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AN APPROACH TO COAST EDGE LINE AT THE EASTERN ANTALYA MARGINAL-MARINE SEA SIDES

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Research Article

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ABSTRACT

In this study, geological and geomorphologic studies having the solution approaches for the coast edge line problem at the marginal-marine environments were realised. Some solutions on the matter were proposed. The eight following locations were chosen: the south of Lara Main Road (1), Aksu River Exit (2), Acısu Stream-2 (3), Ağılısu Stream Exit (4), Köprüçay Exit (5), seashore at the south of Evrenseki (6), seashore at the east of Side (7) and Kızılot (8). Past and new images of the Google Earth satellite views, topographic maps and aerial views; lithological-sedimentological observations, fauna data in sediments, plant cover, artificial structures, previous literature and related law and rules were taken into consideration. Besides the matter were also evaluated in the views of tectonics and sea level changes. From the obtained data two significant subjects are seen as important points on the matter. The first is backward date and validity period in future. The second is effective sea level in height. In fact, recent geomorphologic structure of the eastern Antalya Coasts is the result of mixed functions such as wave, river and wind dominated activities. It is also important to indicate that internal parts of the land also comprise very low elevations up to just a few meters above the sea-level. As a result it is brought out that last and future centuries as a time, observations on the sea level changes in last and future decades as a space should be taken into consideration for the coast edge line solution.

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1. Introduction

Coast edge line problem is one of the main controversial problems between citizens and government institutions or organizations. This problem particularly causes some affects on the facilities of farmers and tourism sector investors who have investments in the region. In the literature, different approaches for the solution of the problem are remarkable. Differences in these approaches put forward insolubility instead of the solution. For that reason, long-term legal processes initiate to defend their rights. One of the examples showing this kind of problem is the sea sides of the Antalya coast. Determination of coast edge line around water masses such as lake and marine also seems to be main subject between citizens and government institutions. Related law and regulations which were issued for making use of the public have been changed with some additions and applied since 1982. 43 article of the 1982 basic law, 3086 numbered coastal law, 3621 numbered coastal law issued in the Official Gazette (Resmi Gazete) on 17 April 1990, cancellation decisions of the Turkish Constitution Court on some articles of the law dated on 18.09.1991, and 3830 numbered law including some changes on the 3621 coastal law are important coastal laws and their regulations. The recent applications are based on 3621 numbered coastal law with the changes of the 3830 law and regulations issued in 1992 and 1994. According to the law and regulations; Coast Line is the natural line of sea, natural and artificial lakes and rivers changing with meteorological events except floods. It extends on the combinations of the water points touched to the landmass. In the same law and regulations, Coast Edge Line (Changes: RG-Official Gazette: 30.03.1994-21890) is defined in the mentioned law and regulations as follow: In the low-flattened coastal areas, it is a border towards the landscape including beach and coastal sand dunes, gravel, rocky, stony, reeds and marshes; in the narrow-high coastal areas, it is the upper limit of the slope or cliff. It cannot be changed either when the border is alterated by unnatural fillings. The area between coast line and coast edge line is known as Coast (Changes:

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RG-Official Gazette: 30.03.1994-21890). It includes both coastal areas as narrow-high coastal areas (it has no beach and platform and ends with a narrow slope or cliff) and low-flattened areas (it comprise lagoon, beach and coastal sand dunes, gravel, rocky, stony, reeds and marshes in a flattened areas, Regulation, 2013).

The Miocene to Pliocene aged ancient marine and terrestrial sediments occur at the basement at the Antalya coasts (Figure 1). The previous literature present geological maps of the region, Quaternary geology and the ages of the formations based on foraminifera, nannofossil and other marine organisms data (Akay et al., 1985; Şenel, 1997*a-c*; Ergin et al., 2004; Avşar et al., 2008; Parlar, 2010; Kanbur, 2012; Sagular et al., 2015; İslamoğlu, 2002; İslamoğlu and Taner, 2002, 2003*a-c*).

Many places in the Eastern Antalya Coasts include low-flattened coastal areas. Many investigations explain observations and details on the coastal edge line determinations at water column such as lake and marine (Abama, 1991; Görmüş et al., 2001, 2005, 2007, 2010, Tüysüz, 2003, Tüysüz and Erturaç, 2005). As known, coast line is related to sea level changes and depends on different factors (Nummedal et al., 1987; Pluet and Pirazzoli, 1991). Among them, tectonic-eustatic, sedimentary-eustatic and glacial-eustatic ones are long-term factors while atmospheric ones (such as precipitation, wind, pressure, temperature, tidal effects) are known as short-term period factors. In the previous literature, it is reported that anthropogenic factors and global warming in the last and next century have affected the sea level up to 100 cm (Douglas et al., 2000; Climate Change, 2013). This situation means that sea level will rise at the low-flattened coastal areas and sea water column will cover in the low elevations in the region. Besides, changes in climate may affect weathering of landscape rocks. As a result of this sediment transportations may occur. All indicated events may be seen as a transgression or regression in the coastal areas. Some examples may be given from the Turkish coastal areas (Kayan, 1988; Brückner, 1997). The effects of the earthquake are also known to cause a decline in the sea sides. Ciner et al. (2009) reports the last five thousand years of the Antalya Coasts based on observations of the beach stones and 14C analysis. They state that subsidence was formed by earthquake effects. They also emphasize the significance of tectonic control on the sea level changes. Besides Turkish National Committee For Coastal Zone Management founded in 1993 have been organising national congresses that many subjects and problems on the matter have been discussed (Akyol et al., 2010; Altın, 2010; Balas, 2010; Sesli et al., 2010; Kutoğlu et al., 2010). Among them Akyol et al., (2010) indicate that geological, agricultural and topographical engineers have more responsibilities on the determination of the coastal edge line and necessity changes on the regulations should be done. Altın (2010) explains the process of determining the coastal edge line. Sesli et al. (2010) presents some examples, particularly related to coast legal and technical aspects from the coasts of Ordu. Kutoğlu et al. (2010) concerns with changes in the Zonguldak surroundings from the 1890s to the present. In addition to these, in the literature it is also indicated that wave heights average derived from the SW winds in the eastern sea sides of the Antalya is 50 cm monthly It changes with daily and seasonal conditions up to 2-8 meters (Özhan and Abdalla, 2002). Depending on the progress of wave heights on the landscape, sea will cover the land in different altitudes. All mentioned investigations brings out that determination of the coast edge line controlled by sea level changes will always be a problem if a limit time for the past and future, and scientific determination criteria are not taken into consideration. The beginning time of mankind history in terms of time seems to be a longer time. Many coastal changes are seen during this time. So, the aim of this study is to present last century coastal changes from the eastern Antalya shores with examples. The study mainly emphasizes that time limit is a significant parameter on the determination of the coast edge line and some changes should be done on the related law and regulations. It also deals with which kinds of scientific criteria should be added to the regulations.

