Chapter 11

A Wetland Management Planning: Problems and Threats Affecting Gökçeada (Aydıncık-Salt Lake) Lagoon

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Abstract

Gökçeada Lagoon is located in the southeast of Gökçeada, the largest island of Turkey. The lake, which is also called Aydıncık Lake or Salt Lake, showing the characteristics of a typical coastal lagoon with its fresh / salt water transition, coastal cords and its ecosystem, was included in the list of "Wetlands of National Importance" with 3.491 ha on 07/02/2019 and gained protection status. Agricultural activities are carried out on fertile alluvial lands around the lake, which was formed as a result of filling a depression area in the south of the island, which has a generally defective structure, with materials carried by waves, winds and rivers, and tourism activities are intensively carried out in the summer months on the coastal coast and dunes. In the lake, which is the centre of attention of local and foreign tourists, the salt layer that emerges with the withdrawal of water due to drought and evaporation in the summer season is used for health purposes by local and foreign tourists, but the use of salt has not yet been introduced to health tourism with certain laws. In the study, it is aimed to prepare a "lagoon management planning" for the solution of environmental and ecological problems that arise despite the protection status of the lake and the framework of coastal laws. It has been determined that the greatest pressure on the ecological, biological and morphological system around the lake is caused by intensive tourism activities, agricultural activities, pollution from domestic wastes and recently increasing construction works. In order to determine the use of the lagoon and the surrounding area, a land use map was prepared using the data of 2022. For coastal change detection, 1985, 2004, 2012 and 2020 satellite images were used to determine the shoreline change and it was determined that there was no change in the lake level. The lack of level change indicates that the lake is fed from different sources. For the management planning of

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the lagoon and its surroundings, SWOT analysis was applied, each land cover and use types were analysed separately and a wetland management plan was prepared.

1. Introduction

Wetlands have an important ecological value with their plant and animal species. They constitute an important resource potential such as providing water environment for living organisms with fresh/salt water transitions, feeding groundwater, protection from flooding, and creating economic value with the surrounding land use types. Wetlands, which form a transition zone between land and sea, consist of many morphological units such as marshes, lakes, peatlands, rivers, flood plains, deltas, mangroves, salt flats, corals, sea coastal areas with a depth not exceeding 6 metres. There are various definitions about wetlands. Wetlands are defined according to the Regulation on 'Protection of Wetlands' of the Presidency of Forestry and Water Affairs dated 4.04. 2014 dated 4.04.2014, according to the communiqué numbered 28962 of the Official Gazette dated 4.04.2014, in Article-4 (ü), wetlands are defined as "all waters, marshes, reeds and peatlands, natural or artificial, permanent or temporary, with still or flowing waters, fresh, brackish or salty, covering depths not exceeding six metres during the ebb of the tidal movements of the seas, which are important as a habitat for living creatures, especially water birds, and the ecologically wetland areas of these areas from the coastal edge line towards the land side". In the 1971 Ramsar Convention, the definition of wetland is defined as "all waters, marshes, reeds and turbieries, natural or artificial, permanent or temporary, still or flowing, fresh, brackish or salty, covering depths not exceeding six metres at low tide, are wetlands" (Official Gazette, 1994, Article 1/1).

Many studies have been carried out in Turkey in recent years in order to determine the shrinkage, disappearance and environmental problems in wetlands and to develop solutions to the problems arising as a result of these determinations.

In these studies, different plans and reports have been prepared and put into practice by various institutions and organisations (ministries, associations and foundations) in the creation and adoption of correct and rational land use awareness in the sustainability and protection of wetlands, in the preparation and implementation of wetland management plans. At the same time, the problems experienced in wetlands have been constantly on the agenda in different newspapers and news websites related to many wetlands and meetings have been held with various official organisations. However, despite all these efforts, the pressure of the rapidly increasing

population in our country, the rapid consumption of natural resources by people, this consumption has attracted people to the coasts and wetlands, especially for the purpose of creating natural landscape beauty and benefiting from their economic values.

In this study, taking Gökçeada Lagoon, one of the important wetlands of Turkey, which has been flooded by local and foreign tourists especially after 1990s, as an example, the ecological, morphological and environmental changes around it were tried to be determined, and the wrong land use patterns in the context of environmental land use were identified and mapped. It has been observed that the protection status and laws are insufficient to eliminate the misuse and anthropogenic pressure on the lake and its surroundings and that new plans and programmes are needed. In this context, geographical field observations were made and a new management plan was prepared for the lagoon and its surroundings. The boundary of the area around the lake was tried to be examined within the framework of the natural and archaeological protected area based on the buffer zone within the scope of the Gökçeada Wetland Management Plan Project. The study is important in terms of providing a geographical observation and perspective to other management plans.

1.1. Current Wetland Management and Conservation Scope in Turkey

Wetlands are divided into 3 classes among themselves: Saltwater environments, freshwater environments and man-made wetlands. With their habitats, biodiversity and productive ecosystems, wetlands are divided into three classes: Saltwater environments include the sea, estuaries, lagoons and saltwater lakes; freshwater environments include river banks, ponds, marshes and peatlands; and man-made wetlands include salt enterprises, water collection areas and dams (Dugan;1990:12). Wetlands are associated with the coast and need to be protected in accordance with coastal laws. While the first legal regulations and legislation related to the coast were published in the Official Gazette on 04/04/1926, a special article was included in Article 4 of the 'Municipality, Roads and Building Law' law on 10.06.1993 as "a 10 m wide area from the dock or the point where the dock can be built on the waterfront will be left free for the benefit of the public." (Turoğlu, 2017a:46). The legal regulations of the Coastal Law covering the sea, lakes and rivers were determined by Articles 8, 9, 10, 11, 12, 13 and 14 of the Land Registry Law No. 2644 adopted in 1934 (Turoğlu, 2017b.46). The 1982 coastal law was on public benefit and utilisation of the coast, and the 1990 and 1994 coastal laws were on legal regulations on the coast, definition

of coastal terms and determination of the coastal edge line. According to the amendments made in 1994, Article-8 is regulated as determination of land on the coastal edge line and its transfer to maps, Article-14 is regulated as land acquisition through filling and drying, Article-17 is regulated as planning on the coast and coastline and annotation to the title deed (Coastal Law, 1990: 3621 no-20495).

In Turkey, official regulations based on various laws and rules have been made in order to ensure the protection and sustainability of wetlands.

The Ramsar Convention (Convention on Wetlands of International Importance Especially as Waterfowl Habitats) is an important international convention signed in Ramsar, Iran on 2 February 1971 for the protection and sustainability of wetlands. Turkey's accession to this convention was announced in the Official Gazette dated 17 May 1994, Tuesday, 94/5434: "Our accession to the annexed "Convention on Wetlands of International Importance, especially as Waterfowl Habitats", which was approved by Law No. 3958 dated 28/12/1993, was decided by the Council of Ministers on 15/3/1994, pursuant to Article 3 of Law No. 244 dated 31/5/1963, upon the letter of the Ministry of Foreign Affairs dated 4/3/1994 and numbered EIUK-1012-2189." (Official Gazette, 1994). The Regulation on the Protection of Wetlands was announced in the Official Gazette of the Ministry of Environment and Forestry with 'Wetlands Communiqués' on different dates. These communiqués are respectively according to years;

- 1. Wetlands Communiqué (Official Gazette dated 28. 05. 1994 and numbered 21943)
- 2. Wetlands Communiqué (Official Gazette dated 05. 04. 1995 and numbered 22249)
- 3. Wetlands Communiqué (Official Gazette dated 15. 04. 1998 and numbered 23314)
- 4. Wetlands Communiqué (Official Gazette dated 09. 02. 2005 and numbered 25722)
- 5. Wetlands Communiqué (Official Gazette dated 20. 06. 2009 and numbered 27264)
- 6. Wetlands Communiqué (Official Gazette dated 31. 01. 2013 and numbered 28545).

