DARK REPORT 2020

Air Pollution and Health Impacts

righttocleanair PLATFORM

Right to Clean Air Platform - Turkey

Right to Clean Air Platform-Turkey consists of 16 professional organizations and NGOs working on air pollution and health impacts in Turkey since 2015. The aim of the Platform is to advocate for the right to live in an environment with clean air and to protect the public health from air pollution, especially resulting from the existing and planned coal-fired power plants in Turkey.

Platform Constituents are:

Association of Public Health Professionals (HASUDER)
CAN Europe
General Practitioner Association of Turkey
Greenpeace Mediterranean
Green Peace Association
Green Thought Association
HEAL - Health and Environment Alliance
Physicians for Environment Association
Turkish Medical Association (TTB)
Turkish Neurological Society
Turkish Respiratory Society (TÜSAD)
Turkish Society of Occupational Health Specialists (İMUD)
TEMA Foundation
Yuva Association
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Executive Summary

The Right to Clean Air Platform is the first umbrella organization formed to preserve and improve air quality by 16 institutions operating in the fields of health and environment in Turkey. Since 2015, the platform has produced several reports and expert opinions on the health impacts of air pollution.

This report is pioneering in terms of being the first one to calculate the **preventable death counts since 2017 due to the air pollution in Turkey.** It is the third study conducted by the Right to Clean Air Platform since 2015 in order to analyse the air quality in Turkey. The report is prepared by combining two consecutive reports from the Platform prepared in 2019 and 2020 about the details of air pollution and its health impacts in Turkey. Additionally, the report contains a specific evaluation of the official air quality data of 2019 as well as a four-year general evaluation of the state of air quality between 2016 – 2020. As another pioneering effort, for the first time, the Right to Clean Air Platform has used the **AirQ+ program** developed by the World Health Organization (WHO) European Office to calculate the number of deaths between 2017 – 2019 that could have been prevented by reducing air pollution in Turkey. Following the aforementioned statistics, the report also details the lacking aspects of legislation in Turkey about air pollution and proposes actions to improve the air quality in the country.

In 2019, we have witnessed the "right to live in a healthy environment", as stated in the Article 56 of Turkish Constitution, being voiced by many people across the entire country in the form of a common demand to breathe clean air in Turkey. 2019 has been a year in which thousands of citizens, especially those from provinces where coal fired power plants operate, contacted decision makers via phone calls, e-mails, and social media to voice their demand for their **"Right to Clean Air"**. This increased awareness is specifically the reason why the Law Proposal that enables a postponement of 2 years for the required environmental investments of coal fired power plants, which have been privatized and exempted from environmental legislation and regulations for already 6 years, were unable to pass into law (Article 45). Even though, later Article 50 was passed at the Turkish Grand National Assembly in November 2019, it has been vetoed by the President and sent back to the parliament, and 5 coal fired power plants that are not in compliance with the environmental legislation were shut down on January 1, 2020.[1]

According to the current data from the Global Burden of Disease[2] study, which is conducted by large-scale fieldwork all over the world, air pollution as a risk factor for death and injuries has risen by 17.4% in Turkey between the years 2007 – 2017. **In other words, air pollution rose from seventh place in 2007 to sixth place in 2017 on the list of risk factors causing death and diseases in Turkey.** Similarly, at our calculations for Dark Report we found out that the reduction of air pollution to the levels suggested by the WHO could have prevented almost **seven times more (approximately 52,000) deaths** than those caused by traffic accidents in 2017.[3]

Current data shows that **91% of the world's population breathes polluted air that is above the guideline limits of the World Health Organization**.[4] According to the 2018 Environmental Performance Index report that includes 180 countries from all over the world, air pollution is defined as the greatest environmental hazard that adversely affects public health.[5] In addition, recent studies have detected particles of black carbon in the samples of placenta tissues, which shows that polluted air is even reaching unborn babies.[6] After all these developments, air quality management is becoming more and more important not only for citizens and but also for decision makers. On a similar note, air pollution strikes as the mostly concerning environmental problem in 2018 in Turkey as well. **According to 2595 participants of a survey conducted in 2019, air pollution is "the biggest problem that affects their lives" where they live.**

The COVID-19 pandemic that arose during the last few months of 2019 reaffirms the vital connection between the environment and public health. Recently conducted studies indicate that individuals are most susceptible to the adverse impacts of viral diseases such as COVID-19 due to the chronic diseases caused by the long term exposure to air pollution. Especially in the light of these recent events, **the management of air quality becomes an even much more important issue for citizens and decision makers around the world.**

[1] Last-minute statement from Minister Kurum: 5 thermal power plants fully, 1 partially closed (News article in Turkish)
[2] IHME, Global Burden of Disease (2020) Turkey
[3] Right to Clean Air Platform (2019), Air Pollution and Health Impacts: The Dark Report Hava Kirliliği ve Sağlık Etkileri: Kara Rapor - Temiz Hava Hakkı
[4] WHO - health topics: air pollution
[5] Yale University (2018), 2018 Environmental Performance Index, 2018 ENVIRONMENTAL PERFORMANCE INDEX
[6] Bove, H. et al (2019), Ambient black carbon particles reach the fetal side of the human placenta, Nature Communications Volume 10, Article number: 3866

Including health professionals who are on the front line against the COVID-19 pandemic, **more than 40 million doctors, nurses and healthcare experts** from 90 different countries including Turkey sent a joint letter to the decision makers to express their call for a 'Healthy Recovery'. Health professionals demand public health to be positioned at the center of economic recovery packages in order to avoid future crises and increase resilience.

Some striking information from Dark Report 2020 are as follows:

- **There are still no regulations with limit values for $PM_{2.5}$ in Turkey and it is not widely measured other than some pilot stations.**
- **No health impacts or cumulative impact assessment** are considered during the Environmental Impact Assessments and permit processes of industrial facilities.
- There is **no sufficient air quality data (PM_{10}) in 30 provinces for 2019.** Additionally, there is **no sufficient data about the carcinogenic fine particulate matter ($PM_{2.5}$) in 60 provinces out of 81 in total.**
- **In Turkey, nearly 18 million people in 30 cities** did not have sufficient data about the quality of the air they breathe in 2019.
- In the provinces of **Eskişehir, Muş, Uşak and Şırnak**, which have a total population of 2 million 196 thousand, even the minimum amount of air quality data has been unknown for 3 consecutive years.
- Among the 51 cities at which sufficient measurement has been made in 2019, air pollution values are above the **World Health Organisation (WHO) guideline values (20 mg/m³) for 98% of the provines. PM_{10} levels are even higher than the national annual PM_{10} limits (40 mg/m_3) for 70% of the provinces with valid measurements.**
- The inhabitants of **Amasya, Bursa, Iğdır and Manisa provinces** have been regularly breathing air that **exceeds the daily pollution limits** presented in the legislation for **at least 68% days of the year (about a minimum of 248 days during the year) for 4 consecutive years.**
- The sulfur dioxide (SO_2) levels, measured in only 55 provinces in 2019, were the highest in the province of **Manisa** where the Soma Coal Fired Power Plants is located.
- Air pollution has become an unsolvable and **chronic issue**, in the provinces of **Iğdır, Düzce, Manisa, Bursa, Kahramanmaraş, and Afyon**, where the population has been breathing always the highest air pollution levels in the country for 4 consecutive years.
- **Ardahan, Tunceli, Rize, Artvin, Bitlis** have been the **provinces with the lowest air pollution levels** for 3 consecutive years, however; most of their pollution levels still exceed the WHO guideline values.
- **There has been some improvement in air quality in Turkey during the first half of 2020.** The coal fired power plants that were shut down in January 2020 in the provinces of **Kahramanmaraş, Sivas, Kütahya and Zonguldak**, as well as the reduced traffic as a result of the precautions against the COVID-19 pandemic in March, led to the improvement of the air quality in **5 metropolitan provinces**. However, due to the reopening of the power plants and the increased activity following the increased mobility at the normalisation period **in June 2020, air pollution began to rise again.**
- According to the analysis using the AirQ+ program, **7.9% (31,476) of all deaths in 2019, 12.13% (45,398) of all deaths in 2018 and 13% of the deaths (51.574 people) in 2017 could have been prevented** if the air pollution were reduced to the WHO guideline values.
- **Istanbul has the highest death number** attributed to air pollution in Turkey since 2017.
- In 2019, the **highest number of deaths attributed to air pollution** were in the provinces of **İstanbul, İzmir, and Manisa** respectively.

- As in the previous years, the highest **percentage of deaths** (33.5%) due to air pollution relative to all deaths was again in Iğdır in 2019.
- Between 2017 and 2019, the death count due to air pollution was approximately **6 to 7 times more than the death count due to traffic accidents.**
- Estimates using the Air Q+ program show that preventable death counts due to air pollution are highest in big cities such as **İstanbul, Bursa and Ankara in 2017; İstanbul, Bursa, Ankara in 2018 and in Istanbul, İzmir and Çorum in 2019.**
- Preventable death counts due to air pollution are the highest relative to other causes of death in **Iğdır, Kahramanmaraş and Afyon**. One of the oldest coal plants in Turkey is in Kahramanmaraş, where 6 new projects are also in the project pipeline.
- According to the first Health Impact Assessment report prepared for a coal fired power plant in Turkey by the Right to Clean Air Platform, **11 million people** from 24 provinces will be affected by the negative health impacts caused by the Eskişehir Alpu Coal Fired Power Plant. The total loss from air pollution will be around **€6.411 billion in 35 years** (calculated according to the 2018 Euro/Turkish Lira exchange rate).

The recovery programs built for post-Covid period need to be aimed at preventing air pollution, which weakens the lungs, heart, and other organs; as well as significantly reducing the rate of increase in greenhouse gases that cause drought, extreme heat, floods, fires, and other forms of life-threatening damage. A healthy recovery requires governments to invest in public health at first. We hope that this transformation will lead to investments to promote a radical renewal of nature through healthy nutrition, renewable energy, walking, cycling, and zero-emission public transport, as well as other positive changes that support the health of the people, the economy, and the planet.

With this report, in addition to all of these demands, we hope to collaborate with all local and national authorities, citizens, and non-governmental organizations to work on vital issues to improve the quality of air in Turkey; such as **the improvement of air quality measurement data, the legislation to designate a legal limit for $PM_{2.5}$, the implementation of the Clean Air Action Plan in provinces and the implementation of health impact assessment procedures during the permit processes of industrial and energy generation facilities.**

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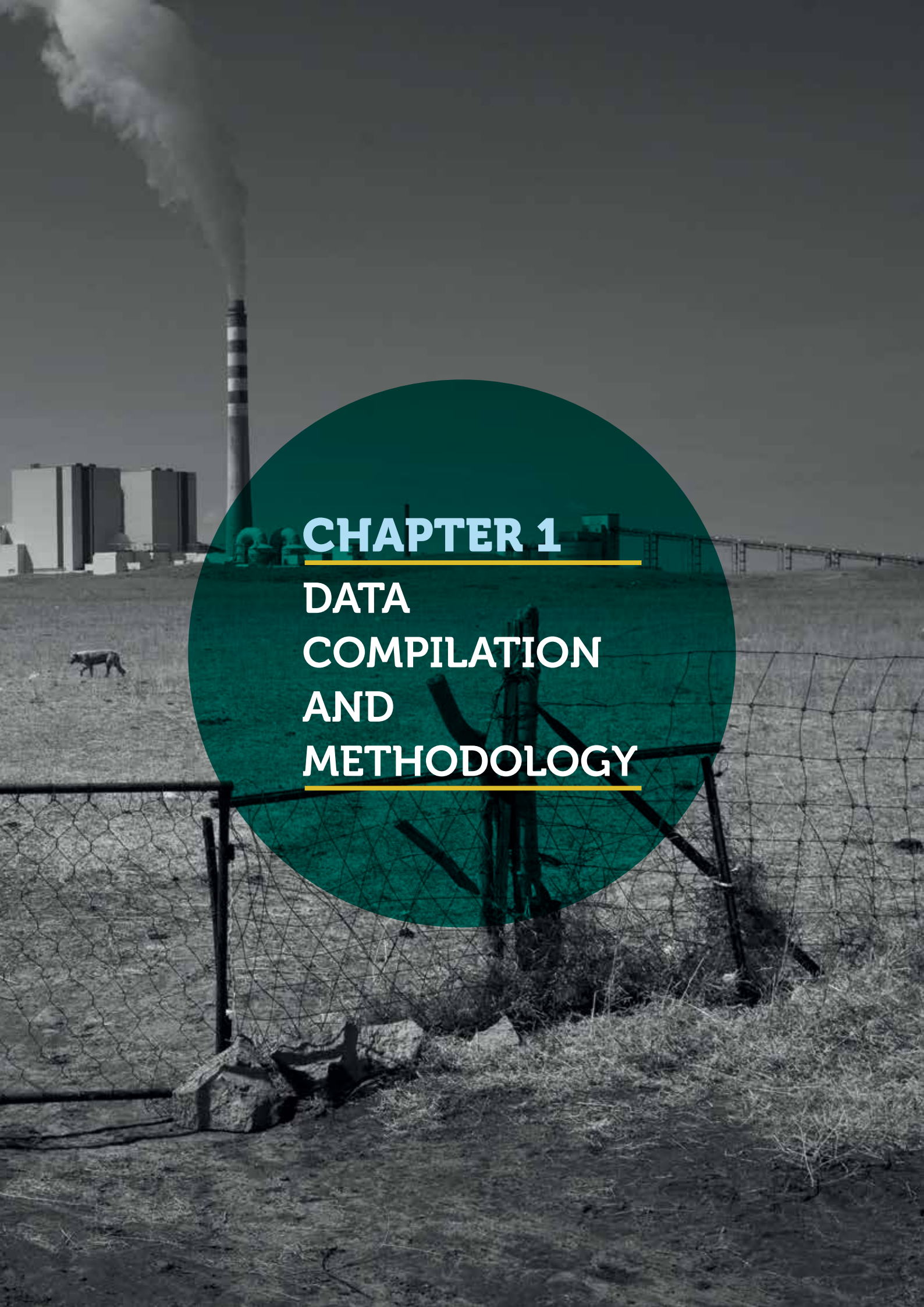

CHAPTER 1

DATA COMPILATION AND METHODOLOGY

The air quality in 30 provinces with a population of nearly 18 million people in Turkey is unknown due to insufficient measurement in 2019.

AIR QUALITY DATA

Data for 2016 - 2018

The air pollution data used in the analysis among 2016- 2018 is downloaded from the **MultStationReport** section on the official website of the **Air Quality Monitoring Department (mobil.havaizleme.gov.tr)** which belongs to the Ministry of Environment and Urbanization. The daily PM_{10} data for 2016 and 2017 that is used in the analysis was downloaded in the form of 24-hour average values for all stations in an Excel spreadsheet format on January 3, 2019 and on January 15, 2019 for 2018 data.

The number of Air Quality Monitoring Stations with downloadable data for years 2016, 2017 and 2018 is 211. However, according to regulations, the air quality monitoring station must record data for **at least 75% of the days** in a year in order for the data of the monitoring station to be reliable to evaluate the air pollution.

For years 2016- 2018, stations that have recorded data for less than or equal to 74% of the year, in other words, stations that conduct **"insufficient measurements"** have been excluded from the evaluation. Then, annual PM_{10} averages for all stations were calculated by taking averages of the suitable 24 hourly PM_{10} measurements downloaded per station. In districts that have multiple monitoring stations, the average of the 24 hourly PM_{10} levels in all stations in that district has been accepted as the daily district average.[7]

However, among many stations in a district, there can be some that have recorded values significantly below or above the other stations in the district depending on the location of the monitoring station. Therefore, the average values may not exactly represent the pollution level for every place in a district. Consequently, in order to conduct a more accurate evaluation about the quality of the air, the stations and districts that exceed the 50 $\mu g/m^3$ level, which is specified by regulations, for more than 35 days every year were also determined.[8] The data was analyzed separately, both according to **the guideline values recommended by the World Health Organization (WHO)**[9] and **the national limits specified by the Directive on Air Quality Evaluation and Management (AQEMR)**.[10]

$PM_{2.5}$ exposure is considered a **proxy indicator** to calculate the health impacts of air pollution on human health. However, there is no legal limit value in the legislation for $PM_{2.5}$ in Turkey, and although gradually increasing in number, the number of provinces in Turkey where $PM_{2.5}$ levels are measured is still few. Thus, the $PM_{2.5}$ level is estimated from the PM_{10} measurements for places where no air pollution monitoring measurements are made. The World Health Organization states that $PM_{2.5}$ concentrations that cannot be determined by measurement can be calculated using **national conversion factors** ($PM_{2.5}$ / PM_{10} ratio). If national conversion

[7] Air pollution
[8] WHO outdoor air quality guidelines
[9] WHO outdoor air quality guidelines
[10] Directive on Air Quality Evaluation and Management. Official Gazette Dated 06. June 2008 / 26898.

factors are not available, regional data obtained based on the average of the country-specific conversion factors are used. The World Health Organization also emphasizes that the $PM_{2.5}$/PM_{10} conversion factor may vary by location (usually between 0.4 and 0.8) and therefore the $PM_{2.5}$ value calculated for each city based on the concentration of PM_{10} may deviate from the actual value. The converted value should only be accepted as approximate.

The data from the stations that have $PM_{2.5}$ measurements were used to calculate the health impacts from air pollution in 2017 in Turkey. For other stations and/or provinces with no official measurement data, $PM_{2.5}$ data were obtained by multiplying the PM_{10} values at our data set for official measurement values in 2017 with the conversion coefficient given by the World Health Organization (0,66327).

Then, the $PM_{2.5}$ data set for 2017 and the population count, as well as official death counts in cities obtained from the **Turkish Statistical Institute (TUIK)** were used to estimate the preventable death counts.

The study conducted by the Platform is the first of its kind in terms of its **methodology of using the AirQ+ Model Software** in order to calculate the preventable death counts due to the air pollution in Turkey, starting from 2017.[11] The data about the air quality measurement for PM_{10} and $PM_{2.5}$ as well as the death counts are obtained from the official data sources. $PM_{2.5}$ data for the cities where measurements are not available were converted for PM_{10} levels by using the conversion rate determined by WHO.

Data for 2019-2020

The air pollution data for 2019 is downloaded from the Data Bank section of the **National Air Quality Monitoring Network** website **(havaizleme.gov.tr)** of the Ministry of Environment and Urbanization. Before downloading the data, the Environmental Reference Laboratory of the ministry was contacted, and the validation of the data for 2019 was completed by the laboratory. Even after the validation, the data from the stations with negative values their in SO_2, NO_x and O_3 data were deemed invalid and not included in the calculation.[12]

From the 24-hour PM_{10} measurements downloaded for every station, the annual PM_{10} average values were obtained by calculating the average value of the stations with sufficient data **(measurements were made on more than 90% of the days of each year)** according to the Air Quality Evaluation and Management Regulation. However, only 51 provinces had measurements for more than 90% of the days per year, and no sufficient data exists for the remaining 30 provinces. In provinces with no PM_{10} data for more than 90% of the days, the annual average was calculated using the data measured on more than 75% of the days in a year, in accordance with the sufficiency criteria of the European Environment Agency (EEA).

[11] This report is prepared by compiling two reports about air quality and health impacts monitoring, published in 2019 and 2020 by the Right to Clean Air Platform, that methodologically follow one another.

[12] The daily PM10, PM2.5, SO2, NO2, SOx, NOx, O3 data, which form the basis of the study, were downloaded at once, based on 24-hour average values, in the form of an Microsoft Excel table (2020)

$PM_{2.5}$ data for 2018 and 2019 were used to calculate the health impacts of air pollution in 2018 – 2019. From the 24-hour $PM_{2.5}$ measurements downloaded for every station, the annual $PM_{2.5}$ average values were obtained by calculating the average value of the stations with sufficient data (measurements were made on more than 90% of the days of each year) according to the Air Quality Evaluation and Management Regulation. However, only 21 provinces had measurements for more than 90% of the days per year, and no sufficient data exists for the remaining 60 provinces. Because $PM_{2.5}$ stations are not widespread in Turkey, it is not possible to comment on the health impacts of air pollution by just using $PM_{2.5}$ measurement data over 90% of the year. Considering the significant strain this will create in terms of public health, the data measured on more than 75% of the days in a year were used out of necessity, in line with the methods accepted in other countries with data-related problems whenever possible.

For provinces where $PM_{2.5}$ data were not measured for at least 90% of the year, measurements made for 75% or more were used. In provinces where even that is absent, PM_{10} measurement data recorded for more than %90 of the year was multiplied by the conversion coefficient (0.66327) determined by the WHO to obtain the $PM_{2.5}$ values. Finally, in provinces where PM_{10} measurements were not made for %90 of the year and $PM_{2.5}$ values cannot be calculated, $PM_{2.5}$ values were obtained by the multiplication of the PM_{10} measurements made for 75% or more of the year in accordance with the sufficiency criteria of the European Environment Agency (EEA) and the conversion coefficient (0.66327) determined by the WHO.

In provinces with more than one monitoring station, the average of 24-hour PM_{10} levels of all stations in that province was accepted as the daily average. Mobile stations were also considered to be within the borders of the province they are located in. However, there can be stations with pollution measurements more or less than the rest of the stations in that province, depending on the specific location of the station. Therefore, the average may not exactly and homogeneously reflect the pollution level for all parts of the province. Consequently, for a more accurate evaluation, the average of annual PM_{10} values of the stations and provinces, as well as the stations and provinces where **measurements have exceeded the 50 µg/m³ threshold for more than 35 days in a year** have been determined.

Moreover for 2019 - 2020 analysis, **remote sensing** satellite data from two different types of data sources are also used with the assistance of the Center for Research on Energy and Clean Air (CREA)[13]. **Remote sensing** refers to sensors placed on satellites to collect information about aerosols and air composition. The two most common sensors adopted for NO_2 and SO_2 estimations, namely OMI and its successor TROPOMI are used. OMI and TROPOMI are passive sun backscatter spectrometers with spatial resolutions of respectively 13x24km^2 and 3.5x7 km^2 and a daily global coverage. Level 3 data is used for both OMI and TROPOMI data. Also, data from air quality measurements stations of the Ministry of Environment and Urbanization are combined with satellite data.[14]

[13] Center for Research on Energy and Clean Air (CREA) https://energyandcleanair.org/

[14] Measurement data for 2020 is downloaded on July 15, 2020 and filtered for outliers and negative values using a MAD (Median absolute deviation) filtering before aggregating at the city level.

THE PROBLEM OF INSUFFICIENT MEASUREMENT

According to the Table "1. Data Quality Goals" under the last section Appendices "Data quality goals and the compilation of air quality assessment results" of the Directive on Air Quality Evaluation and Management; the mandatory data coverage for sufficient data collection at stations is 90% days of the year.

In 2019, the number of Air Quality Monitoring Stations containing downloadable data was 257. However, in order for the data from a station to be used to minimum reliably evaluate air pollution, the monitoring station needs to have produced data for at least 75% of the days of the year. Thus, stations that recorded data for 74% or fewer days of the year were named "Station with Insufficient Measurement" and excluded from the scope of the assessment.

Although the number of air quality measurement stations has increased since 2017, the number of stations with sufficient data has decreased dramatically in 2019.

Upon examining Air Quality Monitoring Stations in Turkey with downloadable data for the last four years, it can be seen that the percentage of stations that fulfill the measurement criteria of 75% is insufficient for a comprehensive analysis of air quality in all provinces. In fact, when the "90% or more days" criterion specified in the Turkish legislation is applied, the percentage decreases to an even more alarming level. In the provinces where 90% and more days of PM_{10} data were not available in 2019, although the measurements made for 75% and more days were used, sufficient measurements were not made in 21 provinces.

