



LAKE GALA NATIONAL PARK
WASTE TYPES AND QUANTITIES
CURRENT STATE ANALYSIS

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1. INTRODUCTION

1.1. Purpose of the Study

"The Meriç Delta Wetland", located where the Meriç River flows into the Aegean Sea, is a class A wetland within the territory of Turkey and Greece and has "international importance". Lake Gala National Park is an important part of the Meriç Delta Wetland. Lake Gala makes many ecological and economic contributions to the region where it is located.

This study was prepared within the scope of the project titled BSB142, BIOLEARN, which is being carried out within the framework of the first call for proposals of the ENI Black Sea Basin Cross-Border Cooperation Programme, for which the European Union Presidency acts as the national authority.

The purpose of the study is to conduct research on pollution distribution, quantities and types of pollution in Lake Gala in order to reduce the pollution in the wetlands and to ensure the sustainability of the wetlands within the balance of protection and use in the Black Sea Basin. In the first stage of the study, the literature data are presented. General information of the area and information about previous studies in the field are provided. In the second part of the study, surveys are conducted in order to determine the factors causing pollution in the region and the type and quantity of pollution by interviewing stakeholders.

2. GENERAL INFORMATION ABOUT WETLANDS

2.1. Definition of Wetlands

Wetlands are defined as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.¹

According to the RAMSAR Convention "The Wetlands are defined as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres."

According to the Regulation on the Protection of Wetlands, "the Wetland area refers to the zone of habitats such as open water surfaces, lagoons, estuaries, saltpans, temporary and permanent fresh and salt water marshes, wetland meadows, reeds and peatlands."

Wetland ecosystems around the world cover an estimated 1,280 million hectares; that is, it covers 33% more than the US surface area and 50% more than Brazil. Wetland systems are classified in many different ways:

- Marsh (1991) divided wetlands into three groups depending on hydrological conditions and physiographic location. These are; Surface wetlands, Groundwater wetlands, River and lake shore Wetland systems²,
- They are also classified by the Ramsar Convention according to the geographical conditions of wetlands or their formation mechanism. A total of 42 wetland types are defined under three main headings including: 1-Marine and Coastal Wetlands (coral reefs, mangroves, sea meadows, and estuaries). 2-Terrestrial Wetlands (swamps, peatlands, lakes, rivers and underground water habitats). 3- Artificial Wetlands (rice fields, dams, water reservoirs and fish lakes).

¹ https://acikders.ankara.edu.tr/pluginfile.php/81431/mod_resource/content/0/7-8-%20Sulak%20alanlar%20ve%20C3%A7%C3%B6z%C3%BCm%20C3%B6nerileri.pdf

² <https://sutema.org/mavi-gezegen/sulak-alan-ekosistemleri.39.aspx>

- According to the classification made by the European Community (1993), wetlands are divided into 7 main groups. These are; Estuaries and deltas, fresh water swamps, lakes, river and flood plains, Peatlands, Coastal wetlands, Constructed wetlands.

Table 1. Functions of wetlands

Functions of Wetlands	
Balancing the water regime and ensuring water quality	Groundwater discharge Flood control Balancing the Underground Water Preventing the saltwater intrusion
Softening the climatic conditions	
Biodiversity - Creating a habitat for living things	
Providing economic benefit	Agricultural activities Animal husbandry activities Recreational tourism activities Fishing activities Reed production
Transport possibilities	

In 1999, a survey was conducted on the area covered by wetlands on an international scale by evaluating more than 500 regional and national inventory sources within the scope of the Ramsar Convention and according to these estimates, the area covered by wetlands in the world was determined as approximately 12.8 million km² (MFWA, 2013).

In terms of wetlands, Turkey has the richest wetlands in Europe and the Middle East excluding the Commonwealth of Independent States. In our country, there are around 250 wetlands over 1 million hectares. It has been determined that 81 wetlands are of international importance in Turkey according to international criteria as a result of the studies conducted so

far. 18 of these, including the Meriç Delta, which also contains Lake Gala, are wetlands of "A" class quality.

Table 2. List of wetlands in Turkey

A Class Wetlands		
1. Manyas Gölü	7. Meriç Deltası	13. Çamaltı Tuzlası
2. Seyfe Gölü	8.Kızılırmak Deltası	14. Işıklı Gölü
3. Göksu Deltası	9. Eber Gölü	15. Beyşehir Gölü
4. Burdur Gölü	10.Ereğli Sazlığı	16.Eğirdir Gölü
5. Sultan Sazlığı	11.Tuz Gölü	17.Seyhan, Ceyhan Deltası
6. Ulubat Gölü	12.B.Menderes Deltası	18. Akşehir Gölü

Other Wetlands of International Importance		
1. İğneada Longoz Ormanı	23. Bolluk Gölü	45. Kargamış (Fırat Nehri)
2.Büyük Çekmece Gölü	24.Eşmekaya Gölü	46. Hazar Gölü
3.Küçük Çekmece Gölü	25.Hirfanlı Barajı	47. Erzurum Ovası
4.Terkos gölü	26. Karamık Sazlığı	48.Çıldır Gölü
5.Tuzla Gölü	27.Karakuyu Gölü	49.Kuyucak Gölü
6.Sapanca Gölü	28. Acı Göl	50. Balık Gölü
7.İzmit Gölü	29. Çaltı Gölü	51. Saz Gölü
8.Kocasu Gölü	30.Çorak Gölü	52. Murat Vadisi
9.Marmara Gölü	31. Salda Gölü	53.Haçlı Gölü
10. Küçük Menderes Deltası	32. Kovada Gölü	54. Nazik Gölü
11. Güllük Sazlığı	33. Çavuşçu Gölü	55. Nemrut Gölü
12. Köyceğiz Gölü	34. Hotamış Sazlığı	56. Çaldıran Sazlığı
13.Efteni Gölü	35. Karapınar Ovası	57. Bendimahı Deltası
14.Sülüklü Gölü	36. Yeşilirmak Deltası	58. Çelebibağ Sazlığı
15.Yeniçağa Gölü	37. Sankum Gölü	59. Ahlat Sazlığı
16.Sarıyer Barajı	38. Yedikuğular Gölü	60. Erçek Gölü
17.Mogan Gölü	39. Kaz Gölü	61. Van Sazlığı
18.Çöl Gölü	40. Yarışlı Gölü	62. Edremit Sazlığı
19.Uyuz Gölü	41. Karataş Gölü	63. Horkum Gölü
20. Kulu Gölü	42. Tödürge Gölü	64. Yüksekova Sazlığı
21. Samsam Gölü	43. Tuzla Gölü	
22. Kozanlı Gölü	44. Türkoğlu Sazlığı	

*Presence of birds hosted by the wetlands have been considered while determining the "A" Vlass wetlands. Wetlands hosting more than 25.000 waterfowls at once have been qualified as "A" Class Wetland.

Since the beginning of the 20th century, wetlands all over the world have been subjected to adverse interventions within the scope of soil recovery and combating malaria and have begun to be destroyed. The loss of wetlands due to the numerous benefits they provide to humans

Commonborders. Commonsolutions.

has revealed the lack of values and functions that are often neglected, and the importance of wetlands has started to be recognized, and the studies conducted on the protection of wetlands has increased and continues to increase³.

The Ramsar Convention is an international convention aimed at conservation and sustainable use of the wetlands. The contract has been named after the city of Ramsar, where it was signed in Iran on February 2, 1971. Turkey became a party to the contract after signing in 1994. Subsequent to the signing of this contract, some wetlands in our country with international characteristics have been declared as Ramsar Sites. All of these areas also have different conservation statuses. In Turkey, many regulations regarding the conservation of wetlands have been made. These regulations are; RAMSAR Convention, Law No. 4856 on the Establishment and Organization of the Ministry of Environment and Forestry, Land Hunting Law No. 4915, Environment Law No. 2872 (as amended by Law No. 5491), Regulation on the Protection of Wetlands, Wetlands Communiqué No. 16 of Prime Minister's Circular No. 993/1 (Official Gazette dated 05/04/1995 and numbered 22249), Wetlands Communiqué (Official Gazette dated 15/04/1998 and numbered 23314) Wetlands Communiqué (Official Gazette dated 09/02/2005 and numbered 25722) (Kuzulugil, 2017).

2.2. Sources and Causes of Pollution of Wetlands

Although wetlands have many functions and contribute to the region in which they are located, they indicate an accelerated degradation tendency due to intensive irrigation practices, groundwater abstraction and drainage (Koch et al., 2012). The problems experienced in wetlands in the world and in Turkey can be listed as follows (Baran, 2018):

- Desiccation for agricultural or settlement purposes in wetlands
- Water quality deterioration in wetlands. Wetland are generally formed at the deepest or lowest point of the basin where they are located. For this reason, almost all of the drainage water coming out of the agricultural lands, residential areas and industrial facilities in the basin eventually reach the wetlands. Lack of the treatment facilities in

³ https://www.dogadernegi.org/wp-content/uploads/2015/08/T%C3%BCrkiyenin-Ramsar-Alanlar%C4%B1nda-Sulak-Alan-Y%C3%B6netim-Planlar%C4%B1-De%C4%9Ferlendirme-Raporu_Bask%C4%B1.pdf

both residential areas and industrial facilities or improper operation of the treatment facilities constitute the biggest sources of pollution in wetland ecosystems.

- Habitat destruction in wetlands
- Administrative problems in wetlands
- Lack of awareness of the people living around the wetlands and non-public participation in wetland management

The main issues encountered in natural lakes and wetlands in our country are the decrease in water quantity, the threat towards biological diversity and deterioration in water quality. Damage caused to lakes from agricultural and residential areas and adverse interventions of people in the ecosystem (environment) lead to serious concerns in the sustainability of our natural areas, so the deterioration of water quality in lake basins caused by human effects, urban, agricultural and industrial wastes should be brought under control.

