Changes in the Coastline and Water Level of the Akşehir and Eber Lakes Between 1975 and 2010

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Introduction

- Although representing a relatively small percentage of Earth's water, lakes are integral features of the global hydrological system.
- Changes in the coastline and water level of lakes mainly reflect changes in precipitation, evaporation, runoff and human activities integrated over the lakes and their basins.

- Changes in the coastline and water level of lakes are an important task that has applications in different fields such as coastline erosion monitoring, coastal zone management, watershed definition, flood prediction and water resource evaluation.

- This task is difficult, time consuming and can be impossible for a huge region such as an entire country or continent, when using traditional ground survey techniques.

Remotely sensed data acquired by satellites are more and more widely used for the identification, monitoring and delineation of lake mapping at regional or global scales.

- The main objectives of this study are to estimate changes in the coastline and water level of lakes using derived water levels from satellite imagery, remote sensing techniques and in situ water level measurements and to investigate the impacts of human activity and climate on lake levels and water reserves.

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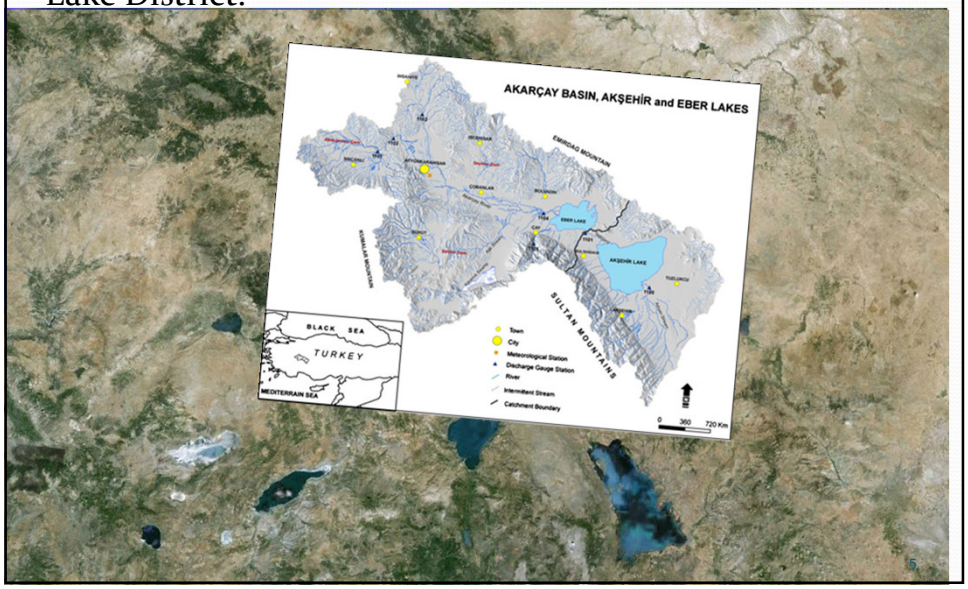
Study Area

- The Aksehir and Eber lakes which are the subject of this study are also important lakes in the Akarcay basin in the Lake District.



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Lake	Altitude (m.a.s.l)	Lake area (km2)	Catchment area (km2)	Maximum depth (m)	Mean depth (m)
Akşehir	952	361	2.376	7	5
Eber	965	150	4.961	4	2

- Akarcay basin is a closed basin and covers an area of 7.300 km2 in the western Anatolia.

- The Akşehir and Eber Lakes are closed lakes in the Akarçay Basin and, therefore, are an ideal site to evaluate the effects of climate and human activity changes on the water resources system.

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- At present, there is no direct surface water connection between the two lakes.
- However, an aqueduct and an open channel existed until 1990.
- The Eber Lake provides a direct sustained outflow to the Akşehir Lake through the Taşköprü channel.

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- The Eber and Akşehir Lakes are closed basins within the Akarçay Basin and, therefore, the only way of water loss is though evaporation
- The lakes are used for different purposes such as small-scale commercial fishing, recreation and irrigation.
- The water level variations of the Akşehir and Eber Lakes are mainly driven by hydrologic conditions over the Akarçay Basin because it contributes up to 70% of the Eber Lake water volume.