Based on the communiqués, in accordance with the Law No. 28962 published in the Official Gazette on 4 April 2014, the purpose of the protection of wetlands is "to determine the principles of protection, management and

development of wetlands within the territorial borders and continental shelf of Turkey and the principles of cooperation and coordination between the institutions and organisations in charge in this regard." According to the Wetland Communiqués, different wetlands in our country are taken under protection in each communiqué. According to the communiqués on the protection of wetlands, while determining the procedures and principles for protection in the communiqué numbered 1; according to Articles 2 and 3 of the Ramsar Convention, Articles 23 and 24 of the Regulation on the Protection of Wetlands, and according to Communiqué numbered 2. According to Articles 2 and 3 of the Ramsar Convention and Articles 23 and 24 of the Regulation on the Protection of Wetlands, Burdur Lake, Bird (Manyas) Lake, Seyfe Lake, Göksu Delta and Sultan Reed wetlands were included in the protection list in Communiqué No. 2; Yumurtalık Lagoon (Annex-1), Meke Maarı (Annex-2) and Kızören Obruğu (Annex-3) were included in the protection list in Communiqué No. 4; Kars Kuyucuk Lake was taken under protection in Communiqué No. 5, and Nemrut Kalderası Wetland was taken under protection in Communiqué No. 6. According to the Regulation on the Protection of Wetlands (Official Gazette, dated 04.04.2014, No. 28962), the protection of wetlands other than the Ramsar Convention is realised by the principles and laws of 'Wetlands of National Importance' and 'Wetlands of Local Importance'.

While determining these areas with Article-18, "Wetlands of national importance: Wetlands having at least one of the "Wetland of International Importance Criteria" adopted at the Meeting of the Parties to the Convention" and wetlands of local importance include "wetlands not included in the list of wetlands of national importance and Ramsar Sites".

Limitations for the protection of wetlands are also defined in the Official Gazette as follows: According to the Communiqué No. 28962 of the Official Gazette dated 4.04.2014, Article-4 (v, y, z) of the Regulation on 'Protection of Wetlands' of the Presidency of Forestry and Water Affairs defines the wetland boundary, wetland management plan, artificial wetland and sustainable use zone.

Wetland boundary is defined as "the line passing through the buffer zone boundary in wetlands of national importance, and the line passing through the maximum point of the water surface for wetlands of local importance or artificial wetlands, taking into account seasonal changes", and wetland management plan is defined as "the line passing through the maximum point of the water surface in order to ensure the rational use of wetlands, plans that define all activities and measures such as monitoring and supervision with

a holistic approach", as artificial wetland, "man-made water structures that have at least one of the criteria of wetlands of international importance, such as dams and ponds built for the purpose of drinking, using and irrigation water supply and electricity generation, and the wetland ecosystem formed around them", Article-4 (aa) defines sustainable use zone as "natural or semi-natural open water surfaces, lagoons, lagoons, estuaries, saltpans, temporary and permanent fresh and salt water marshes, wet meadows, reeds and peatlands, and dune ecologically supporting these ecosystems, the area in which people are traditionally allowed to continue their economic activities such as fishing, reed, peat extraction, forestry, gathering, agriculture and animal husbandry in habitats such as beaches, scrub, woodland, floodplain forests".

The main Ramsar protected areas in Turkey are Adana Akyatan Lake (14.700 ha, 1998), Burdur Burdur Lake (24.800 ha-1994), İzmir Gediz Delta (14.900 ha-1998), Mersin Göksu Delta (15.000 ha-1994), Samsun Kızılırmak Delta (21.700 ha-1998), Konya Kızören Obruğu (127 ha-2006), Kars Kuyucuk Lake (416 ha-2009), Balıkesir Manyas Kuşgölü (20. 400 ha-1994), Konya Meke Maar (202 ha-2005), Bitlis Nemrut Lake (4.589-2013), Kırşehir Seyfe Lake (10.700 ha-1994), Kayseri Sultan Reed (17.200 ha-1994), Bursa Ulubat Lake (19.900 ha-1998) and Adana Yumurtalık Lagoon (19.853 ha-2005). The number of Wetlands of National Importance is 59 and the number of Wetlands of Local Importance is 32 (DKMP, 2022; DKMP, 202).

2. Materials and Methods

The maps and literature review used in the preparation of the study were used as the main material in the analysis and evaluation processes. 1985, 2004, 2012 and 2020 satellite images were used to determine the lagoon shore and level change. Images were overlapped with the image overlay method and the level difference was tried to be determined. While preparing the land use map, the raw land (soil) data obtained from the Ministry of Agriculture and Rural Affairs were used and these data were digitised using ArcGIS 10.3 software. In order to create the current land use on the basis of the data, all land cover units were classified and the values belonging to similar classes were combined. The classification of each land cover was determined manually by using the "Image classification" tool for controlled classification processes. Maximum likelihood classification tool was used for controlled classification and colour assignments were made for each land cover. The data were converted to vector for area and numerical calculations.

While preparing the wetland management plan, different wetland management plans, especially the literature similar to the study area, were utilised. With the management plan of Gökçeada Lagoon, it is aimed to determine the basic strategies and action plans that offer solutions for the future of the wetland, prevent threats and risks, and achieve these goals. SWOT analysis was used as a method in the preparation of the management plan. SWOT analysis is one of the most appropriate strategy methods that makes internal and external analyses in determining the critical threats and opportunities of the environment in any field, and examines and addresses how opportunities and threats will develop mutually (Gürel and Tat, 2017a:994). It consists of four components: strengths, weaknesses, opportunities and threats (Sarsby, 2012a:6; Taş, 2010a:81) (Figure 1). Based on this analysis, the strengths and weaknesses in Gökçeada Lagoon were determined and the threats and opportunities in the wetland were mutually evaluated with geographical recommendations. Some of the figures used in the study were taken from Google Earth and arrangements were made on them.

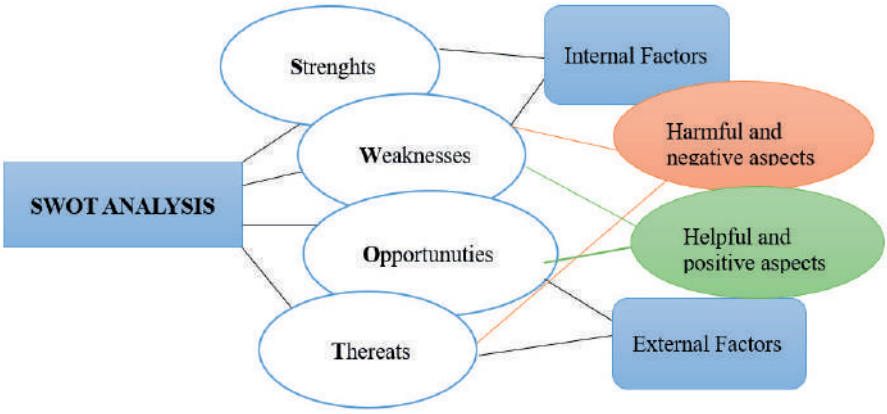

Figure 1. Swot analysis analytical components (revised; Sarsby, 2012b:6; Gürel and Tat, 2017b:994; Taş, 2010b:81).

