...::KENT AKADEMİSİ | URBAN ACADEMY

Volume: 16 Issue: 2 - 2023 | Cilt: 16 Sayı 2 - 2023

ARTICLE INFO | MAKALE KÜNYESİ
Research Article | Araştırma Makalesi
Submission Date | Gönderilme Tarihi: 12.05.2022
Admission Date | Kabul Tarihi: 27.03.2023

CITATION INFO | ATIF KÜNYESİ
Konuk, N. Ergun, O.N.(2023). Monitoring the Coastal Changes in Samsun, Turkey, *Kent Akademisi Dergisi*, *16*(2):1003-1016. https://doi.org/10.35674/kent.1115909

Monitoring the Coastal Changes in Samsun, Turkey

Samsun, Türkiye'de Kıyı Değişimlerinin İzlenmesi

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Öz

Bu çalışmada, Samsun il merkezinde, kıyısal alanda yıllar içinde dolgu yapılarak meydana gelen değişimleri hesaplamak amaçlanmıştır. Çalışma alanına ait mevcut hava fotoğrafları ve ortofoto ayrıntılı olarak incelenmiştir. 1935 yılından itibaren yaklaşık periyodik aralıklı hava fotoğrafları ve 2012 tarihli ortofoto kullanılarak ArcGIS 10 programının ArcMap modülü ile çalışılmıştır. Samsun ilinde kıyısal bölgede dolgu alanı miktarı, 1935-1972 yılları arasında 852.286 m2, 1972-2006 yılları arasında 1.478.218 m2, 1935-2006 yılları arasında 2.330.504 m2 ve 2006-2012 yılları arasında 238.316 m2 olarak belirlenmiştir. İlde 1935 yılından 2012 yılına kadar yapılan dolgu miktarı toplamda 2.568.820 m2 olarak hesaplanmıştır. Sonuç olarak, Samsun il merkezinde kıyı bölgesinde dolgu yapılarak oldukça önemli miktarda değişimler olduğu görülmüştür. Kıyı alanlarındaki değişimler karadan denize veya denizden karaya meydana gelmektedir. Bu çalışmada kullanılan yöntem ile sadece kıyı alanlarında kazanılan alan değil, kıyı alanlarında kaybedilen alan değişimleri de hesaplanabilmektedir.

Anahtar Kelimeler: Kıyı, Kıyı Alanı, Kıyı Şeridi, Kıyı Yönetimi, Dolgu Alanı

ABSTRACT

In this study, it is aimed to calculate the changes in the coastal area in Samsun city center by filling in the years. Existing aerial photographs and orthophotos of the study area were examined in detail. It has been studied using the ArcMap module of ArcGIS 10 software, using approximately periodic aerial photographs of 1935 and orthophotos of 2012. The amount of filling area in the coastal region of Samsun province was determined as 852.286 m^2 between 1935-1972, 1.478.218 m^2 between 1972-2006, 2.330.504 m^2 between 1935-2006 and 238.316 m^2 between 2006-2012. The amount of filling made in the province from 1935 to 2012 was calculated as 2,568,820 m^2 in total. As a result, it has been observed that there are significant changes by filling the coastal area in Samsun city center. Changes in coastal areas occur from land to sea or from sea to land. With the method used in this study, not only the area gained in coastal areas, but also the changes in area lost in coastal areas can be calculated.

Keywords: Coast, Coastal Area, Coastline, Coastal Management, Filled Area

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1. Introduction

Coastal areas have been attractive areas for societies throughout history. People have settled especially in coastal areas throughout the history and established civilizations and cities in coastal regions (de Miranda Grilli et al., 2019). Coastal natural resources that promote economic and social development are playing an important role in the development of countries. Coastal areas are complex regions with many physical (human, green areas, water, etc.) and non-physical (establishments, acts) dimensions, which interact with each other, have rich natural resource potential and biodiversity, and are always under a pressure of development (Carmo, 2019; Marques, 2017; de Oliveira, 2019). Due to these advantages, coastal areas are centers of attention as both national and international areas of utilization (Khamis et al., 2017; Manrique et al., 2018; Munoz, 2020).