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- The Akarçay Basin is one of the smallest closed basins in Turkey.
- The area is characterized by a continental climate with very cold rainy/snowy days in winter but very hot and dry weather in summer.

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The Akşehir and Eber Lakes are two of the biggest lakes in the Akarçay Basin

- their surrounding area is used for cherry growing, especially the western sides of both lakes because the microclimate affects the lakes.
- Cherry growing is the most important agricultural production for local people.
- The lakes are home to many endemic birds and a wide variety of animals.



MATERIALS AND METHODS

The basic data used in this study includes:

- Digital Elevation Model (DEM),
- Landsat images
- monthly river discharge and lake level data
- monthly rainfall and temperature data
- population data
- fieldwork studies and results of other relevant studies.

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In this study, ten multitemporal images were collected between 1975 and 2010.

Dates	Satellite/sensor	Path/Row	Spatial Res. (m)	Revisit (days)	Radiometric Res. (bit)	Spectral Res.(Band)
16/06/1975	Landsat MSS	192/033	80 × 80	16	7	4
30/06/1984	Landsat TM	178/033	30 × 30	16	8	7
11/05/1989	Landsat TM	178/033	30 × 30	16	8	7
25/05/1994	Landsat TM	178/033	30 × 30	16	8	7
09/05/2000	Landsat ETM+	178/033	30 × 30	16	8	8
16/06/2002	Landsat TM	178/033	30 × 30	16	8	7
19/06/2006	Landsat ETM+	178/033	30 × 30	16	8	8
13/05/2007	Landsat ETM+	178/033	30 × 30	16	8	8
13/05/2009	Landsat TM	178/033	30 × 30	16	8	7
08/07/2010	Landsat TM	178/033	30 × 30	16	8	7

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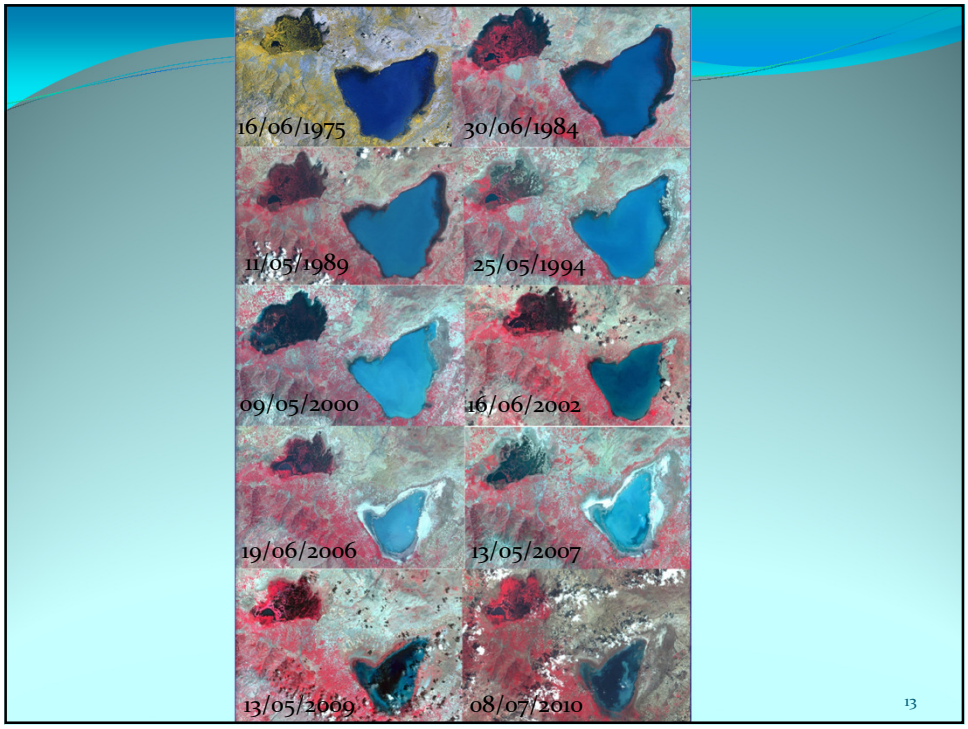

ANALAYSIS OF THE TEMPORAL CHANGE OF LAKES

- From the results of the image analysis, the levels of the Akşehir and Eber Lakes fell dramatically and shrunk in area from 1975 to 2010.
- The water surface areas of the Akşehir and Eber Lakes also decreased from 356,93 to 126,89 km2 and from 119,88 to 97,15 km2, a loss of 64.4% and 19.0% over the 35-year period, respectively.

