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Türkiye'de COVID-19 Döneminde NO2 Emisyonunun Analizi

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Anahtar Kelimeler
Sentinel-5P,
TROPOMI,
Covid-19,
Azot Dioksit

ÖZ

2019 yılında ortaya çıkan Koronavirüs salgını, bireylerde solunum yetmezliği ile başlamaktadır. Havada bulunan çeşitli gazlar bireylerin yaşam kalitelerini etkilemektedir. Örneğin; nitrojen en büyük hava kirleticilerinden biridir. Bu gaz insan sağlığı ve çevre üzerinde olumsuz etkilere sebep olmaktadır. Ülke genelinde virüsün yayılmasının önüne geçmek için bazı tedbirler alınıp, kısıtlamalar yapılmıştır. Bu durum her ne kadar insanları psikolojik olarak yıpratsa da hava kalitesi ve çevre üzerinde olumlu etkiler yaratmıştır. Bu çalışmada Sentinel-5P TROPOMI uydu sensöründen alınan NO2 gazının Türkiye genelinde Covid-19 pandemisindeki miktarı incelenmiştir. Ayrıca salgın dönemindeki, ulaşım ve sanayileşmedeki durumun hava kirliğini etkileyen önemli bir faktör olup olmaması da çalışmada ele alınmıştır. Elde edilen sonuçlar doğrultusunda salgın dönemindeki kısıtlamalarda ülke genelinde NO2 miktarında gözle görülür şekilde azalmalar yaşandığı görülmüştür. Buna ek olarak 2020 Haziran ayında kısıtlamaların kalkmasıyla birlikte nitrojen gazında artmalar meydana gelmiştir. Salgın döneminde NO2 miktarındaki değişimin anlamlı olduğu görülmektedir.

An Analysis of NO_2 Emission During COVID-19 Period in Turkey

Keywords
Sentinel-5P,
TROPOMI,
COVID-19,
Nitrogen Dioxide

ABSTRACT

The coronavirus epidemic, which emerged in 2019, begins with respiratory failure in individuals. Various gases in the air affect the life quality of individuals. For example, nitrogen is one of the most significant air pollutants, and this gas causes adverse effects on the environment and human health. In order to prevent the spread of the virus throughout the country, some precautions have been taken, and restrictions have been made. Although this situation wears people down psychologically, it positively affects air quality and the environment. This study examined the amount of NO2 gas taken from the Sentinel-5P TROPOMI satellite sensor in Turkey during the Covid-19 pandemic period. Whether the situation in transportation and industrialization during the epidemic period is an essential factor affecting air pollution is also discussed in the study. In line with the results obtained, it has been observed that there has been a noticeable decrease in the amount of NO2 throughout the country in the restrictions during the epidemic period. In addition, there was an increase in nitrogen gas with the removal of the restrictions in June 2020. It is observed that the change in the amount of NO2 is significant during the epidemic period.

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1. INTRODUCTION

The coronavirus disease (COVID-19) first began to spread in Wuhan, China, and quickly showed its effect worldwide. According to reports published by the World Health Organization (WHO) on 02.08.2021, it was stated that the number of cases for the whole world reached 198.022.041, and the number of deaths reached 4.223.460. On the same date, when examining the situation of the Covid-19 effect in Turkey, it was observed that 5,727,045 cases were seen, and 5,332 deaths were recorded (WHO, 2021). Although it is unknown exactly how Covid-19 spreads, it has been determined that it is a respiratory disease that affects the respiratory system and lungs (Lai et al., 2020). For this reason, some measures have been taken in all countries of the world to prevent the spread of the virus. Social distancing and hygiene rules are at the top of these measures (WHO, 2020; Bherwani et al., 2020; Gautam, 2020).

Therefore, the disease has become a factor that affects health on a global scale and affects the whole of life. One of the most critical issues that can be given as an example its general effects is the relationship between humans and the environment. Due to its nature, humans and the environment are in constant interaction (Aykac et al., 2012; Bacak et al., 2020). In this period, the human-environment interaction has been positive and negative in two directions. Considering the positive side, due to the restrictions brought by the measures (temporary closure of industrial facilities, decrease in traffic circulation, etc.), environmental and air pollution have decreased. This situation has caused severe changes in environmental factors.

The Sentinel satellite mission has been providing radar and optical data from 2015 to the present, as well as recently air quality data. For instance; Digital Elevation Model (DEM) researches (Karabörk et al., 2021) and deformation analysis (Orhan, 2021) studies are carried out with Sentinel-1 radar data, while studies such as classification (Apaydın & Abdikan, 2021), segmentation (Knopp et. al., 2020) and water quality (Toming, 2016) are performed with Sentinel-2 optical data.

Gases in the air in specific amounts affect the quality of life of individuals (Arbex et al., 2012; Clay et al., 2018). These gases are nitrogen, oxygen, water vapor, argon, carbon dioxide, neon, helium, methane, krypton, hydrogen, ozone, and xenon. For example, NO2 (Nitrogen dioxide) in the atmosphere is among the most critical pollutants that irritate the airways in individuals. In this case, it has been observed that it is harmonies with the transmission and death rates in Covid-19, as it triggers the respiratory tract (Kong et al., 2020).

Recently, various gases in the atmosphere have been tracked with satellite-based remote sensing data. Where air pollutants are concentrated and whether they increase or decrease is revealed due to the analysis. The purpose of this study is to monitor the vertical column status of NO2 gas before, during, and after Covid-19 using TROPOMI satellite data. In addition to this, the causal relationship of the effect of the number of coronaviruses on air quality is discussed. The first section of the paper introduced the materials and methods used, and in the second section, the study area and how the data was processed were explained. In the last section, the effect of Covid-19 on NO2 gas in the troposphere is mentioned.

2. MATERIAL and METHOD

2.1. Study Area

Selected as the study area, Turkey is surrounded by seas on three sides and consists of 7 different regions (Mediterranean, Eastern Anatolia, Southeastern Anatolia, Central Anatolia, Black Sea, Marmara, and Aegean) (Figure 1). In terms of its mathematical location, it is located between 26o- 45o east meridians and 36^{o}-42^{o} north parallels.

Figure 1. Study Area

2.2. Data Sources and Data Process

Within the scope of the study, it was aimed to investigate whether the NO2 value, which is one of the air pollution parameters, has undergone a significant decrease as a result of the quarantines applied by the authorities/organizations throughout Turkey during the Covid-19 (Coronavirus disease) epidemic. Therefore, the study covers the COVID-19 pandemic (September 10, 2019, in China), (Turkey on March 10, 2020), and (last data on October 10, 2021) over a six-month timeframe each. Sentinel-5P (Sent-5P) satellite images are used for NO2 data. The mission of this satellite is to monitor the atmosphere and enable air pollutants to be studied on a global basis (URL2, 2021).

Python v3.18 programming language was used for processing Sent-5P satellite images. In the software used, netCDF4, Harp, NumPy, and matplotlib libraries were used. Determining the temporal changes in the NO2 parameter is of great importance in terms of air pollution and environmental problem detection. Therefore, the determination of this parameter and minimizing air pollution values are critical issues, for a livable and healthy city/country.

3. RESULTS and DISCUSSION

In the country, the rapid increase in the population, the development of industry, increase the amount of fossil fuel use and also cause an increase in greenhouse gases in the atmosphere (Zhang & Cao, 2015; Bauer et al., 2015; Xu et al., 2016). For this reason, air pollution is a problem for developed and developing countries. A report on air quality is published by the World Health Organization every year. According to this report, air quality affects the standards of one's life quality. Common diseases in people exposed to air pollution;

respiratory failure, asthma, lung cancer, cardiovascular diseases (Pant & Harrison, 2013). Since the amount of NO2 in the atmosphere directly affects the air quality, it also plays an important role in human health. While Turkey's population was 83.154.997 million in 2019, it has reached 83.614.362 million by increasing 459.365