Industrialization and urbanization deteriorate coastal values and threaten coastal resources, imposing restrictions on both current and future coastal public utilization (Pillet, 2019). Opening up new coastal settlements and apportioning more coastal areas to tourism and recreation activities to meet the increasing demand in coastal zones greatly increase the bearing capacity of coastal resources (Alvarez et al., 2009; Fidan, 2016). In addition to being fields of utilization, coastal regions are also being considered as ideal places for waste treatment (Anderson et al., 2018; Özügül et al., 2017). Intense use of coastal areas can cause not only depletion of resources but also irrevocable environmental pollution (Kankara et al., 2015; Lins-de-Barros, 2017; Thieler et al., 2009). Coastal areas with heavy human traffic should be improved and protected in a rational way (McFadden, 2007; Ramsey et al., 2015).

Coastal zone management includes planning of environmental changes in coastal areas and making arrangements for both the transfer of natural and cultural values of coastal regions to future generations and the rational evaluation of these rich resources (Bao and Gao, 2016; Chang et al., 2018). The overall purpose of coastal zone management is to ensure sustainable development and to protect biodiversity in coastal areas (Devillers et al., 2019). The most important stage of coastal zone management studies is the creation of a coastal zone management strategy plan (Bao et al., 2019; Kerguillec et al., 2019). This plan should be prepared with an integrated approach and should cover the entire coastal management zone by making and implementing decisions to meet both present and future social needs optimally (Cantasano et al., 2020; Meumann et al., 2017). As coastal zone management provides both environmental and economic advantages, it helps to prevent or reduce irreversible environmental damage and obtain financial gains in the long-term (Klimasauskaite and Tal, 2020; Vespasiano et al., 2019).

The coastline is one of the most important landforms. It is also the line where the sea meets the land by the side of a definite tidal elevation point that can change in a short time (Winarso et al., 2001). The coastline, which is an intermediate line between land and water, is defined as one of the most complex, dynamic and unstable geomorphic components of the coastal environment, which changes the coastal landforms together with the coastal zone (Alesheikh et al., 2007; Yasır et al., 2020)

Turkey has a total of 8,333 km of coastline, of which 1,542 km in the Mediterranean Region, 2,671 km in the Aegean Region, 1,695 km in the Black Sea Region and 1,017 km in the Marmara Region. (Doğan et al., 2005). Remaining coastline is covered by Turkish islands on these seas. Samsun has a coastline of 208 km, bordered by Kanlıçay in the west and Akçay in the east. The pressures on the city's coastal zone continue to increase due to its geographical features, natural resource potential, ecosystem richness, urbanization, industrialization, port utilization, breakwater facilities, and filling structures. Samsun has a total population of 1,348,542 people according to the 2019 census, of which 1,119,136 people is living in coastal districts (TUIK, 2019). The ratio of population in coastal districts to total population is around 82.99%, demonstrating that coastal districts are preferred settlements in Samsun.

The population of coastal districts increased by 8.3% between 2014 and 2019. However, the population living outside coastal districts decreased by around 3.2% for the same years.

It is possible to come across problems about coastal use in Samsun, including ever increasing coastal population, settlement of some industrial areas on sea shore, sea pollution, environmental and infrastructure facilities in coastal areas, and construction of some fishing ports.

This study examined the deformation and change occurring in coastal areas of Samsun since 1935. In addition, the change of the total coastal area in Samsun by years was determined by using visual evaluation in the ArcMap module in ArcGIS 10 program.

2. Materials and Methods

Samsun is geographically located between $40^{0}\ 50^{\prime}$- $41^{0}\ 51^{\prime}$ north latitude, $37^{0}\ 08^{\prime}$ - $34^{0}\ 27^{\prime}$ east longitude, and surrounded by Ordu in the east, Tokat and Amasya in the south, Sinop in the west, and the Black Sea in the north. Samsun is located in the middle part of the Black Sea coastline and has a surface area of 9725 km^2, which constitutes around 1.2% of Turkey.