Lake	1975	1984	1989	1994	2000	2002	2006	2007	2009	2010
Akşehir	356.93	370.23	342.44	267.52	236.56	205.13	110.76	123.56	126.48	126.89
Eber	119.88	165.20	119.98	66.14	145.16	126.32	86.21	68.81	85.66	97.15

Water surface area changes from 1975 to 2010 of the Akşehir and Eber Lakes (km²)

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- The identified water body change by Landsat images correlated with the change of water level in the Akşehir and Eber Lakes gauged by the DSI.
- The results showed a good agreement between both Landsat images and in situ datasets.
- The highest lake level was 956.02 m in 1985 and the lowest lake level was 953.35 m in 2004.
- Over the 29 years, the Akşehir Lake level declined by 2.67 m.

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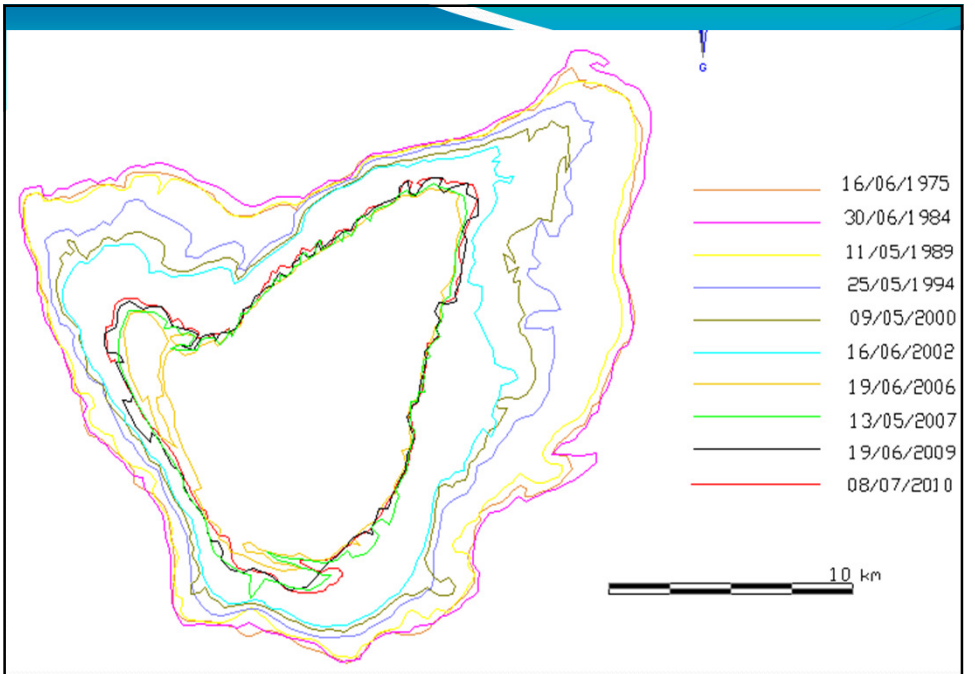

