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Investigation of Experienced Air Pollution on Selected Pollutants Scale in Kırıkkale City (2018-2019)

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ABSTRACT

The city of Kırıkkale, which gained importance with the industrial facilities established in the Republican period, began to receive immigration from the surrounding regions and beyond in the 1920s and 1930s. The everexpanding industrial facilities that were on the outskirts of the city at the time became part of the urban area as the city grew bigger. The city, trapped in a valley topographically, was developed in the east-west direction as it has a defective structure in the north and south. The density and severity of air pollution occurring in the low-lying city is high compared to its surroundings. The change in air pollution in the city of Kırıkkale between 2018 and 2019 was investigated based on the number of dwellings, population size and density, fuel type, industrial facility presence and traffic. This study is important because it is the most up to date of its kind. While the amount of SO_2 and PM10 was high in 2018, CO values increased in 2019 as well. The number of lost data is high in 2018 and 2019. The reasons for this include failure of the measuring devices due to the lack regular maintenance; power cuts…etc. In order to fully measure the air pollution and air quality of the city, measurement stations should be installed at different points, supported by mobile measurement tools, fossil fuel consumption without standard features should be reduced and people should be kept informed about air pollution values in certain parts of the city.

Anahtar Kelimeler:
Kırıkkale Şehri,
Hava Kalitesi,
Kükürt dioksit,
Partikül Madde,
Karbon monoksit.

ÖZ

Cumhuriyet döneminde kurulan sanayi tesisleri ile önemi artan Kırıkkale şehri 1920 ve 1930'lu yıllarda yakın ve uzak çevreden göç almaya başlamıştır. Artan göç ile nüfus miktarında da artış meydana gelmiş ve şehir plansız gelişme ile karşı karşıya kalmıştır. Kurulduğu dönemde şehir dışında kalan sanayi tesisleri zamanla şehir içinde kalmış ve ayrıca bu tesislere de yenileri eklenmiştir. Topografik olarak vadi içinde sıkışıp kalan şehir kuzeyi ve güneyi sorunlu bir yapıda olduğu için doğu-batı yönünde gelişme göstermiştir. Çevresine göre alçakta kalan şehirde oluşan hava kirliliğinin yoğunluğu ve şiddeti fazladır. Ayrıca şehrin gelişme yönünü etkileyen önemli meteorolojik faktörlerden olan rüzgârın doğu-batı yönünde esmesi ve çevrede bulunan yüksek alanları aşamaması kirli havanın şehir üzerinde kalmasında etkili olmaktadır. Bu çalışmada, 2018-2019 yılları arasında Kırıkkale şehrinde hava kirliliği açısından oluşan değişimler incelenmiştir. Güncel olması nedeniyle bu çalışma önem arz etmektedir. 2018'de SO_2 ve PM10 miktarı fazla iken 2019'de da CO değerleri artış göstermiştir. 2018 ve 2019'da kayıp veri sayısı fazladır. Bunun nedenleri arasında ölçüm cihazlarının arıza vermesi, bakımlarının zamanında yapılmaması, enerji kesintisi vb. durumların yer aldığı görülmektedir. Şehrin hava kirliliğinin ve hava kalitesinin tam anlamıyla ölçülebilmesi için farklı noktalara da ölçüm istasyonları kurulmalı, mobil

ölçüm araçları ile desteklenmeli, standart özelliği olmayan fosil yakıt tüketimi azaltılmalı ve anlık olarak insanlar şehrin belirli alanlarında hava kirliliği değerleri konusunda bilgilendirilmelidir.