3. LOCATION AND GEOGRAPHICAL FEATURES OF LAKE GALA NATIONAL PARK

3.1. Geographical Location and Topographic Features

Lake Gala National Park is located in the middle of Ipsala and Enez Districts, in the area where the Meriç River flows into the Aegean Sea, also known as the Meriç Delta between 40° 46' 11.37" North - 26° 11' 14.87" East coordinates (Tokatlı & Gürbüz, 2014) (Figure 1). Lake Gala was formed as a result of the Meriç River changing its bed during heavy rainy periods, overflowing up to the foothills of Hisarlı and Çandır Mountains and blockage of the areas in the Meriç River Delta by the alluvium. The Lake consists of 2 parts: Grand Gala Lake (Çeltik Lake) and Small Gala Lake. These 2 lakes and Lake Pamuklu can form a single lake by being flooded during overflows in the basin (SHW, 2003). The area of Lake Gala is 556 ha and Lake Pamuklu is 188 ha (at 0 m elevation). The total lake area is 744 ha (Lake Gala Water Resources Management Plan, 2019). The surface area of Lake Gala varies depending on meteorological conditions and the release of the water taken from the lake for paddy irrigation works and left in the fields at the end of the harvest period. (Lake Gala Flora Fauna Final Report, 2016).



Figure 1. Location of Lake Gala National Park

There is no distinct stream flowing into Lake Gala. However, after the rainfall, there are small streams and creeks that are aggregated in the vicinity and in the Keşan Valley and reach the lake from these points. These small streams and creeks dry out shortly after the rainfall and do not indicate a continuous flow. The Meriç River, which is located in the wetlands contained by the Lake Gala National Park, is in interaction with the Hamzadere Dam, Yenikarpuzlu Pond, Enez Lagoons and DSI water conduits (Lake Gala Flora Fauna Final Report, 2016).



Figure 2. Borders of Lake Gala Lake National Park

3.2. Flora and Fauna Characteristics

A total of 1028 living species, including 511 plant taxa (491 vascular plants, 20 cryptogamic plants) and 517 animal species (322 vertebrate species, 195 invertebrate species), were identified in the Lake Gala National Park. A total of 263 species of vertebrate have been identified in the Lake Gala National Park as a result of the conducted literature and field studies. The number of bird species was determined as 217, mammal species as 44, inland fish species as 27, reptile species as 25 and amphibians as 9. Among the bird species, 6 species are in (VU) category and 9 species are in (NT) category. Among the mammals, 5 species are in (VU) category and 2 species are in (NT) category. Among the fish species, 1 species, *Anguilla anguilla* (Eel), is in the category of (CR), which is in extreme danger of extinction, and 1 species is in the (VU) category. Among the reptiles, 8 species are in (VU) category, and 3 species are in (NT) category.

217 bird species are observed in the National Park, of which 65 species are native, 55 species are winter migrants, 59 species are summer migrants and 38 species are transit migratory birds. Lake Gala National Park is an important stopover site especially for water birds, located on the western branch of bird migration routes.



Figure 3. Birds of Lake Gala



Figure 4. Plants of Lake Gala

4. POLLUTION AND ECOSYSTEM THREATS IN LAKE GALA NATIONAL PARK

4.1. Pollution Sources in Lake Gala National Park

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The environment of Lake Gala is also an important area that needs to be protected as well as being an important ecological area in terms of paddy cultivation in Turkey. Lake Gala, which is an ecologically sensitive area, is under threat especially due to paddy farming practices and anthropogenic pressures. As a result of literature research and field studies conducted on pollution sources and types in Lake Gala, the factors that may have an impact on the lake can be listed as follows:

- **Pollution Caused by Agricultural Activities**
- **Pollution Caused by Excursionists/Recreational Activities**
- **Eutrophication**
- **Pollution Caused by Nutrias**
- **Chemicals in Water**
- **Industrial Pollution**

4.1.1. Pollution Caused by Agricultural Activities

Lake Gala National Park is adjacent to paddy fields from west, east, north and southwest. Intense paddy cultivation is carried out around the lake and 24% of Turkey's paddy production is met from this region. The flow of irrigation water in the paddy agricultural fields to Lake Gala causes the chemical fertilizers and pesticides used together with the irrigation water to pass into the system. Within the scope of Telmata and Cimra Irrigation Projects completed by the Directorate General for State Hydraulic Works (SHW), drainage channels were built around the Lakes of Gala and Pamuklu in order to prevent the discharge of dirty water from paddy fields to the Lakes. However, these channels prevent the polluted waters coming out of the paddy fields from entering the lakes and also prevent the supply of lake. (Long Term Development Plan for Lake Gala National Park, DKMP- General Directorate of Nature Conservation and National Parks). In the interviews made with local residents under the study conducted by Balık (2018) in the region, local residents emphasized that this system was not fully functioning and that water was withdrawn from Gala and Pamuklu Lakes and then released. The water coming back to the lake from the agricultural fields adversely affects the water quality of the lake (Republic of Turkey Ministry of Forestry and Water Affairs, General Directorate of Nature Conservation and National Parks, 2010; Balık, 2018). In particular, a lot of chemical fertilizers are used in order to get more efficiency in the first growing period of the paddy. Water resources contaminated as a result of fertilization in agricultural areas are absolutely mixed with lake water. In addition, the release of pesticides by plane to paddy fields has been detected by birdwatchers in the region recently, and it is inevitable that these pesticides used in excess will cause serious damages to the lake ecosystem. Flowing irrigation water used in paddy agricultural fields to the Lake Gala causes the chemical fertilizers and pesticides applied together with the irrigation water to pass into the system as well.

It has been observed that agricultural practices implemented with a monoculture approach in Ipsala District and surrounding villages impoverish the soil in terms of some minerals. Inorganic and phosphate fertilizers are applied extensively in all agricultural production areas in order to eliminate the mineral deficit. It is believed that the most important sources of high nitrogen and phosphorus compound values determined in the region are agricultural activities (Ministry of Agriculture and Forestry 1st Regional Directorate, Edirne Branch Office 2019).

We can briefly summarize the pollution caused by agricultural activities in Lake Gala as follows:

- Burning the stubble after the paddy harvest
- Using the chemical fertilizers during the growing season in paddy fields and mixing of these fertilizers with groundwater and discharge water and lake water
- The accumulation of heavy metals and chemicals in mud layers in paddy fields
- Agricultural spraying
- Intensive monoculture farming practice
- Return of irrigation water to the lake

4.1.2. Pollution Caused by Excursionists/Recreational Activities

Lake Gala has a rich variety of habitats with its proximity to the sea, forest ecosystem in the vicinity, meadows and mountainous settings, as well as its fresh watery and watery environment. This causes the site to be visited too much during the year. But this situation also creates pollution. Especially, wastes are generated as a result of daily visits in the visitor area located in Tuztepe area.

A field study was conducted in order to determine the amount of pollution and types caused by daily visits and recreational activities around Lake Gala. Within the scope of the field study, 5 sample areas were selected through the GPS UTM mobile coordinate program. By taking the coordinates of these areas, studies have been conducted on the types of pollution in the areas within the coordinates.

Table 3. Determination of Waste Caused by Excursionists in Lake Gala National Park

Name of Wetland	LAKE GALA NATIONAL PARK	
Location	Lake Gala-Enez / Edirne TURKEY	
GPS Point		Waste Type
First Site	Point 1: 429671 -4511697 Point 2: 429665-4511708 Point 3: 429642 -4511689 Point 4: 4296664511686	- food packaging waste - cigarette litter - wet wipe waste - nut waste - plastic waste

Second Site	Point 1: 429670- 4511683 Point 2: 429674-451176 Point 4: 429669- 4511682	<ul style="list-style-type: none"> - food packaging waste - cigarette litter - wet wipe waste - Plastic waste
Third Site	Point 1: 429630- 4511675 Point 2: 429698-4511680 Point 3: 429697-4511687 Point 4: 429685- 4511683	<ul style="list-style-type: none"> - food packaging waste - barbecue waste - plastic cover
Fourth Site	Point 1: 429696-4511703 Point 2: 429684-4511704 Point 3: 429692-4511704 Point 4: 429682- 4511697	<ul style="list-style-type: none"> - glass bottle - farmyard manure - diapers
Fifth Site	Point 1: 429650-4511669 Point 2: 429662-4511662 Point 3: 429663-4511664 Point 4: 429658- 4511663	<ul style="list-style-type: none"> - glass bottle - diapers - wet wipes

As a result of the research conducted in the field of Lake Gala for the detection of pollution types, food packaging and wipes were detected as the highest wastes. These wastes are concentrated around the sitting areas built in the lake. In the examination conducted by determining the sample areas in the field, plastic cover wastes, nuts, crushed glass bottle wastes were found more intensely following the food and packaging wastes. There are also sporadic animal droppings and cigarette litters in the area.

4.1.3. Eutrophication

Eutrophication, also called as secondary pollution, is a phenomenon of chemical changes occurring due to the fact that domestic wastewater rich in terms of phosphorus in lakes, agricultural drainage waters and some industrial wastewater increase nutrition in the lake, causing excessive algae growth and an increase in the amount of organic matter.

