Abstract: Geographical information systems are frequently used in analyses of air quality based on location and time. They are also used in the creation of pollution distribution maps to determine the parameters related to air pollutants. In this study, a spatial analysis of SO\textsubscript{2}, PM\textsubscript{10}, CO, NO\textsubscript{2}, and O\textsubscript{3} pollutants, which cause air pollution within the borders of the municipal urban areas of Konya province, was carried out for the years 2019–2020. In this context, air pollution maps were produced using the IDW interpolation method with data obtained from the National Air Quality Monitoring Network stations, which belong to the Ministry of Environment and Urbanization, in the Konya region. The results obtained were examined with maps and graphics based on the limit values found in the Air Quality Assessment and Management Regulation published by the Ministry of Environment and Urbanization. In this context, the periods of lockdown experienced during the COVID-19 pandemic were also evaluated in terms of air pollution. From the evaluation made on the values taken from the air quality stations, it can be observed that the air pollution did not violate the national limit value much in 2019 and 2020.

Keywords: air pollution; geographic information system; pollutants; spatial analysis

1. Introduction

Air pollution is one of the most critical concerns encountered in urban areas, especially in developing nations. According to reports from the World Health Organization (WHO), 7,000,000 people die from air pollution each year. Of this number, 4,000,000 deaths are caused by outdoor pollution and 3,000,000 are caused by indoor pollution [1]. The situation is even worse for younger age groups. According to the World Health Organization, 7% of children aged 15 and younger worldwide live in areas below the PM2.5 limit value set by the World Health Organization. This rate is more serious in children aged 5 years and younger, and 10% of these children die from air pollutants. [2].

Scientists and researchers have long been working to measure and monitor the values of pollutants, monitor and model their quality, and determine the causes and sources of pollution. In addition, work has been performed to find solutions to air quality problems by determining strategies. Mathematical models (statistical model—multiple linear regression and deterministic models—point, area, and line source models, etc.) show how pollutants emitted into the atmosphere from any source will disperse according to their chemical reactions to atmospheric conditions [3]. These mathematical models are divided into statistical and deterministic models. Statistical models are based on the analysis of past air quality monitoring data. Deterministic models are based on a mathematical description of the physical and chemical processes that occur in the atmosphere. These models are based on mathematical equations that express conservation laws of mass, momentum, and energy [4]. Air quality modeling is crucial for preventing environmental damage from the emissions emitted from facilities or sources in a region and to create control strategies [5,6]. The American Meteorological Society and Environmental Protection Agency...
Regulatory Model (AERMOD) is mostly used to model air quality. AERMOD examines the distribution of emissions from industrial facilities over a short distance (a maximum of 50 km). In addition, there are point, areal, and linear models developed by the California Puff Model (CALPUFF) and the Environmental Protection Agency (EPA). Meteorology and the meteorological parameters in a region play a vital role in air quality modeling [7–10]. However, the process of obtaining these data is time-consuming [10]. There are also various studies on air quality monitoring using remote sensing data [11–16]. In addition to these methods, geographic information systems (GISs) are used in modeling air quality. GISs are a very important application of information technology in terms of producing new and fast solutions to social problems apart from the traditional approach by using a variety of geographical information found around the world. GISs allow researchers to evaluate and analyze the results obtained from any map-based data or information. Since the coordinates of stations at which pollutants are measured can be determined, GISs are very effective in creating pollution distribution maps. There are many studies in the world and in Turkey that are using GISs in pollutant analyses of PM10, PM_{2.5}, CO, SO2, NO2, and NOx [17–27]. In these studies, spatial distribution maps of air quality were designed using GISs, and the results of the pollution index map, designed using ArcGIS software, were discussed. In addition, when using a GIS, the air pollution potential of the study area is investigated by considering the determining factors, such as population density, traffic, industries, wind speed, precipitation, and temperature.

