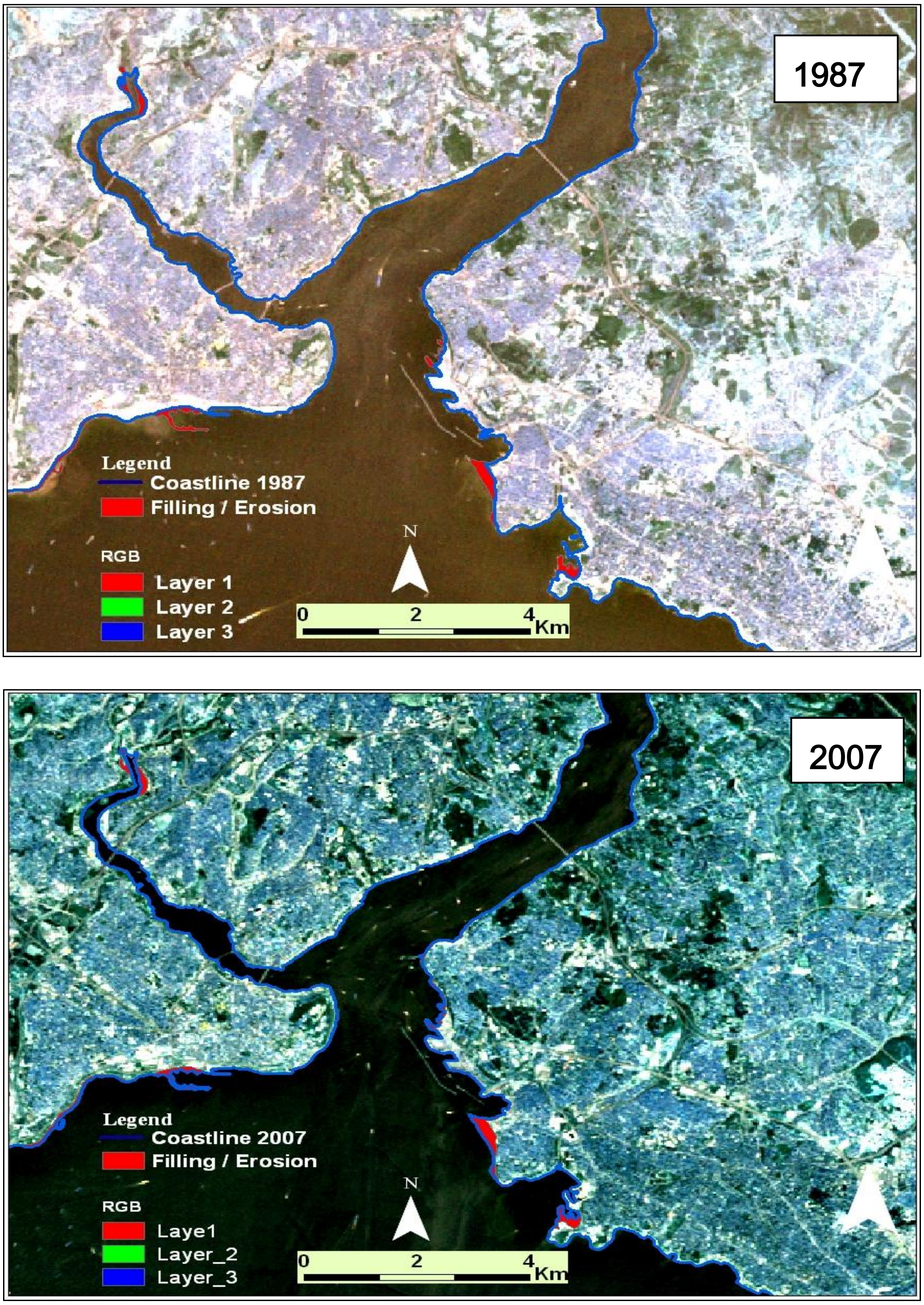
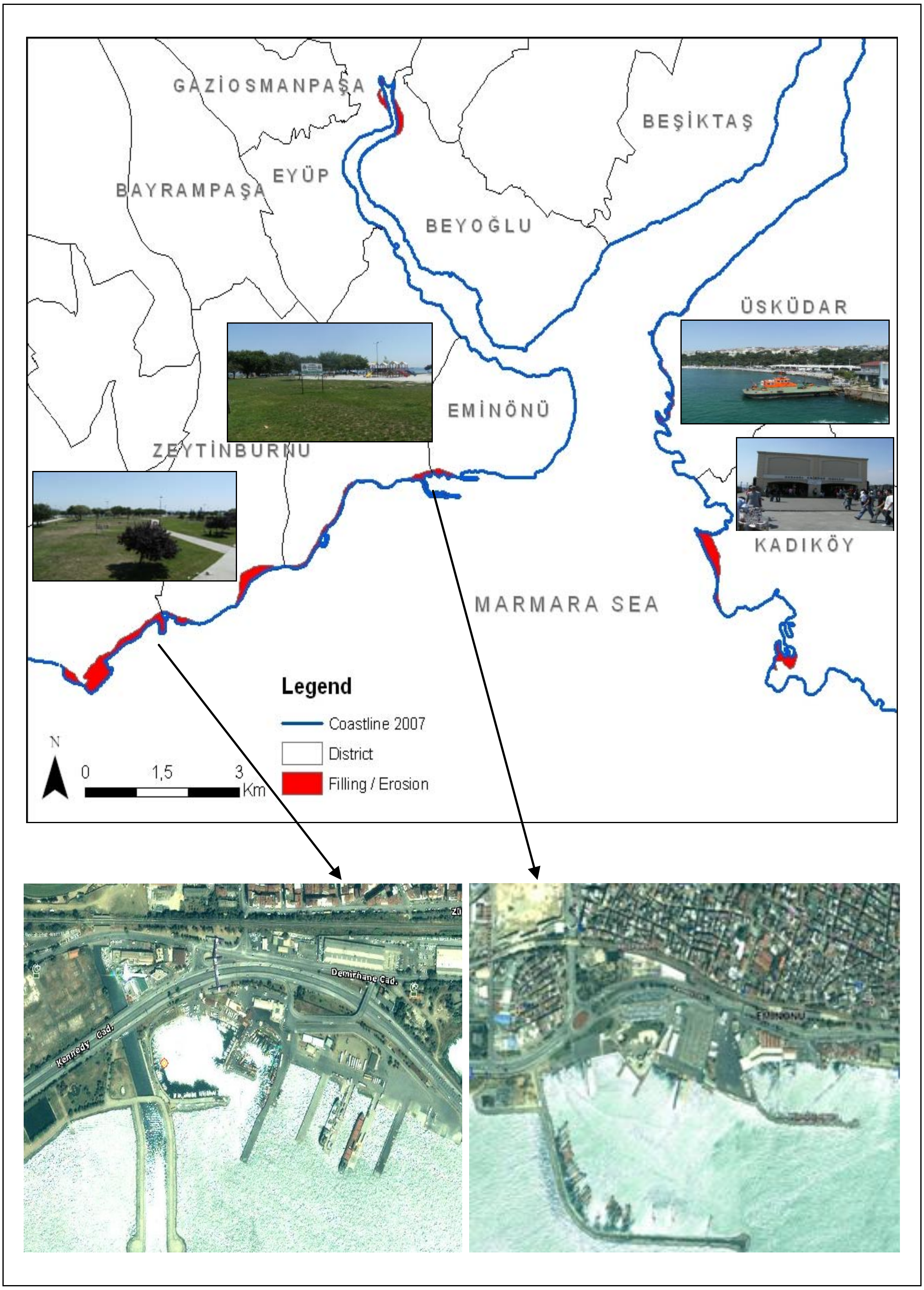


FIGURE 62: FILLING AREAS AND COASTALINE EMİNÖNÜ AND ZEYTİNBURNU DISTRICTS ALONG MARMARA COASTS (2007)



At Üsküdar and Golden Horn, in between 1987 and 2007, total area of 26 hectares was filled. On the filled areas in Üsküdar, coastal road of Üsküdar-Harem, and parks were constructed. At Golden Horn, filled areas were used to construct recreational parks.

FIGURE 63: SATELLITE IMAGES OF FILLING AREAS AND COASTLINES ALONG MARMARA COASTS (1987 AND 2007)

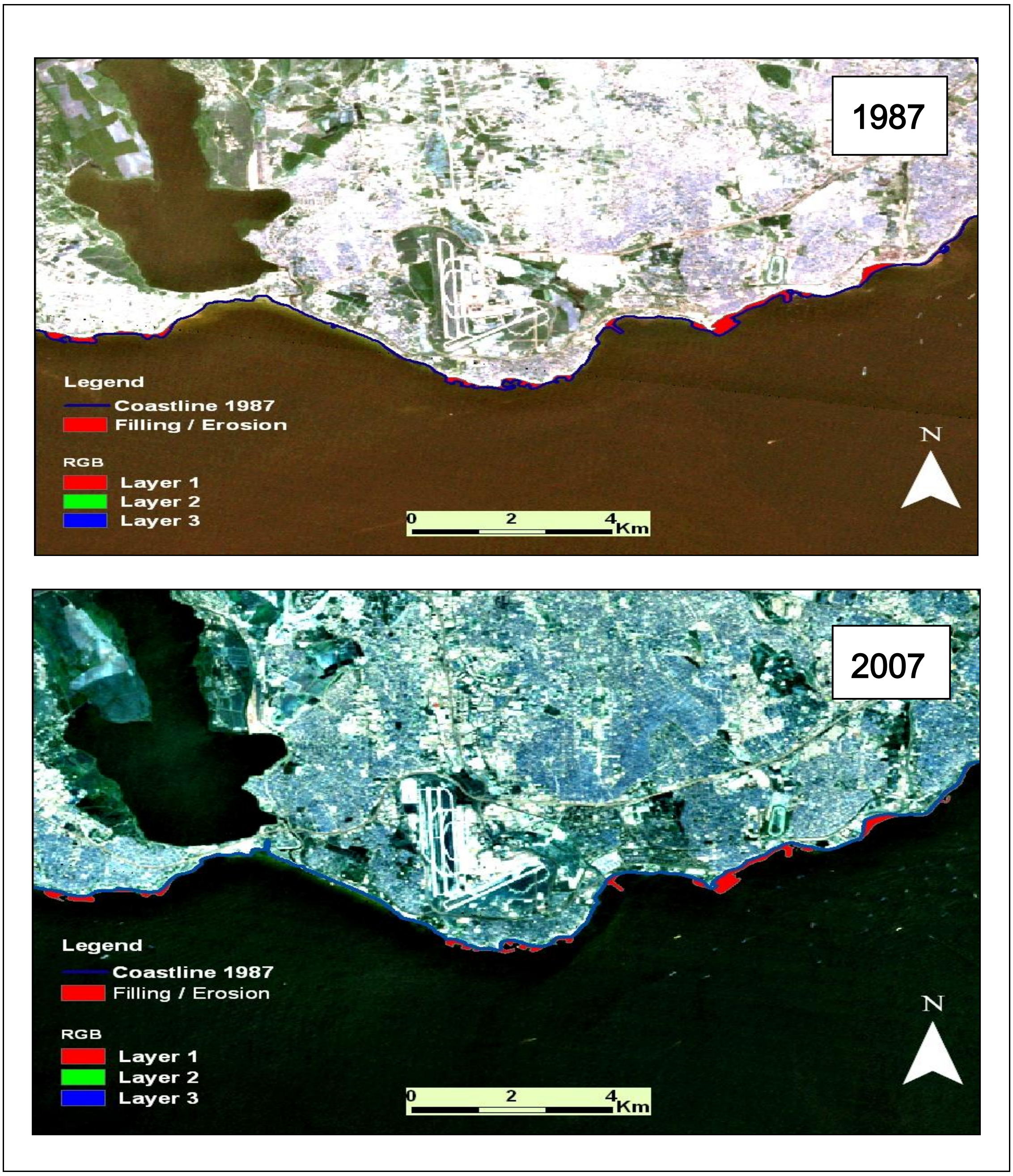


FIGURE 64: FILLING AREAS AND COASTLINE IN AVCILAR AND BAKIRKÖY DISTRICTS ALONG MARMARA COASTS (2007)