Although Lake Gala generally has the characteristics of a mesotrophic lake, some organic and inorganic deposits in the lake cause a move towards the formation of eutrophic lake. Especially soil erosion formed by excessive rain causes more organic and inorganic materials to be transported in Meriç River and it is observed that in similar areas such as Lake Gala where the water stagnates, thin layers of these materials are formed on the lake bed by sedimentation. In addition, the solids in the discharge waters coming from the paddy fields

undergo sedimentation in the lake environment as well. As a result, increasing organic and inorganic substances in the lake environment cause the rapid growth and reproduction of aquatic plants in the lake. Almost all of the organic materials formed in the lake environment can be broken down in the natural ecological cycle and used repeatedly in future vegetation periods and they do not pose a threat to the ecosystem. However, nitrate and phosphate waters coming from paddy fields trigger the formation of eutrophication in Lake Gala. It is believed that this situation leads the healthy organic matter cycle in the ecosystem that covers Lake Gala and its surroundings and the carrying capacity of the ecosystem to a challenging critical point. For this reason, the water quality is deteriorating gradually and the feeding, growth and reproduction cycle of all plant and animal creatures in the lake ecosystem is adversely affected (Republic of Turkey, Ministry of Forestry and Water Affairs, General Directorate of Nature Conservation and National Parks, 2010). This situation may cause a decrease in the amount of dissolved oxygen and the death of the aquatic ecosystem in the lake in the long term. For this reason, the presence of plankton in the lake is sometimes seen as a polluting factor for the lake. Further, the increase in the amount of plankton poses a threat to fish living in the lake as well (Öterler, 2019). As the eutrophication (pollution) increases in natural lakes, maintaining the natural balance of the lakes becomes more and more important since there is no conservation of the flora and fauna.

4.1.4. Pollution Caused by Nutrias

A new element that threatens the biodiversity of Lake Gala National Park is invasive species, which are living outside their natural habitats, threatening the lineage of local species in their newly arrived habitats and harming biodiversity. Therefore, they also pose a threat to human health by contaminating various pathogenic microorganisms in addition to the economic damage they cause. In the Lake Gala National Park, the animal species (nutria) is an invasive species. Nutrias are semi-aquatic, invasive rodent mammal species. It has been observed that the population of nutrias has increased rapidly in Lake Gala in the recent years. The excessive proliferation of these species in the lake causes the ecological balance to deteriorate by consuming reeds in the lakes (Özkan, 2020). Nutrias gnaw the reeds by the roots around the lake, causing polluting effects on the lake, causing the reeds to rot and putrefaction in the lake.

Nutrias cause pollution and disrupt the ecological balance in the lake, as well as damaging the birds' nesting materials, directly and indirectly, disrupting the breeding of some waterfowl in lakes (Özkan, 2020).

4.1.5. Chemicals in Water

In a study conducted by Dökmeci (2005) in Lake Gala and the drying channels feeding the lake, heavy metal contents were determined in water and sediment samples. According to the results of the study conducted, it was reported that the cadmium and lead values in sediment samples are quite high, especially the drying channels have third-fourth class water quality in terms of Cd and Pb elements and that the main reason for this situation was the agricultural activities carried out around Lake Gala.

In another study conducted by Tokatlı et al (2014) in the same region, it was determined that nitrogenous and phosphorus compounds were quite high in the surface waters of the region and the riskiest parameter in the waters of Lake Gala and Irrigation Canal was nitrite nitrogen, which was thought to be caused by agricultural activities.

Within the scope of the IPA Transboundary Cooperation in Lake Gala, a study was conducted with the aim of evaluating the water quality under the project activities for the protection and restoration of natural heritage in Burgaz and Enez. Under the research study, physical, chemical and bacteriological analyzes were carried out by taking water samples from 3 sample areas between July 2017 and September 2018.

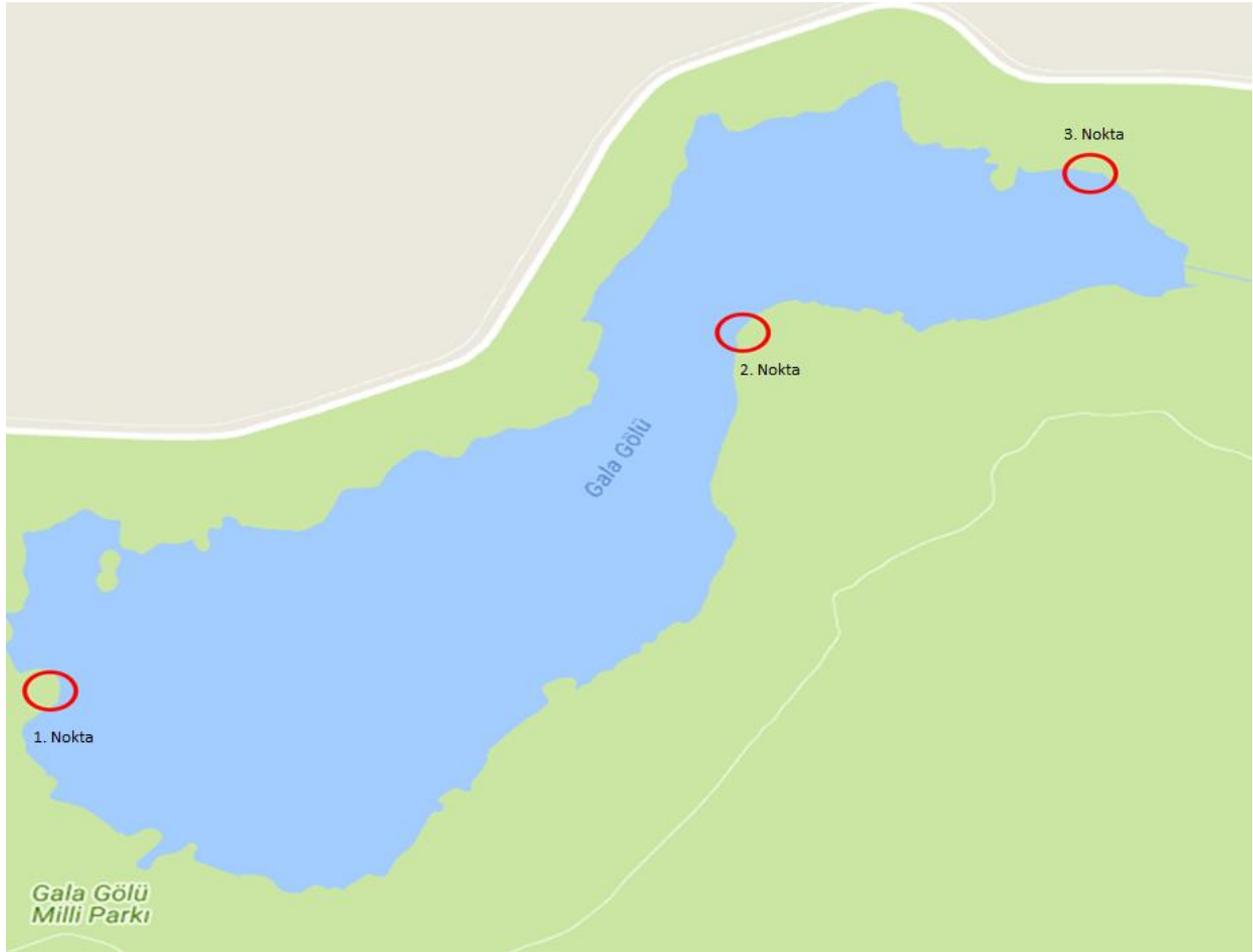


Figure 5. Sampling areas for Lake Gala water quality analysis (Gürbüz et al., 2018)