2. Studied Locations and Methods

The study mainly focuses on the significance of coast edge line determination based on its limit time, progress and place. The locations comprise the following eight areas from the eastern Antalya coasts (Figure 1): Particularly it is seen that river and stream exits are more important on the coastal formation. So, river and stream exits were chosen. These are as follows: the south of the Lara Road (1),

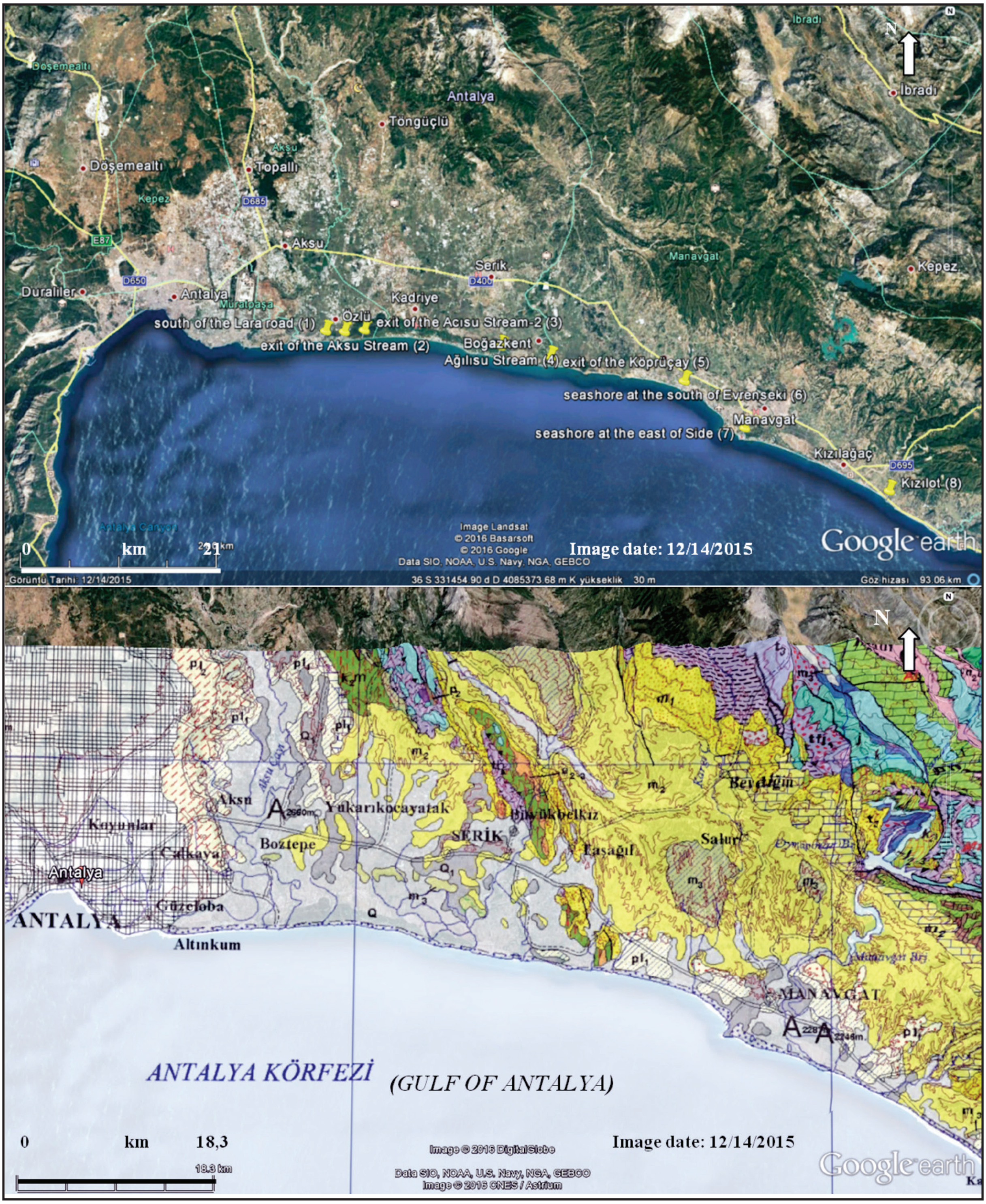

Figure 1- A map showing the studied locations (www.googleEarth) and geological map of the area on the satellite view (travertine outcrops having narrow coastal side around the Antalya, particularly low plains at the eastern parts of the Antalya, Miocene to Pliocene aged basement geological units are seen in the region, k2m. Cretaceous ophiolitic melange, e2-3. Eocene neritic limestone, m3. Miocene aged, ancient marine siliciclastic sediments, pl1. early Pliocene aged terrestrial, occasionally marine clastic sediments, Q. Quaternary alluvium, travertine-terrestrial, please see MTA geological map 1/500.000 in scale for other detail explanations of the map.

exit of the Aksu Stream (2), Acısu Stream-2 (3), exit of the Ağılısu Stream (4), exit of the Köprüçay (5), the southern shore of the Evrenseki (6), shore of the eastern Side (7) and Kızılot (8) (Figure 1).

In the study, new and old Google Earth satellite data (the dates are given on the images) and aerial photographs were used. The changes were marked in the old and new images. In the field works, observation holes were realized by auger or grap. Observations on lithology, soil, plant cover and artificial constructions were performed. Fauna observations and soil analysis in the laboratory were also realized. So, data on geological, geomorphologic, topographic, soil characteristics and plant cover features as well as previous reports and law and regulations were used for the determination of coast edge line.

3. Results and Discussion

Low-flattened eastern Antalya Coasts generally include many meandering and braided river systems arising in the Taurides and pouring to marine. Approximately northwest-northeast trending coastal margin at the south of the Isparta Angle (Gutnic et al,. 1979) has a typical view for formation of marine shores. Observations about the studied areas are given as follows:

3.1. Satellite Data

Google Earth satellite data dated as 2003 and 2015 were evaluated. Some changes on the coasts are clearly seen within twelve years; even it is obvious within five years. However the views also have errors depending on pixel resolution. Figure 2 shows vertical and horizontal differences, a few meters in distance. The reasons of that may be related to many factors such as beaming error, data difference, transformations of projection systems and corrections on the errors. Although these errors may be important, clear geomorphologic differences and changes on coastal edge line are clearer in the views. Figures 2-4 shows satellite views and changes in the studied coastal areas.

The south of Lara Main Road: Touristic constructions and buildings on the sand dunes (I), flattened area around the exit of the one of the branch of the Aksu Stream (Acısu-1) filled by beach sediments (II), change of the exit of the stream (III) and changes in the size and locations of the swampy areas (IV) are seen as the main changes (Figures 3A- B). Longer beach or shore of the sea, and shorter stream angle are seen in the 1/25.000 scaled topographical map of the area dated on 1962 (Figure 3G).

Exit of the Aksu Stream: Mankind effects at the exit of the Aksu Stream (I), changes on the coast line (II) and buildings (III) are the important changes in the area (Figures 3C-D). Changes on the coastal edge line is seen clearly in 1962 topographic map, 1/25.000 in scale (Figure 3G).

Acısu Stream-2: Left side bending at the exit of the Aksu River is seen and called as Acısu Stream in the eastern part of the river (Figure 3E-F). Although some coastal changes are seen in the area, hollow of stream parallel to sandy dunes is more or less the same during the last fifty-sixty years. Widening sandy barrier (I), differences at the exit of the stream (II) are the main changes. Standard topographical map 1/25.000 in

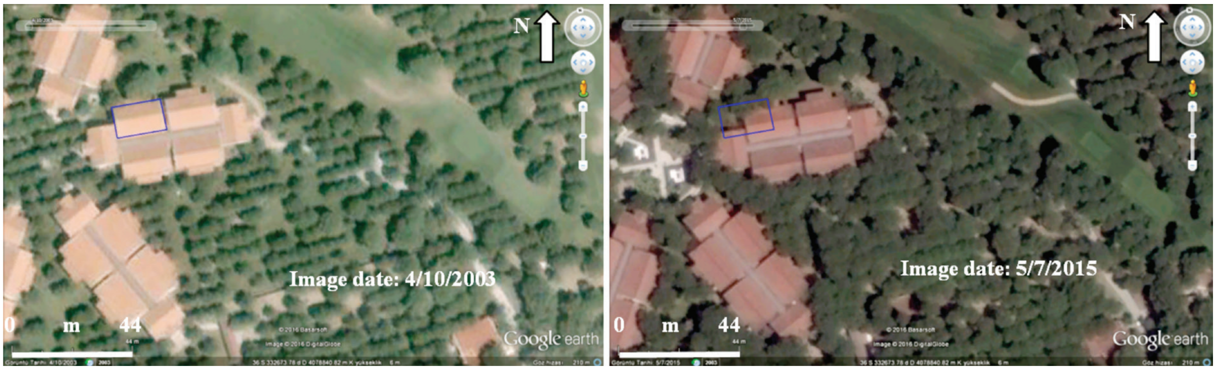

Figure 2- Google Earth satellite views showing illusion scale in meters in Recent and past views (it is clear that the same building is seen in different place in the 2015 satellite view, coordinates are shown in the figures).

