Proceeding Book of ISESER 2023

O 2.   FOREST FIRES AND ITS EFFECT ON AIR POLLUTION IN SUMMER

Büşra KIRBIYIK[1*], Şükrü DURSUN[2]

[1]*Konya Technical University, Institute of Graduate Studies Department of Environmental Engineering, Konya Türkiye*
[2]*Konya Technical University, Environmental Engineering Department, Konya, Türkiye*

E-mail*: busraarisoy@gmail.com, sdursun@ktun.edu.tr*

ABSTRACT: Air pollution levels; It shows how much the interaction is between particles such as dust, smoke, odour, water vapor and gas, and chemicals that are in amounts that can harm living things and the environment. While determining the level of air pollution, it is essential to consider the structure of the region and meteorological conditions. It is known that the factors causing air pollution can have negative effects on living and environmental health and can create significant effects, and therefore air pollution is seen as an important problem. In order to reduce these effects, it is important to improve air quality as well as measuring pollutants and monitoring air quality; It is necessary to determine the source of the cause of pollution. Especially in hot and dry weather, forests with large combustible materials, which are at risk of fire, can therefore be damaged. The air temperature reaching high points, the relative humidity falling below 30%, and the drying winds that reduce the direction, intensity and humidity of the wind are the reasons for the emergence and spread of forest fires. Air pollution, the source of which is forest fire, especially due to the duration and severity of exposure to particulate matter; It can cause irritation in the respiratory tract, burning in the nose and eyes, decrease in air volume in the lungs, diseases such as asthma, bronchitis, heart failure, and even premature death. About 90% of the particulate matter emitted from the smoke caused by forest fires consists of PM and is of different sizes. The spread of forest fires, whether they are long or short; Short- and long-term weather changes such as atmospheric pressure, increase-decrease in temperature, wind direction and strength, decrease-increase in relative humidity and precipitation played a major role.

Keywords: Air Pollution, Dust, Smoke, Forest Fire, Wind Direction

1. INTRODUCTION

Air pollution levels; It shows how much the interaction is between particles such as dust, smoke, odour, water vapor and gas, and chemicals that are in amounts that can harm living things and the environment(Qasim, 2019). While determining the level of air pollution, it is essential to consider the structure of the region and meteorological conditions (Kunt, 2018). It is known that the factors causing air pollution can have negative effects on living and environmental health and can create significant effects, and therefore air pollution is seen as an important problem. In order to reduce these effects, it is important to improve air quality as well as measuring pollutants and monitoring air quality; It is necessary to determine the source of the cause of pollution (Dursun, 2021).

Weather, it can be expressed as a mixture of gases containing nitrogen and oxygen, which are of vital importance for living things (Aydınlar,2009). Stable to nitrogen, oxygen and inert gases among the gases that make up the atmosphere; water vapor, carbon dioxide, ozone, etc. gases are called volatile. Among the gases that are not constantly present are pollutants.

Air Pollution, according to WHO, pollution in the atmosphere; It is the situation of pollution of the outdoor and/or indoor air with any agent that degrades its natural structure and changes its properties. It is known that heating in winter, motor vehicles in traffic, industrial facilities where production takes place and forest fires that occur for certain reasons are the main sources of air pollution. Among the pollutants that pose a danger to public health; particulate matter (PM), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) (Gül İ., 2018).

Air Pollutant Sources, pollutant parameters in solid, liquid or gaseous state can be defined as substances that can harm people's health, life of living things and the environment, depending on the amount, density and duration in the air (Gül İ.,2018). It is possible to divide the sources causing air pollution into 2;

Proceeding Book of ISESER 2023

1. Artificial sources; Fuel used for heating, motor vehicles, and air pollutant sources that occur as a result of human activities such as industry.

2. Natural resources; Forest fires, volcano, etc. are sources emitted directly into the atmosphere.

Forest Fires, Especially in hot and dry weather, forests with large combustible materials, which are at risk of fire, can therefore be damaged. The air temperature reaching high points, the relative humidity falling below 30%, and the drying winds that reduce the direction, intensity and humidity of the wind are the reasons for the emergence and spread of forest fires (Küçük,2016).