In many recent studies, the effect of the lockdown due to the COVID-19 pandemic on air pollution was investigated [28–30]. During the COVID-19 pandemic, public transportation or vehicle usage rates greatly decreased with the transition to distance education in schools, the flexible working method of institutions, and the announcement of curfews. In the research conducted in large cities (New York, Los Angeles, Zaragoza, Rome, Dubai, Delhi, Mumbai, Beijing, and Shanghai) around the world, it was stated that the PM_{2.5} value decreased during the closures due to COVID-19 compared to previous periods (2017–2019) [28]. In a study conducted in Brazil, the concentrations of PM, CO, NO2, and O3 were determined during the closure period and before the closure. A certain decrease in the pollutant levels was determined. It was stated this decrease may also be caused by meteorological effects. [29]. In China in 2019, almost all avoidable activities were prohibited since Wuhan announced a lockdown on 23 January 2020. Despite reduced activity, severe air pollution events still occurred in the North China Plain, prompting discussions regarding the reasons for which severe air pollution was not avoided. Due to the meteorological effects, it was concluded that the pollution continued despite the closure and that additional measures should be taken [30]. In addition to these studies, there were also studies investigating the discomfort and death rates caused by COVID-19 in regions in which the air pollution was intense [31–33]. According to mobility reports published by Google, the mobility rates of public transport stations decreased by 64% throughout Turkey from the time that the rule for passenger transport in public transport vehicles at 50% capacity was implemented on March 23 to the normalization [34].

Konya is one of the cities with the highest air pollution in Turkey. With the IKONAIR (Improvement of Air Quality Management In Metropolitan Cities) project, which was completed in 2012 after two years of work, the Konya air quality was studied in detail, and comprehensive action plans covering the years 2012–2019 were prepared with all positive and negative scenario evaluations. At the beginning of the project, information describing the emissions from all relevant sources in Konya was collected, including emissions from domestic heating, traffic, and industry. The contemporary state of air quality in Konya was determined based on the air quality measurements taken from continuous monitoring stations, data collected from a specially designed measurement campaign, distribution model calculations, and an emissions inventory [35,36]. In another study, the air quality of eight provinces in Turkey, including Konya, was analyzed with respect to PM_{10}, SO2, NO2, NO, NOx, CO, and O3 data between 2009 and 2016. As of 2016, a decrease of 22.4% was detected in the air pollution in these cities according to the PM, O3, and NO2 data. While air
pollution was above the national legal limit value from 2009 to 2013, it showed a decreasing
trend from 2013 to 2016. It can be speculated that the determinations, improvements, and
plans that were made in line with the scenarios envisaged within the scope of the ICONAIR
project initiated in 2012 contributed to this decrease [37]. Similarly, in a study conducted
using SO$_2$ and PM$_{10}$ data from the years 2010–2012, air pollution was revealed to be above
the national limit values, despite the causes of pollution and solution suggestions [38].

In this study, a spatial analysis of SO$_2$, PM$_{10}$, CO, NO$_2$, and O$_3$ pollutants was carried
out using data from 2019–2020 from within the borders of the adjacent area of Konya. Air
pollution maps were created by using the SO$_2$, PM$_{10}$, CO, NO$_2$, and O$_3$ data, measured in
1, 8, and 24 h, that were obtained from air quality monitoring stations within the borders of
the adjacent area of Konya. Pollution maps were examined according to European Union
and national limit values. The spatial analysis was carried out while taking into account
the effects of traffic density, industry, industrialization, etc. The effects of the closure
processes experienced in 2019–2020 on air pollution during the COVID-19 lockdown were
also evaluated.

2. Air Pollutants and Air Quality

Air quality monitoring stations under the control of the Ministry of Environment and
Urbanization were established in all provinces in order to obtain accurate air pollution
values, raise awareness that the fight against air pollution is important for people, and to
explain that management policies must be created to allow access to clean air for all people.
Sulfur dioxide (SO$_2$), particulate matter (PM$_{10}$), nitrogen oxides (NO$_x$), carbon monoxide
(CO), and ozone (O$_3$) parameters are automatically measured from these stations.

