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Analysis of Climatic Parameters of Tunceli-Bingol and Mus Provinces with Meteorological Data

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Abstract

In this study, climatic parameters such as pressure, temperature, humidity, wind speed, solar radiation and sunshine duration of Tunceli, Bingol and Mus provinces in Eastern Anatolia region were examined and modeled within the scope of a 15-year observation period. Linear regression analysis was used for modeling of the climatic parameters. The following issues have been identified with the use of the determined models: i) It can help the studies to be carried out on the effects of climate conditions within the scope of the environment and energy. ii) For the coming years, the forecasts for the provinces in question can be made. iii) Solar energy has come to the forefront as an alternative energy potential for the provinces analyzed.

Keywords: Meteorological data, Climatic parameters, Tunceli, Bingol, Mus.

Tunceli-Bingöl ve Muş İllerinin Meteorolojik Verilerle İklim Parametrelerinin Analizi

Özet

Bu çalışmada, Doğu Anadolu bölgesinde bulunan Tunceli, Bingöl ve Muş illerinin, basınç, sıcaklık, nem, rüzgar hızı, güneşlenme şiddeti ve güneşlenme müddeti gibi iklim parametrelerini 15 yıllık bir rasat süreci için incelendi ve modelleme yapıldı. İklim parametreleri modellemesinde lineer regresyon analizi kullanıldı. Belirlenen modellerin kullanımı ile i) iklim şartlarının çevre ve enerji üzerindeki etkileri konusunda yapılacak çalışmalara yardımcı olabileceği, ii) gelecek yıllar için söz konusu illerin iklim yapıları ile ilgili tahminlerinin yapılabileceği, iii) incelenen iller için alternatif enerji potansiyeli olarak güneş enerjisinin ön plana çıktığı belirlendi.

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Anahtar Kelimeler: *Meteorolojik veri, Klimatik parametreler, Tunceli, Bingöl, Muş.*

Nomenclature

P	hPa]	Pressure
T	[^{o}C]	Temperature
RH	[%]	Relative Humidity
WS	[m/s]	Wind speed
SD	[h]	Sunshine duration
SI	[cal/cm^2]	Solar radiation
Y	-	Year

1. Introduction

Energy is one of the important factors in the social and economic development of societies. Various forms of energy, especially new and renewable forms of energy, utilize climate conditions as a data source. It is necessary to examine the meteorological data related to the climate in order to determine and develop the energy potential and problems of the settlements today and in the near future, while also offering solutions to their problems. Climate data has gained importance in energy analysis carried out within the scope of heating buildings by architectural means, installation of cooling facilities and planning of agricultural production (Bakirci et al, 2006).

Many studies have been carried out on the climatic parameters both around the globe and in our country. In most of these studies, empirical relations related to air parameters have been developed. Some of these studies are summarized below.

Bakirci et al. (2006) used the meteorology data of Erzurum in energy related studies of the province. Cobanyilmaz and Yuksel (2013) investigated the damage of climate change to settlements and examined the case study of Ankara. Donmez (1984) investigated the general climate structures of the cities. General Directorate of Meteorology -Department of Climatology settled the climate classification structure of Turkey (MGM, 2017). Geymen and Dirican (2016) investigated changes in sea level caused by climate change. Apple et al. (2006) and Sen (1999) made weather forecasting models using meteorological data. Bicer (2019) developed the temperature and humidity models of some provinces in the Euphrates Basin using meteorological data. Yesilata et al. (2004) investigated the effect of dam lakes in the GAP Region on temperature and humidity changes in the provinces of the region. Bacanli and Tugrul (2016) investigated the effect of Governor Recep Yazıcıoğlu Gökpınar Dam Lake on the local climate. Emiroglu et al. (1996), Tonbul (1986) and Kadioglu (1994) investigated the effects of Keban Dam Lake, on the climate of Elazig province, in their

separate studies. Bicer and Yildiz (1994) investigated the effects of Atatürk Dam Lake on Sanliurfa province outdoor temperature parameter.

