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# DETERMINATION OF THE CARBON FOOTPRINT FROM COMMERCIAL AIRCRAFT FOR ADANA AIRPORT

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## ABSTRACT

Climate change is described by the United Nations Secretary-General Ban Ki-Moon as "the biggest common problem we have ever faced as humanity". The heat holding capacity of greenhouse gases causes global warming, which causes climate change. The Intergovernmental Panel on Climate Change (IPCC) has revealed the main cause of global climate change as an increase in greenhouse gas emissions as a result of human activities. The transportation sector is one of the important sources of greenhouse gases, which has a negative impact on global climate change. In order to measure the damage caused by human activities on nature in terms of carbon emission, carbon footprint measuring greenhouse gases in terms of carbon dioxide (CO2) equivalent is used. This study was carried out to determine the carbon footprint originating from aircraft for Adana Airport in 2019. The emission calculations used to determine the carbon footprint are estimated by the Tier 2 approach proposed by the Intergovernmental Panel on Climate Change.

***Keywords:*** Carbon footprint, Air transportation, Greenhouse, LTO, Climate change
**JEL-Classification:** Q53, N7, L91, L93

# ADANA HAVALİMANI İÇİN TİCARİ UÇAKLARDAN KAYNAKLANAN KARBON AYAK İZİNİN BELİRLENMESİ

## ÖZET

İklim değişikliği Birleşmiş Milletler Genel Sekreteri Ban Ki- Moon tarafından " insanlık olarak şimdiye kadar karşılaştığımız en büyük ortak sorun" olarak tanımlanmaktadır. Sera gazlarının ısı tutma kapasitesi küresel ısınmaya neden olmakta bu da iklim değişikliğine sebebiyet vermektedir. Hükümetler arası İklim Değişikliği Paneli (IPCC), küresel iklim değişikliğinin ana nedenini sera gazı emisyonlarında, insan faaliyetleri sonucunda gözlenen artış olarak ortaya koymuştur. Ulaştırma sektörü küresel iklim değişikliğinde olumsuz etkiye sahip olan sera gazlarının önemli kaynaklarındandır. İnsan faaliyetlerin doğa üzerinde bıraktığı hasarı karbon salınımı cinsinden ölçebilmek için, sera gazlarını, karbondioksit (CO2) eşdeğeri cinsinden ölçen karbon ayak izi kullanılmaktadır. Bu çalışma 2019 yılı Adana Havalimanı için uçaklardan kaynaklanan karbon ayak izinin belirlenmesi amacıyla yapılmıştır.

Karbon ayak izinin belirlenmesi amacıyla kullanılan emisyon hesaplamaları Hükümetler arası İklim değişikliği paneli tarafından önerilmiş olan Tier 2 yaklaşımı ile tahmin edilmiştir.
***Anahtar Kelimeler**:* Karbon ayak izi, Hava taşımacılığı, Sera Gazı, LTO, İklim değişikliği
**JEL-Sınıflama:** Q53, N7, L91, L93

## 1. Introduction and Theoretical Framework

Climate change is not only a seasonal change but also a global problem that has negative effects on the environment and human health in the long term. With the studies, it has been revealed that the changes in temperature and precipitation will increase in a few decades. Two different ways are followed against the negative effects of these changes. One is to reduce global warming by reducing greenhouse gas emissions, and the other is to take measures to adapt to these changes. The amount of greenhouse gases available in the world is enough to cause climate change by increasing global warming even if greenhouse gas emissions are reduced. This shows that measures should be taken to adapt to the changes. (Çevre ve Sehircilik Bakanlığı, 2012)

Scientific studies anticipates effects such as the rains becoming unexpected and the occurance of drought and heat waves, as a result of increase in temprateure in Turkey. Depending on the temperature rise of 2C climate change on Earth will lead to an increase in the overall temperature of the Mediterranean basin and the average temperature in Turkey is estimated to increase by 2.5 ° -3.7 ° C. (T.C. Tarım ve Orman Bakanlığı Meteoroloji Genel Müdürlüğü, 2019)

The fact that the negative effects are so predictable and observable with scientific studies reveals the importance of studies adapting to climate change. In the IPCC Fourth Assessment Report, it is emphasized that it is important to see this situation as a strategic approach not only for international institutions and organizations but also for regional structures and countries. It is stated that the importance of adapting to global climate change should be adopted in different sectors and management levels. In addition, the panel revealed that global climate change causes greenhouse gases to accumulate in the atmosphere and cause global warming.

Greenhouse gases are the gases that have the most heat retention properties in the Earth's atmosphere. Greenhouse gases covered by the Kyoto Protocol; Carbon dioxide (CO2), Methane (CH4), Nitrogen oxides (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur hexafluoride (SF6). These gases, some of which are emitted naturally and some of them as a result of human activities, prevent the heat loss of the world by keeping the sun rays reflecting from the earth in the atmosphere. This is called the greenhouse effect. When calculating the amount of greenhouse gases in the atmosphere in terms of climate change, ppm (one particle per million) is taken as the carbon dioxide equivalent. The World Meteorological Organization (WMO) published the greenhouse gas density in 2018 as 407.8 ppm in the report published in 2019 with the release of greenhouse gases. The report also highlighted that the concentration of heat-retaining greenhouse gases in the atmosphere has reached a record level, and stated “This long-standing trend shows that the new geenrations will face with more serious impacts of the climate change such as temprature increases, weather conditionchanges, water stress, rise in the sea levels and degradation in marine and land ecosystems”. (World Meteorological Organization (WMO), 2020)

In order to measure the damage caused by human activities on nature in terms of carbon emission, a carbon footprint measuring greenhouse gases in terms of carbon dioxide (CO2) is used. Carbon footprint is a measure of the amount of CO2 that occurs during the product life cycle from the supply, production, use and disposal of the product (Wiedman & Jan, 2008). It is divided into primary footprint and secondary footprint. The primary footprint is a measure of direct CO2 emissions resulting from the burning of fossil fuels, and the secondary footprint is a measure of indirect CO2 emissions that occur during the product life cycle during the supply, production, distribution, use and disposal of the product (Sağlık Bakanlığı, 2015).

Turkey is the country with the greatest increase in the carbon emissions, since the 1990s. Carbon Footprint, as the Sign feet total on a global scale is the largest component of Turkey's Ecological Footprint is also the most important part (WWF-Türkiye, 2012). 26% of carbon footprint formation is from electricity generation, 22% from manufacturing industry and construction, 16% from buried emissions of imported products, 12% from Housing and Services, 4% from International Transport emissions, 2% It is due to Agriculture, Forestry and Fisheries and 2% of non-Electricity Energy production. (WWF-Türkiye, 2012)

The transportation sector is responsible %25.6 (26.8 million Tep) of final energy consumption in Turkey in 2016. The biggest part of the transportation sector greenhouse gas emission comes from 92.4% of road transportation and 5.2% of domestic air transportation. International aviation-based greenhouse gas emissions were calculated as 10.72 Mt CO2 equivalent in 2016. (Türkiye Cumhuriyeti Çevre ve Şehircilik Bakanlığı, 2018)

The study was carried out to determine the carbon footprint originating from aircraft for Adana Airport in 2019. This study is expected to contribute to the efforts of decision-makers, authorities and stakeholders to mitigate the negative consequences of climate change and adapt to impacts, due to the reduction of carbon emissions from air transport..

The similar studies national and international literature has been scanned. In the studies of Altuntaş and Karakoç, the environmental impacts of domestic flights between 2006 and 2009 carried out in Eskişehir, Uşak, Adıyaman, Çanakkale and Ağrı were examined. (Altuntaş & Karakoç, 2011). Özgünoğlu and Uygur calculated carbon emissions from aircraft at the airport by examining LTO numbers with Tier 2 method in their study for Kahramanmaraş Airport. In the study, they determined that Airbus320 (A320) was the most landing and taking off flight to Kahramanmaraş Airport in 2016. (Özgünoğlu & Uygur, 2017). Kesgin examined the emission amounts from the aircraft for Ataturk, Antalya and Esenboga airports (Kesgin, 2006) Kumaş and colleagues conducted a similar study for Muğla Dalaman Airport.. (Kumaş, İnan, Akyüz, & Güngör, Muğla Dalaman Havalimanı Uçaklardan Kaynaklanan Karbon Ayak İzinin Belirlenmesi, 2019). And the study conducted by Perl et al. In 2001, they calculated the cost of emissions from aircraft at Lyon-Satolas airport with different scenarios. (Perl, Patterson, & Perez, 1997)

## 2. Methodology

The United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992 with the participation of around 150 countries. The Convention defines climate change as the biggest threat on a global scale. It is within the scope of the contract to work on reducing the damage caused by human activities on nature. In this framework, it calls on the parties to

periodically develop, renew and publish their national inventories, and to use comparative methodologies in greenhouse gas emission inventories. (IPCC, 1997).

In this context, IPCC Greenhouse Gas Inventory calculations published; energy, industrial processes, use of solvents and other products, agriculture, use of the geography of the earth and forests, wastes are the main topics. Energy within these main headings is calculated from including directly or indirectly greenhouse gasemissions. These are CO2, CH4, N2O, NOX, CO and NMVOC and SO2 emissions. Emissions in energy systems are divided into two, emissions from fuel combustion and fugitive emissions. Unlike other emission calculations, CO2 emission calculations generated by direct fuel burning in the transportation sector can be calculated more clearly. IPCC created Tier methods to take into account variables such as fuel characteristics, fuel consumption, emission factors, combustion conditions and technology. It is possible to make calculations at different levels according to the complexity in the methodology used. While the Tier 1 method is a method that performs simpler basic calculations, Tier 2 and Tier 3 calculations are more complex and require more data. In this study, contrary to the general calculations, the Tier2 method, which can obtain more consistent results in country and region-specific investigations, was preferred.

The Tier 2 method is used only for jet engines using jet fuel. In Tier 2 method, aircraft operations are divided into 2 stages as LTO and cruise stages. In order to apply Tier 2 method, it is necessary to know the LTO number and aircraft types. Annual commercial aircraft LTO numbers (Table 3) for Istanbul Airport are taken from State Airports Authorities. In addition, emission factors and fuel consumption values (Table 1) of commercial aircraft were taken from ICAO (International Civil Aviation Organization). These values are multiplied according to the equation no 1 and emission amounts are calculated.

LTO Emission = LTO number * LTO emission factor (1)

## 3. Research and Findings

The method we use gives approximately the amount of emission that takes place between the ground and 1000m level (Tier 2) and given to the atmosphere. Fuel and emission amounts used in LTO phase are calculated with the help of LTO statistics given for each aircraft type. Table 1 contains LTO emission factors for different aircraft types.

**Table 1:** LTO Emission Factor By Aircraft

| | **Aircraft Types** | **$CO_2$** | **HC** | **$NO_x$** | **CO** | **$SO_2$** | **Fuel Consumption (kg/LTO/Aircraft)** |
|---|---|---|---|---|---|---|---|
| **Wide-Body Commercial Aircrafts** | **A320** | 2440 | 0.57 | 9.01 | 6.19 | 0.77 | 770 |
| | **A321** | 3020 | 1.42 | 16.72 | 7.55 | 0.96 | 960 |
| | **A330** | 7050 | 1.28 | 35.57 | 16.20 | 2.23 | 2230 |
| | **B738** | 2780 | 0.72 | 12.30 | 7.07 | 0.88 | 880 |

**Referances:** (International Civil Aviation Organization (ICAO), 2011)

Emissions from airline traffic depend on the type of fuel used, the height at which the exhaust gas is released, the type and efficiency of the engine, and the length of the flight. Emissions are caused by jet kerosene and aircraft gasoline used as fuel in aircraft. The amount of energy use and the amount of emissions thus generated depends on the operating conditions of the aircraft and the time it spends at each level (LTO or cruise condition). In order to apply this approach, both domestic and international commercial LTO numbers and aircraft type should be known. The number of commercial aircraft LTO in Adana Airport could not be reached on the basis of aircraft type. In this study, table 2 used by Kumaş et al was used. Table 2 refers to the proportional distribution of aircraft brand and models in Turkey.(Kumaş, İnan, Akyüz, & Güngör, Muğla Dalaman Havalimanı Uçaklardan Kaynaklanan Karbon Ayak İzinin Belirlenmesi, 2019)

**Table 2:** The amount of the aircraft brand and types in Turkey

| **Aircraft Types** | **Amount** | **% Ratio** |
|---|---|---|
| **AIRBUS - A320** | 61 | 11,65 |
| **AIRBUS - A321** | 67 | 12,78 |
| **AIRBUS - A330** | 91 | 17,33 |
| **BOEING - B737-800 (B738)** | 303 | 58,24 |

**Referances:** (Kumaş, İnan, Akyüz, & Güngör, Muğla Dalaman Havalimanı Uçaklardan Kaynaklanan Karbon Ayak İzinin Belirlenmesi, 2019)

Moreover, the Adana Airport to the landing-takeoff aircraft types, brands and models of aircraft in Turkey were examined to check if it matches with proportionally distribution. During February, Adana Airport daily commercial aircraft LTO numbers were tracked on the basis of aircraft type, the data obtained were compared with the findings in Table 2 and it was determined that they were compatible. This review is in Appendix 1.

**Table 3** : 2019 Adana Airport Monthly Commercial Aircraft LTO Number

| **2019 Adana Airport Monthly Commercial Aircraft LTO Number** | | | |
|---|---|---|---|
| | **Domestic Flights** | **International Flights** | **Total Flights** |
| **January** | 2438 | 381 | 2819 |
| **February** | 2157 | 320 | 2477 |
| **March** | 2479 | 496 | 2975 |

| | | | |
|---|---|---|---|
| **April** | 2256 | 507 | 2763 |
| **May** | 2204 | 477 | 2681 |
| **June** | 2190 | 527 | 2717 |
| **July** | 2016 | 621 | 2637 |
| **August** | 2074 | 630 | 2704 |
| **September** | 2054 | 535 | 2589 |
| **October** | 2144 | 483 | 2627 |
| **November** | 2173 | 422 | 2595 |
| **December** | 2208 | 412 | 2620 |
| **Total** | **26.393** | **5.811** | **32.204** |

**Referances:** (Devlet Hava Meydanları İşletmesi, 2019)

Distribution of aircraft models used in Turkey are given in Table 2. Table 3 shows the monthly LTO numbers at Adana Airport. By multiplying Table 2 and Table 3, monthly LTO numbers were determined according to the proportional distribution of aircraft models.

**Table 4:** Monthly LTO Numbers According To The Proportional Distribution Of Aircfart Models

| **Monthly LTO Numbers According To The Proportional Distribution Of Aircfart Models** | | | | | |
|---|---|---|---|---|---|
| | **Total LTO Number** | **A320 (%12,78)** | **A321 (%17,33)** | **A330 (%11,65)** | **B737 (%58,24)** |
| **January** | 2819 | 360 | 488 | 328 | 1641 |
| **February** | 2477 | 316 | 429 | 288 | 1442 |
| **March** | 2975 | 380 | 515 | 346 | 1732 |
| **April** | 2763 | 353 | 478 | 321 | 1609 |
| **May** | 2681 | 342 | 464 | 312 | 1561 |
| **June** | 2717 | 347 | 470 | 316 | 1582 |
| **July** | 2637 | 337 | 456 | 307 | 1535 |

| | | | | | |
|---|---|---|---|---|---|
| **August** | 2704 | 345 | 468 | 315 | 1574 |
| **September** | 2589 | 330 | 448 | 301 | 1507 |
| **October** | 2627 | 335 | 455 | 306 | 1529 |
| **November** | 2595 | 331 | 449 | 302 | 1511 |
| **December** | 2620 | 334 | 454 | 305 | 1525 |
| **TOTAL** | 26.393 | 3373 | 4573 | 3074 | 15371 |

The data obtained is multiplied by LTO emission factors (Table 1) for different aircraft types obtained from ICAO (International Civil Aviation Organization, 2011), and the emission amount is calculated according to the equation no 2. In this way, monthly emission amount of each aircraft was obtained on the basis of aircraft type. The result of the calculations is given in Table 5.

**Table 5:** Adana Airport 2019 Monthly Commercial Aircraft LTO Number Emission Values According To Aircraft Types

| **Year 2019** | **Aircraft Types** | **Carbon Emission By Aircraft Types (Kg/LTO/Aircraft)** | **LTO Number by Aircraft types** | **Total Amount of CO2 Emissions(Kg/LTO/Uçak)** |
|---|---|---|---|---|
| **January** | A320 | 2.440 | 360 | 878.400 |
| | A321 | 3.020 | 488 | 1.473.760 |
| | A330 | 7.050 | 328 | 2.312.400 |
| | B738 | 2.780 | 1641 | 4.561.980 |
| **February** | A320 | 2.440 | 316 | 771.040 |
| | A321 | 3.020 | 429 | 1.295.580 |
| | A330 | 7.050 | 288 | 2.030.400 |
| | B738 | 2.780 | 1442 | 4.008.760 |
| **March** | A320 | 2.440 | 380 | 927.200 |
| | A321 | 3.020 | 515 | 1.555.300 |
| | A330 | 7.050 | 346 | 2.439.300 |
| | B738 | 2.780 | 1732 | 4.814.960 |
| **April** | A320 | 2.440 | 353 | 861.320 |
| | A321 | 3.020 | 478 | 1.443.560 |
| | A330 | 7.050 | 321 | 2.263.050 |
| | B738 | 2.780 | 1609 | 4.473.020 |
| **May** | A320 | 2.440 | 342 | 834.480 |
| | A321 | 3.020 | 464 | 1.401.280 |
| | A330 | 7.050 | 312 | 2.199.600 |

| | | | | |
|---|---|---|---|---|
| | B738 | 2.780 | 1561 | 4.339.580 |
| **June** | A320 | 2.440 | 347 | 846.680 |
| | A321 | 3.020 | 470 | 1.419.400 |
| | A330 | 7.050 | 316 | 2.227.800 |
| | B738 | 2.780 | 1582 | 4.397.960 |
| **July** | A320 | 2.440 | 337 | 822.280 |
| | A321 | 3.020 | 456 | 1.377.120 |
| | A330 | 7.050 | 307 | 2.164.350 |
| | B738 | 2.780 | 1535 | 4.267.300 |
| **August** | A320 | 2.440 | 345 | 841.800 |
| | A321 | 3.020 | 468 | 1.413.360 |
| | A330 | 7.050 | 315 | 2.220.750 |
| | B738 | 2.780 | 1574 | 4.375.720 |
| **September** | A320 | 2.440 | 330 | 805.200 |
| | A321 | 3.020 | 448 | 1.352.960 |
| | A330 | 7.050 | 301 | 2.122.050 |
| | B738 | 2.780 | 1507 | 4.189.460 |
| **October** | A320 | 2.440 | 335 | 817.400 |
| | A321 | 3.020 | 455 | 1.374.100 |
| | A330 | 7.050 | 306 | 2.157.300 |
| | B738 | 2.780 | 1529 | 4.250.620 |
| **November** | A320 | 2.440 | 331 | 807.640 |
| | A321 | 3.020 | 449 | 1.355.980 |
| | A330 | 7.050 | 302 | 2.129.100 |
| | B738 | 2.780 | 1511 | 4.200.580 |
| **December** | A320 | 2.440 | 334 | 814.960 |
| | A321 | 3.020 | 454 | 1.371.080 |
| | A330 | 7.050 | 305 | 2.150.250 |
| | B738 | 2.780 | 1525 | 4.239.500 |
| **Total** | A320 | 2.440 | 3373 | 8.230.120 |
| | A321 | 3.020 | 4573 | 13.810.460 |
| | A330 | 7.050 | 3074 | 21.671.700 |
| | B738 | 2.780 | 15.371 | 42.731.380 |
| | | | | 86.443,660 |

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## 4. Conclusion, Recommendations and Constraints

Climate change is one of the biggest problems of today. Climate change affects not only the environment but also human health. Greenhouse gases are the gases that have the most heat retention propertie in the Earth's atmosphere. These gases, some of which are emitted naturally and some of them as a result of human activities, prevent the heat loss of the world by keeping

the sun rays reflected from the earth in the atmosphere. According to the Ministry of Environment and Urbanization data, the biggest part of the greenhouse gas emissions in the transportation sector stemmed from road transport and air transport, with 92.4% and 5.2% respectively. Calculation of carbon emission rates, accordingly increased awareness will facilitate adaptation to climate change and our fight against climate change. The works to be carried out by each stakeholder on this subject at an international and local scale will strengthen this struggle.

This emission amount calculated from civilian airline transportation includes the traffic of scheduled or charter aircrafts realizing cargo and passenger transportation. Military and private uses are not included. Also, the Tier 2 method proposed in the 1996 IPCC Guideline is valid only on jet aircraft using jet fuel. Aircraft gasoline is used in small aircraft and corresponds to 1% of all fuel used in aviation. Therefore, emission factors have not been calculated for this low amount, which has such a low rate in global consumption and from private aviation. These are some of the limitations of the study.

The total amount of CO2 emissions from commercial aircraft at Adana Airport for 2019 was measured as 86,443,660 kg. This amount of CO2 emitted into the atmosphere is equal to the amount of greenhouse gas emissions emitted during a 345,204,926.91 km road by an average commercial vehicle when converted by "greenhouse gas emission equivalent calculation" systems. It is also equal to the carbon emission originating from the electrical energy consumed by 9,975 houses in a year. Considering all these, more rigorous and detailed studies should be conducted on carbon emissions to improve the air quality of the sphere where we live and for a cleaner air quality. These studies should be carried out together with the leading companies of the aviation industry.

As stated in the constraints, the study covers the traffic of scheduled or charter aircraft in passenger and cargo transportation in civilian commercial use. Coverage can be expanded by including in scheduled and charter aircraft data, and can be done in regional studies by examining other airports in the region.

**Appendix 1.** Daily LTO number based on aircraft model at Adana Airport

| | **A319** | | **A320** | | **A321** | | **A330** | | **B737-800** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Arrival** | **Departure** | **Arrival** | **Departure** | **Arrival** | **Departure** | **Arrival** | **Departure** | **Arrival** | **Departure** |
| **2.02.2020** | 1 | 2 | 3 | 3 | 4 | 5 | 1 | 0 | 35 | 34 |
| **3.02.2020** | 0 | 0 | 9 | 9 | 7 | 8 | 0 | 0 | 29 | 27 |
| **4.02.2020** | 0 | 0 | 5 | 5 | 7 | 8 | 0 | 0 | 23 | 28 |
| **5.02.2020** | 0 | 0 | 6 | 7 | 6 | 6 | 1 | 1 | 23 | 21 |
| **6.02.2020** | 0 | 0 | 7 | 6 | 9 | 7 | 1 | 1 | 27 | 29 |
| **7.02.2020** | 0 | 0 | 9 | 9 | 7 | 10 | 1 | 1 | 25 | 24 |
| **8.02.2020** | 1 | 1 | 3 | 4 | 4 | 5 | 1 | 1 | 15 | 14 |
| **9.02.2020** | 1 | 1 | 6 | 6 | 5 | 6 | 1 | 1 | 28 | 27 |
| **10.02.2020** | 0 | 0 | 8 | 7 | 6 | 6 | 0 | 0 | 28 | 28 |
| **11.02.2020** | 0 | 0 | 3 | 4 | 8 | 9 | 0 | 0 | 26 | 26 |
| **12.02.2020** | 0 | 0 | 6 | 6 | 5 | 5 | 0 | 0 | 25 | 25 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **13.02.2020** | 0 | 0 | 6 | 6 | 9 | 10 | 0 | 0 | 27 | 27 |
| **14.02.2020** | 0 | 0 | 7 | 7 | 5 | 4 | 1 | 1 | 29 | 30 |
| **15.02.2020** | 1 | 1 | 7 | 6 | 6 | 7 | 1 | 1 | 30 | 30 |
| **16.02.2020** | 1 | 1 | 6 | 7 | 4 | 4 | 2 | 2 | 29 | 28 |
| **17.02.2020** | 0 | 0 | 8 | 8 | 7 | 5 | 1 | 1 | 30 | 29 |
| **18.02.2020** | 0 | 0 | 6 | 6 | 9 | 10 | 0 | 0 | 24 | 25 |
| **19.02.2020** | 0 | 0 | 3 | 4 | 1 | 1 | 2 | 2 | 31 | 30 |
| **20.02.2020** | 0 | 0 | 8 | 8 | 8 | 7 | 0 | 0 | 27 | 28 |
| **21.02.2020** | 1 | 1 | 8 | 8 | 3 | 4 | 1 | 1 | 33 | 32 |
| **22.02.2020** | 2 | 2 | 8 | 8 | 4 | 4 | 0 | 1 | 30 | 30 |
| **Total** | 8 | 9 | 132 | 134 | 124 | 131 | 14 | 14 | 574 | 572 |