Figure 3- Google Earth satellite views of 2003 and 2015 for the following locations A-B. South of the Lara Main Road, C-D. exit of the Aksu Stream, E-F. exit of the Acısu Stream-2, G. topographical map of these three locations in 1962, (a) south of the Lara Main Road, (b) exit of the Aksu Stream, (c) Acısu Stream-2, numbers show changes in time.

scale and dated as 1962 show a natural water channel at the exit of the Acısu Stream in the land (Figure 3G).

Ağılısu-Acısu Stream: So many differences in the nature are not seen in the area during the fifty-sixty years. The most changes are observed as human made constructions and buildings at the pouring place of the stream to the sea. Stream name is the Ağılısu in the topographic map, 1/25.000 in scale dated as 1963. Dried channels that are related to underground water level are clearly seen at the northern sandy dunes at the new dated topographical map (Figures 4A-D).

Exit of the Köprüçay: It is called as Karaöz Stream in the standard topographical map, 1/25.000 in scale dated as 1963. Significant changes are seen around

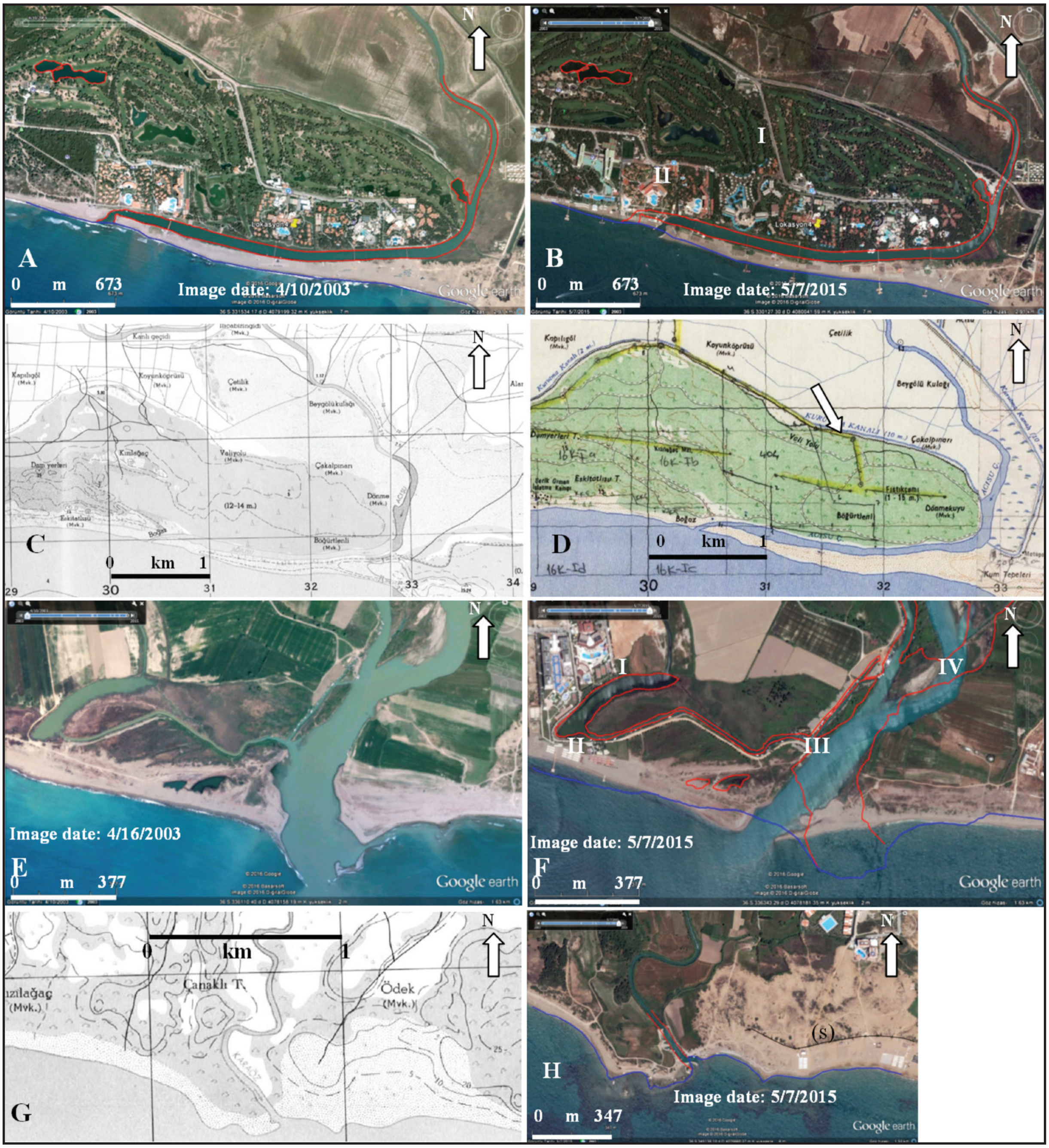

Figure 4- Google Earth satellite views of 2003 and 2015, past and recent topographic maps for the Ağılısu (A-D), Köprüçay exit-Karaöz Stream exit (E-F), Google Earth view of south of Kısalar location, black line may be thought as wave effect boundary in last decade, numbers show changes in time.

the exit of the stream. Displacement of the exit of the stream and changes in the coastal line are seen as important changes in comparing the views (Figures 4A-D).

Seaside at the southern Evrenseki: When comparing the views of 2003 and 2015 Google Earth satellite views, buildings or constructions and changes on the coastal edge line are seen clearly (Figures 5A-B).

Seaside of the eastern Side: During the last two decades, significant differences are not seen in the area when comparing the satellite views (Figures 5C-D).

Kızılot: Sheki occurred around the coast edge of the area during the last fifteen years is seen clearly in comparing of satellite views (Figures 5E-F).

3.2. Field Work Observations - Observation Holes

Sediments in the observation holes by grap and pits by hand auger were examined and analysed in the mentioned areas above as Ağılısu, seaside of the eastern Side and Kızılot. The following includes details of observation holes and pits. Besides soil characteristics and formations, past aerial views, plant cover changes in time were also indicated in the text.

Ağılısu: Figures 7-8 show faunal and lithological characteristics of the sediments in the observation holes and pits around the Ağılısu Stream (Figure 6A). In the first observation hole, the lithology changes from bottom to top as swamp muddies, ancient beach sands, soil A horizon and sand cover. Observation

Figure 5- Comperative Google Earth satellite views of 2003 and 2015 for the south of the seashore at the south of Evrenseki , seashore at the east of Side and south of Kızılot.