The study area, which covers Kurupelit Stream in the west and Kirazlık in the east, forms a 34 km coastline. This covers approximately 28.33% of the coastline of Samsun province.

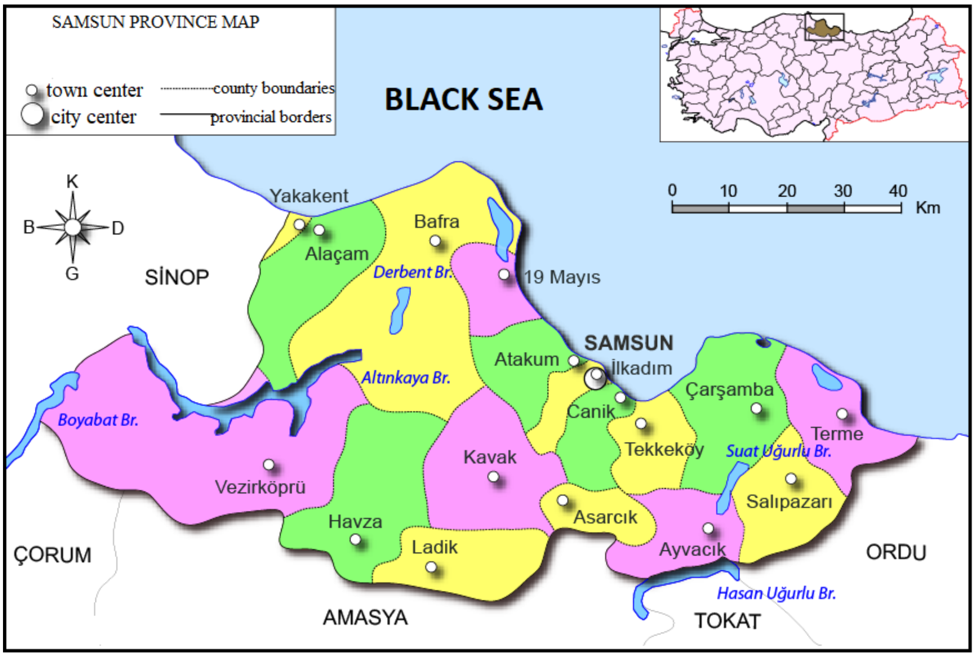


Figure 1. Study Area (http://cografyaharita.com/haritalarim/4l_samsun_ili_haritasi.png)

The study examined the changes in coastline and coastal area usage by utilizing aerial photographs and orthophoto. Aerial photographs were obtained from the General Command of Mapping. A total of 18 aerial photographs were used, including 2 from the year 1935 (no. 50 and 52), 3 from 1972 (no. 8670, 8698 and 8704), 2 from 2006 (no. 916 and 932) and 11 from 2009 (no. 1578, 1580, 1582, 1794, 1796, 1798, 1800, 1802, 1804, 1806 and 1808).

The last orthophoto of Samsun belongs to 2012. As a result of the evaluation of the current aerial photographs according to the years, the current coastline was determined using ArcMap, the module of the ArcGIS 10 software, over the last orthophoto of Samsun. The images in GeoTiff format were overlapped with common points in orthophotos by using the WGS-84 datum, whereby the dullness was eliminated. This study examined the changes in coastlines by years to determine the coastal area change in Samsun.

3. Results and Discussion

3.1. Coastal Changes

Available aerial photographs from 1935, 1972, 2006 and 2009 were overlapped with the last orthophoto of Samsun in 2012 to follow the fill area gain. Figure 2 shows the superposition of available aerial photographs from 1935, 1972, 2006 and 2009 with the last orthophoto of Samsun in 2012, respectively. Figure 3 presents the last orthophoto of Samsun. Common points were determined in the east and west, and the parts outside the common area were not taken into consideration.