1. Introduction

With the industrial revolution, the replacement of the people forces with the machines ensured the formation of industrial societies. People who migrated to cities had to make continuous production in order to raise the standards of development and living, thereby causing the environmental and human health problems, which are among the biggest problems of our age [1]. The most important of the environmental problems are those related to water, soil, and air. Air, which is the subject of our study, is an important factor that directly affects human health. In the best climatic conditions, people feel more dynamic and healthier in parameters such as humidity, temperature, wind, and precipitation [2]. Because a healthy person breathes approximately 16 kg of air per day [3], air pollution becomes critical for the human's wellbeing and can cause serious problems. Not only do these problems affect human, plant, and animal health, they can also cause deformation of soil and human structures. Air pollution is estimated to cause the death of 1 in 8 people globally for reasons ranging from heart disease, stroke, respiratory disease, and cancer. The World Health Organization (WHO) reported that in 2016, 91% of the world's population lived in areas where satisfactory air quality levels were not achieved [4]. According to a report released by the Chamber of Environmental Engineers Chamber of Turkey in 2018, 60 million people are exposed to polluted air.

There are two important reasons for air pollution in Turkey: urbanization and industrialization. Significant concentrations of air pollution grew during the breakthrough in urbanization and industrialization [5]. In cities with rapid urbanization, industrialization and high number of vehicles, air pollution levels are important. In Kocaeli, Zonguldak, Karabük, Kırıkkale, Gaziantep, Kayseri and Tekirdağ; and especially in Istanbul, Izmir and Ankara, the level of air pollution is above or very close to the limit values. The intensity of air pollution varies according to topographic and meteorological characteristics. The air pollution intensity and severity differ in areas topographically in the pit or high, and in areas with meteorologically stable or unstable weather conditions.

Kırıkkale is situated in the Central Anatolia Region; it is surrounded by high areas where the valley floor of the Central Kızılırmak section expands. In 1989, the winner of Kirikkale province status, are known for their industry during the Republican period established in the context of industrial facilities in Turkey. Air pollution conditions were examined in Kırıkkale, which is a dense field in terms of industry, where factories affiliated with MKEK in 1920s and TÜPRAŞ refinery were established in 1960s. The aim of our study is to evaluate and compare the amount of air pollution experienced in Kırıkkale in 2018-2019, the amount of pollutants originating from point (residential), areal (factory) and linear (traffic or vehicle) and to propose solutions to the problems that arise as a result of these comparisons.

2. Materials and Methods

Some selected air pollutants data of 2018-2019 of Kırıkkale city were used. Sulfur dioxide (SO_2), particulate matter 10 (PM10) and carbon monoxide (CO) values, which are major air pollution contributors in the area, were examined and explained in tables and graphics. It has also been compared with the limit values under Turkey Air Quality Assessment and Management Regulations. These limit values are 125 µg / m³ for 24 hours in SO_2, 50 µg / m³ for 24 hours in PM10, and 10,000 µg / m³ for 8 hours in maximum. The data of the study were obtained from the reports of the Ministry of Environment and Urbanization Air Quality Monitoring stations. The data provided were calculated as monthly, yearly, and seasonal averages, a 24-hour average for SO_2 and PM10 values, and a maximum of 8 hours for CO.

3. Results

Kırıkkale city is located in the Central Kızılırmak section of the Central Anatolia Region that is home to Turkey's longest river, especially in the north and south of the Red River tributary of the creek valley Çoraköz Kırıkkale. It's located in the area where the expansion is converted with high space (Figure 1). The fact that the valley is in the pit area where it expands and its north and south are surrounded by high areas causes the intensity and severity of air pollution and adds complications towards dissipating the existing pollution.

In terms of climate characteristics, Kırıkkale city is in the temperate climate zone. The terrestrial climate characteristics seen in the Central Anatolia Region are also observed in the city. For this reason, winters are cold and

rainy, and summers are hot and dry [6]. Winters are very cold in the city, as the average height of the city of Kırıkkale is approximately 700 m and the continental climate prevails. Therefore, the need to warm up in winters is high. The average annual temperature in Kırıkkale was 12.6 ° C, the highest temperature was measured at 31 ° C in July and the lowest at 2.9 ° C in January [7]. Temperature values fall below 0 ° C in the city in December, January, and February.

Another meteorological factor that plays a role in the severity of air pollution is the frequency of wind blow and the dominant wind direction. The direction depending on the maximum number of winds blows throughout the year in the city of Kırıkkale is NW-E-SW and W, respectively [8]. Since the city is located at the base of the valley in the east-west direction morphologically, the wind is channeled in the east-west direction.