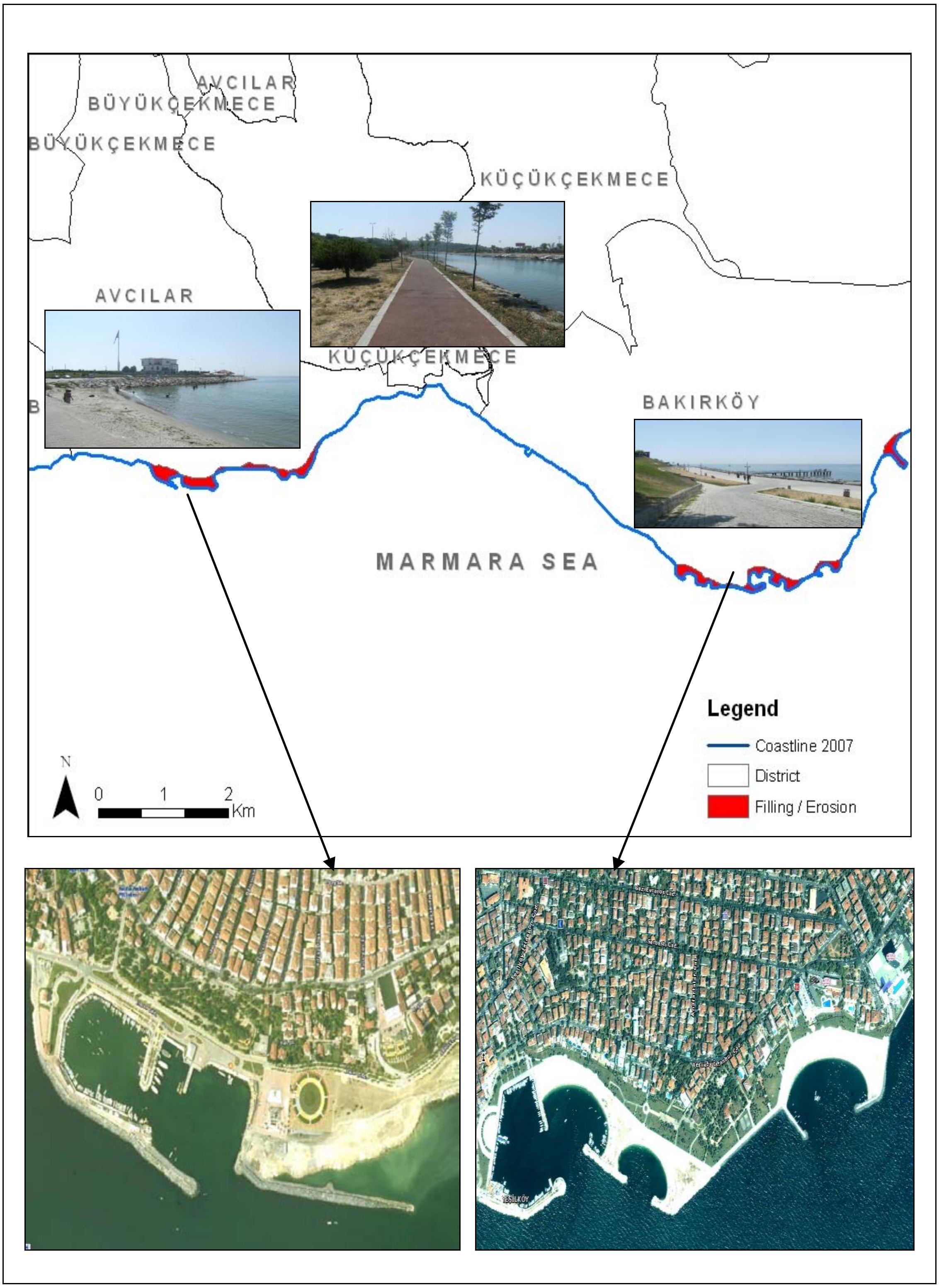
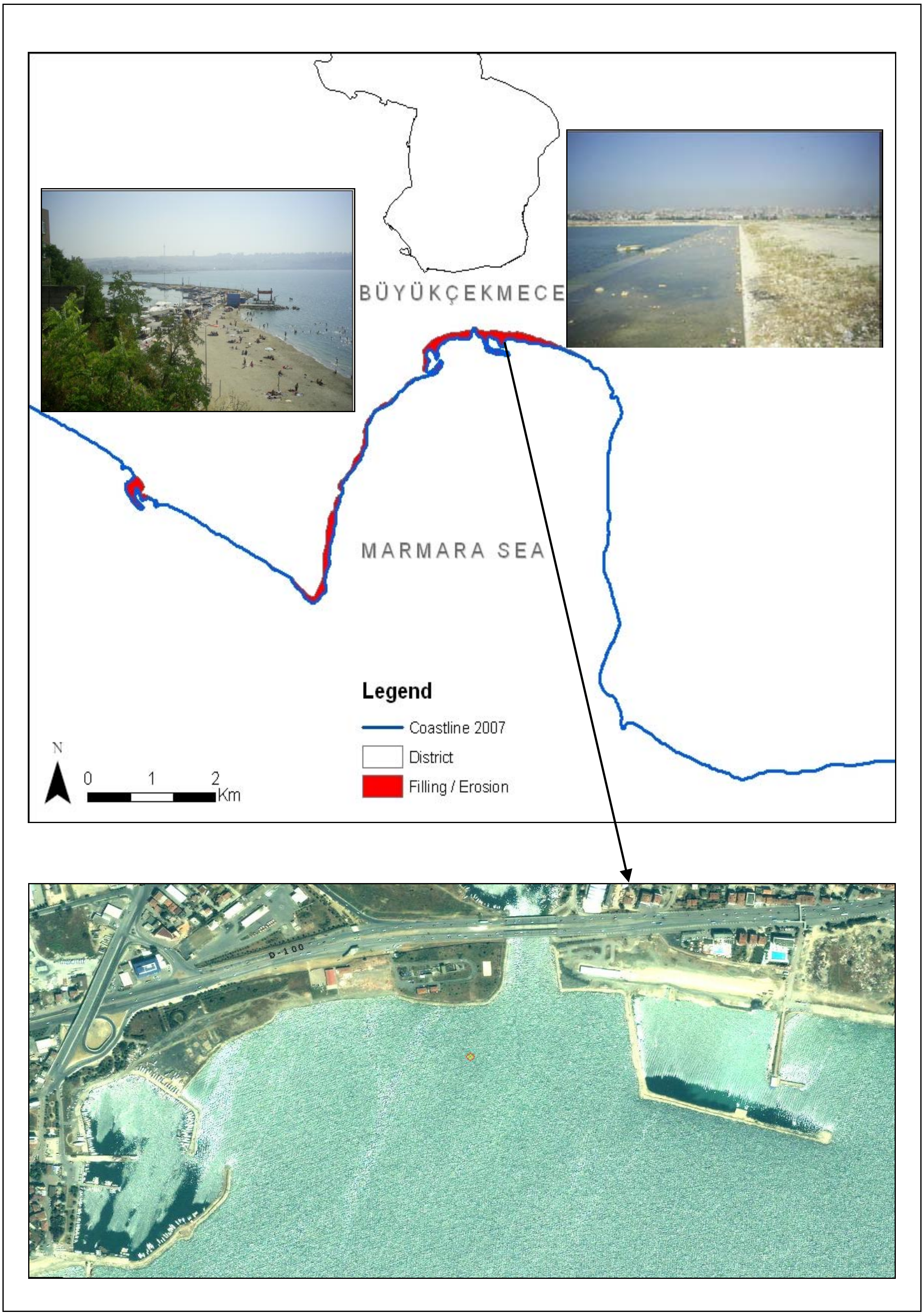


FIGURE 65: SATELLITE IMAGES OF FILLING AREAS AND COASTLINES ON MARMARA COASTS

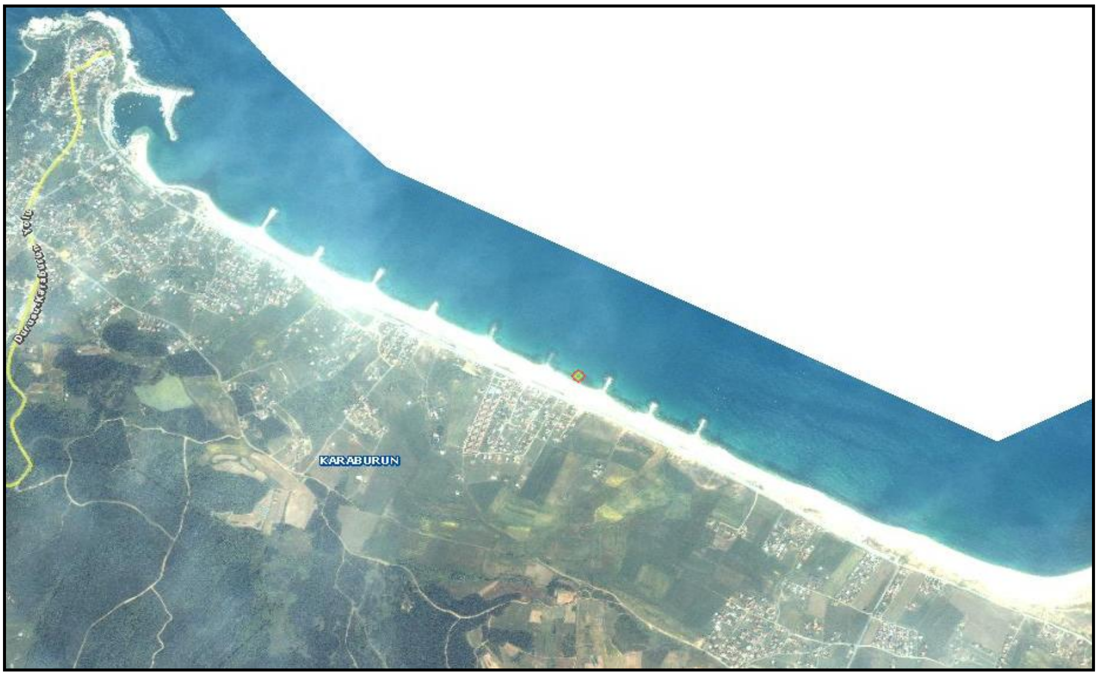
FIGURE 66: FILLING AREAS AND COASTLINE IN BÜYÜKÇEKMECE DISTRICTS ALONG MARMARA COASTS (2007)



2.2. The Coastline Changes on the Black Sea Coasts of İstanbul

In İstanbul, Black Sea has one of the least structured coastal areas because of the narrow continental shelf and the nonsuitability for settling. Şile, Gaziosmanpaşa and Eyüp coasts are the most populated and structured areas. In these districts, filling areas at shallow coasts are used as ports, docks, piers or beaches. Black Sea coastal line at the northern coasts of Eyup and Gaziosmanpaşa advanced towards the sea as a result of filling of an area of 502 hectars (Figure 70). However, some of the fillings at this region are not only for being dock, wharf or recreational. For instance, accumulation of soil that is discarded from quarries and flows into the sea generated an artificial foreland of 500 meters at Karaburun coast (Figure 67, 68, 69) (Arı et al, 2007). In the coastal region between Kilyos and Karaburun, between 1984 –1994, 160 hectares of sea had been filled in with piles of coal, clay and sand. During this filling, 590 hectares of forest was destroyed (Gazioğlu et al. 1997). In addition, at this region, as a result of both natural and human factors (such as wave abrasion and transfer of soil and sand from coasts by human) coastal line advanced towards land in an area of 50 hecctares (Figure 71, 72).

FIGURE 67: ORTHO-PHOTO IMAGE OF KARABURUN COAST



Surce: İBB, 2009

FIGURE 68: FILLING AREAS AT KARABURUN COASTS

Surce: İBB, 2009

FIGURE 69: FISHERMEN'S SHELTER AT THE FILLING AREA OF KARABURUN COAST

FIGURE 70: FILLING AREAS AND COASTLINE IN EYÜP AND GAZİOSMANPAŞA ALONG BLACK SEA COASTS (2007)

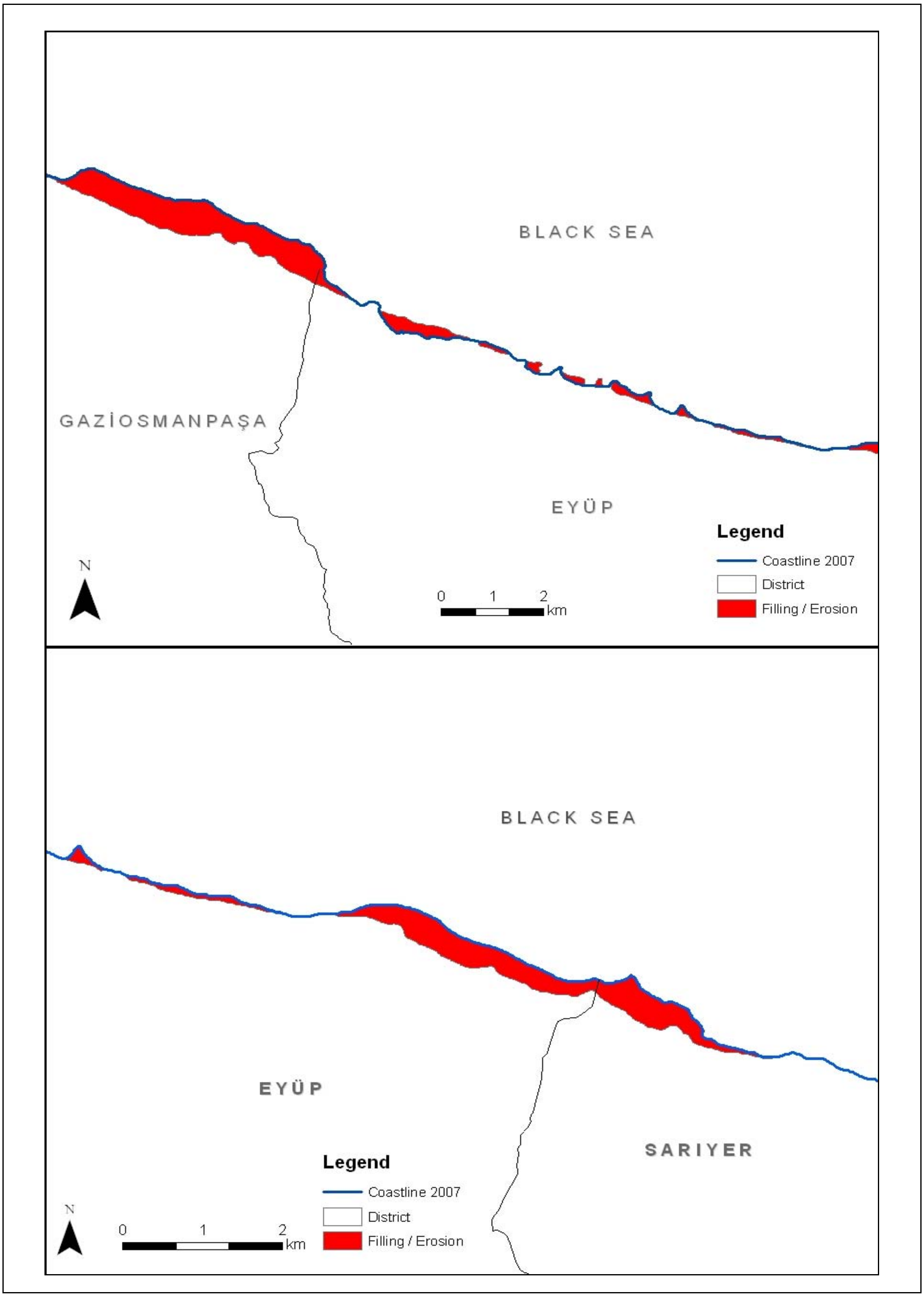


FIGURE 71: LAND USAGE AT AREAS OF COASTLINE CHANGE BETWEEN SARIYER AND GAZİOSMANPAŞA (1987)