Table 1 - The number of stations where PM_{10} measurements were conducted in 2016 - 2019

Year	Number and Percentage of Stations that Conducted %75 or More Measurement	Number and Percentage of Stations with Insufficient Measurement	Total Number of Stations
2016	167 (%79)	44 (%21)	211
2017	185 (%88)	26 (%12)	211
2018	163 (%77)	48 (%23)	211
2019	152 (%59)	105 (%41)	257

Source: The data set is taken from the Dark Report studies published in 2019 and 2020 by the Right to Clean Air Platform.

AIR QUALITY DATA AROUND THE WORLD

Despite the declaration of air pollution as the "greatest environmental risk for health" by the World Health Organization (WHO), 51% of all countries in the world with a total population of 1.4 billion do not publicly share their air quality data.[15]

A recent report titled 2019 World Air Quality Report prepared by OpenAQ that includes global air quality data from 212 countries reveals that 1.4 billion people cannot access air quality data. In other words, half of the countries on the planet are among the weakest countries in terms of preserving the quality of their outdoor space. Air pollution causes 4.2 million deaths every year on a global scale. This number is more than the total death count of Ebola, HIV/AIDS, tuberculosis and malaria (2.7 million).

While some countries including Pakistan, Nigeria and Ethiopia produce no air pollution data, other large countries such as Brazil, China, India, Indonesia, South Africa, and Turkey do not share their air pollution data with the public in a completely open and transparent manner.

OpenAQ has listed 4 criteria for complete and transparent access to air quality data:

- Physical data,
- Station-based data with coordinates,
- Detailed time information,
- Programmed access.

Turkey fulfills only one (Programmed Access) of the 4 criteria designated for complete, transparent access to air quality data.

Air quality data monitoring system in Turkey has improved in recent years thanks to the new user-friendly and improved internet page of official data **(www.havaizlemegov.tr)**. Although the coordinates of the measuring stations are online available; criteria and information about the places and representativeness of those stations are not shared with the public. In addition, the scarcity of stations or insufficient data quality, especially in regions with industrial facilities, continues to be a major problem. Although live data from air monitoring stations are seen at web page they are not reliable because; it is said by the officials that these data are not validated and there may be errors. Due to validation, there can be different data sets each time you download the same data. This situation makes it difficult to make an accurate analysis of air pollution and expecting last year's data to be validated in the first quarter of each year also poses another challenge. In addition, the data of the stations cannot be downloaded collectively, downloading each station one by one and then combining it creates a very large workload. **Finally, data about the emissions from industrial facilities are not shared with the public even if it was requested by applications in line with Right to Information Law.** Unless the problems regarding the number of stations, the number of measurement days and the accuracy of the data are solved; it is hardly possible to say we have access to complete and open air quality data in Turkey.

There are no public programs for long-term outdoor air quality measurement on a national scale in 13 of the world's most populous countries with a total population of more than 1 billion people. Real-time data is produced in at least 30 countries, but not all of this data is publicly available yet. Making this data more open will affect 4.4 billion people living in countries such as China, India, Russia, Brazil, the Philippines and Japan. The 13 most populous countries with a population of more than 50 million (4.2 billion total population) produce real-time air quality data, but not all data can be accessed on a national scale by the government.[16]

[15] 2019 World Air Quality Report
[16] 2019 World Air Quality Report

Among the 13 countries with a population over 50 million whose air quality data is not fully accessible, Turkey ranks tenth, following Egypt and Vietnam.

Table 2 - 13 Most Populous Countries That Are Unable to Fulfill the Fully Open and Accessible Air Pollution Data Criteria

	Country	Population	Fully Open & Accessible Air Quality Data Criteria
1	PR China	1.439 billion	Programmed Access, Station Level and Coordinates
2	India	1.380 billion	Programmed Access
3	Indonesia	274 million	Physical Data, Station Level and Coordinates, Programmed Access
4	Brazil	213 million	Station Level and Coordinates, Programmed Access
5	Russian Federation	146 million	Physical Data, Station Level and Coordinates, Programmed Access
6	Japan	126 million	Station Level and Coordinates, Programmed Access
7	Philippines	110 million	Physical Data, Station Level and Coordinates, Detailed Time Information, Programmed Access
8	Egypt	102 million	Physical Data, Station Level and Coordinates, Detailed Time Information, Programmed Access
9	Vietnam	97 million	Physical Data, Station Level and Coordinates, Programmed Access
10	Turkey	84 million	Programmed Access
11	Iran	84 million	Detailed Time Information, Physical Data, Programmed Access
12	Thailand	70 million	Programmed Access
13	South Africa	59 million	Programmed Access

Source: OpenAQ (2020), 2019 World Air Quality Report

The open source website of the **World Air Quality Index** can be followed to see the air quality indices of countries and cities around the world in real time and with comparisons.[17]

[17] World's Air Pollution: Real-time Air Quality Index

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CHAPTER 2

TURKEY'S FOUR-YEAR AIR POLLUTION SCORECARD

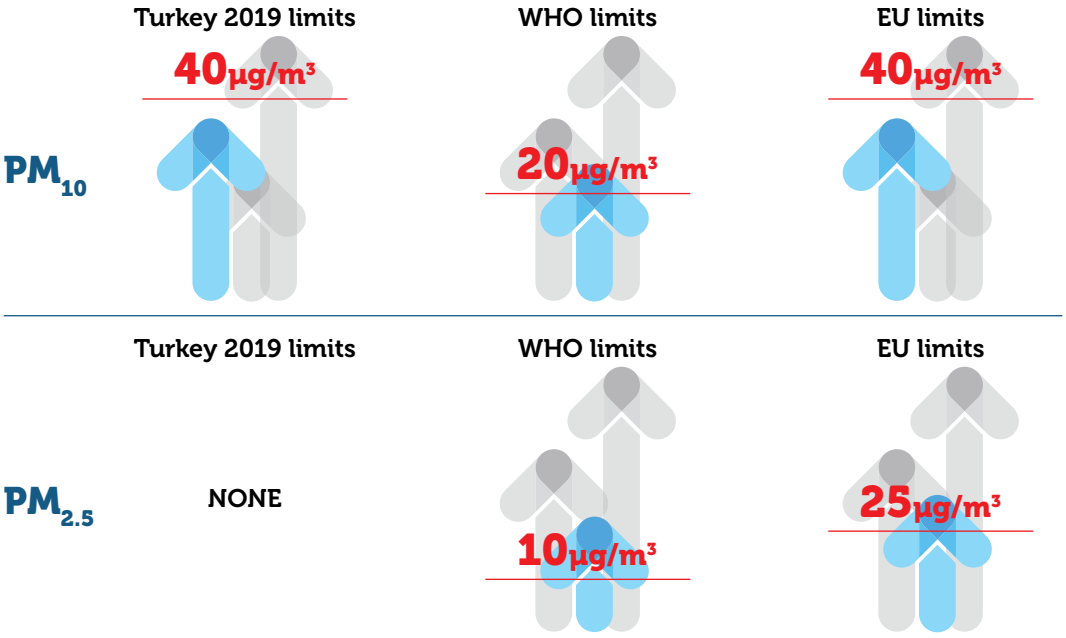
In Turkey 60 cities do not have sufficient $PM_{2.5}$ measurement data in 2019.

In this section, the air quality data of Turkey in 2019 from monitoring stations and provinces is analyzed according to the limit values of Turkey and the WHO. A tentative analysis about the first half of 2020 is also provided. Additionally, this data is compared with the pollution levels measured between 2016 and 2018. For the assessment in this section, PM_{10} levels were used because it is one of the most regularly and widely measured pollutants in Turkey.

The fine particulate matter ($PM_{2.5}$) levels obtained by using PM_{10} data or, where available, from $PM_{2.5}$ measurements are used to calculate the health impacts of air pollution.[18]

The limit values used for the comparison of air quality data from provinces and stations are from the guideline values of the WHO as well as the legislations of Turkey and the EU. Unfortunately, a limit value for $PM_{2.5}$ in Turkey has not been determined yet. The national limit value for PM^{10} in Turkey has been lowered gradually from 48 µg/m³ in 2017 to 44 µg/m³ in 2018 and finally reached the EU levels of 40 µg/m³ in 2019.[19]

Figure 1 - Comparison of Particulate Matter Limits

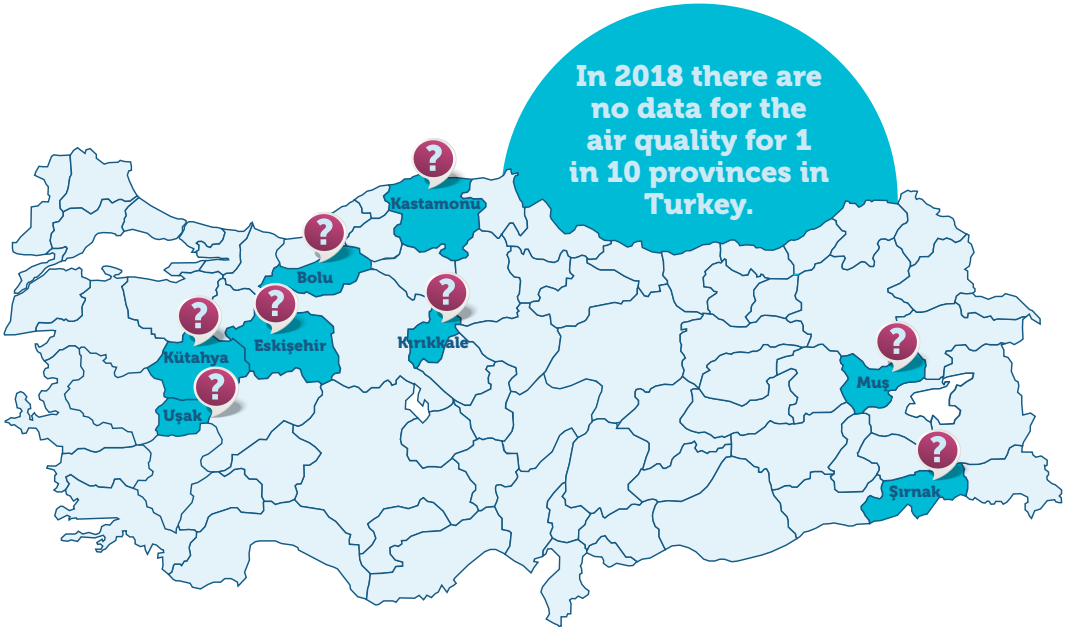


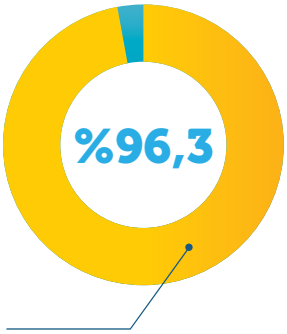
The limit values for coarse particulate matter (PM_{10}) in Turkey, EU legislation as well as the WHO guideline values are used in order to comment on the quality data. Unfortunately, a limit value for $PM_{2.5}$ still does not exist in Turkey.

[18] All comments for cumulative results between 2016-2019 are based on conclusions from previous Dark Reports (2016-2020)
[19] Dark Report 2019 (in Turkish)

TURKEY'S AIR POLLUTION LEVELS IN 2018

In 2018, 8 districts (48 stations) had data that is less than %75 days of the year, so it is not possible to comment on air quality and health impacts in Eskişehir, Bolu, Kastamonu, Kırıkkale, Kütahya, Muş, Şırnak and Uşak.





The rate of stations exceeding the WHO guideline value in Turkey in 2018 in 96,3%.

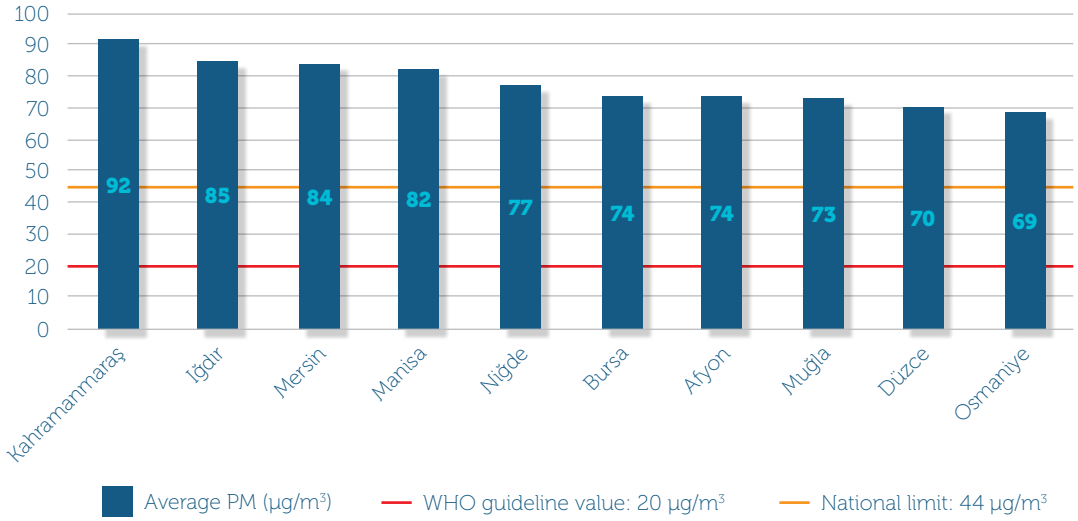
In 2018, the most polluted air is measured in Kahramanmaraş where Afşin - Elbistan coal fired power plant has been operating since 1980s.

163 stations in Turkey that have sufficient measurement data show that, in 96.3% of them, the yearly PM_{10} average is higher than the WHO limit values. Looking at the provinces, it can be seen that the yearly PM_{10} averages are over the WHO limits in all of the 73 cities with sufficient measurement data, except for one.

According to the Air Quality Evaluation and Management Regulations (AQEMR) which specifies national limits, the specified limit value for PM_{10} was 44 µg/m^3 in 2018. In 73 cities with sufficient measurement data, only 32 met the limit value in the regulations regarding yearly PM_{10} averages. 41 districts have higher air pollution measurements even beyond Turkey's national limit values.[20]

[20] Yavuz, C. (2018), Air Pollution in Urban Area: "Air Pollution Monitoring Network Examination of Five-Year PM10 Measurement Data of Ankara Station"; Public Health Congress Verbal Declaration

Figure 2 - 10 Provinces with the Dirtiest Air in 2018



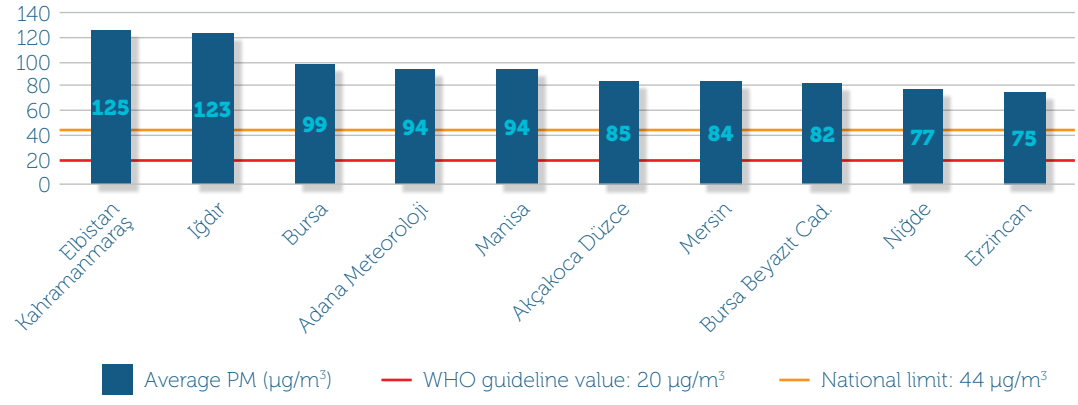
Source: Ministry of Environment and Urbanization, National Air Quality Monitoring Network

PM_{10} Averages of Measurement Stations in 2018

According to Turkish legislation, the daily PM_{10} values should not exceed 50 µg/m³ more than 35 times in a year. In 2018, only 163 out of a total of 221 Air Quality Monitoring Stations have taken sufficient measurement data.

In a total of 15 stations in the districts of Elbistan, Iğdır, Soma, Bursa, Mersin, and Erzincan, pollution measurements showed values exceeding limit values for more than 300 days, which shows that air pollution is a problem that encompasses all of 2018.

Figure 3 - 10 Stations with the Highest PM_{10} Average in 2018



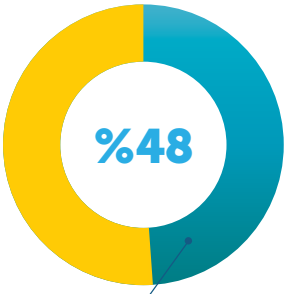
Source: Ministry of Environment and Urbanization, National Air Quality Monitoring Network

TURKEY'S AIR QUALITY LEVELS IN 2019

In 2019, nearly 18 million people do not have sufficient data about the pollution levels of the air they breathe.

According to our guidelines, sufficient data was not obtained from 48% (124 stations) of 257 total stations in 2019. This means that nearly half of the stations could not produce sufficient data for 90% or more of the year, as defined in the regulations. Additionally, sufficient air quality data was not measured in 30 provinces throughout the year in 2019 according to the guidelines. **In 2019, 17.878.224 people that make up 21% of the population of Turkey do not have sufficient data about the air quality (PM_{10}).**[21]

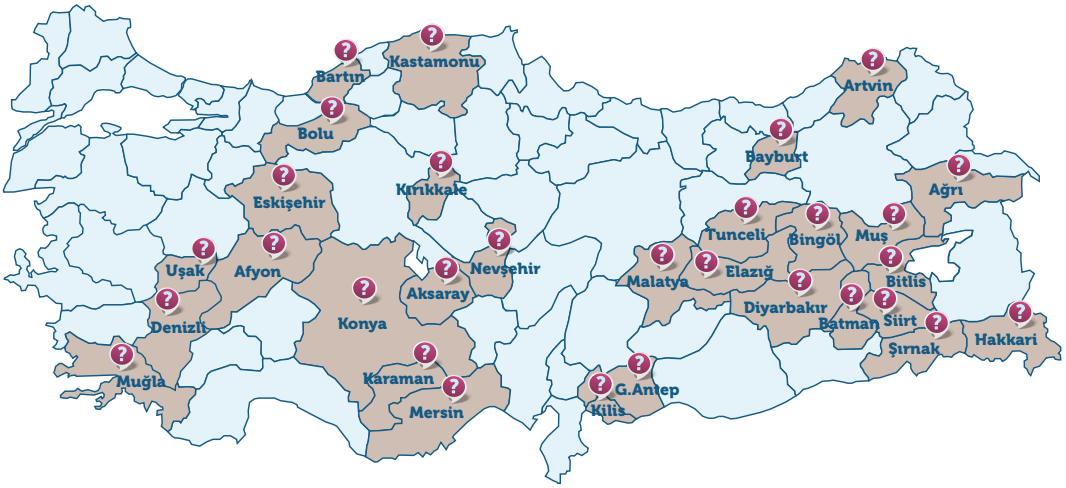
Furthermore, minimum sufficient data was not even measured for 75% of the year at 21 provinces. In fact, as stated in the relevant regulation, PM_{10} values should be measured on 90% or more days per year in order to make a healthy and reliable evaluation based on the data. Even though, PM_{10} measurements made for 75% or more days were used in the provinces with an insufficient amount of 90% or more days of PM_{10} data in 2019; it was still not possible to make a comment on air quality in 21 provinces due to the lack of even a minimal amount of measurements.



In 2019, nearly half of the PM_{10} monitoring stations lack sufficient amount of data.

Although the total number of measurement stations (211) was less in 2018, there were 8 provinces with no data. On the other hand, the number of stations producing data has increased to 257 in 2019, but there is a great decrease in the quality of the received data. In this case, even if the measurements were made, we do not even have minimal knowledge about the quality of air in one fourth (21 cities) of the provinces in Turkey due to the measurements not being made for at least 75% of the year. In 2019, the minimum (75% data) level of air quality information at 105 stations and in 21 provinces is unknown.

Map 1 - Insufficient Particulate Matter (PM_{10}) Measurement in 2019



Insufficient data = Particulate Matter (PM_{10}) data measured less than 90% of year

[21] TÜİK, ADNK Data 2019

In the provinces of Eskişehir, Muş, Uşak, and Şırnak with a total population of 2. 196.000 people, the minimum (75% data) level of air quality information has been unknown for 3 years.

Air Quality Assessment for 2019

PM_{10} measurement data in 2019:

Number of provinces with sufficient measurements: 51
Number of stations with sufficient measurements: 152
WHO annual guideline (PM_{10}): 20 µg/m^3
Number of provinces under the WHO guideline: 2
National legislation limit (PM_{10}): 40 µg/m^3
Number of provinces exceeding the national legislation limit: 36
Percentage of stations exceeding the national legislation: %59,6

Map 2 - State of Air Quality in 2019 By Province (PM_{10})

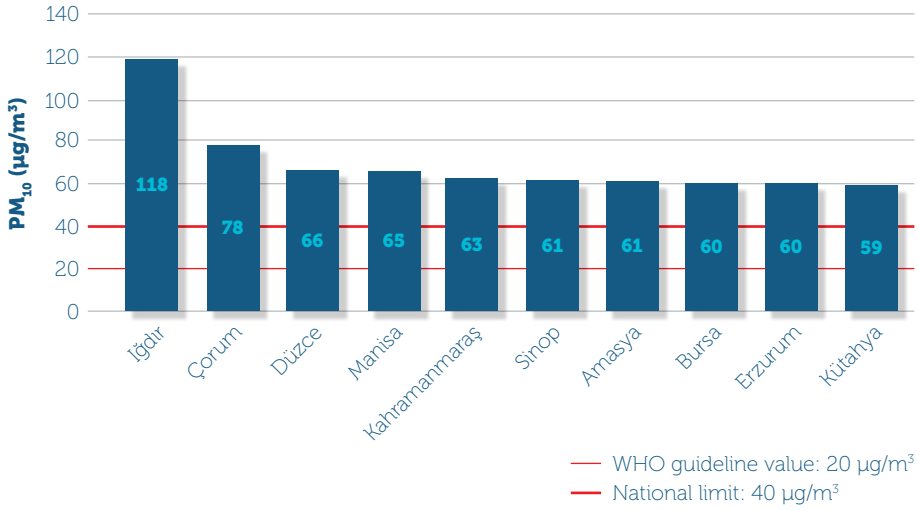
Provinces with an asterisk (*) indicate that the average value from the measurements taken for more than 75% of the year is used due to the absence of data recorded for more than 90% of the year.

In 2019, 98.3% of 124 stations with sufficient measurements have annual average PM_{10} levels that exceed the WHO guideline limits. Furthermore, 36 provinces exceed even national guideline limits for air quality that is as half as WHO values.

In 2019, 98.3% (122) of 124 stations in Turkey where sufficient measurements were taken demonstrate average annual levels of PM_{10} that exceed the WHO guideline limits. Even according to national legal limits in Turkey, 70% of the country (36 provinces) exceeds the average annual limits set nationally for PM_{10}. **In 2019, the only provinces where the air was within the recommended limits by the WHO were Adana and Hatay.** In addition, in 101 (81.4%) of 124 stations where a sufficient number of measurements were taken, 24-hour PM_{10} levels exceeded the daily 50 µg/m³ limit more than 35 times during the year, which was not to be exceeded as stated in the legislation.

Looking at the provinces in 2018, 72 of the 73 provinces where measurements were taken for at least 75% of the year have average annual PM_{10} values above the WHO limits. **In 2018, the only province where the air was within the recommended limits by the WHO was Ardahan.**

Figure 4 - 10 Provinces with the Highest Annual Average PM_{10} Level (2019)



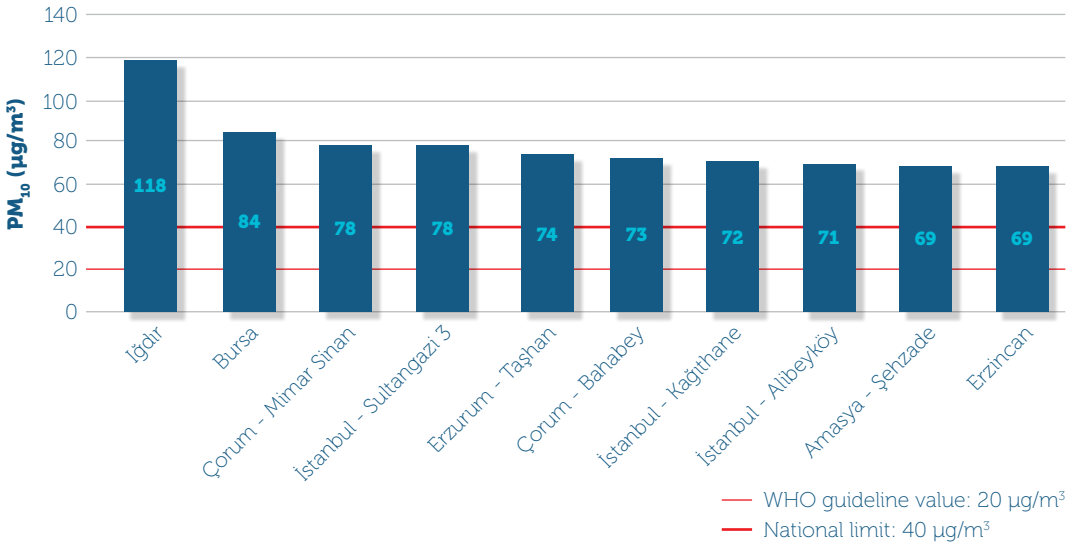
Turkey's worst-quality air in 2019 was breathed in the province of Iğdır, as was the case in the previous 4 years. Since 2014, the question of air pollution in the province of Iğdır has been brought to the agenda of the parliament by MPs of the province, urging authorities to take precautions[22]. However, the data shows that there is unfortunately not enough improvement in the reduction of air pollutant sources in Iğdır, where the air has not risen due to its geographical structure, despite the warnings and precautions. In 2019, in addition to **Düzce, Manisa, Bursa and Kahramanmaraş**, which were listed in the top 10 provinces with the poorest air quality in previous years, new provinces such as Sinop, Erzurum and Amasya were added.

[22] News (in Turkish) PERVİN BULDAN'DAN SORU ÖNERGESİ - Iğdır Haberleri and Vekil Oğan'ının Iğdır'ın Hava Kirliliği İle İlgili Yaptığı Çalışmalar

Average PM_{10} Values by Station in 2019

Especially in provinces where a large number of people live, having more than one station increases data quality. However, taking the average of all stations to find the provincial average sometimes causes us to miss the stations with low air quality. When the measurements at the stations were individually inspected, it is seen that they can have higher or lower annual averages than the annual average of the provinces they are a part of. In provinces with more than one station, stations with lower levels measured on average can reduce the effect of the measured pollution measured at stations in the most polluted locations, causing the pollution in the province to appear low.

Figure 5 - 10 Stations with the Highest Annual Averages PM_{10} (2019)



Bursa is an example that demonstrates analysis based on only provincial averages can be misleading and stations should also be considered. Although the annual average PM_{10} values in Bursa as high as 60 µg/m3, the pollution levels measured at 4 stations at the provincial border vary between 84 µg/m³ and 43 µg/m³.

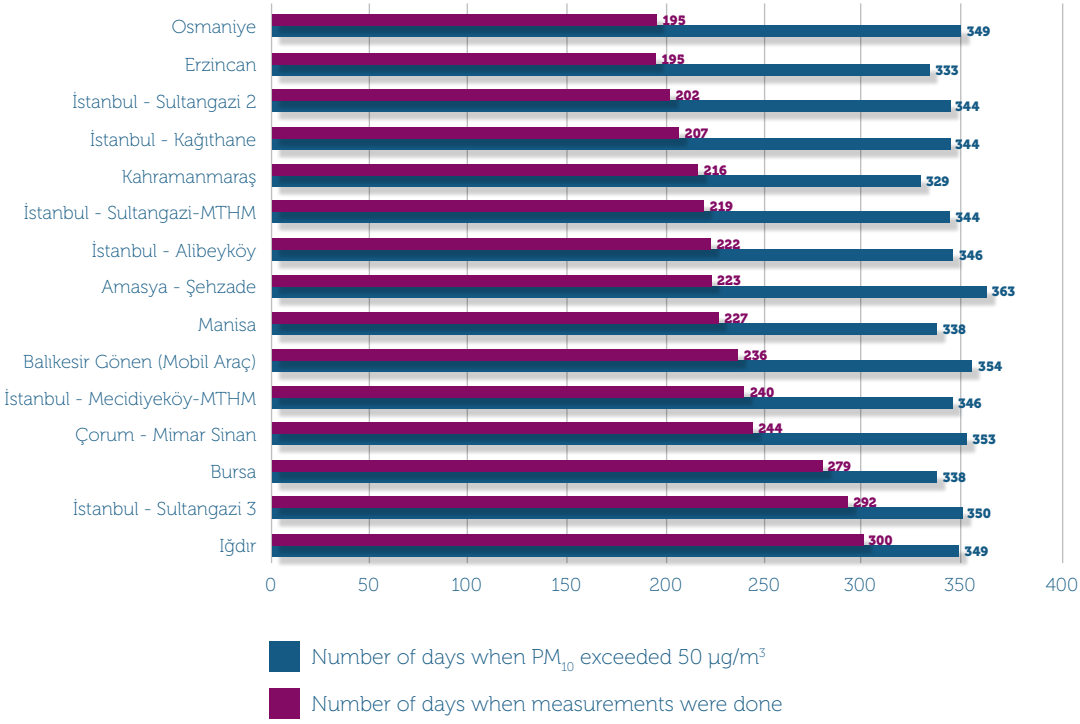
Provinces with Dirty Air in 2019

People living in the provinces of Amasya, Bursa, Iğdır and Manisa have been breathing polluted air above the daily limit of 50 µg/m³ regularly in at least 68% of the year for the last 4 years.

It is stated in Appendices of the Air Quality Evaluation and Management Regulation that the 50 µg/m³ value specified as the limit value for the 24-hour average of the PM10 pollutant cannot be exceeded more than 35 times per year.

It can be seen at Figure 6 that in 15 stations in provinces including Iğdır, Bursa, İstanbul, Kahramanmaraş, Çorum, Amasya, Manisa, Erzincan, Osmaniye, it can be seen that the severe air pollution experienced throughout 2019 is also **a year long problem.**

Figure 6 - 15 Stations with the Most Polluted Air in 2019



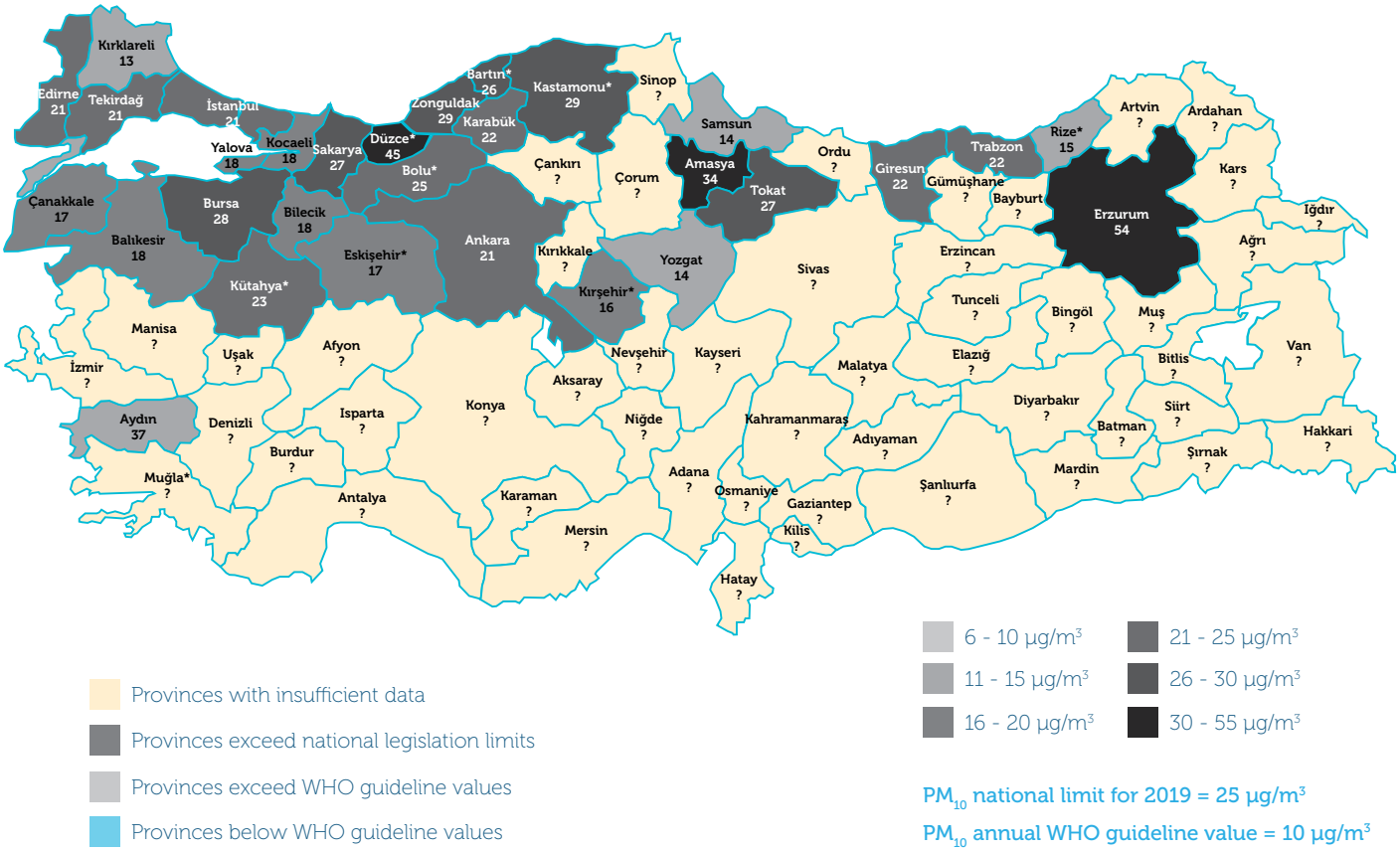
In **Iğdır** where polluted air is breathed for 300 days, the maximum measurement goes up to 418.61 µg/m^3 and in **Çorum** up to 309.08 µg/m^3. It is around 200 µg/m^3 in other provinces on the list. In addition, in **Amasya, Bursa, Iğdır, Manisa,** the limit of 50 µg/m^3 has been exceeded at least more than 250 days a year for the last 4 years between 2016 and 2019. This shows that there is a serious air pollution problem in these provinces that has not been resolved for years and causes polluted air to be breathed for at least 68% of the year.

Annual Average $PM_{2.5}$ Values by Province in 2019

In 2019, the level of carcinogenic fine particulate matter ($PM_{2.5}$) is not measured in 60 provinces in Turkey.

Unfortunately, only 21 provinces and 48 stations recorded $PM_{2.5}$ measurements for 90% or more days during the year of 2019. Since the number of stations that meet the sufficient data criteria specified in the legislation is very small, 8 more stations that took measurements for 75% or more of the days of 2019 can be added to obtain the minimum level of data. Even then, we can only access fine particulate matter data of 29 provinces at least at a minimal capacity. In 2019, we find it difficult to make a healthy comment about a carcinogenic pollutant that citizens living in 52 provinces are exposed to throughout the year.

Map 3 - Map of $PM_{2.5}$ Annual Average Values of All Provinces in 2019



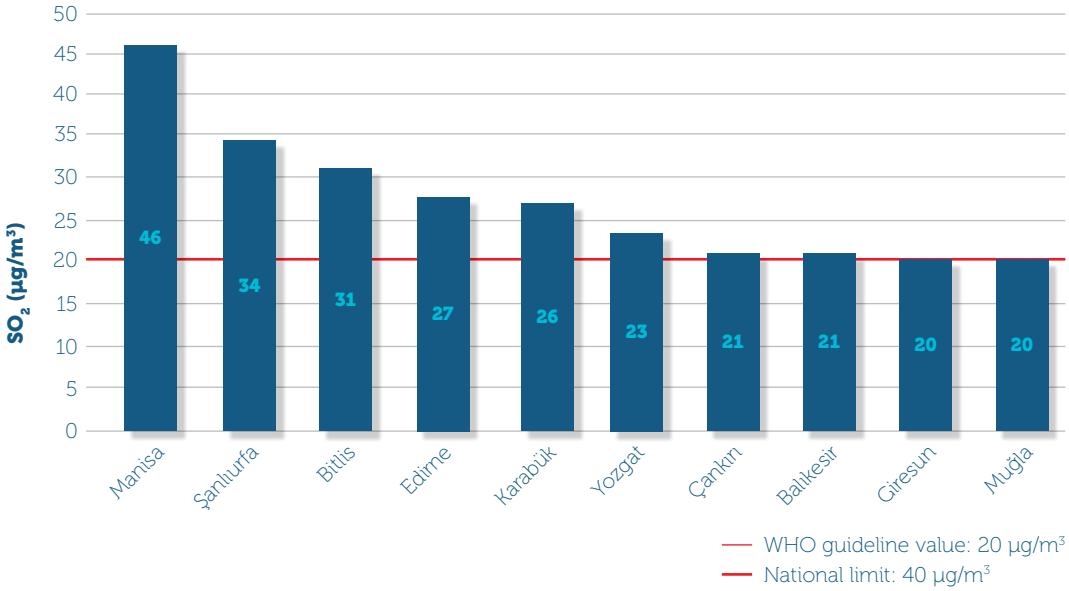
Provinces with an asterisk (*) indicate that the average value from the measurements taken for more than 75% of the year is used due to the absence of data recorded for more than 90% of the year.

SO_2 Measurement Data for 2019

The sulfur dioxide (SO_2) levels, which were measured in only 55 provinces in 2019, were the highest in the province of Manisa where the Soma Coal Fired Power Plant is located.

In 2019, sulfur dioxide levels were measured in only 55 provinces and 120 stations. According to these measurements, the province with the highest average annual SO_2 levels is Manisa. SO_2, as stated in the first section, originates mostly from industrial activities. The coal fired power plant located in the Soma district of Manisa is likely to be effective in the highest countrywide SO_2 level in 2019.

Figure 7 - Annual Average SO_2 Levels in Provinces in 2019



AIR QUALITY IN THE THREE LARGEST PROVINCES IN 2019

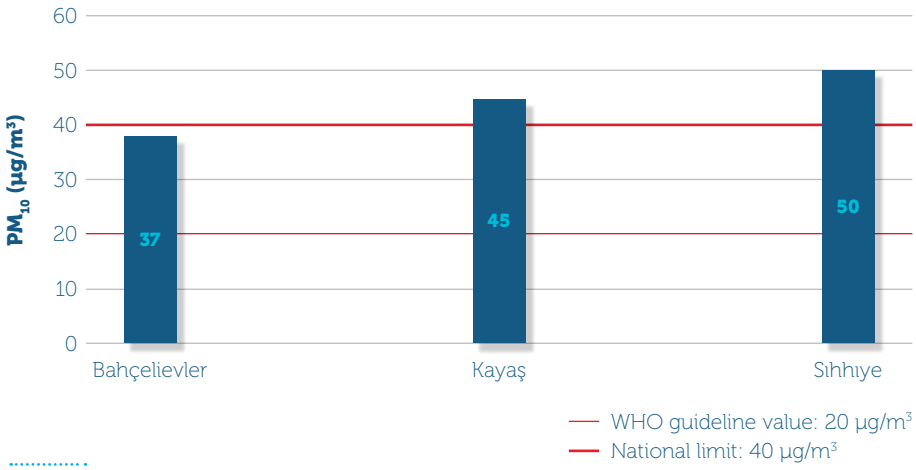
In this section, the state of air quality will be inspected in the districts of the three largest provinces which make up 31% of the total population of Turkey.

Air Quality in the Province of Ankara

In 2019, the province of Ankara, which is also the capital of Turkey, has experienced its largest data problem in the last 4 years. There is insufficient data about air quality in densely populated districts such as Çankaya and Keçiören.

Although data from 9 air quality measurement stations in Ankara were downloaded from the website of the National Air Quality Monitoring Network, the number of stations with sufficient measurements for 90% or more of the days of 2019 is only 3 (Bahçelievler, Kayaş and Sıhhiye).[23] This situation points at a severe data quality problem. It can be seen that the air quality is close to the legislation limit values at the stations with sufficient measurement. However, it should not be forgotten that this value is twice the guideline value recommended by WHO.[24]

Figure 8 - Stations with Sufficient Measurements in Ankara in 2019 (PM_{10})



[23]

[24] WHO Global Ambient Air Quality Database

While the average air quality of Ankara between 2016 and 2018 was at high levels of around 60 µg/m^3, it is somewhat misleading that it seems to have rapidly decreased to 45 µg/m^3 in 2019. In 2019, the number of stations with sufficient measurements in Ankara is very inadequate.[25] Therefore, no reliable comments can be made about whether the air quality of Ankara has improved in the last 4 years. We also do not exactly know how many people were exposed to polluted air, as there is no data on the Çankaya and Keçiören districts, which is where most of Ankara's population live.

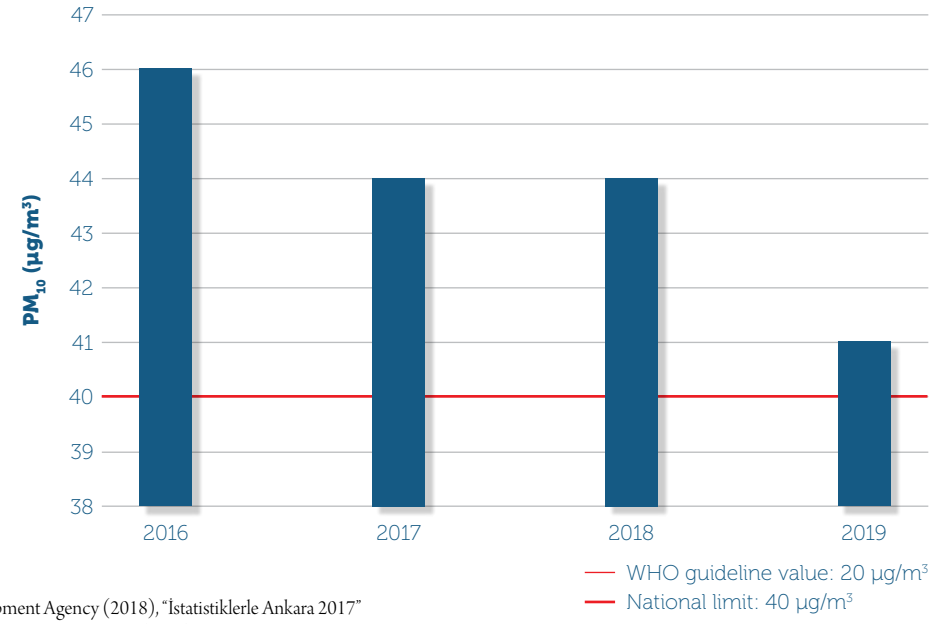
In the report published by the Ankara Chamber of Medicine in 2019, it is stated that the main sources of air pollution in Ankara are transportation and heating.[26] According to the 5-year analysis of PM_{10} measurements obtained from the National Air Quality Monitoring Network in Ankara, conducted by Cavit Işık Yavuz, a faculty member of Hacettepe University Public Health Department, the downward trend after 2013 started to reverse in 2015 and afterwards.[27] The data indicates that although there are some differences based on the stations, the general pollution level is above the limit values, and that PM_{10} pollution may cause serious health problems for Ankara and its people. Studies on health impacts related to the subject should be increased, and goal-oriented short, medium and long-term planning and courses of action should be made while also determining the sources of pollution.

Air Quality in the Province of İstanbul

Even if the average values improved overall in Istanbul in 2019, the PM10 level exceeded the 50 µg/m3 level more than 200 days in Sultangazi, Mecidiyeköy, Alibeyköy, and Kağıthane stations.

Since İstanbul is affiliated with the Marmara Clean Air Center and it has measurement stations belonging to the İstanbul Metropolitan Municipality, pioneering efforts are carried out in many fields. As a positive development in terms of air quality in 2019, it can be seen that the average level of PM_{10} in İstanbul has decreased compared to previous years, and approached the level suggested by the legislation. However, it should not be forgotten that even this level is twice the guideline values recommended by WHO.

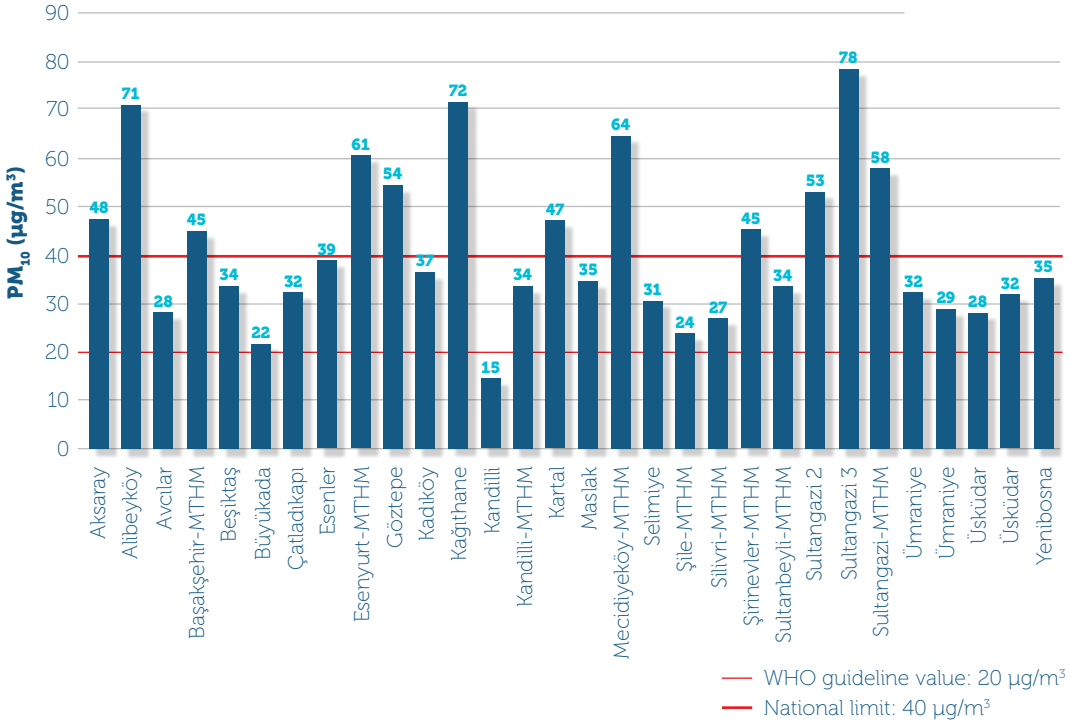
Figure 9 - Three-Year Comparison of Average PM_{10} in İstanbul Province



[25] Ankara Development Agency (2018), "İstatistiklerle Ankara 2017"
[26] TTB Ankara Chamber of Medicine (2019), Ankara's Health with Data.
[27] Yavuz, C. (2018), Air Pollution in Urban Areas: Investigation of Five-Year PM10 Measurement Data of Air Pollution Monitoring Network Ankara Stations

As a province with a population of more than 15 million people, there is no data to ensure proper monitoring of air quality in the most populous districts of Istanbul. There are a total of 39 districts in İstanbul. The number of measurement stations with sufficient data in these districts increased from 23 in 2018 to 30 in 2019. However, **there are still no air quality measurement stations in the districts of Gaziosmanpaşa and Güngören, which are the two districts with the highest population density (more than 40,000 inhabitants per square kilometer).** There is also no air quality measurement data in other districts with high population density (more than 29,000 inhabitants per square kilometer) such as Bayrampaşa and Bağcılar.

Figure 10 - Air Quality at the Stations of İstanbul Province in 2019 (PM_{10})



In 2018, sufficient measurements were not made in districts such as Aksaray, Esenler, Göztepe, Kadıköy, and Yenibosna, which experienced high air pollution in the past years. In 2019, while the air quality in these districts improved, it is understood that the pollution levels in Kağıthane, Alibeyköy and Sultangazi stations reached twice the national limit values.

Also during 2019, Sultangazi, Mecidiyeköy, Alibeyköy, and Kağıthane stations exceeded 50 µg/m^3 level of PM_{10} almost more than 200 days (55%). This indicates that polluted air is regularly inhaled in these areas.

Air Quality in the Province of İzmir

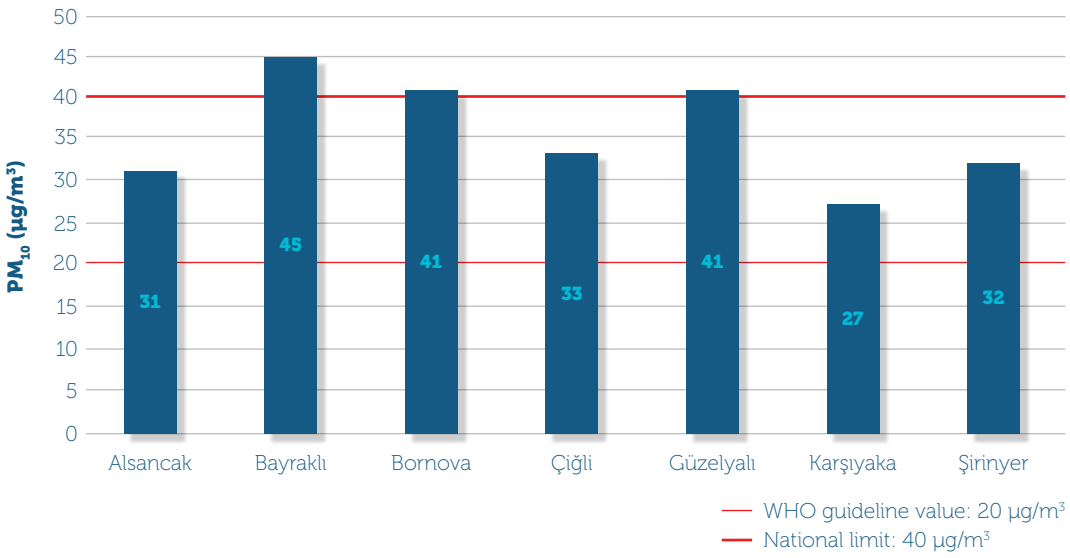
Air quality has improved in the province of İzmir in 2019 compared to the last 4 years. However, there is still no air quality data for the industrial zone.

Even though there are 13 air quality measurement stations in İzmir, only five of them recorded sufficient data for more than 90% of 2019. Moreover, the measurements were not made in the most crowded district of İzmir. Similarly, it is a province with less air pollution compared to Ankara and İstanbul. However, despite these advantages, there has not been a steady, consistent decrease in pollution outside Alsancak over the years.

In 2019, although there was no change in the number of stations compared to previous years, Izmir's annual average level of PM_{10} has decreased compared to the previous years. This indicates that the air quality has improved in the vicinity of the measurement stations.

Since June 2016, the data from air measurement stations in the Aliağa, Menemen, Yeni Foça and Bozköy regions of İzmir, where thermal power plants and heavy industrial facilities are concentrated, have not been uploaded to the website where the information of Air Quality Monitoring Stations is shared. Consequently, İzmir Chamber of Medicine sent a letter in 2019 to the Provincial Directorate of Environment and Urbanization to have them disclose and explain the level of air pollution in Aliağa, Menemen, Yeni Foça and Bozköy, and a signature campaign was started by the Aliağa Environment Platform addressed to the Ministry of Environment and Urbanization to have them provide the data to the public.

Figure 11 - Average Annual PM_{10} Levels at the Stations of İzmir Province)



The primary source of air pollution in İzmir is the fact that approximately 2900 small and large industrial facilities are located in the district of Aliağa. Pollutants from these sources are transported to the city as they are carried by prevailing winds. The most important pollutant sources in Aliağa are the power plant, iron and steel factories and rolling mills that process scrap metal, and the new oil refinery, which will start production as its construction is completed, as new petrochemical facilities are added to the sources of pollutants[28].

[28] TMMOB İzmir Province Coordination Council, Aliağa Region Assessment Report, 2012

Despite the black smoke coming out of the chimney for a long time **due to the failure at the Petkim petrochemical facilities** in May 2020, its operations continued. Although the Foça Environment Platform (FOÇEP) and MPs of the region demanded urgent action, such a serious situation in terms of public health was ignored during the days when clean air is most needed during the COVID-19 pandemic[29].

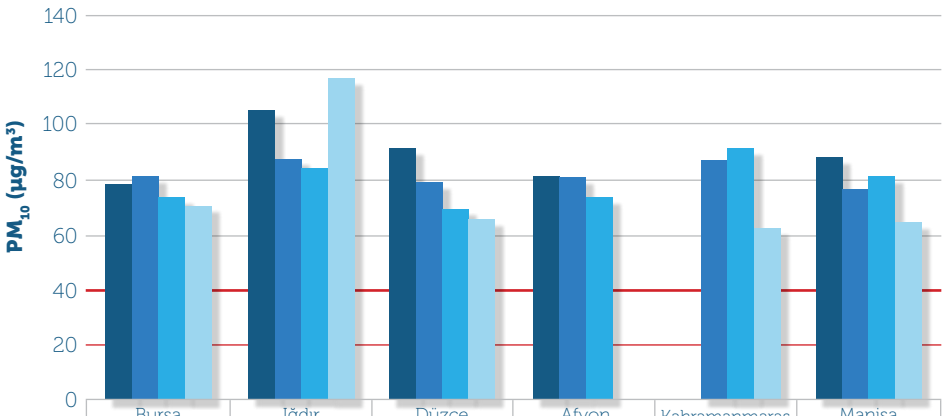
The possible sources of air pollution in the province of İzmir may be listed as follows:

1. Approximately 2900 industrial facilities of various sizes in Aliağa,
2. Industrial facilities located in Atatürk Organized Industrial Zone in Çiğli,
3. Two cement plants located in the Pınarbaşı and Naldöken neighborhoods,
4. Industrial facilities located in Kemalpaşa, increasing in number,
5. The quarries that increase the number and surround the city,
6. Unplanned urbanization and the lack of air corridors, preventing the city from making effective use of air circulation and movements
   - Adjacent high-rise buildings on the sea-facing side of the city
   - The skyscrapers that are increasing in number
   - Failure of the prevailing winds to dilute urban air pollution
7. Domestic heating, especially by using low-quality coal,
8. The increasing number of vehicles in the transportation network, causing the traffic to slow down due to the low number of main arterial roads, even making it come to a halt in the morning and evening hours.

In the provinces of Iğdır, Düzce, Manisa, Bursa, Kahramanmaraş, and Afyon, where the population has been breathing highly polluted air for the past 4 years, air pollution has become an unsolvable, chronic issue.

COMPARISON OF PM_{10} AVERAGES IN 2016 - 2019

Figure 12 - The Provinces with the Dirtiest Air for the Last 4 Years (PM_{10})



	Bursa	Iğdır	Düzce	Afyon	Kahramanmaraş	Manisa
2016	79	106	92	82		89
2017	82	88	79	82	88	77
2018	74	85	70	74	92	82
2019	60	118	66		63	65

WHO guideline value: 20 µg/m³
National limit: 40 µg/m³

[29] https://www.izgazete.net/politika/chpli-polattan-petkim-aciklamasi-arizaya-ragmen-calismaya-h47368.html

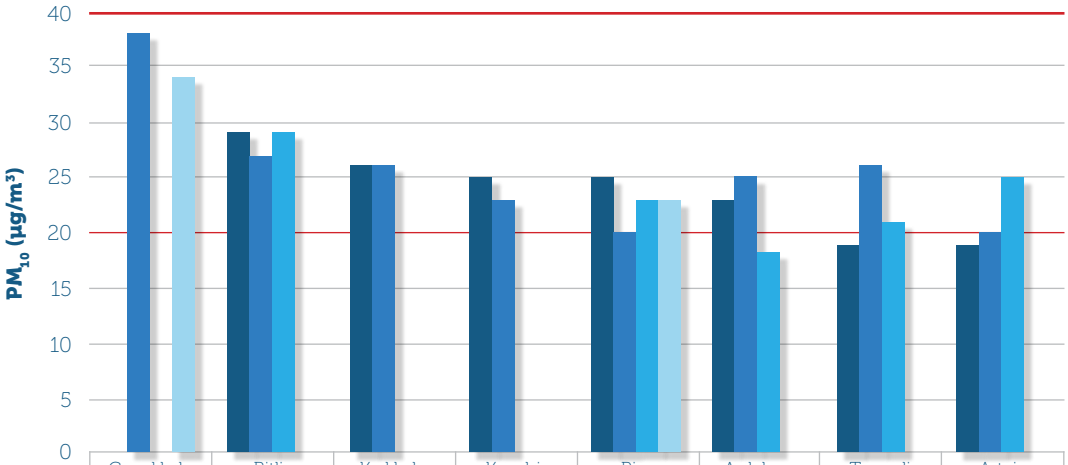
For the last 3 years, it can be seen that the number of stations that take sufficient daily measurements has been fluctuating. While a sufficient number of measurements were made in 79% of the stations in 2016, this number increased significantly to 88% in 2017, but dropped behind the 2016 values to 77% in 2018. We stated that in 2019, sufficient data in accordance with the guidelines could not be obtained in 30 provinces. However, it is pleasing to see a generally decreasing trend in pollution levels compared to 2018 in the provinces where measurements were taken. **Air pollution is consistently at the highest level in 4 provinces (Iğdır, Düzce, Manisa and Bursa) for the last 4 years. Kahramanmaraş and Niğde have become two of the 10 most polluted provinces in the last 2 years.** This shows that the problem of air pollution in Turkey is not necessarily limited to big cities such as İstanbul, Ankara and İzmir where traffic is also a significant problem.

In the last 4 years, it can be said that in 6 out of 81 provinces, the quality of air throughout the province is consistently harmful for human health. Continuous exposure to air pollution, as it will be described in detail in the next section, leaves the people vulnerable to many infectious diseases including COVID-19.

PROVINCES WITH BETTER AIR QUALITY FOR THE LAST 4 YEARS

Even though air pollution was low in the provinces of Ardahan, Tunceli, Rize, Artvin, and Bitlis for 3 consecutive years, some of the pollution levels still exceeded the WHO guideline values.

Figure 13 - Provinces with the Cleanest Air for the Last 4 Years (PM_{10})

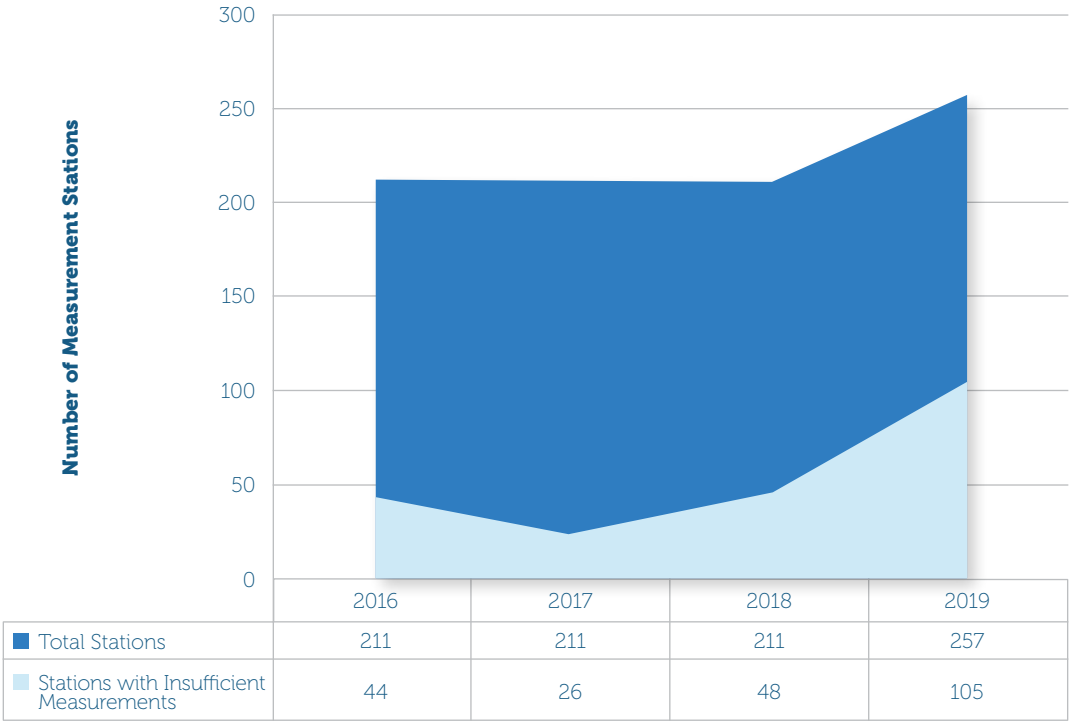


	Çanakkale	Bitlis	Kırıkkale	Kırşehir	Rize	Ardahan	Tunceli	Artvin
2016		29	26	25	25	23	19	19
2017	38	27	26	23	20	25	26	20
2018		29			23	18	21	25
2019	34				23			

WHO guideline value: 20 µg/m³
National limit: 40 µg/m³

Even though there are four provinces that managed to have the highest amount of pollution for four consecutive years, there is only one that succeeded to consistently rank among the provinces with the lowest levels of pollution. Even on the list of clean provinces with the lowest average annual PM_{10} values, many of them have values above the 20 µg/m³ recommended by the WHO. It is also important to remember that because any level of exposure to particulate matter causes health problems, there is no completely safe level per se. The provinces of Ardahan, Tunceli, Rize, Artvin, and Bitlis, all of which are located in the Black Sea and Eastern Anatolia regions, have been experiencing low levels of air pollution for three years since 2016. The public and decision makers alike should be careful to protect and maintain the air quality in these provinces.

Figure 14 - Number of Stations with Insufficient Measurements For The Last 4 Years



	2016	2017	2018	2019
Total Stations	211	211	211	257
Stations with Insufficient Measurements	44	26	48	105

As it can be seen on the graph above, **approximately one station out of four in Turkey did not take enough measurements between 2016 and 2018.** However, the number of stations that took insufficient measurements has doubled in 2019 to a percentage of 40%. This certainly indicates that the disclosed data does not truly reflect the air pollution in Turkey. On the other hand, considering the fact that these stations did not take measurements in regions and periods in which air pollution is severe illustrates the importance of the problem of not taking and/or being able to take measurements.

OVERVIEW OF THE AIR QUALITY OF TURKEY IN 2020

Satellite images and ground measurement station data were used with the help of the CREA[30] team to analyze the impacts of some major events in 2020 on the air quality of Turkey. The impacts of the following events on air quality were examined by looking at SO_2, NO_2 and PM levels:

1- The total closure of 5 coal fired power plants and the partial closure of 1 coal plant on January 1, 2020 due to their lack of compliance with the Turkish Environmental Law after the rejection of the draft Law (Article 50)[31]. A decrease in the SO_2 levels is expected in the first three months of 2020 (Q1) compared to the last quarter of 2019 (Q4), as SO_2 levels are mostly impacted by industrial activities such as the combustion of coal.

2- The COVID-19 quarantine measures[32] (partial lockdown in metropolitan provinces) announced on March 11, 2020 by the Minister of Health due to the ongoing COVID-19 pandemic caused by the novel coronavirus. Although factories are not closed, many people started working from home and it was forbidden to travel in and out of 31 provinces in Turkey. This dramatic decrease in urban movement and traffic is expected to cause some improvement in NO_2 levels in the second quarter of 2020 (Q2).

3- The operation of the closed coal fired power plants have partially started again on June 11, 2020. Although it is claimed that there are some investments done to improve the filtration systems, there are a lot of photographs with black clouds taken by the people living near the plants such as the Afşin Coal Fired Power Plant in Kahramanmaraş. Thus, a rise in the SO_2 levels is expected in the third quarter of 2020 (Q3).

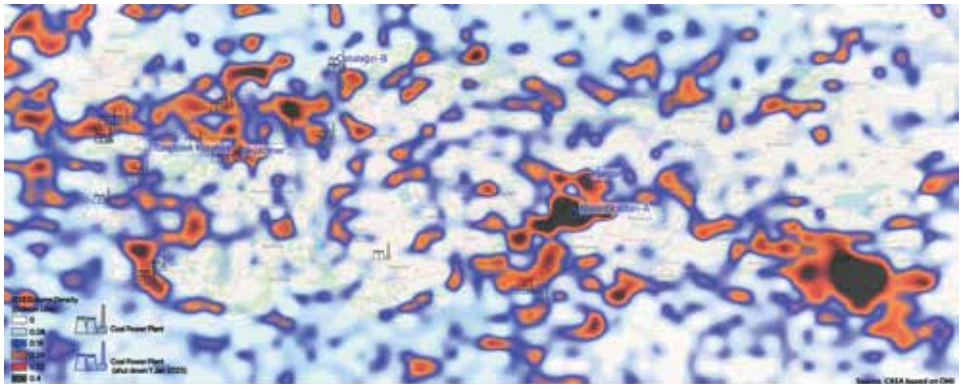
Impact of Closed Coal Fired Power Plants (SO_2)

SO_2 Column Density - OMI

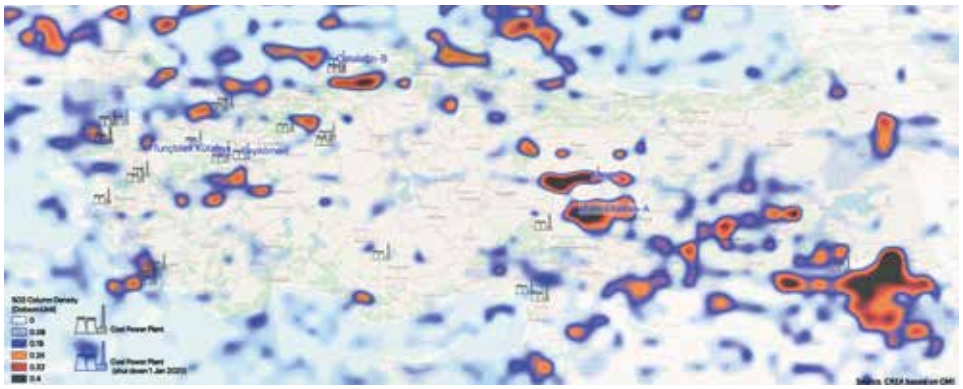
We see a sharp decrease in SO2 in 2020Q1 in most clusters, regardless of whether coal power plants were closed. This improvement in the air quality is expected to be a combination of the seasonal decrease in the amount of coal and wood burned by households for heating, the closure of some of the dirtiest coal fired power plants that are even seen at the satellite images as hot spots in 2019, and the decrease of urban movement and industrial production due to the measures related to the COVID-19 pandemic. **However, it is important not to forget that these improvements in air quality are only meaningful in terms of decreased health risks if they are implemented in the long run at the post-pandemic period as well.**

[30] https://energyandcleanair.org/
[31] More information about Article 50 can be found at Chapter 4.
[32] https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Turkey

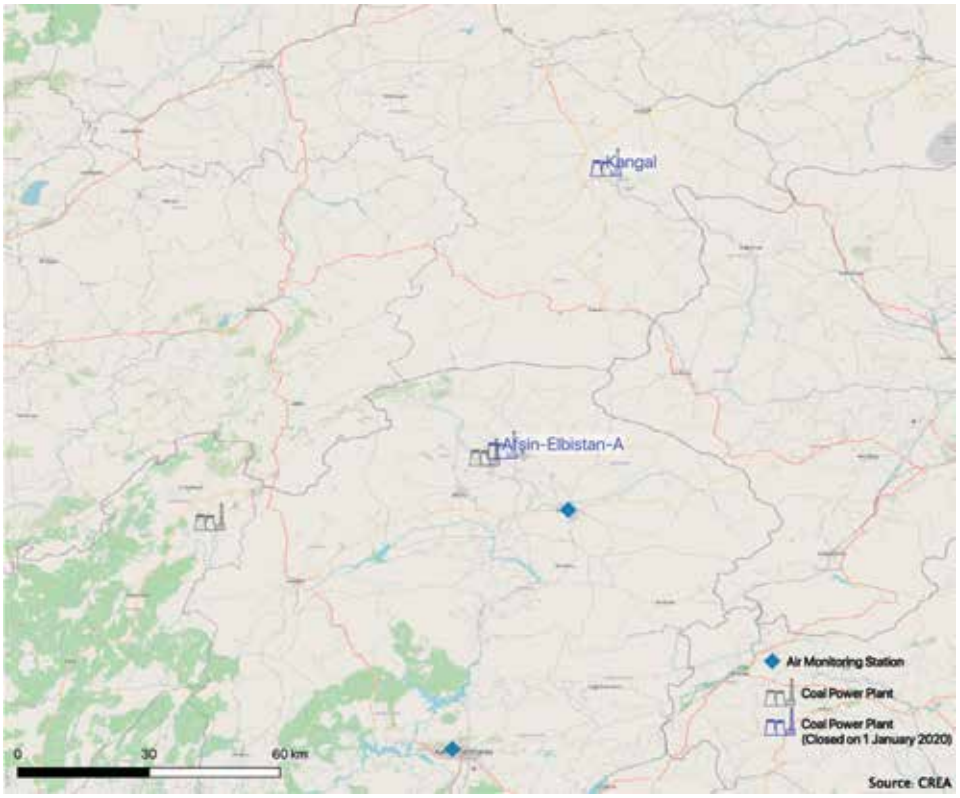
2019Q4



2020Q1

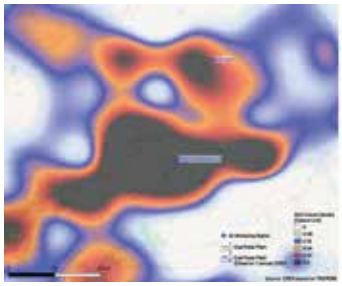


Afşin-Elbistan A Unite (Kahramanmaraş Province) & Kangal (Sivas Province) Coal Fired Power Plants

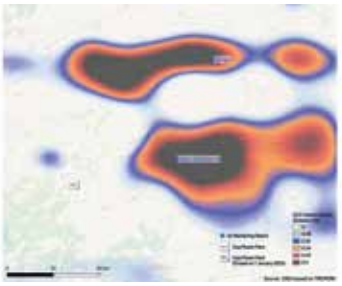


Satellite - OMI

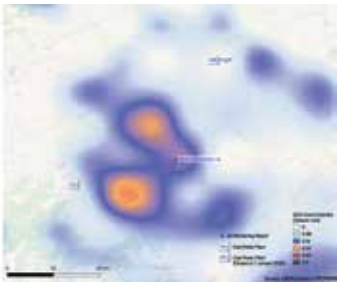
2019Q4



2020Q1



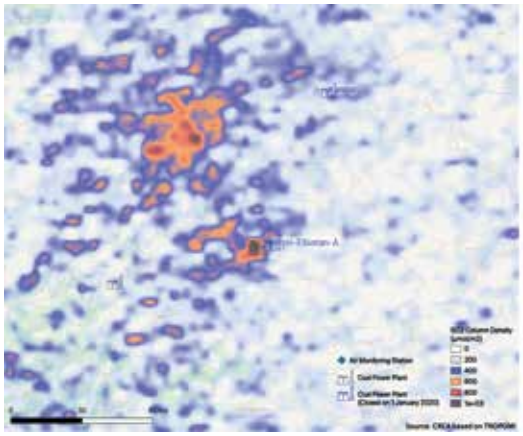
2020Q2



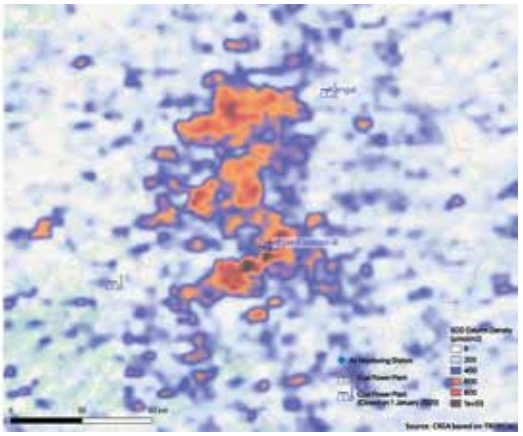
Satellite - TROPOMI

Only TROPOMI offers data in June 2020. SO_2 density before and after the official authorization to restart targeted power plants are shown in the maps below.

Before 11 June 2020 [14 days]



After 11 June 2020 [14 days]

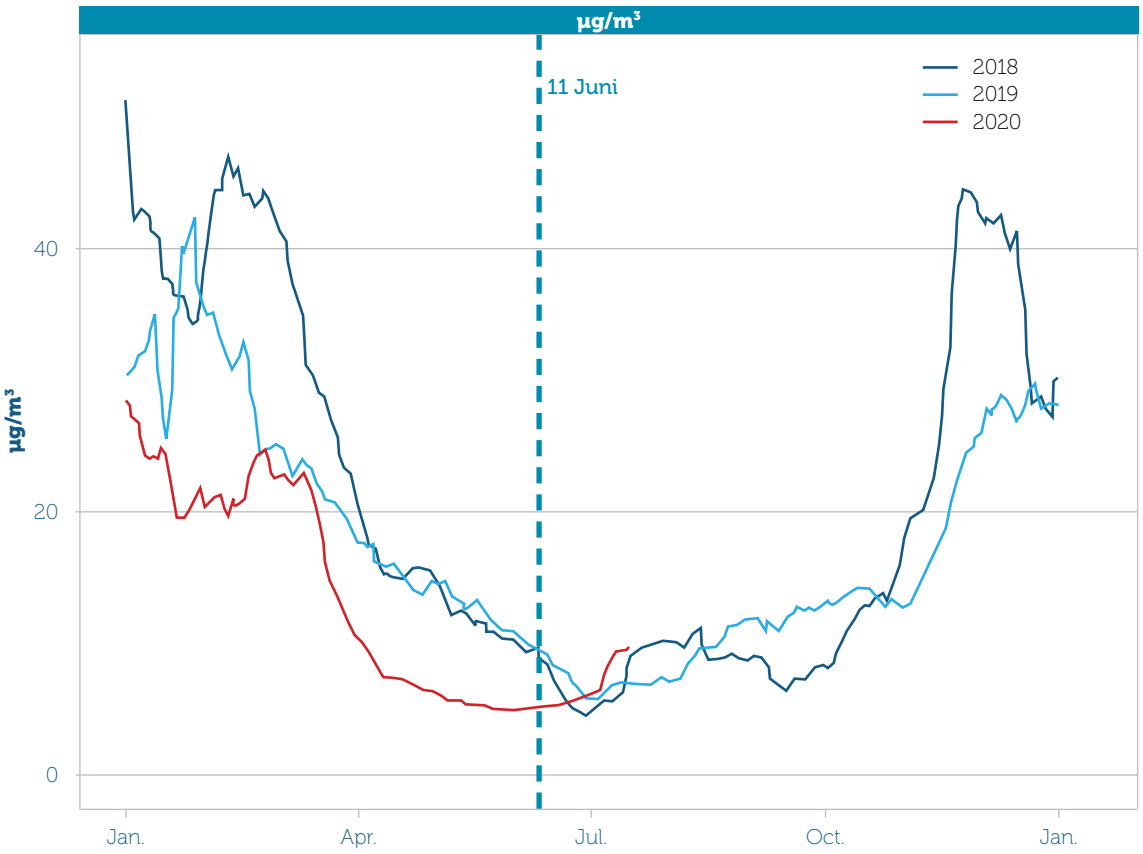


Ground monitoring

There is one air monitoring station in Elbistan/K.Maraş, located 22 km from the power station.

SO_2 Concentration Levels in K. Maraş

30-day running average

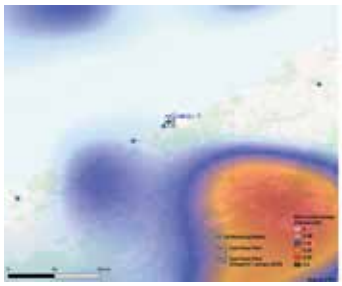


As it can be seen above, from mid-March to early July, SO_2 levels have been unusually low in K. Maraş. A sharp increase can be seen in early July, reaching levels significantly higher than previous years at the same time.

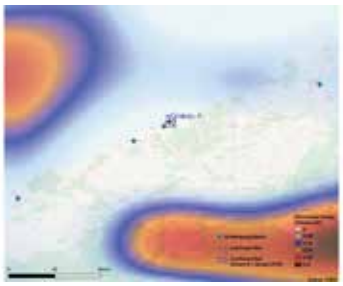
ÇATES Çatalağzı Coal Fired Power Plant (Zonguldak Province)

Satellite - OMI

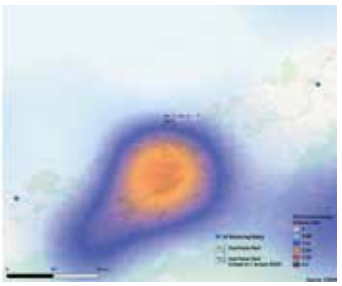
2019/Q4



2020/Q1

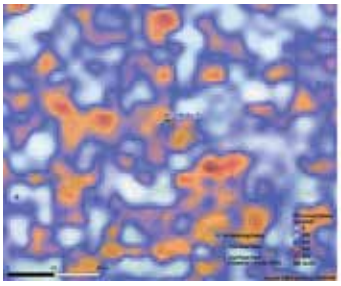


2020/Q2

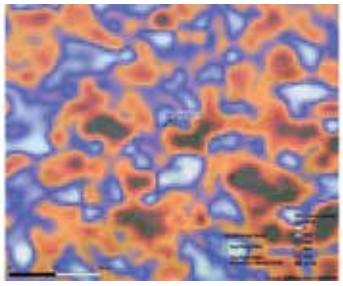


Satellite - TROPOMI

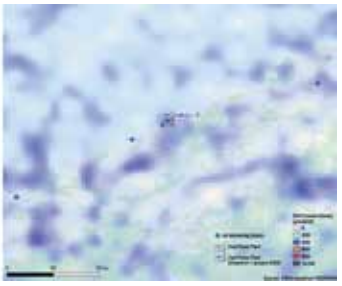
2019/Q4



2020/Q1

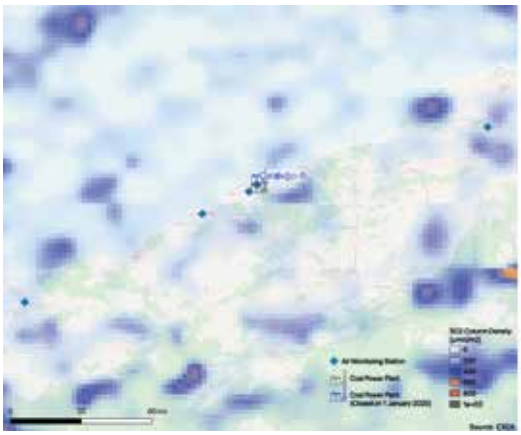


2020/Q2

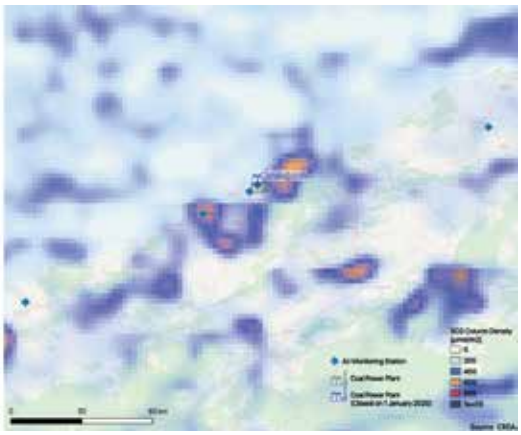


Only TROPOMI offers data in June 2020. SO_2 density before and after the official authorization to restart targeted power plants are shown in the maps below.

Before 11 June 2020 [14 days]



After 11 June 2020 [14 days]



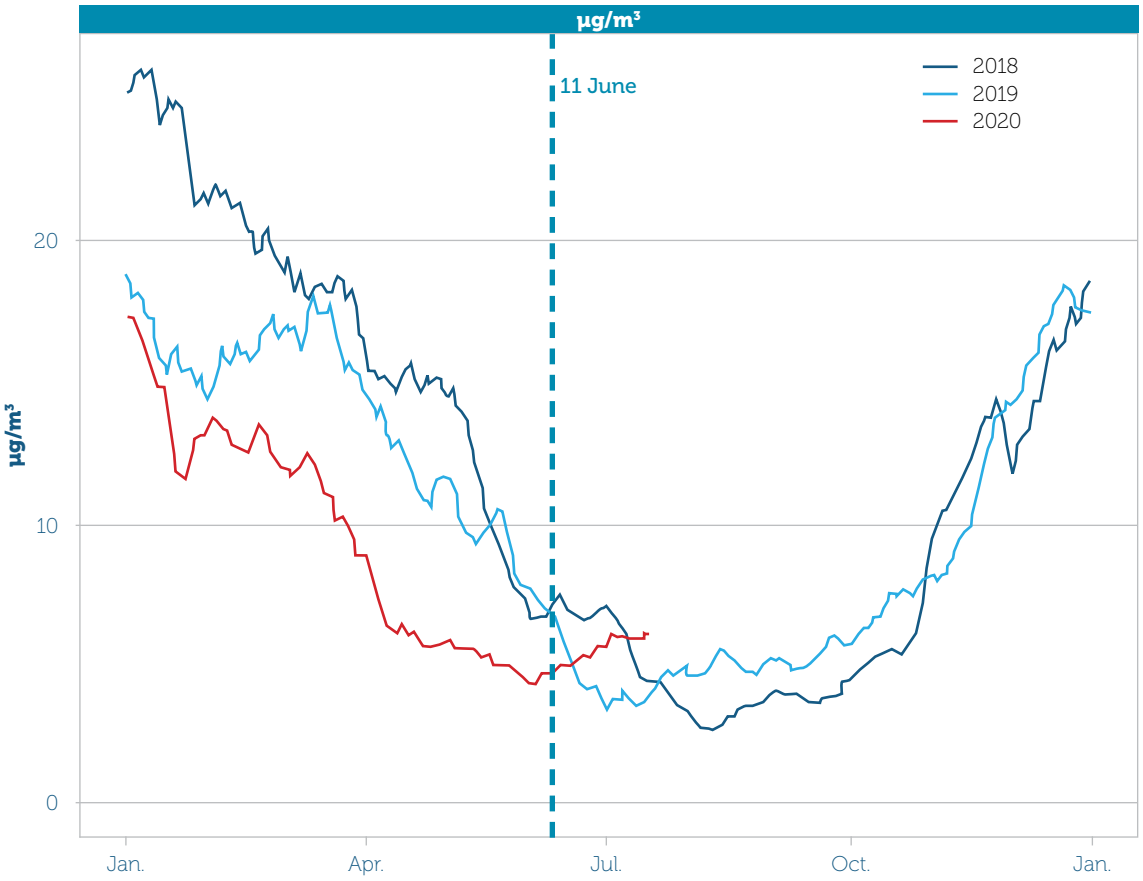
A slight increase both within Zonguldak city and close to Çatalağzı power plant can be observed.

Ground monitoring

There are four monitoring stations in the vicinity of Çatalağzı Coal Fired Power Plant, including one in the city portion of the province of Zonguldak. The chart below shows an average of these four stations.

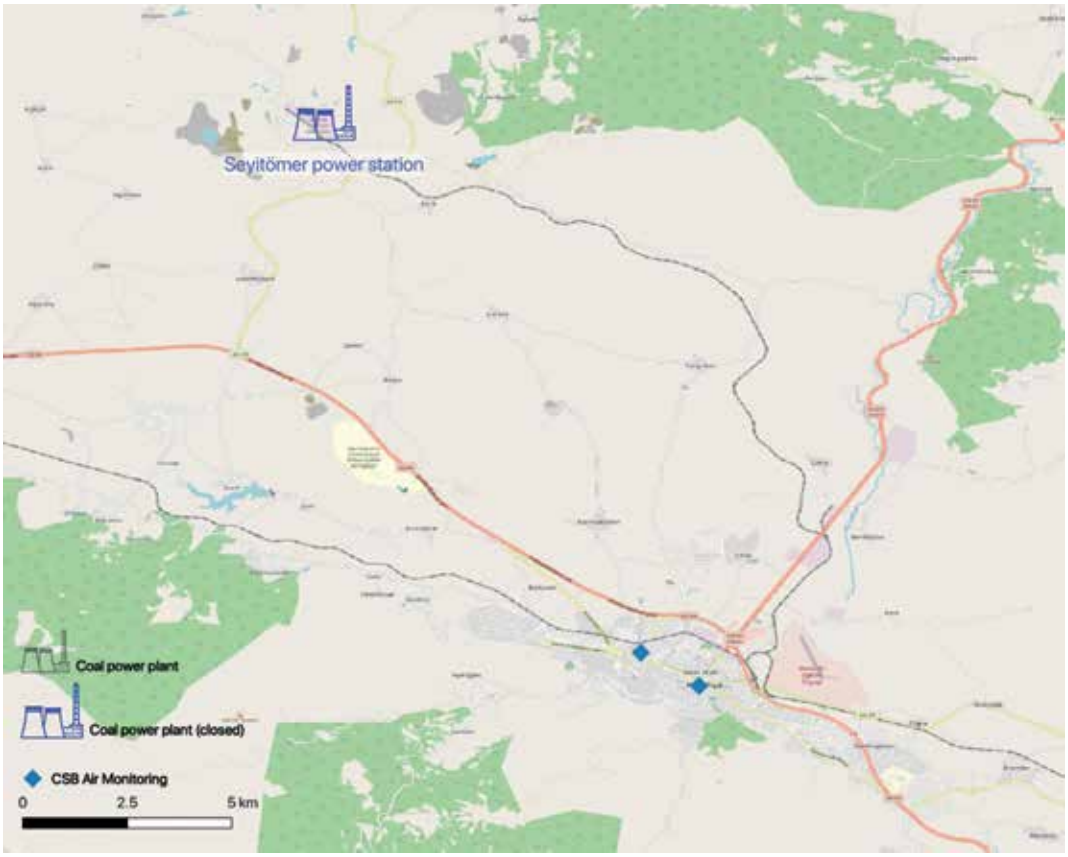
SO_2 Concentration Levels in Zonguldak

30-day running average



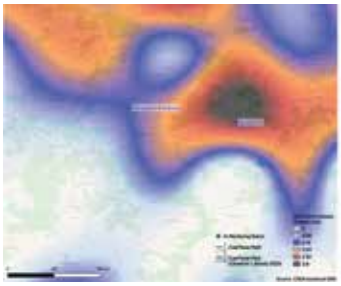
SO_2 levels have been historically low in the first half of 2020. However, since early June, SO_2 levels are on an ascending trend, now exceeding levels at the same date in previous years.

Seyitömer & Tunçbilek Coal Fired Power Plants (Kütahya Province)

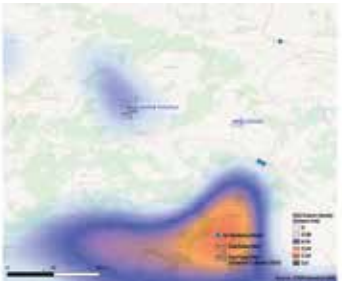


Satellite - OMI

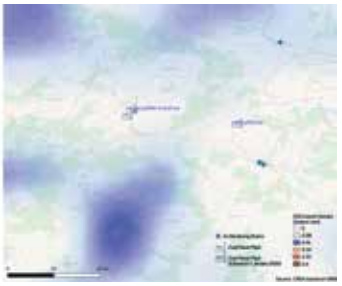
2019/Q4



2020/Q1

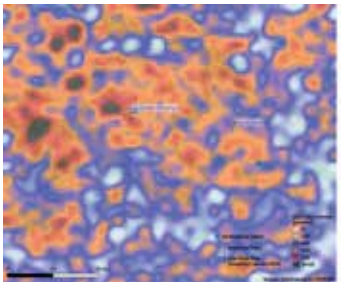


2020/Q2

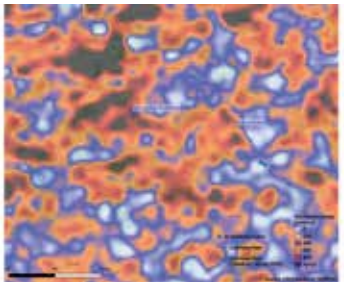


Satellite - TROPOMI

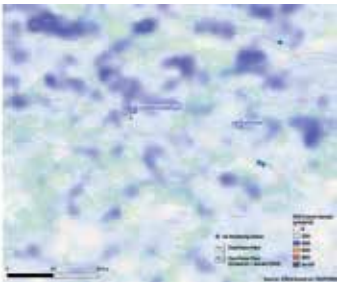
2019/Q4



2020/Q1

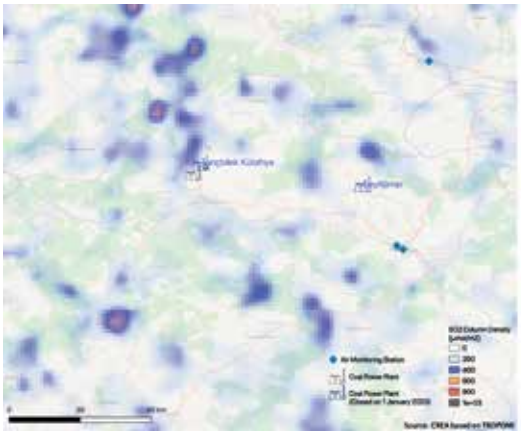


2020/Q2

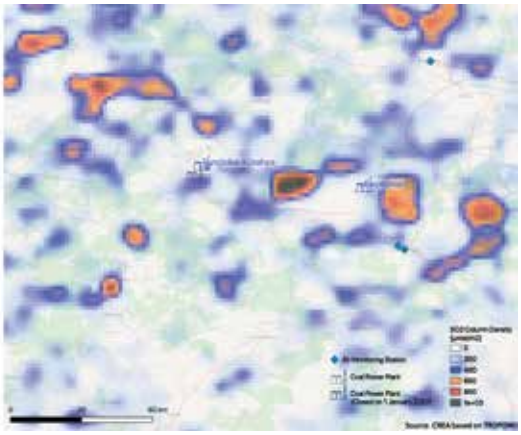


Only TROPOMI offers data in June 2020. In the maps below, we show SO_2 density before and after the official authorization to restart targeted power plants.

Before 11 June 2020 [14 days]



After 11 June 2020 [14 days]



Ground monitoring

The closest monitoring stations to Seyitömer Termik Santrali are located in Kütahya itself, approximately 20 km away from the power plant. The chart below shows the average of these two monitoring stations.

SO_2 Concentration Levels in Kütahya

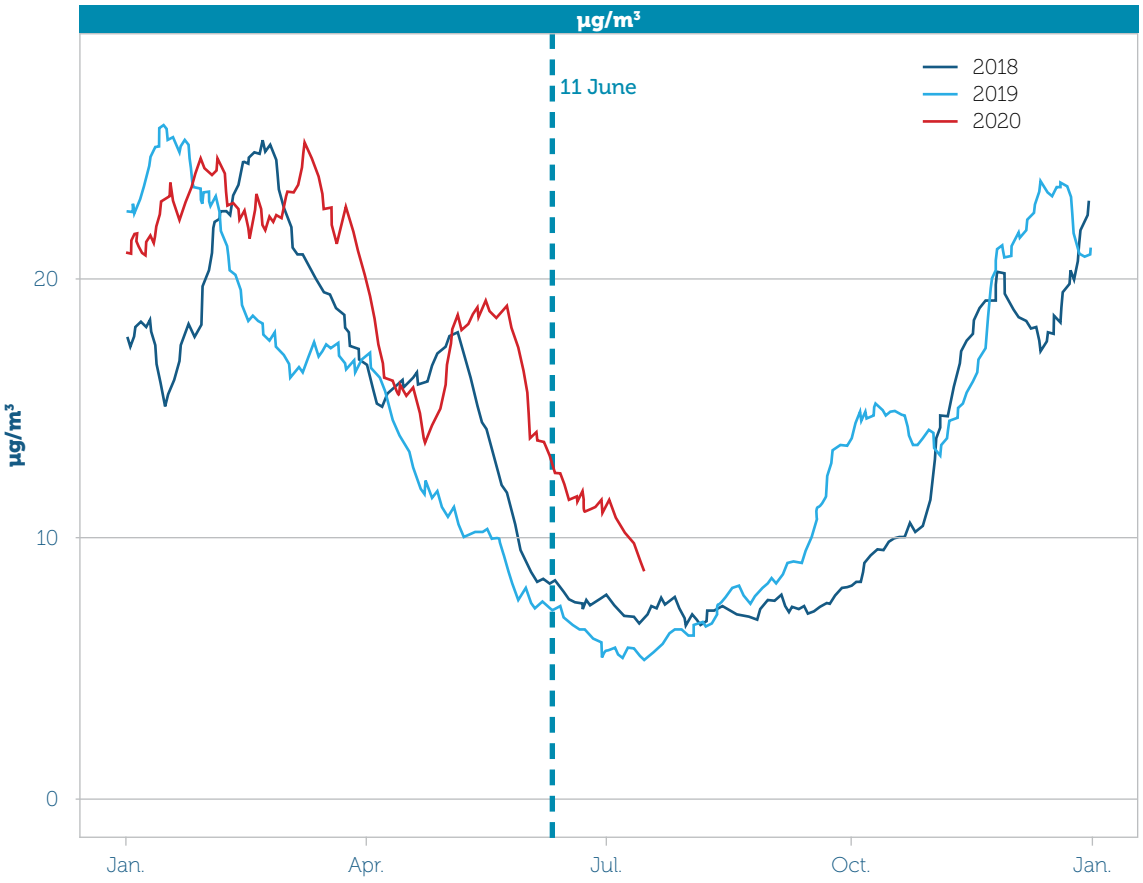
30-day running average

Data is incomplete in 2019. Like in other cases, SO_2 concentration levels have been historically low in the first half of 2020. There is no upward trend after June 11, 2020, the day when the power plant may have resumed its operation.

There is one monitoring station in the vicinity of Tunçbilek Coal Fired Power Plant, located 1 km away in Karabük.

SO_2 Concentration Levels in Karabük

30-day running average



Air Quality in January - June 2020

NO_2 Satellite Data (TROPOMI)

2019/Q4

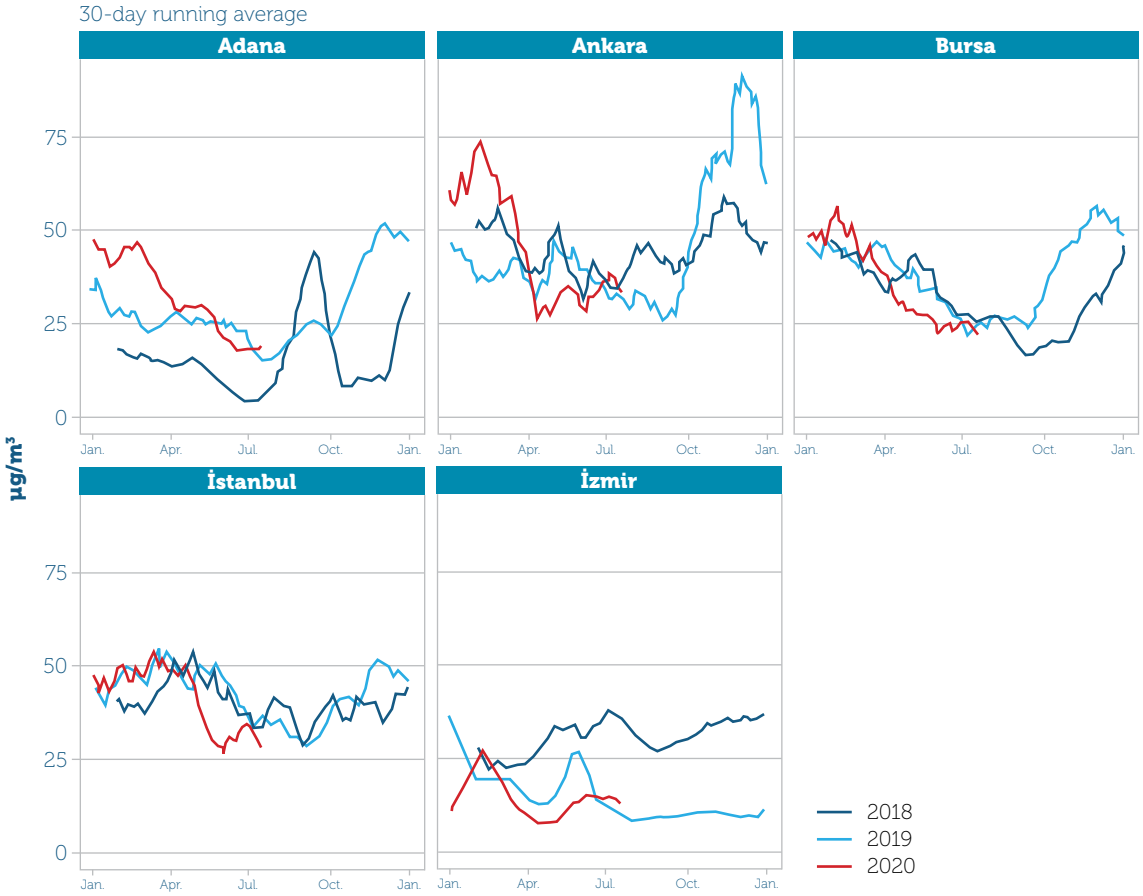
2020/Q1

2020/Q2

NO_2 Levels at the 5 Most Populous Metropolises in Turkey

It can be seen that there has been a fall of nearly 80% at the mobility to retail stores and transit stations and 45% at workplaces in Turkey.[33] It is expected that this fall of mobility will decrease the amount of fossil fuels used for transportation as there are not many green transportation alternatives (cycling roads etc.) used in Turkey on a big scale yet. The data from the ground monitoring stations of the Ministry of Environment and Urbanisation also shows that the fall of fossil fuels used at traffic resulted with a fall of NO_2 levels especially in big cities. After the travel bans were lifted in June, there has been a rise at NO_2 levels in some cities.

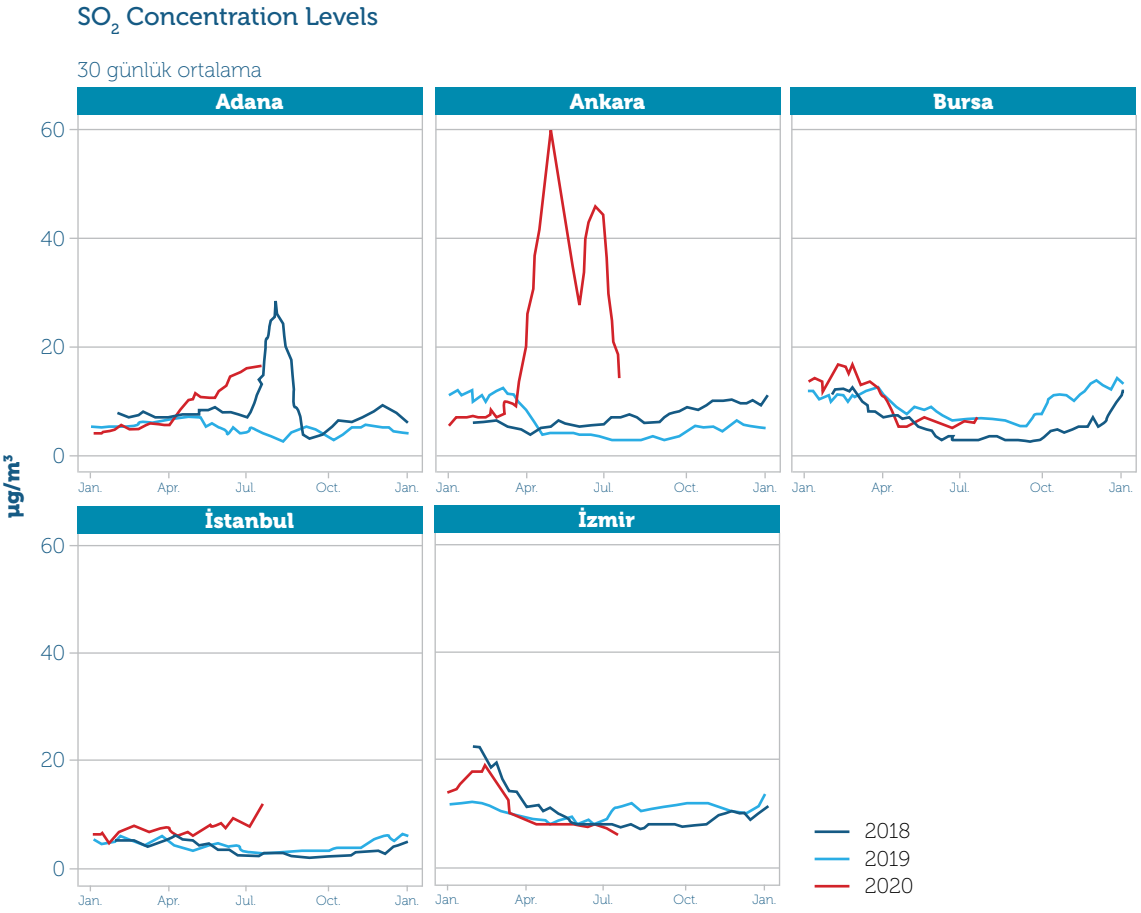
NO_2 Concentration Levels



[33] News Turkey's mobility sharply decreases as COVID-19 measures yield results

PM_{10} Concentration Levels

30-day running average



Turkey's Electricity Generation From Coal

In 2019 , electricity consumption in Turkey increased 5.6% compared to the previous year, and according to the predictions of the Ministry of Energy and Natural Resources, this consumption is expected to increase around 4.8% each year. The increase in electricity consumption is seen as one of the tools of development strategy in Turkey, and especially coal and lignite investments are given incentives. This situation is detrimental to climate change and the efforts toward clean air. According to a study conducted by the Health and Environment Alliance (HEAL) in 2017, each 1 lira of incentive given to fossil fuels incurs an extra 10 lira of health cost only regarding air pollution[34]. Coal-fired thermal power plants threaten the health of humans as well as the environment both in the area they operate and in the entire country.[35]

In 2018, Turkey's electricity production breakdown was 37.3% lignite and hard coal in addition to 29.8% natural gas, which makes a total of 67.1% of fossil fuels.[36]

According to the "Unpaid Health Bill" report on the negative impacts of coal-fired thermal power plants on health published in 2015 by the Health and Environment Alliance (HEAL), air pollution caused by coal-fired thermal power plants gave rise to 2,875 premature deaths

[34] HEAL, Unpaid Health Bill (2016)
[35] CAN, "Gerçek Bedel" website (2018)
[36] Turkey Coal Power Plants (TKİ),(2016), "2015 Kömür (Linyit) Sektör Raporu".

in Turkey.[37] However, the numbers and total capacity of coal-fired thermal power plants have increased since the report was published: The total installed capacity was 14.6 GW in 2014, it has increased to 19.9 GW as of September 2018. This caused an increase in premature deaths and diseases; however, since we don't have the relevant data, air pollution related to energy production in Turkey and the data pertaining to air pollution in the vicinity of coal-fired thermal power plants was analyzed in this section.

The number of coal-fired thermal power plants are also increasing each year: As of September 2018, the installed capacity of 27 coal-fired thermal power plants is 19.9 GW, and an additional 33.4 GW capacity of new coal-fired thermal power plants is being planned. Turkey is a country which is planning the most new coal-fired thermal power plants in the European region countries (EU 33), regarding number as well as capacity. If these planned power plants are built, Turkey's installed capacity based on coal will be multiplied by 2.5 times.[38]

In the Kahramanmaraş province, the Afşin-Elbistan district, there are 2 coal-fired thermal power plants in operation, which use lignite as fuel, having a capacity of 2.795 MW. The Elbistan measurement station results show that air pollution in the region where the plants are running is gradually increasing and the yearly PM_{10} average has exceeded the national limit value by 3 times, and the WHO limit value by 6 times. **Despite this situation, the construction of 6 new coal-fired thermal power plants is being planned. Afşin-Elbistan D-E-F-G units are being planned as public investments, whereas the approval phase of the Akbayır and Elbistan power plants are being undertaken by the private sector.**

Health Impacts of Some Planned Coal Fired Power Plants

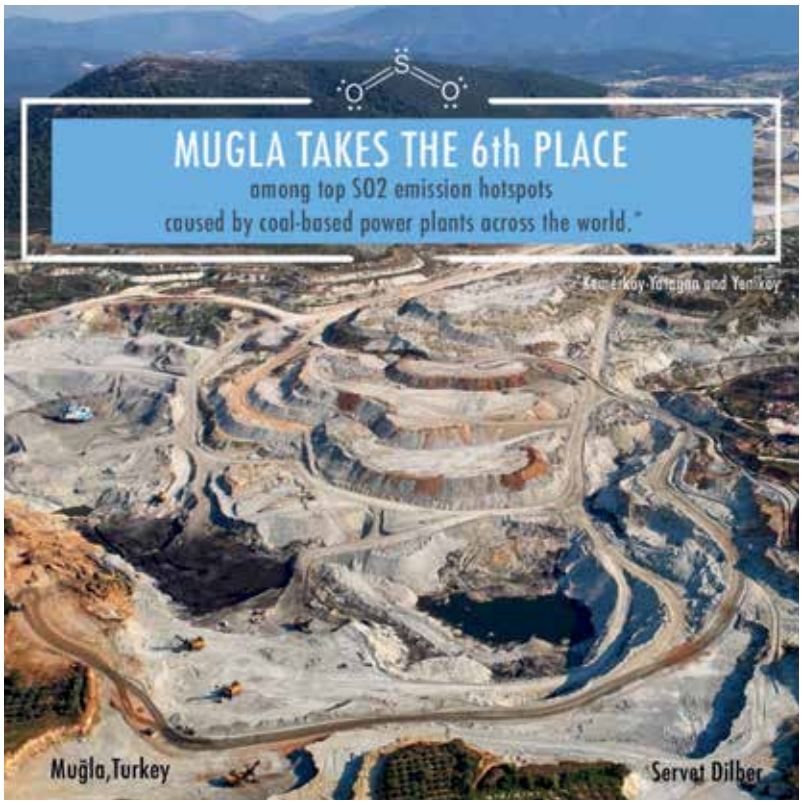
Health impacts assessment is not included at any part of the evaluation procedures for any industrial project in Turkey.

Unfortunately, health impacts assessment is not included at any part of the evaluation procedures for any industrial project in Turkey. Right to Clean Air Platform is providing input through the expert reports prepared about the health impacts of the planned coal fired power plants to the evaluation committees working under the Ministry of Environment and Urbanisation. Moreover, if those coal fired power plants are allowed; expert reports are submitted to the courts cases filed by the local people, NGOs or chambers of doctors etc. against the accepted Environmental Impacts Assessment reports of the projects.

Right to Clean Air Platform has prepared **the first Health Impact Assessment (HIA) report for a coal fired power plant in Turkey in 2020.** Greenpeace Mediterranean conducted a modelling study to understand the negative impacts of the planned Eskişehir Alpu Coal Fired Power Plant on health.[39] According to this study, if the Alpu coal fired thermal power plant begins operation in Eskişehir, it will cause 3,200 early deaths in 35 years. Premature death means death before the average life term of 75 years . According to the HIA report, **11 million people from 24 cities** will be affected by the negative health impacts caused by the Eskişehir Alpu Coal Fired Power Plant.[40] The total loss from air pollution will be around **€6.411 billion** in 35 years (calculated according to 2018 Euro/Turkish Lira exchange rate).

[37] CAN, HEAL, WWF, (2016), "Europe's Dark Cloud"
[38] Ministry of Natural Resources and Energy "Dünya ve Ülkemizde Enerji ve Tabi Kaynaklar Genel Görünümü 2017"
[39] Greenpeace, 2018, "Eskişehir'de Termik Santral Tehlikesi"
[40] Health Impact Assessment: ALPU, a coal fired power plant in Turkey (2020)

Afşin – Elbistan A Coal Fired Power Plant is in operation for 33 years, and the B power plant is in operation for 15 years. According to modelling results, Afşin Elbistan Coal Fired Power Plant is estimated to have caused **17,000 premature deaths** up to now due to particulate matter ($PM_{2.5}$) and nitrogen dioxide (NO_2) pollution. **If the 6 newly planned coal-fired thermal power plants in Afşin are built, they are expected to cause 32,000 early deaths in total until the end of their operation life.**[41]



In Muğla, it is estimated that 45,000 premature deaths happened due to air pollution related to the 3 coal-fired thermal power plants since 1983. Even if the planned rehabilitation after privatization is completed, the power plants are estimated to cause 5,270 early deaths in the following 10 years.[42]

[41] Afşin-Elbistan power complex - Global Energy Monitor
[42] News: Milas - Muğla Report of Right to Clean Air Platform

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CHAPTER 3

HEALTH IMPACTS OF AIR POLLUTION IN TURKEY (2017-2019)

In 2013 World Health Organisation announced that particulate matter is carcerogenic.

HEALTH IMPACTS OF AIR POLLUTION

What is $PM_{2.5}$?

Particulate matter (PM) is the term for a pollutant that consists of a mixture of solid particles and liquid droplets found in the air. Particulate matter is measured by micrometers ($\mu g/m^3$) and named by its sizes such as PM_{10}, $PM_{2.5}$, and $PM_{0.1}$.

$PM_{2.5}$ is 30 times smaller than the average human hair and it can disperse for thousands of kilometers beyond country borders and continents, **thus it is an important indicator for the protection of public health.**

Every year 8 million people in the world die due to their exposure to indoor and outdoor air pollution. Ambient air pollution is responsible for 27.5% of deaths due to lower respiratory and 26.8% of deaths due to Chronic Obstructive Pulmonary Disease (COPD).

$PM_{2.5}$ is particularly important to protect public health because;

- $PM_{2.5}$ causes more health risks PM_{10} by reaching the deepest parts of the lungs and directly entering the blood circulatory system.
- $PM_{2.5}$ is the most common index used worldwide for the calculation of the burden and mortality due to air pollution-related diseases.
- The main source of $PM_{2.5}$ and smaller particulate matter (such as $PM_{0.1}$) is related to human activities such as heating, transportation, industry and electricity generation[43].

It has been shown that exposure to particulate matter is associated with neuropsychiatric diseases as well as diseases in the cardiovascular and respiratory systems. The common underlying mechanism is the increase in inflammation triggered by particulate matter.

The Impacts of Air Pollution on Our Genes

Air pollution and especially particulate matter, which is one of its components, cause serious health problems in the human body, especially respiratory, cardiovascular and nervous systems. Although the mechanisms underlying this relationship are not well known, changes in DNA methylation, which have been proven to be sensitive to air pollutants and the most well known molecular markers of epigenetic[44] status of the cell, have been demonstrated by different studies. Interestingly, changes in DNA methylation[45] that occur in response to environmental stimuli are thought to not only play a role in the pathogenic mechanism, but also mediate the body's adaptation to air pollutants.

[43] https://www.epa.gov/sites/production/files/2014-05/documents/huff-particle.pdf

[44] **Epigenetics** is a branch of biological science that inspects changes in gene expression that do not arise from changes in the DNA sequence, but are also hereditary. Epigenetics includes modifications that do not change the DNA sequence, but result in changes in the function and regulation of DNA, proteins and RNAs.

[45] DNA methylation is defined as the genetic changes in gene expression in a manner that is independent from the DNA sequence.

The biological mechanisms underlying the adverse health impacts of particulate matters have been partially revealed, and epigenetic mechanisms are thought to play a central role. Epigenetic mechanisms are flexible genomic variables that can alter genome expression under external influences and, at the same time, ensure stable proliferation of gene activity in future cell generations. Changes in epigenetic marks have been found to be associated with human cancer, cardiovascular, respiratory system, and neurodegenerative diseases. The most studied epigenetic mechanism is **DNA methylation, which involves the addition of a methyl group to the 5' position of the cytosine residues in the CG dinucleotide.** DNA methylation in the starter region of the gene ('gene promoters') suppresses gene expression. On the other hand, the general reduction of DNA methylation (mainly due to hypomethylation of repetitive elements in non-coding regions of the gene) is frequently observed in cancer cells and may affect genomic stability. DNA methylation also occurs in the body of the gene. Finally, global methylation, often assessed by measurement of repetitive element methylation such as Alu and LINE-1, reflects the overall methylation state of the genome.

As stated in this text, many studies support the hypothesis that particulate matter can alter DNA methylation. However, not all stages of life are equally affected. **The time before pregnancy, in the womb (intrauterine period), early childhood and old age are periods of life in which humans are more susceptible to the impacts of particulate matter**[46].

Air pollution and COVID-19 pandemic

The Center for Research on Clean Air and Energy (CREA) has prepared an information note about the impact of long term air pollution exposure on the impacts of Covid-19 virus[47]. Past and current air pollution exposure around the world is worsening the unfolding COVID-19 epidemic. Air pollution increases the risk of many pre-existing conditions that make COVID-19 more severe and deadly, including diabetes, lung diseases, asthma, heart disease and cancer. These health conditions substantially increase the risk of hospitalization and death for COVID-19 patients. This means that millions of people were already suffering from chronic diseases and disabilities or undergoing treatments like chemotherapy because of their past exposure to air pollution, and this is making them more vulnerable to COVID-19. It's also likely that the risk of infection is affected by the impact of air pollution on the immune system, and the respiratory symptoms for infected people are made worse by air pollution - there is evidence of this for respiratory infections in general but not yet specifically for COVID-19.

[46] Particulate matter exposure shapes DNA methylation through the lifespan. Ferrari L, Carugno M, Bollati V. Clin Epigenetics. 2019 Aug 30;11(1):129. doi: 10.1186/s13148-019-0726-x.
Pregnancy Exposure to Atmospheric Pollution and Meteorological Conditions and Placental DNA Methylation. Abraham E, Rousseaux S, Agier L, et all. Environ Int. 2018 Sep;118:334-347. doi: 10.1016/j.envint.2018.05.007. Epub 2018 Jun 21.
Genome-wide DNA Methylation and Long-Term Ambient Air Pollution Exposure in Korean Adults. Lee MK, Xu C, Carnes MU, et all. Clin Epigenetics. 2019 Feb 28;11(1):37. doi: 10.1186/s13148-019-0635-z.
DNA methylation and exposure to ambient air pollution in two prospective cohorts. Plusquin M, Guida F, Polidoro S, et all. 2017 Nov;108:127-136. doi: 10.1016/j.envint.2017.08.006. Epub 2017 Aug 24.
[47] CREA (2020), How air pollution worsen impacts of Covid-19 https://energyandcleanair.org/wp/wp-content/uploads/2020/04/How_air_pollution_worsens_the_COVID-19_pandemic.pdf30;11(1):129. doi: 10.1186/s13148-019-0726-x.

COVID-19 is a new disease and much remains uncertain or unknown, but we can already say that:

- High levels of air pollution affect the natural defenses of the body against airborne viruses, making people more likely to contract viral diseases, and this is likely to be true for SARS-CoV-2 as well. This means that it is likely that air pollution exposure is contributing to the spread of the disease.
- Air pollution exposure is a key risk factor for many of the chronic diseases that make people more likely to get severely ill, require intensive care and ventilation, and die from COVID-19. A strong body of existing scientific research shows that a significant part of the burden of diseases like chronic respiratory disease, heart disease, asthma and diabetes worldwide is attributable to air pollution. This means that past air pollution exposure is now contributing to the death toll and the enormous pressure on healthcare systems from the disease.
- For many respiratory infections, air pollution exposure on infected people can worsen their symptoms and increase the risk of hospitalization and death. This is likely to be true for COVID-19 patients as well but has not yet been confirmed with specific studies. This means that current air pollution levels, which remain dangerous in much of the world despite reductions caused by measures to control the virus, are likely contributing to the number of severe cases and deaths from COVID-19. What we know for sure is that current air pollution levels are contributing to illness and need for health care services from other diseases, adding to the pressure on health care systems. Air pollution is a key risk factor for deaths from Lower Respiratory Infections. Globally, one death in six related to these infections is attributed to PM2.5 air pollution, amounting to approximately 400,000 deaths per year[48].

CALCULATING HEALTH IMPACTS OF AIR POLLUTION

Each 10 µg/m^3 increase in PM_{10} values can cause a 0.7% increase in cardiovascular diseases and a 1,4% increase in respiratory diseases.[49] **In 2013, the International Agency for Research on Cancer categorized external environment air pollution as a whole, and PM pollution especially as a certain carcinogen, and also announced that it increased the risk of bladder cancer.**[50] In this respect, particulate matter pollution is especially important regarding public health. Also particulate matter has a very wide spectrum of negative health impacts, the respiratory system, cardiovascular system and neurological system first of all.

The negative health impacts of air pollution develop in accordance with increased exposure, and there is no safe threshold value under which there will be no negative health impacts at all. However, in research undertaken in Europe and the USA, the threshold for $PM_{2.5}$ beyond which negative health impacts will be seen was estimated as 3–5 µg/m^3. The long term limit value for $PM_{2.5}$ has been specified as 10 µg/m^3 annually. This value is the lower end of the interval of the research undertaken by the American Cancer Society (ACS) where significant impacts were observed on survival. In all these undertaken research, long term exposure to $PM_{2.5}$ was reported to have strong correlation with death[51].

[48] GBD 2017 http://ghdx.healthdata.org/gbd-2017
[49] Unicef; (2016), Clear the air for children: Executive Summary
[50] Roberts AL, Kristen L, Hart JE, Laden F, Just AC, Bobb JF; (2013), Perinatal air pollutant exposures and autism spectrum disorder in the children of Nurses' Health Study
[51] Global Effect Factors for Exposure to Fine Particulate Matter

The loss of health criterion DALY (Disability Adjusted Life Year) is a summary indicator for public health and counts lost years due to diseases and disorders that can cause death (1 DALY is equal to 1 healthy year lost from life).[52]

AirQ+ is a program developed by the WHO Europe Regional Office to calculate the impacts and health load of air pollution on a certain population. All calculations done by AirQ+ are based on methodologies obtained from epidemiologic research and dose-response functions. The dose-response functions used in the software are based on the systematic evaluation of all current research and meta-analysis.

In the case of $PM_{2.5}$ values exceeding 10 µg/m^3, the AirQ+ program accepts the death risk (relative risk coefficient) for people over the age of 30 related to long term air pollution due to non-external reasons as 1.062 (95% Confidence interval: 1.041 - 1.084).[53] The number of deaths estimated by this program is the number of deaths expected when the $PM_{2.5}$ level exceeds 10 µg/m^3, in other words, the number of deaths that could have been prevented by eliminating air pollution caused by $PM_{2.5}$.

Preventable death means that deaths will not occur if air pollution is eliminated.

These calculations have been made on district level and later compiled to reach the estimated country-wide death figure due to air pollution.

In this calculation, 4 components are taken into consideration when numerically evaluating the negative impacts of air pollution on health for a residential area (which is a district for this study):

1- Air pollution concentrations;
2- The magnitude of the exposed population and its composition;
3- Mortality and morbidity criteria (incidence);
4- Concentration-response function

[52] Key features of AirQ+1.3, WHO/Europe
[53] AirQ+: software tool for health risk assessment of air pollution

Table 3 - Variables Used in The Calculations Made With Airq+ and Their Descriptions

$PM_{2.5}$ (Annual Average)	The average $PM_{2.5}$ level data is compiled by the Platform by dividing the sum of all annual averages of the stations that record sufficient data in each province by the number of stations. (See Chapter 1, the Methodology section) Direct measurement data was used whenever $PM_{2.5}$ measurements at the stations were involved. If a station only measured PM_{10} levels, the annual average PM_{10} levels were calculated based on the conversion coefficient used for Turkey by the WHO.[54] (See Chapter 1, the Methodology section)
Population over 30	Population data by province and age group were obtained by dynamic querying from the Turkish Statistical Institute's Address-Based Population Registration System database, and the population data for people at or over the age of 30 living in each province was recorded from this data.
Total Death Count over 30	The total number of deaths by province and age group were obtained by dynamic querying from the Turkish Statistical Institute's Death Statistics database, and the number of deaths for people at or over the age of 30 was recorded from this data.
Rate of external injury/ poisoning	The Turkish Statistical Institute's "Distribution of causes of death by permanent residence" database was used. Among the total deaths in this database, the rate of deaths under the "external causes of injury and poisoning" category was calculated.
Number of deaths over 30 attributed to air pollution (excluding external causes)	Using the rate of the deaths under the "external causes of injury and poisoning" category, the number of deaths over the age of 30 excluding "external causes of injury and poisoning" was calculated for each province. Then, the numbers for all provinces were added up to obtain the sum of the aforementioned deaths in Turkey. Considering the 95% confidence intervals of the relative risk coefficient, the lowest and highest estimates for the death count attributed to air pollution were obtained.
Percentage of deaths attributed to air pollution	The ratio of deaths attributed to air pollution relative to the total death count in each province was calculated as a percentage value.
30+ years old mortality rate attributed to air pollution (per 100,000)	Using the number of deaths over the age of 30 excluding "external causes of injury and poisoning" and the total population count over the age of 30, the crude death rate (per 100,000) was calculated.

[54] https://www.who.int/phe/health_topics/outdoorair/databases/AAP_database_methods_2014.pdf?ua=1

Between 2017 and 2019, almost 6 to 7 times as many deaths as traffic accidents occurred due to air pollution.

PREVENTABLE DEATH COUNT FROM AIR POLLUTION IN TURKEY

In Turkey, the number of deaths attributed to air pollution in a total of 399,025 deaths in 2017 (for people over the age of 30, and excluding accidents/external wounds) has been calculated as **51,574** on the average.[55] Calculations based on the confidence interval for the risk show that, in 2017, the minimum number of deaths attributed to air pollution in Turkey is 34,544, and the maximum number is 66,381. In other words, air pollution killed 7 times more people than traffic accidents in Turkey in 2017.

[55] Mortality rate, under-5 (per 1,000 live births) - Turkey | Data

In 2019, the provinces with the highest number of deaths attributed to air pollution were İstanbul, İzmir and Manisa respectively.

The highest number of deaths attributed to air pollution is **İstanbul with 5851 deaths. Bursa follows this with 3098 deaths, and Ankara is third with 2139** deaths. In 2017, 3 cities that have seen the highest fatalities due to air pollution are İstanbul, Bursa and Ankara. In 2017, 3 cities that have seen the highest fatalities based on percentage of their population is Iğdır, Kahramanmaraş and Afyon, in order of percentage.

As levels of air pollution increase, the percentage of deaths attributed to air pollution also increases. The cities with the highest number of deaths attributed to air pollution based on the percentage of their population are **Iğdır with 25.5%, Kahramanmaraş with 25.1% and Afyon with 23.7%** respectively. These cities are at the same time cities which have the highest air pollution in 2017 too.

According to recent data, among the 396,670 deaths over the age of 30 in 2019 in Turkey (excluding accidents/external injuries), 31,476 of them were attributed to air pollution. **In 2019, the percentage of deaths attributed to air pollution in Turkey was determined to be 7.9%.**

Among the 382,098 deaths over the age of 30 in 2018 in Turkey (excluding accidents/external injuries), 45,398 (11.9%) of them were attributed to air pollution. Compared to the data obtained in our first Air Q+ calculations in 2017 in which the total death count was 398,716 and the death count attributed to air pollution was 51,794, the numbers from the last two years indicate that **deaths attributed to air pollution has been decreasing throughout the years. However, the numbers are still significantly high, which is a stark reminder of how many lives can be saved by reducing air pollution.**

Tablo 4 - 10 Provinces with the Highest Death Counts Attributed to Air Pollution in 2019

	Number of Deaths Attributed to Air Pollution			Percentage of Deaths Attributed to Air Pollution			Rate of Deaths Attributed to Air Pollution (per 100,000)		
Provinces	Avr.	Min.	Max.	Avr.	Min.	Max.	Avr.	Min.	Max.
İstanbul	3761	2480	4932	6,4	4,22	8,4	38,92	25,66	51,04
İzmir	2075	1373	2714	8,08	5,34	10,56	70,82	46,85	92,62
Manisa	1680	1134	2156	18,5	12,48	23,75	177,68	119,92	228,1
Bursa	1584	1052	2064	10,26	6,82	13,37	80,36	53,38	104,7
Ankara	1552	1024	2036	6,4	4,22	8,4	43,38	28,61	56,89
Konya	1271	847	1652	11,87	7,91	15,42	94,62	63,04	122,92
Kayseri	1004	674	1295	16,01	10,75	20,64	116,63	78,33	150,42
Antalya	932	618	1216	9,18	6,08	11,98	57,42	38,06	74,95
Çorum	881	599	1122	22,33	15,19	28,46	247,75	168,54	315,8
Erzurum	867	591	1104	23,25	15,85	29,59	204,87	139,64	260,69

The province with the highest number of deaths due to air pollution in 2019 is **İstanbul** with 3761 deaths, followed by İzmir and Manisa.

Tablo 5 - Provinces with the Highest Death Percentage Attributed to Air Pollution in 2019

	$PM_{2,5}$	Number of Deaths Attributed to Air Pollution			Percentage of Deaths Attributed to Air Pollution			Rate of Deaths Attributed to Air Pollution (per 100,000)		
Provinces	Avr.	Min.	Max.	Avr.	Min.	Max.	Avr.	Min.	Max.	Max.
Iğdır	78	226	158	282	33,57	23,41	41,85	214,29	149,42	267,15
Erzurum	54	867	591	1104	23,25	15,85	29,59	204,87	139,64	260,69
Çorum	52	881	599	1122	22,33	15,19	28,46	247,75	168,54	315,8
Düzce	45	418	283	536	18,9	12,83	24,35	170,51	115,2	218,7
Manisa	44	1680	1134	2156	18,5	12,48	23,75	177,68	119,92	228,1
K. Maraş	42	791	533	1017	17,51	11,79	22,52	118,24	79,65	152,08
Sinop	41	331	223	426	17,01	11,45	21,9	218,69	147,17	281,52
Elazığ	39	477	320	615	16,01	10,75	20,64	131,97	88,63	170,19
Kayseri	39	1004	674	1295	16,01	10,75	20,64	116,63	78,33	150,42
Osmaniye	39	357	240	460	16,01	10,75	20,64	110,17	73,99	142,07

As seen in the table above, the province with the highest percentage of deaths over the age of 30 (excluding accidents/external injuries) in 2019 is Iğdır with 33.57%. Iğdır, which had the worst quality of air among all Turkish provinces in 2019, the percentage of deaths attributed to air pollution were 25.5% in 2017 and 28.17% in 2018. **In Iğdır, the number of deaths attributed to air pollution has increased for 3 years due to increased PM2.5 pollution and hit an all-time high in 2019.**

The high percentage of deaths attributed to air pollution in these provinces is related to the high $PM_{2.5}$ annual averages. In other words, the percentage of deaths attributed to air pollution increases proportionally to the high annual average of $PM_{2.5}$ in these provinces. This is because the AirQ+ calculation tool makes its calculations by considering the limit values of the WHO Air Quality Guide. When the $PM_{2.5}$ values in the outdoor air exceed 10 µg/m^3, the AirQ+ program accepts the risk of death over the age of 30 without external injuries, which is associated with long-term air pollution, as RR: 1,062 (95% CI: 1,041-1,084). The results obtained from the provinces where the calculations are made show that as the $PM_{2.5}$ values exceed 10 µg/m^3 more frequently, the attributed values also increase in proportion.

On the other hand, Çorum is the province with the highest rate of deaths attributed to air pollution per 100,000 people. This is because both $PM_{2.5}$ pollution and the overall rate of deaths over the age of 30 are high in the province.

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CHAPTER 4

LEGISLATION RELATED TO AIR QUALITY IN TURKEY

In 2019 Turkish citizens raised their vioces to prevent new exemptions to coal fired power plants and Draft Bill is vetoed.

EXEMPTIONS TO PRIVATIZED COAL FIRED POWER PLANTS

In February 2019, a law proposal called "Article 45" was about allowing 13 coal fired power plants to continue polluting the air without making any environmental investments such as filtration systems or coal ash dam requirements for two more years which they already have been enjoying for six years so far. The existing plants that are 30 years old in average could lead to 1,100 more premature deaths until the end of 2021. The plants are in the cities like Kahramanmaraş, Zonguldak and Manisa where air quality is already too low and people have serious health problems. It's worth to mention that in a county of Kahramanmaraş called Elbistan was suffering from six times higher air pollution rates according to WHO's safe limits where two coal plants are operating within 3,5 GW capacity. In the city of Zonguldak where seven coal fired power plants are operating and PM10 rates are three times higher than WHO levels in 2018, a pediatric oncology department has been opened in a state hospital recently.

Article 45 in the law proposal to change the Turkish Mining Law was met with huge public concern. Right to Clean Air Platform that embodies groups including Turkish Medical Association, Turkish Neurological Society, Turkish Society of Public Health Specialists, Greenpeace Mediterranean, HEAL, TEMA Foundation, 350.org, CAN-Europe, WWF-Turkey started a campaign and asked the citizens to call the deputies by phone and tell that they can not wait two more years to have the filters installed at the coal plants to be able to breath clean air.

On Valentine's Day of 2019, all the parties at the Turkish National Assembly gave a surprising gift to their citizens. To the surprise of millions who are familiar with the polarized political scene of the country, all parties agreed to withdraw a proposal on granting exemptions to privatized coal fired power plants from environmental investments including filtration systems, flue gas facilities, and ash dams - thanks to **a powerful campaign led by local and national NGOs and concerned citizens who collected 70K signatures in 1 week.**

There were key moments to the success of this public health campaign in a country where energy politics is much more powerful than any other issue.

Clear and simple demand combined with collective actions of all levels

This significant success that public health is prioritized over the demands of the coal-fired power plants' operators is a result of joint actions by NGOs that are not only interdisciplinary but also operating at multi-levels; local, national and international. The demand for the campaign was kept as simple and clear from the beginning and right to clean air was the main target: "we want filters". Even deputies were surprised by this demand who were expecting a green movement saying "shut down those plants" and probably a group not open for conversation.

Get the public message heard by decision makers

Public petitions resulted in more than 70K signatures in one week and lots of social media engagement that demanded the right to clean air. Members of the Right to Clean Air Platform both from environment and health background made visits to the Parliament to

give information about the potential impacts of the Article. The signatures submitted by local groups to the deputies from the cities that are severely affected by mentioned power plants and they showed the pictures of black smoke coming from the stacks every day along with the air pollution analysis results.

Health and environment actors advocating together

The Turkish Right to Clean Air Platform which lead the rapid response campaign consists of NGOs from environment and health background such as Turkish Medical Association, Turkish Thoracics Society, Turkish Neurological Society, Turkish Society of Public Health Specialists, Greenpeace Mediterranean, HEAL, TEMA Foundation, 350.org, CAN-Europe, WWF-Turkey and has a three years old collaboration culture of advocacy with representatives from different disciplines and generations.

Turkish campaign has shown that health and air pollution are beyond party politics and that everyone deserves clean air. This lesson learned is very valuable and it can be a guide for all countries struggling with the same problems that threaten the environment and people's health. A genuine call for clean air - especially in developing countries - can address millions.

However, in November 2019 there was another law proposal (Article 50) about the same exemptions to allow at least 13 coal fired power plants to continue polluting the air without making any environmental investments such as filtration systems or coal ash dam requirements for two and half more years. This time there was a criteria stating that if the investment termin plan is not submitted to the Ministry of Environment and Urbanisation in the first 6 months, the coal plants will be closed. Despite the reactions from the civil society and local people, Article 50 is accepted at the Turkish National Assembly. However, the President has vetoed the draft Law for the first time and sent it back to the National Assembly. Therefore, it is not accepted and the coal fired power plant companies had to comply with the Turkish Environmental Law as of 2020.

As an outcome of the successful campaign led by citizens and the civil society, the Turkish Ministry of Environment and Urbanization announced on the first days of 2020 that five coal-fired power plants totally and one coal-fired power plant partially stopped operation. However, there is no data about the investments done by the other CPPs and the reasons why they were given permanent or temporary environmental permits to operate. In June 2020, some units of the closed five coal plants also started to operate again. There are videos and pictures of the dark clouds coming from the stacks especially in Afşin - Elbistan / Kahramanmaraş since they started to operate again. The authorities announced that they are monitoring the emissions from online systems and will stop operation if the levels go beyond the limits.[56] Despite all the freedom of information applications by the NGOs and locals, the levels of pollutants at the emissions of the CPPs is not shared publicly. According to the information we received from the field, local press and industry magazines, the "dry absorber spraying" system was installed

[56] News (in Turkish) Bakan Kurum'dan kapatılan termik santrallerle ilgili açıklama

as a Chimney Gas Sulfur Treatment plant in all of the power plant units, which were issued temporary activity certificates on 08.06.2020. No other improvements have been made.
Comments of the experts from Chamber of Mechanical Engineers are follows:

1) Compliance and long term impacts of those systems with Turkey's high sulphur coal is untested so far.
2) It brings additional load to the electrofilters, filters may be insufficient. In this case, both the dust emission increases and the sulfur retention efficiency decreases well (or production can be continued without running the filters).
3) Our coals may malfunction frequently, electricity production can be stopped due to malfunction (or electricity production can be continued by releasing pollutants during the malfunction).
4) It may not be operated continuously due to cost (but production can be continued in the plant).

Therefore, we demand the Ministry of Environment and Urbanisation not to permit those coal fired power plants that do not have the necessary environmental investments to operate again.

NATIONAL LIMITS FOR PARTICULATE MATTER

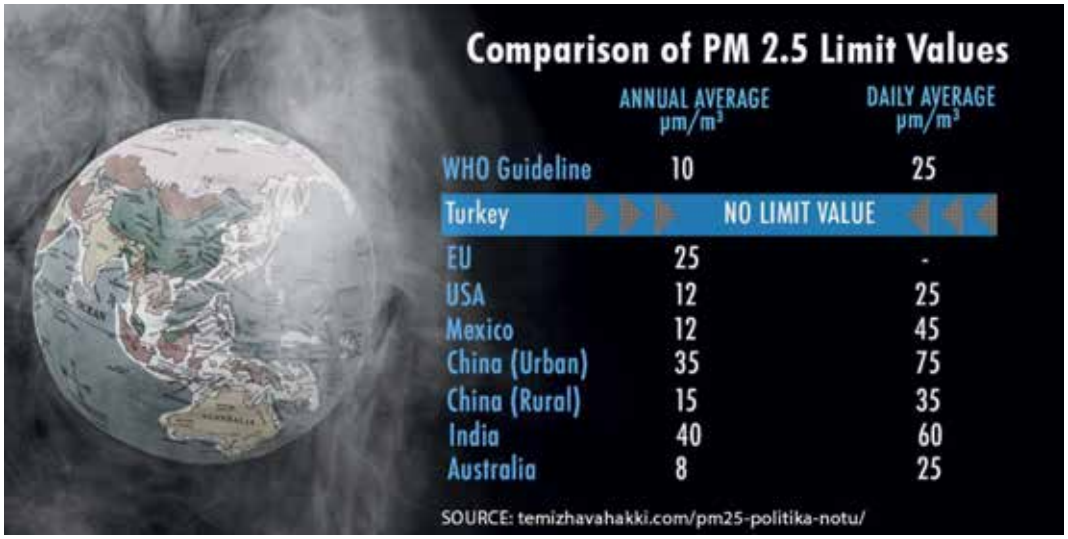
In line with the CAFE Directive, the national limit value for PM_{10} in Turkey has been lowered gradually from 48 µg/m³ in 2017 to 44 µg/m³ in 2018 and finally reached the EU levels of 40 µg/m³ in 2019.[57] However, it is important to note that even the EU limits for annual and daily PM_{10} levels are far beyond the guideline values of WHO. It is also important to note that, there is no safe amount of particulate matter as stated in the previous chapters about health impacts of air pollution.

However, there is no legal limit value specified or regulation issued for the most dangerous pollutant $PM_{2.5}$. The Right to Clean Air Platform has applied to the Ministry of Environment and Urban Planning, Environment Management General Directorate on this matter, and according to the reply given, the regulation for specifying a limit value for the $PM_{2.5}$ pollutant is still in draft phase, and the date of entry into force is indefinite. In the same application, the monitoring methods for air pollutants which exceed border values and whether the necessary measures are being taken have also been asked, and the Ministry has given general and intangible replies. This gives rise to questions about implementation of the clean air action plans.

Turkey still lacks official limit values for $PM_{2.5}$ which is one of the most harmful air pollution-related pollutants for human health. Unlike other pollutants, $PM_{2.5}$ can easily enter the blood circulatory system and access the deeper parts of the respiratory system. In 2019, $PM_{2.5}$ was measured at only 81 monitoring stations out of 339 installed by the Turkish Ministry of Environment and Urbanisation. However, there have been no measures taken because unlike EU member countries, Turkey still does not have relevant legislation that sets national limits for $PM_{2.5}$ pollution.

[57] Dark Report 2019 (in Turkish)

There are still no national limits for fine particulate matters ($PM_{2.5}$) in Turkey.



Several countries such as Australia, Canada, Japan, and the USA adopted national limits that are in line with the guideline values proposed by the World Health Organisation (WHO). Even in China, where coal production has the lion's share in energy policies, there are regulations that set different $PM_{2.5}$ limits for urban and rural areas. However, Turkey lacks any regulation in order to limit or prevent $PM_{2.5}$ pollution and does not have decent data about the $PM_{2.5}$ levels in all cities. It is indispensable that national limits for $PM_{2.5}$ are determined in consideration of the WHO guideline values and European Union limits in Turkey too.

It is beyond dispute that law policies and legal regulations are the foundation of efforts to achieve a cleaner air. **The best example in this respect is the "clean air is a right, it can't wait for 2 years" campaign led by the Right to Clean Air Platform in the beginning of 2019.**

It is a correct decision to stop 6 coal-fired power plants that do not comply with the Environmental Law were sealed by the government officials. However, it is important to remember that, even if those coal plants are retrofitted and filters are installed; those plants will continue to cause air pollution and climate change as a result of their emissions. The main aim must be to improve the air quality in Turkey in such a way to have air pollution below WHO guideline values in line with the 'right to live in a healthy environment' in our constitution and international statements. In order to reach that target, we need permanent solutions that are in line with scientific principles and the needs of society. It can only be reached if the fossil fuels are abandoned and policies that will foster investments in energy efficiency and renewable energy resources are accelerated with a just plan that will compensate for the inequalities created in the past.

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CHAPTER 5
RECOMMENDATIONS

Thousands of people called for 'right to clean air' in 2019 to stop the exemptions given to coal fired power plants.

The right to breathe clean air and to live in a healthy environment has been a hot topic in Turkey in 2019. Furthermore, the effects of the worldwide **COVID-19 pandemic** due to the novel coronavirus have made 2020 a year in which the importance of breathing clean air, protecting nature and living in a healthy environment is felt deeply in our daily life.

As a result of thousands of people who made their voices heard by demanding their **"Right to Clean Air"** throughout 2019, the operations of coal-fired power plants that did not have their investments in accordance with the environmental legislation were ceased at the first hours of the new year. Affected by the closed power plants and reduced vehicle traffic in the pandemic period, progress was seen in the improvement of air quality in Turkey, as was the case for the rest of the world. **However, in order to reduce the health impacts of air pollution such as premature deaths and chronic diseases, long-term exposure to air pollution must also be reduced.**

In order to permanently improve the air quality in Turkey, decision makers are strongly advised to follow these steps:

- The data quality of all air quality measurement stations in all cities must be improved,
- Fine particulate matter (PM2.5) pollutant levels must be measured in all provinces,
- National limit values for PM2.5 in line with the WHO guidelines and at least European Union limit values should be adopted,
- The coal fired power plants that did not complete the required environment investments must not be permitted to operate,
- Health impact assessments must be compulsory at the permitting procedures of planned industrial and energy generation facilities,
- Economic recovery packages that prioritize public health and aim to create resilient models against crises must be created.

The recovery programs built for this period need to be aimed at preventing air pollution, which weakens the lungs, heart, and other organs; as well as significantly reducing the rate of increase in greenhouse gases that cause drought, extreme heat, floods, fires, and other forms of life-threatening damage. As the Right to Clean Air Platform, that progress in this regard will lead to a fair and equitable transformation that supports the health of the people, economy, and the planet through healthy nutrition, renewable and efficient energy, walking, cycling, and zero-emission public transport, so that further crises may be prevented. To that end, it is clear that more efforts are needed to highlight the advantages and disadvantages of issues that are relevant to this transformation process.

In order to improve air quality, it is essential to properly measure it. In that respect, there have been positive developments in 2019 as a result of the efforts of the Ministry of Environment and Urbanization, such as an increase in the number of measurement stations, emission

inventory studies, and efforts to update the Clean Air Action Plans. However, **nearly 18 million people in 30 provinces** do not have sufficient data regarding the air they breathe all year long. Furthermore, there has not even been a minimal amount of data for 3 years in the provinces of **Eskişehir, Muş, Uşak and Şırnak** where **2 million 196 thousand people** live in total. Emission data from the chimneys of industrial facilities are also not disclosed to the public. Although it has been said that the relevant legislation has been prepared for the last three years, no national limit value was adopted regarding PM2.5, which is the main cause of many health problems including cancer.

The analyses made by the Right to Clean Air Platform indicate that air pollution has become a yearlong, chronic problem in some provinces. For instance, people in the provinces of **Amasya, Bursa, Iğdır, and Manisa** have been regularly breathing air that exceeds the pollution limit values in the legislation for **at least 68% of the year** for the last 4 years. The air pollution problem remains unresolved in **Iğdır, Düzce, Manisa, Bursa, Kahramanmaraş, and Afyon,** where severely polluted air has been breathed continuously for the last 4 years.

The air quality in Turkey has increased in the first half of 2020, as is the case all around the world. The air quality in first half of 2020 in certain cities have improved according to the analysis at the report. Firstly, SO_2 levels in **Kahramanmaraş, Kütahya and Zonguldak** cities have decreased due to the closure of the coal fired power plants. Secondly, the NO_2 levels have decreased in **5 metropolises** dues to the fall of vehicle traffic as a result of the precautions taken in March against the COVID-19 pandemic. However, due to the reopening of the power plants and the increased traffic upon the lifting of the travel restrictions, **air pollution started to increase again in June 2020.**

Health costs and deaths due to air pollution in Turkey are considerably high. Since 2017, more than 6 times as many **deaths due to air pollution** as traffic accidents have occurred every year. 7.9% (31, 476 deaths) of all deaths in 2019 and 12.13% (45,398 deaths) of all deaths in 2018 could have been prevented, if air pollution has been decreased to the guideline values of World Health Organisation for $PM_{2.5}$.

The Right to Clean Air Platform, which consists of 16 professional organizations and NGOs working on environment and health in Turkey since 2015, proposes some recommendations to improve the air quality management and diminish the health impacts of air pollution in Turkey.