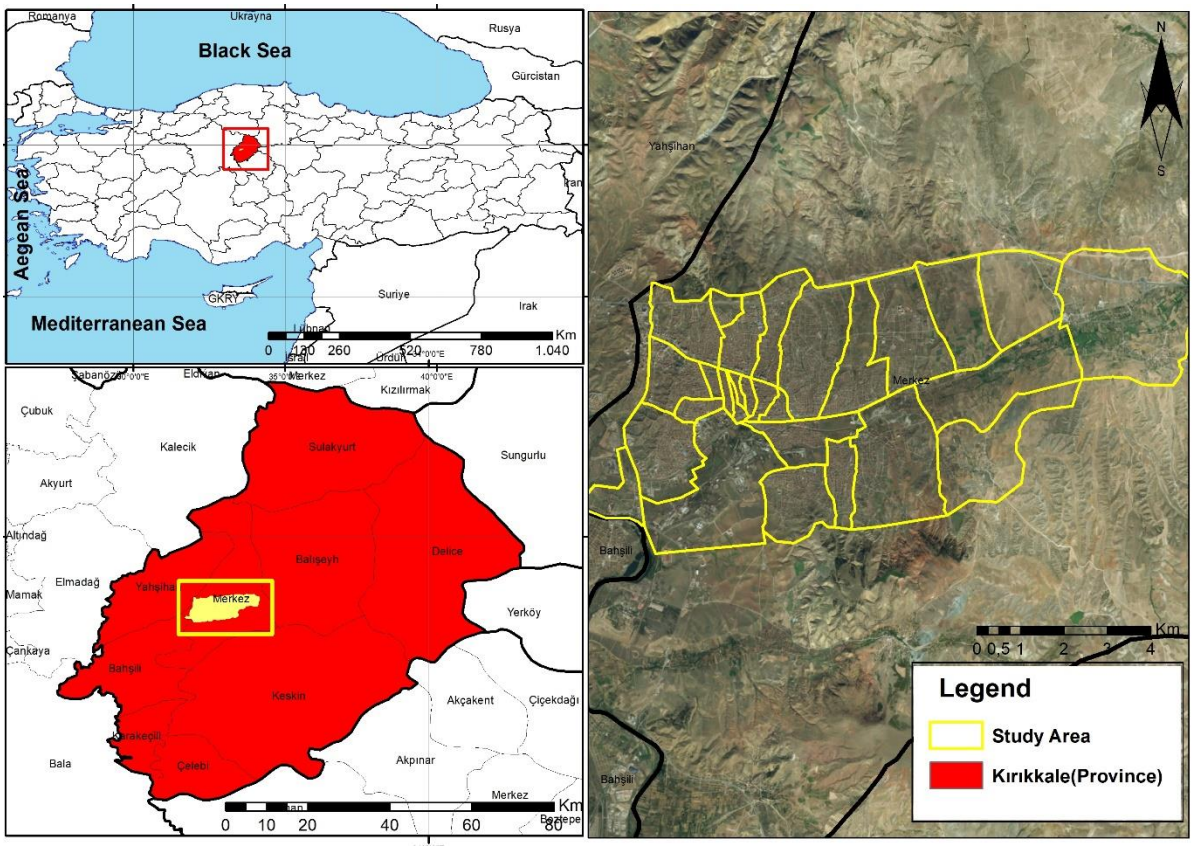

Figure 1. Study Area Location

The existence of TÜPRAŞ and iron and steel factories affiliated to MKEK, which was established in the first years of the Republic, which are actively producing in the city of Kırıkkale, constitutes an important source of air pollution in the city of Kırıkkale. MKEK facilities, which remained outside the city during the first years but became part of the city as the city developed and expanded, and TÜPRAŞ which is located near the city cause significant air pollution. Gas complaints originating from TÜPRAŞ have been the subject at local, regional, and national levels in some periods [9].