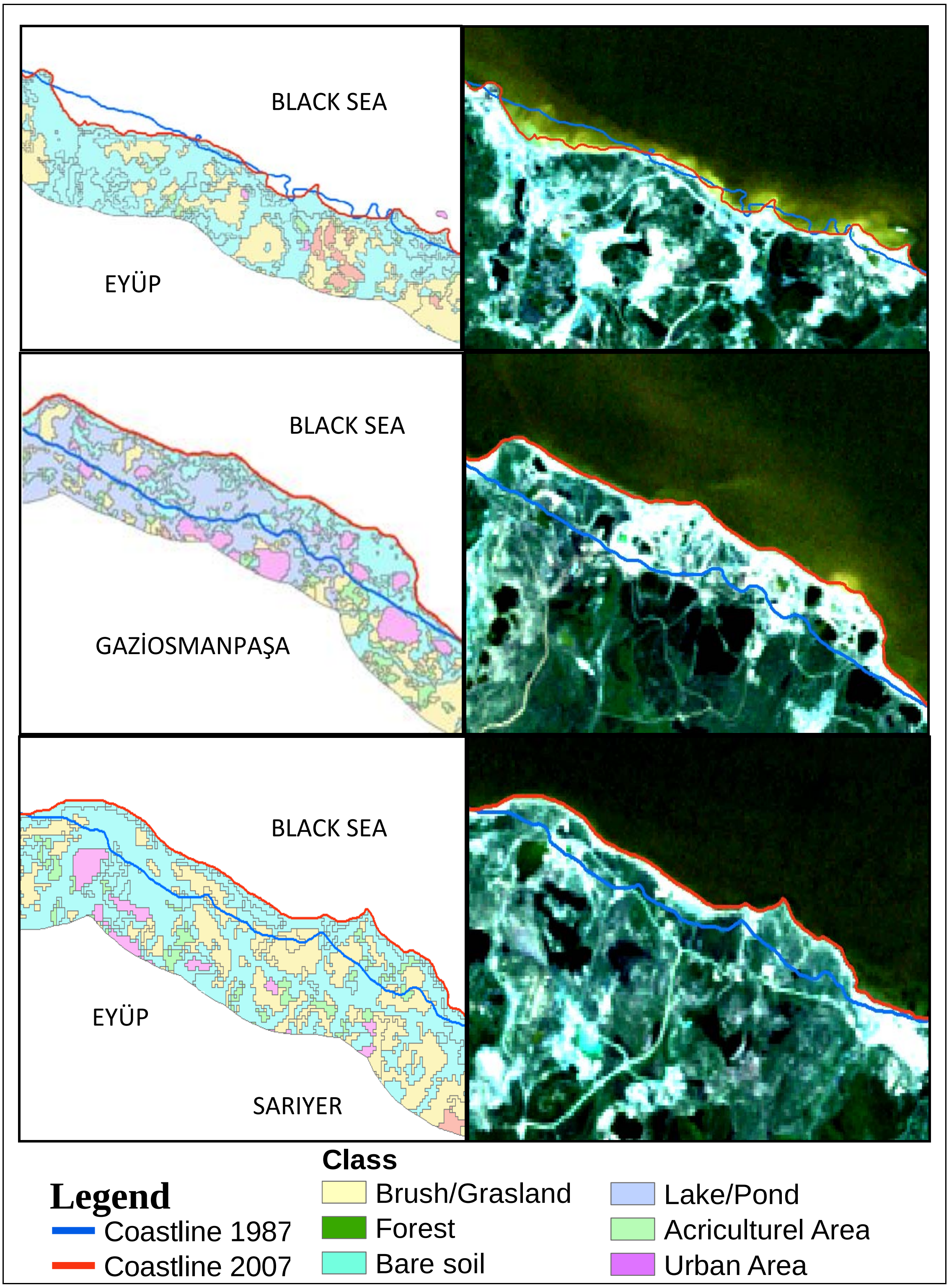
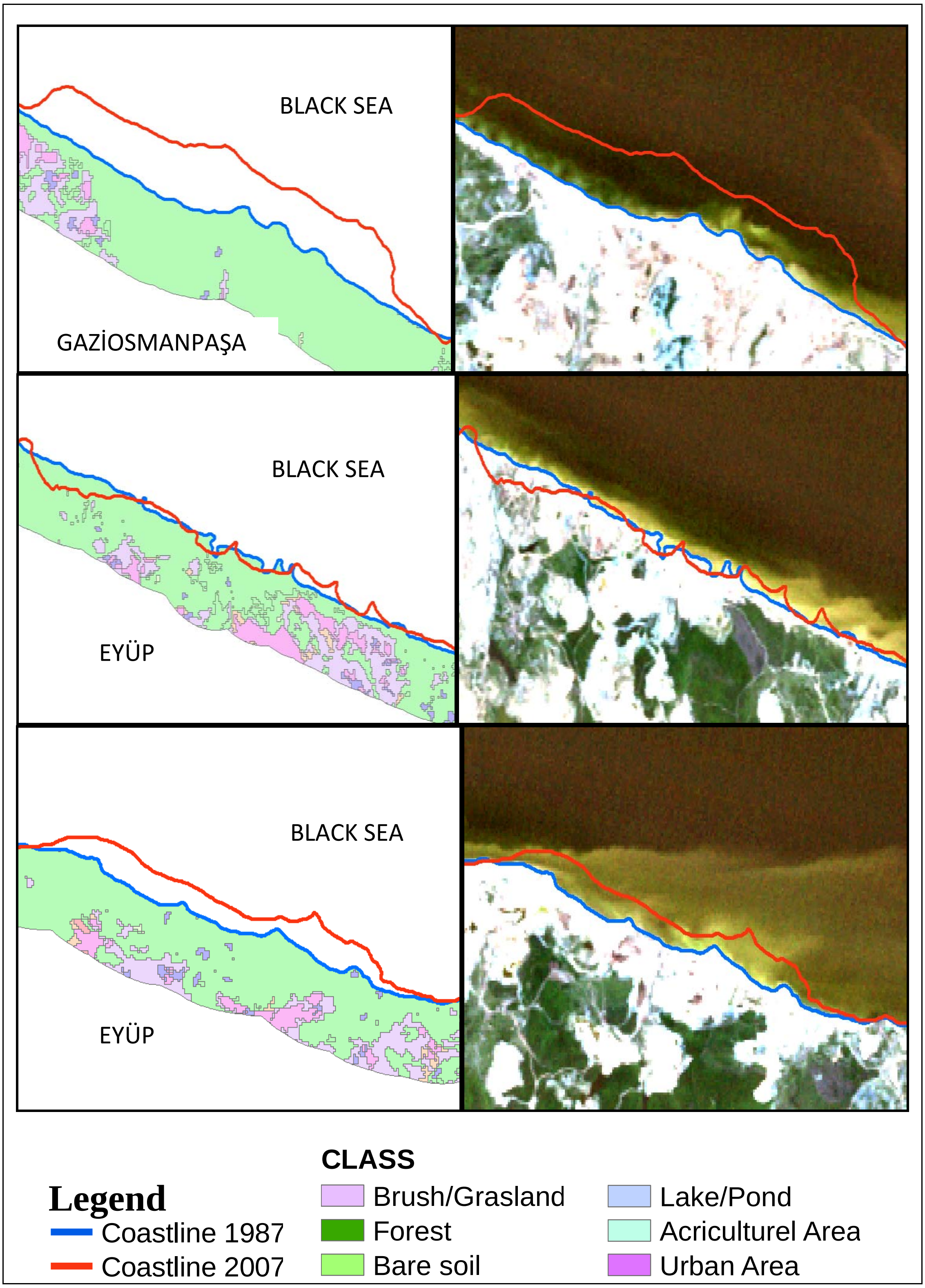


FIGURE 72: LAND USE AT AREAS OF COASTLINE CHANGE BETWEEN SARIYER AND GAZİOSMANPAŞA (2007)



CHAPTER 3: LAND USE CHANGES ALONG THE COAST OF İSTANBUL BETWEEN 1987 AND 2007

Land use changes along the coast of İstanbul are analyzed on 1000 meter zone from coast line to land by means of Landsat TM data 1987 and 2007. The land groups relevant to both of years are evaluated at six different classes in determination process of land use changes at the coast areas. These are; urban areas, agricultural areas, forests, bare soils, brush/grassland and lake/pond. It's not classified approximately 8 hectares area due to standing under cloud in 1987 satellite image so this area is shown under cloud headline in land classification of 1987.

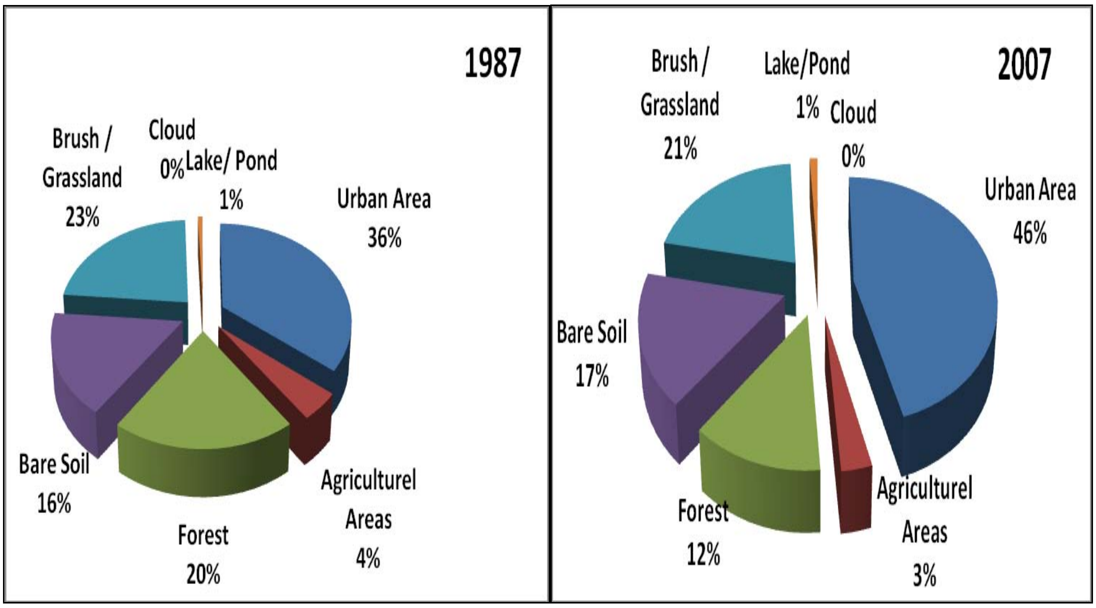
According to 1000 meter buffer generated for coast line of İstanbul in 1987 and 2007 is different for both years as surface area measurement. Land use area surface measurement is 39586 hectares in 1987. Land use area surface measurement is 39848 hectares in 2007. The surface area measurement difference is 261 hectares in two periods. This difference depending on the changes of İstanbul coast line is sourced from 1000 meters zone change as an area in both different times from coast to land.

It's determined important change for land use of İstanbul coast between 1987- 2007 in a short time like 20 years. The largest place of land class is residential areas which is about 39586 hectares working area in 1987. It's evaluated as residential areas like house, way, industrial establishment and the other constitutions in classifications. Depending on this with 36 percent and 14095 hectares residential areas form of total working areas in 1987. The most dense residential areas are İstanbul Bosporus coasts and Marmara sea coasts in 1987. The most dense population was in Üsküdar, Maltepe, Kadıköy and Kartal districts coasts for Anatolia side also Zeytinburnu, Bakırköy, Avcılar, Küçükçekmece and Büyükçekmece coasts in Europe side. In Bosporus, Beykoz and south coast of Sarıyer and Beşiktaş coasts (Table 17).

TABLE 17: LAND USE AND CHANGES IN İSTANBUL COASTS

Class	1987		2007		Change	
	ha	%	ha	%	ha	%
Urban Area	14095	36	18231	46	4136	29
Agricultural Areas	1775	4	1154	3	621	-35
Forest	7783	20	4905	12	2877	-37
Bare Soil	6562	16	6747	17	185	2,8
Brush / Grassland	9108	23	8381	21	726	-8
Lake/Pond	256	0,6	427	1	171	67
Cloud	8	0,01	-	-	-	-
Total	39586	-	39848	-	261	0,6

FIGURE 73: LAND USE AND CHANGES IN İSTANBUL COASTS



As it’s seen in table 17, brush/grassland is the second land use class in the largest covering area of total working area in 1987. It’s shown in this class all of the grass and bushes. Total area of brush/grassland is 9108 hectares in 1987. This area is 23 percent of total area. Brush/grassland are generally dense around the forest areas.

The forests have covered 20 percent area with 7782 hectares at working area in 1987. In this year, the districts that have denser forest areas are firstly Beykoz and Sarıyer then Silivri and North side of Büyükçekmece. Externally, the areas including grove and parks around the Bosporus sign the existence of forests (Table 17).

One of the land class containing large areas is called as bare soil and there is no grass and any facility on it. They are naked land surfaces. In 1987, this land class has covered 6562 hectares area in working area. It was 16 percent of total land in 1987. Bare soil class is denser in Silivri, Büyükçekmece and Black sea coasts of İstanbul. In Bosporus, Beykoz and North side of Sarıyer are the other places containing blank lands.

When it’s look, land use class in 1987 (Table 17), it is easily seen agriculture areas with 1775 hectares area is 4 percent of working areas. Agriculture areas are seriously located in Silivri, Beykoz and North side of Sarıyer in this year.

The section shown as lake/pond in land use class of work area forms pieces of Büyükçekmece, Küçükçekmece and Terkos Lake work area. These sections with 256 hectares surface refered as water form 0.6 percent of working area in 1987 (Table 17).

In this work, it has determined important land use changes in 1000 square meter buffer area from coast line of İstanbul between 1987 and 2007 (Figure 73). The most important variation as a hectare was seen in residential areas. While residential areas were 36 % of working area in 1987, it increased 4136 hectares and covered 46 % of the area up to 2007.

As it's seen from Table 17, there is increasing minimally in bare soil and water land class like residential areas from 1987 to 2007. While bare soil was 16 % of work area in 1987, it increased 185 hectares (2.8 %) up to 2007. There is little difference in water area up to 2007. It increased 171 hectares from 1987 to 2007.

It's obviously seen from work, there is increasing in residential areas in spite of decreasing in agriculture and forest areas. The most important losing is in forest areas as hectare. In 1987, while forests cover 7783 hectares, it is lost 2877 hectares up to 2877. In this case, forest areas decreased 37 % in 20 years (Table 17, Figure 73). Forests decreased from 20 % to 12 % in this period of time. The most decreasing in forest cover has seen in Maltepe, Kartal, Büyükçekmece, Beykoz, Sarıyer, Şile and Gaziosmanpaşa districts.

After the forest cover, the most important losing as land class is in agriculture areas. Agriculture areas decreased 621 hectares in 20 years. It represents 35 % decreasing. Agriculture areas covering 4 % of working areas decreased to 3 % from 1987 to 2007. It's not determined an important variation in Brush/Grassland land class whereas covering large scale of working area. It's observed that 8 % decreasing in brush/grassland class in 20 years. It covers 726 hectares area. Brush/grassland land class covered 23 % of working area in 1987 whereas 21 % in 2007 (Figure 73).