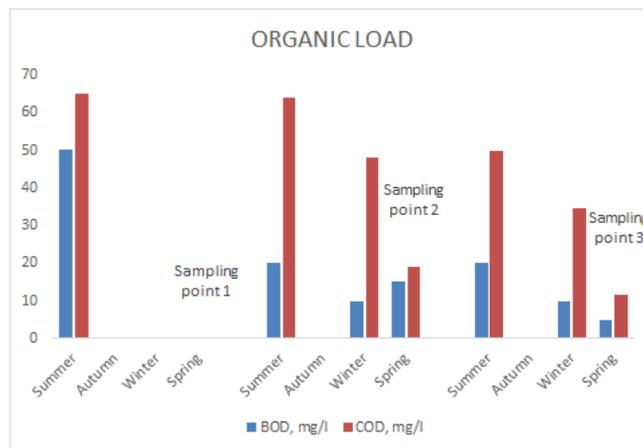


Figure 6. Seasonal display of BOD and COD parameters

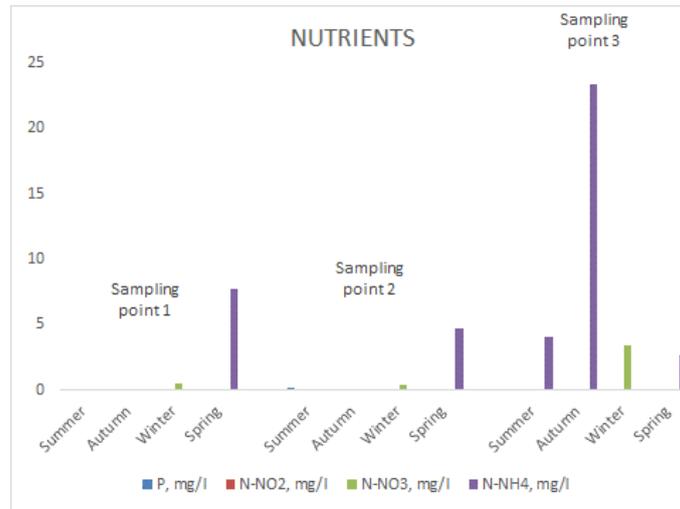


Figure 7. Seasonal representation of P, HN₄-N, NO₃-N and NO₂-N parameters

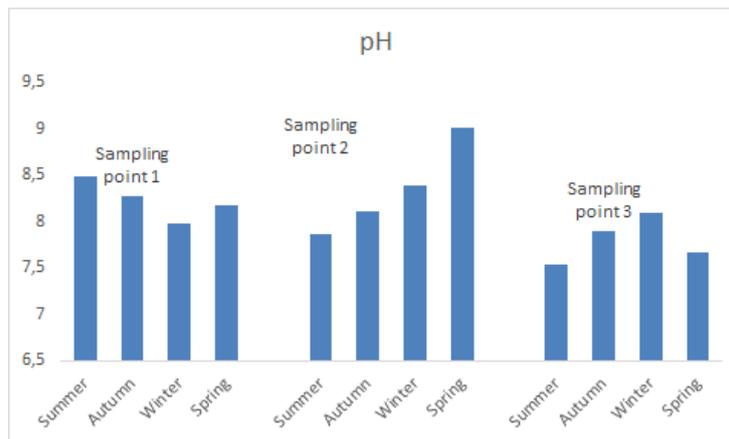


Figure 8 Seasonal representation of pH values

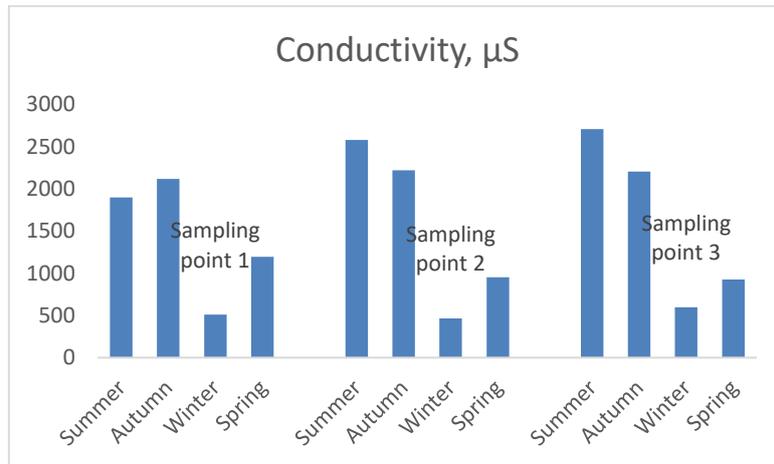


Figure 9. Seasonal representation of electrical conductivity values

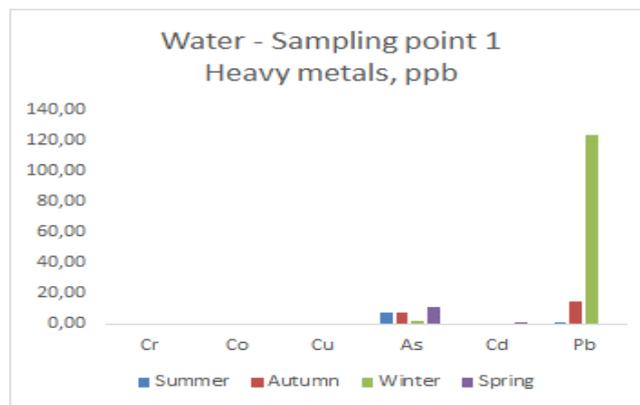


Figure 10. Seasonal representation of heavy metal values of water samples taken from the first sampling point

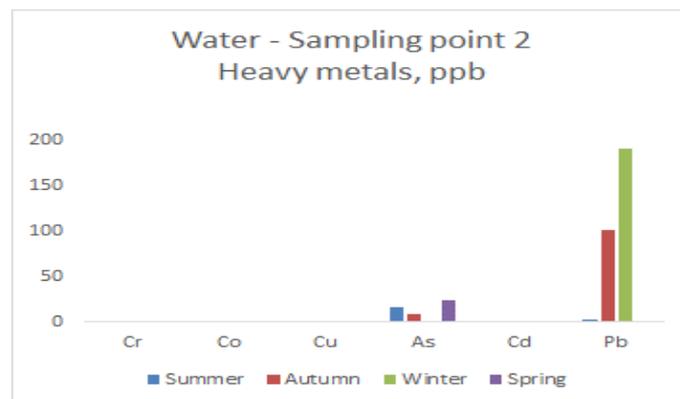


Figure 11. Seasonal representation of heavy metal values of water samples taken from the second sampling point

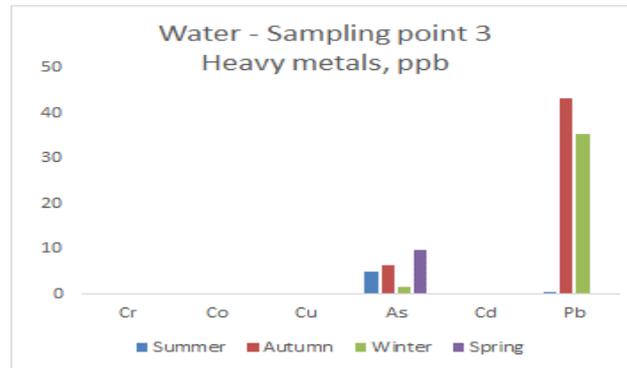


Figure 12. Seasonal representation of heavy metal values of water samples taken from the third sampling point

Examining the Lake Gala in terms of water quality (Çebi et al., 2018):

- The results obtained in all three points were similar to each other.
- Salinity values varied between 0.185 and 2.708, and an increase in salinity was observed during summer. **In dry years, the salt ratio of the lake water increases as a result of the effect of the sea and water intake for paddy cultivation and this causes problems.**
- The oxidation parameters were not of a size to cause problems.
- Among the nutrients, only NH-N proved to be a problem.
- Faecal coliform pollution was detected in the lake water. Since the sampling was made from the lake shore, the intensive human and animal activities caused the values to increase in certain months.
- Mn, Fe and Pb contamination was detected in some months.
- No Zn, Cu, Cr, Co, Ni and Cd contamination was found.
- Lake Gala is exposed to a significant amount of organic and inorganic pollution caused by the intensive agricultural activities carried out around the lake, some of the tail water returning from paddy fields in İpsala and Keşan Districts and mixing of the Ergene River water with the lake at a fair amount.
- Since a large amount of chemical based compound fertilizers (20-20-0, 18-46-0) are applied in the paddy production around the lake, the amount of phosphorus that can be taken reached higher (11.48 mg kg⁻¹-97.36 mg kg⁻¹) quantities. Since the paddy farming areas are submerged for most of the year, the amount of iron and manganese,

which are also a plant nutrient, reached higher quantities (Fe; 15.08 mg kg⁻¹-174.34 mg kg⁻¹, Mn; 39.48 mg kg⁻¹-101.84 mg kg⁻¹ in the soils close to the lake (0-15 km diameter) (Gürbüz et al., 2018). The amount of these elements in the lake water reached higher values in some months as a result of both surface and subsurface feeding and sediment transport from the surroundings.

- It is estimated that the presence of excess lead (Pb) in the lake water in some months may be caused by the use of agricultural machinery during paddy cultivation periods and the traffic on the local roads.

In the "Final Report of the Lake Gala National Park Water Resources Management Sub-Plan and the Establishment of the Lake Hydrological Model Sub-Plan," which was commissioned by the Ministry of Agriculture and Forestry, 1st Regional Directorate, Edirne Branch Office in 2019, analyzes were conducted regarding the quality of the Lake Gala water between February 2018 and July 2019.

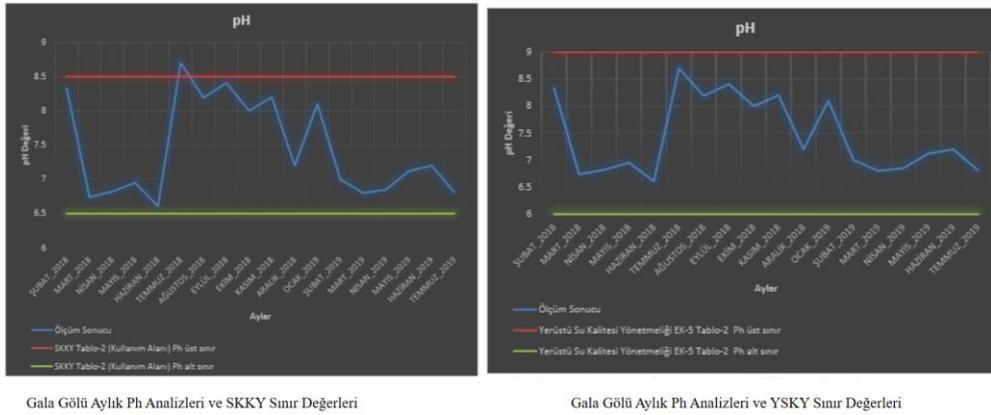
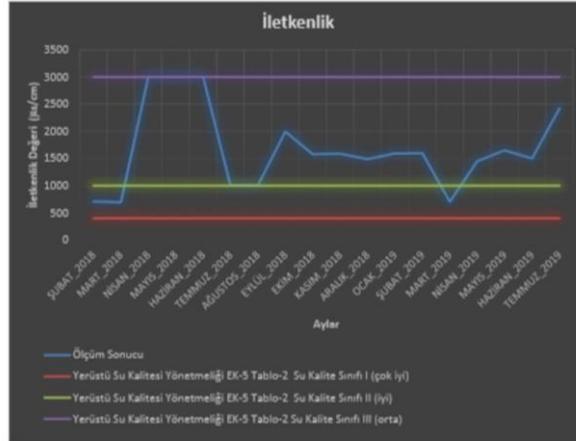
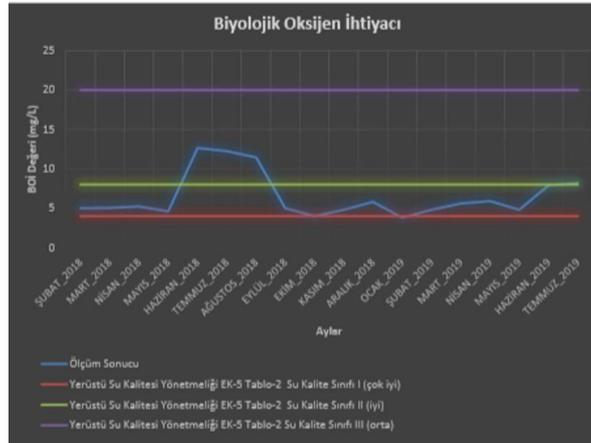