In order to determine the air quality, measuring instruments that record the concen-
trations of pollutants with existing connections are used. The data obtained from these
measurement instruments were converted into Air Quality Index (AQI) parameters using
the developed algorithms. These converted values were obtained separately for each pollu-
tant. The highest AQI value obtained for a day provides the evaluated pollutant value [39].

The air quality index is calculated for five main pollutants (PM$_{10}$, SO$_2$, NO$_2$, O$_3$, and
CO). The AQI consists of six categories: the first category includes very good quality (very
clean) air, while the sixth category indicates very bad quality (very polluted) air [5].

Air quality in Turkey is measured by the Ministry of Environment and Urbanization
at 355 stations in 81 provinces through the National Air Quality Monitoring Network. It is
available to relevant researchers (www.havaizleme.gov.tr (accessed on 12 February 2023)
and http://mobil.havaizleme.gov.tr (accessed on 12 February 2023)).

3. Materials and Methods

Konya is located between the 36°41’ and 39°16’ north latitudes and the 31°14’ and
34°26’ east longitudes (Figure 1). The average elevation of Konya is 1.016 m, and it has a
population of approximately 2 million. It is a closed basin surrounded by mountains that
form a vast pit. The surrounding mountain ranges limit air movement and wind formation
and, especially in winter, prevent the polluted air from leaving the city, causing fog and
smoke to concentrate and increasing air pollution [40–42]. The south of the basin has warm
and rainy winters and hot and dry summers, while the central and northern parts have cold
winters and hot and dry summers. Generally, precipitation occurs in the winter and spring.
In recent years, the renewable energy, software, food, weapons, automotive spare parts, defense, and agricultural and other machinery-manufacturing industries and the pharmaceutical sectors, etc., have been developing in Konya. As one of the 81 provinces of Turkey, Konya ranks first in the export of agricultural machinery and equipment, fourth in the export of the defense industry, fifth in the number of industrial enterprises, second in the number of automotive sub-industries and basic metal manufacturers, third in the number of machinery equipment manufacturers, and third in the number of food manufacturers. Fossil fuels consumed in residences and workplaces due to the need for heating are among the biggest causes of air pollution in the Konya city center. However, it is known that pollutants originating from large-scale industrial establishments, which are established in the city center, and exhaust emissions resulting from the rapidly increasing vehicle density, industry, and human factors also increase pollution [35,36].

This study was carried out within the borders of the adjacent area of Konya province. Data from 2019-2020 on the SO$_2$, PM$_{10}$, CO, NO$_2$, and O$_3$ pollutants, obtained from five stations which regularly measure pollutants and are operated by the Ministry of Environment, Urbanization and Climate Change, were used. These data are presented hourly and daily on the Ministry website free of charge. These stations allow for detailed measurements to be taken with a high accuracy. The type of sensors and type of measurements are shared in detail on the Ministry’s air quality centers web page [43,44]. However, the number of stations is not yet high enough for geospatial analysis. For this purpose, low-cost sensors (LCS) can be used; however, the European Union does not allow measurements from these sensors to be used for reporting [45,46].

The locations and study areas of the stations belonging to the province of Konya are shown in Figure 2.

![Figure 1. The map of Konya Province.](image-url)
Complex data began to be supported by producing a type of software called spatial data server software. This software allows spatial data to be stored in database systems. These software find a wide application area in GISs because they allow for different queries and are easy to use. The most important analytical operation of a GIS is the use and analysis of spatial data [47]. Statistical analysis and geostatistical analysis can be performed with a GIS. In statistical analysis, the daily highest, lowest, and average temperatures can be easily calculated without the need for the spatial information of the stations. Geostatistical analysis, on the other hand, is an inexpensive and logical method for analyzing various datasets that require a high cost and long-term analysis [48]. Geostatistical analysis enables the estimation of the variables by interpolating the variables that do not have an observational area with a certain structure in a certain area and the positions of the observable variables [48]. By combining geostatistical and spatial analyses, users can decide on the frequency, distribution, and impact of the sampling stations and analyze the interaction between transport and air pollution. Kriging and deterministic methods (inverse distance weighted—IDW, global polynomial, local polynomial, radial-based functions, and linear regression) can be mentioned for geostatistical analysis [10,16,49,50]. One of these studies aimed at assessing the spatial air quality and the fitness of spatial mapping using data collected by twelve selected monitoring stations in Mumbai, India. The collected data were spatially interpolated using the available interpolation tools of ArcGIS [51], including inverse distance weight (IDW), Kriging (spherical and Gaussian), and Spline techniques by the leave-one-out scheme [10]. To estimate the amount of PM\textsubscript{10} and SO\textsubscript{2}, the traditional multiple linear regression (MLR) and artificial neural network (ANN) modeling were applied to the processed remote sensing data. The results thus obtained were assessed using an independent test data. Multitemporal Landsat ETM+ remote sensing imagery of the study area in Vadodara, India, was used [16]. The objective of another study was to map PM\textsubscript{2.5} using two widely used spatial interpolation techniques (Kriging and IDW) by predicting the concentration at distinct, unmonitored locations. The generated maps can help in policy formulation, with financial, logistical, and location problems, and with decision making by providing aid in the PM\textsubscript{2.5} visualisation of spatial and temporal variabilities [52]. Ray and Kim evaluated the spatial and temporal distributions and the standard deviation

![Locations of study area and Konya Province air quality monitoring stations.](image-url)
and means of SO\textsubscript{2} in seven major cities. The potential sources of SO\textsubscript{2} and its exposure risk in the target cities were also assessed [49].

The most commonly used deterministic methods are the inverse distance weighted (IDW) and Spline methods [10,47–49]. The IDW method was used in this study.

The IDW method is preferred for obtaining the value of unknown points by using the values of known points. In this method, only the data are evaluated and compared locally [53].

IDW method formulated with (Equation (1));

\[
Z(X_0) = \frac{\sum_{i=1}^{n} z(X_i) \cdot d_i^{-r}}{\sum_{i=1}^{n} d_i^{-r}}
\]

where \(Z(X_0)\) is the location where the estimates will be made, \(z(X_i)\) is a function of \(n\) where the measurements are made, \(r\) represents the weights assigned to the predicted value, and \(d\) is the distance between the known value point and the value to be estimated. This method is very suitable for describing continuously changing data (precipitation, wind, pollution, etc.) covering a region [53].

4. Results and Discussion

National and EU member state limit values are provided in Table 1. The graphics and maps of the pollutants were evaluated according to this table. Considering the different effects of different air pollutants at different concentrations and durations, the level of air pollution is explained with a numerical scale so that it can be understood more easily in daily life. The Air Quality Index (AQI) consists of six categories. Category 1 represents very high quality (very clean) air; Category 6 refers to very poor quality (very polluted) air [11]. A comparison of the AQI values and the concentration levels of pollutants for the five main pollutants (PM\textsubscript{10}, SO\textsubscript{2}, NO\textsubscript{2}, O\textsubscript{3}, CO) is provided in Table 2.

Table 1. Limit values of some pollutants [2].

<table>
<thead>
<tr>
<th>Air Quality Standards</th>
<th>SO\textsubscript{2} µg/m\textsuperscript{3}</th>
<th>NO\textsubscript{2} µg/m\textsuperscript{3}</th>
<th>CO µg/m\textsuperscript{3}</th>
<th>O\textsubscript{3} µg/m\textsuperscript{3}</th>
<th>PM10 µg/m\textsuperscript{3}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 h Average</td>
<td>1 h Average</td>
<td>8 h Average</td>
<td>8 h Average</td>
<td>24 h Average</td>
</tr>
<tr>
<td>national legal limit value</td>
<td>410</td>
<td>270</td>
<td>10,000</td>
<td>120</td>
<td>70</td>
</tr>
<tr>
<td>EU member states limit value</td>
<td>350</td>
<td>200</td>
<td>10,000</td>
<td>120</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 2. Air Quality Index and concentration levels [2].

<table>
<thead>
<tr>
<th>Air Quality Index</th>
<th>SO\textsubscript{2} µg/m\textsuperscript{3}</th>
<th>NO\textsubscript{2} µg/m\textsuperscript{3}</th>
<th>CO µg/m\textsuperscript{3}</th>
<th>O\textsubscript{3} µg/m\textsuperscript{3}</th>
<th>PM10 µg/m\textsuperscript{3}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 h Average</td>
<td>1 h Average</td>
<td>8 h Average</td>
<td>8 h Average</td>
<td>24 h Average</td>
</tr>
<tr>
<td>Good</td>
<td>0–50</td>
<td>0–100</td>
<td>0–100</td>
<td>0.5–500</td>
<td>0–120</td>
</tr>
<tr>
<td>Moderate</td>
<td>101–150</td>
<td>251–500</td>
<td>201–500</td>
<td>10,001–16,000</td>
<td>161–180</td>
</tr>
<tr>
<td>Severe</td>
<td>301–500</td>
<td>&gt;1101</td>
<td>&gt;2001</td>
<td>&gt;32,001</td>
<td>&gt;701</td>
</tr>
</tbody>
</table>

No data could be obtained from the Erenköy station in 2019. For this reason, this station was disabled while the maps were being created. Therefore, data from four stations in 2019 and five stations in 2020 were used.

In Figure 3, the monthly 24 h averages of PM\textsubscript{10} air pollution for the years 2019 and 2020 taken for one year are shown. The limit value given in Table 1 is 70 µg/m\textsuperscript{3} for PM\textsubscript{10}. It is shown using a red dashed line. When the values are examined, it can be observed that
the value is below the limit value during the year; however, the limit value is approached and then exceeded in October, November, and December. PM$_{10}$ pollution maps are shown in Figure 4.

![Figure 3. Monthly Values of PM$_{10}$ (2019–2020).](image)

![Figure 4. PM$_{10}$ pollution maps of the adjacent areas of Konya province for the years 2019–2020.](image)

Industry activities are at the forefront of the factors affecting the PM$_{10}$ value. Heating-induced fuel consumption activities also negatively affect the PM$_{10}$ value and are very harmful to human health. Particulate matter emitted from the factories operating in the central districts of Konya, which was chosen as the study area, maintain standards throughout the year. However, an increase was observed in October, December, and January, when the consumption of heating fuel increased. When the values formed on the map are examined, it can be seen that the monthly averages for 2019 and 2020 are generally in the good category. Sometimes there is a transition to the middle category, and very rarely the values are in the sensitive category. The time series of the PM$_{10}$ index and the standard deviation, minimum, maximum, and average values of the PM$_{10}$ values are provided for each station in Figures 5–8. Among the pollutants, only the PM$_{10}$ value is observed to exceed the national legal limit value at certain times. For this reason, only the PM$_{10}$ value was examined with the daily time series graph. As can be seen in Figures 5–8, the PM$_{10}$ values are quite high in winter months compared to summer months.

In Figure 9, the monthly 1 h averages of the SO$_2$ air pollutants, taken for one year for the years 2019 and 2020, are shown. According to the Table 1, the limit value for SO$_2$ is 410 µg/m$^3$. When the maps are examined, the averages for 2019 and 2020 all appear in the good category. When an evaluation is made on the maximum and minimum values, it has been observed that the dirtiest place is Meram and the cleanest place is the Selçuklu district (Figure 10). It can be seen that the values are higher in the winter season, and that the values decrease depending on the season and the warming of the weather conditions. During the lockdown period, when curfews were enforced, industrial emissions decreased compared to the pre-pandemic period.
During the lockdown period, when curfews were enforced, industrial emissions decreased compared to the pre-pandemic period.

Figure 5. PM$_{10}$ time series and min., max., mean, and std values of Karatay station (2019–2020).

Figure 6. PM$_{10}$ time series and min., max., mean, and std values of Meram station (2019–2020).

Figure 7. PM$_{10}$ time series and min., max., mean, and std values of Selçuklu station (2019–2020).
In Figure 11, the monthly 8 h averages, taken for one year, of CO air pollutants for the years 2019 and 2020 are shown. The limit value for CO is 10,000 µg/m³ (Table 1); it is not shown on the chart in order to avoid complicating the reading of the tables since it is a much higher value than the other values obtained. While the main sources of indoors CO pollutant are cigarette smoke and heating, approximately 90% of the sources in outdoor environments are gasoline vehicles. In addition, fires, forest fires, and solid waste incineration plants are responsible for 10% of the carbon monoxide in the outdoor environment. Since it is a colorless, odorless, and tasteless gas, people who are exposed to this gas may not realize it most of the time. Therefore, it is very important to have protection systems in living spaces [3]. The maximum value for 2019, 2333.02 µg/m³, was recorded at Meram station in December. The maximum value for 2020, 2006.52 µg/m³, was recorded at Meram station in December. It can be seen that there is a higher increase in the winter months compared to other times. Despite this increase, the CO value is below the
national legal limit value. Figure 12 shows the CO pollution maps of the adjacent areas of Konya province for the years 2019–2020.

Figure 11. Monthly values of CO (2019–2020).

Figure 12. CO pollution maps of the adjacent areas of Konya province for the years 2019–2020.

In Figure 13, monthly averages of 1 h, taken for one year of NO$_2$ air pollutants in 2019 and 2020, are shown. The maximum value for 2019 (105.01 µg/m$^3$) was recorded at Karatay station in July. The maximum value for 2020 (71.77 µg/m$^3$) was recorded at Selçuklu station in October. The limit value for NO$_2$ is 270 µg/m$^3$; all averages are in the good category. NO$_2$ pollution maps are shown in Figure 14. NO$_2$ greatly affects human health and is one of the most important air pollutants in urban areas. The main sources of NO$_2$ pollutants are human resources and the overuse of these resources, such as fossil-fuel-burning boilers in industrial plants, and vehicles on land, in the air, and in the sea. In terms of human health effects, even the brief exposure of a healthy person to very high NO$_2$ concentrations can cause serious lung damage. It has been observed that the curfews initiated with the measures taken during the lockdown period caused the air quality to increase, and the NO$_2$ values decreased in parallel.

Figure 13. Monthly Values of NO$_2$ (2019–2020).
Figure 14. NO₂ pollution maps of the adjacent areas of Konya province for the years 2019–2020.

The O₃ pollutant was recorded only at the Karkent, Karatay, and Erenköy stations. The limit value provided in Table 1 is 120 µg/m³, and it was not possible to exceed the limit value for 2019 and 2020. It can be seen that the highest values for 2020 were recorded at the Erenköy station in the first 6 months. Monthly values and pollution maps of O₃ are shown in Figures 15 and 16. The ozone concentration usually occurs in the summer months when the sun is effective; that is, during the high temperatures of the summer. It can seriously badly affect those who perform physical activity outside at noon, the entire respiratory system, asthma patients, lung patients, children, and the elderly. Considering the monthly values, it can be seen that there was a significant decrease in air pollution in 2019 and 2020 due to the COVID-19 lockdown.

Figure 15. Monthly values of O₃ (2019–2020).