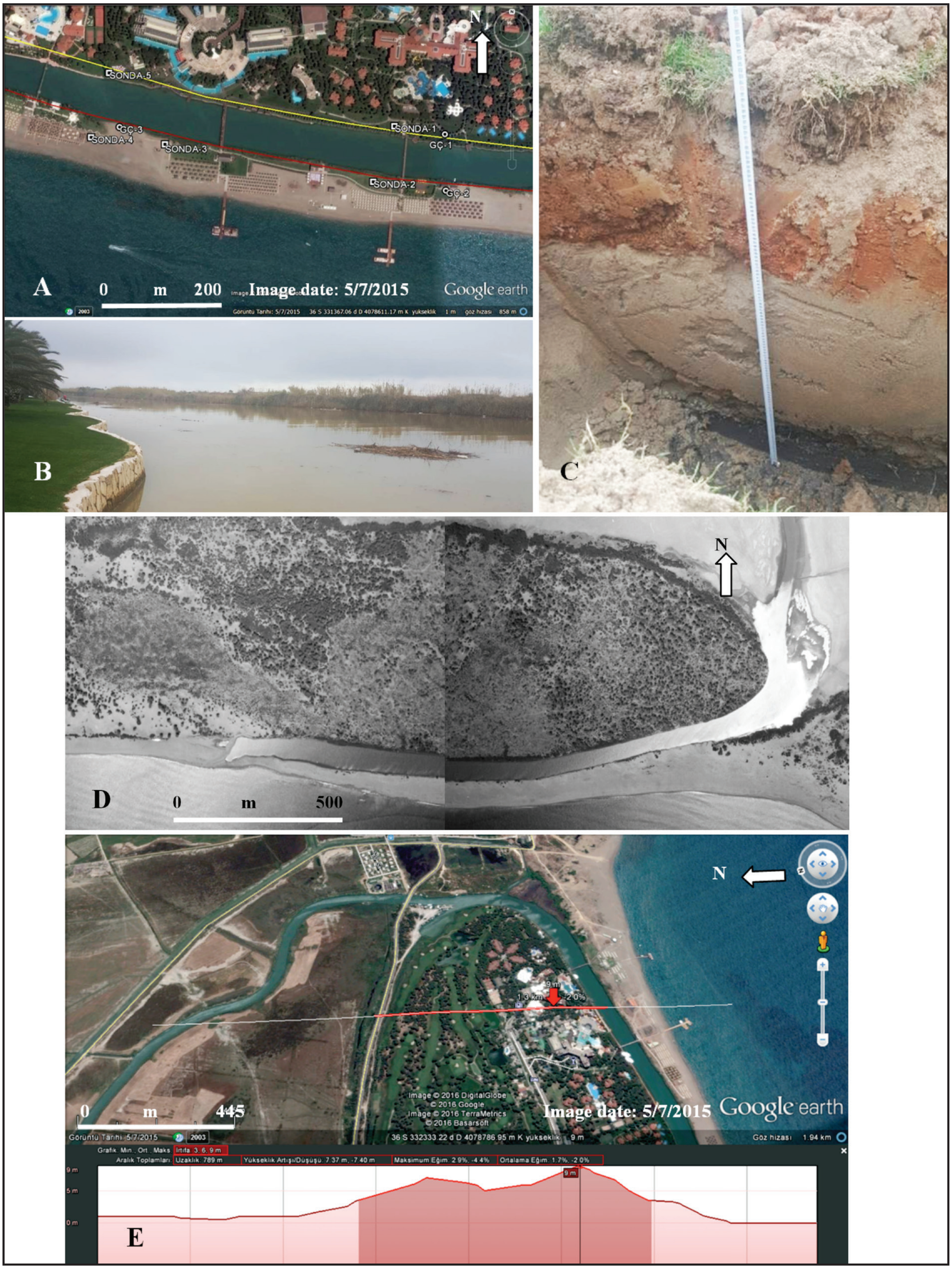

Figure 6- A view indicating of the locations of the observation holes from the Ağılısu (A), a view from the dunes that include reedy at the south of Ağılısu (B), lithologies in the observation hole (C), past aerial photographic view in 1953 (D) and a topographical cross-section showing elevations (E).

holes grapped around the beach 2 and 3 includes marine sand lithologies.

It is clearly seen that a shallow inner lake were formed around the Ağılısu area in the past aerial view, 1953 in date (Figure 6D). It could be interpreted as a lagoon. However, its formation around the exit of the stream, transportation of stream sediments and elevation values, a few meters in heights prove that it was most probable an inner lake in the land. Besides swamp occurrences, stream bending related to sandy barrier, not reaching to the sea directly, it may be assumed that inner land conditions such as river and wind were the predominant conditions during the last seventy years. In the south, 1,5 meters beach sediments in height from the sea level to Acısu Stream occur at the tidal part of the marine. However sandy dunes reach up to 3,5 meters in height. At the northern part of the Acısu Stream, the elevation increase towards the northern landscape starting from 1, 8 meters (Figure 8).

The stream is clearly seen that it is related to a meandered river system. Formation of the stream, parallel to marine, decreasing elevation, fine terrestrial materials, swamp formation, brown in colour are also seen. Streams and river systems arising out of the Taurides mountain reach to the low altitudes and show many bendings before pouring to the sea. Materials derived from the mountains have been altered to fine sized clastics and deposited with muddy materials in flattened areas. It is seen that a sandy barrier, parallel to the Mediterranean Sea was occurred by the effects of winds and waves.

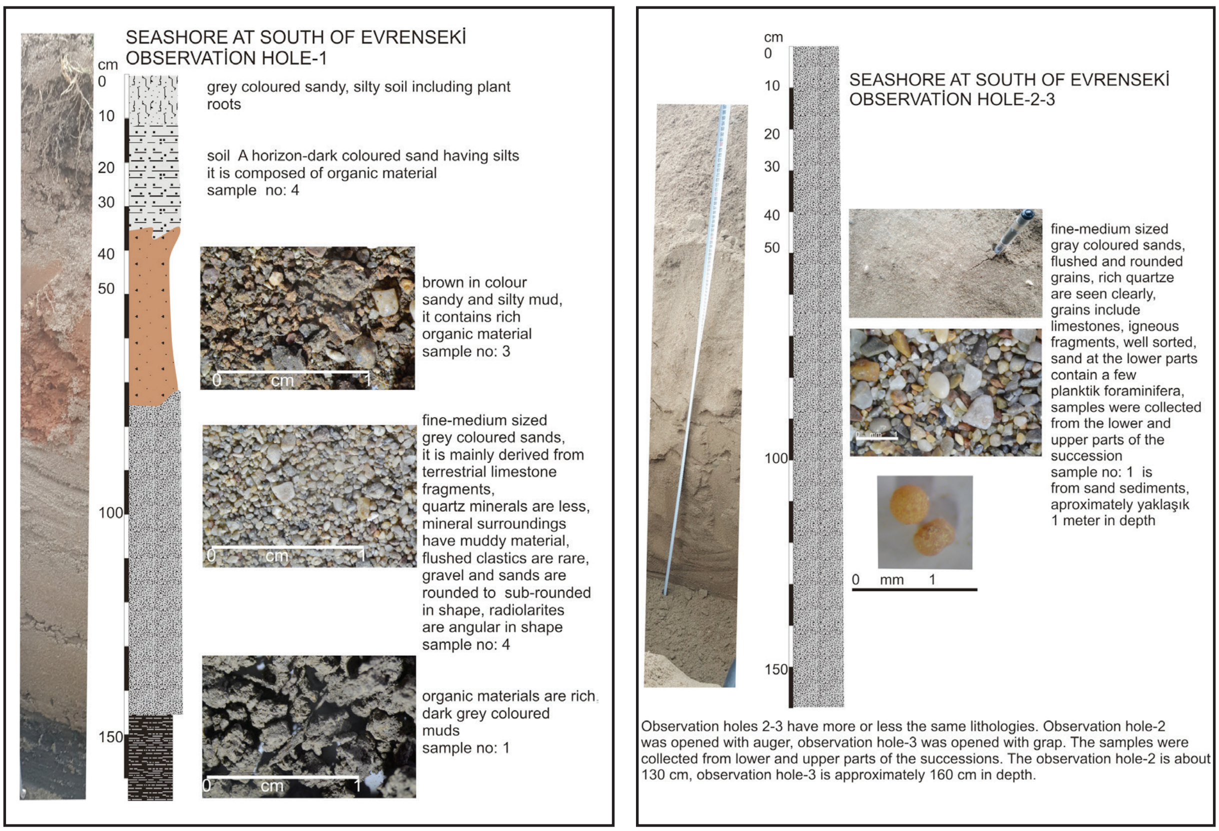

Figure 7- Stratigraphic sections of the observations holes from the Ağılısu area.