Figure 13. Lake Gala pH analysis -February 2018 to July 2019



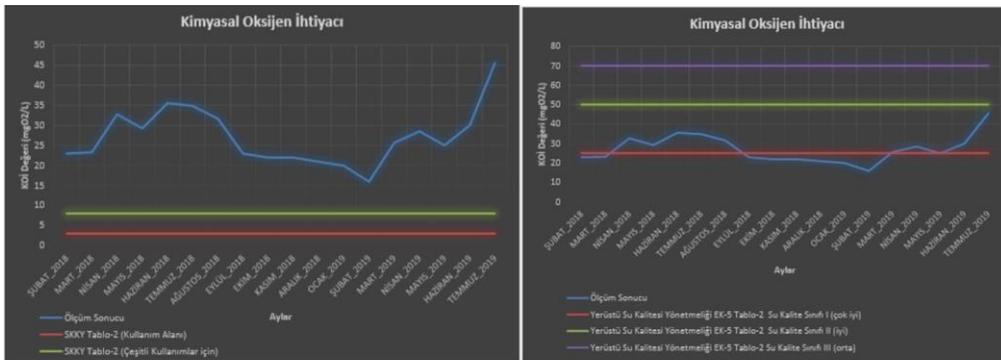
Gala Gölü Aylık İletkenlik Analizleri ve YSKY Sınır Değerleri

Figure 14. Lake Gala conductivity analysis- February 2018 to July 2019



Gala Gölü Aylık BOİ Analizleri ve YSKY Sınır Değerleri

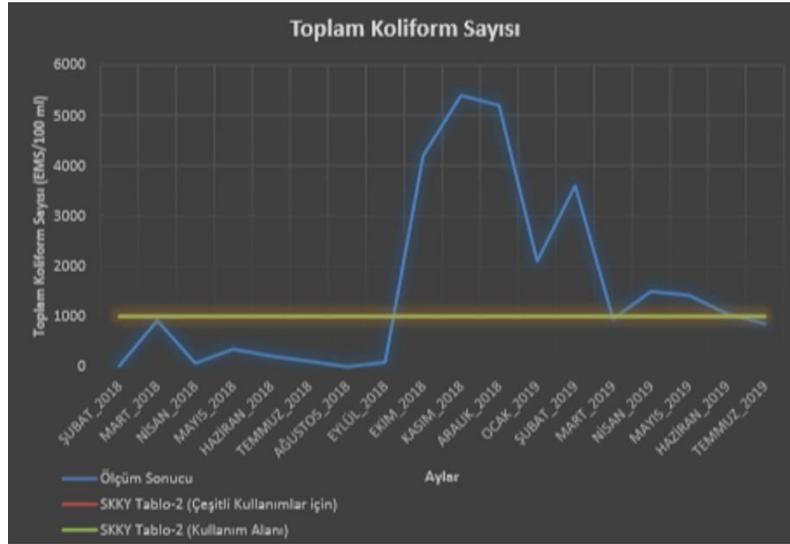
Figure 15. Lake Gala BOD analysis- February 2018 to July 2019



Gala Gölü Aylık KOİ Analizleri ve SKKY Sınır Değerleri

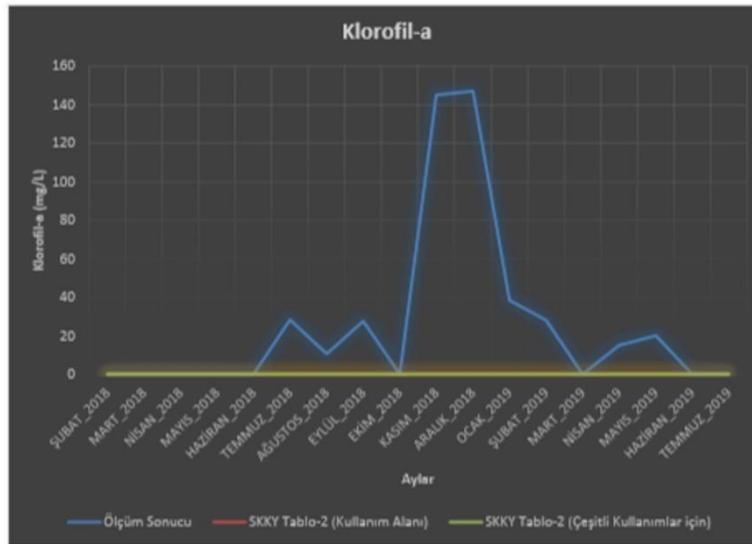
Gala Gölü Aylık KOİ Analizleri ve YSKY Sınır Değerleri

Figure 16. Lake Gala COD analysis- February 2018 to July 2019



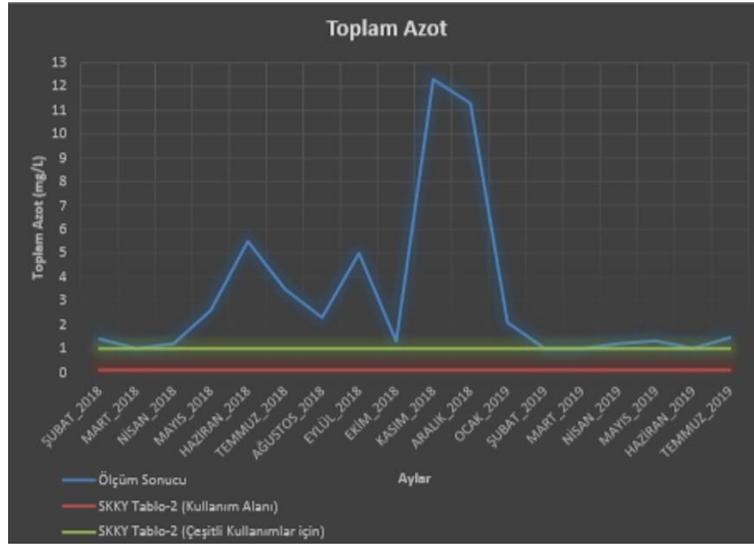
Gala Gölü Aylık Toplam Koliform Sayısı Analizleri ve SKKY Sınır Değerleri

Figure 17. Lake Gala coliform count analysis- February 2018 to July 2019



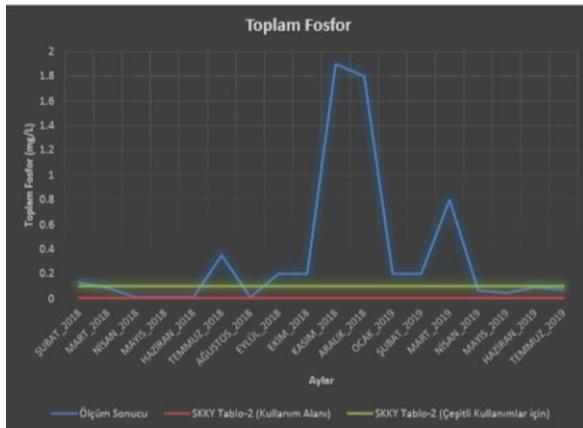
Gala Gölü Aylık Klorofil-a Analizleri ve SKKY Sınır Değerleri

Figure 18. Lake Gala Chlorophyll-A analysis- February 2018 to July 2019

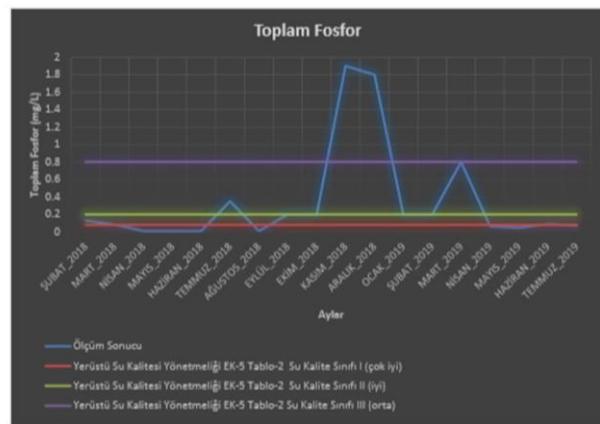


Gala Gölü Aylık Toplam Azot Analizleri ve SKKY Sınır Değerleri

Figure 19. Lake Gala Nitrogen analysis- February 2018 to July 2019



Gala Gölü Aylık Toplam Fosfor Analizleri ve SKKY Sınır Değerleri



Gala Gölü Aylık Toplam Fosfor Analizleri ve YSKY Sınır Değerleri

Figure 20. Lake Gala Phosphorus analysis- February 2018 to July 2019

According to the Analysis Results;

- Although pH values were close to each other, the highest value was measured as 8.7 in July, 2018. The pH value is within the limits specified in Table-2 of the Regulation on Water Pollution Control and Annex-5, Table-2 of the Regulation on Surface Water Quality.