In this study, using the 15-year meteorological data, the climate structures of Tunceli, Bingol and Mus provinces located in the west of Elazig, Bingol, Mus, Van depression area of Eastern Anatolia Region were examined (Figure 1). Modeling was done using linear regression analysis for the parameters of the provinces examined such as pressure, temperature, humidity, wind speed, sunshine intensity and sunshine duration. Using these models, it will be possible to find the estimated values of the weather parameters of the provinces in the coming years and the trend of change according to the years and the effects of weather conditions on the environment, while also having the ability to analyze & explain the energy details.

Fig. 1. Location of provinces in the East Anatolia Region of Turkey

2. Material and Methods

Monthly and annual meteorological measurement results of Tunceli, Bingol and Mus provinces as examined in this study were obtained from the General Directorate of State Meteorological Affairs (MGM) and modeled for each of the following air parameters by years

2.1. Pressure

In the 15-year observation process (2005-2019) of the provinces within the scope of the study, the pressure parameter measurement results are shown by years, and the modeling of the change can be seen in Figure 2. Examining this figure, the annual average pressure values for the observation process variance can be seen between 903.1-904.6 hPa for Tunceli, 885.6-888.8 hPa for Bingol and

868.1-870.9 hPa for Mus on a provincial basis. It was observed that this parameter of the provinces remained almost constant during the observation period.

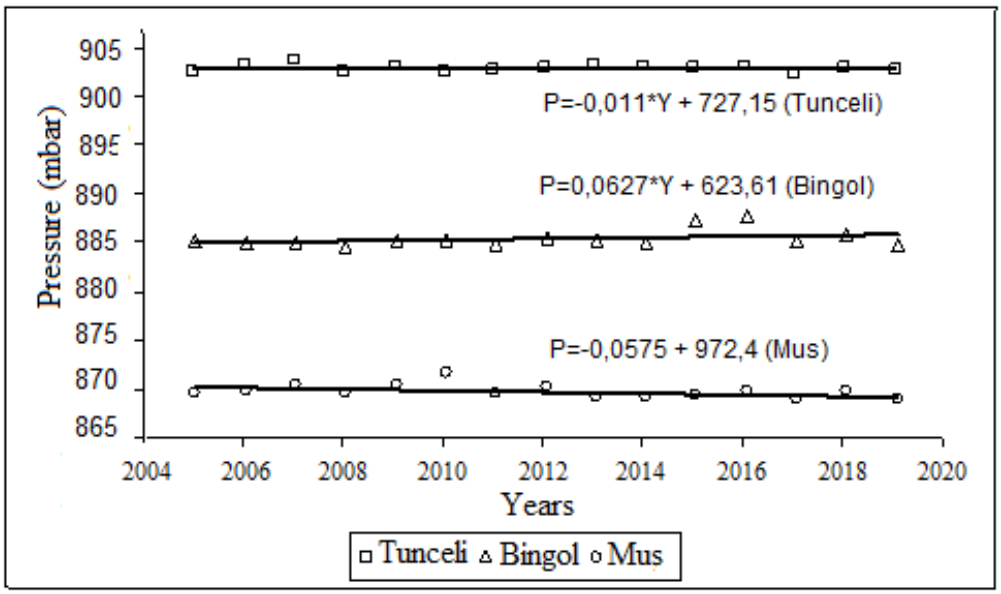

Fig. 2. Change of pressure parameters of provinces by years

2.2. Temperature

The change of the temperature parameter for the determined observation process of the provinces by years can be seen in Figure 3. The temperature equations of the provinces have revealed the increase in temperature and have been decisive for the coming years. As seen in the figure, annual average temperature values varied between 10.2-14.2 °C for Tunceli, 9.5-13.5 °C for Bingol and 6.6-12.0 °C for Mus. It is observed that the slopes, which consist of annual average temperature values, are in an increase, albeit very small.

