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Winter Season Analysis of Global Warming Impact on Sivas Province

Mustafa ERTURK [1*], ***Kenan BALCI*** [2], ***Can COSKUN*** [3]

[1] *Balıkesir University, Balıkesir Vocational School, Department of Electricity and Energy, Balıkesir, TURKEY*

[2] *Recep Tayyip Erdoğan University, Turgut Kıran Maritime Faculty, Rize, TURKEY*

[3] *İzmir Democracy University, Faculty of Engineering, Mechanical Engineering Department, İzmir, TURKEY*

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Abstract. The climate has undergone various levels of change since the existence of the Earth. With the industrial Resolution, humankind has begun to be influential in climate change. Industrial revolution lead to unsteady greenhouse gases emissions that led to the global warming and consequent climate change impacts at different scales in various regions of the world. Accordingly, the seasonal periods started to change especially for seasons of Spring and Fall and consequently undesirable changes in the natural events started to occur such as excessive rain, outdoor temperatures above seasonal normal levels. Nowadays, global climate change is one of the most significant problems that mankind has to front with respect to its results. Due to global warming the Turkish province of Sivas is in a sensitive position because of its location. In this study, Sivas province is studied in terms of monthly and seasonal temperature trends. The temperature trends are analyzed by the use of linear regression techniques and the results indicate a significant rise in temperature trends.

Keywords**:** Sivas, Global climate change, Temperature, Winter seasons.

Kış Sezonunda Sivas İlinin Küresel Isınma Etkisinin İncelenmesi

Özet. Dünyanın varoluşundan günümüze iklim birçok defa değişim göstermiştir. Sanayi devrimi ile birlikte insanoğlu iklim değişikliği üzerinde etkili olmaya başlamıştır. Sanayi devrimiyle birlikte atmosferdeki sera gazı miktarının sürekli olarak artması dünyanın küresel olarak ısınmasına neden olmuştur. Bu durum geçiş mevsimleri (ilkbahar, sonbahar) sürelerinin azalttığı için yeryüzünde istenmeyen doğa olaylarına (aşırı yağmur, mevsim sıcaklıkları üzerinde görülen dış hava sıcaklıkları) neden olmaktadır. Günümüzde küresel iklim değişikliği, sonuçları itibariyle insanoğlunun karşılaştığı en önemli problemlerden biri olarak gösterilmektedir. Sivas ili 'de konumu itibariyle küresel iklim değişikliğinden etkilenen hassas bir konumda yer almaktadır. Bu çalışmada, Sivas ili özelinde aylık ve mevsimlik sıcaklık trendleri incelenmiştir. Lineer regresyon teknikler kullanılarak sıcaklık trendleri analiz edilmiştir. Sonuçlar, sıcaklık trendleride anlamlı artışa işaret etmektedir.

Anahtar Kelimeler**:** Sivas, Küresel iklim değişikliği, Sıcaklık, Kış sezonu.

1. INTRODUCTION

Fossil fuels burnings result in the emission of carbon dioxide into the atmosphere and contributes to global climate change by causing greenhouse gas effect. Radical changes in fossil fuel based technologies are necessary in order to reduce this threat to the environment [1]. In energy systems, both improvements in energy efficiency and the use of renewable energy sources are some of the most effective means of reducing CO2 emission [2]. In the last five

* Corresponding author. *Email address:* *mustafaerturk65@gmail.com*

years, there has been an important increase in sustainability and eco-friendly production processes and the use of renewable energy sources for the products [3].

The change in global temperature averages trend does not demonstrate an equal distribution in all geographies. The heating trend between 40º and 70º degrees north latitudes occurs at a higher level. In the countries located at middle and high latitudes, the effect of global climate change is observed at a higher level [4].

Due to its regionally different climate structure, Turkey is one of the countries, which will be highly affected from the impacts that may occur in relation to the global climate change. Different regions of Turkey are impacted by the global climate change in different ways and at various levels. Areas that will be the most affected from the global change appear to be the arid, semi-arid and sub-humid regions [5]. Thus, the central Anatolia region happens to be one of the places that will be mostly affected due to its geographical position. In the master thesis the changes and trends in the rainfall and temperature data due to the global warming process [6]. The author revealed the reality of Turkey's global climate change. Barak (2009) stated as a result of its semi-arid feature climate is the biggest factor that affects the Central Anatolia Region [7]. As known, those regions with semi-arid climate respond to climate changes rather quickly. In the thesis study, Barak (2009) determined the areas, which were locally affected from the climate change. It is stated that some regions with steppe climate have evolved into semi-desert steppe climate. In some areas, evaporation rate is found to increase and it was stated that the greatest factor that play role in that increase is the rise in temperature. Especially, between the years 1991-2006, the impact of global climate change was identified to be at the highest level.

