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Climate Trend Analysis of the Level Changes of Iznik Lake in Turkey

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Abstract

The purpose of this study was to carry out the statistical analysis on the changes in watershed climate and the level of Iznik Lake, which is one of the major lakes in Turkey, and determine the trends. Correlation and regression analysis were carried out in order to manifest the association between climate elements and changes in the lake elevation and a positive significant association between them was determined. Quadratic and Linear Trend models were used to determine the trend inclinations. According to the results obtained from the analysis, the watershed area shall have an increased vaporization of approximately 10 cm (100mm) until the year 2025, whereas according to the values foreseen by the United Nations for the earth in a century's time which are approximated as an increase of 1,4-5,8 °C, the increase has been concluded as 0,5 -5 °C. According to the Quadratic Trend model, the increase would be (140 mm), whereas according to the Linear Trend model there would be a decrease of 20 mm. As a result, it was estimated that according to both trend analysis carried out in order to determine the level changes of Iznik lake, the lake level shall decrease approximately 30 cm until the year 2025.

***Key words**: Iznik Lake, Level change, Trend analysis, Trends, Climate change*

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INTRODUCTION

Iznik Lake is a freshwater lake with a tectonic formation in Marmara Region; it is the largest lake in South Marmara Region as well as being the fifth largest natural lake in Turkey. The ellipse shaped lake in the Marmara Region was formed by the filling of a concave formation situated in the middle part of the Pamukova-Iznik-Gemlik Bay tectonic rift sequence which is one of the consecutively aligned east-west directed graben systems in the Marmara Region. Samanlı Dağları (mountain range) are located north of the lake while the southern side is occupied by Avdan Dağı (Mountain) (Figure 1). The lake area is 298 km^2. The length of the lake in the east-west direction is approximately 32 km while its widest part is 11,5 km. For the most part the lake is over 30 m in depth, making it one of the deepest lakes in Turkey. Off shore of the lake's southern part paralleling the shoreline is a graben continuing for 13 km. The deepest section of this graben which is situated at a depth of 60 m, is 65 m. The surface of the lake is 84 m above sea level. The base line of the lake varies between 20-25 meters (Darkot and Tuncel, 1981; Kayan, 1996).

In the present day, practically all climatologists accept the fact that the climate system of the earth is deteriorating. Since the beginning of the industrial revolution the burning of fossil based fuels, deforestation, changes in land use and greenhouse gases emitted into the atmosphere during industrial processes have increased rapidly. These facts have strengthened the natural greenhouse effect and together with urbanization have caused the surface temperatures of the earth to increase. The warming of surface temperatures which started towards the end of the 19th century has become more pronounced during the 1980's has lead with each passing year to record breaking global temperatures. The last temperature record was broken in 1998. From the point of both mean temperatures as well as mean north and south hemisphere temperatures on a global scale, 1998 was the hottest year since 1860 (Türkeş et al, 2000)

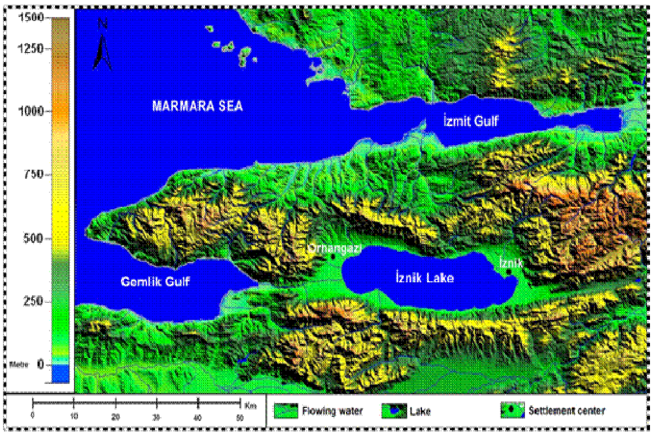

Figure 1 Site Location Map of Iznik Lake and its environs

According to the statement of Türkeş (2002), according to the 3rd Evaluation Report of Intergovernmental Panel on Climate Change (IPCC) which is an organization of the United Nations consisting of experts on the subject of global climate change and which was published in 2001, the mean global surface temperature has increased between 0,4-0,8 °C (approximately 0,6 °C) during the 20th century. According to the results obtained from developed climate models, IPCC's most recent report foresees an increase between 1,4-5,8 °C in global mean surface temperature during the 1990-2100 period (Türkeş, 2002)

According to the results of the Mann-Kendall trend test prepared for Turkey, changes have been observed in precipitation. There has been a major decrease in winter precipitation in the western provinces of Turkey during the past fifty years. On the other hand, the data provided by stations located in the northern parts of Central Anatolia in general show an increase in fall precipitation (First National Communication of Turkey on Climate Change, 2007).

Also, when the results of the Mann-Kendall trend analysis for temperature are examined, a significant increase in summer temperatures can be observed. Increases in summer temperatures can be observed mainly in the western and southern parts of Turkey. Winter temperatures in Turkey, on the other hand, are decreasing. The most significant decreases have been observed in shore stations (First National Communication of Turkey on Climate Change, 2007).

Being under the influence of a diversified climate structure in Turkey, climate change in Turkey is best reflected through changes in marshland levels. The scenario of the study was to discuss the association of elevation fluctuations occurring in Iznik Lake during the years 1975-2008 and climate fluctuations, deduce projections with the trends and determine the interactions.

The purpose of this study was to manifest the associations between elevation changes of Iznik Lake and climate elements and change trends. Iznik Lake, which is one of our lakes with a delicate balance in a world which is threatened by global warming as each day goes by, has been used as a sample. The area is under the influence of Marmara Transition Climate which is a deteriorated form of the Black Sea and Mediterranean Climates. Iznik Lake is in the position of being the most significant water source in its watershed and constitutes a major economic unit as a source for the area in agricultural irrigation, as a recreation area, for fishery production and fishing. Determining the reflections of global warming and its trends which have become the most critical problem nowadays on the lake as well as establishing their association statistically, and deducting projections for the future have gained importance. If this can be realized it can allow an opportunity for more intelligent usage and for carrying out works for the enhancement of sustainability.

MATERIAL AND METHOD

In this study, data pertaining to precipitation, temperatures and vaporization obtained from meteorological stations in Bursa, Iznik and Orhangazi as well as lake level measurements (DSI-State Hydraulic Works) were subjected to various analysis with statistical programs SPSS and Minitap in order to analyze their association. **Regression** and **Correlation** models were used to lay down the linear impressions and the associations between precipitation, temperature, vaporization and changes in lake level while **Quadratic and Linear** Trend models were used to forecast future estimates. Thus the significance associations between the climate and lake level changes and their tendencies were studied. The amount of precipitation falling into the watershed was mapped by utilizing surface (surface analysis) which is one of the interpolation methods. In addition, surface analysis was used again to produce a temperature map of the watershed in order to determine the changes in the mean temperature of the watershed in accordance with the morphology. The adjoint deviation method was used to determine climatic oscillations in the Iznik watershed.

RESULTS

The structural characteristics and Morphometry of Iznik Lake Watershed

The Iznik Lake Watershed consists of one of the graben areas on the Anatolian Peninsula in the Marmara Region. Basically it coincides with a part of the east-west directional fault lines and a section of the graben which is under sea water forming a bay surrounded from north to south reaching mountainous and plateau areas (similar to Izmit ve Gemlik bays). Some sections have becomes lakes, (like Sapanca, Iznik, Ulubat and Manyas lakes), others have become alluvial fill areas (such as Bursa, Yenişehir, Inegöl plains) (Akbulak, 2007).

According to research carried out by researchers such as Philippson (1917), Lahn (1948), Ardel (1949, 1953 and 1954), Tanoğlu and Erinç (1956), Bilgin (1967) Akartuna (1968) and Kayan, (1996, the graben area, which includes the study area, was formed as a result of faulting. On the other hand, Chaput (1976) determined that this area displayed a faulted structuring and that the strate had become very thin in places. More contemporary studies reveal the Iznik Depression as a watershed with pull-apart characteristics (Barka, 1992, 1997; Emre et al, 1997; Akbulak, 2007). Iznik Lake, which is the 5th largest lake in our country, covers a 302,2 km^2 area of the watershed bed.

Iznik Lake, İzmit- Sapanca and Gemlik-İznik-Pamukova gulleys have been formed on the blocks on top of collapsed earth crust along the western branches of North Anatolia Fault Zone. This formation begins from Middle Miocene age and continues today (Dewey-Şengör 1979). Later earth crust movements during the Pliocene age, on one hand, and changing climate conditions on the other, caused most of the lake watersheds to dry out (Kayan 1996). Continuing tectonic movements have caused the Gemlik-Iznik-Pamukova Pliocene gulley to change formation, different systems have been formed by latitudinal fragmentation. With the thresholds within the gulley, the graben is formed by Gemlik Bay in the west, Iznik Lake in the center and Pamukova in the east. Karsak threshold between Gemlik Bay and Iznik Lake and Karadin threshold between Iznik Lake and Pamukova separate these systems from one another (Figure 2). In addition, changes have occurred in the latitudinal profile of Gemlik-Iznik-Pamukova gulley during this period. Samanlı Dağları has twisted towards the north while Gürle-Avdan mountains have turned south. Thus the Iznik depression has been formed amongst the rising blocks due to the stress tectonics (Kayan, 1996).

The western shorelines of Iznik lake have an approximate north-south direction and circumscribe a wide concave circular arc to the west. With the exception of minor delta forming indentations and protrusions in the north, the shoreline is very smooth. The contours of Orhangazi plain situated west of this shoreline are approximately 7 km long in the shape of a triangle. The surface of the plain which narrows from the shores of Iznik lake westerly towards the Karsak strait inlet consists of geomorphological units formed by various impacts. Among the main ones are continental plains, alluvial fans on the southern shore and the plain floor which narrows westerly from the lake shore.

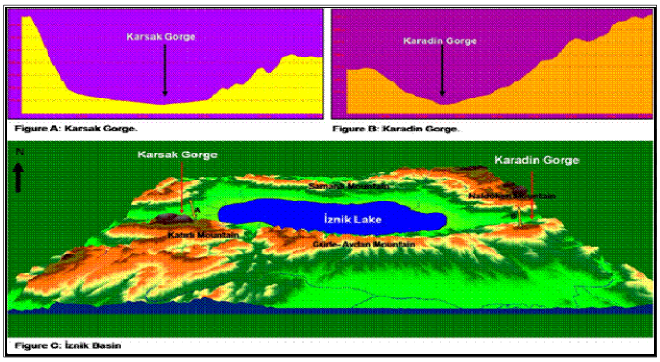

Figure 2 Topographical characteristics of Iznik lake and watershed

In the northwest of Orhangazi plain, sheer slopes ascend in the section which thrusts into the area between Gemlik bay of Samanlı Dağları and Iznik Lake. There sheer slopes can also be observed in the northerly facing sections of Avdan and Gürle Mountains on the southern section of the lake. Slightly sloping continental plains 1.5-2 km wide are observed in the forefront of these sheer slopes. The continental plains transcend to the plain base in the lake (Tanoğlu and Erinç, 1956).

Continental plains have been formed by the integration of deposit cones in front of the mountainous mass in the south and north of Orhangazi plain. The continental plain in the south is both steeper as well as wider (Kayan, 1996). The continental plain starts at 200 m, and reaches an approximate width of 3 km until the shores of Iznik Lake (Figure 3). It is stated that accumulation on these surfaces is active even today (İkeda et al, 1989). However, the presence of the fissure in the entrance of Karsak strait describes the fundamental formation of the continental plain as having taken place in the early Pliocene period while the formation due to alluvial accumulation continues to date (Kayan, 1996).

The continental plains of the plain base start at lake level (84 m) and continue to the starting level of the continental plain area which is 95-100m. However these transitions are ambiguous. The changes in the lake level and thus the changes in the shoreline have had a major role in the formation of the plain. Especially the gorge ploughed by Karsak stream in the southern part of the lake becomes deep towards the west. The waterfront west of the lake starts at 96 m and decreases sequentially 94, 92, 89, 88 and 87 m towards the lake and maintains its present day level (Figure 4)

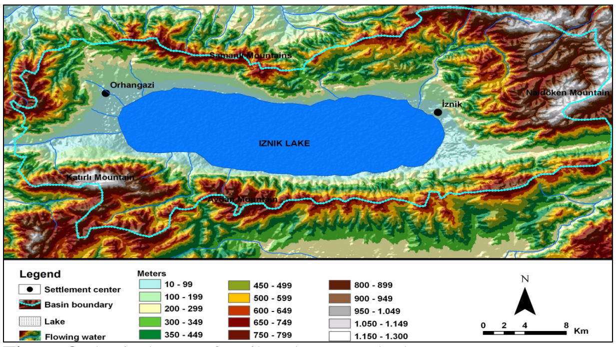

Figure 3 Physical Map of Iznik Lake Watershed

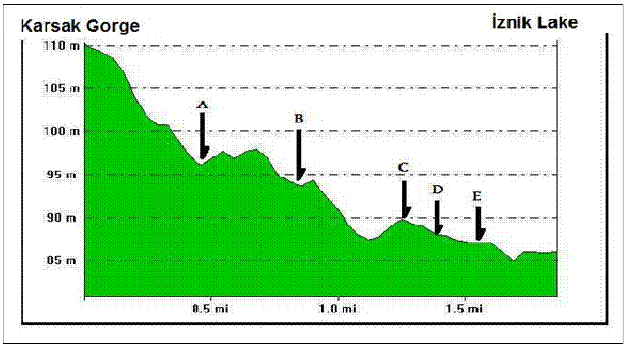

Figure 4 Traces belonging to the Pleistocene age level heights of the section from Karsak Strait to Iznik Lake correspond to the levels **A:** 96, **B:** 94, **C:** 89, **D:** 88, **E:** 87 m (Kayan, 1996, has been drawn as a reference).

The catchment area of Iznik Lake is 1.246 km^2. The major tributaries carrying water to the lake are Karadere in the northeast and Sölöz Stream known by the name of Kocadere flowing into the southwest section. Other than these sources, the lake is supplemented by karstic sources in the bottom and rainwater. Karsak Stream empties its excessive waters into Gemlik Bay. Actually Karsak Stream does not directly exit from Iznik Lake; it is formed by water seeping through a gravel and sand barrier which is a few meters high and located in the southwest of the lake. Iznik Lake was declared a conservation area in 1990. The lake is surrounded by expansive agricultural areas and olive orchards. The lake is exploited in order to irrigate agricultural areas and this is one of the major reasons for the ebbing of the lake water in the summer. In addition, the lake is used for fishing, potable and domestic water and recreational purposes.

3.1. Statistical Analysis of Climate and Lake Level Changes

The climate of Iznik Lake watersheds corresponds to the climate type described as Marmara Transitional Climate. Although Marmara transitional climate has similarities to both the Mediterranean Climate as well as the Black Sea climate there are major differences. Mean Annual precipitation level in the watershed vary between 460 mm and 830 mm. However, depending upon exposure, the northerly slopes of Katırlı and Avdan mountains south of the lake receive more precipitation. Dependent upon the increasing elevation, the annual precipitation amount received by the summit section of Avdan and Katırlı mountains verges 800 mm. The distribution of the precipition in the watershed has been determined with surface analysis (Figure 5). It is distinctive that the water is collected during winter and spring seasons within the year while insufficient or scarcity of precipitation prevails during the summer months. In addition to the lack of precipitation in summer, increasing temperatures and vaporization contribute to drought.

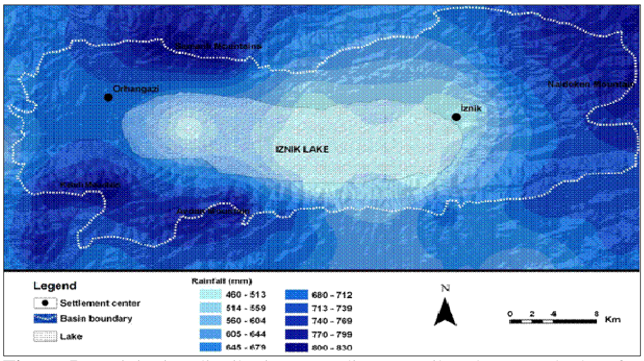

Figure 5 Precipitation distribution according to Iznik Lake watershed surface analysis.

When the yearly precipitation changes in the watershed were studied it was evidenced that precipitation from 1975 until 1981 had been stable while there had been a fluctuating decrease in precipitation during the period from 1981 until 2007. The deviations can be seen as negative from average (Figure 6).

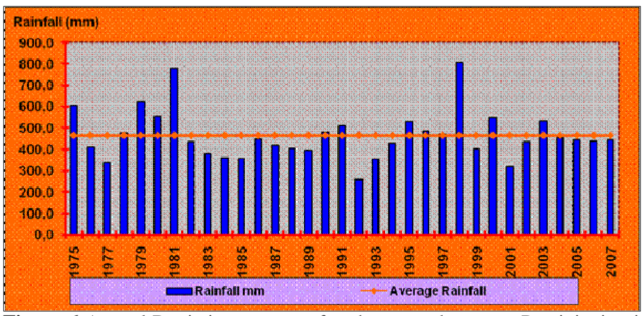

Figure 6 Annual Deviation amounts for change and average Precipitation in Iznik.

According to the meteorology stations in the watershed area and its vicinity, the annual longitudinal mean temperature in Iznik is 14,5 ºC and 14,1 ºC in Orhangazi. The mean annual temperature in Gemlik, which is further west, is 15,8 ºC while the temperature in southerly Bursa is 14,5 ºC.

These values are for the flat floor sections of the watershed. The temperatures in the watershed area towards the northern and southern mountain summits decrease in relation with elevation and exposure. A study of the mean annual temperature changes revealed a general increase of 0,5 ºC between the years 1975 to 2007. When annual maximum temperature trends were studied, a serious increase could be observed especially for the period 1991 to 2007. According to Iznik meteorology data the maximum annual temperature in 1991 which was 26,5 ºC had increased to 31 ºC in 2007. Although major changes have not occurred for minimum temperatures, a decreasing trend which had been observed during the severe winter of 1983 started to increase once more from 1987 onwards (Figure 7). A study of the distribution of temperatures in the watershed area reveals that according to surface analysis, the floor area has a high temperature while dependent upon elevation, the high sections of the mountains have a decreased temperature. Accordingly, the annual mean temperature of 14,5 ºC in the low continental plains around the lake area, decrease on an average of 0,5 ºC per 100 meters and drops down to 10 ºC in the high sections of Avdan, Katırlı and Samanlı Dağları (Figure 8).

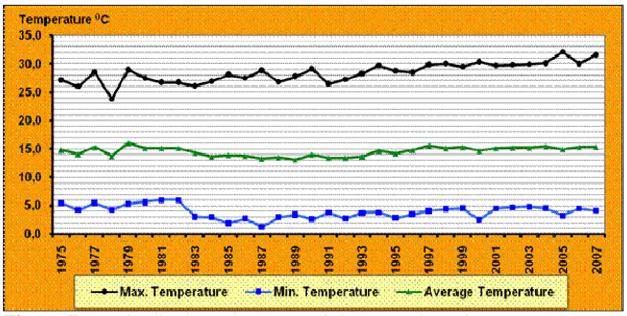

Figure 7 Longitudinal yearly mean, minimum and maximum temperature changes in Iznik.

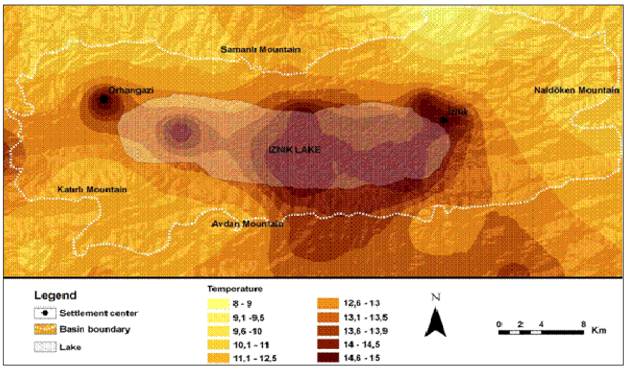

Figure 8 The distribution of mean temperatures in Iznik Lake Watershed according to surface analysis

When adjoint deviation method was applied to Iznik Lake watershed area, it was observed that drought had been experienced during the period 1975-1977, while a humid period had been experienced during the period 1977 to 1981. The period from 1981 to 1989 had been especially arid; during the next two years humidity had increased and after 1991 the impact of an arid period returned and continued until 1994. After this date and until 1998, a humid period prevailed, the period from 1998 until 2000 was stable and the impact of an arid period re-emerged during the 8 years from the year 2000 onwards (Figure 9).

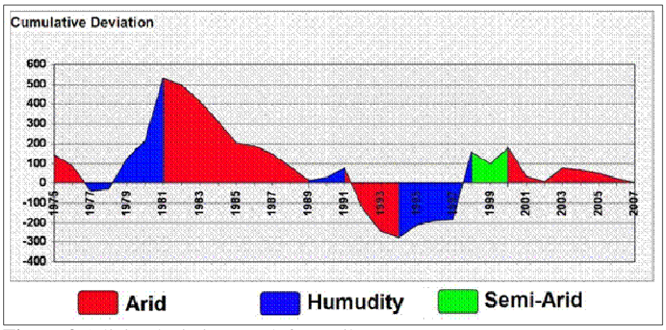

Figure 9 Adjoint deviation graph for Iznik.

Statistical Analysis and Results

Statistical analysis regarding the temperature, vaporization, precipitation and lake levels of Iznik lake and its watershed have been carried out. First of all a correlation analysis was carried out in order to lay down the internal correlation of each data. Statistically an insignificant negative association was discovered between temperature and vaporization. There is a positive significant association between vaporization and lake level as well as between precipitation and temperature. The fact that there is a positive significant association between temperature and lake level means that when temperature increases the lake level will decrease.

According to the regression analysis carried out for the watershed area, there is a positive significant association between temperature and vaporization. Apparently an increase of 1 mm in precipitations corresponds to an increase of 0,6 mm in lake level. Climatologically the conception of increasing precipitation during periods of increased temperature is insignificant. Increase in temperature corresponds to a decrease in lake level and a positive significant association between temperature and lake level were established. A positive significant association between temperature and vaporization were established and this is verified by the forecast of increased vaporization in line with increased temperature bringing the significance level of the association up to 96%. It can be anticipated that depending upon the increased vaporization on the lake surface, the formation of orographic precipitation is supported by the horizontal motion of hot air ascending in the mountainous area in the vicinity. Thus a contribution to explaining the increase in precipitation can be obtained by the altitudes of the mountainous areas surrounding the lake.

Linear and Quadratic trend models were used to study and also to predict future trends for the change and trend patterns of the watershed area. The aim of using both methods was to achieve the most appropriate values and significance levels over 90% as a result of accuracy estimates. Thus it was possible to determine temperature, precipitation and vaporization changes and trends of the climate elements according to the study areas for relevant years. In addition, the changes and trends in lake level were determined and projections for the future were made. As a result of the procedures carried out, the future reflections of climate elements and lake level associations were determined.

Out of the Quadratic and Linear Trend Models applied for vaporization values of Iznik Lake and its close vicinity the analysis results for the Quadratic Model which turned out a significance and accuracy percentage exceeding 90% were assessed. According to the Quadratic Trend analysis the vaporization in the watershed area fluctuated between the years 1975 and 2008, however, it is significant that the trend has been increasing after 1990. It has been determined that in future, especially after the period following 25th Index value (2208), the vaporization shall continue to increase. An increase of 20 cm (100 mm) in vaporization is foreseen (Figure 10).

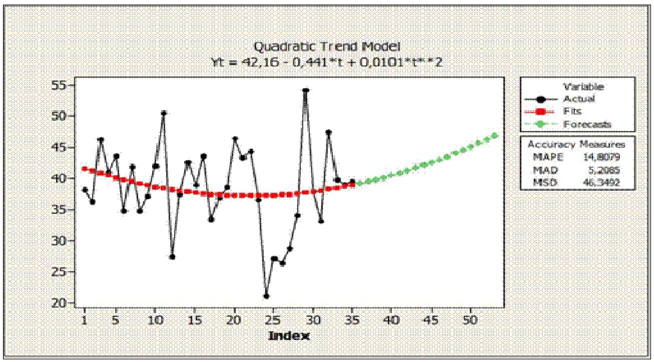

Figure 10 Vaporization trend analysis for Iznik in accordance with Quadratic Trend Model.

A study of the temperature analysis results for Iznik Lake and watershed area show that global warming will be reflected in the region. The results of the analysis support the United Nations global climate change analysis forecasting a 1,4-5,8 °C temperature increase during the 1990-2100 period. According to the Quadratic and Linear Trend models applied on Iznik Lake watershed area, major increases in temperature will continue steadily, especially after the year 2000, and this rapid increase is foreseen to continue until the year 2025. According to the Quadratic Trend model, the increase of the temperature which began after 1990 in the watershed continued to increase slowly until 2008. After 2008, the tendency to increase became more pronounced and it was estimated that the temperature of 16°C would reach 21°C by the year 2025 and that the approximate increase in temperature would be around 5 °C (Figure 11). Although the realization of this increase in a climatic sense seems improbable, there is a strong possibility that the trend increase might realize.

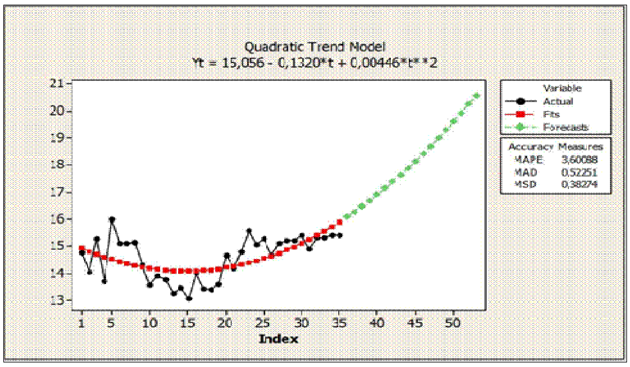

Figure 11 Temperature trend of Iznik Lake Watershed Area in accordance with Quadratic Trend model

According to the Linear Trend model the temperature shall increase on a steady and continuous basis. It has been determined that especially during the period from 2008 until 2025, the temperature will continue to increase until it reaches an average increase of around 0,5°C in 2025. The fact that the change trend is increasing and regular as well as the foreseen 0,5°C increase show that the results of the Linear Trend model are more plausible (Figure 12).

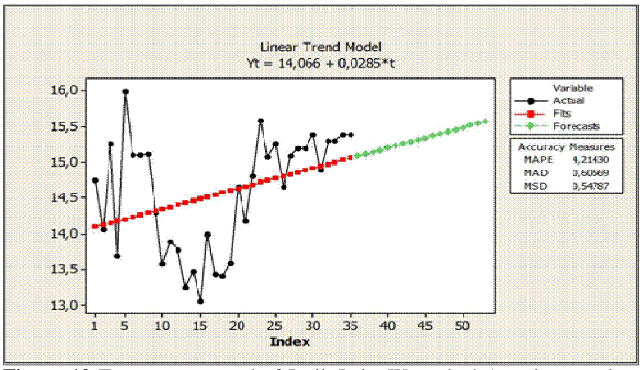

Figure 12 Temperature trend of Iznik Lake Watershed Area in accordance with Linear Trend model.

According to a study of the Quadratic trend analysis results carried out for precipitation, it was concluded that there will be a major increase in precipitation in the Iznik Lake watershed area. It is depicted that this increase will be around 140 mm and match the 1975 ratio (Figure 13). The results of this analysis and trend foreseeing the increase in precipitation made us contemplate whether this was due to the precipitation regime of the area being within the Black Sea precipitation regime. Previous analysis results carried out had determined that trends within the Black Sea precipitation regime had a strong possibility of increasing (Cengiz et al, 2006).

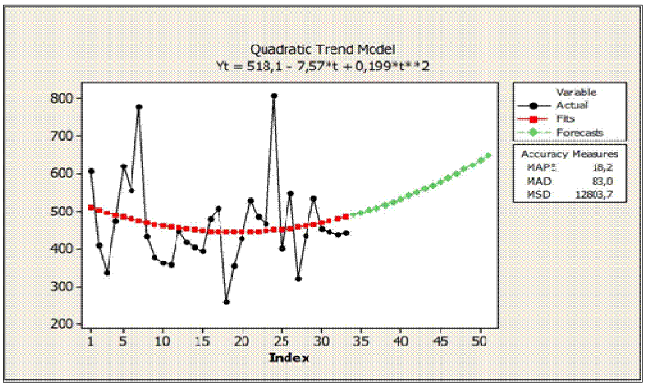

Figure 13 Precipitation trend of Iznik Lake Watershed Area in accordance with Quadratic Trend model

On the other hand, according to the Linear Trend model, it has been concluded that there will be a decrease in precipitation in the watershed area. According to the method there is a general trend of decreased precipitation and the continuation of this trend is foreseen in the future. The precipitation is expected to decrease approximately 20 mm in the period between 2008 and 2025.