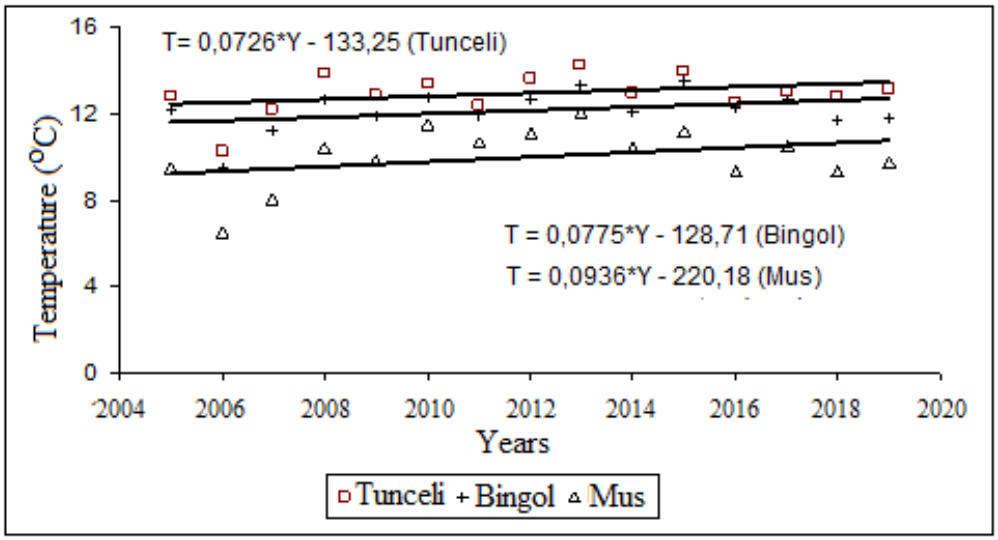

Fig. 3. Change of temperature parameters of provinces by years

2.3. Relative Humidity

The modeling of the annual average humidity parameters of the three is shown in Figure 4 and the humidity difference between the provinces has been revealed and the change in the humidity parameter has been formulated according to the years. As can be seen in the figure, annual average humidity values varied between 51-67 % for Tunceli, 50-61 % for Bingol and 58-68 % for Mus on a provincial basis.

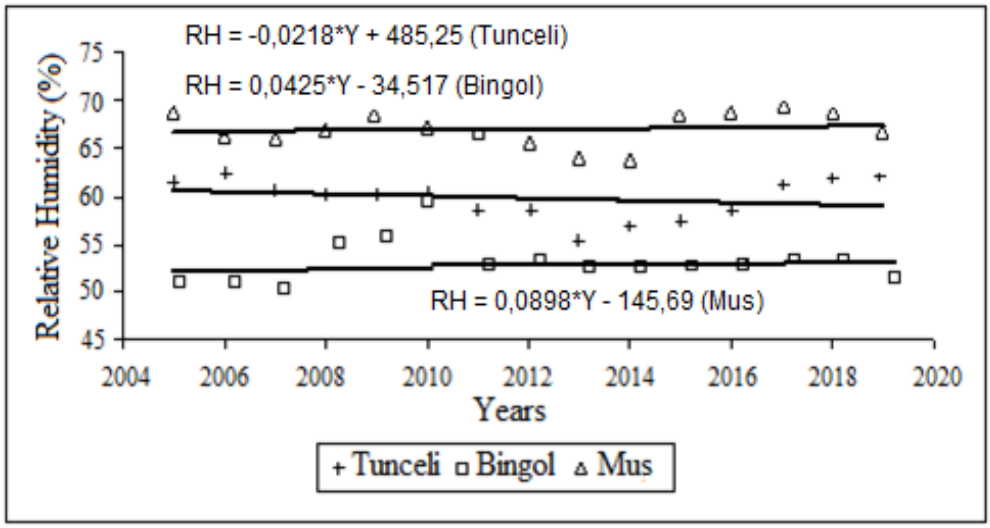

Fig. 4. Change of humidity parameters of provinces by years

2.4. Wind Speed

Wind speed parameter was modeled for the observation process of the provinces within the scope of the study and can be seen in Figure 5. The equations obtained for the change of wind parameters by years will give an idea about the wind potential of the provinces both for the present time and future years. Examining Figure 5, it can be seen that the annual average wind values in the mentioned observation process varied between 1.3-1.6 m/s for Tunceli, 0.8-1.5 m/s for Bingol and 0.9-1.5 m/s. for Mus, on a provincial basis.