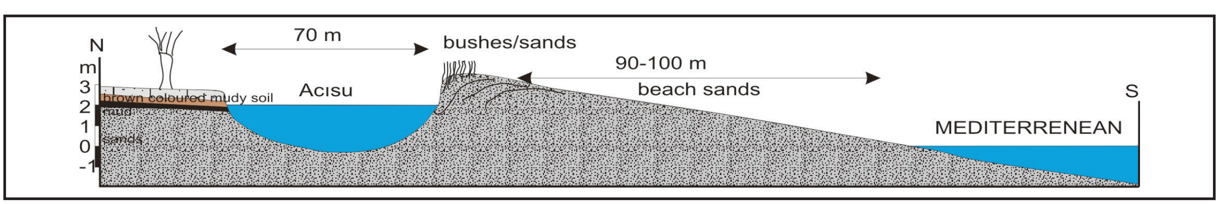

Figure 8- Topographic cross section showing the relation between marine and Acısu Stream (a sandy barrier including marine sands is interesting to notify).

Land use around the Ağılısu area: Plant cover in having the worth of agricultural usage have not been observed at the northern and the southern parts of the Ağılısu Stream. Due to the Recent landscape design to the north of the Acısu Stream, grass, palm and other landscape plants are seen in the area. In the south of the stream, sand dunes, sedge, reed, sand lily and trichome types are usual plant cover. In the past aerial views of the area, it is seen that the northern area of the stream have dwarf trees (such as pırnal-ılex and kermaz oak) that are typical plant cover of the area. In the same views, there have been rarely high-tall plants and forest trees (Pines). However, the southern part of the stream has more or less the same view in comparing Today's view. Formation of natural vegetation is related to soil characteristics. Durable sedge, reed types, sand lily and sea nergisi- daffodil are usual plant material at the saline and alkaline conditions while plant cover diversity and its richness, forest development comprising high-tall plants and shrubbery are seen on terrestrial soil material. Observing of plant cover at the southern part of the Ağılısu Stream from the last a few decades to Recent show that it was dried many years ago.

At the northern and the southern parts of the Ağılısu Stream, grapped observations holes that are vertical and horizontal to the stream were realized. They were also compared each other. In the first observation hole at the northern part of the stream, the sediments were divided into 5 layers. At the top artificial filling material 10 cm in thickness (0-10 cm) is a landscape design material. It is clear that these materials were filled by mankind effects. It was not taken into consideration for the last century history. Then darker topsoil material 25 cm in thickness (from 10 cm to35 cm) follows. Analysis of topsoil material shows that they are loamy, carbonated and alkaline sands (Tables 1-2). Rich organic materials are seen. Value of EC is 260 mmhos/cm. Third layer is 35 cm in thickness (35-70 cm). Its colour is reddish brown. It is composed of clay material including sub-rounded gravels 1-2 cm in size. This soil is less alkaline and have not carbonate material. Organic content is medium. EC value is 350 mmhos/cm. Towards to bottom, light coloured fine sands, and 50 cm in thickness (70-120 cm) are seen. They have alkaline, carbonates and less organic material. EC value is around 185 mmhos/cm. Fine clastics starting from 120 cm are seen at the bottom of the sediments. 'dir. They are grey to green in colour and include silty clay material. Carbonized plant relicts were observed. They have rich organic material and include less alkaline, carbonated material. EC value is 510 mmhos/cm. Report on the soils of the Antalya Basin in 1970, and report on the landscape of the Antalya City show that the soils in the area are alkaline character V. class Regosoller (L4-1 O Vs) type according to Forest Land Use, Land Capability Classification. In the second observation hole at the southern part of the Acısu Stream, the sediments are divided into two layers. At the top, light coloured coarse sands, 70 cm in thickness are seen. They have alkaline and carbonated characters. EC value is 60 mmhos/cm. The bottom part include light coloured sands. They have also alkaline and carbonated material. They do not include organic material. EC value is 190 mmhos/cm. Report on the soils of the Antalya Basin in 1970, and report on the landscape of the Antalya City show that the materials in the area are VIII. class Beach Sediments (SK T VIII) type according to Forest Land Use, Land Capability Classification.

It is thought that the divided layers and their irregular physical and chemical features in the first observation hole show an alluvial origin. Upper layers were formed within their settlement place with deposition of different materials transported in the Acısu Stream during the last a few decades. Occurrences of organic material and plant relicts derived from the land areas show that the soil layers were got out of the marine conditions a long time ago.

Although some marine effects are seen in northern Acısu Stream, different layer occurrences and Recent geomorphologic view were related to the stream effects. Floods have brought many materials derived from the Taurides. The different sediments were deposited within the different layers in the area. It is assumed that the area was got out of marine conditions and terrestrial soil materials were deposited around the stream during the last century.

The eastern coast of Side: One observation well by scoop, two observation holes by auger were realized within the coast of the eastern Side. Figure 9 shows lithological and faunal observations of the well. When the topographical cross sections, N-S in direction were examined, it is seen that sand dunes reaches up to 19-20 meters in heights and plane areas are around 1 meter high above the sea level. In the topographical map, a zone, 60-80 meters in width is

Table 1- Soil properties of observation hole 1.

	pH	EC (μmhos/cm)	Carbonate CaO (%)	Organic Material (%)	Classification
Topsoil-surface soil (10-35 cm)	8,6	260	12	1,5	Loamy sand
Medium soil (35-70 cm)	8,2	350	0,5	2	Clay
Bottom soil (70-120 cm)	8,5	185	8	0,01	Fine sand
Swamp muddies (from 120 cm)	8,2	510	16	4,5	Silty clay

Table 2- Soil properties of observation hole 2.

	pH	EC (μmhos/cm)	Carbonate CaO(%)	Organic Material (%)	Classification
Topsoil-surface soil (0-70 cm)	9,4	60	6	0,01	Sand
Bottom soil (70-150 cm)	9,8	190	7	0,01	Sand

observed as beach sands. Northern area of the beach sands covers green belt.

Land use around the eastern coast of Side: There have not been any differences of natural plant characteristics between the area at the northern coast edge line and a belt at the southern coast edge line extending from east to west towards the sea, 10-50 meters in width. Beach sand sediments are seen 10 meters in width in the east part of the area and 50 meters in width in the western part of the area. A belt 50 meters in width at the northern and the southern parts of the coast edge line had the same plant characteristics in the past aerial photos (Figure 10).

Appearing of natural plant cover is related to soil formations. The increase of the amount and diversity of plant cover, forest having shrubs and tall pine trees are only seen in terrestrial soils while sedge and reed types, sand lily, sea daffodil plants that are resistant to sea pressure are observed within the soils formed in saline and alkali conditions. According to plant cover appearance there have not been any differences between coast edge line surrounding and a belt, 10-50 meters in width at the south. This observation show that soils were formed at both sides of the coast edge line by terrestrial effects.

Sediments in the observation hole-2 at the eastern side includes 5 layers. The topmost unit is 15 cm in thickness (0-15 cm). They include artificial materials of landscaping formed and transported by human-being. Below the first unit, dark coloured surface soil was seen from 15 to 45 cm, 30 cm in thickness. According to soil analysis, they have sandy soils, carbonate and alkaline in character (Table 3). Organic material is poor in these soils. EC value is 65 μmhos/cm. Third layer is 15 cm in thickness (45-60 cm). It contains alluvial gravely sands. Gravels are sub rounded in shape and 1-2 cm in size. This layer is mainly composed of coarse sands. It has less carbonates, less alkaline and poor organic materials. EC values was found as 50 μmhos/cm. The section continuous with dark coloured sandy soils from 60 to70 cm. Reddish brown sandy silts are seen between 70 and 80 cm, 10 cm in thickness. It has alkaline, carbonated characters. Organic material is moderate. Value of EC is 240 μmhos/cm. The bottom layer starts from 80 cm. In the observation hole, the bottom layer is about 150 cm in thickness. Brown coloured layer is composed of fine sands. The layer including poor organic material has carbonated and alkaline characters. EC value is 90 μmhos/cm.

Report on the soils of the Antalya Basin in 1970, and report on the landscape of the Antalya City show that the soils in the area are alkaline character VI. class Regosoller (L8-2 O VIes) type according to Forest Land Use, Land Capability Classification. Report on the soils of the Antalya Basin in 1970, and report on the landscape of the Antalya City show that the materials in the belt between 30-30 meters south of coast edge line and seaside are VIII. class Beach Sediments (SK T VIII) type according to Forest Land Use, Land Capability Classification.