It was not matter to form land use map for year 2007 because of meeting to clouds in some regions of satellite image in 1987. It did not meet to cloud satellite image in 2007 (Table 17).

It was not matter to form land use map for year 2007 because of meeting to clouds in some regions of satellite image in 1987. It did not meet to cloud satellite image in 2007 (Table 17).

There are lots of reasons in land use variation of İstanbul coast regions, basic elements of them are increasing population and urbanization. After 1950, İstanbul especially faced rather fast and planless urbanization with the effect of emigration. According to census in 1985, while the population of coast districts is 5299647, it increased to 8157853 in 2007 (TÜİK, 2009). Large scale of this population lives in coast regions. Depending on increasing population, urbanization is realized along the Marmara sea coast, west-east axis and to north, both sides of Bosporus in İstanbul (Karaburun et al. 2009). In the following table, it's given the population quantities of İstanbul coast districts in the period of 1985 and 2007.

TABLE 18: THE POPULATION OF DISTRICTS IN İSTANBUL COASTS

Districts	**Population**			
	1985	**1990**	**2000**	**2007**
Adalar	14785	19413	17760	10460
Bakırköy	1238324	1328276	208398	214821
Beykoz	136063	163786	210832	241833
Beyoğlu	245999	229000	231900	247256
Eminönü	93383	83444	55635	32557
Eyüp	377187	211986	211986	325532
Fatih	497459	462464	403508	422941
G.Osmanpaşa	289841	393667	752389	1013048
Kadıköy	577863	648282	663299	744670
Kartal	572546	611532	407865	427111
Sarıyer	147503	171872	242543	276407
Beşiktaş	188117	192210	190813	191513
Üsküdar	490185	395623	495118	582666
Zeytinburnu	147849	165679	165679	288743
Çatalca	117380	64241	81589	89158
Silivri	55625	77599	108155	125364
Şile	19310	25372	32447	25169
Yalova	90228	113417	-	-
Maltepe	-	-	355384	415117
B.Çekmece	-	142910	384089	688774
K.Çekmece	-	479419	594524	785392
Pendik	-	295651	389657	520486
Tuzla	-	-	123225	165239
Avcılar	-	-	233749	323596
Toplam	**5299647**	**6275843**	**6560544**	**8157853**

Source: TÜİK, 2009

When we examine the data of table 18, we see decreasing population of Eminönü district up to 2007. The reason is usage of district for industrial and commercial facilities more than residential area. The existence of Covered Bazaar, Tahtakale and Laleli shows that. There is an important increasing in the population of Marmara east coast, Üsküdar-Tuzla axis and from Zeytinburnu to Büyükçekmece.

Depending on urbanization, it was seen that important changes in land use class. It’s not possible to show the land use variatons on a map because of doing it in 1000 meter width area of İstanbul coasts. To examine in detail it’s treated as three different headlines. After this section, land use changes of İstanbul coast regions are divided in to Black Sea coasts, Bosporus and Marmara Sea coast and examined under these headlines.

3.1. Land Use Changes in Marmara Coasts between 1987 and 2007

The Marmara coast regions of İstanbul are the most important areas that the ways of land use between 1987 and 2007. As it’s seen that from Table 19 and Figure 57, residential area covered the largest place with 58 % and 8471 hectares of 14606 coast areas in 1987. Also it’s actually seen that the urbanization and increasing population of İstanbul coasts are too much in 1987 (Table 19). The most dense residential areas were Üsküdar, Maltepe, Kadıköy and Kartal district coasts in Anatolian side and Zeytinburnu, Bakırköy, Avcılar, Küçükçekmece and Büyükçekmece coasts in European side (Figure 74, 75).

As it’s seen that from Table 19 and Figure 58, brush/brassland is the second land use class at the working area in 1987. It’s shown in this class all of the grass and bushes. Total area of brush/grassland is 2136 hectares in 1987. This area is 15 % of total area. Brush/grassland is generally dense around the forest areas. The reason is destruction of forests by the way with constructions.

One of the land class containing large areas is called as bare soil and they are naked land surfaces. In 1987, this land class has covered 1798 hectares area in working area. It was 12 % of total land in 1987. Bare soil class is denser in Silivri, Büyükçekmece and Black sea coasts of İstanbul. In Bosporus, Beykoz and north side of Sarıyer are the other places containing blank lands (Figure 74, 75).

When we look land use class of Marmara coast in 1987 (Table 19), we see that agriculture areas covering with 1345 hectares and 9 % of working areas. Agriculture areas seriously denser in Büyükçekmece, Silivri, Beykoz and north side of Sarıyer (Figure 74, 75).

The forests have covered 4 % area with 670 hectares at working area in 1987. In this year, the districts that have denser forest areas are firstly Beykoz and Sarıyer then Silivri and north side of Büyükçekmece. Externally, the areas including grove and parks around the Bosporus sign the existence of forests (Table 19, Figure 74, 75). Due to urbanization in Marmara Sea coasts of İstanbul, it’s not able to see too much rate of forest areas.

The section shown as Lake/pond in land use class of work area forms pieces of Büyükçekmece, Küçükçekmece and Terkos Lake work area. These sections with 183 hectares surface area form 0.1 % of working area in 1987 (Table 19).

It was not classified approximately 2 hectares area in order to stay under cloud in 1987 satellite image. So it was shown under cloud headline at land classification in 1987.

TABLE 19: LAND USE CHANGES FOR MARMARA COASTS BETWEEN 1987 AND 2007

Class	1987		2007		Change	
	ha	%	ha	%	ha	%
Urban Area	8471	58	11649	79	3177	37
Agricultural Areas	1345	9	448	3	896	-66
Forest	670	4	14	0,1	656	-97
Bare Soil	1798	12	1496	10	302	-16
Brush / Grassland	2136	15	929	6	1208	-43
Lake / Pond	183	0,1	219	1,4	36	19
Cloud	2	0,04	-	-	-	-
Total	14606	-	14756	-	138	

FIGURE 74: LAND USE AND CHANGES IN MARMARA COAST OF İSTANBUL

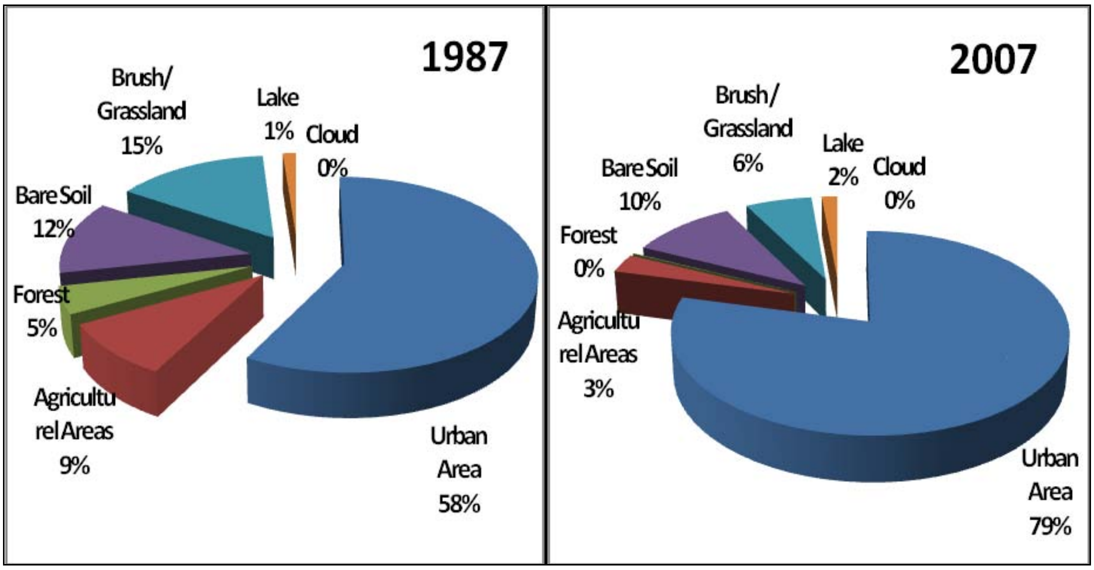
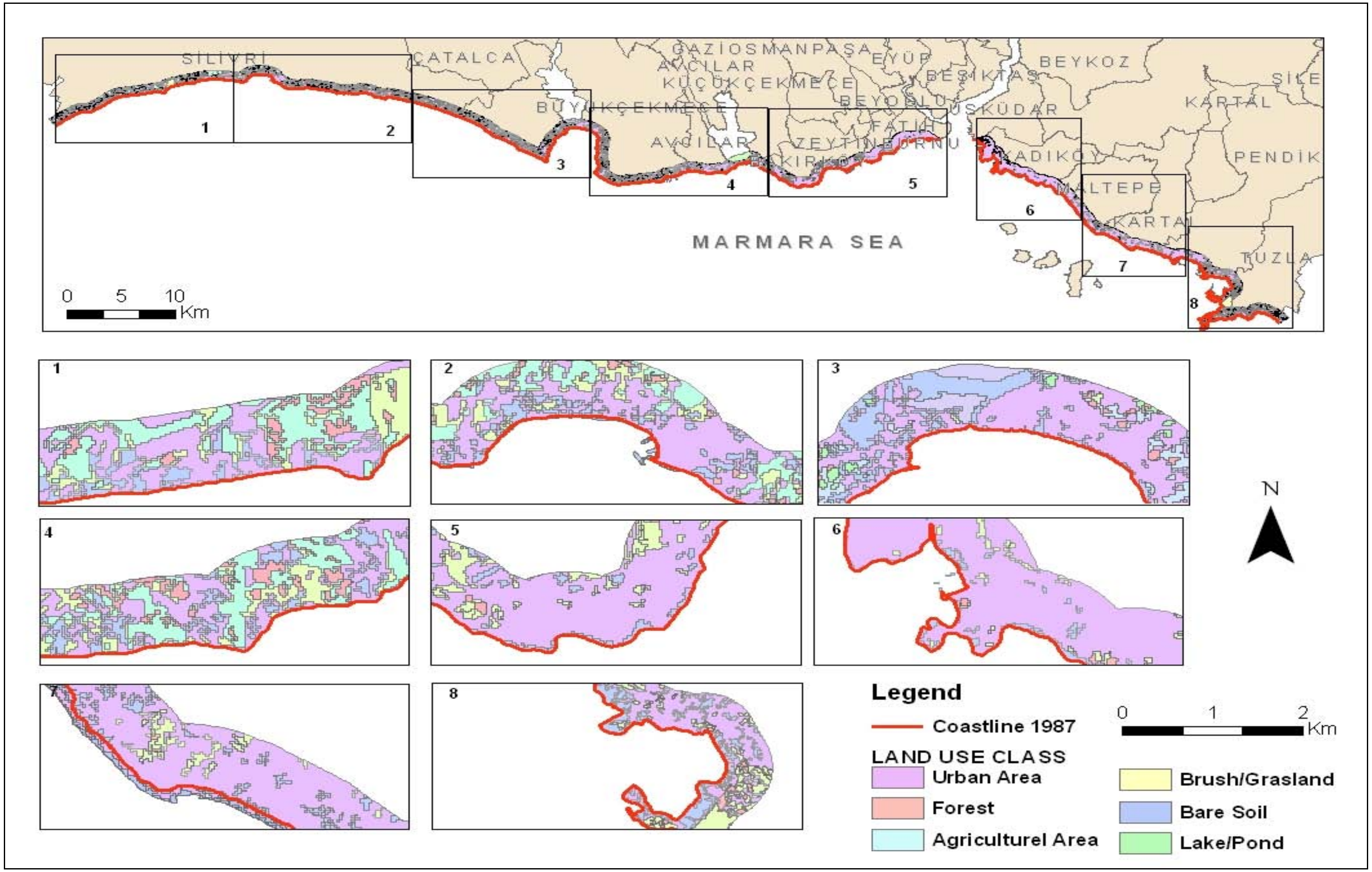


FIGURE 75: LAND USE MARMARA SEA COASTS OF İSTANBUL (1987)



As it’s seen from Table 3 and Figure 73, while residential areas generally increase, brush/grassland and forest areas decrease from 1987 to 2007. As a hectare, the most important lost has seen in brush/grassland areas. In two decades, it decreased 1208 hectares and 43 % according to 1987. Although it covers 6 % of working areas, it decreased depending upon too much residential area.

After the brush/grassland, the most important losing as hectare is in agriculture areas. While agriculture areas are 1345 hectares in 1987, it decreased with 896 hectares and 66 % up to 2007. There is an important decreasing agriculture areas depending on to increase in residential areas (Table 19 and Figure 74). The most decreasing was seen in Büyükçekmece, Silivri and Avcılar coasts.

In 1987, while forests cover 670 hectares, it decreased 656 hectares up to 2007. In this case, forest areas decreased 97 % in 20 years (Table 19, Figure 74). Forests decreased from 4 % to 0.1 % in this period of time. The most decreasing in forest cover has seen in Maltepe, Kartal, Büyükçekmece, Beykoz and Sarıyer districts (Table 19, Figure 75).

In 2007, residential areas are with 11649 hectares and 79 % of 14756 hectares land in the Marmara Sea coasts. Residential areas increased with 3177 hectares and 37 % according to 1987 (Table 19, Figure 74). The most dense residential areas are Maltepe, Kadıköy and Kartal district coasts in Anatolia side and Avcılar, Büyükçekmece coasts in European side from 1987 to 2007 (Figure 76, 77, 78, 79, 80).

FIGURE 76: OLD COAST OF AVCILAR; BEACHES AND CAMPING AREAS

Source: Özdemir, 2004

FIGURE 77: LAND USE BEHIND THE AVCILAR COAST

Source: Özdemir, 2004

As it's seen from Table 19 and Figure 58, land class called as bare soil decreased 16 % between 1987 and 2007. In 1987, while bare soil has covered 12 % of working area, it decreased approximately 302 hectares up to 2007. Bare soil has covered 10 % (14756 hectares) of working area. Bare soil class is at second row after the residential areas in 2007, it decreased depending on increase in residential areas within 20 years (Table 19 and Figure 58).

The section has shown as Lake/Pond in land use class of work area forms pieces of Büyükçekmece, Küçükçekmece lake work area. While these sections refered as lake/pond with 219 hectares surface form 1.4 % of working area in 2007 also it increased 36 hectares up to 2007 (Table 19).