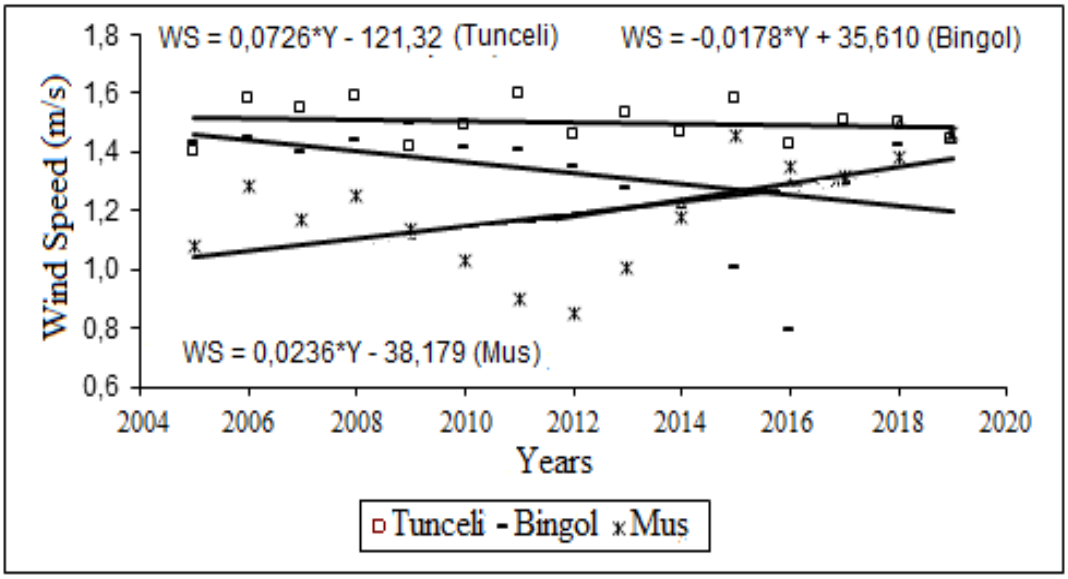

Fig. 5. Change of wind speed parameters of provinces by years

2.5. Sunshine Duration

The sunshine duration parameter change in the observation process of the provinces can be seen in Figure 6, and the sunshine parameter modeling for the three provinces was carried out by years. The equations found give an idea about the sunshine duration of the provinces in the following years. As can be seen in the figure, annual average sunshine duration values in the observation process varies between 6.9-7.9 h/day for Tunceli, 6.2-7.5 h/day for Bingol and 6.3-8.3 h/day for Mus.