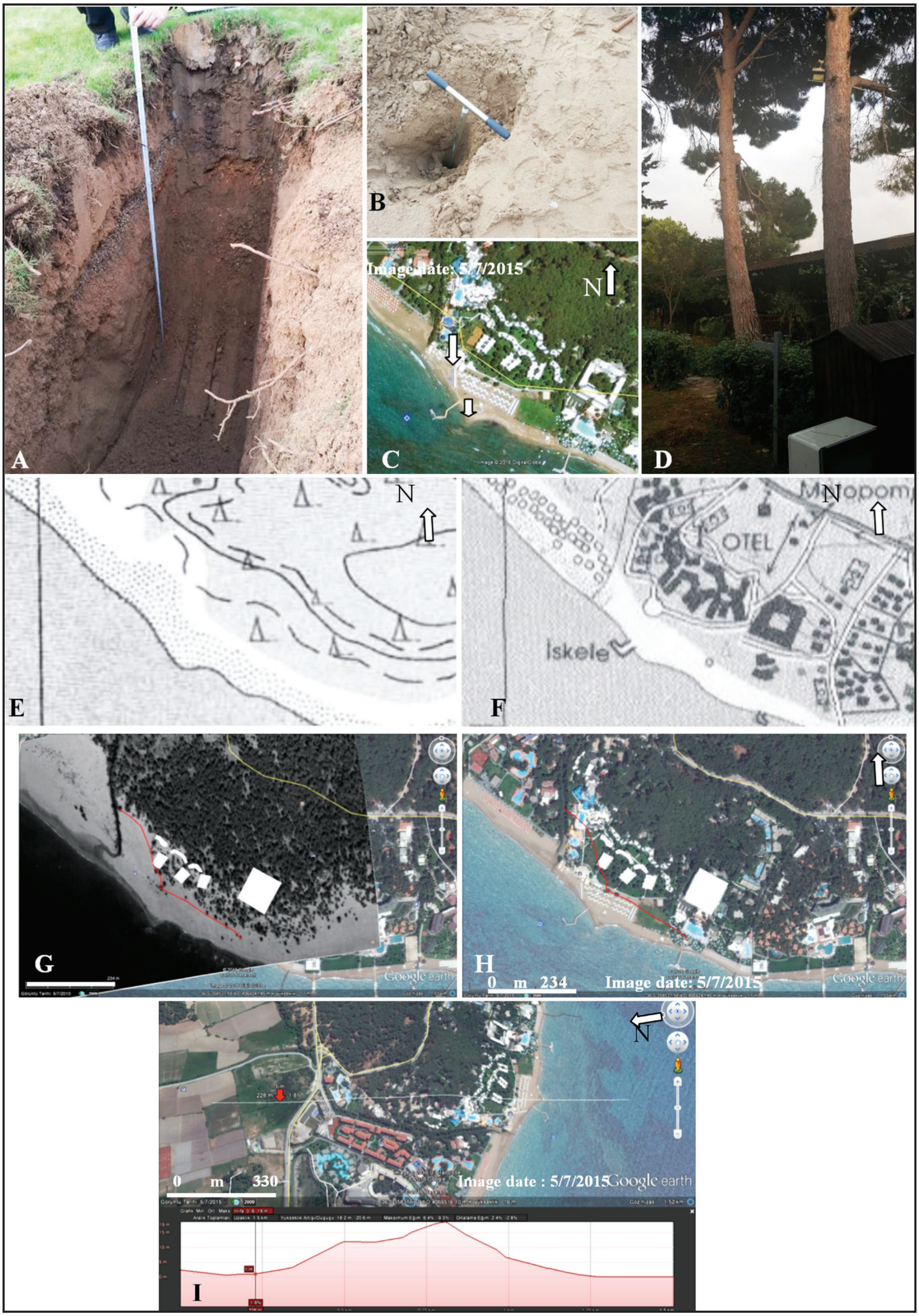

Figure 9- Views from the seashore at the east of Side. (A). Observation hole, (B). a hole digged by hand screw, (C). Google Earth view, (D). Old plant cover, (E). Topographic map in 1963, (F). Recent topographic map, (G). Aerial view in 1953, (H). 2015 Google Earth view, (I). Topographic cross-section.

Figure 10- Stratigraphic section including observation details of the hole around seashore at the east of Side.

Layers of soils were identified based on sediment succession and their features. The layers characteristics, particularly on physical and chemical features and irregular changes show alluvial origin. The sediments were formed by surface currents and floods at the western side. Different size materials were deposited in different times. Organic contents of layers and roots of plants, 5-6 cm in diameter indicate terrestrial plant structures. The soils were under the terrestrial conditions a long time ago. High tall plants also show that soils of the area is related to land occurrences.

Around Kızılot: Coast line is parallel to beach around Kızılot. A different geomorphologic view is seen due to the Miocene aged hard rock's exposing towards the sea It differs from the flattened plain area. Conciliated rocks such as conglomerates and sandstones have terrace elevations reaching up to approximately 10-15 meters in height. It is clear that terrace formation is related to wave effects. There have been small streams on the both sides of the area at the west and east. It is thought that terrace steps about 3-6 meters in height at the northern side of the area is also due to exposing of the Miocene aged hard rocks.

Land usage: The area has no agricultural potential. Natural plant cover divides the area into two parts. The first part has a touristic building including a garden. The garden comprise pines, 50-60 years in age and occasionally citrus fruits. The second part has also a garden including various ornament and landscape plants, and walking area with wooden structures. These area are clearly seen in the satellite view, 2003 in date. Figures 11-12 show satellite and field views. Regular palm trees are observed within the southern coast. The second part of the area in the past aerial photographs includes bushes and other small land plant cover on the coastal sands. The first part area in the past aerial photograph has more or less the same present view. Based on the past aerial photographic view, it may be said that the first part of the area has terrestrial soil occurrences and plant cover from the past to Today. However, it may be thought that the second part was under the marine effects twenty years ago. Because it's poor plant cover also supports this interpretation. The figures include field views. Based on the obtained data, it is assumed that the first part has the same Today's geomorphologic view while the second part was under the marine effects a few decades ago. The second part turned to land and dunes were formed. First bushes and terrestrial small plants growth within the coastal sands.

The first part has a narrow slope separated from the coast. It has also semi-narrow-high coastal property. It was formed and turned to land a long time ago. The second part at the eastern part of the Kızılot has partly a flattened area. It does not show narrow-high coastal property. Artificial fillings and soil transportations may be seen. To interpret the past history, the data on morphologic, topographic, geologic and geomorphologic features are needed. Only landscape characteristics are not enough to get the past data.

4. Conclusions

Coasts of the Antalya Bay generally includes low-flattened coastal areas. Streams reaching to the sea turns to meandered type rivers at the coast plains. Different geomorphologic views have been formed by the effects of stream, waves and winds at the coastal plains. Changes on coast edge lines are seen on the stream exits related to convoluted revines towards right or left sides.