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- When the electrical conductivity (EC) values are examined, it is observed that the values are at maximum levels in April, May and June 2018. Due to the elevation difference caused by the fall of the lake level, the lake remains under the influence of sea water and the salt concentration and electrical conductivity of the lake water increase.
- The electrical conductivity (EC) values are predominantly between the water quality class II (good) and water quality class III (medium) specified in the Annex-5 Table-2 of the Regulation on Surface Water Quality. Due to the elevation difference caused by the fall of the lake level, the lake remains under the influence of sea water and the salt concentration and electrical conductivity of the lake water increase. Fish kills are observed due to high salt concentration
- The lake water temperature increases depending on the seasons and reaches the highest level in July and August.
- The highest value of Dissolved Oxygen was seen in February, 2018. Dissolved Oxygen value is predominantly above the 5 mgO₂ / L value specified in the Table-2 of the Regulation on Water Pollution Control and the water quality class III (medium) value specified in the Annex-5 Table-2 of the Regulation on Surface Water Quality.
- The highest Suspended Solid amount was measured in May 2018. The quantities measured in the 18-month period are mainly between the 5-15 mg/ L values specified in Table-2 of the Regulation on Water Pollution Control.
- It is observed that TN and TP reached the highest levels in November, 2018 and Chl-a values reached their maximum levels in the period of November-December, 2018.
- The fact that precipitation increases with the beginning of the spring months, the pollution load is carried by ground and surface waters, and the maximum increase in the parameters is seen especially in April, May and June, paddy planting time takes place in these months and the irrigation water in the paddy agricultural fields flows into the Lake Gala causes the chemical fertilizers and pesticides used together with the irrigation water to pass into the system. Therefore, the organic load of the lake is increasing day by day, and it has begun to exhibit a eutrophic characteristic.

- COD value is an important parameter indicating organic pollution in waters. Due to the increase in microbial activity in the spring and summer months, the rate of degradation of organic substances increases, thus, the COD value also increases. The lake is determined in 2nd class water quality according to Inland Water Resources Quality Criteria in terms of COD, which is one of the most significant pollution parameters. In terms of BOD values, Gala Lake is determined to have 3rd class water quality.
- Nitrogen and phosphorus forms are evaluated because phytoplankton play a limiting role in primary production. This situation occurs due to the decrease in the upper layer of the water, nitrogen and phosphorus and the increase in phytoplankton in the summer period.

4.1.6. Industrial Pollution

The industrial effect and the discharge of industrial wastewater into the Ergene River in the Thrace Region poses a great threat to the wetlands located in this area. Although there is no industrial activity in the Lake Gala basin, the pollution factors formed in the Ergene River as a result of the mixing of the waters of the Ergene and Meriç Rivers affect the Gala Lake as well. According to the research studies conducted in various periods on Lake Gala, industrial pollutants have been detected from time to time in the lake water and the waters that feed the lake (Şişman, 2003; Dökmeci, 2005).

4.2. Evaluation of Lake Gala Pollution Analysis Survey

“Lake Gala Pollution Analysis Survey” consisting of 11 questions was conducted in order to determine pollution types and sources in Lake Gala. The survey was conducted for the participants at the STAKEHOLDER MEETING FOR TYPES OF POLLUTION AND DUE DILIGENCE IN LAKE GALA held on 23 July 2020. 30 people answered the survey. According to the survey results;

- Information about the socio-demographic characteristics of the participants in the survey was obtained in the 1st and 2nd questions.

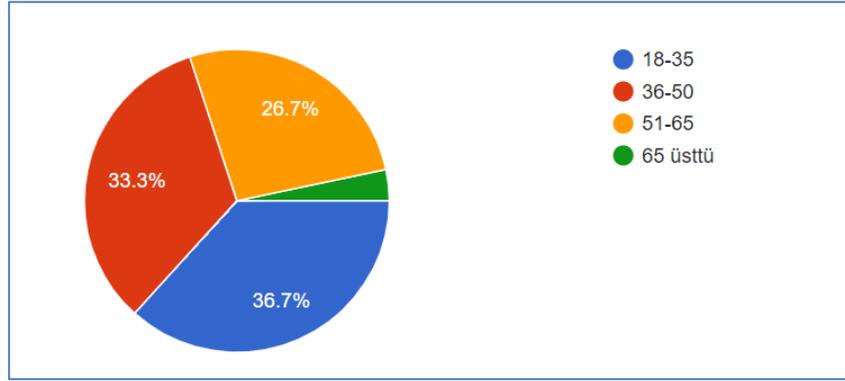


Figure 21. The first question graph of Lake Gala Pollution Analysis

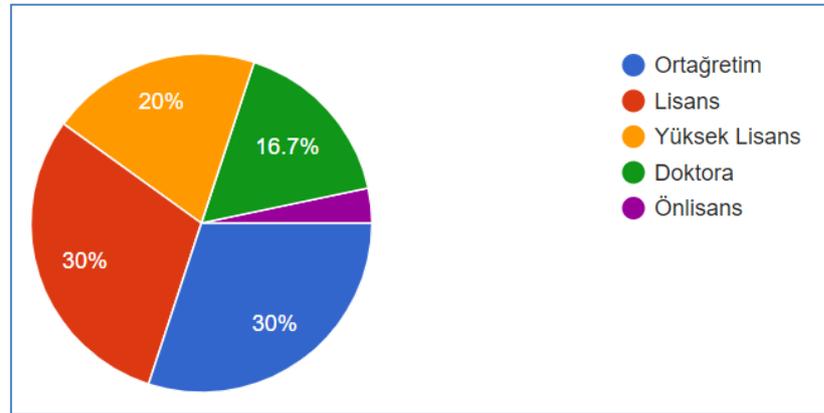


Figure 22. The second question graph of Lake Gala Pollution Analysis

- 29 people answered the question of "how do you benefit from Lake Gala". 37.9 % of the participants have a picnic/day-long visit, 20.7% are biological researches, 13.8% are bird watching, 10.3% are hunting and fishing, and % 3,4 of them answered as other.

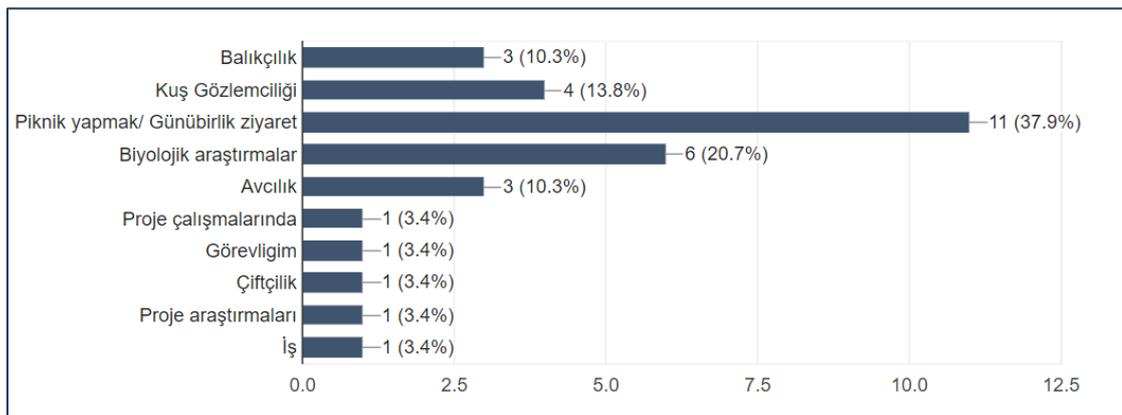


Figure 23. The third question graph of Lake Gala Pollution Analysis

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- 30 people answered the question of "how often do you visit Lake Gala".

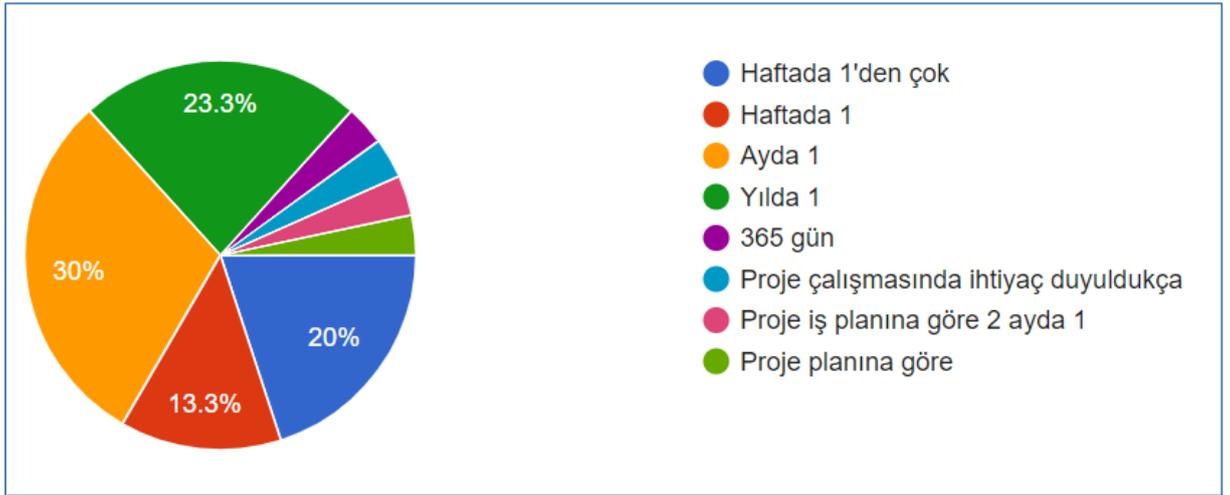


Figure 24. The fourth question graph of Lake Gala Pollution Analysis

- 30 people answered the question of "what are the pollution sources you identified in Lake Gala and its vicinity". 73.3% of the participants responded as agricultural pollution, 70% wastes caused by day-long visits, 23.3% animal pollution, 6.7% industrial pollution, 9.3% nutrias.