3. Findings

3.1. General Characteristics of Gökçeada (Aydıncık-Tuz Lake) Lagoon and Environment

Gökçeada Lagoon is located in the Aegean Sea in the southeast of Gökçeada (Kahraman, 2006:25; Cengiz et al., 2009a:14), the largest island of Turkey (285.5 km2) and the most extreme border in the northwest of

Turkey (İnce-Avlaka) between 40° 05' 12"- 40° 14' 18" N, 25° 40′ 06″-26° 01' 05" E coordinates (Kahraman, 2006:25; Cengiz et al., 2009a:14), on the coast of Aydıncık district. The lake is bordered by Aydıncık (Kefalos) Bay to the northeast, Efelek district centre to the northwest, and Kefalos coastal beach and the Aegean Sea to the south (Figure 2). According to the data obtained from the 2020 satellite image, the lake area is 193 ha and the lake perimeter length is 5.7 km. The lake is 2.2 km in the widest area on the west-east axis and 1.3 km on the north-south axis.

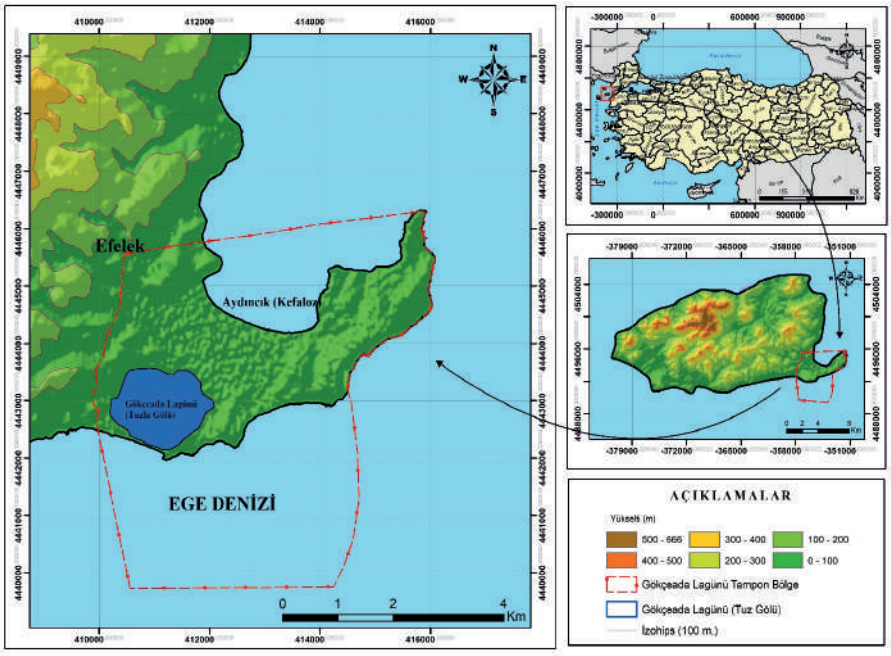

Figure 2. Location map of Gökçeada Lagoon.

In and around the lagoon, Quaternary alluvial deposits and slope rubble surfaced on the slopes of the domes, loose sandstone, claystone, siltstone, mud, etc. belonging to the Upper Miocene aged Kirazlı Formation in the limited area south of Aydıncık Bay, shallow marine deposits in the west and north, and Middle Miocene aged Ayvacık Formation called Eşelek volcanics, basaltic andesite, andesitic proclastics, agglomerates, etc. shallow marine deposits, and to the west and north, the Middle Miocene aged Ayvacik Formation, which consists of Eşelek volcanics, basaltic andesite, andesitic proclastics, agglomerates and tuff (subvolcanic) and occasional dark grey proxen andesitic lavas (Kesgin and Varol, 2003:50; Sarı et al, 2015:3; Temel and Çiftçi, 2002:22; Ündül and Aysal, 2016:129). While

the north of Gökçeada rose, the south of Gökçeada descended due to tectonic movements, and Gökçeada Lagoon, also known as Salt Lake, completed its formation in this tectonic but shallow depression (Öner and Vardar, 2017b:209).

The lagoon, which is located between 0-3 metres in elevation in a plain between sea level and approximately 50 metres in the north, was formed on a shallow, low coastal plain 3 metres deep from the bedrock. Gökçeada Lake is located on Aydıncık Peninsula within the tombolo formed as a result of the connection of an island formerly called Kefalo to the land (Gökçeada) with a double cordon, and is surrounded by dune plains located on two cords formed to the north and south (Öner and Vardar, 2017a:206). According to Yücel (1966), the dune plain in the north developed rapidly in Aydıncık Bay where Değirmen Stream reaches the Aegean Sea (Photo 1) due to the alluvium carried by the stream, and the marshes formed as a result of the disappearance of the old lagoons thought to be located in the north along the coastal promenade were filled in time and completed their development by forming and expanding faster than the dune plain in the south (Yücel, 1966:68,69). In addition to the detritic elements carried by Değirmen Stream, the prevailing wind direction was also effective in the rapid development of the tombolon in the north (Kurter, 1989a:59). Today, the width of the tombolon in the north is 1.6 km at its widest point and 1.5 km from the easternmost end of the lagoon to the shore of Aydıncık Bay. The width of the coastal cordon in the south is 0.3 km at its widest point and its length is approximately 1.8 km. The formation of the lake continued until the end of the Pleistocene and the dead cliffs extend steeply on the shores of Aydıncık Bay (Yalçınlar, 1980:251). The slope in the northeast-southwest direction around the lagoon varies between 0-2°% and between 2-30°% in the Aydıncık Peninsula and in the areas where the elevation increases in the northwest (Cengiz et al., 2009b:20).

Photo 1. Aydıncık Bay (yesilgazete.org).

In Aydıncık Peninsula, the land covered with sand dunes to the north of Tuz Lake and reclaimed from the sea is called Ovacık, and this plain is used for agricultural activities. Apart from the plain area, the plateau area in the same peninsula gradually descends to the river bases with terraces, and the river slits exceed 20 m in places (Kurter, 1989b: 49-50; Yaşar, 2006:10).

Gökçeada Lagoon is a coastal area with a special hydrological structure that is a transition area between fresh and salt water inflow with its unique ecosystem and is also an important wetland ecosystem (Çelik, 2021:70). On the island, where the northeast-southwest sector winds are effective, salty water enters the lagoon from the sea to the lagoon in winter months with the effect of southwest winds, overcoming the dune wall in the south, and fresh water enters the lagoon through the channel opened by DSİ. The lake drainage area is 31.34 km2 and the total area of 4.13 km2 in the lagoon, which is fed by precipitation, water from the sea and fresh water channel, constitutes only the precipitation surface area (Aslan et al., 2021:3).

The island, which is under the influence of the Marmara transition regime, is warm, dry and clear in summer and cold, rainy, windy and partly cloudy in winter. According to Gökçeada Station data, the maximum amount of precipitation falling in December, January and February is 6-21 mm, and the dominant wind direction is northeast characterised by the northeastern

characteristic, while the southwest characterised Lodos is effective in the spring and autumn months (Acar et al., 2014a:190). The average annual temperatures vary between 4°C and 29°C and rarely fall to -2°C or rise above 32°C. The highest temperature measured is 39.7°C in August and the lowest temperature is -11.5°C in February (www.mgm.gov.tr).

Photo 2. Salt layer on the mud on the surface of Gökçeada Lagoon during the dry period.