Sivas province constitutes the basis of this study and it is located in the Central Anatolia Region as one of the provinces sensitive to climate changes due to its location. As a result of this, vegetation and natural resources are damaged to a great extent in Sivas and Kayseri provinces. Especially, these provinces are the main areas, where environmental problems such as drought and flood may occur. Moreover, this problem leads to a great amount of pressure on water resources [8].

In this study, temperature trends are analyzed on monthly, seasonal and annual basis by using the data obtained from the meteorology stations in Turkey. An analysis is performed on what level global climate change is effective in the winter period in Sivas.

2. MATERIALS AND METHODS

In this study, outdoor temperatures data are obtained from the Meteorological Service of Turkey at meteorology stations throughout Turkey for the trend determination in the outdoor temperatures. The Thom test was used to determine the degree of homogeneity of these data series. The results of the test revealed that in general, the data had a homogeneous structure. Moreover, the non- parametric Mann and Kendall correlation coefficient is used. Subsequently, the linear trends of temperatures are calculated for Sivas province. The linear trend and Mann-Kendall results are evaluated.

Python, open source software, is used to perform the analyses. Outdoor temperature values are analyzed in different categories with this software. Overall, the analyses are carried out in the form of hourly, daily, monthly and annual bases.

2.1 Determination of Outdoor Temperature Distributions for Sivas

The distributions obtained from the software enabled the hourly, monthly, seasonal and annual analyses of outdoor temperatures as presented below. The monthly distribution of outdoor temperature of Sivas province in the winter season is given in Figure 1. It can be seen that on a monthly basis, during the period between November and June the outdoor temperatures change between - 28°C and 28°C. On the other hand, during the period between December and March the peak point is around 0°C with a rate of 7%. Furthermore, the outdoor temperature distribution in Sivas province during winter season is given in Figure 2.

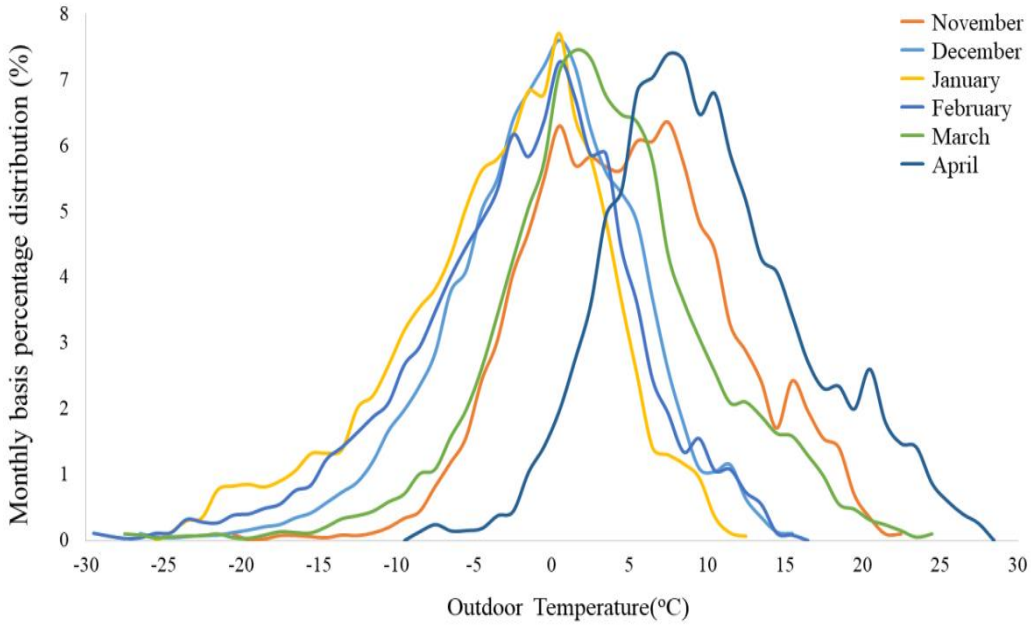

Figure 1. The monthly distribution of outdoor temperature of Sivas province in the winter season.