Transportation is also a very important factor. In addition to the increase in the number of vehicles, the transportation networks developed and became more complex [10]. Complex transportation networks and vehicle equipment have become more environmentally harmful. Carbon monoxide gas, especially from exhausts of motor vehicles, is a very toxic pollutant. The number of motor vehicles, which has an important effect on the increase of carbon monoxide level in Kırıkkale city, was 69,696 in 2018 and 68,142 in 2019. The number of cars within the number of motor vehicles was 42,634 in 2018 and 40,906 in 2019. The number of cars per thousand was 149 in 2018 and 145 in 2019 [11].

The high amount and density of the population is also a major factor in the formation of air pollution. The large population increases the amount of housing available and the domestic warming increases with the increasing amount of housing. The population density in Kırıkkale was 63.21 in 2018 and 62.42 in 2019. The total population was 286,602 in 2018 and 283,017 in 2019.

With all these factors taken into consideration, it is observed that the limit value of the Pm10 in particular, exceeded the amount almost every month. Especially in 2019, PM10 limit value had exceeded or reached the limit level every month. Particulate substances that settle in the lungs and bronchi cause harmful consequences such as COPD, asthma, and lung cancer. In the amount of SO_2, it is seen that the limit value has been exceeded in some months (Figure 2). It is seen that SO_2 amount exceeded the limit value in May, June, and July in 2018. In 2019, it is seen that limit values are not exceeded in SO_2. When 2018 and 2019 are compared, it is seen that there are missing measurements in both Pm10 and SO_2 values in 2018 and even no measurements were made in some months. Pm10 and SO_2 averages in 2018 were considerably lower than those in 2019 (Figure 2).

When analyzed seasonally, it is observed that both pollutants increased in winter in 2018. In addition to the summer and spring seasons, there was an increase in the two pollutants in the winter and autumn seasons in 2019. This increase was more than what was recorded in 2018.

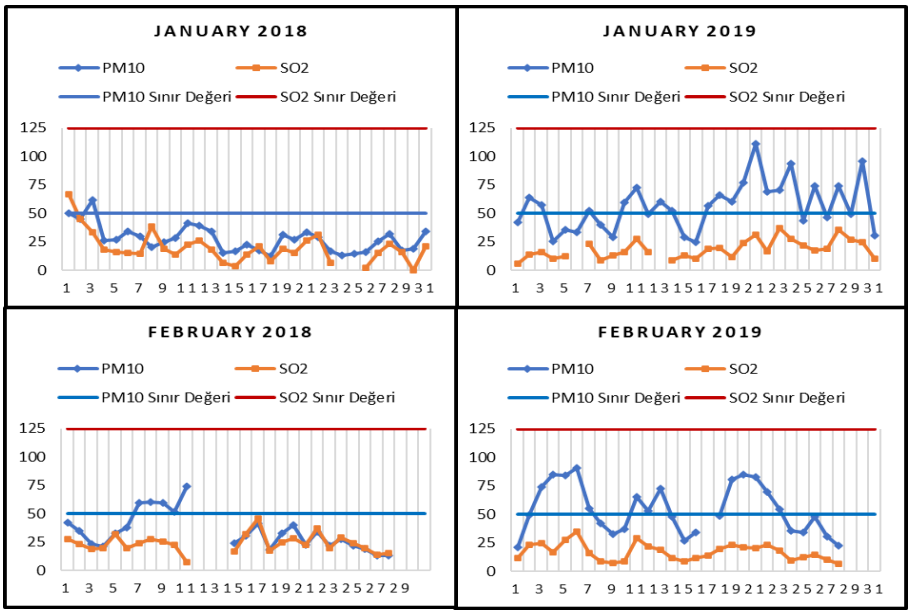

Figure 2. Monthly PM10 and SO_2 Amounts and Limit Values of Kırıkkale City (2018-2019)