Shorelines changes of the Akşehir Lakes

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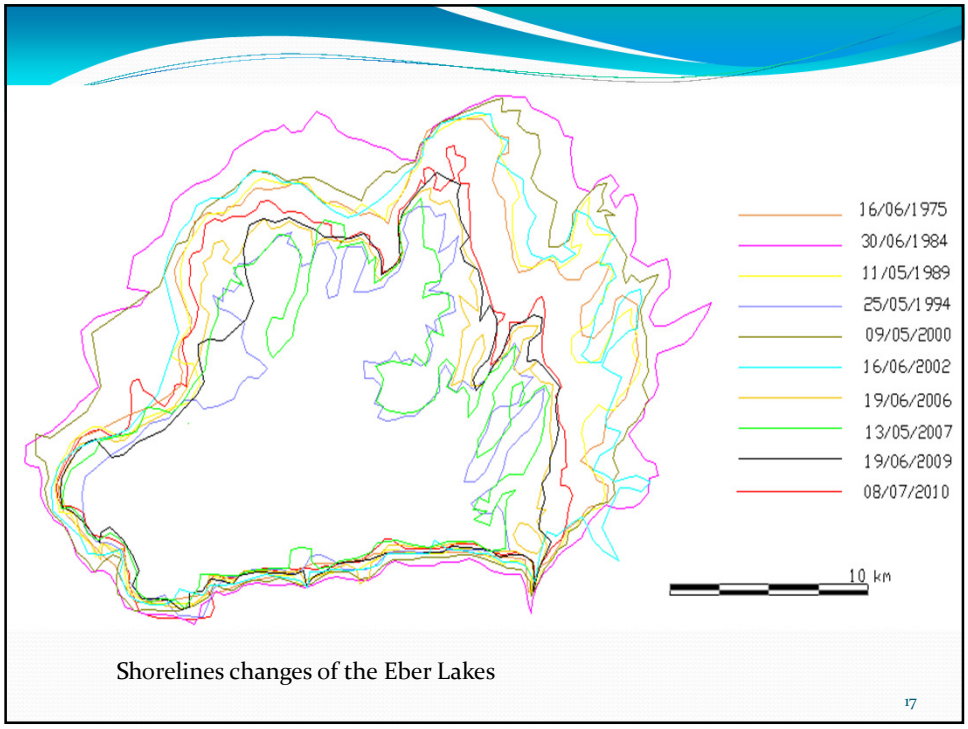

Shorelines changes of the Eber Lakes

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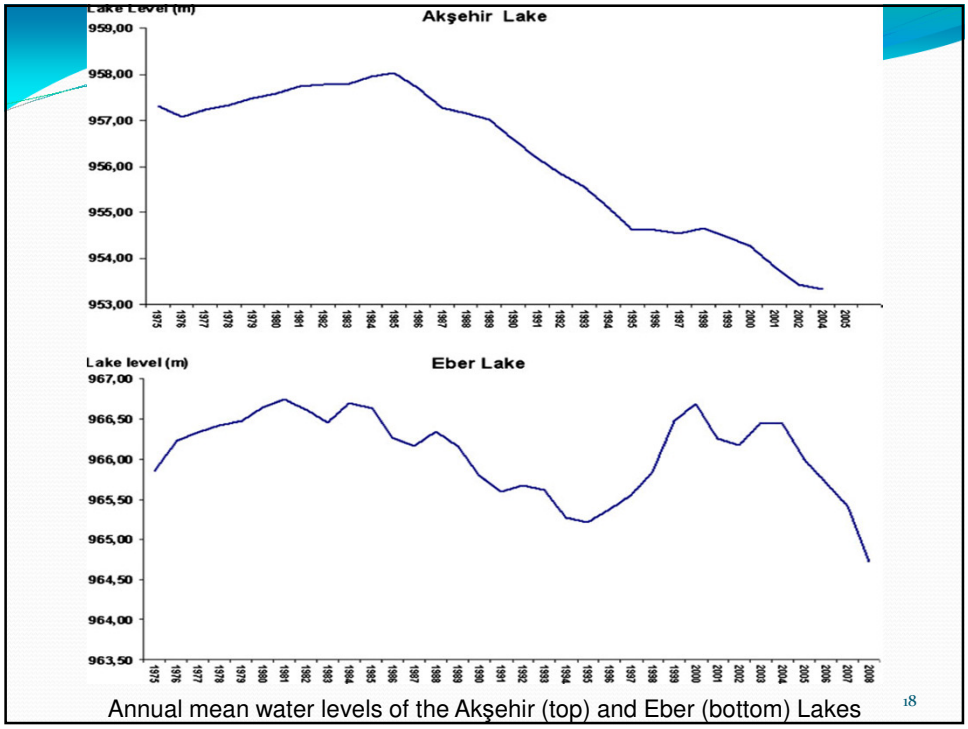

Annual mean water levels of the Akşehir (top) and Eber (bottom) Lakes

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- There are two main reasons for this declining water level of the Akşehir Lake.
- First, before 1990, the Akşehir and Eber Lakes were connected via the Taşköprü channel.
- The flow to the Akşehir Lake has now stopped.
- Second, there are many cherry gardens in alluvial fans on the western side of the Akşehir Lake.
- A number of wells were also opened by local people to irrigate the cherry gardens especially in growing season.
- This situation hampered the groundwater flow of the alluvial fans to the Akşehir Lake.

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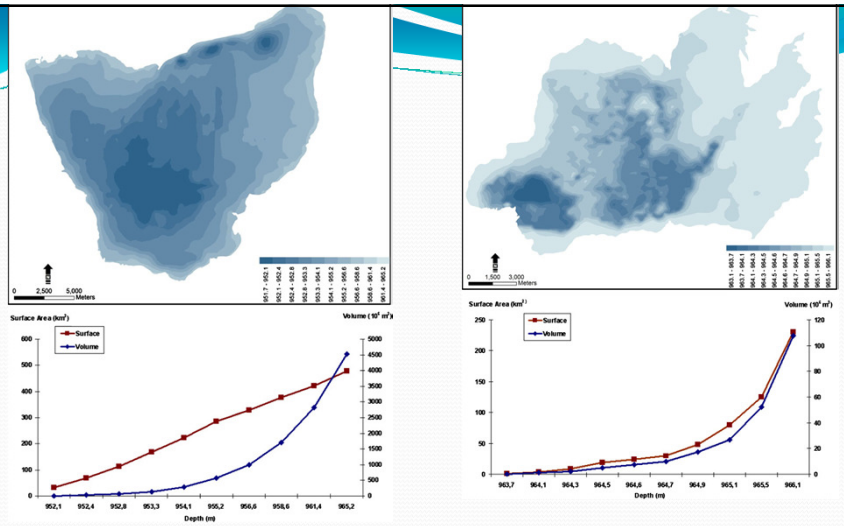

- Bathymetric information (depth contours) is vital for lake water management.
- Bathymetric data were used to characterize the lake bottoms.

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CAUSES OF THE CHANGES IN THE COASTLINE AND WATER LEVEL

- The causes of lake level fluctuations are usually attributed to anthropogenic and/or climatic factors.
- In other words, a lake's water balance is controlled both by water use from human activities and climatic conditions.
- Water use can be broadly classified into agricultural, domestic, industrial uses.

	Agricultural use hm^3	%	Domestic use hm^3	%	Industrial use hm^3	%
1970	121,455	93	9,878	7	0,112	< 1
2000	226,950	92	19,474	8	0,223	< 1

Total and proportional water uses by each sector on Akarçay Basin in 1970 and 2000

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- In the basin since 1965, many irrigation systems have been built for agricultural irrigation, domestic use and flood control.
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- Three dams and seven pounds were constructed on the Akarçay River and its tributaries.

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- The water volume of irrigation systems, nearly the entire water volume of the Eber Lake, is being held upstream of lakes catchments by dams and pounds.
- This is very important because it derives water from rivers for human activities such as agricultural irrigation and domestic uses upstream of lakes catchments.

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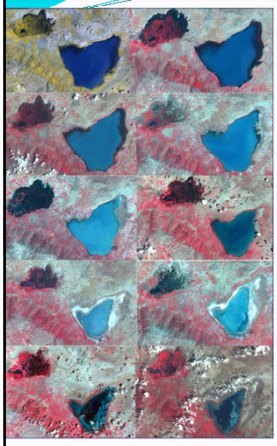
CONCLUSION



- This study investigated coastline and water level changes of lakes to identify the causes for the decline in lake levels using the satellite imagery, remote sensing techniques and in situ water level measurements, monthly temperature, precipitation and runoff data from 1975 to 2010.