FIGURE 78: LAND USE MARMARA SEA COASTS OF İSTANBUL (2007)

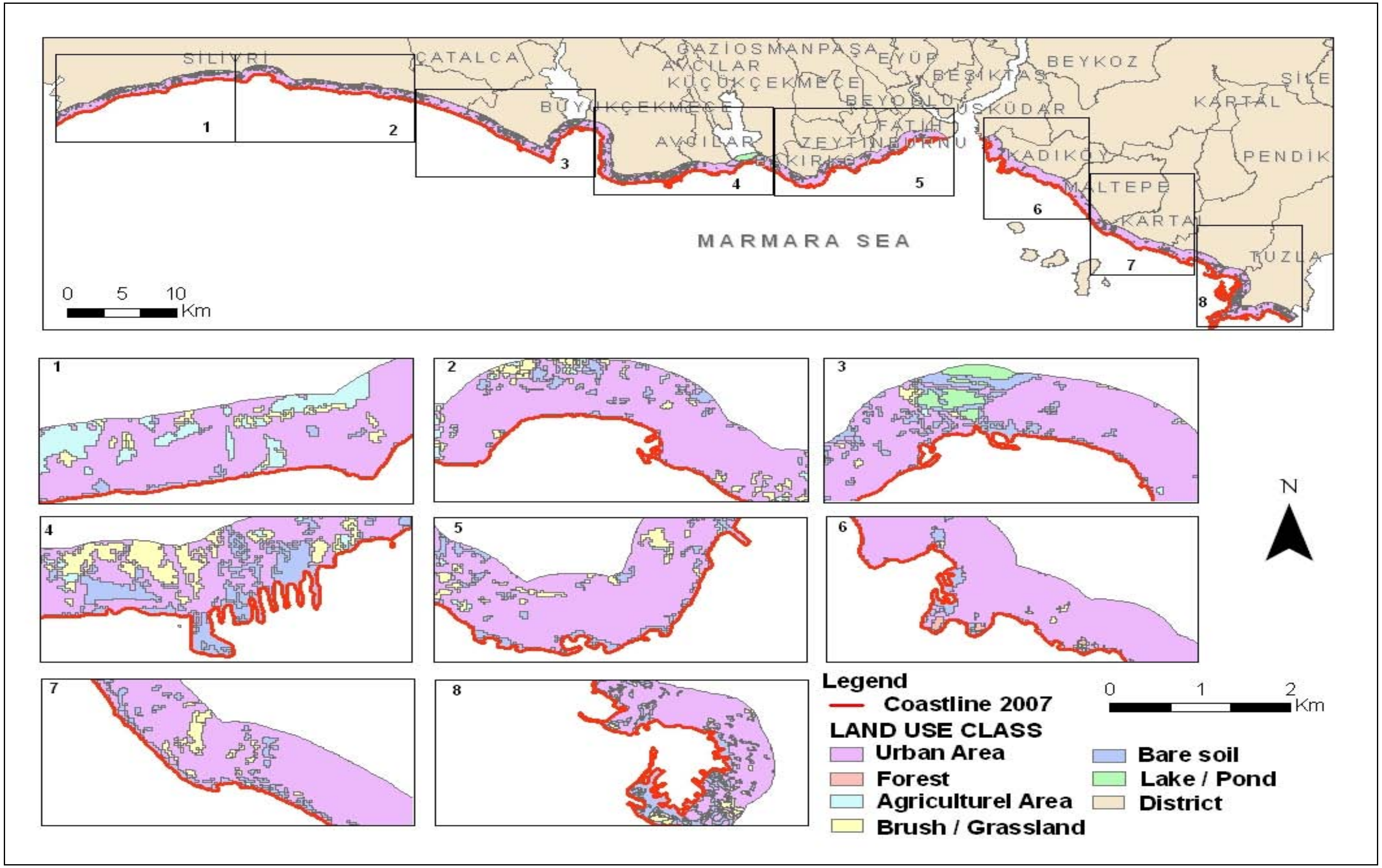


FIGURE 79: LAND USE CHANGES IN MALTEPE, KARTAL COASTS (1987 - 2007)

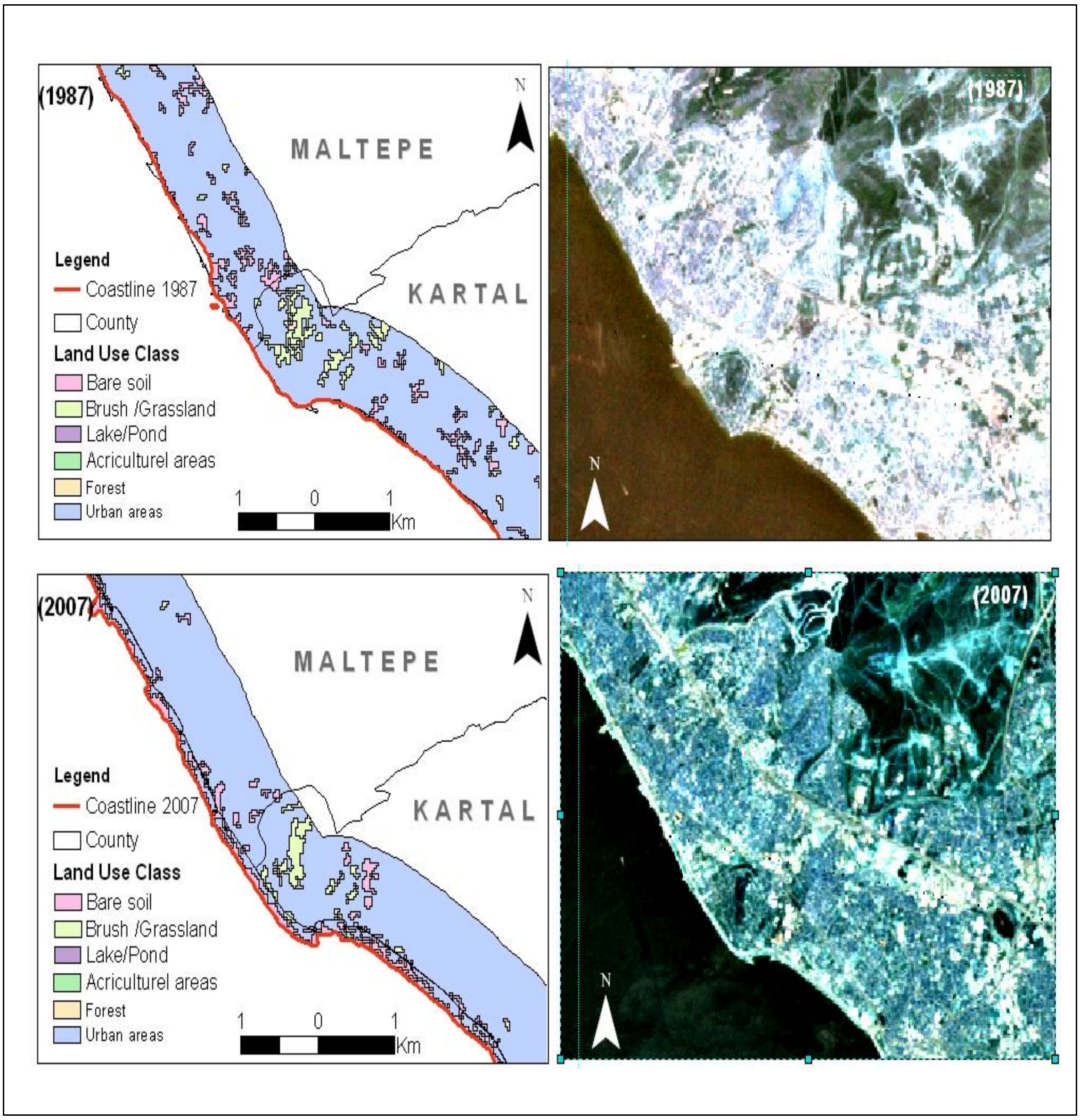
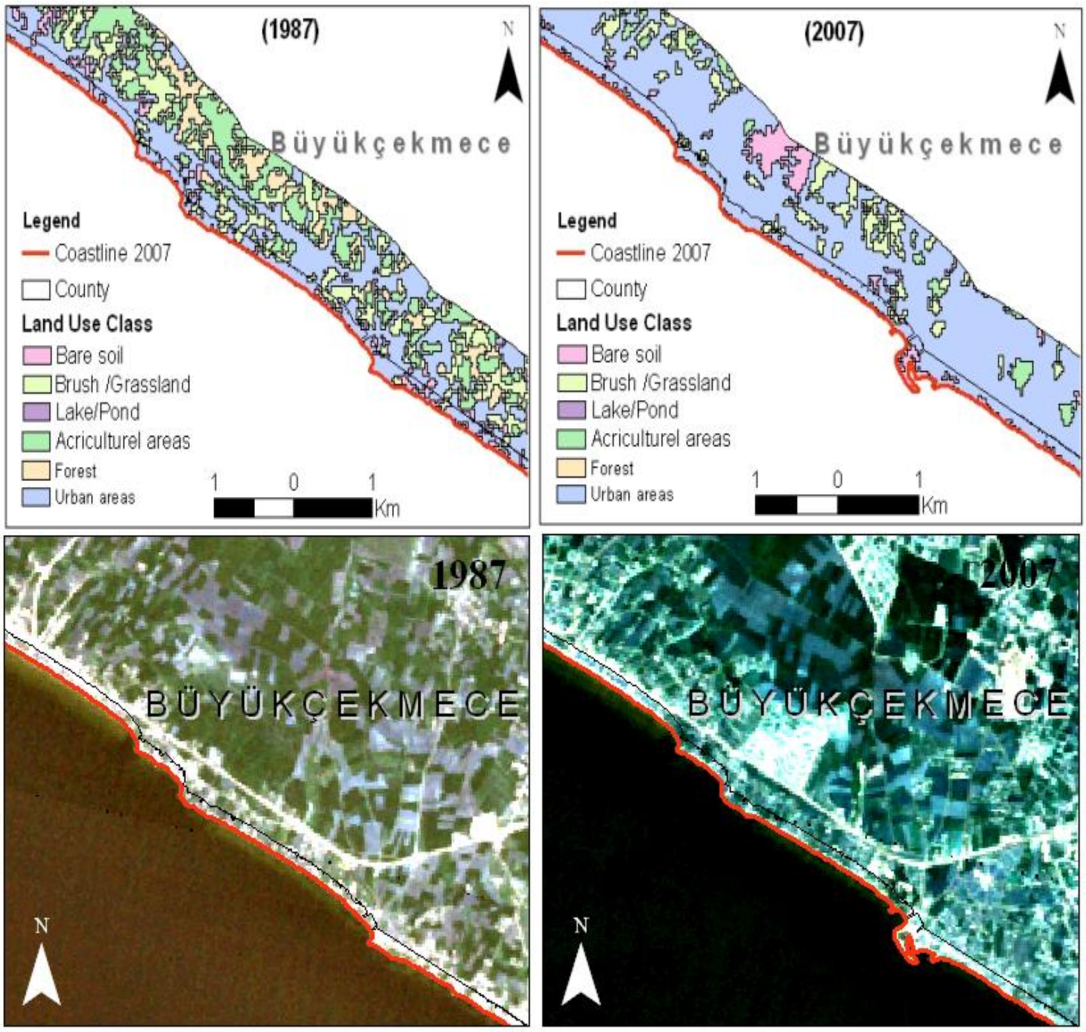


FIGURE 80: LAND USE CHANGES IN BÜYÜKÇEKMECE COASTS

(1987 - 2007)



3.2. Land Use Changes in İstanbul Bosporus Coasts Between 1987 and 2007

As it’s seen from Table 20 and Figure 81, while 5030 hectares area is used as residential area with 61 % and it is the most rate of the total area.

İstanbul coasts are generally preferable locations as urbanization and population even in 1987. The most dense residential locations and population were Beşiktaş, Üsküdar coasts, Beykoz and south coasts of Sarıyer (Figure 81, 82).

As it's seen that from Table 20 and Figure 65, brush/grassland is the second land use class at the working area in 1987. Total area of brush/grassland is 1776 hectares in 1987. This area was 21 % of total area. Brush/grassland is generally dense around the forest areas. The reason is destruction of forests by the way with constructions. Due to the increasing construction and urbanization, brush/grassland and forest areas were destructed especially in Sarıyer and north side of Beykoz coasts (Figure 81, 82).

The forests at Bosporus coasts have covered 17 % area with 1429 hectares in 1987. In this year, the districts that have denser forest areas are Beykoz and north side coasts of Sarıyer. Out of these, the areas including parks and groves are the other places that show existence of forest in Bosporus (Figure 65, 66).

After forests in Bosporus coasts, largest land class that called as bare soil is naked land surfaces. It was covered 41 hectares of working area in 1987 and it was 0.49 % of total 8table 20). The most dense locations of blank lands are Beykoz and north side of Sarıyer (Figure 81, 82).

When it's looked at land use classes of İstanbul Bosporus coasts in 1987 (Table 20), it's seen that agriculture areas cover only 19 hectares and 0.23 % of working area. In that year agriculture areas mostly dense in Beykoz and north side of Sarıyer (Figure 81, 82).

The sections refered as Lake/pond in İstanbul Bosporus coasts form 7 % and 0.06 hectare surface area of total working area in 1987 (Table 20).