The lagoon and its surroundings have important economic and socio-cultural values on the island. While tourism activities are carried out at Aydıncık Beach on the dune plain in the north and Kefalos Beach on the dune in the south, agricultural activities are carried out in the plain area between Eşelek in the northwest, Aydıncık Beach in the east and the lagoon in the south. The salt that emerges with the evaporation of water in the lagoon due to the summer drought meets the salt need of the people in Gökçeada (Photo 2), and at the same time, the black mud (consisting of quartz, sulphur, sodium, potassium, calcium, iron, barium, magnesium, carbonate, sulphate, sulfate, quartz, sulphur, sodium, potassium, calcium, iron, barium, magnesium, carbonate, sulphate) formed in the lake is used in the mud cure treatment, which is thought to be good for some diseases, and is interesting for tourists (gokceada.gov.tr).

3.2. Gökçeada (Aydıncık-Tuz Lake) Lagoon Land Cover/Use

According to the land use map prepared according to the data of the Ministry of Agriculture and Forestry, 10 classes of land cover types were identified in and around the lagoon. According to the data obtained from the lagoon lake water surface 2020 satellite image, 193 ha, non-irrigated arable agricultural lands in the north 171.76 ha, mixed agricultural areas in the south of Efelek settlement area cover an area of 52.46 ha. Mixed agricultural areas are located together with fruit trees, vineyards and olive

groves. Agricultural activities constitute the main economy on the island, olive farming activities are carried out in the form of organic agriculture, and there are olive oil producers with organic agriculture certificates. In addition, vintage events are organised. The natural vegetation around the lake is spread over a large area of 1162.9 ha and covers 75.5 % of the land. Natural meadows extending in the east of the lake in the NW-SE direction are also spread in large areas along the north of Efelek. The area covered by natural grasslands is approximately 676 hectares in the vicinity of the lake. Sparsely vegetated areas in the west and sclerophyll vegetation in the northwest of the lake. The sclerophyllous vegetation is composed of heathland and maquis vegetation in the form of evergreen shrubs (Figure 3, Table 1).

Table 1. Spatial distribution of land cover classes in Gökçeada (Aydıncık-Tuz Lake) Lagoon.

Land Cover Classes	**Field (ha)**	**(%)**
Mixed agricultural areas	52,46	3.4
Non-irrigated arable land	171,76	11.1
Natural grasslands	675,98	43.9
Broad-leaved areas	14,39	0.9
Mixed forests	11,24	0.7
Low vegetation cover	230,69	15
Sclerophyll vegetation	178,07	11.6
Plant exchange areas	52,46	3.4
Coast and dunes	152,97	10
Total	**1540,02**	**100**

The total population in Eşelek settlement located in the north of the lagoon is 186 people according to TURKSTAT 2022 data. The total population of Gökçeada is 10.348. Agricultural activities and ovine breeding activities in pastures are carried out in small village settlements with less population. The alluvial soils with good drainage around the lagoon are fertile soils and agricultural activities are carried out on these soils. According to Dönmez 1985, reeds grow on the soils where drainage is disturbed, where there is no flow and which become swampy. It is not possible to grow plants in alluvium where salt accumulates, that is, in hydromorphic salty alluvium, in swampy areas (Dönmez, 1985:78). In the area where Tuz Lake is located and the surrounding dunes, in the marshy areas remaining from the old lagoon on the coastal cordon in the north, heathland and herbaceous plants grow,

and no forest formation is encountered. Aptesbozan (Pimpinella saxisfrage, Poterium spinosum), one of the herbaceous plants with a spiny structure, which spreads in the areas where there are pastures, spreads in large areas in and around the lagoon and even throughout the island. With the reduction of goat breeding, which is thought to damage agricultural soils and pastures, this plant has spread to wider areas, limiting the development area of other herbaceous plants (Gökkuş, et al., 2013:68). Although the breeding of this Imbros sheep breed, which belongs to the island, is not suitable for intensive breeding due to the temperament of the sheep, it is carried out in almost every part of the island in the form of breeding conditions defined as "wild", damaging herbaceous plants, pasture areas and agricultural areas (Konyalı et al., 2004:2; Aktürk et al. 2005:229).

Although the tourism potential in Gökçeada is very high, its development potential is limited due to certain factors (Yaşar, 2006b:3). In addition to coastal tourism as sea tourism, the interest in water sports increases the importance of the beaches on the coasts. Coastal tourism activities start in June and end in September according to the sunbathing time. The average sunbathing time in Gökçeada is approximately 10 hours in June and approximately 11 hours in July and August (www.mgm.gov.tr). In addition, amateur fishing activities are also carried out on the sea coasts. The coast and dunes around Tuz Lake, where coastal tourism and water sports are carried out, cover an area of approximately 152.97 ha and 10% (Figure 3, Table 1). Kefalos Beach extends approximately 1.7 km along the coastal promenade in the south, Aydıncık Beach extends 1 km along the coastal promenade in the north and İncekum Beach extends approximately 1 km in the southeast. Tourism activities are carried out at Aydıncık Beach, Kefalos and İncekum Beach. Kefalos Beach is more active than Aydıncık and İncekum Beaches due to the facilities, restaurants and the presence of Gökçeada Windsurfing Training Centre (Photo 3).

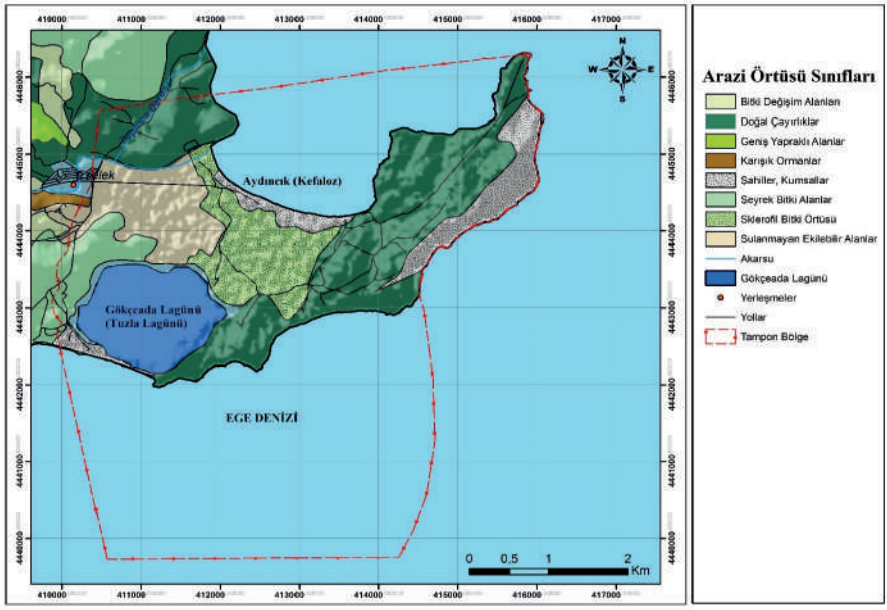

Figure 3. Land use map of Gökçeada Lagoon.

Every year, many local and foreign tourists come to the island from different countries to see historical and natural beauties, surfing, and coastal tourism. According to the data of the Ministry of Culture and Tourism, the number of domestic tourists coming to the island in 2020 was 270,189 people and the number of tourists staying overnight was 446,09. While the number of foreign tourists entering the island is 35,858 people, the number of foreign tourists staying overnight is 47,321. In 2020, the total number of domestic and foreign tourists arriving and staying on the island is 799,456. There are 81 tourism business certified facilities on the island (canakkale.ktb.gov.tr).

Photo 3. View of Kefalos Beach (sandy beach) and the facilities on it (Google Earth Pro, Photo: Burak Ulukan and taken by İsmail Akpınar in 2016).

3.3. Coastal Change in Gökçeada (Aydıncık-Tuz Lake) Lagoon

According to the data obtained from the images analysed using Google Earth satellite images on the shores of Gökçeada Lagoon and overlapped by applying the image overlay method, the perimeter length of the lake area, which was approximately 1.83 km2 in 1985, was approximately 5.38 km; in 2004, the lake area was 1.91 km2 and the perimeter length was 5.72 km; in 2012, the lake area was 1.90 km2 and the perimeter length was 5.54 km; in 2020, the lake area was 1.90 km2 and the perimeter length was 5.66 km (Figure 4, Figure 5). Lake coastal areas and perimeter lengths are approximately close to each other. The data obtained in the 35-year period between 1985-2020 show that there are no major changes in the lake area and perimeter length over the years. Considering the land use map, it was determined that irrigated agricultural activities are not carried out in the agricultural areas in the north of the lake. Agricultural areas in Gökçeada are irrigated by rivers, dams and ponds. In addition, the continuous inflow of salty water from the sea to the lake and the inflow of fresh water to the lake through the canal constructed by DSİ ensure the protection of the water surface of the lake area.

Figure 4. Spatial change in Gökçeada Lagoon over the years (between 1985-2020-Google Earth).

The reason for the small-scale changes in the lake area and perimeter length is the seasonal climatic changes. In the summer months, the surface of the lake is covered with a layer of salt after the surface water evaporates

due to drought, and in the rainy season (especially in winter months due to rains) the lake is covered with water again. The depth of the lake is not much (about 3 m on average) and high temperatures due to summer drought are the main factors in the high evaporation. As the water recedes with the drought, the land in the centre of the lake rises to the water surface in the form of an island (Figure 5). The water surface area in the lake does not carry any apparent pressure and risk. However, it is under the danger of unplanned and irregular construction due to tourism and agricultural activities as well as population density. Hundreds of unlicensed structures built around the lagoon cause environmental pollution. The construction and existence of these structures cause pollution in and around the lagoon waters.

Figure 5. Spatial change of Gökçeada Lagoon overlaid image (between 1985-2020-Google Earth).

3.4. Preparation of Management Plan for Wrong Field Utilisation in Wetland and Surrounding Areas

3.4.1. Preparation of Wetland Management Plan by Applying SWOT Analysis

Tuz Lake was declared a "Wetland of National Importance" in 2019 with an area of 3491 hectares with the NUTS (1) - Level 3 SR(1) - Level 3, 222 code and Protected Area National Classification 06.02.02.0050 code (Ilgar, 2021:619). In 2014, it gained its national identity after its "Wetland of Local Importance" status (Aslan, et al., 2021b:1) (Figure 6). The lagoon, which is one of the 135 important wetlands in our country and hosts important bird

species as a marine and coastal wetland, is brackish/salty (tarımorman.gov.tr). The lake, which is an important bird nesting area as in all wetlands, is especially a flamingo (Phoenicopterus roseus) accommodation and longfinch (Himantopus himantopus himantopus) incubation area (tvk.csb.gov.tr).

Tuz Lagoon, one of the most important wetlands of Gökçeada, is one of the coastal lagoons that provides biological production and has a high socio-economic potential value. It is home to pelicans, wild ducks, geese and migratory birds, especially flamingos. The increasing population in recent years and the natural attractions and historical beauties of Gökçeada attract local and foreign tourists to the island, but also create many problems. Misuse of land in and around Salt Lake can be listed under certain headings: The existence of new constructions that will create pollutants such as hotels or andesite quarries, the existence of wild garbage storage areas and the mixing of garbage into the water, the unconscious use of the sludge that emerges on the surface area of the lagoon, and the lack of necessary management and planning for its use in the field of health, pressures of local and foreign tourists visiting the lagoon on the ecology of the lake, presence of illegal and illegal wells around the lagoon, unplanned tourism activities, domestic, chemical and sewage wastes, agricultural pollution (pesticides, insecticides and unconscious irrigation activities), uncontrolled and irregular construction, air pollution, privatisation of coastal areas, lack of infrastructure.

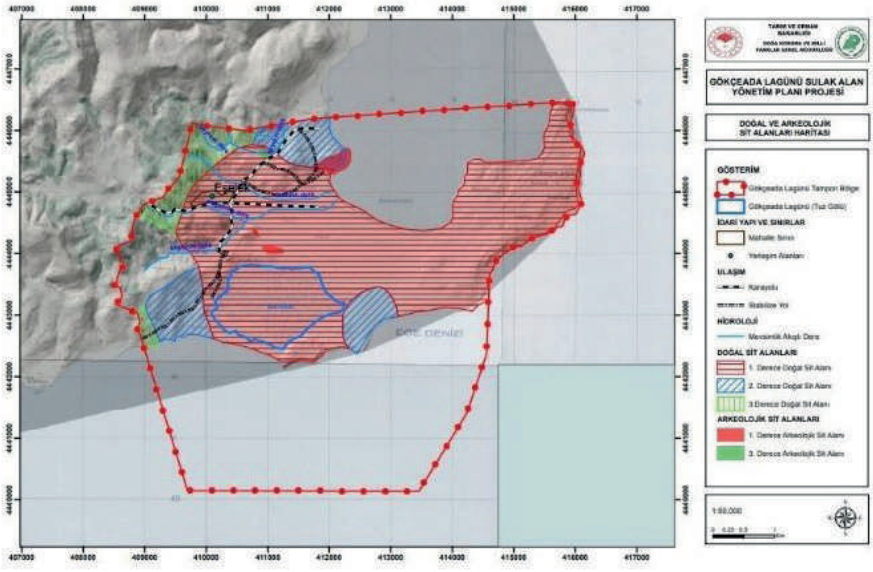

Figure 6. Gökçeada Lagoon Wetland Management Plan, Natural and Archaeological Site Map.

In Gökçeada Lagoon, which is under serious risks and threats in the future despite its protection status, SWOT analysis was used to identify and plan these risks and threats in advance and to create new opportunities. SWOT analysis is a simple method that is easy to understand, has a strategic method, and enables to reach the desired goal with fast and correct use. Generally, the data prepared based on qualitative and subjective data are more general and variable according to different interpretations since they are based on the subject. Therefore, data collection, evaluation and decision-making processes should be managed very well (Sarsby, 2012c:7).

While applying SWOT analysis, it was tried to find answers to the following questions about the study area: where is the area to be planned, in which way planning is needed in this area, what is the potential of the area to be planned, and what are the criteria for success in planning (Mugabi, Kayaga and Njiru, 2007:3; Taş, 2010c:81).Land use characteristics in and around Gökçeada Lagoon are the basic material used in the development of planning. Agricultural areas, forest, herbaceous areas, heathland and pastures, tourism areas, coast, beach and beaches, water body, settlement areas will be analysed separately within the scope of SWOT analysis and then the lagoon and its surroundings will be considered as a general planning.

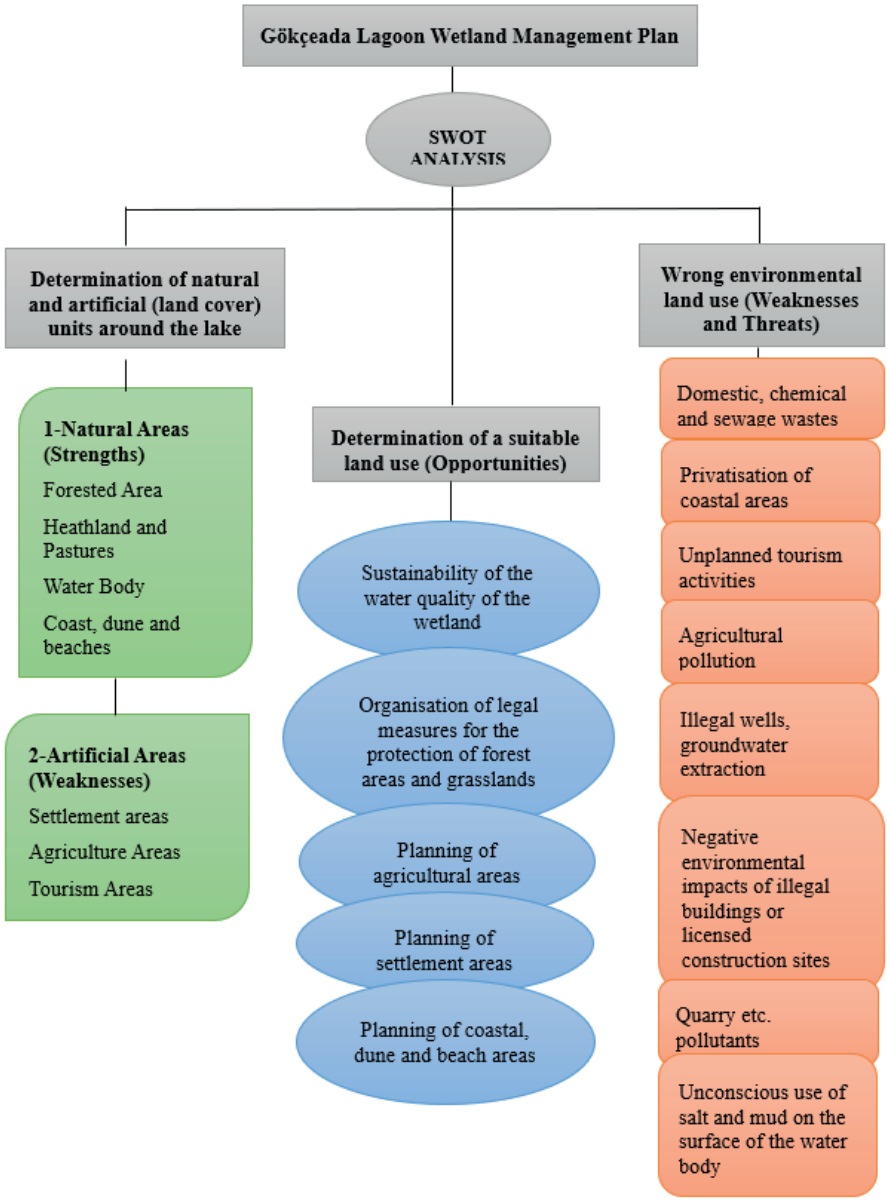

Figure 7. Adaptation of the components determined according to the "SWOT Analysis" analytical method to Gökçeada Lagoon.

3.4.1.1. Planning of Gökçeada Lagoon Wetland with SWOT Analysis and Solution Suggestions

No significant areal change was detected in the determination of coastal change on the water surface of the lagoon using satellite images (see Figure 4, Figure 5). The level changes in the lagoon are water withdrawals caused by evaporation due to summer drought. The salt and the mud under the salt that emerges with the withdrawal of water is an opportunity for the economy of Gökçeada. Salt is produced from the lake and the mud is used for health purposes. At the same time, there is a threat for the salt layer and mud formed in the lake. The intense pressure of tourists coming in the summer months on the lake surface causes pollution of the lake and disturbs the birds in the lake. The lake surface is a nesting and accommodation centre for water birds. The fresh water input canal opened to the lake by DSİ is a positive direction to increase the lake water level. However, water inflow should be under control. Excessive freshwater input will cause changes in the water chemical parameters of the lagoon, which is in salty-fresh water interaction, and will pose a threat especially for fish and other aquatic animals. Water withdrawal for agricultural purposes does not seem to be serious. However, if the construction of illegal wells is not taken under control, it will cause the groundwater level to decrease. The lake drainage supply with groundwater flow will be adversely affected by this situation. Water analyses should be carried out regularly for the pollution of lake water and chemical parameters should be measured continuously.

As recreational activities, water regulation, drinking water supply, use as irrigation water, terrestrial drainage, tourism activities continue to be carried out in and around the lagoon, the good condition of the water will gradually deteriorate and pose a threat to the wetland. Therefore, it is necessary to determine the water quality status as a priority. The initial and final state of the water should be monitored. Supervised water treatment facilities should be provided to remove chemical inputs, biological pollutants, solids and gases from the water.

Another threat to the lake is the change in its morphological structure. The coastal dunes in the coastal areas are the coastal cordon of the lagoon lake. Under intense settlement and tourism pressures, if artificial wooden and stone jetties and culverts are built around the coastal promenade and sand is extracted from the sandy areas for construction purposes, the morphological development of the lake will be adversely affected. Although there is no such problem today, it is necessary to take precautions in advance for future pressures and legal regulations should be taken into consideration.

3.4.1.2. Planning and Solution Suggestions for Forests, Heaths, Pastures and Grasslands around Gökçeada Lagoon with SWOT Analysis

The presence of vegetation has always been a positive aspect for settlements, ecosystem, air cleanliness and wetlands. As you go up to higher altitudes around the lagoon, you pass to forested areas due to the increase in precipitation. Forested areas start after 50 metres in the south of Efelek. However, in the northeast of the lagoon, where the elevation decreases and the climate becomes more arid, sclerophilous vegetation (heathland and pastures) and grass communities cover a large area in the sandy areas. The wide distribution of heathland and pastures is also a favourable aspect for animal husbandry activities. The heathland and pastures cover a wide area between the lagoon and the area between Aydıncık Bay and the lagoon between sea level and 5 m (see Figure 3). While the decrease in slope is a negative aspect for the growth of forest areas, pastures and heathlands are an opportunity for the spread of grass communities. In the south of the lagoon, vegetation development is limited by agricultural areas. Fertile and wetlands are very suitable for vegetation development. Although the geological structure is composed of Quaternary alluvial deposits, the geomorphological slope is low, and the flat plain area is extremely suitable for vegetation development, vegetation development is affected by the adverse conditions of climatic characteristics in the plain area.

Another favourable factor for vegetation is the wide distribution of the herbaceous plant aptesbozan (Pimpinella saxisfrage, Poterium spinosum), which has a spiny structure, in the areas where pastures are spread. The reduction of goat breeding and Imroz sheep breed with the idea that it damages agricultural lands and pastures has accelerated the spread of this plant species and turned into an opportunity. However, the fact that it is a limiting factor for the development of other plant species is a negative aspect. The rubbish left in the environment by tourism activities is a threat to vegetation.

When the SWOT analyses on forest, heathland, pasture and grassland are evaluated, no serious planning is required for forest areas. The threat due to ovine breeding activities on pasture and grassland areas has been reduced. Only in order to prevent the increase in domestic and environmental wastes due to tourism activities, it would be appropriate to establish garbage collection units in and around the lake and to increase the frequency of this activity, to prevent the burning of the collected garbage in the lake protection area, and to build garbage storage and transformation areas on bare lands that are not suitable for agriculture in terms of land capability.

3.4.1.3. Planning of Agricultural Areas around Gökçeada Lagoon with SWOT Analysis and Solution Suggestions

The issue to be considered in agricultural planning is spatial planning. It is necessary to determine the areas suitable and unsuitable for cultivated agriculture according to the land use capability class. The most important economic activity around Gökçeada Lagoon is agriculture. In addition, the island is called 'organic agriculture island' as one of the best examples of organic agriculture. Agricultural activities are intensively carried out in and around Gökçeada in the form of indiscriminate intensive agriculture. In the study conducted by Cengiz et al. (2013), areas suitable for agricultural land use for Gökçeada were identified by mapping. While the land in the eastern part of the lagoon is moderately suitable for agriculture, the northern part and fragmented areas are determined as very good for agriculture. The areas suitable for agriculture are the alluvial floodplain carried by Büyükdere, which flows towards the southeast and flows into the Aegean Sea from Aydıncık Bay and is very fertile. The sandy areas where Kefalos Beach and Incekum Beach are located, where shallow marine deposits such as loose sandstone, claystone, siltstone, mud, etc. are spread, have been identified as unsuitable areas for agriculture. The geological structure of the land forms a strong direction in and around the lagoon.