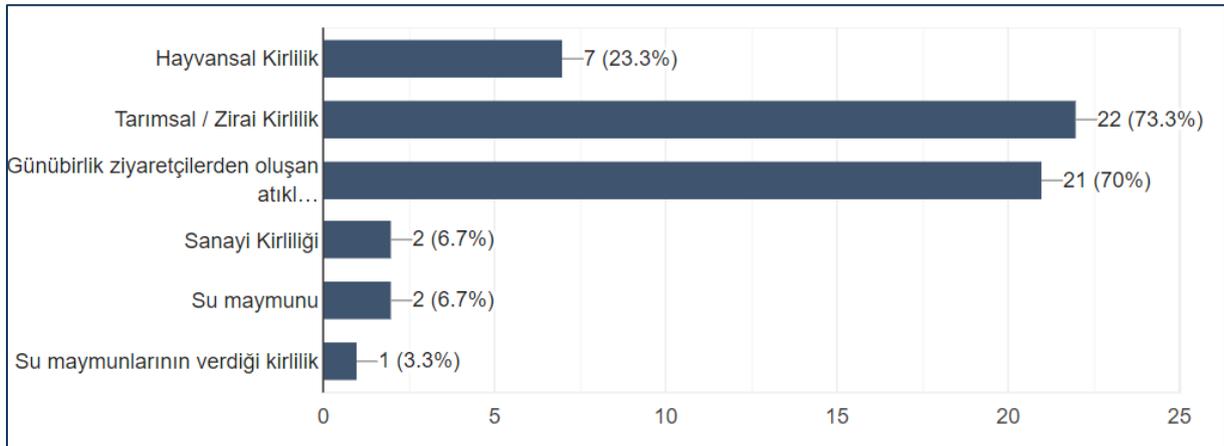


Figure 25. The fifth question graph of Lake Gala Pollution Analysis

- 30 people answered the question of "what are the types of pollution you have identified in Lake Gala and its vicinity". %66.7s of the participants responded as plastic wastes, 60% wastes caused by day-long visits, 50% agricultural wastes, 40% as recyclable wastes such as glass, paper etc.

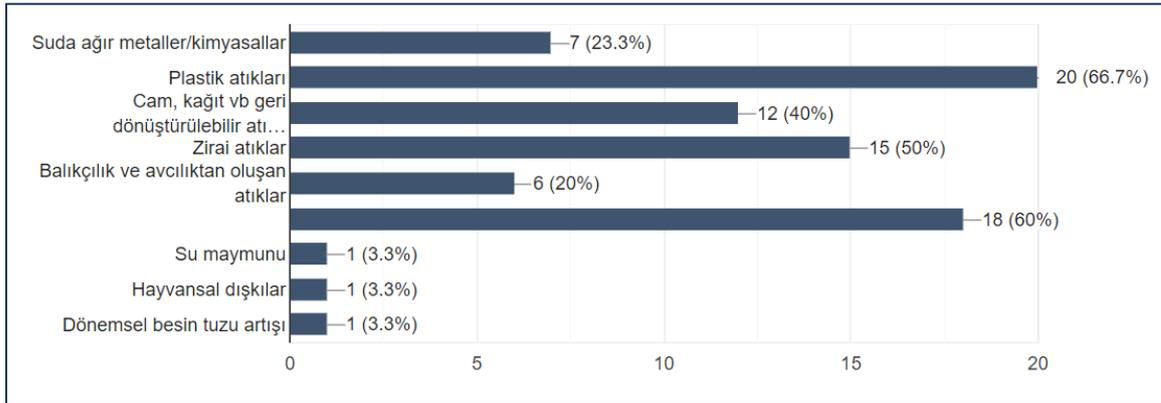


Figure 26. The sixth question graph of Lake Gala Pollution Analysis

- 21 people answered the question of "what are the steps you suggest to take to reduce pollution". Answers received;
 - Increased control (the highest rate of response)
 - Imposing fine
 - Determining Transport Usage Capacity and Carrying Out Appropriate Activities
 - Placing trash cans in the area
 - Raising Awareness of the society
 - Observation towers to be created without disrupting natural fabric and enhancing camera security
 - Preventing pesticides and fertilization, and preventing the return of polluted water after supplying clean water for the paddy farming.
- 28 people answered the question of "do you think that the cooperation of public and non-governmental organizations operating in our region regarding the environment is sufficient". More than 50% of the participants answered No.



Figure 27. The eighth question graph of Lake Gala Pollution Analysis

- 28 people answered the question of "in your opinion, what is the overall environmental awareness level of the citizens in our region". More than 35% of the participants answered as "Unconscious".

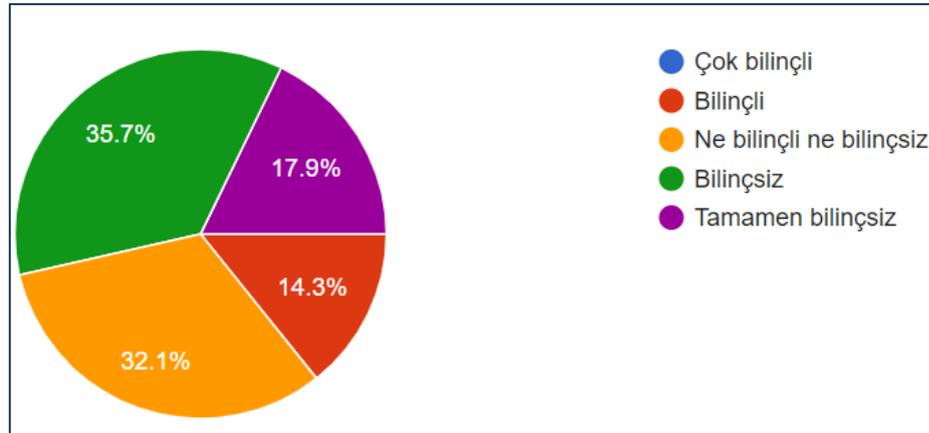


Figure 28. The ninth question graph of Lake Gala Pollution Analysis

- 28 people answered the question of "raising public awareness is important in protecting Lake Gala". More than 95% of the participants answered as "I agree".

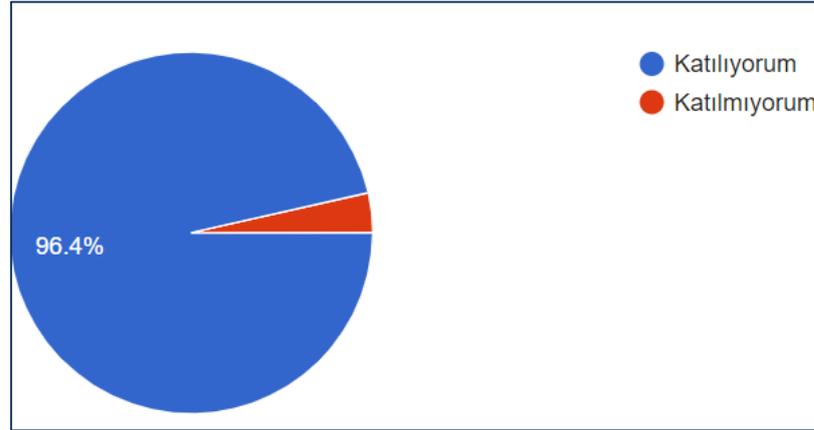


Figure 29. The tenth question graph of Lake Gala Pollution Analysis

- 29 people answered the question of "are you planning to participate and contribute to the activities of the BioLearn project, which aims to raise environmental awareness". 89% of the participants answered "Yes".

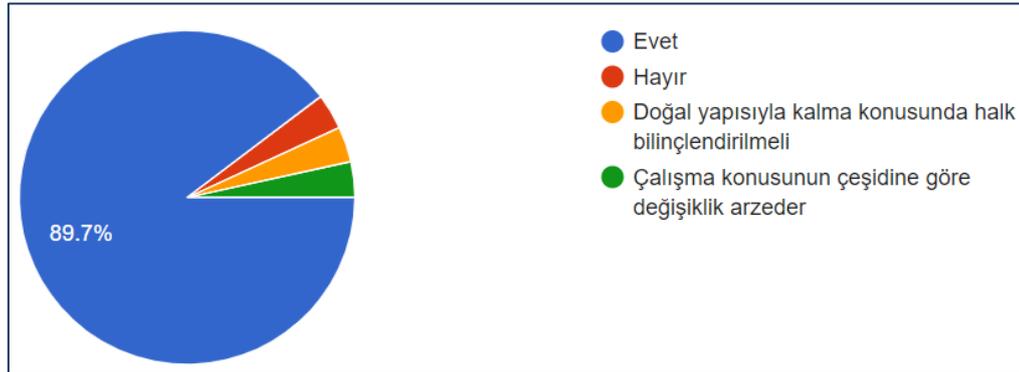


Figure 30. The eleventh question graph of Lake Gala Pollution Analysis

4.3. The Effects of Declaring Lake Gala as a National Park on the Prevention of Pollution

2369 hectares of land covering Lake Gala and Lake Pamuklu has been declared as a "Natural Conservation Area" pursuant to the 3rd Article of the National Parks Law No. 2873 with the decision of the Council of Ministers dated 08/08/1991 and numbered 91/2052. However, subsequent to this declaration, Ipsala District and all of its affiliated villages were declared as "Agricultural Reform Implementation Area" with the decision of the Council of Ministers dated 27/12/1992 and numbered 21448. Agricultural land was leased to farmers with the application of Agricultural Reform, however, these lands remained within the natural

conservation area. The existence of lands belonging to the General Directorate for Foundations within the Natural Conservation Area caused conflict between institutions and social problems in the region, contradicting with the status of the conservation area. (Minutes of TGNA Minutes, 2004). The area was declared as a national park in 2005 with the aim of establishing an understanding with the institutions, preventing destruction on the protected area, expanding the boundaries of the protected area and allowing agricultural land use in the region. After the announcement of Lake Gala as a National Park, many expropriation studies were carried out and the agricultural field problem within the area boundaries was solved to a great extent. The owners who had fields around the lake were given fields from other places by exchanging the foundation lands. The expropriated land around the lake is approximately 28 hectares (General Directorate of Nature Conservation records in Edirne, 2011). With the announcement of Lake Gala as a National Park, discharge water was prevented from flowing into the lake. This situation ensured that heavy metals did not accumulate in the lake and the polluting effects of the lake were reduced.