## REFERENCES


- Altuntaş, Ö., & Karakoç, H. (2011, 01). Türkiye'deki Bazi Hava Alanlarinda İç Hat Uçuşlari İçin Uçak Seçiminde Çevresel Etkilerin Göz Önünde Bulundurulmasinin İncelenmesi. *Havacilik Ve Uzay Teknolojileri Dergisi, 5*(1), s. 11-18.
- Çevre ve Sehircilik Bakanlığı. (2012). *İklim Değişikliği Ulusal Eylem Planı 2011-2023.* Ankara.
- Devlet Hava Meydanları İşletmesi. (2019). *Türkiye Geneli Havalimanları Uçak, Yolcu ve Yük Trafiği İstatistikleri ve Tahminleri.* Devlet Hava Meydanları İşletmesi.
- International Civil Aviation Organization (ICAO). (2011). Doc9889. *Air Quality Manuel*. Montreal, Kanada: International Civil Aviation Organization (ICAO).
- Kesgin, U. (2006, 03). Aircraft emissions at Turkish airports. *Energy, 31*(2-3), s. 372-384.
- Kumaş, K., İnan, O., Akyüz, A., & Güngör, A. (2019). Muğla Dalaman Havalimanı Uçaklardan Kaynaklanan Karbon Ayak İzinin Belirlenmesi. *Academik Platform Journal of Engineering and Science, 7*(2), s. 291-297.
- Kumaş, K., İnan, O., Akyüz, A., & Güngör, A. (2019). Muğla Dalaman Havalimanı Uçaklardan Kaynaklanan Karbon Ayak İzinin Belirlenmesi. *Academic Platform Journal of Engineering and Science*, 291-297.
- Özgünoğlu, K., & Uygur, N. (2017). Kahramanmaraş Havalimanı İçin Uçaklardan Kaynaklanan Emisyonların Belirlenmesi. *Kahramanmaras Sutcu Imam University Journal of Engineering Sciences*, 24-30.
- Perl, A., Patterson, J., & Perez, M. (1997, 06). Pricing aircraft emissions at Lyon-Satolas airport. *Transportation Research Part D: Transport and Environment, 2*(2), s. 89-105.

- Sağlık Bakanlığı. (2015). *İklim Değişikliğinin Sağlık Üzerine Olumsuz Etkilerinin Azaltılması Ulusal Programı ve Eylem Planı.* Ankara: Sağlık Bakanlığı. 01 20, 2019 tarihinde https://hsgm.saglik.gov.tr/depo/birimler/cevre-sagligi/2-ced/iklim-degisikligi/Iklim_Degisikligi_Eylem_Plani.pdf adresinden alındı

- *T.C. Tarım ve Orman Bakanlığı Meteoroloji Genel Müdürlüğü*. (2019, Ocak 29). Türkiye İçin İklim Projeksiyonları: https://www.mgm.gov.tr/iklim/iklim-degisikligi.aspx?s=projeksiyonlar adresinden alındı

- Türkiye Cumhuriyeti Çevre ve Şehircilik Bakanlığı. (2018). *Türkiye'nin Yedinci Ulusal Bildirimi.* Ankara: Türkiye Cumhuriyeti Çevre ve Şehircilik Bakanlığı.

- Wiedman, T., & Jan, M. (2008). *A Definition of 'Carbon Footprint'*. Hauppauge NY, USA.: Nova Science Publishers. 01 17, 2019 tarihinde http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.467.6821&rep=rep1&type=pdf adresinden alındı

- *World Meteorological Organization (WMO)*. (2020, 01). World Meteorological Organization: https://public.wmo.int/en/media/press-release/greenhouse-gas-concentrations-atmosphere-reach-yet-another-high adresinden alındı

- WWF-Türkiye. (2012). *Türkiye'nin ekolojik ayak izi raporu.* Kalifornia: Global Footprint Network.