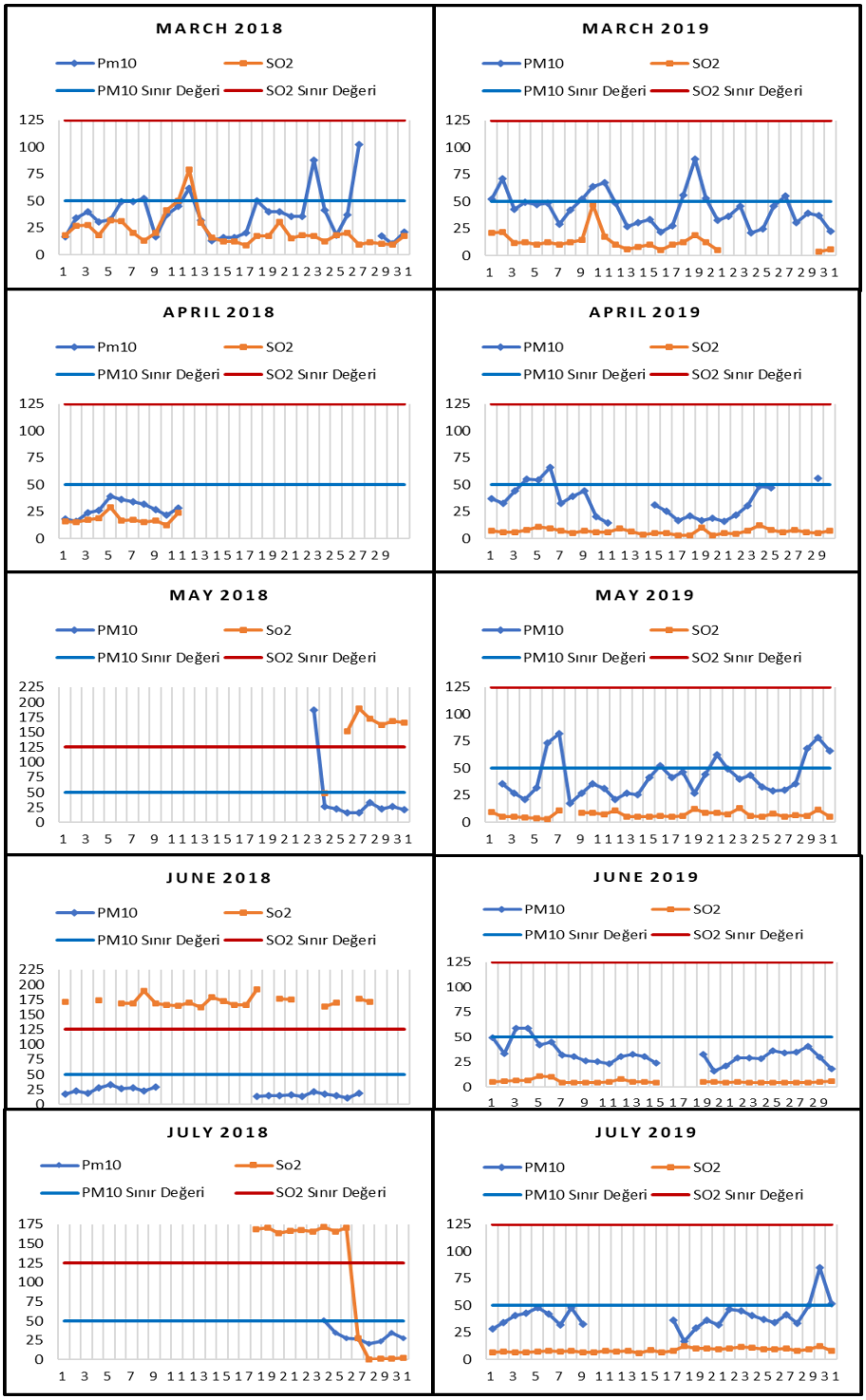

Figure 3. Monthly PM10 and SO_2 Amounts and Limit Values of Kırıkkale City (2018-2019)