Forest fire is the presence of 4 main substances (Kavzoğlu, 2021). These;

- Negligence and carelessness (47%)
- Intention (10%)
- Natural/lightning (11%)
- Products of unknown cause (32%)

Air pollution, the source of which is forest fire, especially due to the duration and severity of exposure to particulate matter; It can cause irritation in the respiratory tract, burning in the nose and eyes, decrease in air volume in the lungs, diseases such as asthma, bronchitis, heart failure, and even premature death.

About 90% of the particulate matter emitted from the smoke caused by forest fires consists of PM and is of different sizes. The spread of forest fires, whether they are long or short; Short- and long-term weather changes such as atmospheric pressure, increase-decrease in temperature, wind direction and strength, decrease-increase in relative humidity and precipitation played a major role (Chandler vd., 1991).

Climatic conditions in which fires occur, especially forest fires; It has been determined that the temperature is high, the bond moisture and the moisture content of the combustible material are low.

Air temperatures above seasonal normals are reported, especially in periods when the burning area is large and there is significant increase in growth numbers (Lagouvardos et al., 2019; Turco et al., 2019).

Air Pollutant Parameters

Tablo 1.1 Source and effects of Air Pollutants (Mihelcic ve Zimmerman, 2010)

Polluting	Source	Effects
NO_2	It is formed when nitrogen (N_2) in the air reacts with O_2 during fuel combustion. Combustion processes and motor vehicles and equipment.	Its inhalation may consist of small irritating particles, thus causing respiratory problems in sensitive individuals. It is the substance that causes ozone formation. Some NO_2s react with water vapor to form nitric acid, forming acidic rain, snow or fog.
SO_2	It is produced when sulfur-containing fuels are burned or metals are extracted from sulfur-containing ore. Sulfur oxidizes and SO_2 is formed. About two-thirds of emissions come from burning coal to generate electricity.Improper combustion and combustion of fossil fuels.	It dissolves easily in water vapor, becomes sulfuric acid, can form small sulfate particles that increase respiratory disease and mortality rates, especially in children and the elderly. In addition to the turbidity created by sulfate particles, SO_2 can also accelerate the deterioration of building materials, including historical sculptures and architecture. Lung failure, arteriosclerosis and respiratory diseases.
CO	It is produced by incomplete combustion of fuels. Expulsion into air without complete combustion. More than half of the emissions are from vehicles on the road.	It bleeds easily. At low levels, the most serious health threat from even a single exposure is for those with cardiovascular problems. While high levels in the ambient atmosphere are rare, they can often cause suffocation indoors with poorly

11

Proceeding Book of ISESER 2023

		functioning heating systems and poor ventilation.
O_3	There is no direct source of ozone. It is formed by a series of chemical reactions caused by sunlight. Transportation, natural gas wells, landfills…	It is known to be a strong respiratory irritant. Especially people with weak respiratory system are at risk. This includes people with lung disease, children, the elderly. Respiratory diseases such as lung inflammation, breathing difficulties, aggravated asthma, pneumonia can cause (URL 1.1).
PM	Some particles are acid, organic chemical, metal or soil. Some particles are created through atmospheric reactions of gases such as sulfur dioxide or nitrogen dioxide. All particles with a diameter of 10μm and less are considered PM10, and all particles with a diameter of 2.5μm and smaller are considered PM2.5.	PM10 appears to cause problems for the respiratory system. It has effects such as irritation of the respiratory tract, cough, irregular heartbeat, asthma, premature death in people with heart or lung disease. Primary particles may be this size, but most are larger. Most secondary particles are 10 μm smaller (URL 1.2).

Air Quality; In particular, the air quality of a region changes depending on human factors, and it can spread according to meteorological events. The areas that adversely affect air quality from human factors are transportation, industry and warming in winter. For this reason, measuring the air quality of a region is of great importance in terms of determining the quality of life of the people living in that region and taking the necessary precautions.

Environmental Protection Agency; It is an index created based on the limit values specified in the current legislation. The air quality index created for particulate matter (PM10), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and ozone (O_3), which are known as the main pollutants, is an important criterion for evaluating air quality (Tel,2019). With the air quality index created according to the air quality standards applied in our country, the health effects on living things are determined by classifying according to the concentration of pollutants in the air.

2. MATERIAL AND METHOD
2.1. Material
2.1.1. Working Area
Antalya is located in the west of the Mediterranean Region of our country and its location lies between 29.005'-32.963' west-east longitude and 35.281'-38.082' south-north latitude. Burdur, Isparta provinces and the northern part of Antalya; Karaman, Mersin provinces and the east of Antalya; Mediterranean with the southern part of Antalya; Muğla province and the west of Antalya; Konya province is adjacent to the northeast of Antalya. With a surface area of approximately 20,177 square kilometers and a population of 2.619.832 in 2021, it ranked fifth in our country's rankings (URL-2.1).