10 recommendations from Right to Clean Air Platform to increase air quality in Turkey:

1. **Measurement:** Reliability of measurement data for all cities must be improved, public access to data by real time channels must be provided, data must be announced in an easily understandable format, all previous non-disclosed measurement results shall be made public, modelling studies to select locations of the new air pollution measurement stations should be conducted, publicly shared and the same criteria must be implemented for the existing stations.

2. **Fine particulate matter $PM_{2.5}$:** Legally binding regulations about safe limits on $PM_{2.5}$, which are in accordance with limits by WHO, must be adopted and the pilot $PM_{2.5}$ measurement must be disseminated to all cities through the stations at places that are representative enough to show the impact of the air pollution on Turkish citizens.

3. **Publicly available data:** All data sources required in order to calculate the health impacts and estimated premature deaths due to air pollution in each city in Turkey must be urgently disclosed and made easily accessible to the public, NGOs and academia.
4. **Permitting procedure:** Up-to-date modelling programs that show cumulative impacts as well as $PM_{2.5}$ impacts in complex terrain must be used to calculate the air pollution dispersion that will result from the facilities in the pipeline as well as the existing facilities must be demanded from the investors during the EIA (Environmental Impact Assessment) approval processes of industrial investments.
5. **Health Impact Assessment:** During the approval processes of all industrial investments "Health Impact Assessment" report that includes the change in premature death levels from air pollution must be demanded in addition to "Environmental Impact Assessment" from the investors and active involvement of Ministry of Health officials to the approval procedures of industrial facilities must be attained.
6. **Subsidies:** State subsidies on coal fired power plants must be ceased urgently, the energy efficiency policies shall be implemented and energy policies on renewable energy generation must be announced by the Ministry of Energy and Natural Resources.
7. **Policy:** Binding and applicable legal structures must be developed by the officers and authorities working on air quality management in order to prevent the air pollution as well as to compensate the damages caused by air pollution. National legislations shall be adjusted to comply with the limits of all pollutants including PM_{10}, $PM_{2.5}$, and SO_2 with the air quality guidelines of WHO and this must be applied to all industrial facilities in operation without any exception.
8. **Clean Air Action Plans:** The compulsory Clean Air Action Plans that determine the duties and responsibilities of the legal authorities as well as the public must be prepared for all cities with the participation of all relevant stakeholders such as the experts and civil society organisations working on health impacts as well as air pollution, publicly announced and immediately implemented.
9. **Alternatives:** Public transportation and bicycles in cities shall be promoted, areas closed to motor vehicles shall be created, forests must be preserved and increased, legislative amendments shall be done to decrease the pollutant emissions caused by vehicles, climate and environment friendly alternatives for household heating must be disseminated.
10. **Cooperation:** Interdisciplinary work among relevant state institutions, especially between the Ministry of Health and the Ministry of Environment and Urbanization, must be attained in order to make policies to evaluate the health impacts of air pollution during the permitting process of new industrial pollutants as well as maintaining collaboration with professional organizations and NGOs that work on air pollution and health.

APPENDICES

1- Number, percentage, and (per 100,000) rate of deaths over the age of 30 (excluding accidents/ external injuries) due to air pollution in 2017 by province

Provinces	$PM_{2.5}$ Level	Number of Deaths Atributed to Air Pollution	Number of Deaths Atributed to Air Pollution (lowest)	Number of Deaths Atributed to Air Pollution (highest)	Percentage of Deaths Atributed to Air Pollution (lowest)	Mortality Rate Attributed to Air Pollution (per 100.000)
Adana	37	1417	950	1831	15	106,3
Adıyaman	34	289	193	374	13,4	86
Afyon	55	1042	711	1325	23,7	235,2
Ağrı	45	261	177	335	19	108
Aksaray	45	358	242	459	19	151,9
Amasya	32	290	194	377	12,4	133,8
Ankara	26	2139	1418	2792	9,2	62,6
Antalya	34	1226	819	1588	13,4	81,3
Ardahan	17	27	18	36	4,1	47,4
Artvin	13	24	16	32	1,8	21,6
Aydın	30	799	532	1039	11,3	111,6
Balıkesir	36	1452	972	1877	14,5	174,9
Bartın	34	205	137	266	13,4	157
Batman	41	215	145	276	17	78,4
Bayburt	26	44	29	58	9,2	100,1
Bilecik	35	195	131	253	14	140,9
Bingöl	29	99	66	128	10,8	69,1
Bitlis	18	41	27	54	4,7	25,8
Bolu	21	126	83	165	6,4	64,8
Burdur	46	373	253	479	19,5	216,2
Bursa	48	3098	2099	3963	20,4	165,1
Çanakkale	24	343	227	448	8,1	95,7
Çankırı	36	220	147	285	14,5	181,2
Çorum	35	541	362	700	14	155,3
Denizli	46	1152	779	1476	19,5	175,1
Diyarbakır	33	537	358	696	12,9	64,7
Düzce	53	485	330	618	22,8	207,2

Number, percentage, and (per 100,000) rate of deaths over the age of 30 (excluding accidents/ external injuries) due to air pollution in 2017 by province (continue)

Provinces	$PM_{2.5}$ Level	Number of Deaths Atributed to Air Pollution	Number of Deaths Atributed to Air Pollution (lowest)	Number of Deaths Atributed to Air Pollution (highest)	Percentage of Deaths Atributed to Air Pollution (lowest)	Mortality Rate Attributed to Air Pollution (per 100.000)
Edirne	34	452	302	586	13,4	165,4
Elazığ	33	374	250	485	12,9	107,1
Erzincan	44	251	169	322	18,5	184,1
Erzurum	33	479	320	621	12,9	116,4
Eskişehir	**	-	-	-	-	-
Gaziantep	36	897	601	1160	14,5	85
Giresun	26	326	216	426	9,2	111,8
Gümüşhane	32	109	73	141	12,4	110,8
Hakkari	50	113	77	144	21,9	97,5
Hatay	38	986	566	1089	15,5	107,4
Iğdır	59	164	112	208	25,5	163,7
Isparta	38	434	291	560	15,5	158,2
İstanbul	28	5851	3887	7623	10,3	63,3
İzmir	28	2518	1673	3281	10,3	89
Kahramanmaraş	58	1041	713	1320	25,1	161,9
Karabük	33	211	141	274	12,9	138
Karaman	51	291	197	371	21,9	192,5
Kars	41	222	150	286	17	145,5
Kastamonu	33	463	309	600	12,9	183,8
Kayseri	45	1169	790	1500	19	141,4
Kırıkkale	18	82	54	108	4,7	47,3
Kırklareli	28	288	191	375	10,3	120
Kırşehir	16	50	33	66	3,5	34,1
Kilis	28	66	44	86	10,3	90,4
Kocaeli	31	890	593	1156	11,9	77,6
Konya	47	2082	1410	2666	20	161
Kütahya	44	806	544	1035	18,5	214,5

Number, percentage, and (per 100,000) rate of deaths over the age of 30 (excluding accidents/ external injuries) due to air pollution in 2017 by province (continue)

Provinces	$PM_{2.5}$ Level	Number of Deaths Atributed to Air Pollution	Number of Deaths Atributed to Air Pollution (lowest)	Number of Deaths Atributed to Air Pollution (highest)	Percentage of Deaths Atributed to Air Pollution (lowest)	Mortality Rate Attributed to Air Pollution (per 100.000)
Malatya	35	558	373	722	14	116,9
Manisa	51	1957	1330	2497	21,9	213,6
Mardin	42	345	232	443	17,5	89,4
Mersin	48	1628	1103	2082	20,4	146,4
Muğla	45	950	642	1219	19	149
Muş	**	-	-	-	-	-
Nevşehir	32	226	151	293	12,4	123,2
Niğde	54	429	293	546	23,3	201,1
Ordu	31	620	413	805	11,9	126,5
Osmaniye	48	441	299	565	20,4	141,4
Rize	13	40	26	53	1,8	18,8
Sakarya	41	954	642	1228	17	155,5
Samsun	37	1207	809	1559	15	144,3
Siirt	43	133	90	171	18	92,5
Sinop	40	316	213	408	16,5	223,2
Sivas	39	647	434	834	16	171,7
Şanlıurfa	48	838	568	1071	20,4	92,7
Şırnak	**	-	-	-	-	-
Tekirdağ	40	824	554	1062	16,5	129,7
Tokat	42	733	494	943	17,5	192
Trabzon	27	463	307	604	9,7	92,5
Tunceli	17	21	14	28	4,1	42,4
Uşak	**	-	-	-	-	-
Van	27	238	158	310	9,7	46,9
Yalova	28	157	104	204	10,3	96,1
Yozgat	17	21	14	27	4,1	8
Zonguldak	30	435	290	566	11,3	107,9
Total	**2756**	**51.794**	**34.674**	**66.659**	**1093,5**	**9406,6**

2- Number, percentage, and (per 100,000) rate of deaths over the age of 30 (excluding accidents/ external injuries) due to air pollution in 2018 by province

Provinces	Number of Deaths Attributed to Air Pollution			Percentage of Deaths Attributed to Air Pollution			Rate of Deaths Attributed to Air Pollution (per 100,000)		
	Avr.	Min.	Max.	Avr.	Min.	Max.	Avr.	Min.	Max.
Adana	1520	1021	1961	16,01%	10,75%	20,64%	112,89	75,82	145,58
Adıyaman	247	165	322	11,34%	7,54%	14,74%	71,79	47,78	93,35
Afyon	969	657	1,238	20,91%	14,18%	26,73%	214,05	145,18	273,57
Ağrı	233	156	300	16,51%	11,10%	21,27%	94,36	63,44	121,58
Aksaray	137	91	179	8,08%	5,34%	10,54%	56,33	37,27	73,67
Amasya	257	171	335	10,80%	7,18%	14,06%	115,75	76,96	150,66
Ankara	2808	1871	3648	11,87%	7,91%	15,42%	81,12	54,05	105,39
Antalya	1134	755	1473	11,87%	7,91%	15,42%	72,64	48,39	94,37
Ardahan	8	5	11	1,20%	0,78%	1,58%	13,65	8,92	18,06
Artvin	47	31	62	3,54%	2,33%	4,67%	40,09	26,3	52,83
Aydın	633	419	827	8,63%	5,71%	11,27%	86,37	57,19	112,84
Balıkesir	1136	756	1477	11,34%	7,54%	14,74%	133,5	88,85	173,6
Bartın	167	111	217	11,34%	7,54%	14,74%	124,26	82,7	161,58
Batman	150	100	195	11,34%	7,54%	14,74%	53,26	35,45	69,27
Bayburt	52	35	67	11,34%	7,54%	14,74%	110,09	73,27	143,16
Bilecik	206	138	267	13,96%	9,34%	18,07%	146,07	97,71	189,08
Bingöl	100	67	131	10,08%	7,18%	14,06%	67,12	44,63	87,37
Bitlis	53	35	69	5,84%	3,85%	7,66%	31,92	21,03	41,9
Bolu	-	-	-	-	-	-	-	-	-
Burdur	367	247	571	18,50%	12,48%	23,75%	208,38	140,65	267,52
Bursa	2821	1904	3622	18,50%	12,48%	23,75%	146,88	99,14	188,57
Çanakkale	319	211	417	7,52%	4,97%	9,85%	86,8	57,36	113,68
Çankırı	132	87	172	8,63%	5,71%	11,27%	92,72	61,4	121,15
Çorum	411	273	535	10,80%	7,18%	14,06%	115,47	76,77	150,29
Denizli	1066	720	1367	18,99%	12,83%	24,25%	159,57	107,81	204,67
Diyarbakır	377	250	492	9,18%	6,08%	11,98%	44,2	29,3	57,69
Düzce	416	281	533	19,47%	13,17%	24,95%	172,71	116,8	221,33

Number, percentage, and (per 100,000) rate of deaths over the age of 30 (excluding accidents/ external injuries) due to air pollution in 2018 by province (continue)

Provinces	Number of Deaths Attributed to Air Pollution			Percentage of Deaths Attributed to Air Pollution			Rate of Deaths Attributed to Air Pollution (per 100,000)		
	Avr.	Min.	Max.	Avr.	Min.	Max.	Avr.	Min.	Max.
Edirne	356	237	464	10,80%	7,18%	14,06%	128,22	85,25	166,9
Elaziğ	435	292	561	16,01%	10,75%	20,64%	120,65	81,03	155,6
Erzincan	219	147	282	16,01%	10,75%	20,64%	153,63	103,18	198,12
Erzurum	333	221	435	9,18%	6,08%	11,98%	79,15	52,47	103,32
Eskişehir	-	-	-	-	-	-	-	-	-
Gaziantep	649	431	845	10,26%	6,82%	13,37%	60,21	39,99	78,44
Giresun	320	212	418	9,18%	6,08%	11,98%	104,06	68,98	135,82
Gümüşhane	80	53	105	9,72%	6,45%	12,68%	83,16	55,18	108,45
Hakkari	13	8	17	2,38%	1,56%	3,14%	10,62	6,95	14,02
Hatay	260	171	342	4,12%	2,71%	5,43%	27,61	18,13	36,35
Iğdir	178	122	224	28,17%	19,40%	35,50%	172,9	119,1	217,91
Isparta	520	350	668	18%	12,14%	23,14%	186,46	125,72	239,59
İstanbul	5806	3856	7564	10,26%	6,82%	13,37%	62,39	41,44	81,29
İzmir	2383	1581	3107	9,72%	6,45%	12,68%	82,87	54,99	108,07
Kahramanmaraş	1109	761	1403	26,42%	18,13%	33,41%	168,66	115,74	213,3
Karabük	95	63	125	5,84%	3,85%	7,66%	60,82	40,07	79,84
Karaman	98	65	129	6,96%	4,60%	9,12%	63,73	42,07	83,5
Kars	151	101	197	12,40%	8,27%	16,09%	98,12	65,44	127,36
Kastamonu	-	-	-	-	-	-	-	-	-
Kayseri	1108	746	1425	17,51%	11,79%	22,52%	131,6	88,65	169,26
Kirikkale	-	-	-	-	-	-	-	-	-
Kirklareli	305	203	397	10,80%	7,18%	14,06%	124,88	83,03	162,55
Kirşehir	61	40	80	4,12%	2,71%	5,43%	39,77	26,12	52,35
Kilis	71	47	92	10,80%	7,18%	14,06%	93,56	62,21	121,78
Kocaeli	710	471	927	9,18%	6,08%	11,98%	60,84	40,33	79,41
Konya	1383	924	1792	13,44%	8,98%	17,42%	104,94	70,13	135,96
Kütahya	-	-	-	-	-	-	-	-	-
Malatya	621	417	800	16,51%	11,10%	21,27%	127,27	85,56	163,98

Number, percentage, and (per 100,000) rate of deaths over the age of 30 (excluding accidents/ external injuries) due to air pollution in 2018 by province (continue)

Provinces	Number of Deaths Attributed to Air Pollution			Percentage of Deaths Attributed to Air Pollution			Rate of Deaths Attributed to Air Pollution (per 100,000)		
	Avr.	Min.	Max.	Avr.	Min.	Max.	Avr.	Min.	Max.
Manisa	2168	1479	2757	23,71%	16,18%	30,15%	233	158,96	296,22
Mardin	302	202	390	14,99%	10,05%	19,37%	75,57	50,65	97,64
Mersin	1969	1344	2501	24,17%	16,51%	30,70%	173,87	118,74	220,85
Muğla	1041	706	1331	20,91%	14,18%	26,73%	157,06	106,53	200,74
Muş	-	-	-	-	-	-	-	-	-
Nevşehir	151	100	197	8,63%	5,71%	11,27%	80,09	53,04	104,64
Niğde	397	270	506	21,86%	14,85%	27,89%	182,77	124,21	233,18
Ordu	597	398	776	11,87%	7,91%	15,42%	116,3	77,48	151,09
Osmaniye	400	271	513	19,47%	13,17%	24,95%	125,67	84,99	161,04
Rize	37	24	47	1,79%	1,17%	2,36%	16,23	10,62	21,45
Sakarya	896	602	1155	16,01%	10,75%	20,64%	142,31	95,58	183,53
Samsun	636	421	831	8,08%	5,34%	10,56%	74,22	49,1	97,07
Siirt	111	74	144	13,44%	8,98%	17,42%	75	50,12	97,17
Sinop	172	114	224	9,18%	6,08%	11,98%	113,55	75,27	148,22
Sivas	420	279	546	10,80%	7,18%	14,06%	105,81	70,35	137,73
Şanliurfa	680	457	876	16,51%	11,10%	21,27%	72,73	48,9	93,71
Şirnak	-	-	-	-	-	-	-	-	-
Tekirdağ	474	314	618	9,18%	6,08%	11,98%	72,28	47,91	94,35
Tokat	481	321	625	11,87%	7,91%	15,42%	122,73	81,77	159,45
Trabzon	353	233	462	7,52%	4,97%	9,85%	67,92	44,89	88,91
Tunceli	12	8	16	2,38%	1,56%	3,14%	21,39	14	28,24
Uşak	-	-	-	-	-	-	-	-	-
Van	270	179	351	10,80%	7,18%	14,06%	51,71	34,38	67,31
Yalova	100	66	132	6,40%	4,22%	8,40%	58,92	38,86	77,27
Yozgat	344	229	447	11,87%	7,91%	15,42%	129,37	86,19	168,08
Zonguldak	357	237	467	8,63%	5,71%	11,27%	88,03	58,29	115,02
	45398	**30404**	**57562,24**	**12,13%**	**8,14%**	**15,68%**			
	Total			**Average**					

2- Number, percentage, and (per 100,000) rate of deaths over the age of 30 (excluding accidents/ external injuries) due to air pollution in 2018 by province

Provinces	Number of Deaths Attributed to Air Pollution			Percentage of Deaths Attributed to Air Pollution			Rate of Deaths Attributed to Air Pollution (per 100,000)		
	Avr.	Min.	Max.	Avr.	Min.	Max.	Avr.	Min.	Max.
Adana	0	0	0	0%	0%	0%	0	0	0
Adiyaman	328	219	424	14%	9%	18%	93,63	62,63	121,2
Amasya	327	219	424	13%	9%	17%	145,46	97,2	188,45
Ankara	1552	1024	2036	6%	4%	8%	43,38	28,61	56,89
Antalya	932	618	1216	9%	6%	12%	57,42	38,06	74,95
Ardahan	55	36	72	9%	6%	12%	92,2	61,12	120,35
Aydin	663	439	866	9%	6%	11%	89,08	58,99	116,38
Balikesir	484	318	637	5%	3%	6%	56,46	37,12	74,25
Bartin	137	91	179	9%	6%	12%	101,84	67,51	132,94
Bilecik	71	46	93	5%	3%	6%	49,43	32,5	65,01
Bolu	184	122	240	9%	6%	11%	89,82	59,48	117,35
Burdur	210	139	273	11%	7%	14%	118,17	78,57	153,81
Bursa	1584	1052	2064	10%	7%	13%	80,36	53,38	104,7
Çanakkale	176	115	231	4%	3%	5%	47,17	30,98	62,1
Çankiri	123	81	161	8%	5%	10%	94,85	62,68	124,15
Çorum	881	599	1122	22%	15%	28%	247,75	168,54	315,8
Denizli	829	554	1074	13%	9%	17%	122,05	81,56	158,13
Düzce	418	283	536	19%	13%	24%	170,51	115,2	218,7
Edirne	216	142	283	6%	4%	8%	76,87	50,69	100,81
Elaziğ	477	320	615	16%	11%	21%	131,97	88,63	170,19
Erzincan	215	144	278	15%	10%	19%	149,66	100,31	193,36
Erzurum	867	591	1104	23%	16%	30%	204,87	139,64	260,69
Eskişehir	224	147	295	4%	3%	5%	38,38	25,21	50,53
Gaziantep	852	568	1106	12%	8%	16%	76,69	51,15	99,54
Giresun	257	169	336	7%	5%	9%	83,99	55,45	110,04
Gümüşhane	100	66	130	11%	7%	14%	101,68	67,61	132,36
Hatay	0	0	0	0%	0%	0%	0	0	0

Number, percentage, and (per 100,000) rate of deaths over the age of 30 (excluding accidents/ external injuries) due to air pollution in 2018 by province (continue)

Provinces	Number of Deaths Attributed to Air Pollution			Percentage of Deaths Attributed to Air Pollution			Rate of Deaths Attributed to Air Pollution (per 100,000)		
	Avr.	Min.	Max.	Avr.	Min.	Max.	Avr.	Min.	Max.
Hatay	0	0	0	0%	0%	0%	0	0	0
Iğdir	226	158	282	34%	23%	42%	214,29	149,42	267,15
Isparta	352	234	457	12%	8%	15%	124,6	83,02	161,88
İstanbul	3761	2480	4932	6%	4%	8%	38,92	25,66	51,04
İzmir	2075	1373	2714	8%	5%	11%	70,82	46,85	92,62
Kahramanmaraş	791	533	1017	18%	12%	23%	118,24	79,65	152,08
Karabük	116	77	152	7%	5%	9%	73,85	48,76	96,77
Kars	148	99	192	11%	8%	15%	95,39	63,49	124,04
Kastamonu	386	257	503	10%	7%	14%	148,93	99,02	193,84
Kayseri	1004	674	1295	16%	11%	21%	116,63	78,33	150,42
Kirikkale	229	153	297	13%	9%	17%	127,53	85,14	165,38
Kirklareli	50	33	66	2%	1%	2%	20,31	13,28	26,84
Kirşehir	54	35	71	4%	2%	5%	34,73	22,79	45,77
Kocaeli	372	245	490	5%	3%	6%	30,86	20,29	40,59
Konya	1271	847	1652	12%	8%	15%	94,62	63,04	122,92
Kütahya	332	219	435	8%	5%	10%	86.81	57,37	113,64
Manisa	1680	1134	2156	19%	12%	24%	177,68	119,92	228,1
Mardin	213	141	278	10%	6%	13%	51,75	34,34	67,49
Muğla	800	536	1034	15%	10%	19%	118,22	79,24	152,74
Nevşehir	65	43	86	4%	2%	5%	33,92	22,25	44,7
Niğde	247	165	320	13%	9%	17%	113,52	75,79	147,22
Ordu	582	387	756	11%	8%	15%	114,68	76,33	149,13
Osmaniye	357	240	460	16%	11%	21%	110,17	73,99	142,07
Rize	68	45	90	3%	2%	4%	30,06	19,7	39,65
Sakarya	567	376	739	10%	6%	13%	87,92	58,34	114,66
Samsun	192	126	254	2%	2%	3%	22,07	14,45	29,13
Siirt	86	57	112	11%	7%	15%	57,12	37,98	74,35

Number, percentage, and (per 100,000) rate of deaths over the age of 30 (excluding accidents/ external injuries) due to air pollution in 2018 by province (continue)

Provinces	Number of Deaths Attributed to Air Pollution			Percentage of Deaths Attributed to Air Pollution			Rate of Deaths Attributed to Air Pollution (per 100,000)		
	Avr.	Min.	Max.	Avr.	Min.	Max.	Avr.	Min.	Max.
Sinop	331	223	426	17%	11%	22%	218,69	147,17	281,52
Sivas	559	374	723	14%	9%	18%	141,94	94,95	183,73
Şanliurfa	488	325	635	11%	7%	14%	50,59	33,64	65,85
Tekirdağ	334	220	438	6%	4%	8%	49,45	32,61	64,86
Tokat	416	276	542	10%	6%	13%	105	69,67	136,93
Trabzon	338	223	443	7%	5%	9%	64,56	42,62	84,59
Van	248	164	323	10%	6%	13%	45,94	30,48	59,91
Yalova	69	45	91	5%	3%	6%	39,09	25,7	51,41
Yozgat	69	45	91	2%	2%	3%	26,01	17,03	34,34
Zonguldak	438	291	570	11%	7%	14%	107,65	71,57	140,12
	31476	**20955**	**40917**	**10,2**	**6,8**	**13,2**			
	Total			**Average**					

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