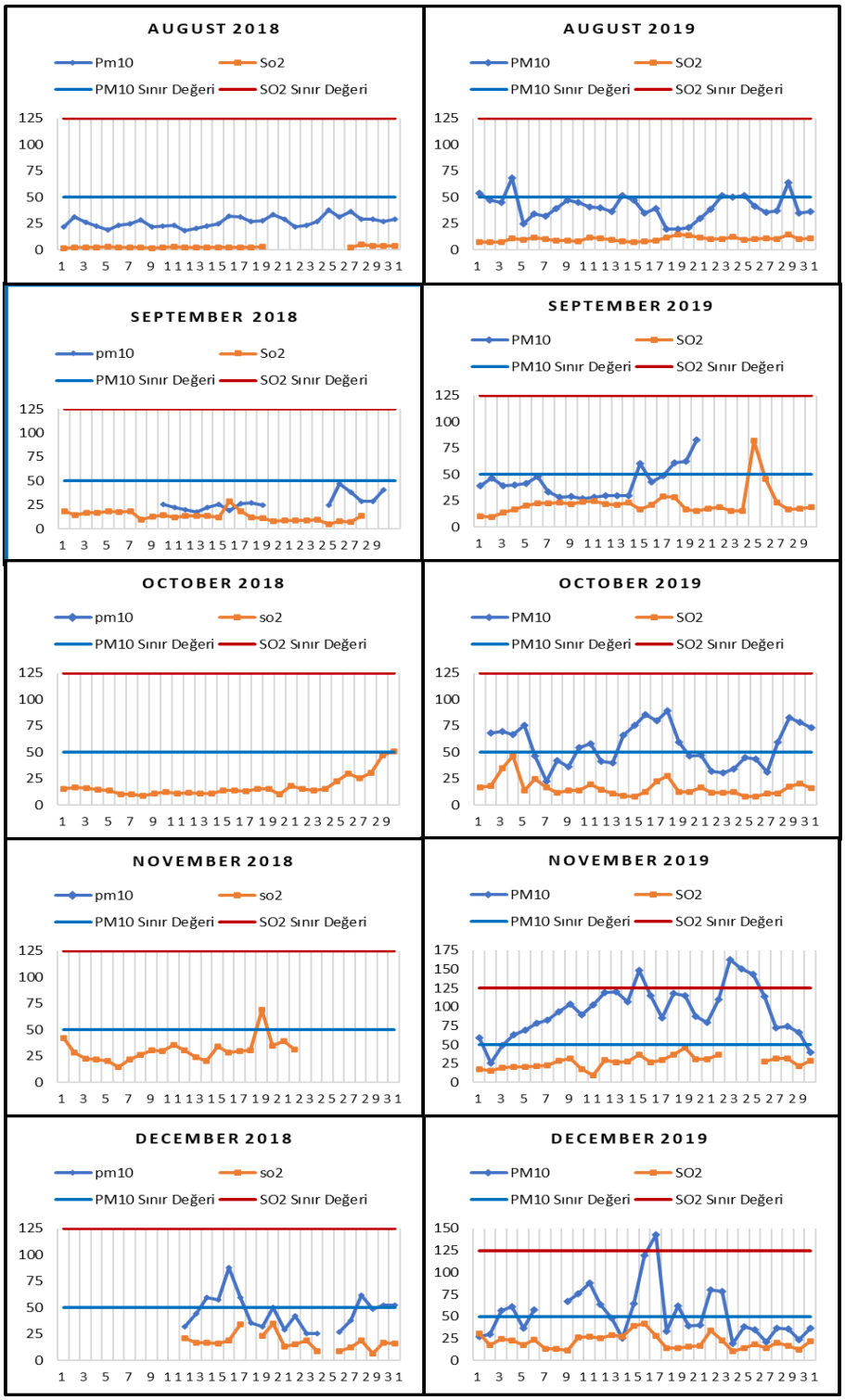

Figure 4. Monthly PM10 and SO_2 Amounts and Limit Values of Kırıkkale City (2018-2019)
Source: Environment and Urban Ministry, 2018-2019

The amount of CO has also exceeded the limit value in some periods in the city of Kırıkkale. CO gas, which is generally sourced from traffic, arises as a result of incomplete fuel burning in vehicles, as well as not burning fuels used for heating purposes in houses (Figure 3).