In Antalya, there is a Cold Semi-Continental Climate type in the inner parts, and in general, a Mediterranean climate, which is a climate type with high temperatures and no precipitation in the summers, rainy winters and warm temperatures. It is known that the temperature at noon in summer can reach over 40°, while the average temperature is between 28-36°. The temperature in winter generally varies between 10-20°. The annual average relative humidity is around 64% (URL-2.1).

According to the pressure, relative humidity, temperature and precipitation data received from the General Directorate of Meteorology, if the average values of the fire period (28/07/2021-06/08/2021) in 2021 are considered and compared with other months; It is observed that the relative humidity has decreased by half and the temperature has increased by an average of 4-5 °C.

Forest Structure; 1,146,062 hectares of forestland constitute 56% of the surface area of Antalya Province and 5.4% of our country. 654,870 hectares of these forest areas are productive (57%), while 491,192 hectares are unproductive (43%). Tree species of Antalya Province; It is dominated by maquis,

Proceeding Book of ISESER 2023

which can adapt to summer drought, rise to a height of 500/600 meters, and remain green in winter. At altitudes between 600 and 1,200 meters, oak and red pine (65%) are seen, and at higher altitudes, larch (8%) and Aleppo pine are seen. At altitudes between 1,200/2,100 meters, it consists of fir (5%) - cedar (16%) - beech - juniper (4%) and Scots pine. (URL- 2.2).

2.1.2. Antalya Province Air Quality Measurement Station Information

In 2021, a total of eight air quality monitoring stations belonging to the Ministry of Environment, Urbanization and Climate Change are in operation in Antalya province, and data is simultaneously sent to the Ministry's Continuous Monitoring Center (SİM) system.The Air Quality Stations available in Antalya city center and the air pollutant parameters measured at these stations are shown in Table 2.1. The locations of the air pollution measurement stations in Antalya are shown in Figure 2.1.

Table 2.1. Air pollutant parameters measured at stations

| STATION NAME	STATION TYPE	MEASURED AIR POLLUANT PARAMETERS						
		PM_{10} $(\mu g/m^3)$	$PM_{2,5}$ $(\mu g/m^3)$	SO_2 $(\mu g/m^3)$	CO $(\mu g/m^3)$	NO_2 $(\mu g/m^3)$	NO_x $(\mu g/m^3)$	O_3 $(\mu g/m^3)$
Antalya-Alanya	heating	X				X		
Antalya-Gazipaşa	rural	X	X	X		X	X	X
Antalya-Kumluca Industry	Urban industry	X	X	X	X	X	X	X
Antalya-Manavgat	heating	X		X		X		X
Antalya-Center	heating	X	X	X	X	X	X	X
Antalya-Muratpaşa	heating	X		X		X	X	
Antalya-Serik	heating	X		X	X	X	X	
Antalya-traffic	Urban traffic	X	X		X	X	X	X
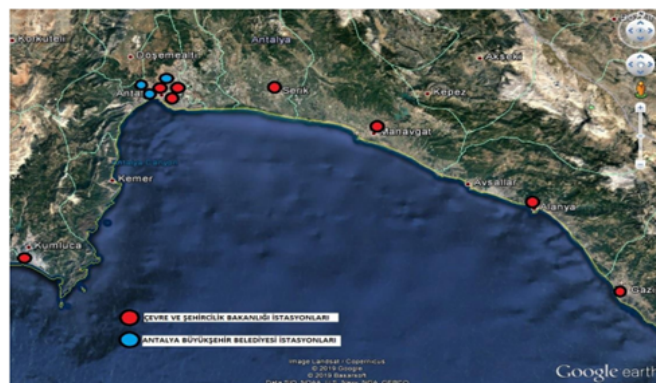
Figure 2.1. Locations of air quality measurement stations in Antalya (URL-2.3)

2.1.3. Devices and Measurement Methods in the Air Quality Measurement Station

Information about the air quality measurement devices at the stations is as follows.

• Continuous Particle Matter Measuring Devices

1. Enviorenment SA MP101M:It is used to determine the amount of dust in the air. A value is obtained by placing a diaphragm between the beta ray reflector and the filter.
2. Thermo 5014i:It continuously measures the mass concentration of particles in the environment.

Proceeding Book of ISESER 2023

3. Metone Bam 1020:It performs PM10 and PM2.5 measurements in accordance with EU standards and EPA standards (URL 2.4).

• Particle Matter Measuring Devices
1.Environnement SA PM162M:Particles at constant flow rate are sampled and collected on filters for gravimetric weighing and physicochemical laboratory analysis.
2.MCZ LVS16:It is a microcomputer controlled device for dust sampling in membrane filters with a diameter of 47-50 mm.
3. LECKEL SEQ 47/50:PM10 and PM2.5 parameters are measured according to the TS EN 12341 measurement method.
4.MCV HVS1:Measurements are made by collecting gas with 140-150 mm diameter membrane filters.
5. Thermo Black Carbon Meter:This device measures light by passing it through a filter and is therefore affected by particle size, shape and distribution of light due to reflection (URL 2.4).

• Ozone Measuring Devices
1. Environment 0341M - O342M - O342e: It is a device that operates on the principle of ultraviolet absorption and continuously measures low concentrations.
2. Thermo 49i:The device measures ozone in the air up to 200 ppm and does this using UV photometric technology.
3. Teledyne T400:It uses a system that measures the low range of ozone in the environment, based on the Beer-Lambert law (directly proportional to the amount of light absorbed) (URL 2.4).

• Carbon Monoxide Measuring Devices
1. Environment SA CO12M - CO12e: It works according to infrared absorption principles and is used to measure carbon monoxide in the atmosphere, especially at low concentrations.
2. Thermo 48i:It is a device that measures the amount of carbon monoxide in the atmosphere between 0-10000 ppm using gas filter technology.
3. Teledyne T300:It measures absorbed infrared energy in low carbon monoxide ranges according to the Beer-Lambert law (URL 2.4).

• Nitoxide Measuring Devices
1. Environment SA AC32M - AC32e:It is used to measure low concentrations of nitrogen monoxide and nitrogen dioxide gases in the ambient atmosphere.
2. Thermo 42i:It is a device that continuously measures nitrogen dioxide and nitrogen oxide parameters in less than five seconds.
3. Teledyne T200:It performs reliable and accurate low-level measurements using the principle of chemiluminescence (a very small amount of light and heat radiation as a result of the reaction) combined with state-of-the-art electronics (URL 2.4).

• Sulfur Dioxide Measuring Devices
1. Environment SA AF22M - AF22e:It continuously measures sulfur oxide based on the principle of measuring fluorescence in ultraviolet rays.
2. Thermo 43i: It measures the amount of sulfur dioxide in the atmosphere up to 100 ppm using UV fluorescence technology.
3. Teledyne T100: It performs reliable, accurate and easy measurements of sulfur dioxide at low concentrations using the UV fluorescence principle (URL 2.4).

• International Standards Used in Measurements (URL- 2.5)
1. For PM10 and PM2.5; The measurement method used in the gravimetric method is: TS EN 12341:2014 and EPA40CFRPART50.
2. For PM10 and PM2.5; The measurement method used in the beta ray absorption method is: TS ISO10473 and EPA40CFRPART50.
3. For O3; Measurement method used in ultraviolet photometry method: TS EN14625
4. For NO2 and NOx; Measurement method used in the chemical luminescence method: TSEN14211
5. For SO2; Measurement method used in ultraviolet fluorescence method: TSEN14212

6. For CO; Measurement method used in wavelength-free infrared spectroscopy (IR Absorption) method: TSEN14626

2.2. Method
2.2.1. Modeling and Graphics Program Surfer

It is a modeling program created by Golden software company and used to create grid-based, two-dimensional contour maps and three-dimensional surface maps of scattered data recorded at different points (POLAT, 2002).

It visualizes the collected data in high quality in the most accurate way while preserving its sensitivity. It does this by using the XY position and its corresponding Z value.

It is a mapping program that performs regularly spaced interpolation of irregularly spaced data with the grid method (It is the development of the deficiency in any series by calculating it with a mathematical method.) (Dursun,2022).

It consists of map types with many options such as contour line, three-dimensional surface, color relief.

3. RESULTS

As a result of the evaluation made for the fire that occurred in Manavgat district of Antalya Province, which is the area of the thesis study, it was seen that the fire lasted 10 days (July 28 - August 6, 2021) and affected an area of approximately 55 thousand hectares, and approximately 55% of this occurred in the first two days.

Manavgat district covers a residential area of approximately 2,283 km2 and has a population of 245740. It is adjacent to Serik district in the east, İbradi, Akseki, Gündoğmuş and Alanya districts in the west, and Isparta province is located in the north.

It was determined that the severe northeasterly wind had an impact on the Manavgat district on July 28/29, the average hourly relative humidity decreased to 6% and the air temperature increased to 41°C (MGM, 2021).

Like the fire that occurred in Manavgat District of Antalya Province; A large number of spot fires occur due to the increase in the severity of fires, which start and multiply when the winds are dry and at high speeds and the humidity is very low. This causes the fire to spread and the fire line to expand rapidly. On the first and second day of the fire, settlements, wooded areas and agricultural lands were affected by the severe northerly winds. Pollutants affecting air pollution have dispersed towards the sea under the influence of wind.

The decrease in humidity in the atmosphere and the drying effect of the winds caused the humidity of the dead combustible material to decrease rapidly, and in the calculation (Bilgili et al., 2019), it was determined that the humidity of the combustible material decreased to 3%. In addition, on July 28, the Meteorological Fire Index (MYI) value reached 99 and the day average value was determined as 87 (TOVAG, 2021).

Approximately two days after the fire started, monk and qibla winds started to blow from the south-southeast direction. In the following period, as the relative and flammable material humidity increased and the wind speed decreased, the rate of fire spread decreased.

After the fire was completely brought under control, it was observed that the forest fire caused damage to a total area of 47,824 hectares. As a result of the evaluation, an area of 19,497 hectares, which is 41% of the total burned area, was burned after July 30, 2021. In addition, the areas burned on July 30, 2021 remained within the borders of Manavgat district, and approximately 90% of the total fire area (43,082 ha) took place here. After the fire, it was observed that it had an impact on an area of 511 ha in İbradi district of Antalya and 4,231 ha in Akseki district (Kavzoğlu,2021).

4. DISCUSSION AND RECOMMENDATIONS

O_3; It is not an emission-related pollutant, but its concentration increases due to high radiation levels, especially from the sun. It decreases in closed weather and when air pollution is high.

PM_{10}; Since the increase in concentration affects the light path, it can reduce ozone formation. Air quality will increase during low traffic hours and reduction in air pollutants resulting from industrial activity, but ozone will increase as the amount of sunlight reaching the ground increases. It is seen that

atmospheric PM10 measurement results are not only due to emissions but also depend on meteorological factors (Yahaya, 2022).

$PM_{2.5}$; It is known that the source of pollution is traffic and combustion products, but it should not be forgotten that meteorological factors, especially wind speed, also affect the concentration.

NO_2; They are emissions from vehicle exhausts, and have also been found to be an important source in industrial facilities (Sağdıç et al., 2022).

It was estimated that air pollution during the fire period was visible and could reach very risky levels for health. However, with the modeling study obtained with measurement data, it has been determined that especially high levels of particulate matter do not have serious health effects when the regulation is based on average values.

Based on this, it has been concluded that the extent of air pollution and its health effects on living beings cannot be fully determined due to the location and small number of stations belonging to the Ministry where air pollution measurements are made.

It is possible to say that the reason why the fire could not be extinguished for a long period of 10 days and spread over a large area was due to the tree species in the region. Because it is known that the wind speed did not reach very high at that time.

Recommendations

• It is known that 56% of the region, which has a temperate climate and high temperatures in the summer, consists of forest areas. It should be taken into consideration that there will be a risk of fire at any time, and our state must take the necessary precautions on this issue, a planning study must be carried out, and the necessary equipment must be available and sufficient to prevent it immediately when a fire occurs.

• It is known that 11% of the causes of forest fires are natural and the other part are human activities. In order to prevent forest fires, the public should be informed, training should be provided on this subject and its importance should be mentioned.

• Although high humidity in the region is a meteorological factor that prevents fire, the decrease in humidity constitutes a reason for fire. Meteorological factors are something that should always be taken into consideration.

• It is important to inform the public about wind speed and direction, which have a great impact on the distribution of air pollution caused by fires.

• In order to obtain more accurate data and take necessary precautions, the Ministry; The number of air quality measurement stations should be increased and spatially distributed.

• Although the ability to extinguish it depends on the plant species in the region, it is necessary to increase the number of green areas and protect them, and it should not be forgotten that in the case of any fire, species are as important as plants.

• Increasing the use of renewable energy resources such as solar and wind; It is seen as an important solution to meet energy needs as well as reduce air pollution (Ulubey et al., 2021).

• Sources of PM10 and PM2.5 content should be identified and their release into the air should be prevented.

• According to WHO, it was concluded that the PM2.5 limit value remained high in the region throughout the year. Legislation needs to be made regarding the PM2.5 limit value, which is not included in the regulation. Additionally, the number of studies on health impact assessment should be increased and attention should be drawn to its importance.

• Antalya province is a touristic region, with the population increasing due to the intense interest in tourism, especially in summer; increase in the number of sea and land motor vehicles, etc. For these reasons, the increase in air pollution is inevitable. This criterion should also be taken into consideration and necessary precautions should be taken to improve air quality.

REFERENCES

Aydınlar, Güven, Kırksekiz, 2009 "Hava Kirliliği Nedir, Ölçüm Ve Hava Kalite Modelleme Yöntemleri Nelerdir?" Sakarya Üni; 1-2,8-10

Aydoğan M., 2019 "İstanbul'un Hava Kalitesinin Zamansal Ve Alansal Değerlendirilmesi" Yüksek Lisans Tezi, Atatürk Üni, Erzurum

Proceeding Book of ISESER 2023

Bilgili, E., Coskuner, K.A., Usta, Y., Saglam, B., Kucuk, O., Berber, T., & Goltas, M. (2019).Diurnal Surface Fuel Moisture Prediction Model For Calabrian Pine Stands İn Turkey. İforest - Biogeosciences And Forestry, 12(3), 262-271. Doi:10.3832/İfor2870-012

Chandler, C., Cheney, P., Thomas, P., Trabaud, L., Williams, D.,1991, Fire In Forestry, Volume:1, Chapter 2, 31-54, U.S.A.,

Cindoruk S.S. ,2017 "Havadaki No Ve NO2 Parametrelerinin Marmara Temiz Hava Merkezi Ölçümleri Kapsamında İncelenmesi" Omer Halisdemir University Journal Of Engineering Sciences, Volume 7, Issue 2, (2018), 600-611

Dursun Şükrü, :Ijees, 2021, "Evaluatıon Of Aır Qualıty In Konya Cıty Center After The New Corona-19 Output And Wıth Its Cautıon"

Dursun Şükrü, Naseer Qasım Mina, :2022, Advanced Engineering Science, "Determination And Modelling Of Pm2.5 Level İn Summer Time İn Selcuk University Shopping Centre Konya, Turkey"

Dursun Şükrü, Naseer Qasım Mina, 2022, Advanced Engineering Science, 2022,"Pm2.5 Concentration Measurements And Mapping At Gokusagı Mall For Autumn 2018, İn Konya, Turkey"

Dursun Şükrü, Naseer Qasim Mina, 2022 "Measurements And Modelling Of PM2.5 Level İn Summer time Period in Novada Main Shopping Centre Konya, Turkey":Engineering Applications, 19-32

Dursun Şükrü, Qasim Mina Naseer, 2022:J. Int. Environmental Application And Science, "Pm2.5 Level İn Autumn Period Measurements And   Modelling İn Novada Mall (Konya, Turkey)" vol 17 (2): 63-74

Dursun Ş, Sağdıç M, Toros H, 2022, Informa Uk Limited, "The İmpact Of Covıd-19 Measures On Air Quality İn Turkey",.23, 1-2, 47-59

Gül İ., 2018 "Edirne Merkez İlçede Çevre Ve Şehircilik Bakanlığı Hava Kalitesi İzleme İstasyonunda Ölçülen Partiküler Madde 10 (Pm10) Bileşiminin Araştırılması" Uzmanlık Tezi, Trakya Üni Halk Sağlığı Anabilim Dalı, Edirne,1-2

Kavzoğlu T.,2021 "Orman Yangınları Sebepleri, Etkileri, İzlenmesi, Alınması Gereken Önlemler Ve Rehabilitasyon Faaliyetleri" Turkish Academy Of Sciences, Ankara,

Kırmacı H.K., 2019 "Kahramanmaraş İli İçin Hava Kalitesinin Analizi Ve Modellenmesi" Doktora Tezi, Erciyes Üni, Fen Bilimleri Ens., Kayseri

Kunt Fatma, Dursun Şükrü, 2018 :Ulusal Çevre Bilimleri Araştırma Dergisi, "Konya Merkezinde Hava Kirliliğine Bazı Meteorolojik Faktörlerin Etkisi" 54-61

Lagouvardos, K., Kotroni, V., Giannaros, T. M., & Dafis, S. (2019). Meteorological Conditions Conducive To The Rapid Spread Of The Deadly Wildfire İn Eastern Attica, Greece. Bulletin Of The American Meteorological Society, 100(11), 2137-2145. Doi:10.1175/ Bams-D-18-0231.1

MGM (2021). Antalya, Manavgat 17954 Nolu İstasyon Verisi, T.C. Çevre, Şehircilik Ve İklim Değişikliği Bakanlığı, Meteoroloji Genel Müdürlüğü. Ankara, Türkiye.

Mihelcic J.R., Zimmerman J. B., 2010. Environmental Engineering: Fundamentals, Sustainability, Design. John Wiley & Sons, Inc

Polat, O., 2002, Golden Software Surfer V.8 Kullanım İle İlgili Notlar.

Qasim Mina Naseer,Dursun Şükrü, 2019 :Int. J. Of Environ. Poll. Environ. Modell., "Measurements Of Ambient Particle Material Level İn Shopping Centers İn Konya City" 37-43

Tel M., Sağlamtimur N.D., 2019 "Niğde İl Merkezinde Evsek Isınma Kaynaklı Emisyonların Aermod View Hava Kalitesi Modeli Kullanılarak İncelenmesi" Yüksek Lisans Tezi, Niğde Ömer Halisdemir Üni, Niğde

Tovag (2021). Web Tabanlı Yangın Davranışı Tahmin Sistemi (Ydtweb) (Tovag120o095). Türkiye Bilimsel Ve Teknolojik Araştırma Kurumu (Tübitak) Proje Sonuç Raporu.

Turco, M., Jerez, S., Augusto, S., Tarín-Carrasco, P., Ratola, N., Jiménez-Guerrero, P., & Trigo, R.M. (2019). Climate Drivers Of The 2017 Devastating Fires İn Portugal. Scientific Reports, 9(1), 13886. Doi:10.1038/S41598-019-50281-2

Ulubey Aydın, Gusev Aleksandr, Dursun Şükrü, Toros Hüseyin, Hadziç   Majda,   Yayın Yeri:Envıronmental Aspects Of Energy, 2021, "Evaluatıon Of Aır Qualıty (Carbon Monoxıde) In Megacıty İstanbul"

Url-1.1 Particulate Matter Pollution. [İnternet]. Epa (Erişim Tarihi: 05.01.2022); Available From: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#pm

Url-1.2 Ground-Level Ozone Basics. [İnternet]. Epa (Erişim Tarihi:01.06.2022) Available From: https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics#effects

Proceeding Book of ISESER 2023

Url-2.1 Erişim Tarihi: (11.05.2022) https://tr.wikipedia.org/wiki/antalya#cite_note-3

Url-2.2   Erişim Tarihi: 12.05.2022 https://webdosya.csb.gov.tr/db/ced/icerikler/antalya_2020_-cdr-20210812095503.pdf

Url-2.3 Erişim Tarihi: 15.02.2022 https://webdosya.csb.gov.tr/db/ced/icerikler/antalya_cdr_2019_son-20200907101243.pdf

Url- 2.4 Erişim Tarihi 14.06.2023 https://havakalitesi.ibb.gov.tr/Icerik/hakkimizda/olcum-cihazlari

Url- 2.5 Erişim Tarihi 14.06.2023 https://havakalitesi.ibb.gov.tr/Icerik/hakkimizda/olcum-yontemleri

Url-2.6 Erişim Tarihi: 15.03.2023 https://support.goldensoftware.com/hc/en-us/articles/231348728-a-basic-understanding-of-surfer-gridding-methods-part-1

Yahaya Noor Zaitun, Jalaludin J, Toros Hüseyin, Dursun Şükrü, 2022, Yayın Yeri:Iop Conference Series: Earth And Environmental Science,"Air Quality Status İn Konya City Centre, Konya, Turkey During Pandemic Covid-19"