A definite past time for coast edge line is not seen on the law and regulations. For that reason, a problem appears government organizations and citizens, tourism sector investors. Our observations show that a period such as seventy and eighty years should be taken into consideration for the past history time. Because marine effects and coast edge line are seen in the inland areas in geological times. In the inland, kilometres far away from the sea, marine transgression and regression towards the land occurred within thousand years. Foraminifera and other organism relicts within the observation holes support the idea. Besides it is also assumed that a limit time of coast edge line for the feature such as seventy years or a century will be useful as acceptance time. Because sea level changes may be so different from the Today's level within thousand years. Another problem in determining of coast edge line is sea level effect towards land in height. The obtained data indicate that elevation height such as one meter or interpreting of the coast edge line from the past aerial photographs, 70 years ago (beach boundary and plant cover line towards the sea) may be a good solution for the problem. However inland areas may include

Table 3- Soil properties of observation hole 1.

	pH	EC (µmhos/cm)	Carbonate CaO(%)	Organic Material (%)	Classification
Top soil (15-45 cm)	9,4	65	17	1.8	Sand
Gravel interbedded layer (45-60 cm)	8,5	50	20	-	Gravelly coarse sand
Top soil continue (60-70 cm)	9,4	65	17	1.8	Sand
Medium soil (70-80 cm)	9,0	240	10	1.2	Sandy silt
Bottom soil (from 80 cm)	9,3	90	18	1.0	Fine sand

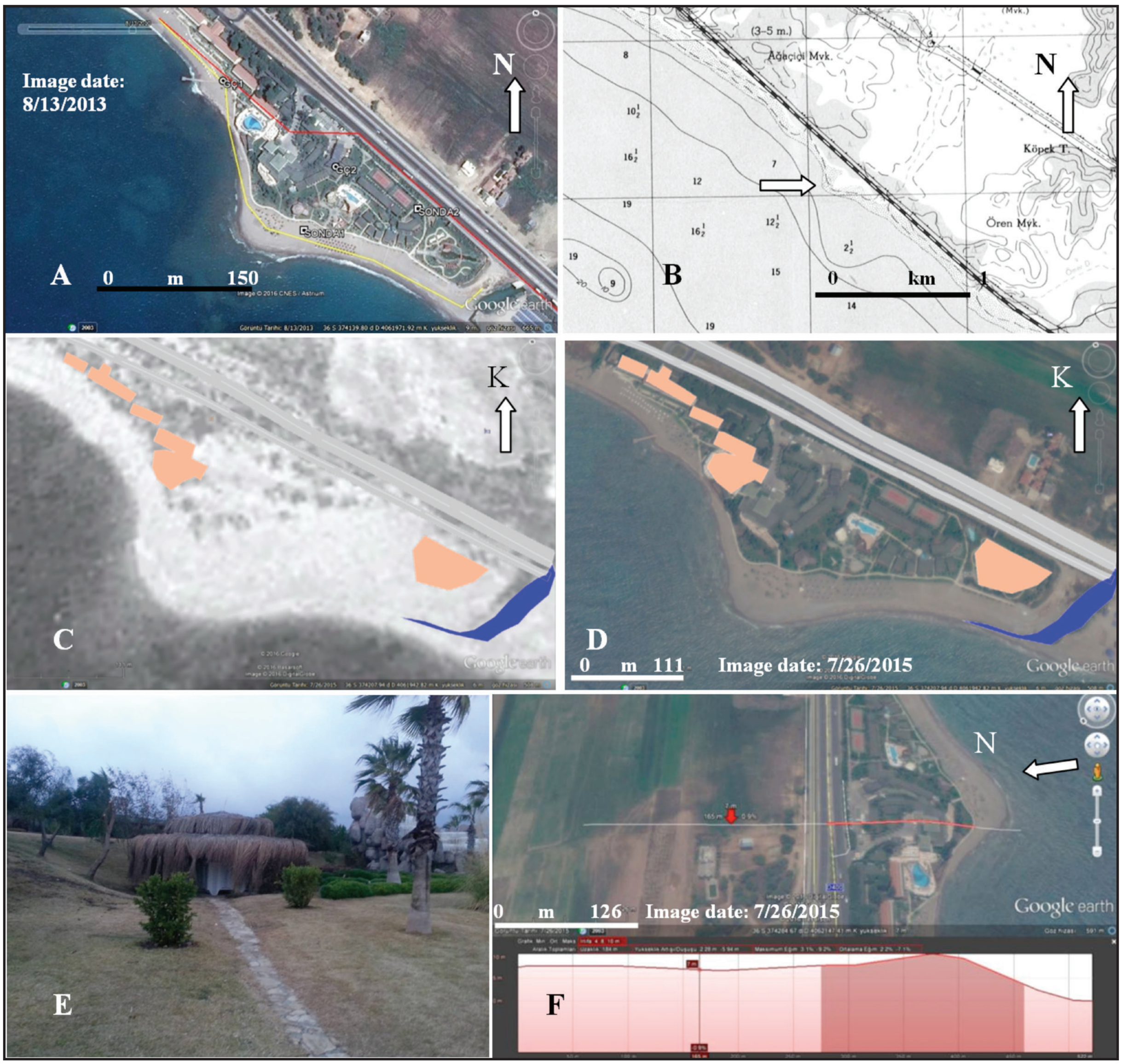

Figure 11- Google Earth view showing the investigation locations from the Kızılot area (A), topographic map (B), aerial view in 1953 (C), Google Earth view in 2015 (D), clear elevation differences (E) and topographic cross section (F).

Figure 12- A general view from the beach area (A), observation hole at the north part of the beach area (B), a view from the Miocene aged (5-10 million years) conglomerate-sandstone, carbonate sandstone lithologies (C), closer views of the siliciclastics (D, E).

low elevations, only a few meters in height behind the sand dunes. The wave effects reaching up to 2-8 meters in height should also be observed inland areas. The research results on the transgression towards the sea and depression after earthquake effects should also be taken into consideration. After all data, the elevation height may be suggested.

Although there have been no enough data on the active tectonism and its effects to coast edge line, it is clear that tsunami and tidal effects related to tectonism are not seen as big as the effects in marine conditions. If these effects happen, it is also obvious that the marine transgression may affect inland areas, kilometres far away from the sea. However all mentioned negative occurrences are not valid in the area. So, determination of coast edge line by Today's data is thought to be solutions for the problems.

In conclusion, it is thought that clarifying of limit times for the past and future, sea level effect height and definition criteria for the coast edge line within the law and regulations should be evaluated for the solution of the problems.

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References

Abama, M. 1991. Açıklamalı-Gerekçeli Kıyı Kanunu. Cansu Basın yayın Gazetecilik Ltd. Şti. Ankara, 372s.

Akay E, Uysal S, Poisson A, Cravatte, Y., Muller, C. 1985. Stratigraphy of the Antalya Neogene Basin. Bull. Geol. Soc. Turkey, 28, 105-119.

Akyol, N., Sesli, F.A., Gün, S. 2010. Kıyı kenar çizgisi tespitlerinde karşılaşılan problemlerin teknik yönden incelenmesi. Iç: Türkiye'nin Kıyı ve Deniz Alanları VIII. Ulusal Kongresi, 27 Nisan -1 Mayıs 2010 Trabzon Bildiriler Kitabı Cilt 1, Balas, L. (ed.), 173-182.

Altın, S. 2010. Kıyı kenar çizgisi tespiti ve kıyı kenar çizgisine bağlı uygulamalar. Iç: Türkiye'nin Kıyı ve Deniz Alanları VIII. Ulusal Kongresi, 27 Nisan -1 Mayıs 2010 Trabzon Bildiriler Kitabı Cilt 1 (Ed. Balas, L.), 183-195.

Avşar, N., Meriç, E., Alramazanoğlu, A., Dinçer, F. 2008. Antalya Körfezi (GB Turkey) Kıta Sahanlığı Bölgesi Güncel Bentik Foraminifer Toplulukları. Yerbilimleri, 29 (3), 111-136.

Balas, L. 2010 (Editor). Türkiye'nin Kıyı ve Deniz Alanları VIII. Ulusal Kongresi, Bildiriler Kitabı, 27 Nisan -1 Mayıs 2010 Ankara, Kıyı Alanları Yönetimi Türkiye Milli Komitesi, Orta Doğu Teknik Üniversitesi Ankara CI, CII ve C3, 1619s.

Brückner, H. 1997. Coastal changes in Western Turkey; rapid delta progradation in historical times. In: Briand, F., Maldonado, A. (eds.): Transformations and evolution of the Mediterranean coastline. CIESM Sci. Ser. 3, 63-74, Monaco.

Climate Change, 2013. Contribution of Working Group I to the fifth assessment report of the IPCC. The Physical Science Basis. Geneva, Switzerland.