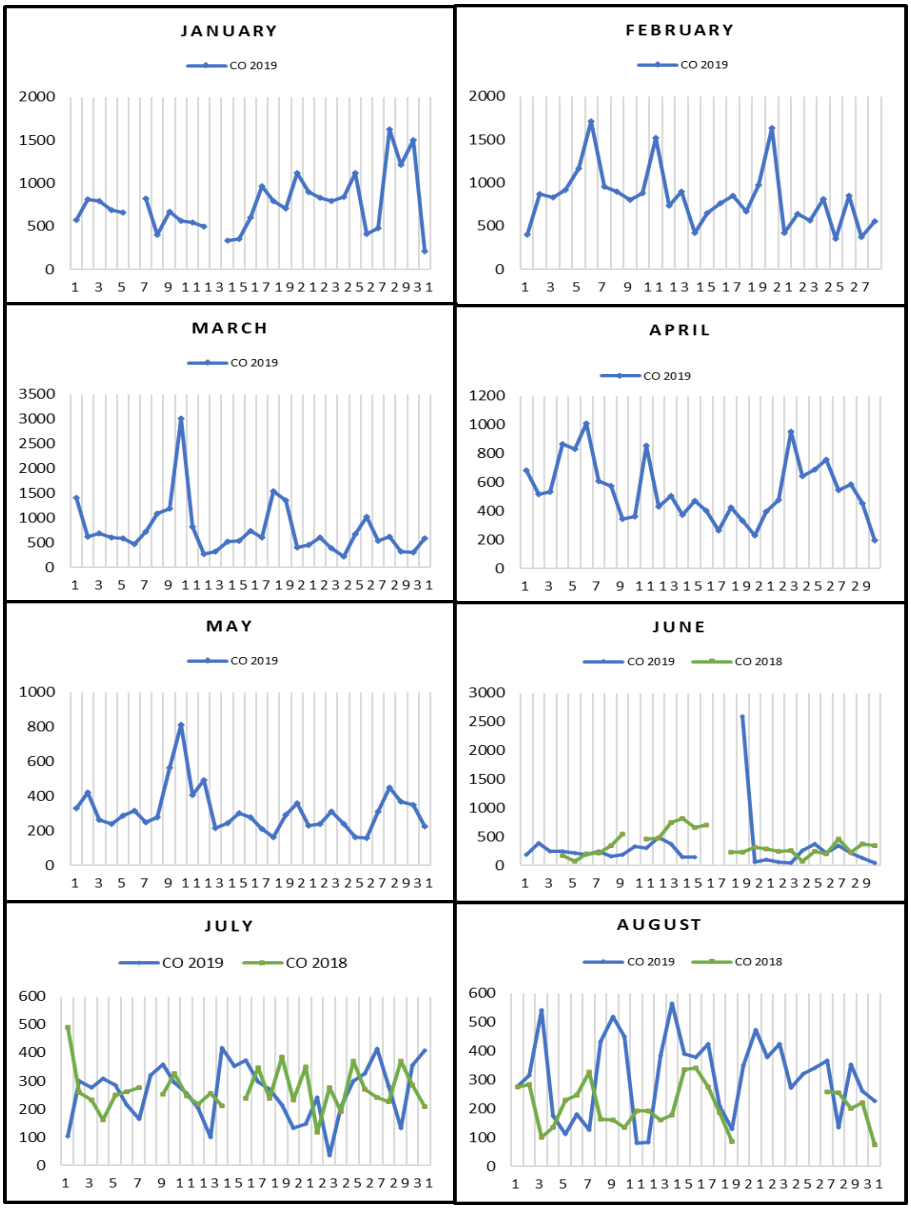

Figure 5. Monthly CO Amount of Kırıkkale City (2018-2019)