In order to prevent the discharge water from flowing into the lake, a canal was built by the paddy fields to the lake and irrigation water has been transferred to this channel. However, this situation creates problems regarding the natural supply resources of the lake.

5. CONCLUSION

Pollution caused by agricultural activities and daily visits has been identified as the main pollutant elements in Lake Gala according to the literature reviews on pollution types and due diligence in Gala Lake, presentations made at the "Stakeholder Meeting on Pollution and Due Diligence in Lake Gala" held on 23 July 2020, stakeholder discussions, and the obtained survey data. The most important element in the pollution of water in Lake Gala is the agricultural practices carried out in the paddy fields around the basin. The fertilizers and pesticides implemented in these fields increase the pollution load in the lake.

According to the water analysis conducted in Lake Gala in July, 2017 and September, 2018 and the dates between February 2018 and July 2019, the water quality is not very bad. But from time to time, it has been observed that the salinity and chemical elements in the lake

increase. The reason for this is the fertilization of paddy fields around the lake. In the pollution studies and assessments in Lake Gala, the lake should not be considered only as water. The lake should be considered as a whole with the surrounding ecosystem. Pollution of water resources is not the only threat to the ecosystem in Lake Gala. According to the Final Report of the Lake Gala National Park's Flora, Fauna and Vegetation Detection Service Procurement, which was commissioned by the Abolished Ministry of Forestry and Water Affairs, General Directorate of Nature Conservation and National Parks, 1st Regional Directorate, Edirne Branch Office in 2016, some adverse conditions that could threaten the sustainability of the national park's ecosystem were encountered during the field studies carried out in the area. These adverse conditions are listed for the flora and fauna that contribute to the biodiversity of Lake Gala:

- **Poaching activities;** Areas such as Lake Gala National Park are areas that serve as a reserve for the entire region. As the number of bird species and populations in reserve areas is maintained, it is also possible to see these species in other areas. There is also the danger of killing endangered species as a result of the shootings made by the poachers without knowing the species while hunting.
- **Wind Power Plant;** The increase in the number of Wind Power Plants in and around Lake Gala is a threat factor for the Lake, which is on an important bird migration route. Lake Gala National Park is located on an important bird migration route. In the research studies conducted on the subject, it was determined that the establishment of wind power plant sites should be prohibited in areas with a diameter of at least 20 km in important wetlands and in areas that may show a narrow strait. For this purpose, migration routes and areas with narrow strait characteristics should be determined for both migratory soaring birds and waterfowl using the area and performing night migration movements during the spring and autumn migration periods. Although it is thought that the WPP site, which is located 5 km south of the area, will not pose a danger to migratory birds due to the fact that the turbine settlement is parallel to the possible migration routes and the distance between the turbines is 200-300 meters apart, the increase in the number of WPP sites may cause adverse effects. The most

important threat factors of WPP sites in terms of bird species are barrier effect, habitat loss, crash deaths and disturbance impacts, therefore, the WPPs in the area should be evaluated considering these factors.

- **Agricultural activities;** Excessive use of water resources supplying the lakes affects the water regime and fish density due to the gradual expansion of the agricultural areas around the national park.
- **Cutting reeds;** Another observed threat factor is the cutting of the reeds, which are the hiding and nesting areas of songbirds and waterfowls, with the aim of passing the boats of the fishermen. If the cutting period coincides with the breeding season for bird species, a more serious threat may arise for many species that nest in these reeds. Cutting and burning reed areas within the borders of the national parks should not be allowed. Another negative effect of the fishing activities in the region is the fishing nets left inside the lake. Especially for wading birds, getting caught in the fishing net can result in death.

In order to prevent pollution in Lake Gala;

35

- It is inevitable that pollutants originating from industrial and urban areas in the basin where the wetland is located reach to the sources of surface and ground water with runoff. Thus, it may be possible to transport chemical, physical and biological wastes coming from the entire basin to the wetland. The discharge of waste water to surface water without treatment process should be prevented regarding the solution of this problem. Wastewater should never be discharged to underground waters. Public and organizations should be made aware of the ecosystem cycle (Elipek, 2019).
- In order to minimize the effects of this pressure occurring on the lake, Agricultural Pollution Management studies should be carried out first in the villages around the lake and then in the settlements where the streams supplying the lake are affected.
- In the region, an inventory study should be carried out first in a narrow frame and then in a scale that will cover the whole sub-basin. As a result of these studies, more realistic figures about the size of the agricultural areas and the type and amount of fertilizers implemented can be reached. In addition, training should be given on the

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conscious use of water and fertilizers in agriculture, starting from the villages located on the shore of the Lake.

- The awareness of the local community should be raised about good agricultural practices and organic farming practices such as drip irrigation and they should be encouraged to use such practices.
- Because of the use of synthetic chemical inputs, causing erosion by water and environmental pollution, the lack of a production system that consumes the least amount of water (recommending the drip irrigation method) and conserves biological diversity, the organic farming production system should be implemented around the lakes located in the basins.
- It is necessary to tighten and increase the control actions in the lake.
- Garbage containers should be placed around the visitor center in Lake Gala.
- Deterrent penalties should be applied for burning stubble, and paddy harvesting technology should be developed.
- Groundwater in and around Lake Gala should not be used for agricultural irrigation.
- The water used for agricultural irrigation should not be returned to the lake without water treatment.
- Awareness of the society is an important factor in preventing pollution. Trainings should be organized by relevant institutions in order to raise environmental awareness.
- In order to determine the water quality in the lake, analyzes should be made continuously.
- Pollution analysis of soils around the lake should be done 2 or 3 times a year.
- Public Institutions, NGOs and the general public should be in coordination in the arrangements to be made in the lake.
- Paddy agriculture is the main source of income for the people living around the lake. The main polluting factor in the lake results from the paddy farming. Alternative livelihoods with high added value should be created for the people living around the lake.

- Plans for tourism should be developed by determining the carrying capacity of the area.
- A protocol should be signed with the public research unit to ensure that the seasonal water quality can be monitored for many years in order to monitor the water quality of the Lake on a seasonal basis.
- A local unit should be established to carry out the administrative and operational works related to the Lake Gala National Park on site.

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ANNEXES

ANNEX-1 STAKEHOLDER LIST

- 1- GOVERNORSHIP OF EDIRNE
- 2- ISTANBUL REGIONAL DIRECTORATE OF FORESTRY
- 3- DISTRICT GOVERNORSHIP OF IPSALA
- 4- MUNICIPALITY OF IPSALA
- 5- MUNICIPALITY OF ENEZ
- 6- PROVINCIAL DIRECTORATE OF ENVIRONMENT AND URBANIZATION OF EDIRNE GOVERNORSHIP
- 7- EDIRNE PROVINCIAL AGRICULTURE DIRECTORATE, FISHERIES BRANCH OFFICE
- 8- IPSALA DISTRICT AGRICULTURE DIRECTORATE
- 9- ENEZ DISTRICT AGRICULTURE DIRECTORATE
- 10- MUNICIPALITY OF YENIKARPUZLU
- 11- THRACE REPRESENTATION OFFICE OF CHAMBER OF ENVIRONMENTAL ENGINEERS
- 12- KIRKLARELI ATATÜRK SOIL AND WATER AGRICULTURAL METEOROLOGY RESEARCH INSTITUTE
- 13- EDIRNE CHAMBER OF AGRICULTURE
- 14- TRAKYA UNIVERSITY IPSALA VOCATIONAL SCHOOL
- 15- ISTANBUL HUNTING SHOOTING AND SPECIALTY CLUB
- 16- IPSALA HUNTING ASSOCIATION
- 17- YENIKARPUZLU FISHERIES COOPERATIVE
- 18- IPSALA SOCIAL DEVELOPMENT AND PROGRESS ASSOCIATION
- 19- ENEZ AQUACULTURE COOPERATIVE
- 20- ENEZ CHAMBER OF AGRICULTURE
- 21- ENEZ HUNTING AND SHOOTING ASSOCIATION
- 22- ENEZ NATURE ASSOCIATION
- 23- HEADMAN OF HISARLITEPE VILLAGE
- 24- HEADMAN OF ÇATALTEPE VILLAGE
- 25- DOÇEK (NATURE, ENVIRONMENT AND CULTURE ASSOCIATION)
- 26- ENEZ SPORTS CLUB ASSOCIATION



ANNEX-2 SURVEY QUESTIONS

LAKE GALA ENVIRONMENTAL POLLUTION ANALYSIS SURVEY

1. Please select your age group:

- 18-35 36-50 51-65 65 over

2. Educational Background:

- Secondary Education Undergraduate Postgraduate Doctorate Other:

3. How do you benefit from Lake Gala?

- Fishing Birdwatching Picnic / Excursion Biological research Other:

4. How often do you visit Lake Gala?

- More than once a week Once a week Once a month Once a year Other:

5. What are the sources of pollution you have identified in Lake Gala and its vicinity?

- Animal Pollution Agricultural Pollution Pollution of wastes from excursionists Industrial Pollution Other:

6. What are the types of pollution you have identified in Lake Gala and its vicinity?

- Heavy metals / chemicals in water Plastic wastes Recyclable wastes such as glass, paper etc. Agricultural wastes Wastes from fishing and hunting Wastes from daily visits Other:

7. What steps are you suggesting to be taken to reduce pollution?

.....
.....



.....

8. Do you think that the cooperation of public and non-governmental organizations operating in our region regarding the environment is sufficient?

Yes No Other:

9. What do you think is the level of environmental awareness among the citizens in our region in general?

Very conscious Conscious Neither conscious nor unconscious Unconscious Completely unconscious

10. Public awareness is important in conservation of Lake Gala.

I agree I disagree Other:

11. Do you plan to contribute to BioLearn project activities aiming at gaining environmental awareness?

Yes No Other: