J. Int. Environmental Application & Science, Vol. 16(2): 53-62 (2021)
Research Paper

Investigation of the Effects of the Measures of the Corona-19 Virus Outbreak on the Konya Atmospheric PM

Alaa M. Al-Lami[1], Hüseyin Toros[2], Mustafa Sağdıç[3, *], Sukru Dursun[4]

[1]Atmospheric Sciences Dept., College of Science, Mustansiryiah University, Baghdad, Iraq; [2]Istanbul Technical University, Faculty of Aeronautics and Astronautics, Department of Meteorology, Maslak, 34469, Istanbul, Turkey; [3]Yıldız Technical University, Faculty of Education, Department of Social Sciences and Turkish Education, Istanbul, Turkey, [4]Konya Technical University, Engineering and Natural Science Faculty, Environmental Engineering Department, 42003 Konya, Turkey.

Received January 21, 2021; Accepted February 26 2021

Abstract: In this study, the change in atmospheric particulate matter values were investigated the curfews imposed due to the coronavirus epidemic in Konya city center. This present study, PM_{10} pollutant data were used in Konya province center data of the Ministry of Environment and Urbanization. The period in which strict measures taken was compared with the period before and after March 16, 2020 - April 15, 2020. In addition, seasonal conditions, 2020 epidemic period data and normal period 2018 and 2019 data were also compared. As a result of the outbreak period, restrictions for the majority of those living in big cities in Turkey can be also seen in PM_{10} values have positive impact on air quality in the Konya city center that have been found with examined data. It turned out that the measures were taken during the virus epidemic, traffic was reduced and the decrease in industrial activities led to a significant improvement in air quality. Considering the measures and improvements in air quality, it is deemed worth investigating how the measures to be taken in the coming periods should be evaluated in the fight against air pollution.

Keywords. *Environment, Air pollution, Konya, Corona Virus, Pandemic, Air quality,*

Introduction

Corona virus pandemic, a novel infectious disease for all over the world, was firstly seen in the Wuhan city of China in December 2019 (Kanniah *et al*., 2020; Huang *et al*., 2020; Chen *et al*., 2020). Pandemic disease was later spread to other countries in Asia, Europe (mainly Italy, Spain, France, the United Kingdom, USA and others), Africa, and America (mainly the United States), and became a pandemic disease. COVID-19 is extremely communicable to more than 11.8 million People (confirmed cases on 09 July 2020) have been contaminated in 210 countries with more than 534, 902 recorded deaths (09 July 2020; URL-1). When countries entered the lockdown, manufacturing operations were shut down worldwide (Muhammad & Xingle, 2020). Transport is, among many other industries, the business most seriously impacted by the lockdown. Road and air transport come to a stop because people were not permitted or hesitant to fly. According to the survey, air traffic decreased by 96 percent attributable to COVID-19, the lowest in 75 years (CNN, 2020). As a potential side effect of this extraordinary lockdown, several countries have undergone a drastic decrease in air quality. In China, the Finnish Centre for Energy and Clean Air Study announced that steps to curb the spread of COVID-19, such as travel restrictions and plant closures, culminated in a 25% decrease in CO2 emission (Carbon Brief 2020, URL-2) Similarly, satellite images by the European Space Agency (ESA) revealed a substantial reduction in NO_2 pollution in northern Italy between 01. January and 11. March 2020. Lockdowns to protect off coronavirus (Bao & Zhang, 2020). Also, the Institute of Environmental Science and Meteorology (IESM) has reported that since the launch of the Luzon strengthened environmental quarantine on 16 March 2020, the PM2.5 and PM10 concentrations in Metro Manila have been substantially decreased due to reduced use in crushing and grinding machines and low road dust exposure (Wang *et al*., 2020).

Particle matter (PM) air pollution is more complicated, spanning a broad variety of applications. This consists of a multi-component matrix derived from different anthropogenic (power production, traffic-related, etc.) and natural causes (biomass combustion, pollen, etc.) and is subject to a variety of

**Corresponding Author: E-mail: msagdic@yildiz.edu.tr, Tel: 0090 5052514216; Fax mail: 0090 2123834808*
[#]This study has been presented at iseser2020

atmospheric processes (Zoran *et al.,* 2020; Ali *et al.,* 2019). In certain urban coagulated regions, PM concentrations are typically dominated by various size fractions (ultrafine $PM_{0.1}$ particles with a diameter of < 0.1 μm; small $PM_{2.5}$ particles with a diameter of ≤0.2.5 μm; coarse PM_{10} particles with a diameter of > 0.2.5 μm and ≤10 μm) (Zoran *et al*., 2019; Khan *et al*., 2019). many studied in different countries were done to investigate the impact of COVID19 on air pollution concentrations and these studies have shown that the lockdown contributed to a substantial decrease in aerosols optical depth AOD over sea and emissions over oceanic regions, although a large decrease in tropospheric NO2 was reported over areas not influenced by seasonal biomass combustion. PM10, PM2.5, NO2, SO2, and CO concentrations showing a notable decreased in urban areas during the lock-down process relative to the same times in 2018 and 2019 (Dutheil *et al*., 2020; Muhammad & Xingle, 2020; Bao & Zhang, 2020; Otmani *et al*., 2020).

The present study aims to investigate the change of PM10 concentration due to the effects of coronavirus outbreak in Konya city center, Turkey using the data of the existing air quality monitoring station in the city before and after Covid19 measures.

Material and Method

Study area and data sources

Konya is a closed basin located in the central part of the interior of Anatolia, Turkey (Figure 1). The closed basin consists of wide ovals and plateaus. As the Taurus Mountains cover the south of the basin, it prevents the moist air of the Mediterranean from coming to the region. Therefore, although it is close to the Mediterranean, it has a very arid climate and has a semi-arid feature. With this feature, summers are hot and dry and winters are cold. Turkey is much less rainfall than in the general. In the past, it was called Turkey's granary and socio-cultural development, as this feature is also changed by the change of climate and water resources. Industrial areas, especially the provincial center, have also developed. Since air circulation is not enough in the city center from time to time, air pollution events reach levels that disturb people on some days.

Climate: In Konya, located in the southern part of Central Anatolia, winters are harsh, cold and snowy, summers are hot and dry. The average annual temperature is 11.6 °C. The daily maximum annual temperature is 17.9 ° C and the minimum annual temperature is 5.4 °C. The highest temperature is 40.6 °C and the lowest is -28.2 °C (URL-3).

Figure 1. Location of research area Konya (URL-4)

Air pollution: Depending on the development of the industry in the city center, fossil fuel consumption for energy needs is one of the emission sources thrown into the air. Again, because the region is very cold in the winter months, fossil fuels used for heating are another important source of air pollution. It is thought that it contributes to air pollution from industrial processes. Vehicles in traffic have a significant impact on air pollution, and their contribution to air pollution especially increases in some

periods and hours. The exhaust gases of the vehicles are especially important in terms of very small PM, CO, and NOx emissions.

Data: The air quality monitoring stations located in the center of Konya as an all-other Turkish city. In this study, air pollution measurement values of 4 stations in the city center of Konya were obtained from the Ministry of Environment and Urbanization WEB page (URL-5). PM_{10}, SO_2, $PM_{2.5}$, NO_2 and O_3 values are measured at the sampling stations of the Ministry and Konya municipality are published on the WEB page as hourly and then daily averages measurement values are given in $\mu g/m^3$.

This present study is to investigate air quality with the change in atmospheric particulate matter values of curfews taken due to the coronavirus outbreak in Konya city center. The 2nd period which is strict measures were taken for Covis-19 which were compared two periods 1 January 2020 - 15 March 2020 and 16 March 2020 - 15 April 2020. In addition, seasonal conditions, 2020 epidemic period data, and normal period 2018 and 2019 data were compared. Period 1st, before the Covid-19 measures (between January 1 and March 15). Period 2nd, after the Covid-19 struggle started (between March 16 and April 15).

R-statistic program, which is an open code statistics program (Abbasnia & Toros 2020), was used to create the distribution of pollution maps of the data, daily air pollutants data of 01.01.2018-15.06.2020 compared.

Results and Discussion

Any region in the world where the industry is highly developed, provincial centers where traffic is very heavy, and settlements in the places where winter seasons are cold and using low-quality fossil fuel consumption affect the quality of human life, especially in people with respiratory diseases problems. The topographic structure and climatic features of a region are also as effective as emission sources in the formation of air pollution. Especially in the winter months, there is an increase in the emission levels as the temperature decreases with increasing fuel usage for heating systems. However, the negativity caused by meteorological conditions causes lower than expected levels of air quality problems.
Using the data of the existing air quality monitoring stations in the Konya city center: it is seen that the air quality increases and then returns to normal levels during the period when a curfew is restricted for measures taken due to the Covid-19 pandemic outbreak period. outbreak restrictions that cause the reduction in vehicle exhaust emissions, which are important factors in the formation of some air pollutant parameters, are thought to be effective in improving the air quality in city centers.

Figure 2 shows the mean daily particle matter concentration for 4 different sampling stations in Konya city center from the beginning of 2020 to the middle of June 2020. Values in the graph show a significant decrease after the pandemic outbreak middle of March 2020 except Selcuklu sampling point differentiation due to the effect of the Saharan dust effect period.

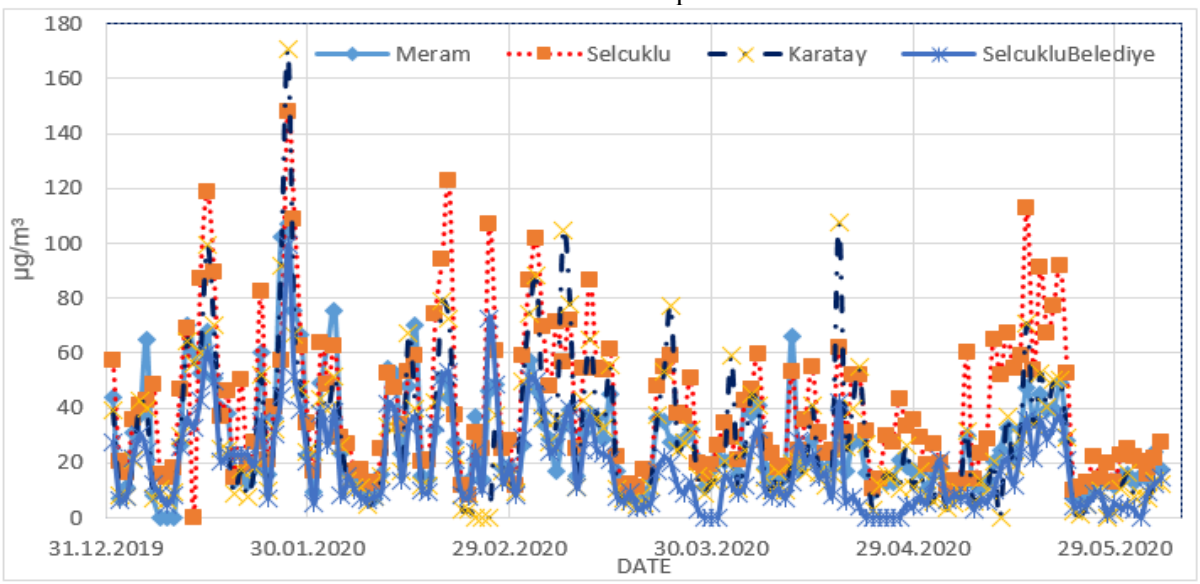

Figure 2. PM_{10} values for four different sampling stations at Meram, Karatay, Selcuklu districts of Konya city center.

When it is seen separately in Figure 3, the daily mean of PM_{10} levels as an air quality parameter in the Meram district sampling station of Konya city. They show that PM_{10} values decreased and values significantly changed for Meram regions during the outbreak of the virus pandemic period.

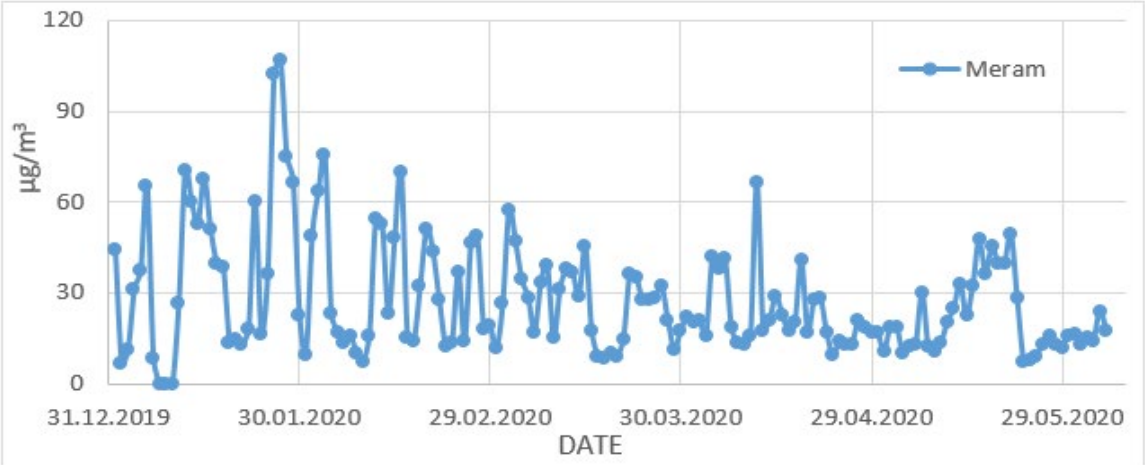

Figure 3. PM_{10} values for sampling stations of Meram district of Konya city center for the beginning of January 2020 to the middle of June 2020.

According to Figure 4, PM_{10} values for sampling stations in the Karatay district of Konya city center are higher than Meram district but values are a parallel trend with the Meram region. This district includes places that are a more industrialized factory region. Values were significantly decreased during the restriction of the COVID-19 pandemic after March 16th, 2020.

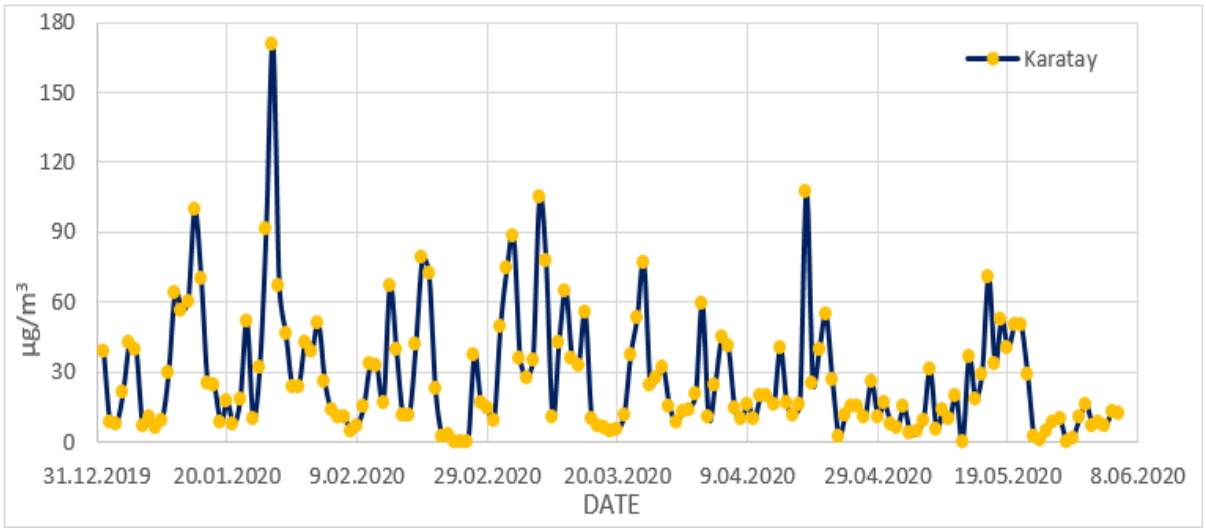

Figure 4. PM_{10} values for sampling stations of Karatay district of Konya city center for the beginning of January 2020 to the middle of June 2020.

When it is seen in Figure 5, PM10 values for sampling stations of the Selcuklu municipality region show a similar sampling period with Meram district, values of PM10 and trends are similar. Improvement of air quality was seen as a similar period of a pandemic outbreak.

Figure 5 shows PM10 values for another sampling station of Selcuklu district in Konya city center during the period beginning of January 2020 to the middle of June 2020. This region is mostly residential areas including a part of a small industrial area. Most of the pollution comes from fossil fuels burning for the production of energy for heating systems in homes. A small amount of pollution was introduced by industry and traffic. During cold wintertime, PM10 values were increased. PM10 values were significantly decreased during pandemic outbreak time and an increase was detected with the situation created by the effect of field dust and then decreased again.

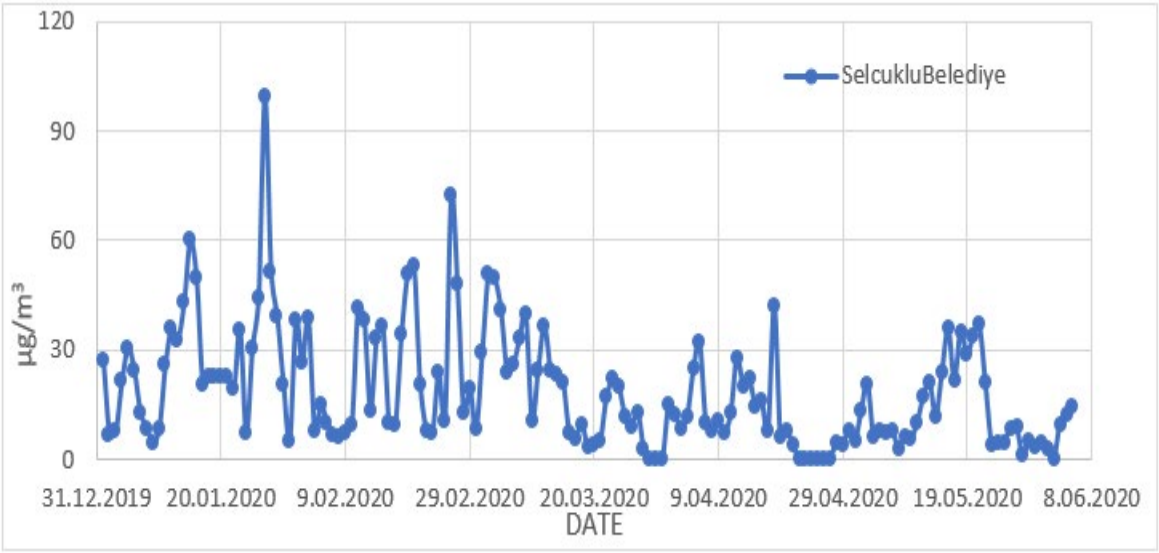

Figure 5. PM_{10} values for sampling stations of the Selcuklu municipality region of Konya city center for the beginning of January 2020 to the middle of June 2020.

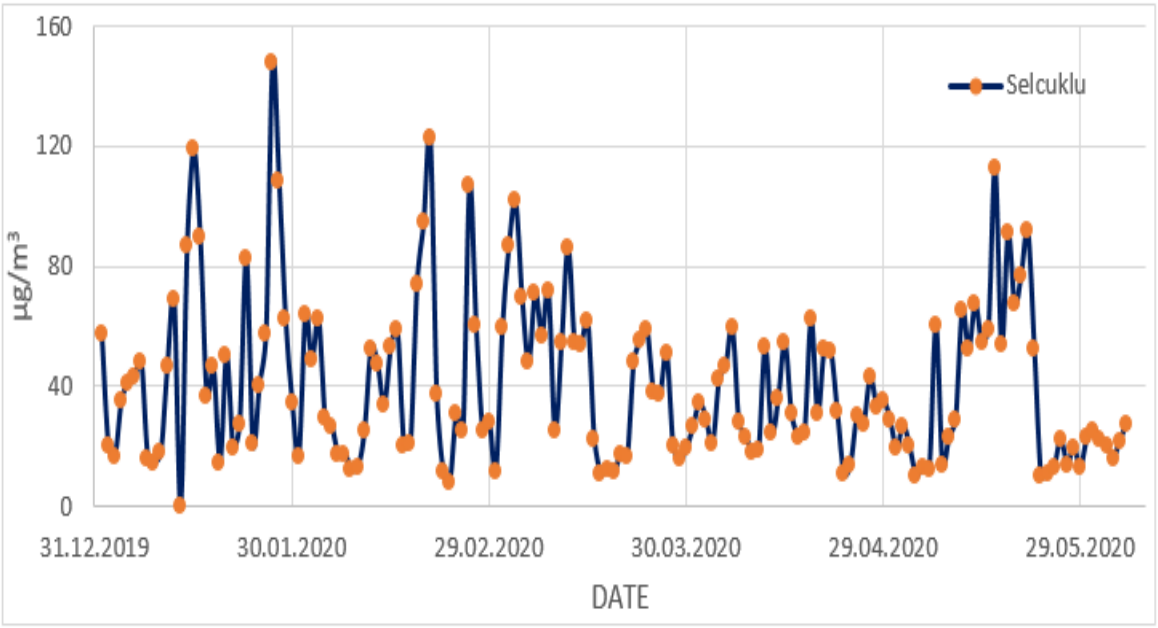

Figure 6. PM_{10} values for sampling station of Selcuklu district of Konya city center for the beginning of January 2020 to the middle of June 2020.

Figure 7 is summarizing the daily mean values of PM_{10} as an air quality parameter for Selcuklu, Konya sampling station from the beginning of January of 2018 to the middle of June 2020. Values showing that PM10 values during the summer hot period lower than colder winter periods the highest values were December 2019. Values significantly decreased during the pandemic outbreak period and after the return to normal levels. Four-month values from the middle of December 2018 are missing for some problem of the sampling equipment in the station.

Daily mean values of PM_{10}, as an air quality parameter of Meram, Konya sampling station from the beginning January of 2018 to the middle of June 2020 (Figure 8) which shows that PM10, values decreased during a pandemic outbreak. PM10 values during the summer hot period lower than colder winter periods and the highest values were seen in December 2019.

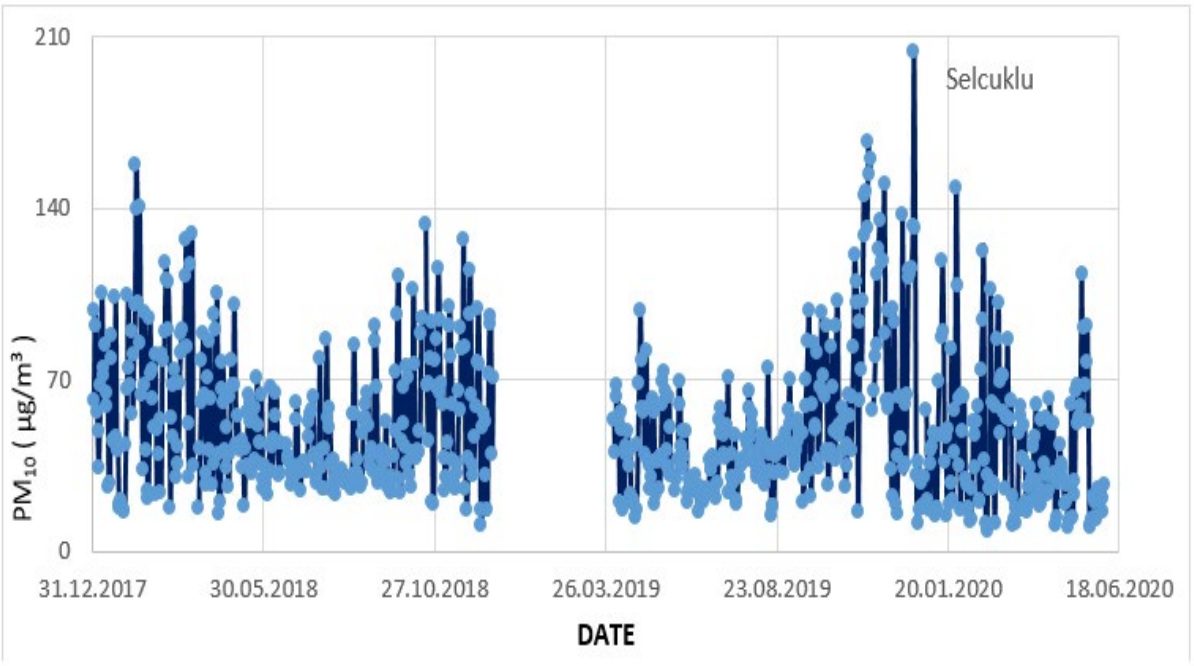

Figure 7. Daily mean values of PM_{10}, as an air quality parameter of Selculu, Konya sampling station from the beginning of January of 2018 to the middle of June 2020.

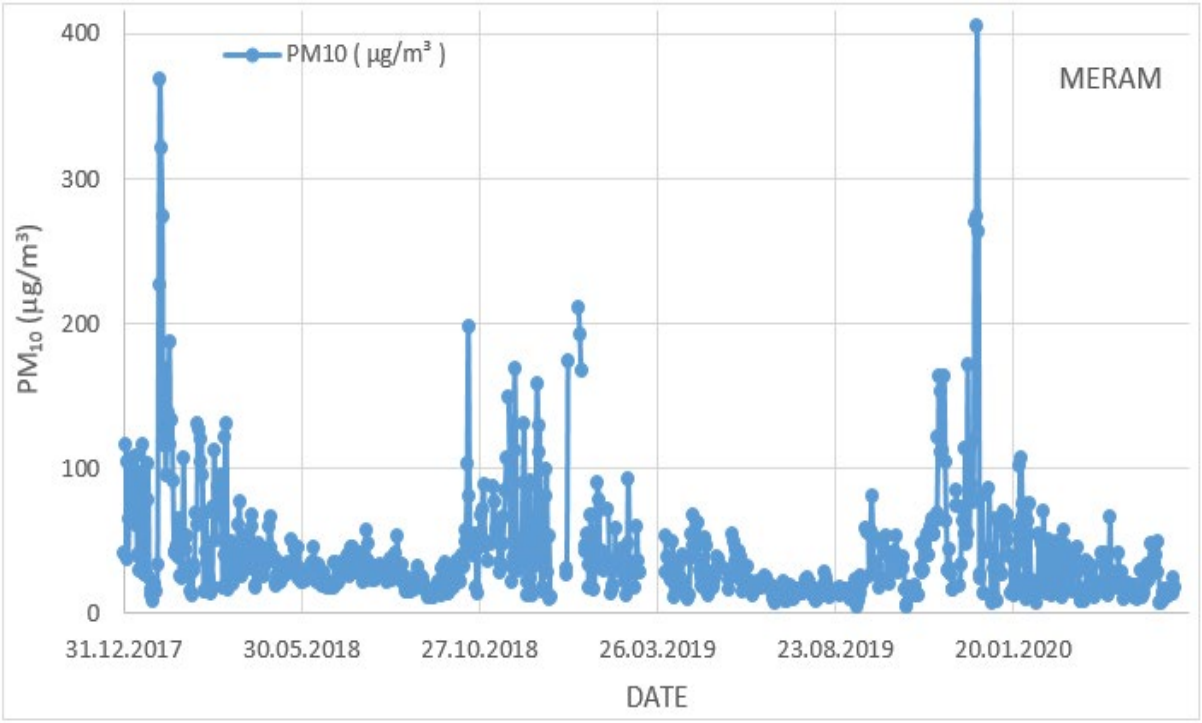

Figure 8. Daily mean values of PM_{10}, as an air quality parameter of Meram, Konya sampling station from the beginning of January of 2018 to the middle of June 2020.

Daily mean values of PM_{10}, as an air quality parameter of Karatay, Konya sampling station from the beginning January of 2018 to the middle of June 2020 (Figure 9) which shows that PM10, values decreased during a pandemic outbreak. PM10 values during the summer hot period lower than colder winter periods.

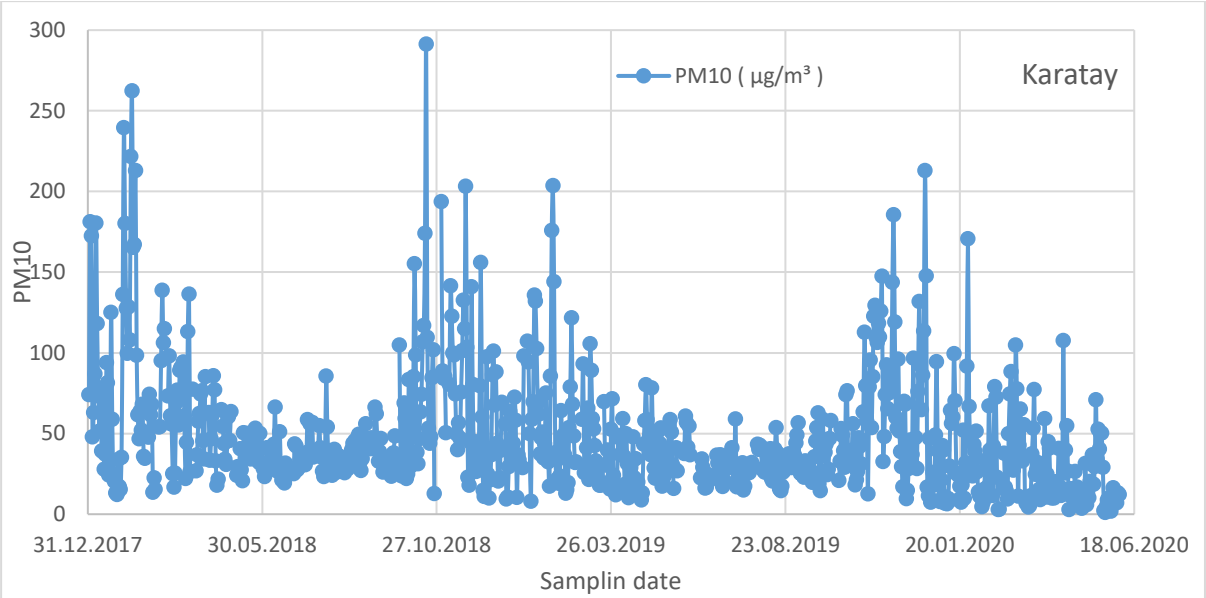

Figure 9. Daily mean values of PM_{10}, as an air quality parameter of Karatay, Konya sampling station from the end of March of 2018 to the middle of October 2019.

Daily mean values of PM10, as an air quality parameter of Selcuklu municipality, Konya sampling station from the beginning January of 2018 to the middle of June 2020 (Figure 9) which shows that PM_{10}, values decreased during a pandemic outbreak. PM_{10} values during the summer hot period lower than colder winter periods. Eight-month values from the middle of December 2018 are missing for some problem of the sampling equipment in the station.

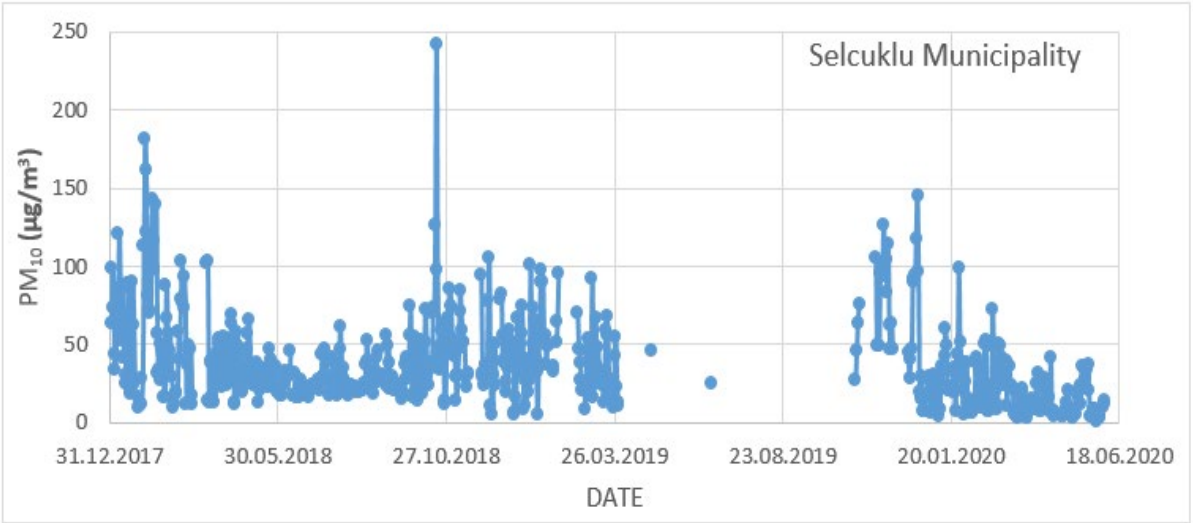

Figure 10. Daily mean values of PM_{10}, as an air quality parameter of Selcuklu municipality, Konya sampling station from the beginning of January of 2018 to the middle of June 2020.

Daily mean values of PM_{10}, as an air quality parameter of Erenkoy, Konya sampling station from the end July of 2018 to the end of December 2018 (Figure 9) PM_{10} values were higher during colder winter periods. Other values than 4 months are missing for some problem of the sampling equipment in the station.

Figure 12 explains the monthly mean of PM_{10} levels for three different sampling stations at Meram, Karatay, and Selcuklu districts of Konya city center from the beginning of January of 2018 to the middle of June 2020. When data were being examined the monthly mean of PM_{10} values for three different sampling stations shows that winter periods are high and summer periods are lower in a comparison between seasonal rates. Solid lines show the period of March 16 to the end of May which is Match 16

to the end of May 2020 is significantly lower than the 2018 and 2019 periods. Table 1 is summarizing the statistical reduction during the period of pandemic outbreak time (16 March to end of April 2020) which is lower than before the quarantine period (1 January to 15 March 2020) and also lower than a similar time scale of 2018 and 2019 period. The monthly mean of $PM_{2.5}$ values during the pandemic outbreak quarantine period (01 January to 15 March 2020) was also lower than before the quarantine period (1 January to 15 March 2020) and the same period of 2018 and 2019.

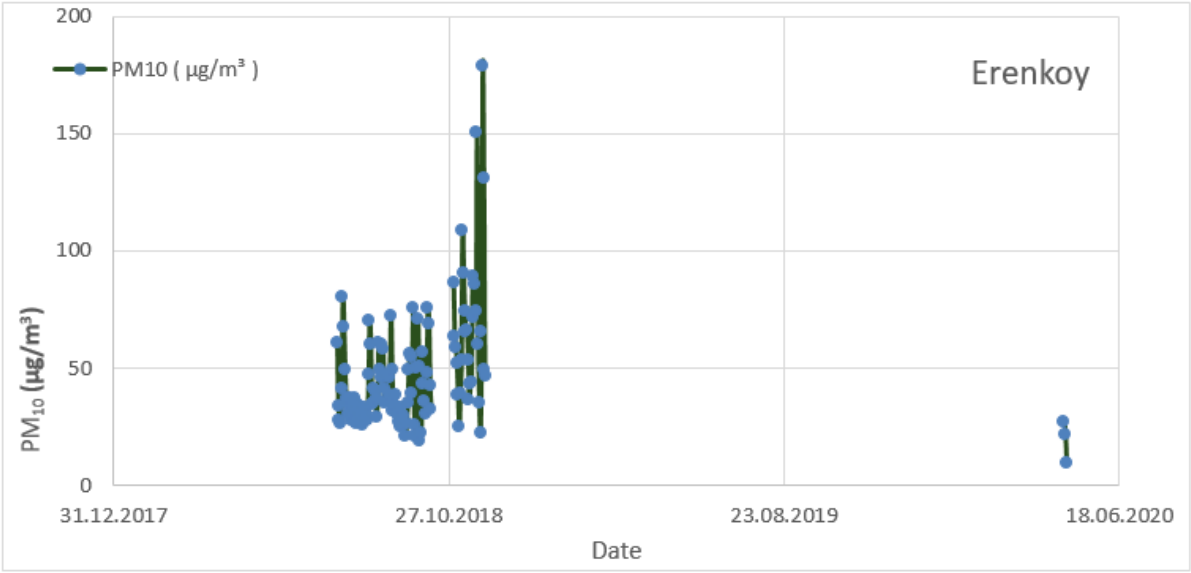

Figure 11. Daily mean values of PM_{10}, as an air quality parameter of Erenkoy, Konya sampling station from the beginning of January of 2018 to the middle of June 2020.

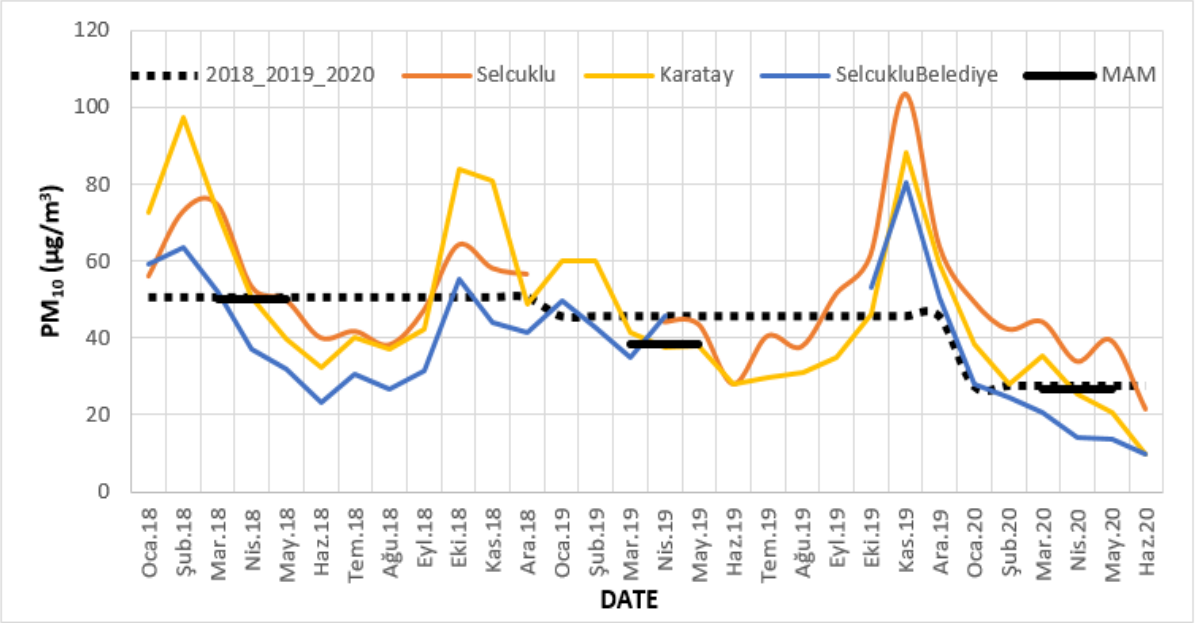

Figure 12. Monthly mean of PM_{10} values for three different sampling stations at Karatay and Selcuklu districts of Konya city center from the beginning of January of 2018 to the middle of June 2020.

PM, air quality parameters of Konya all sampling station which they show PM_{10} and $PM_{2.5}$, values decreased during COVID-19 pandemic outbreak. Some values of sampling stations are missing and some calculations are not possible (n.a.). It is clearly has been shown that during the pandemic quarantine period, air quality was improved (Table 1).

Table 1. Decrease of PM 10 and 2.5-micrometer particle size values during the pandemic outbreak quarantine period (1 January to 15 March 2020).

		PM_{10} (µg/m^3)			$PM_{2,5}$ (µg/m^3)		
Periods / **Years**		**2018**	**2019**	**2020**	**2018**	**2019**	**2020**
Period 1		72	116	42	n.a.	n.a.	35
Period 2		116	35	25	n.a.	26	22
Period 2/ Period 1		61	**-70**	**-40**	n.a.	n.a.	**-36**
Term2 (2020) - Mean Term2 (2018, 2019)				**-66**			n.a.

Conclusion

Due to the continental climate of the Konya province, the winter season is very cold. Therefore, air pollution emissions to the atmosphere increase depending on the amount of fossil fuel used for the heating system of heating of residences and other buildings. Meteorological conditions are also important airborne periods determinant in air pollution since the emission is important in air pollution. Covidien-19 coincides with the emergence of the pandemic in Turkey that period that corresponds with the end of the winter, although air pollution is also reduced with increasing temperature. The restrictions imposed by the pandemic, besides decreasing the traffic density, caused the emissions to decrease as it also reduces the industry activities. Therefore, the decrease in the level of air pollutants between before and after the restriction is more pronounced compared to previous years. Thus, the air quality of restrictions applied during the Covid-19 pandemic quarantine measures was greatly influenced positively. Especially the improvement in air quality may be considered as one of the important gains with the pandemic measures. Air quality monitoring studies are of great importance in terms of determining the causes and sources of pollution. Their distribution, developing appropriate control strategies and controlling the effectiveness of these strategies. It was revealed that the measures are taken in the period of a virus outbreak, prohibition of traffic and the reduction of industrial activities caused, a remarkable improvement in air quality. Considering the measures and improvements in air quality, it is considered to be worth investigating how the measures should be evaluated in the coming periods in combating air pollution.