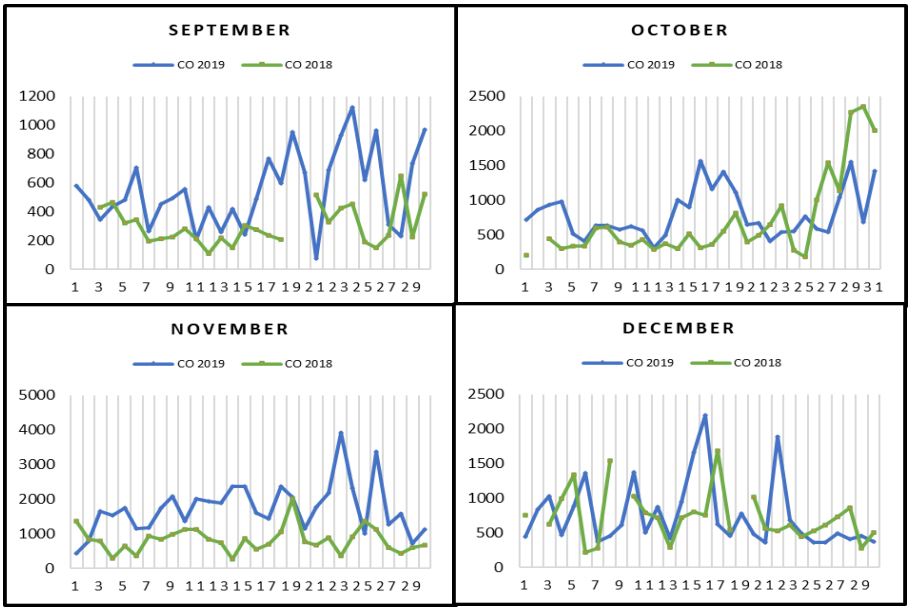

Figure 6. Monthly CO Amount of Kırıkkale City (2018-2019)
Source: Environment and Urban Ministry, 2018-2019

In Kırıkkale city, CO measurements were not performed until June 2018. After June, measurements were made with the deficiencies until December. However, measurements were made every day in 2019. The limit value in CO pollutants was calculated based on a maximum of 8 hours average. In this sense, the limit value is based on 10,000 µg / m^3.

According to the random 8-hour measurement results from the Kırıkkale city measurement station, the limit value was not exceeded. However, even if the limit value has not been exceeded, CO pollutant values are still high. In the months of January, February, March, April, October, November and December, the amount of CO was particularly high (Figure 3). The main reason for this is that the measuring station is on the roadside. In addition, the air quality measurement station is between the buildings. This reduces the reliability of the measurements (Figure 7).

Figure 7. Kırıkkale Air Quality Measurement Station
Source: https://www.haber71.net/hava-kalitesi-anlik-olarak-olculebilecek/

4.Conclusions and Suggestions

The air pollution is close to or above the desired levels in the city of Kırıkkale. Only few studies in this regards were conducted in Turkey, and our study of Kırıkkale is not sufficient. Moreover, there was only one measuring station in Kırıkkale city, some measurements could not be made at some hours of the day, some days or even some months. This is a critical situation that prevents the determination of the air quality of Kırıkkale city. The need to increase the measurements in the cities where the industrial facilities are dense, and in this context, the need to increase the number of stations, especially in the city of Kırıkkale, cannot be stressed enough. Because air pollution data that occurs due to production in industrial cities may show sudden changes in hour and day scale.

Kırıkkale has a natural gas infrastructure. Natural gas is used in the context of heating and production in residences and industrial facilities, but the use of poor-quality coal in residences is also an important condition that increases air pollution. The use of coal that does not comply with the standard ingredients should be prevented.

It is of great importance to place illuminated screens that show the current air quality value is in the areas where the crowd of population is dense. As a matter of fact, provincial-based air quality data are shared by the relevant ministry online and can be accessed from phones and computers, but these channels suffer from lack of following. The local administrations and the Ministry of Environment and Urbanization have a great responsibility to raise awareness and take measures to tackle these problems until the pollution levels are at low levels again.

Competing Interest / Conflict of Interest

The authors declare that they no conflict of interest. The none of the authors have any competing interests in the manuscript.

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We declare that all Authors equally contribute.

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