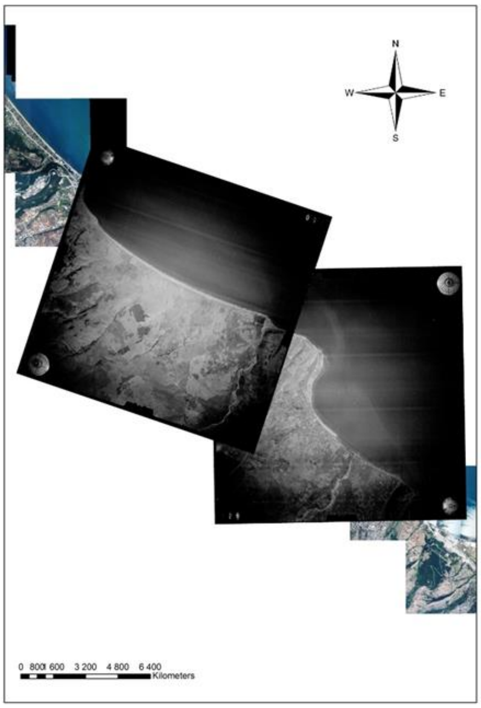


Figure 2.a. The superposition of aerial photographs from Samsun in 1935

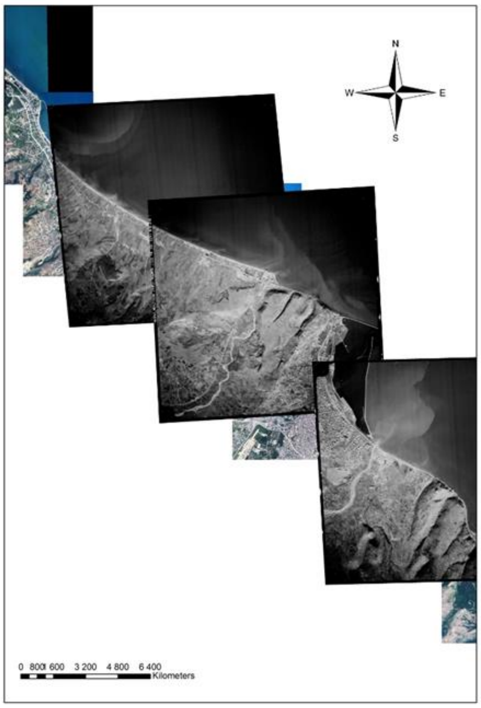


Figure 2.b. The superposition of aerial photographs from Samsun in 1972

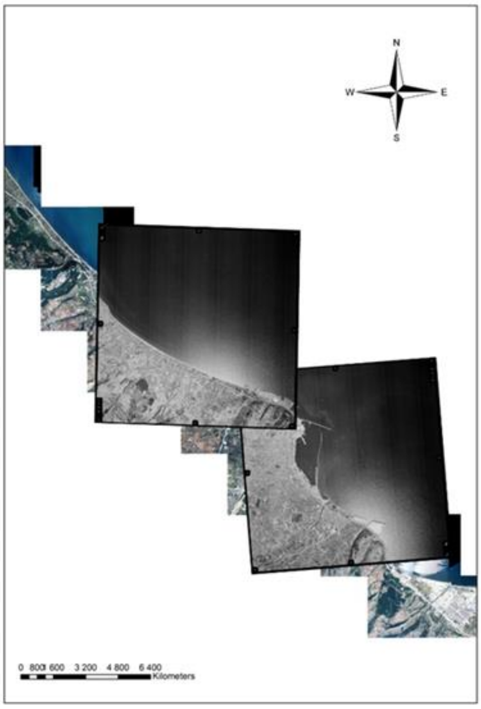


Figure 2.c. The superposition of aerial photographs from Samsun in 2006

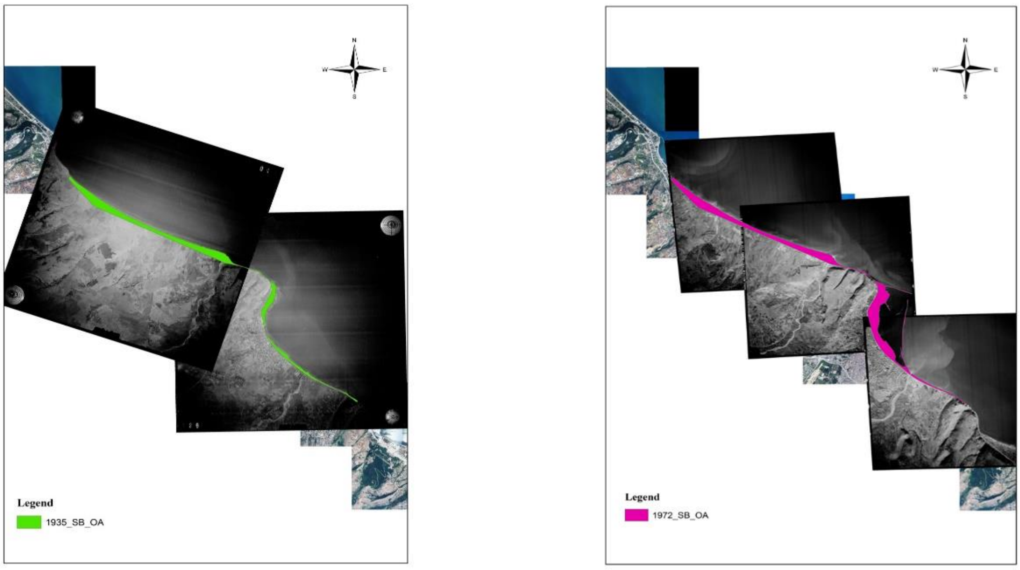
Figure 2.d. The superposition of aerial photographs from Samsun in 2009

Figure 2. The superposition of aerial photographs from Samsun in the same years

Figure 3. The superposition of orthophotos from Samsun in 2012

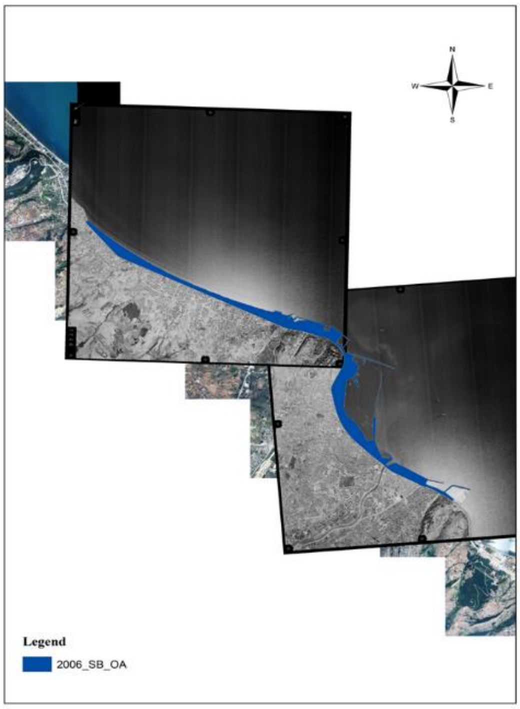
A vector data was created in the field type with shape file (.shp) format from ArcGIS/ArcCatalog menu to digitize the coastlines on the substrate to be used. The coastlines of the years were digitized with the shapefile of the respective field type for each year. Then, a common region with maximum dimensions was determined for areal comparison, whereby the parts outside the common region were cut using the ArcMap/Editor menu.

The middle refuge of Samsun-Sinop Highway, which runs parallel to the coastlines in the sea direction, was chosen as the main line in our studies to determine the fill areas. Changes in the fill areas were followed by years, taking into consideration the changes in areas between the main line and the coastline of the current year. Figure 4 shows the areal change in coastlines of Samsun by years on the available aerial photographs.