The major indicators of global warming being increased temperature and vaporization contribute to the activation of exsiccation and together with the decrease in precipitation are manifested as deteriorating the balance of the natural environment. As a result of analysis applied in the region, both methods reveal an upward trend for temperature and vaporization. As for precipitation, according to the Quadratic Trend model there will be increase, whereas the Linear Trend model manifests a decreasing trend. Lake level change analysis was carried out in order to manifest how these changes and trends regarding climate elements and trends will reflect on the lake level trends and future situation contingencies.

It is not possible to explain the changes in lake level solely with climate changes. The impact has contributions from numerous variables such as alimentation in the lake, precipitation in the watershed area, sources, tributaries, underground waters and melting snow. Water loss is dependent upon the impact of variables such as usage, irrigation, outlets and vaporization. For this reason it is not feasible to attribute changes in lake level solely to climate changes. That is why only change trends between lake level changes and change trends between climate elements and their associations shall be emphasized.

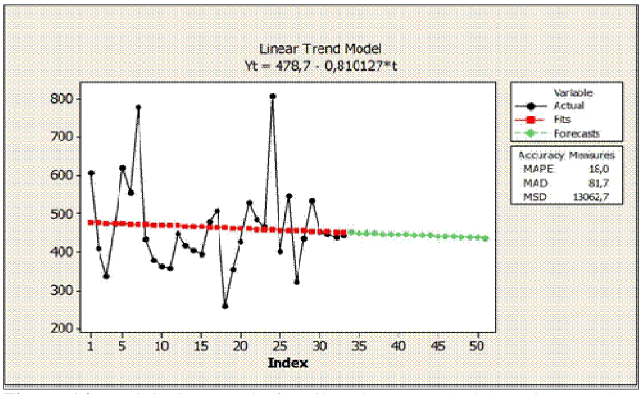

Figure 14 Precipitation trend of Iznik Lake Watershed Area in accordance with Linear Trend model.

İznik Gölü seviye değişimleri ve trend eğilimini belirlemek için kullanılan Quadratic Trend analizine göre göl seviyesi değişimleri 1955'den 2008 yılına kadar düzenli olarak azalmış ve azalma eğiliminin 2025 yılına kadar devam edeceği ve yaklaşık olarak azalma miktarının 30 cm olacağı tahmin edilmiştir (Figure 15). On the other hand, according to the Linear Trend model, it has been determined that the decrease has been regular and continues over the years. According to Linear Trend analysis results the lake level shall descend 30 cm during the 2008-2025 period (Figure 16). Increase in temperature and vaporization, interventions on the sources supplementing the lake and water usage contribute to the impact of this decrease trend. However, the basic trend is that the ongoing climate exsiccation and decrease in lake level will prevail for many years.

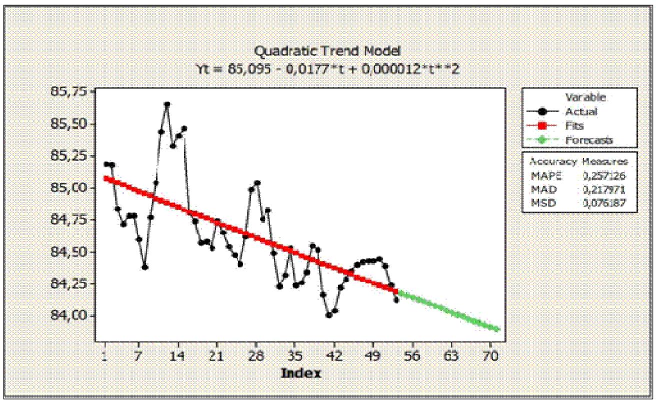

Figure 15 Level trend of Iznik Lake according to Quadratic Trend model.

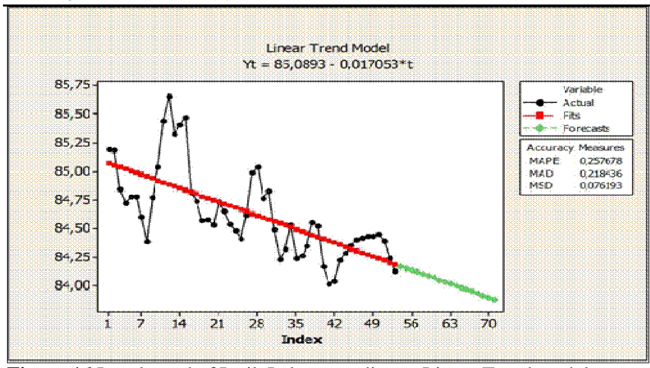

Figure 16 Level trend of Iznik Lake according to Linear Trend model.

DISCUSSION

Because of its geographical characteristics and its potential, Iznik Lake is one the most important lakes in our country. That is why its formation has been the subject of numerous studies. The subject of this study was the association between level changes of Iznik Lake and climate elements.