Natural environmental conditions determined the distribution of agricultural areas in Gökçeada lagoon. Gökçeada consists of hilly areas with an average elevation above 650 metres above sea level, and areas with high elevation limit agricultural activities. Agricultural activities are carried out in the flooded alluvial deposits (Kaleköy and Aydıncık Bay) where Büyükdere's tributaries spread, in the southwestern coastal plain where Ballı Stream flows into the sea and in flat areas on the slopes. The diversity of the land and the limitation of hilly terrain affect the agricultural planning and proposals.

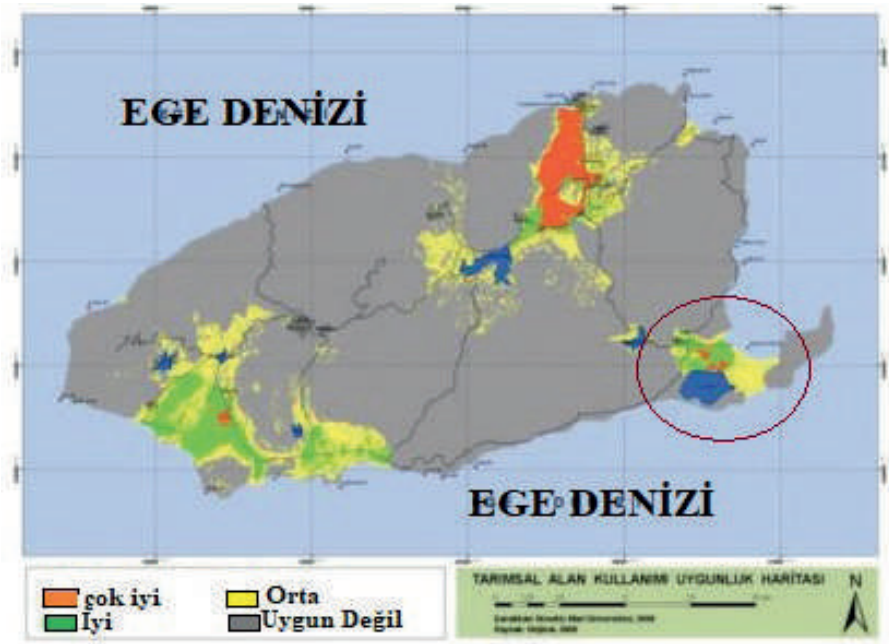

Figure 8. "Agricultural Land Use Suitability Status" (Cengiz et al., 2013c:155).

Agricultural activities are carried out as irrigated and dry agriculture on the island. The purpose of irrigated agriculture is to increase the quality of the yield. Agricultural activities in Ovacık in the north of Gökçeada Lagoon are determined as dry agriculture area in the land use map (Figure 3). There are non-irrigated arable agricultural lands in Ovacık. There are 100-150 wells with depths ranging between 3-18 m and spring waters with flow rates ranging between 0.1-2.0 L/s (Oğuz and Beyribey, 1995:18). While the positive aspect for cultivated and planted areas is irrigation resources, the areas with high elevation seem to be the weak side for agricultural activities. Gökçeada is rich in terms of water resources. Lagoon water surface and the presence of Büyükdere are positive aspects for agricultural areas.

In agricultural areas, there may be floods in Büyükdere Basin. Improvement works carried out in the Büyükdere beds, wrong positioning of the meanders made to reduce the flow rates of the stream, wrong engineering designs, inadequacy of culverts, narrowing of the stream flow area with the constructions on the stream bed (Acar et al., 2014b:187) can be seen as other weaknesses around the island and lagoon as they will facilitate flooding. In addition to flooding, the high slope in Gökçeada increases the erosion risk potential. With erosion, the top layer of soil is transported and

the land becomes inefficient. For this reason, plans and recommendations for the protection of soil for the planning to be made in agricultural areas will be a positive direction for agricultural areas. Looking at the slope values on the island, 64.72% of the land has slope values above 12% and 13.63% of the land is flat to nearly flat (İlay and Kavdır, 2018:69; İlay, 2016:31). The low slope in and around Gökçeada lagoon reduces the risk of erosion and appears as an opportunity for soil protection.

In addition to the effects of geological and geomorphological elements on agricultural areas, climatic characteristics also constitute a strong direction for determining agricultural yield and potential. Summer drought in and around the lagoon is a negative aspect as it increases the need for irrigation in agriculture.

When the SWOT analysis on agricultural areas is evaluated, the following suggestions are made for planning. The biggest problem in agricultural areas is the illegal wells used for irrigation purposes and excessive consumption of groundwater. These wells should be formalised and monitored and a quota should be set for irrigation. In addition, more economical choices such as drip irrigation technique should be made instead of indiscriminate irrigation in agriculture. Artificial ponds can be created by DSİ close to agricultural areas in order to utilise surface water during periods of high rainfall. In addition, instead of only lowland plains, the productivity of the soils on the slopes of the slopes can be increased and agricultural areas where products suitable for the climate can be cultivated can be opened.

3.4.1.4. Planning of Coast, Beach and Beach Areas of Gökçeada Lagoon with SWOT Analysis and Solution Suggestions

When we evaluate the dune areas in terms of geological, geomorphological and climatic aspects, the sandy areas on Kefalos Beach and İncekum Beach and Aydıncık Bay coastal beaches are areas where shallow marine deposits such as loose sandstone, claystone, siltstone, mud etc. are spread and are not suitable for agriculture. In addition, the beaches are on the plains where the slope is low. Elevation values on the beaches are between 0-2 metres. There is no area that has been converted into agricultural land in order to gain agricultural land from the dunes around the lagoon. This is a favourable situation for the dunes. In addition, during the formation of the lagoon, the filling of the swampy areas in the northeast was not caused by human impact but by geomorphological developments. Currently, the most important economic activity on the dunes is the tourism activities between June and September. Although tourism activities are seen as an opportunity

in terms of contributing to the island economy, the danger that has started now and the intense population pressure that will increase in the future pose a serious threat to the beaches and sandy beaches. Hotels, restaurants and other businesses established around the lagoon (Figure 9), especially illegal and unlicensed structures not only spoil the natural appearance, but also unplanned tourism activities in the dune areas and garbage thrown into the environment (Photo 4) cause pollution and pose a threat by damaging the lake ecosystem, especially flamingos.

Photo 4. The rubbish left behind the beach around Gökçeada Lagoon is a threat to the beach and lagoon ecosystem as well as environmental pollution.

The fact that the beaches can be used for tourism activities and make a significant contribution to the economy of Gökçeada can be considered as opportunities created by the beaches and sandy beaches. The beaches around the coastal lagoon are one of the few surfing areas in Turkey (Figure 9).

Figure 9. Gökçeada Lagoon, Kefalos beach, Surf Training Centre Application School and other constructions on the beach in the vicinity.