TABLE 20: LAND USE CHANGES IN İSTANBUL BOSPORUS COASTS BETWEEN 1987 AND 2007

Class	1987		2007		Change	
	ha	%	ha		ha	%
Urban Area	5030	61	5334	64	305	6
Agricultural Areas	19	0,23	91	1	72	370
Forest	1429	17	851	10	577	-40
Bare Soil	41	0,49	625	8	584	1416
Brush / Grassland	1776	21	1406	17	370	-20
Lake / Pond	0,06	7	-		-	-
Total	8296		8309		13,152	0,15

FIGURE 81: LAND USE AND CHANGES IN İSTANBUL BOSPORUS COASTS

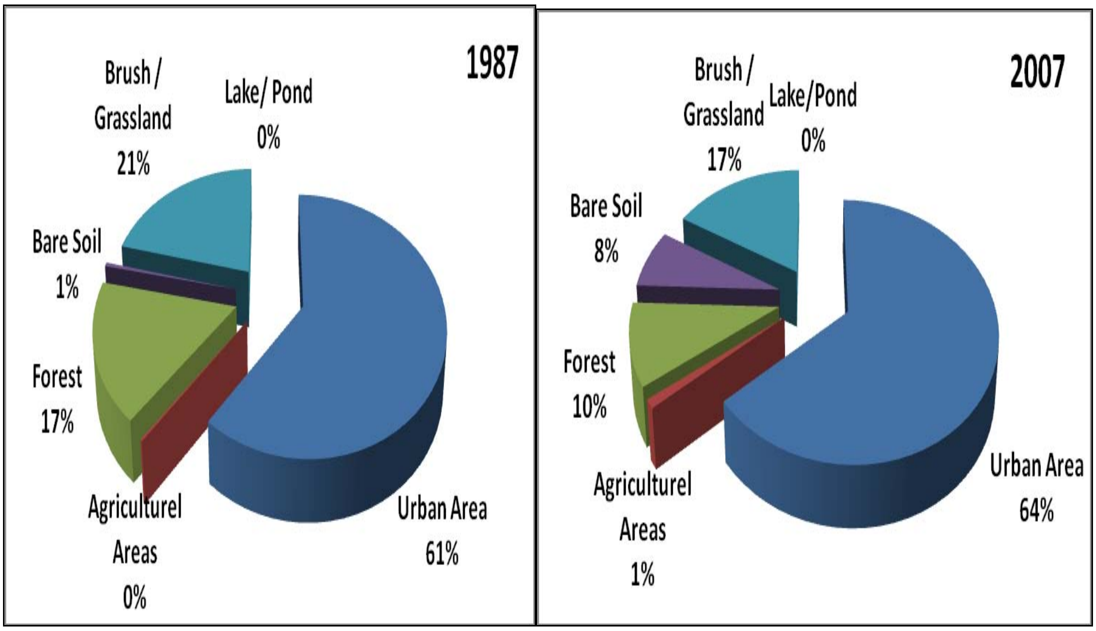
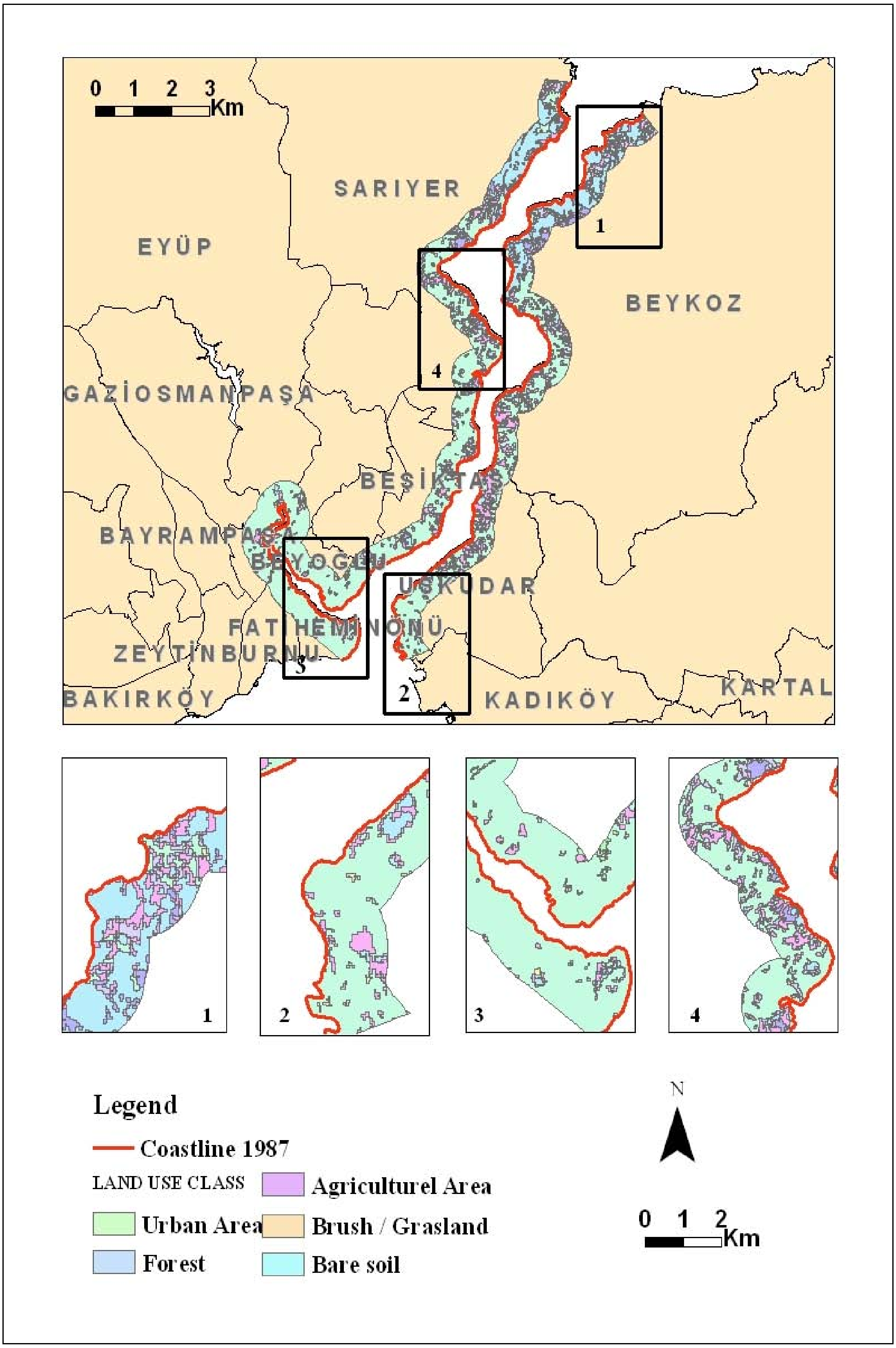


FIGURE 82: LAND USE IN İSTANBUL BOSPORUS COASTS (1987)



Bosporus coasts of İstanbul are the areas including no change in the point of land use between 1987 and 2007. The reason of this is the historical richment of city and need to guard it by Work of art and culture foundation. As it’s seen from Table 20 and Figure 65, there is an increase in residential areas, agriculture areas and bare soil but a decrease in brush/grassland and forest areas.

In Bosporus working area, biggest variation with % 1416 is bare soil between 1987 and 2007. Bare soil land class change is 584 hectares. This is 8 % of the land in 2007 that increased 584 hectares up to 2007. Bare soil lands are mostly located in Sarıyer and north side of Beykoz (Table 20 and Figure 81).

Agriculture areas quantity is 91 hectares in İstanbul Bosporus. There is an increase 370 % in agriculture areas from 1987 to 2007 but it’s quite low rate (1 %) in total working area in Bosporus. Present agriculture areas are located in Beykoz and north side of Sarıyer (Figure 81).

İstanbul Bosporus coasts of working areas are not rich in the point of forest cover. In 1987, while forests cover 1429 hectares, it is lost to 851 hectares decreasing 40 %. It’s obviously seen from work, there is increasing in residential areas in spite of decreasing in forest areas. Depending on increasing new buildings and constructions in Sarıyer and Beykoz cause lost in forests. The rate of forest in Bosporus is 10 % in 2007 (Table 20 and Figure 81, 84).

Construction studies which cause decreasing forest areas in İstanbul Bosporus coasts have also the same effect for brush/grassland. This land class which is 1776 hectares in 1987 has decreased to 1406 hectares with 20 % lost in 2007. Brush/grassland is 17 % of 8309 hectares working area located at Bosporus in 2007 (Table 20, Figure 81). According to Table 20, 5334 hectares residential area forms the 8309 hectares of working area at İstanbul Bosporus land use in 2007. Residential areas are 64 % of the other land classes in that year. It increased 305 hectares and 6 % according to year of 1987. Residential areas have been seen in Üsküdar and Beşiktaş coasts that have high population and urbanization (Table 20, Figure 83, 84).

FIGURE 83: LAND USE CHANGE IN İSTANBUL BOSPORUS

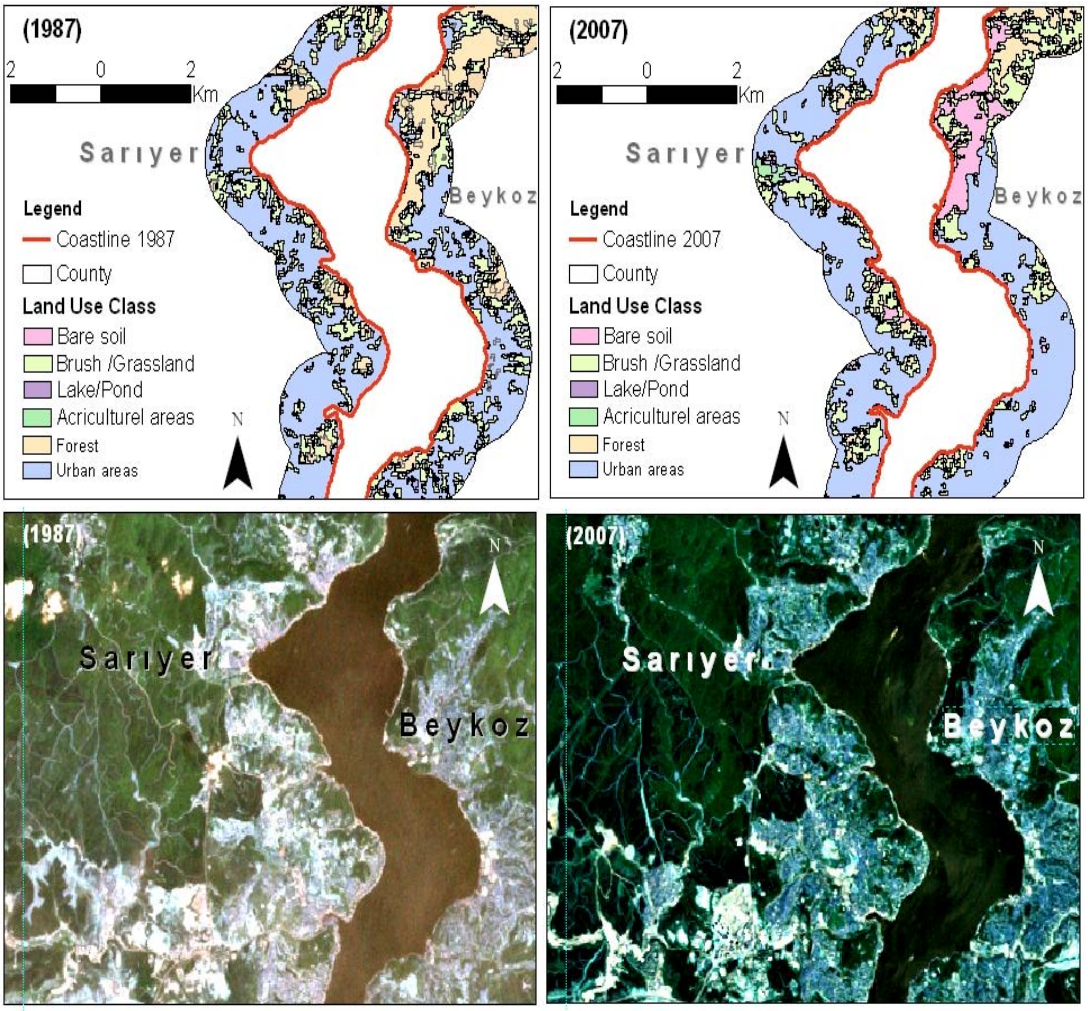
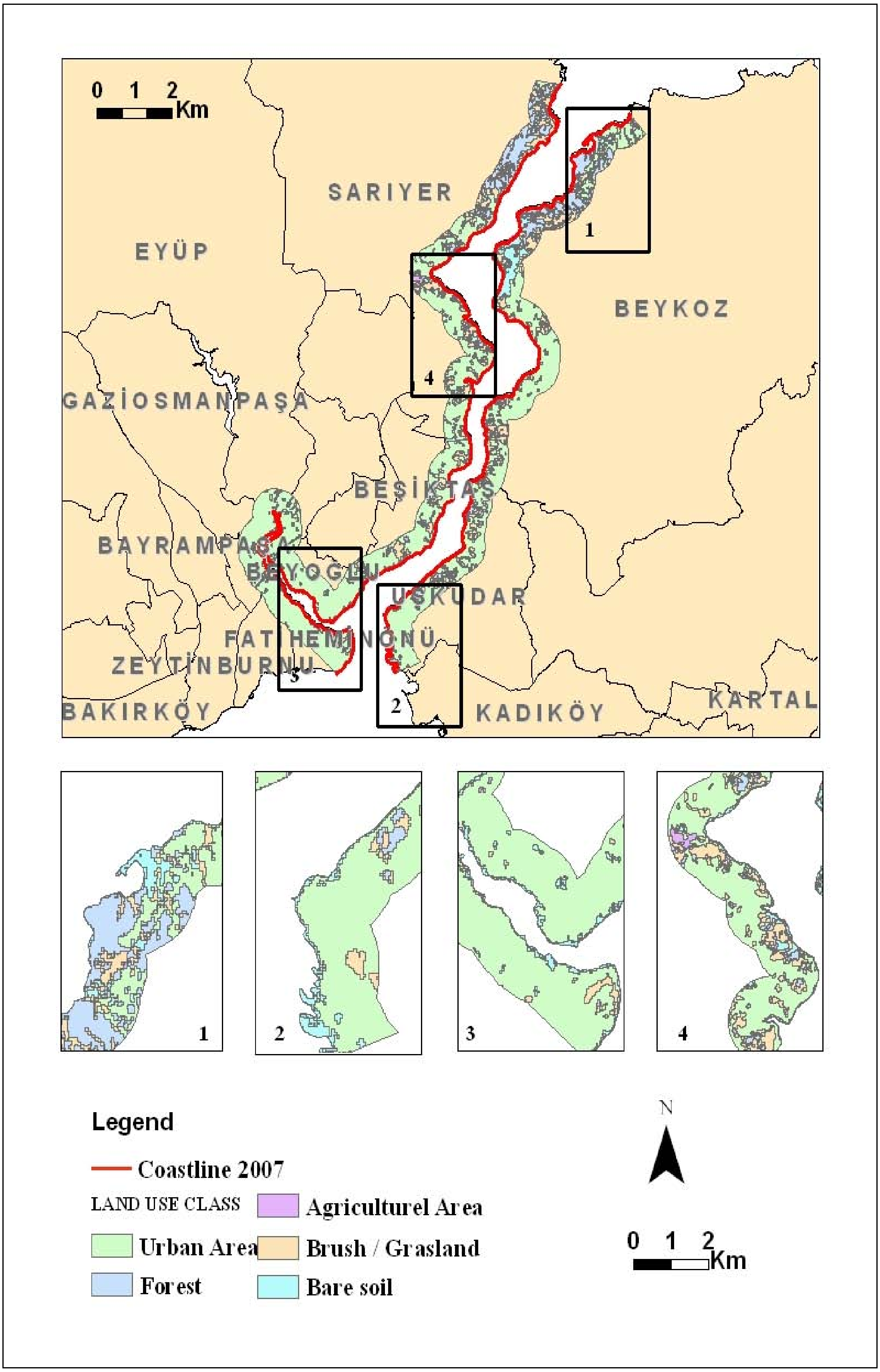


FIGURE 84: LAND USE IN İSTANBUL BOSPORUS COASTS (2007)



3.3. Land Use Changes in İstanbul Black Sea Coasts between 1987 and 2007

Black sea coasts of İstanbul are richest locations including forest cover and bush rate. But lately there is decreasing in forest cover in these areas depending on increasing of residential areas (Table 21, Figure 85 and 86). The quantity of Black sea coasts with 5683 hectares and 34 % of total working area 16683 hectares were used as forest area. The most dense locations of forest areas are Beykoz, north side of Sarıyer, Çatalca and coast side of Gaziosmanpaşa.