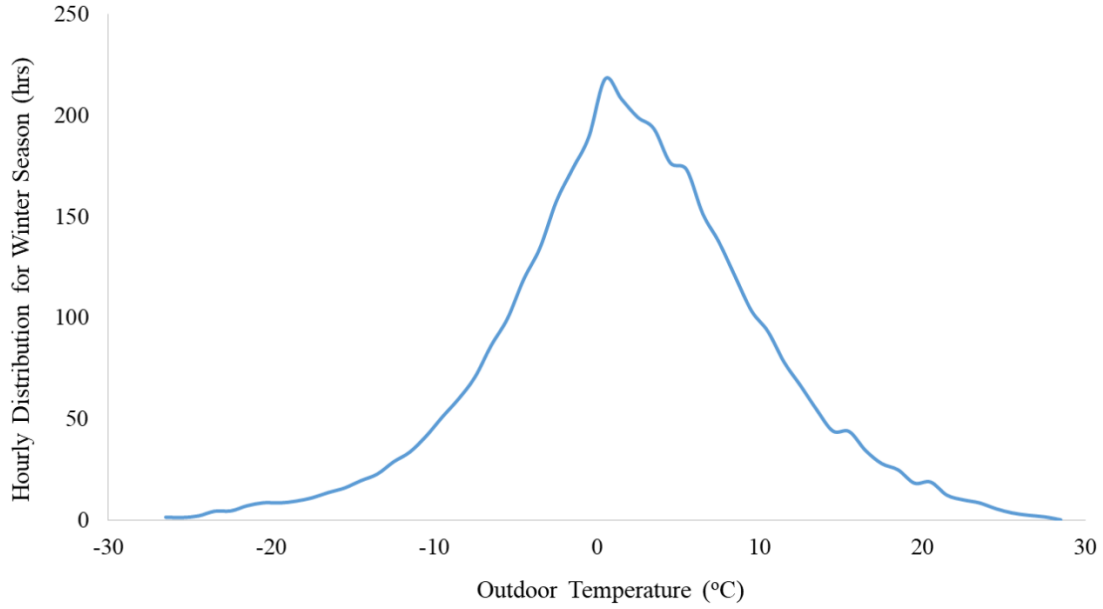

Figure 2. The distribution of outdoor temperature of Sivas province in the winter season.

The average annual winter outdoor temperatures is presented in Figure 2,and it is obvious that the most common temperature range for Sivas province is from -1 °C to 0°C. During the winter period, temperature occurrence is observed on the average as 218 hours in this area. The temperature range occurrence in the winter season reaches to 56°C. When the winter period is taken into consideration, the average temperature is at a level of 4°C. In figure 3, the fluctuation in the average temperature changes for the last 32 years is demonstrated.

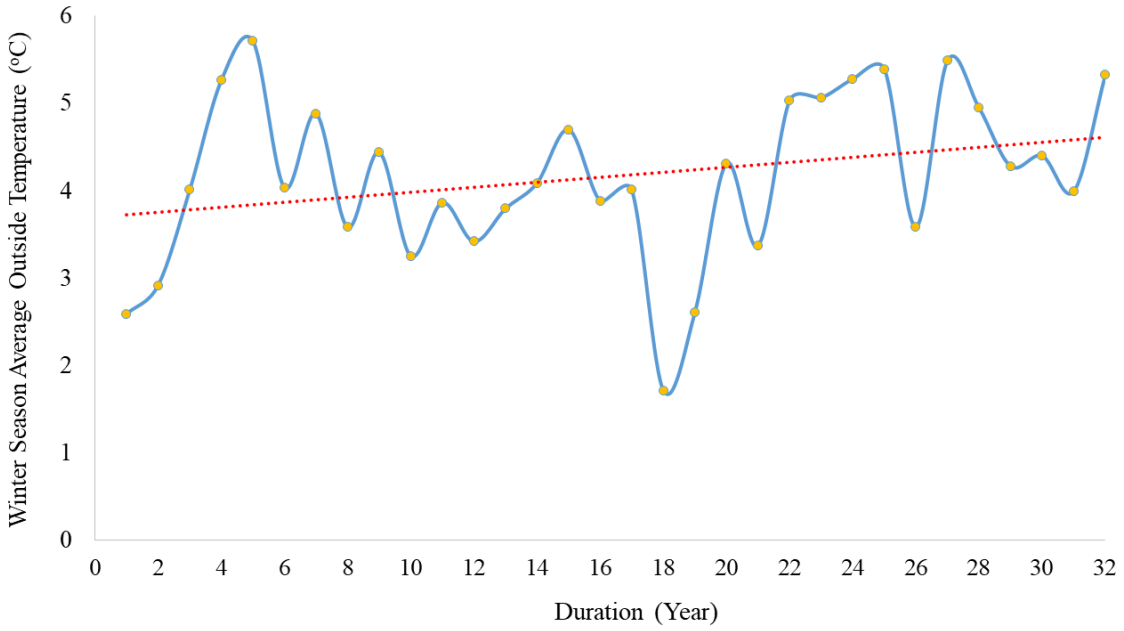

Figure 3. The global climate change effects on winter season average outside temperature