Future Recommendations

Due to the continental climate of the Konya province, the winter season is very cold. Therefore, air pollution emissions to the atmosphere increase depending on the appropriate control strategies and controlling the effectiveness of these strategies. It was revealed that the measures are taken in the period of a virus outbreak, prohibition of traffic and the reduction of industrial activities caused, a remarkable improvement in air quality. Considering the measures and improvements in air quality, it is considered to be worth investigating how the measures should be evaluated in the coming periods in combating air pollution.

Acknowledgments: *The authors are grateful to the Ministry of Environment and Urbanism of Turkey, the Turkish State Meteorological Service for air pollution and meteorological data.*

References

Abbasnia M & Toros H 2020 Trend analysis of weather extremes across the coastal and non-coastal areas (case study: Turkey). *J. Earth Syst. Sci*. **129**:95, 1-13. https://doi.org/10.1007/s12040-020-1359-3

Ali K, Trivedi D K, Chate DM, BeigG, Acharja P and Trimbake H K, 2019 $PM_{2.5}$, PM_{10} and surface ozone over Lumbini Protected Zone, Nepal, during monsoon season of 2012. *J. Earth Syst. Sci*. **128**:881-13. https://doi.org/10.1007/s12040-019-1118-5

Arkin, F, (2020) *Asian COVID-19 lockdowns clear the air of pollutants*. Sci. Dev. Net. https://www.scidev.net/asia-pacific/environment/news/asian-covid-19-lockdownsclear-the-air-of-pollutants.html.

Bao, R, Zhang A, (2020). Does lockdown reduce air pollution? Evidence from 44 cities in northern China. *Sci. Total Environ*. **731**. 139052.10.1016/j.scitotenv. 2020.139052.

Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, Li J, Zhao D, Xu D, Gong Q, Liao J, Yang H, Hou W, Zhang Y, (2020) Clinical characteristics and intrauterine vertical transmission potential of

COVID-19 infection in nine pregnant women: a retrospective review of medical records. Lancet https://doi.org/10.1016/S0140-6736 (20) 30360-3.

CNN, (2020) doi. https://edition.cnn.com/2020/04/09/politics/airline-passengers- decline/index.html.

Dutheil F, Baker SJ, Navel V, (2020) COVID-19 as a factor influencing air pollution? Environ.Pollut. https://doi.org/10.1016/j.envpol.2020.114466.

Huang, C, Wang, Y, Li, X, Ren, L, Zhao, J, Hu, Y, Zhang, L, Fan, G, Xu, J, Gu, X, Cheng, Z, Yu, T, Xia, J, Wei, Y, Wu, W, Xie, X, Yin, W, Li, H, Liu, M, Xiao, Y, Gao, H, Guo, L, Xie, J, Wang, G, Jiang, R, Gao, Z, Jin, Q, Wang, J, Cao, B, 2020. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 395, 497–506. https://pesquisa.bvsalud.org/controlecancer/resource/pt/mdl-31986264?src=similardocs.

Kanniah K, Zaman K, Nurul, Kaskaoutis D, Latif MT, (2020). COVID-19's impact on the atmospheric environment in the Southeast Asia region. S*cience of The Total Environment.* **736**. 139658. https://doi.org/10.1016/j.scitotenv.2020.139658.

Khan MF, Hamid AH, Bari MA, Tajudin AB, Latif MT, 2019. Airborne particles in the city center of Kuala Lumpur: Origin, potential driving factors, and deposition flux in human respiratory airways, Science of The Total Environment 650, Part 1, 1195-1206.

Muhammad S, Long X, (2020). COVID-19 pandemic and environmental pollution: A blessing in disguise? S*ci. Total Environ.* **728**. 138820. https://doi.org/10.1016/j.scitotenv.2020.138820.

Otmani A, Benchrif A, Mounia T, Bounakhla M, Chakir, E, Bouch M, Krombi M, (2020). Impact of Covid-19 lockdown on PM_{10}, SO_2 and NO_2 concentrations in Salé City (Morocco). *Sci. Total Environ*. **735**. 139541. 10.1016/j.scitotenv.2020.139541.

URL-1 http:/webgiscovid19.beyond-eocenter.eu/index.php http:/webgiscovid19.beyond-eocenter.eu/index.php. Retrieved September 2020

URL-2 https:/www.carbonbrief.org. Retrieved September 2020

URL-3 https://www.mgm.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?m=KONYA. Retrieved September 2020

URL-4 https://www.google.com.tr/maps. Retrieved September 2020

URL-5 https://csb.gov.tr/ Retrieved September 2020

Wang, P, Chen, K, Zhu, S, Wang, P, Zhang, H, 2020. Severe air pollution events not avoided by reduced anthropogenic activities during COVID-19 outbreak. Resour. Conserv. Recycl. 158, 104814. https://doi.org/10.1016/j.resconrec.2020.104814.

Zoran M, Savastru RS, Savastru DM and Marina, N. 2020 Assessing the relationship between surface levels of $PM_{2.5}$ and PM_{10} particulate matter impact on COVID-19 in Milan, Italy, *Sci. Total Environ. 738:139825* https://doi.org/10.1016/j.scitotenv.2020.139825, ,

Zoran M, Savastru R, Savastru D and Penache MC 2019 Temporal trends of carbon monoxide (CO) and radon (^{222}Rn) tracers of urban air pollution. *J. Radio. & Nuclear Chem.* **320**, 55-70. https://doi.org/10.1007/s10967-019-06443-7