After the forest cover at Black sea coasts, the largest land class is brush/grassland in 1987. It has been covered 5195 hectares and 31 % of total 16684 hectares (Table 21 and Figure 85).

After the forest and bush, the land class called as bare soil is the largest one with 28 % in 1987. Bare soil with 4722 hectares is formed with rocky areas at coast and inner side of this area. It was generally uncrowded places so the narrowest coast of continental shelf is located along Black Sea coasts (Table 21, Figure 85, 86).

The urbanization places from Figure 70 are densed in coasts of Çatalca, Şile, Beykoz and Gaziosmanpaşa. The residential areas were covering 4 % of working areas in 1987. The reason of less urbanization areas is existence of unsuitable ground shape for these regions.

The quantity of agriculture areas in this period is 412 hectares and 3 % within the other land class including working areas in İstanbul Black Sea coasts. The agriculture areas are mostly accumulated around Çatalca Beykoz, Sarıyer and south side of Şile (Table 21, Figure 86)

In 1987, Black Sea coasts of İstanbul, land class called as Lake/pond is 72 hectares. Lake/pond is 0.43 % of 16683 hectares located on Black Sea coasts of working areas. The reason is small lakes including just small parts of working areas like Terkos (Table 21 ve Figure 85, 86).

It’s not classified approximately 6 hectares area due to staying under cloud for Black Sea coast region in 1987 satellite image.

TABLE 21: LAND USE CHANGES IN İSTANBUL BLACK SEA COASTS BETWEEN 1987 AND 2007

CLASSES	1987		2007		Değişim	
	ha	%	ha	%	ha	%
Urban Area	594	4	1248	7	654	110
Agricultural Areas	412	3	615	4	202	49
Forest	5683	34	4040	24	1643	- 28
Bare Soil	4722	28	4625	28	97	- 2
Brush / Grassland	5195	31	6046	36	851	16
Lake / pond	72	0,43	208	1,2	39,7	55
Bulut	6	0,03	-	-	-	-
Toplam	16683		16783		100	

FIGURE 85: İSTANBUL BLACK SEA COASTS LAND USE DISTRIBUTION

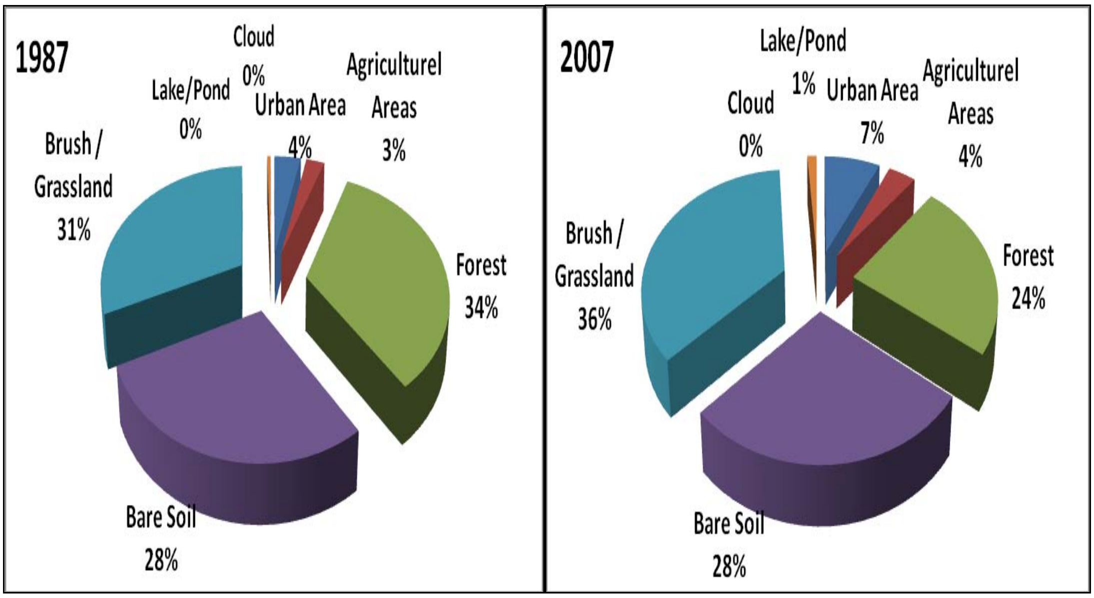
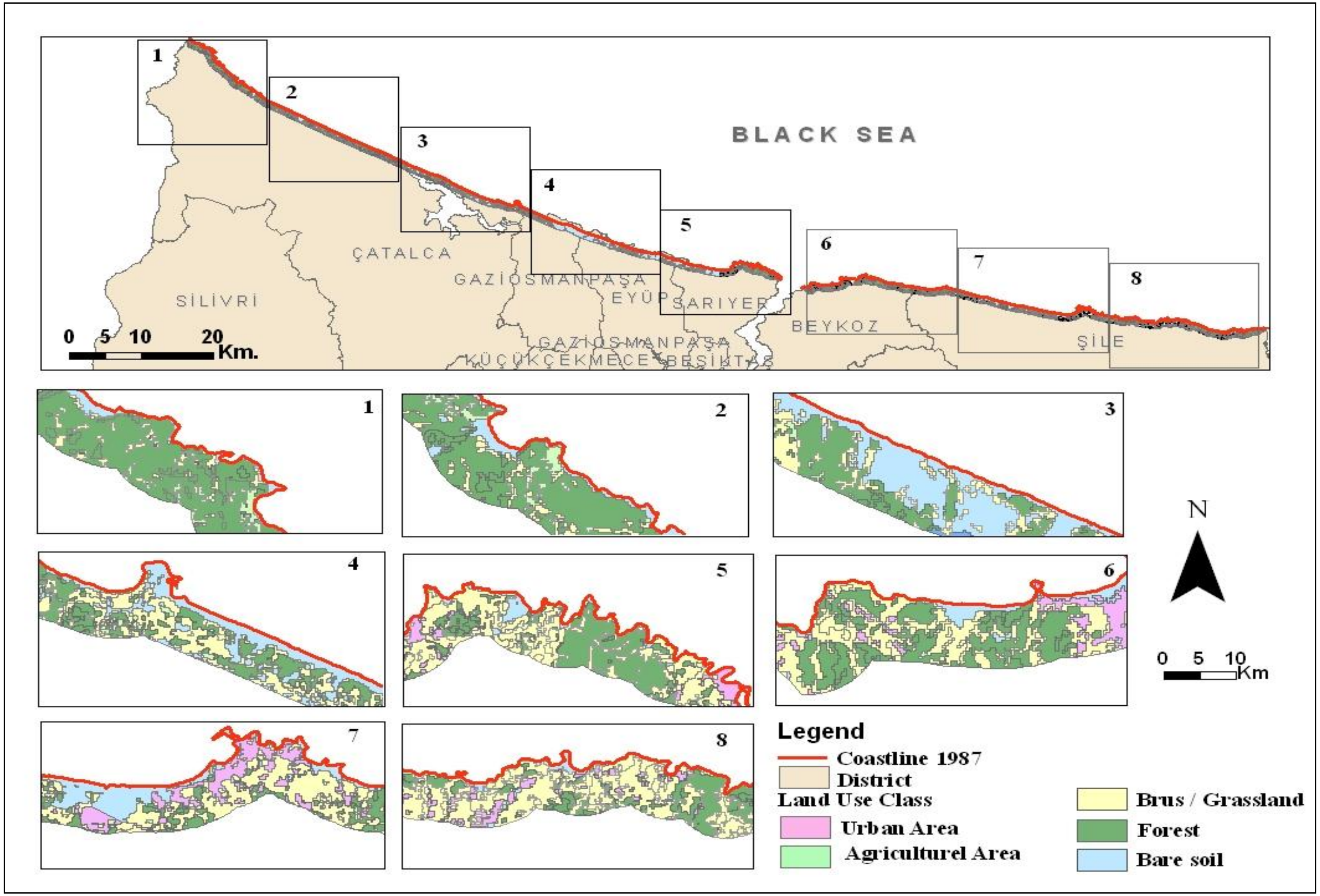


FIGURE 86: İSTANBUL BLACK SEA COASTS LAND USE (1987)



As it's seen from Table 21 and Figure 85, in Black Sea coasts of İstanbul, the rate of residential areas is 1248 hectares and 7 % in 2007. It increased 110 % according to year of 1987. The degree of increasing is 654 hectares. The most increased districts are Şile coasts with Sarıyer, Beykoz and Gaziosmanpaşa coasts. The reason of increasing is second house construction and interesting residential areas like Şile. But urbanization in Black Sea coasts seems quite small in 2007 compared with 1987 changing rate. The source of this case is being far and away of coasts in these sides from historical peninsula and Bosporus (Table 21, Figure 87, 88).

Agriculture areas are the most changable land class with 615 hectares and 4 % after urbanization areas in 2007. It increased 202 hectares and 49 % according to year of 1987. This case is connected with some lands which is started to use again.

The forest areas rate is 24 % and 4040 hectares in 2007. The forest areas decreased 1643 hectares and 28 % accordance with 1987. The urbanization is mostly effective in that decreasing. Especially, constructions in Şile, Beykoz and Sarıyer coasts caused the decreasing of forests even in Black Sea coasts (Table 21 ve Figure 87, 88).

Brush/Grassland lands cover 36 % and 4040 hectares of working areas in 2007. It seems to be an increasing 851 hectares and 16 % accordance with year of 1987 (Table 21, Figure 85, 87). The source of high rate is destruction of forests and convertion to Brush.

Bare soil is 4625 hectares and 28 % of working areas at İstanbul Black Sea coasts in 2007. It decreased 97 hectares according to 1987. It seems to be a decreasing 2 % from 1987 to 2007. This case is related about increasing residential and agriculture areas (Table 21, Figure 85).

Lake/Pond land class is 208 hectares of İstanbul Black Sea coasts in 2007. Lake/pond rate is 1.2 % of total working area located on İstanbul Black Sea coasts. The small parts of lakes just located among the working areas are classified as lake/pond land class. Although an increasing 55 % compared with 1987, it just covers 1.2 % within land classes in 2007 (Table 21, Figure 85, 87).

FIGURE 87: İSTANBUL BLACK SEA COASTS LAND USE (2007)