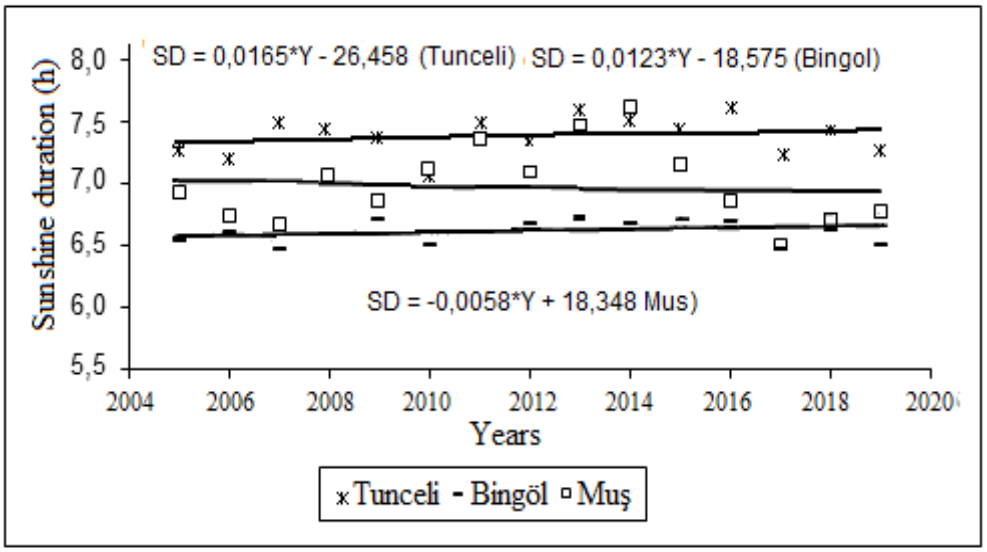

Fig. 6. Change of sunshine duration parameters of provinces by years

2.6. Solar Radiation

The average annual solar radiation of the provinces can be seen in Figure 7 and the difference between the provinces is revealed through modeling by years. The sunshine equations obtained will determine the solar energy potential of the provinces in the coming years. Examining the figure, the annual average solar radiation values vary between 366.45-407.98 cal/cm^2 for Tunceli, 345.46-423.77 cal/cm^2 for Bingol, and 284.02-372.63 cal/cm^2 for Mus.

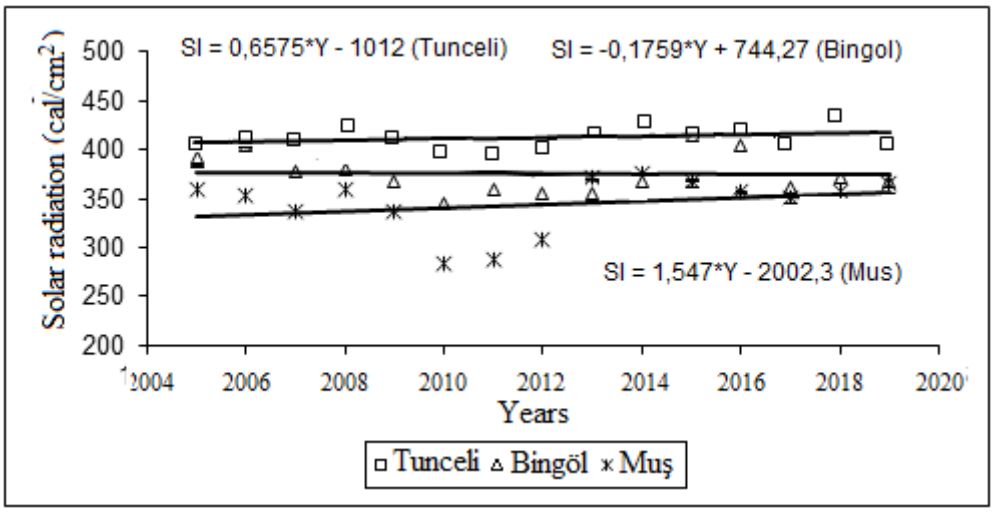

Fig. 7. Change of solar radiation parameters of provinces by years

3. Results and Discussion

Tunceli, Bingol and Mus provinces have been modeled and analyzed with a linear regression method for a 15-year period. With these models, which are shown collectively in Table 1, it will be possible to forecast the weather conditions, sunshine intensity and wind power values of the provinces in the coming years and the effects of weather conditions on the environment and energy.

Table 1. Regression equations of climate parameters of provinces

Climate parameters	Tunceli	Bingol	Mus
Pressure	P = -0,011*Y + 727,15	P= 0,0627*Y + 623,61	P = -0,0575*Y + 972,4
Temperature	T = 0,0726*Y - 133,25	T = 0,0775*Y - 128,71	T = 0,0936*Y - 220,18
Relative humidity	RH = -0,218*Y+485,25	RH = 0,0425*Y - 34,517	RH = 0,0898*Y-145,69
Wind speed	WS = 0,0726*Y - 121,32	WS = -0,0178*Y + 35,61	WS = 0,0236*Y - 38,179
Sunshine duration	SD = 0,0165*Y - 26,458	SD = 0,0123*Y - 18,575	SD = -0,0028*Y+ 18,348
Solar radiation	SI = 0,6575*Y - 1010	SI = -0,1759*Y+ 744,27	SI = 1,547*Y - 2002,3