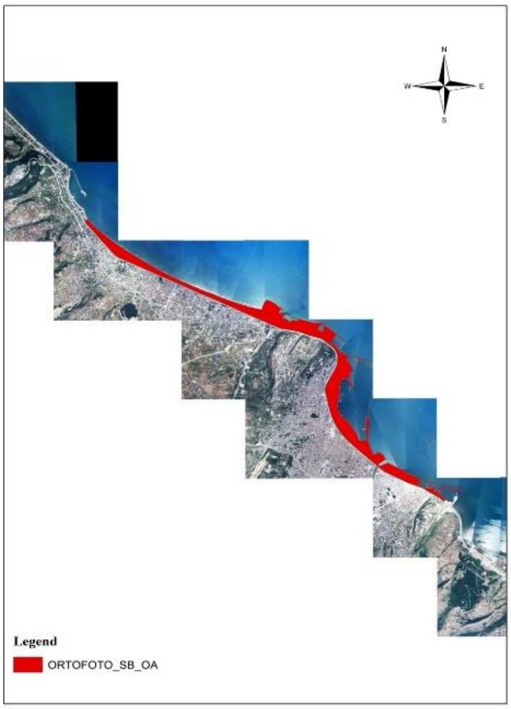
a. The coastline in 1935

b. The coastline in 1972



c. The coastline in 2006

d. The coastline in 2009



e. The coastline in 2012

Figure 4. The coastlines by years in Samsun

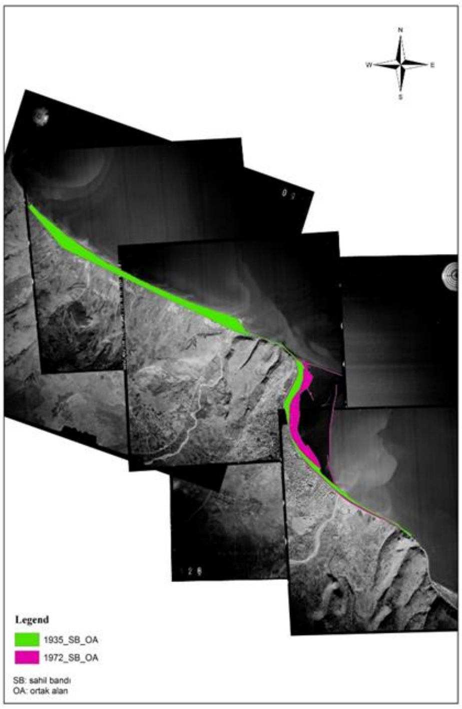
Shoreline areas were calculated with the ArcMap/Attribute Table/Calculate Geometry module of ArcMap software. Digitized aerial photographs and spatial vector data of each year were visualized in different colors and compared with the current orthophoto in 2012 according to consecutive years. The coastline area covered by the study area was calculated using the available aerial photographs of each year and the last orthophoto of Samsun. Table 1 presents the data calculated by years.

Table 1. Coastline area in Samsun by years

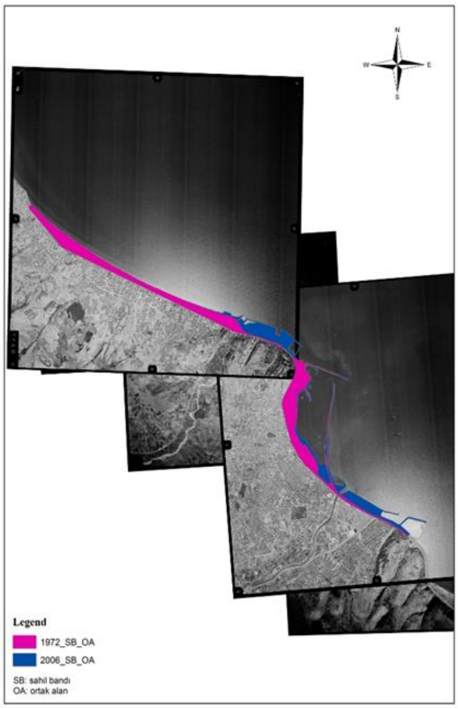
Years	**Coastline area (m^2)**
1935	2.515.130
1972	3.367.416
2006	4.845.634
2009	4.925.849
2012	5.083.950