Lake	1975	1984	1989	1994	2000	2002	2006	2007	2009	2010
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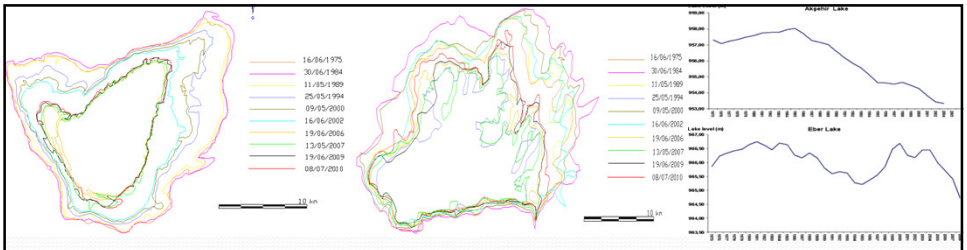

- The results of the ground lake level data (in situ) indicated that the Akşehir Lake level declined by 2.67 m from 1975 to 2004, and the Eber Lake level also declined by 2.03 m from 1975 to 2004. The lakes have experienced a severe decline in water levels in recent decades.
- They are shallow lakes and as such small changes in depth can result in great changes in spatial extent.

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- The results of hydrologic, climatic and human activities data analyses suggest that the change of lake levels might depend more on anthropogenic factors than on climatic factors.
- The use of Landsat images, remote sensing techniques and hydrologic and climatic data provided valuable information on the temporal and spatial changes in the coastlines and water reserves of the Akşehir and Eber Lakes and the impact of human activity and climate on lake levels and water reserves.
- Therefore, these methods could be applied more extensively for lake monitoring purposes

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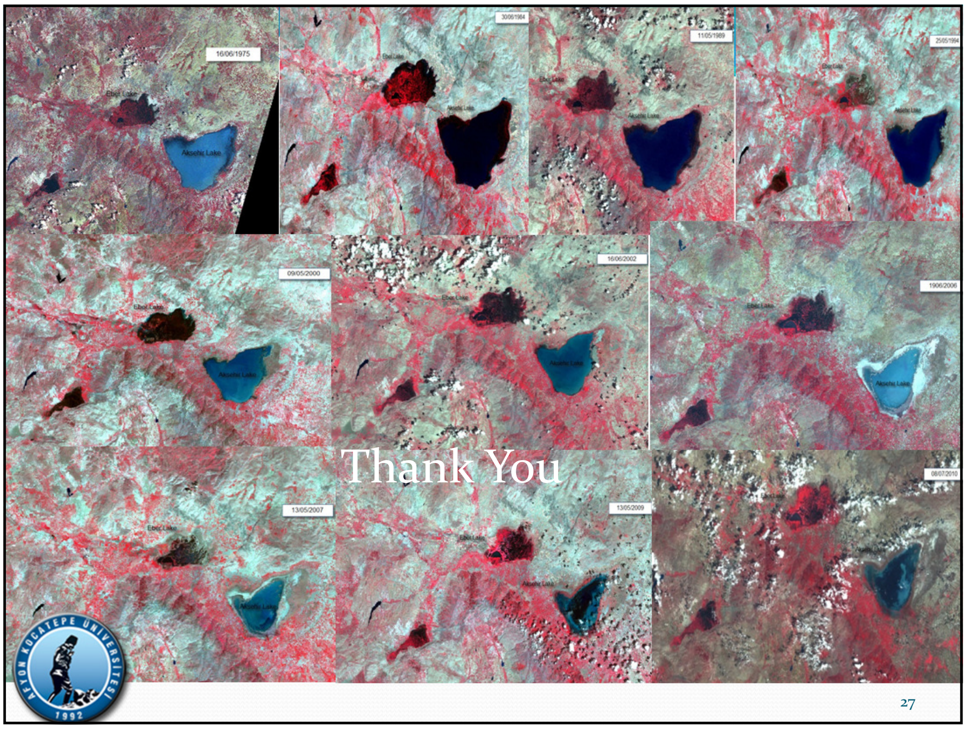
Thank You
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