While there is no significant change in the pressure parameter during the determined observation period of the three provinces examined, there is a slight increase in the temperature parameter. Despite this increase in temperature, relative humidity decreases in Tunceli province, while a significant change is observed in Bingol and Mus provinces. While the sunshine duration of Tunceli and Bingol provinces increased slightly, there was no significant change for Muş province. While Tunceli and Mus show an increasing trend for solar radiation, there is no significant change for Bingöl province. While Tunceli and Mus have an increasing trend with regards to the wind speed parameter, there is a decreasing trend for the Bingol province.

Examining the solar radiation, sunshine duration and temperature parameters of the provinces for both monthly and 15-year observation period, it can be seen that Tunceli is particularly suitable for studies and applications to determine the solar energy potential of the region (Figure 8, Figure 9 and Figure 10). It is also possible to use solar energy resources to be designed in accordance with the conditions for all three provinces examined. As well as using solar energy in hot water supply, energy saving can be offered by using solar energy in order to obtain the necessary cooling for both air conditioning and foodstuffs and medicines to be stored intact. Apart from these, it will be possible to utilize solar energy as an energy source for technical dryers in drying wet food products to be produced in the provinces

In the studies of determining the wind energy potential of the provinces, it was observed that the annual average wind speed values in three provinces were below 1.6 m / s (Fig 5). These figures show that in provinces with a suitable land structure in terms of agriculture and animal husbandry,

wind energy can be used for pumping water or for the electricity need of a small house. In addition, these values may also be sufficient for certain amount of power generation and mechanical applications (such as battery charging).