Figure 5 shows the changes in the coastline and fill areas over the years from the available aerial photographs. In Samsun, an area increase of 852,286 m^2 between 1935-1972 (Figure 5.a) and 1,478,218 m^2 between 1972 and 2006 (Figure 5.b.) were observed. The first period covers 37 years and the second period covers 34 years. Although there is no significant change in time between these two periods, a significant increase in the filling area draws attention. The filling area was determined as 80.215 m^2 (Figure 5.c.) between 2006-2009 and 158.101 m^2 (Figure 5.d.) between 2009-2012. Both periods cover 3 years. However, the amount of coastal area approximately doubled.

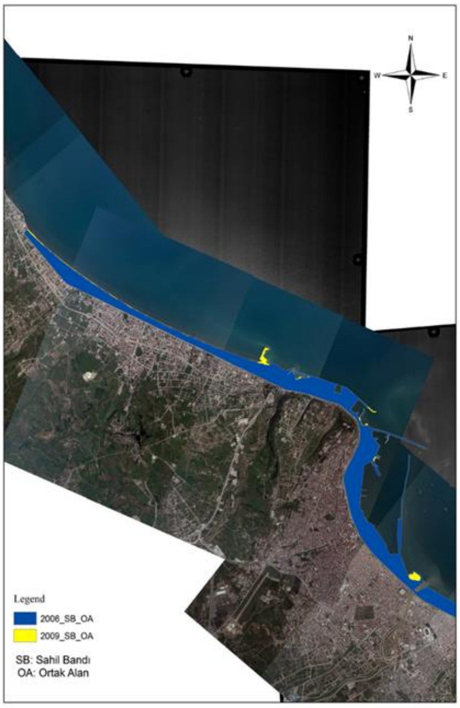
Accordingly, the total amount of filling area between 1935 and 2012 was calculated as 2,568,820 m^2. 33.18% of the total filling area was created in the 37 years between 1935-1972 and 66.82% in the 40 years between 1972-2012. In this respect, the total area filled between 1972-2012 is approximately twice as much than 1935-1972 period. These data show that there has been a significant increase in the filling area in recent years.



a. Changes in the coastline and filled area from 1935 to 1972

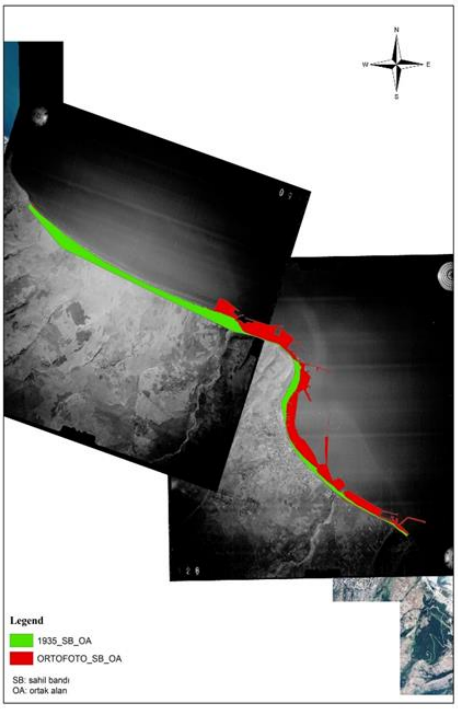


b. Changes in the coastline and filled area from 1972 to 2006



c. Changes in the coastline and filled area from 2006 to 2009

d. Changes in the coastline and filled area from 2009 to 2012



e. Changes in the coastline and bulkhead line from 1935 to 2012

Figure 5. Coastlines and their changes by years

The fill areas built on the eastern axis of Samsun are available in the Eastern Park fill area, the Mert Beach fill area and Lake of Love, and the Bandırma Beach regions. There are 34.6 ha of fill area in the Eastern Park, 24.4 ha in the Mert Beach and Lake of Love, 5.5 ha in the Bandırma Beach, and 12.9 ha in the Canik coastal area. The total amount of fill area in the eastern region of Samsun is approximately 64.5 ha. The construction of the existing fill areas has been completed and today they are in use.