2.2 The Impact of Global Climate Change on Heating

Various methods are used for determining heating energy demand. One of these methods is Degree-Hour (DH) method. In this method, outdoor temperature data of 8760 hours is used. It is calculated in a different way for the heating season and the cooling season. The heating DH value used in this method can be obtained through the following formula:

$$DS = \sum_{j-1}^{N}(T_b - T_o)_j \qquad for\ (T_b \leq T_o)_j \tag{1}$$

In this equation, T_o, is the outdoor temperature and T_b expresses the temperature taken as reference for heating. N stands for the number of hours below the reference temperature. Heating energy demand appears as a result when outdoor temperature falls below the reference degree. The heating DH values are determined for Sivas and presented in Figure 4. A downward trend in heating DH values can be seen and a level of 154 °C- hour is detected in the heating DH value in terms of the winter season. When a value of 100142 °C DH is taken as reference for an average of 32 years, it yields to a decrease of 0.15 % on a yearly basis. On the other hand, at a period of 100 years it is possible to forecast a 15% decrease in the need for heating energy.

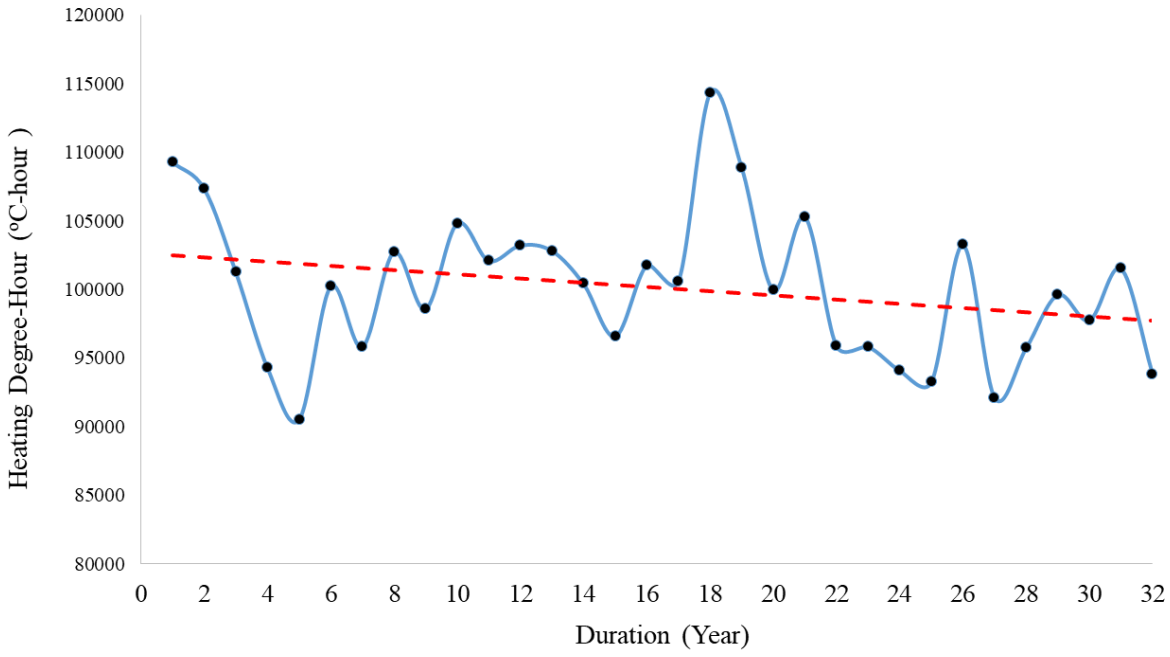

Figure 4. The change trend in heating degree-hours for the winter season

3. DISCUSSION AND RESULTS

When the data set obtained from all over Turkey is examined, the two provinces which will be impacted by the global climate change within the context of the Central Anatolia region seem to be Sivas and Kayseri. When the context of winter period is considered, Gürün district is the

most affected, in addition to Kangal, Altınyayla and Divriği counties in Sivas due to global warming. As can be seen in Figure 5, within a 100 year perspective for Sivas, it can be forecasted that the temperature rise will be between 3.1 °C and 3.9 °C during the winter season. With the impact of global climate change, the average temperature in winter is predicted to rise from 4 °C to 7°C or 8 °C in the context of counties. This temperature increase within Sivas is at a level far above the average temperature rise in winter in Turkey. In the context of the winter season, when Turkey is regarded as a whole, provinces that require precautions are Sivas, Kayseri, Malatya, and Kahramanmaraş. The governors of these four provinces may gather and form a platform and take common actions about global climate change. With this platform, a program and structure can be established that will make the most of government subsidies as the provinces that are most affected by the global climate change. Within Sivas context, detailed studies may be carried out in order to detect the effects of global climate change on economic activities.

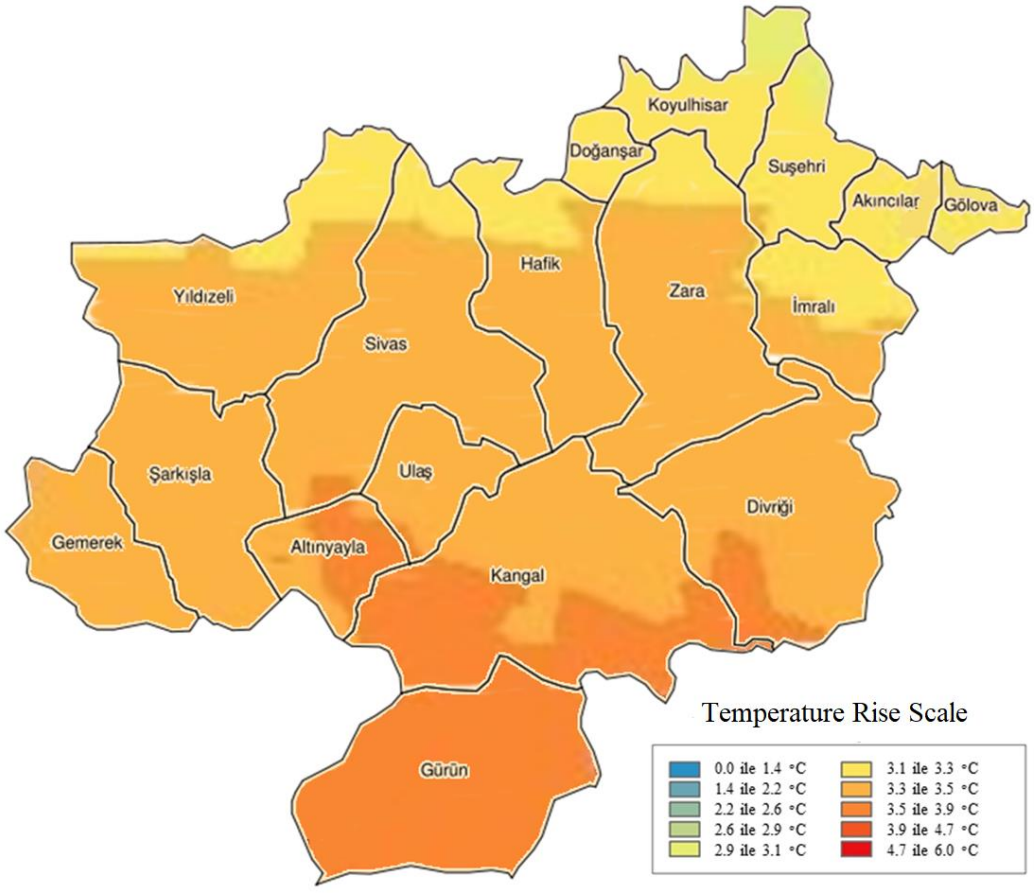

Figure 5. Map of future average outdoor temperature change over 2018-2118 period for the winter season

As known, the economic activities in Sivas are based on agriculture to a great extent. It is known that 70% of the economically active populations work in the agricultural sector. After agriculture, livestock farming comes in the second place as a source of income. In terms of agricultural production, grains and legumes are very important. The amount of cereal

products varies each year in relation to seasonal conditions and they are most affected by the global climate change. The main agricultural products are wheat, rye, beans, lentil, sugar beet and potatoes. During the last few years, there has been a decrease in the wheat production due to the rising effects of global climate change. This shortage in wheat production causes an increase in the cost of bread and this triggers food inflation. The decline in wheat production affects not only Sivas, but Turkey in general. By establishing a common platform for Sivas, Kayseri, Malatya and Kahramanmaraş cities, public and statewide awareness may be raised. After detecting the problem, action might be taken. The aim of this study is to provide a spark for these four provinces, which are the most affected ones by the negative impacts of global climate change, and hence, it is necessary, to take action and lessen from these negative effects. By the pioneering role of the universities in these aforementioned provinces, they may act together and this may inspire the state to act immediately on this issue.

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