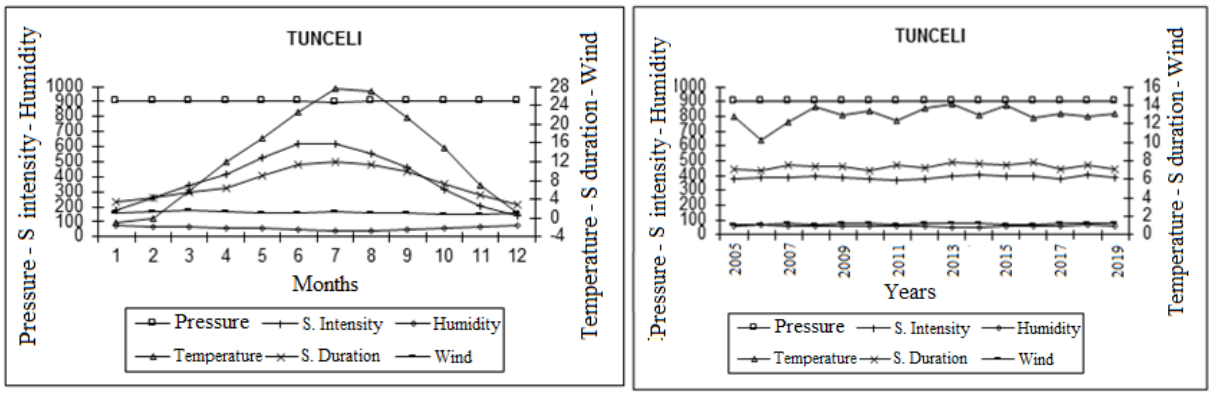

Fig. 8. Monthly and yearly change of weather parameters of Tunceli province

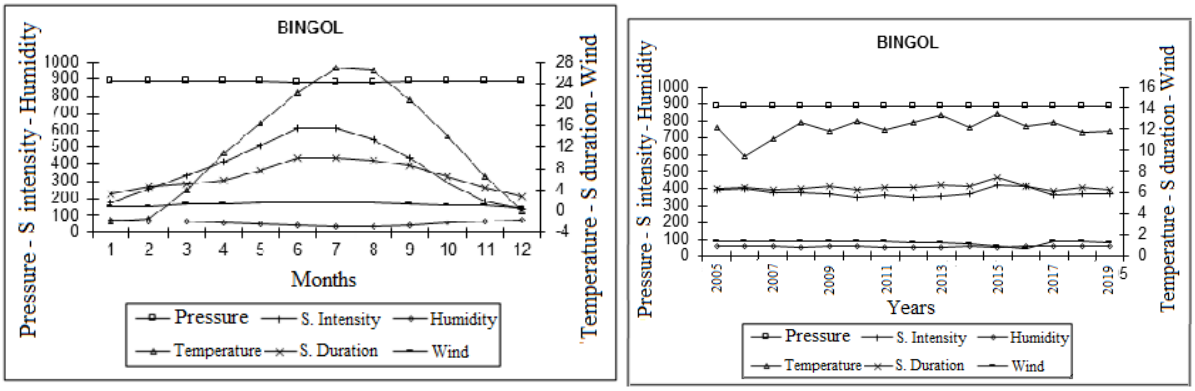

Fig. 9. Monthly and yearly change of weather parameters of Bingol province

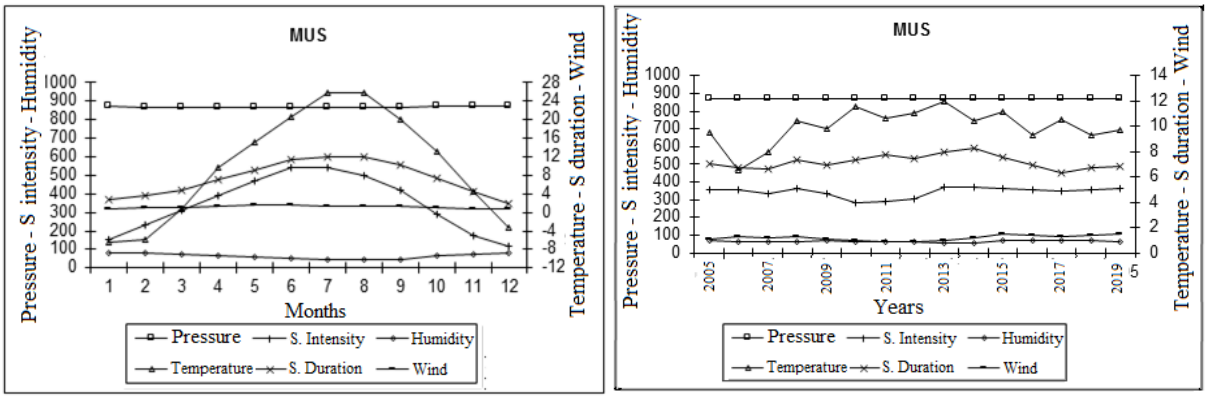

Fig. 10. Monthly and yearly change of weather parameters of Mus province

4. Conclusions

The following results were obtained in this study, which was carried out using 15-year meteorological data for the provinces of Tunceli, Bingol and Mus in the Eastern Anatolia Region.

- ✓ The need for energy is directly related to climate and air. It is necessary to know and analyze the climatic and meteorological data in all details in order to determine the energy potential and problems of both the past and present time, and to carry out studies to improve them.
- ✓ It will be possible to find the weather values of the provinces studied, the estimated values of the weather parameters in the coming years and the trend of change by years.
- ✓ While the temperature and solar radiation increased in the region, there was no significant increase in other parameters.
- ✓ Considering the temperature, sunshine duration and solar radiation parameters for all three provinces as an alternative energy source, the use of solar energy comes to the forefront. Therefore, hot water production in the region will be able to used solar energy to provide the energy to be utilized for drying agricultural products in technical dryers.
- ✓ It has been understood that all three provinces are weak in terms of wind energy, so investments with high financial aspects will not be attractive for these provinces.
- ✓ It will be possible to reduce not only the construction, but also the energy costs thanks to the planning of heating systems which will be designed through the novel outdoor temperature parameters to be kept up to date.

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