The fill areas built on the eastern axis of Samsun are available in the regions of Kurupelit, Atakum and İlkadım. There is a total of 118.4 ha fill area in these regions, including 84 ha in the Western Park at İlkadım, 30.1 ha in Atakum, and 4.3 ha in Kurupelit. The filling activities in the Western Park, Atakum and Kurupelit have been completed and today they are in use. The fill areas in the Western Park and Atakum are allocated for recreational purposes. Those in Kurupelit are being used for infrastructure and breakwater.

3.2. Effects of Coastal Changes

Samsun is a province with important sandy beaches not only in Turkey but also in the world, due to the wide deltas formed by the Kızılırmak and Yeşilırmak rivers for thousands of years. The ratio of its population living in coastal districts to total population is around 82.99%. The total length of the coast of Samsun province to the Black Sea is 120 km and there is a coast-to-side line belonging to the whole. The distance between the coast-side line and the sea in the province varies considerably and does not adapt to environmental factors.

An important part of the problems experienced in the use and management of the coast in Samsun is due to the rapid population growth in Samsun and the unplanned urbanization that developed accordingly. Apart from historical buildings, archaeological sites, forest areas and ecological systems, tourism opportunities related to sea and coastal areas are important natural and cultural resources in Samsun. There are hotels and many secondary residences in the coastal part of the province. On the other hand, daily beach facilities, restaurants and entertainment venues, serving the people of the city and the region, are other tourism venues located in the coastal area. The fact that the facilities where tourism activities are carried out in the coastal area are built without considering the environmental effects and coastal features cause problems such as planning, infrastructure and environmental pollution. Samsun is an important transportation center that offers all kinds of transportation opportunities such as land, sea, air and railway and connects the Black Sea Region to the Central Anatolia Region. The Black Sea coastal road, which runs parallel to the coast, connects the settlements on the coast. The active use of all transportation mediums and their location in the coastal region cause some environmental and urban problems on the coast.

Environmental Plans scaled 1/50.000 and 1/100.000 and integrated coastal zone management plan which is approved in 2010 by Turkish Ministry of Environment and Urbanization are available for Samsun province (Republic of Turkey Ministry of Environment, Urbanization and Climate Change General Directorate of Spatial Planning, 2010)

4. Conclusions

Samsun is an industrial and tourism city with strategic importance at the international, national and regional levels in the Black Sea Region. The total area filled from 1935 to 2012 was calculated as 2.568.820 m^2. The amount of fill area has increased even more in recent years. It has been observed that environmental problems caused by population growth, industry, touristic purposes, secondary residences, fishing activities, incorrectly designed coastal and marine structures, infrastructure in the province of Samsun cause significant pollution and deformation in the coastal region in the study area, and the natural structure is highly deteriorated. On the other hand, it was concluded that the filling areas, which were built on the coast and are still being realized at a rapid pace, will increase the opportunities offered to the public, disrupt the natural life and pose future threats.

Coastal areas have always been areas of interest with their natural elements and potentials that occur in the interaction area of land and marine ecosystems. The deformation of coastal areas that comes with this interest causes irreversible results in coastal areas. In this case, the future of coastal areas should be determined with the Integrated Coastal Area Management (ICZM) approach, which considers the coast and its interaction area as a whole, comprehends all natural and artificial structures and factors affecting the coast and their interaction. The future of coastal areas should be protected together with their natural structures, and sustainable development and development projects should be planned and managed.

This study presented an example to examine the changes in the coasts of our country, which has natural and socioeconomically rich coastal areas. The examination of these changes reveals an idea about the extent to which natural structures have changed.

Çıkar Çatışması: *Yazarlar herhangi bir çıkar çatışmasının olmadığını beyan eder.*

Etik Kurul İzni: *Bu çalışma için etik kurul iznine gerek yoktur.*

Teşekkür: *Teşekkürümüz yoktur.*

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