Figure 16. O₃ pollution maps of the adjacent areas of Konya province for the years 2019–2020.

5. Conclusions

The data obtained in this study, which was carried out within the borders of the adjacent area of Konya Province, were examined through graphics. Air pollution maps of SO₂, PM₁₀, CO, NO₂, and O₃ pollutants were designed, and air pollution analyses were made for the years 2019 and 2020.

In the evaluation of air pollution, it can be seen that the national limit value was not violated often in 2019 and 2020. It can be observed that the PM₁₀ value exceeded the limit.
value in only in October, November, and December in both years. When the full restriction, partial restriction, and full closure processes which occurred in Turkey due to the COVID-19 pandemic in 2020 were examined, no difference could be detected from 2019.

It has been determined that the study area can be evaluated as good according to the limit values of the Air Quality Assessment and Management Regulation published by the Ministry of Environment and Urbanization. Within the scope of the IKONAIR project, action plans with different scenarios were prepared for the years 2012–2019. In order to prevent city air pollution and improve air quality, the current situation has been examined through maps and graphics. Facilities with a high pollution load (emission output) on a source basis, the incineration of industrial wastes, roads with high traffic density, fuel distribution used in domestic heating, and public transportation and alternative roads, etc., were examined. Regions with a high pollution load were graded, and action plans were prepared by planning relevant measures on a regional basis. It is thought that the clean air action plans put into practice for the years 2012–2019 were effective in their results. From the analyses, which included meteorological factors, pollutant emissions, industrial zone facilities, and transportation network plans where fuel use was taken into account with precision, it can be seen that the air pollution is under control. For now, the 2020–2024 clean air action plans have been implemented. In this context, it is stated that the inspection of industrial and domestic fuel use has been increased, transportation networks are planned to reduce air pollution, and air quality monitoring stations are regularly controlled and monitored [54].

Especially in winter, the use of fossil fuels used for heating should be limited, or the use of natural gas should be encouraged. In addition, current pollution maps should be created by determining the situation at certain time intervals. Air pollution action plans should be updated regularly and should be ready for implementation at any time. The carbon fraction is highly effective in PM$_{10}$ values. This can be caused by the migration of air pollutants from neighboring municipalities (where the use of fossil fuels for heating is allowed). In regions with air pollution potential, the surroundings should also be kept under control [55]. It is stated that Krakow is the city with the highest air pollution, despite many restrictive laws in Poland. It has been revealed that the pollutants are transported from the surrounding regions due to the effect of meteorological factors with respect to location. A significant relationship was found between the topographic structure of the city and its meteorological features in terms of air pollution. Solid fuel heating outside the city raises PM$_1$, PM$_{2.5}$, and PM$_{10}$ concentrations due to air pollution input [55]. As a result of the analysis of wind direction, pressure, temperature, and humidity data, it can be stated that the air pollution caused by solid fuel heating decreased to a certain extent during the closures due to COVID-19 in Krakow [46]. Konya is a closed basin surrounded by mountains. For this reason, it is not stated that air pollution from the surrounding regions is carried by meteorological effects. Air pollution can be interfered with by locally taken measures.

Regarding the study carried out using the data obtained from the Air Quality monitoring stations: in order to obtain more reliable and more accurate results, it is recommended to shorten the maintenance times, to intervene immediately in cases of failure, and to provide a temporary station when necessary. The number of stations should be increased for a more rigorous analysis of pollution.

When the air pollution reports are examined by years, it can be seen that the pollution was slightly reduced by the measures taken. However, there are still deficiencies in some areas, especially in the industry. At this point, changing the existing laws and rules related to air pollution, making frequent inspections in the light of these rules, investigating the reasons for the instant increase in air pollution values, and taking the necessary precautions are important steps.

The study is the result of a two-year due diligence. It was intended to make a prediction regarding air pollution in the coming periods by examining the time periods determined in the past.
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