When the SWOT analysis made on the beaches and coasts is evaluated, the coastal law should be observed very well in order not to fill the coasts with unlicensed structures due to the increasing tourism activities in recent years. Article-4 of the Coastal Law (1990) reads as follows: "Supplement: (1/7/1992 - 3830/2 Art.) Structures to be built on the coastlines can approach the coastal edge line by a maximum of 50 metres. Additional: (1/7/1992 - 3830/2 Art.) The areas between the approach distance and the coastal edge line can only be arranged for pedestrian paths, promenade, recreation, rest, cruise and recreactive purposes." The lagoon and its surroundings should be structured by taking into consideration the law, for this purpose, a very good tourism master plan should be prepared for the lagoon and its surroundings, and local administrations, especially geographers and urban regional planners, geologists should be used in cooperation in this plan. As seen in Figure 9, the constructions established before 50 metres should be removed from the shore.

3.4.1.5. Planning of Settlement and Industrial Areas around Gökçeada Lagoon with SWOT Analysis and Solution Suggestions

The closest settlement to the lagoon is Eşelek. Agriculture and animal husbandry activities are carried out in the settlement which is 8 km from the centre and 2 km from Aydıncık Bay. Due to its proximity to the beach due to the development of tourism activities, low-rise houses used for accommodation in the form of hotels and pensions in recent years, fruit and vegetable stalls on the roadside, and two restaurants offer diversity in economic activities. Tourism activities, agricultural activities and animal husbandry are positive opportunities for Efelek settlement. The presence of settlements, domestic and sewage wastes always cause environmental pollution. In this sense, settlements are a risk for the beach and lagoon water body. The settlements that do not comply with the law "settlements can approach 50 m to the coastal edge line" as per the "Coastal Law" from the coastal line on the beach edges are shown in Figure 10 and Figure 11. The settlement in Figure 10 is located only 115 metres from the shoreline.

Figure 10. Gökçeada Lagoon, Kefalos beach is 115 metres inland from the shoreline.

In Figure 11, settlement number 1 is only 29 metres from the shoreline. Settlement number 2 starts at 45 metres from the shoreline and continues until approximately 200 metres. Settlement number 3 is located only between 15-60 metres, settlement number 4 between 65-250 metres and settlement number 5 between 270-300 metres. These structures are a threat to coastal dunes. It is very likely that such structures will increase in the future if no measures are taken.

Figure 11. Construction on the shore of Kefalos beach, Gökçeada Lagoon.

The 'Andesite Quarry', which is planned to be built on an area of 20 thousand hectares a few hundred metres away from the lagoon, which has been frequently reported in the news in recent years, is located within the borders of the important nature area to the east of Gökçeada Lagoon (Photo 5). The construction of this quarry, which is wrong in terms of land use, is an ecological and biological threat to the ecology of the lagoon, the agricultural lands and health of the people living in the surrounding settlements, water birds, especially falamingos, and fish in the lagoon.

Photo 5. Quarries and construction sites around Gökçeada Lagoon (Yeşil Gazete, 2022).

When the SWOT analysis on settlements and industrial areas is evaluated, there are not many populated settlements in the immediate vicinity. The population of Efelek settlement increases according to the number of local and foreign tourists coming in summer months. Although the reason for the establishment of Efelek settlement was agriculture and animal husbandry, tourism activities contributed to the economy of the settlement. The settlement centre is located at an elevation of 30 metres. It is very likely that the settlement and the agricultural areas in the southeast of the settlement will be affected by the possible flood risk of Büyükdere. In addition, there is an erosion risk on the bare sloping surfaces to the west of the settlement, as determined from satellite imagery. This area is devoid of vegetation cover. Efelek settlement should not be allowed to spread over very large areas.

Illegal and unlicensed structures on the coast of Aydıncık Bay in the south and northeast on Kefalos beach should be removed in accordance with the 'Coastal Law'. In addition, law amendments should not be allowed for licence permission. As it is known, the beach areas are included in the lagoon protection status.

In general, while the settlements around the lagoon have more strengths, landscape and sea tourism are favourable for the settlements established on the coast. However, the presence of settlements and the quarry to be built pose a threat to natural morphological development and biodiversity. The quarry should be built on bare land at higher elevations, or it should be completely prevented. In addition to the environmental pollution, air pollution and health problems caused by the quarry, the removal of the rocky area will leave a large area of bare land. It is impossible to restore this land to the natural process. Since the lagoon is located within the protected area, it is unnecessary to make a separate planning for the development of settlements.

Conclusıon

Planning is important in terms of taking the necessary measures in a timely manner, eliminating uncertainties, eliminating confusion and creating a division of labour in the lagoon and its surroundings in order to look into the future and ensure continuity. Strategic planning will contribute to the success of public institutions and organisations by encouraging future-oriented thinking. Management, on the other hand, is the coordination and planning of the rules established for the organisation of the positive course within the framework of the flow of affairs and making the right decisions.

The main geomorphological units in the lagoon and its immediate vicinity consist of water body, shore, beach and beaches, hilly areas, river valley and floodplain, plain area, cliffs, hilly areas and slopes. The geological units are Quaternary and Miocene aged and mostly consist of Quaternary aged alluvium. On the beaches, there are marine and terrestrial deposits, sandstone, clay and silt sized elements. Volcanic elements are encountered in the western and northwestern parts where the slope increases.

In the land use map prepared according to the data of the Ministry of Agriculture and Forestry in and around the lagoon, 10 class land cover types were identified. The water body covers 193 ha, non-irrigated arable agricultural land covers 52.46 ha, natural vegetation covers 1162.9 ha, natural meadows cover 676 ha. Sclerophyll plants spreading in the north-west of the lake are heath and maquis in the form of evergreen shrubs.

According to the coastal level change measurements obtained from the images analysed by using Google Earth satellite images on the shores of Gökçeada Lagoon and overlapped by applying the image overlay method, the area of the lake area in 1985 was 1.83 km2 and the perimeter length of the lake area was 5.38 km; in 2004 the area was 1.91 km2 and the perimeter length was 5.72 km; in 2012 the area was 1.90 km2 and the perimeter length was 5.54 km; in 2020 the area was 1.90 km2 and the perimeter length was 5.66 km. There are no major differences in coastal level change. In the study area, which is under the influence of the Marmara transition climate, there are recessions in the lake level due to evaporation due to summer drought. Although there is no areal change of anthropogenic origin, there is a canal that provides fresh water input to the lake by DSİ.

In the study, it is planned to prepare a management plan by utilising the SWOT analysis method in and around Gökçeada Lagoon. It has been determined that the problems in and around the lake are caused by tourism activities, agricultural activities, settlement and industrial activities. Main threat and risk factors;

- The presence of new constructions such as hotels or andesite quarries that will create pollutants,
- Existence of wild landfill sites and mixing of garbage with water,
- Unconscious use of the sludge generated in the lagoon surface area, lack of necessary management and planning for its use in the field of health,
- The pressures of local and foreign tourists visiting the lagoon on the ecology of the lake,
- Presence of illegal, illegal wells around the lagoon,
- Unplanned tourism activities,
- Domestic, chemical and sewage waste,
- Agricultural pollution (pesticides, insecticides and unconscious irrigation activities),
- Uncontrolled and irregular construction,
- Air pollution,
- Privatisation of coastal areas,
- It can be listed as infrastructure inadequacy.

Tourism activities and agricultural activities are also the most important economic activities in and around the lake. They constitute an opportunity with their contribution to the economy. Since the amount of water required for the quarry planned to be built on the island will be met from the water potential of the area, it is not deemed appropriate to be established in and around the lagoon.

The lagoon and its surroundings are extremely suitable to be recognised in national and international status in terms of formation. While its promotion and advertisement constitute a positive aspect for tourism activities, it will pose a great threat to the lagoon and its surrounding area if proper tourism planning is not made. This study is important as a source for the local administration for the plans and suggestions developed.

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