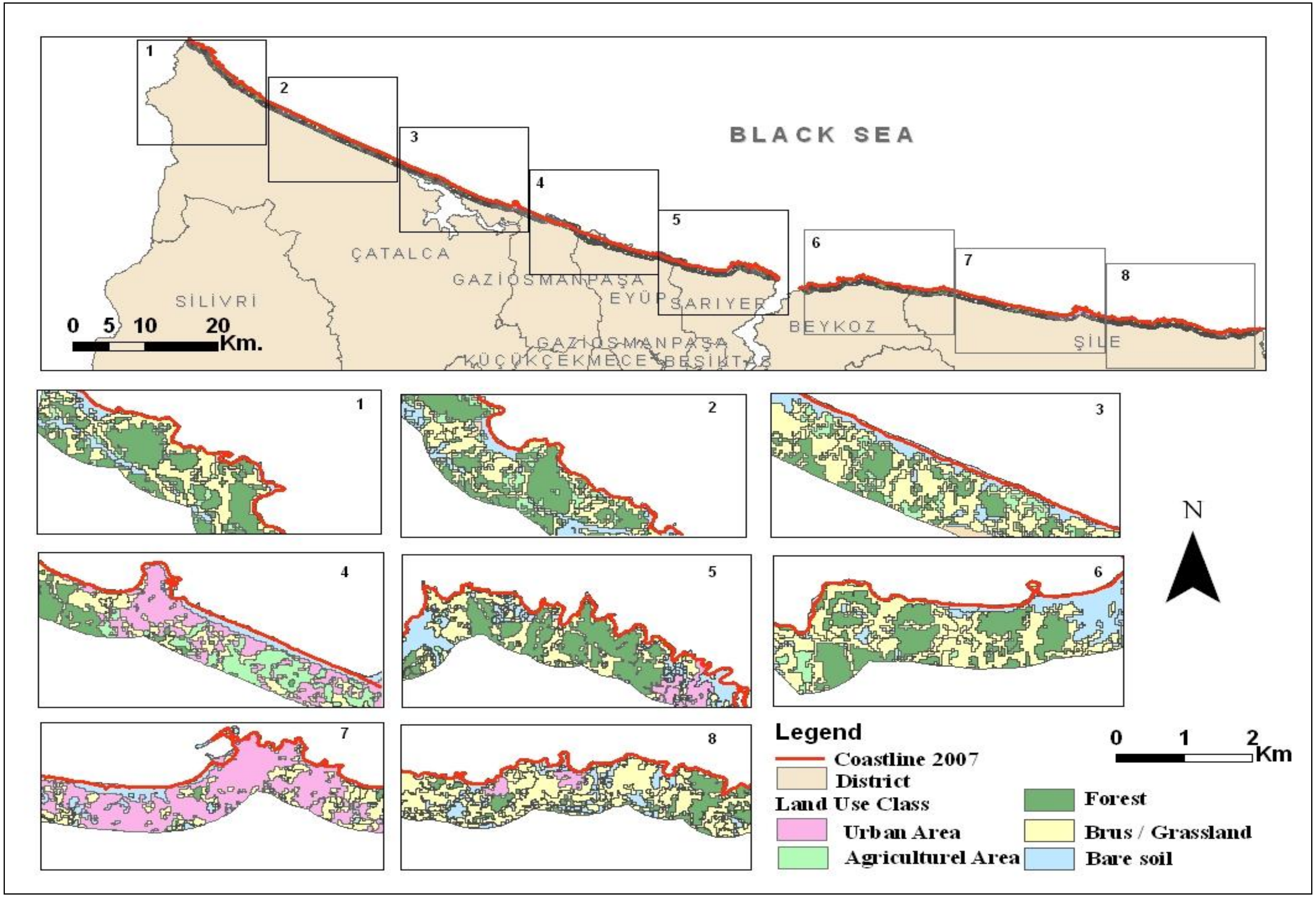
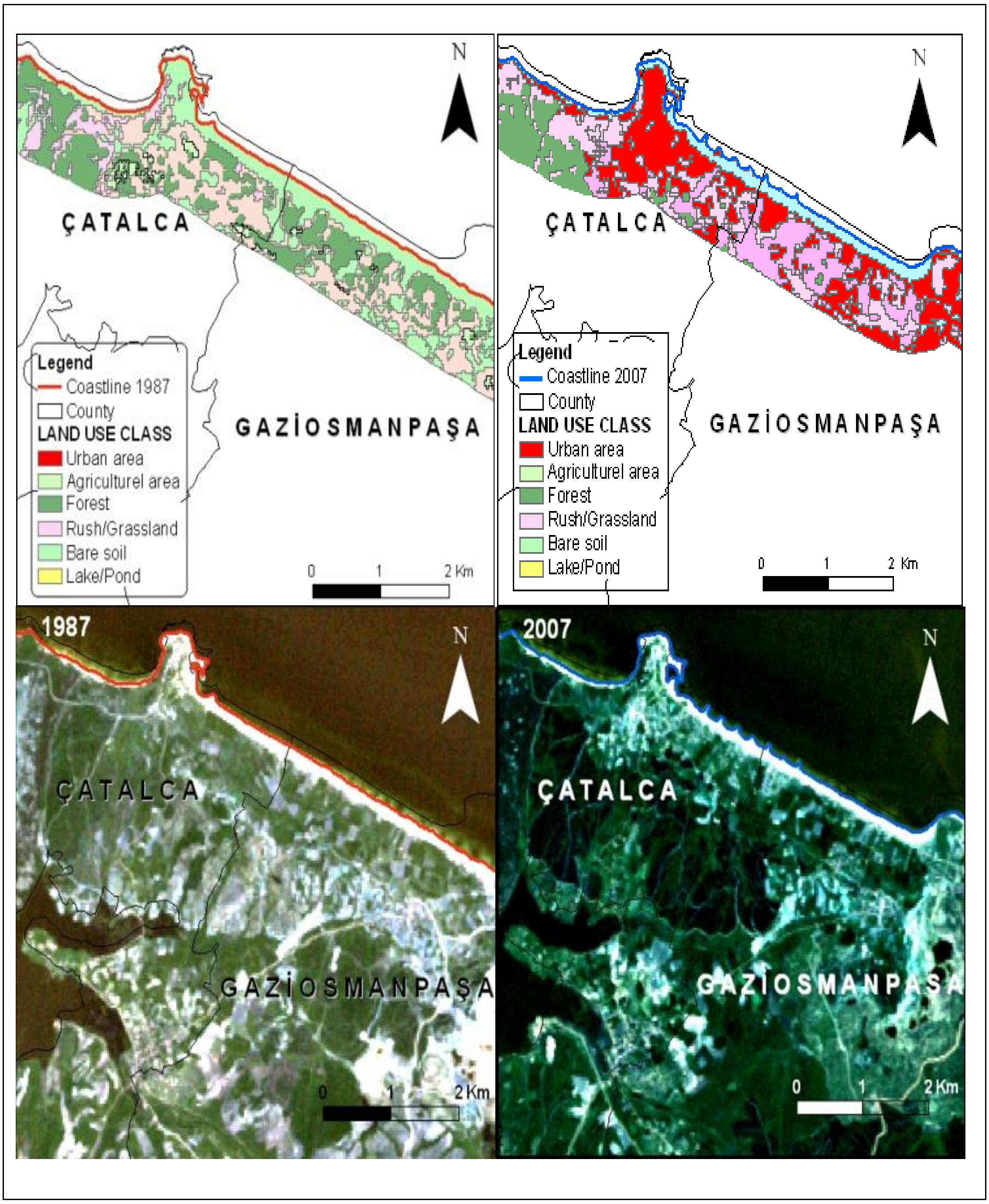


FIGURE 88: İSTANBUL BLACK SEA COASTS LAND USE CHANGES (1987-2007)



CHAPTER 4: CONCLUSION AND RECOMMENDATIONS

Presence of coasts that provide the aesthetic appeal of the city has an additional importance for development and modernization of İstanbul next to its historical and cultural identity. However, similar to many water ways and coastal cities in the world, coasts of İstanbul are under the pressure of population increase, industrialization, trade and tourism activities. As an internal sea, Marmara is subject to industrial pollution due to surrounding industrial facilities. On the other hand, Black Sea coasts are affected by the polluters carried by large rivers originating from Europe such as river Danube. The pollution load in these two seas is moved by deep and surface currents through İstanbul Strait that connects Marmara and Black Sea. As a result, all coastal areas of İstanbul are affected by this pollution. In addition, as a result of high urbanization rate in the city and occupation of areas as close as 15-20 meters to coast line, coastal areas of recreation has shrunk significantly.

To reclaim these lost recreation areas, İstanbul Metropolitan Municipality has filled coastal areas and this activity of filling is still continuing. This filling operation in the direction of both land and sea has an extra importance for the physical structure of the coasts and change of coastal line in İstanbul. Therefore, It has been determined that coasts have been filled by natural and artificial means since Roman era. For instance, many ports were constructed on coastal area of Marmara Sea and Golden Horn during Byzantines such as the first Byzantium Port of Ahırkapı. However, walls of only some of these ports are intact nowadays.

Coastlines are subject to change at many spots in the metropolis of İstanbul as a result of filling of sea due to needs of increased transportation, construction, and tourism. The Tourism Promotion Act of 2634 in 1982 and 2805 Amnesty Law of the development in 1983 are the primary reason for experiencing this change (Özdemir, 2004). Depending on this, there has been an important change in use of coastal line and areas due to increasing recreation oriented filling operations in İstanbul. For this reason, İstanbul should have an active administration of coastal areas in international economy with its strategic strait and sea trade to be able to present its natural beauties, historical, ecological, and morphological structure to the use of public in a planned way. In order to have an active coastal administration, it is important to observe and determine what kind of changes happen in the city coasts and how usage of coastal areas change based on what factors. For this reason, this study has an importance in providing accurate data about determination of coastal line changes due to land use in İstanbul coasts and determination of reasons for these changes to have decisions about planning of future use of these areas. In a study using the images from 30 meter resolution Landsat TM dated 11 May 1987 and 11 May 2007, changes in land cover, coastal line and its use for last 20 years were observed. However, quality of the classification of the land was affected by absence of higher resolution satellite pictures by Ikonoks from same years and being of satellite pictures from Lansat TM 30 meter resolution. For example, bushes and forest areas led to confusions in satellite pictures from 1987. Clouds in the satellite pictures from 1987 also affected the study in a negative way. It will be important to have future studies of the same region using higher resolution satellite views for obtaining more accurate results.

Because revival of the coasts in İstanbul getting significantly important, coasts are organized by filling to solve problems related to transportation, infrastructure, and recreation. These operations also continue today. However, these operations for infrastructure, transportation and etc. caused large changes and damages in physical structure of the İstanbul coasts. Natural coastal lands have been destroyed by addition of filling areas.

Quality of places decreased as a result of deficiency in planning and design at many coastal filling areas except some places like Cadde Bostan and Moda. In addition, coastal highways between residential areas and recreational areas in the coastal filling areas cut the link between the city and the sea. Main reasons of this problem are, the insufficiency of pedestrian and mobile ways connecting between residential areas to coasts and intense traffic in the coastal highways.

In Turkey, the most important problem about the coastal areas is the conflict of authority arising from complex legal processes. As a result of this, protection and use of the coasts were not provided properly in the legislations about coasts. In legislations, it was focused more on use than protection of the coasts. According to the law, it is legalized to occupy the coastal areas for the benefit of the society, however it is not mentioned which coasts and how should be exploited. It is mentioned that fillings that does not damage the ecological balance should be used but it is not clear how inspections of these activities would be done. An additional problem is the conflict of administration between the district municipalities and the Metropolitan Municipality about organization of the coastal areas.

In the area of study, it was observed that human factors -such as filling of coasts and transfer of sand- were more effective than natural factors, in general use of coasts and changes in the coastal lines. In addition, the change was observed most significantly in Marmara and the Black Sea coasts. On the other hand, because of the intensity of the historical and private properties, there has not been observed any significant change in coastal and land use in İstanbul Strait coastline.

In the area of study that includes 24 districts of İstanbul, the population is 815785 according to 2007 data. In the buffer area that comprise of 1000 meters from the coastline to the land, there was a land of 39586 hectares in 1987. This buffer area expanded to 39848 hectares with filling additions in 2007. However, because the buffer line for each year is taken separately, the difference between the two periods is measured to be 261 hectares although it should be 1223 hectares with the coastal fillings.

In the study area, beaches and recreation areas decreased and ceased completely at certain places, areas of approximately 700 hectares at Marmara, 503 hectares at Black Sea, and 26 hectares at the Strait, Golden Horn and Üsküdar coasts have been filled to reconnection of society and the sea. However, it is observed that many beaches had been used by public in the history ceased to exist. For example, there is not any natural beach left at Yeşilköy coastal area.

Although it helped people to connect to sea and relax, filling operations changed coastal lines at many places at İstanbul coastal area. It is observed that coastal line advanced 250 meters far away seaward at sites where coastal filling operations had been done. After the reconstruction law had been into force in 1984, coastlines of İstanbul changed due to filling operations at districts of Eminönü and Fatih of European side, as it was observed by Lansat satellite images in 1987. Change in the coastlines can be observed clearly at Zeytinburnu, Bakırköy, Avcılar, and Büyükçekmece districts looking at the 2007 satellite images. Coastal filling activities are still being continued at Avcılar.

In İstanbul, operations at coastal areas were not only limited to filling. Especially at Black Sea coastal area, soil and sand removal caused coastal line to shrink landward. Total of 50 hectares at Black Sea coast and 26 Hectares at Golden Horn Coast abraded due to human factors such as sand removal from coast.

As a result of all these coastal filling activities total coastline length increased from 459 km. in 1987 to 492 km. in 2007.

In this study, temporal change of İstanbul city coastline was determined and updated coastline information is revealed.

In the area of study, it was observed that recreation, transportation, accommodation, and shopping areas were the main usage ways of the coastal filling areas. Recreational areas comprise of pedestrian and biking ways, tea gardens, play grounds, parks, and picnic areas. As means of transportation, generally sea ports and coastal highways attract attention.

In the area of study, as the year of 2007, 18231, 1154, 4905, 6747, and 8381 hectares of areas were used as residential, agricultural, forest, bare soil, and bush/grassland, respectively. Inside the borders of the area of study, area of the lakes was 427 hectares. Until 2007, while the residential area was expanding, forest, bush/grassland, and bare soil areas decreased (Table 17). In the area of study, it was observed that in 1987 constructions started just behind the coastal line, but in 2007 these buildings were left behind roads and parks as a result of coastal filling activities.

Some suggestions are listed below to solve all problems mentioned and to help get precautions for proper use of coasts.

It should be provided that Coastal areas are easily accessible by public as it is mentioned in the Article 43 of the Constitution of 2709 in 1982, coastal areas are under the provisions and save of the state. In addition, According to the 715th article of 4721st civil law in 2001, coastal areas can not be private property of anybody (Sesli et al. 2003). Thus, required measures should be taken to prevent construction of any building in the areas determined to be inside coastlines by laws. According to the active 5th item of coastal law, construction and planning should not be allowed at coasts where coastline has not been determined. About this subject, municipalities that govern the coastal areas should rescue coastal areas from pressure of private properties and public institutions by establishing regulations for the benefit of society.

Measures of protection should be taken not only at the coastline but also inside the borders determined seaward and landward based on the morphological characteristics of the coast, to protect the topographic and silhouette of İstanbul coasts.

Beaches used by the public were destroyed as a result of coastal fillings that also changed the coastal line at İstanbul metropolitan coasts. At such places it can be seen that coastal fillings destroyed the topographic structure and the silhouette of the coast. In reorganizing İstanbul coastal areas, instead of filling the coasts, new approaches to reclaim coastal areas should be determined, and loss of natural coastlines should be prevented.

It should not be allowed to have excavations, sand and gravel transfers from coasts that will change the coastlines at İstanbul coasts.

Activities that will increase the chance of landslides should be avoided at places such as Gürpınar and Avcılar coastal areas that are susceptible to landslides.

Recreational areas are very important at a city like İstanbul that has an intense work life due to city life and is overpopulated. For this reason, multi-faceted benefit criteria should be based in organizing recreational facilities at coastal areas for people to spend their off times and relax. Coastal areas should be organized in a way that will foster social life. Based on the historical and natural characteristics of İstanbul, qualified coastal areas should be created.

As being attractive areas for tourism at İstanbul strait shores, problems related to organizations and uses such as tourism, transportation, infrastructure, industry, and recreation, should be solved in a holistic plan.

Maritimes and private properties built on the Strait coast line since long times, cut the link between the people and the sea. By forcing new regulations, coastal areas at such places should be deprivatized. In addition, with new arrangements, city and the sea should be reconnected.

Concretization of the coastal lines in İstanbul not only affected the people of the city but also the lives of the organisms in the sea, as a result of impairment of the natural balance and over pollution at coastal areas. Some species became extinct or significantly under populated. For this reason in İstanbul, it is required to have an active administration of coastal areas in international economy with its strategic strait, and sea trade, for people to easily use the natural beauties, historical, ecological, and morphological characteristics. Technological opportunities such as the Geographical Information Systems and Remote Sensing should be used to reach information easier for coastal area management

Measures to prevent erosion such as coastal spurs, should be taken at places where coastal erosion is very effective such as at Karaburun at Black sea shores in İstanbul. In addition, coastal erosion dependent on human factors such as removal of sand should be prevented.

Constructions and misuse of land at coastal areas of İstanbul should be prevented by legal measures and the applications should be inspected.

While organizing the coastal areas, it should be aimed to protect the natural and cultural values of the area and transfer them to future generation with least amount of damage.

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