A correlation analysis between Iznik Lake level changes and trends and each temperature, vaporization and precipitation data was carried out. Statistically a negatively insignificant association was established between temperature and vaporization. On the other hand, a positively significant association was established between vaporization and the lake level, precipitation and temperature. The fact that a positive association was determined between temperature and lake level means that the lake level will decrease when temperature rises.

According to the regression analysis, a positive association was determined between precipitation, temperature and vaporization and lake level. An increase of 1 mm in precipitation supports an increase of 0,6 mm in lake level; increase in temperature parallels vaporization and decrease trends in lake level. When other variables are not taken into consideration (usage, changes in lake water input), it is evident that lake level changes exactly correspond with climate element changes.

Review of the trends analysis reveals an increase in vaporization and this increase is foreseen to realize around 10 cm (100 mm). Temperature forecasts support the global increase of 1,4-5,8 °C predicted by the United Nations. Results determined by the Quadratic Trend model and Linear Trend models were increases of 5°C and 0,5 °C respectively. This increase in temperature supports the increase and trend for vaporization. According to the Quadratic Trend model, a study of the change trend in precipitation results in an increase of 140 mm. Although an increase of this degree in the region is possible, it seems unlikely from a climatological point. According to the Linear Trend model, a decrease close to 20 mm in precipitation amounts is foreseen for the watershed area. According to both models, a decrease of 30 cm is foreseen for the lake level in 2025. When considering these analyses independently from the other variables, they parallel the climate changes and trends as well as lake level changes and trends. In addition, the exsiccation trend of the climate plays an important role in the ebbing of the lake level. It is foreseen that the trends in the region will parallel global warming and probable impact shall be more pronounced towards 2025 (Table 1).

Table 1 Trend analysis results for Iznik Lake watershed area

Years	Quadratic-Vaporization	Quadratic-Temperature	Linear-Temperature	Quadratic-Precipitation	Linear-Precipitation	Quadratic-Lake Level	Linear- Lake Level
2008	39,31	16,08	15,09	490,56	451,14	84,17	84,17
2009	39,60	16,28	15,12	496,70	450,33	84,16	84,15
2010	39,92	16,48	15,15	503,25	449,52	84,14	84,13
2011	40,25	16,69	15,18	510,19	448,71	84,13	84,12
2012	40,60	16,91	15,21	517,53	447,90	84,11	84,10
2013	40,98	17,14	15,24	525,26	447,09	84,09	84,08
2014	41,37	17,38	15,26	533,40	446,28	84,08	84,07
2015	41,78	17,62	15,29	541,93	445,47	84,06	84,05
2016	42,21	17,88	15,32	550,85	444,66	84,04	84,03
2017	42,67	18,15	15,35	560,18	443,85	84,03	84,02
2018	43,14	18,42	15,38	569,90	443,04	84,01	84,00
2019	43,64	18,70	15,41	580,02	442,23	83,99	83,98
2020	44,15	18,99	15,44	590,54	441,42	83,98	83,96
2021	44,68	19,29	15,46	601,45	440,61	83,96	83,95
2022	45,24	19,60	15,49	612,77	439,80	83,95	83,93
2023	45,81	19,92	15,52	624,48	438,99	83,93	83,91
2024	46,41	20,25	15,55	636,59	438,18	83,91	83,90
2025	47,02	20,59	15,58	649,09	437,37	83,90	83,88

CONCLUSION

From an ecological point the local scale reflection of global climate change and its reflections, forecasts and trends which are among the major problems of the world in the 21st century, have a major impact for Turkey.

This study focused on carrying out a statistical analysis of lake level changes and climate associations for Iznik Lake which is located on the graben part of the Anatolian Peninsula in Marmara Region and which is under the influence of the Marmara Transition Climate.

A study of the changes in the watershed area climate and trends reveals that exsiccation prevails. Increase in temperature has caused an increase in vaporization. According to surface analysis results, precipitation in the watershed floor and lowlands is limited while the temperature is high.

Statistical analyses were carried out in order to determine the level changes of Iznik Lake and the watershed area climate change. Correlation and regression analysis between the climate elements and lake level changes were carried out and positive significant associations were determined.

Quadratic and Linear Trend models were used to determine trends. According to the results of the analyses, it has been determined that vaporization in the watershed area will increase approximately 10 cm (100 mm) by the year 2025, while the foreseen temperature increase of 0,5 -5 °C is close to the increase of 1,4-5,8 °C which have been predicted for the world by the United Nations for the century. According to the Quadratic model there will be an increase in precipitation (140 mm) whereas according to the Linear Trend model there will be a decrease of 20 mm.

According to results obtained for both trend analyses carried out for level change of Iznik lake, it has been estimated that there will be a decrease of approximately 30 cm in the lake level by the year 2025. From the analyses results it has been concluded that there is a close association between climate elements and lake level changes and trends. It has been established that changes in the watershed area closely parallel global warming and serious repercussions are expected after 2025.

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