Çiner, A., Desruelles, S., Fouache, E., Koşun, E., Dalongeville, R. 2009. Türkiye'nin Akdeniz sahillerindeki yalıtaşlarının Holosen deniz düzeyi oynamaları ve tektonizma açısından önemi. Türkiye Jeoloji Bülteni, 52(3), 257-296.

Douglas, B., Kearney, M.T., Leatherman, S.P. 2000. Sea level rise: History and consequences. Academic Press, USA, 232s.

Ergin, M., Okyar, M., Ediger, V., Keskin, Ş., Tezcan, D., Salihoğlu, İ. 2004. Antalya Körfezi Kıta sahanlığının Geç Kuvaterner Jeolojisi: Sedimantolojik, mineralojik, jeokimyasal ve sismik araştırmalar. Proje no: YDABÇAG-199Y074.

Görmüş, M., Caran, Ş., Çoban, H., Yılmaz. K. 2001. Bedre-Barla (Eğirdir Gölü Batısı) arasında kıyı kenar çizgisi. 1. Eğirdir Sempozyumu, 31 Ağustos-1 Eylül 2001 Eğirdir, bildiriler kitabı, 387-402.

Görmüş, M., Çoban, H., Caran Ş., Uysal, K., Bircan, C., Tunç, İ.O. 2005. Eğirdir Gölü Batısı Pliyo-Kuvaterner Sedimanları. Türkiye Kuvaterner Sempozyumu V, 205-218.

Görmüş, M., Yağmurlu, F., Şentürk, M., Uysal, K. 2007. Jeolojik sentez : Burdur Gölü çevresi, I. Burdur Sempozyumu, 16-19 Kasım 2005, Burdur, bildiriler kitabı, I. Cilt, Yıldız, G., Yıldırım, M.Z., Kazan, Ş. (eds.), Fakülte Kitabevi Baskı Merkezi, Isparta, 558-569, ISBN: 978-9944-729-01-7.

Görmüş, M., Uysal., K., Uysal, A. 2010.Eğirdir Gölü kıyıları - kıyı kenar çizgisi problemi. SDUGEO (Online) 1 (2),42-53 (www.geo.sdu.edu.tr), ISSN 1309-6656

Gutnic, M., Monod, O., Poisson, A., Dumont, J.F. 1979. Geologiedes Taurides occidentales (Turquie). Mem. Soc. Geol. France, 137, 1-112.

http://google.earth.com

İslamoğlu, Y. 2002. Antalya Miyosen havzasının mollusk faunası ve stratigrafisi (Batı- Orta Toroslar, GB Turkey). Maden ve Tetkik Arama Dergisi, 123/124, 27-58.

İslamoğlu, Y., Taner, G. 2002. Kasaba Miyosen havzasında Uçarsu ve Kasaba formasyonlarının mollusk içeriği ve stratigrafisi. Maden ve Tetkik Arama Dergisi, 125, 31- 57

İslamoğlu, Y., Taner, G. 2003*a*. Antalya ve Kasaba havzalarındaki Miyosen yaşlı mollusk faunasının paleocoğrafik ve paleoekolojik özellikleri (Batı ve Orta Toroslar). Maden ve Tetkik Arama Dergisi, 126, 11-42.

İslamoğlu, Y., Taner, G. 2003*b*. Antalya Miyosen havzasının Bivalvia faunası (Batı- Orta Toroslar, GB. Turkey). Maden Tetkik ve Arama Dergisi, 127, 1- 27.

İslamoğlu, Y., Taner, G. 2003*c*. Antalya Miyosen havzasının Gastropoda faunası (Batı- Orta Toroslar, GB. Turkey). Maden Tetkik ve Arama Dergisi, 127, 29- 65.

Kanbur, S. 2012. Karaöz-Lara arasındaki Plio-Kuvaterner çökellerinin foraminiferleri ve ortamsal yorumlar. S.D.Ü. Fen Bilimleri Enstitüsü, Doktora tezi (unpublished), 289s.

Kayan, İ. 1988. Late Holocene sea-level changes on the western Anatolian coast. Palaeogeogr., Palaeoclimatol., Palaeoecol., 68, 205-218.

Kutoğlu, H.Ş., Akçın, H., Görmüş, K.S., Oruç, M., Öngel, S., Şimşek, Ş. 2010. 1890'lardan günümüze Zonguldak Taşkömür Havzasında endüstrileşmeye bağlı kıyı değişimlerinin incelenmesi. Iç: Türkiye'nin Kıyı ve Deniz Alanları VIII. Ulusal Kongresi, 27 Nisan -1 Mayıs 2010 Trabzon Bildiriler Kitabı Cilt 1 Balas, L. (ed.), 237-244.

MTA. 1989. Türkiye Jeoloji Haritası. 1:2.000.000 Ölçekli, Ankara.

Nummedal, D., Pilkey, O. H., Howard, J.D. 1987. Sea-Level fluctuation and coastal evolution, SEM Spec. Publ., 41, 267p.

Özhan, E., Abdalla, S., 2002. Türkiye kıyıları rüzgar ve derin deniz dalga atlası. Kıyı Alanları Yönetimi Türk Milli Komitesi/MEDCOAST, Orta Doğu Teknik Üniversitesi, Ankara, 445s.

Parlar, Ş. 2010. Belek çevresinde Plio-Kuvaterner Foraminiferleri. Selçuk Üniversitesi Fen Bilimleri Enstitüsü, Doktora tezi (unpublished), 559s.

Pluet, J., Pirazzoli, P.A. 1991. World Atlas of Holocene sea - level changes, Elsevier, Amsterdam, 299s.

Sagular, E.K., Aydemir, A., Yavuzlar, G., Yüzgül, N.S., Uysal, K., Görmüş, M., Yıldız, A., Koşun, E. 2015. Manavgat havzasındaki genç denizel kırıntılı tortulların gerçek çökelim zamanı hangisi? Yeni nannofosil ve ascidian fosil bulgularına dayanan yeni bir stratigrafik yorum. 16.Paleontoloji-Stratigrafi Çalıştayı,25-28 Ekim 2015, Rize, Bildiriler Kitabı, Görmüş, M., Demircan, H. (eds.), Jeoloji Mühendisleri Odası Yayını, 109-116

Sesli, F.A., Kılıçoğlu, C., Akyol, N. 2010. Kıyı kenar çizgisi tespitlerindeki problemlerin ve mülkiyetle ilişkilerinin hukuki ve teknik yönden incelenmesi. Iç: Türkiye'nin Kıyı ve Deniz Alanları VIII. Ulusal Kongresi, 27 Nisan -1 Mayıs 2010 Trabzon Bildiriler Kitabı Cilt 1, Balas, L. (ed.), 197-206.

Şenel, M., 1997*a*. 1:100 000 Ölçekli Türkiye Jeoloji Haritaları, Antalya L10 paftası. No 7, Maden Tetkik ve Arama Genel Müdürlüğü, Ankara.

Şenel, M., 1997*b*. 1:100 000 Ölçekli Türkiye Jeoloji Haritaları, Antalya L11 paftası. No 8, Maden Tetkik ve Arama Genel Müdürlüğü, Ankara.

Şenel, M. 1997*c*. 1/250.000 ölçekli Türkiye Jeoloji Haritaları, Antalya paftası. No: 3, Maden Tetkik ve Arama Genel Müdürlüğü, Ankara.

Tüysüz, O., 2003. Kuvaterner Çalıştayı-IV. Bildiriler Kitabı, 29-30 Mayıs 2003, İTÜ-Avrasya Yerbilimleri Enstitüsü, 213s.

Tüysüz, O., Erturaç, K. 2005. Kuvaterner Çalıştayı-V. Bildiriler Kitabı, 2-5 Haziran 2005, İTÜ-Avrasya Yerbilimleri Enstitüsü, 315s.

Yönetmelik, 2013. Kıyı Kanununun Uygulanmasına Dair Yönetmelikte Değişiklik Yapılmasına Dair Yönetmelik. Resmî Gazete 2 Nisan 2013 Salı, Sayı: 28606.