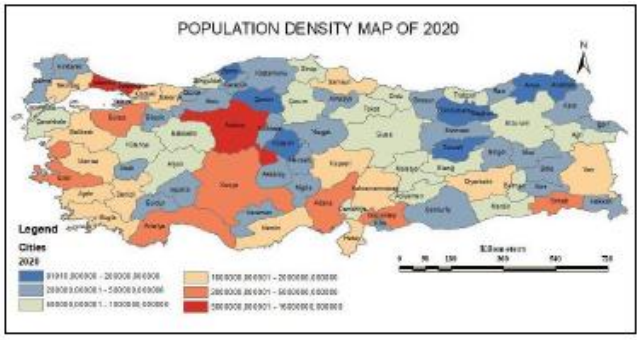

Figure 2. Population number of Turkey by cities (year 2020)

people as of 2020 compared to the previous year (Figure 2). With the increasing number of people and industrialization, motor vehicles and thermal power plants have become important sources of air pollution (NO_2 component).

In 2019 and 2021, the production index increased and decreased in a balanced way, but there were serious changes in 2020, when the epidemic broke out throughout the country (Figure 3). The activity in the economy has come to a standstill. Therefore, industrial facilities, trade centers, and industrial communities could not work in this process. The main reason for this is thought to be the occurrence of restrictions and prohibitions. Although negative economic results were obtained, human-environment interaction was positively affected as a result of the measures taken during the epidemic period.

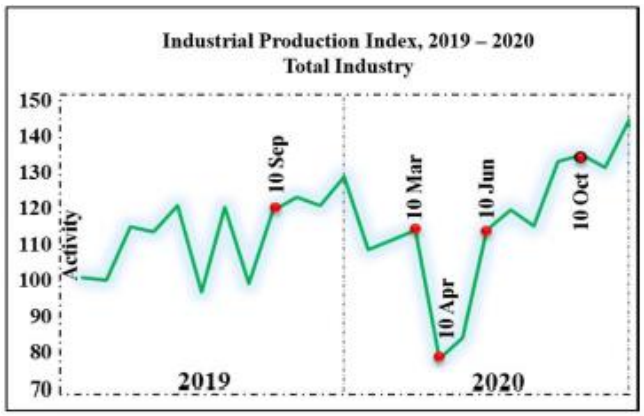

Figure 3. Industrial production index between 2019-2020 (Turkey)

The NO_2 component, which affects the air quality in certain periods (10 September 2019, 10 March 2020, 10 April 2020, 10 June 2020, 10 October 2020) throughout Turkey, has been examined. (Figure 4).

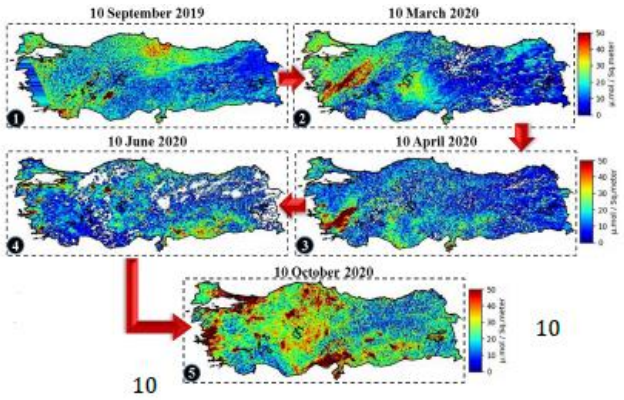

Figure 4. Nitrogen Dioxide (NO_2) Emissions over TURKEY

When the visual results are interpreted, it is understood that the Covid-19 pandemic period has affected the air quality. However, on March 10, when the virus started to appear in our country, increases in the amount of NO2 began to occur. It can be seen more prominently in the western parts of our country. As of April 2020, a curfew was imposed on those above the age of 65, and then young people and children which under the age of 20, in order to reduce the impact of the epidemic on its spread. Afterwards, a curfew was imposed on weekends and in 30 metropolitan cities, and a curfew was implemented across the country between May 23-26. It is seen that there is a great decrease in NO2 thanks to the curfew. This indicates an improvement in air quality. As of June 1, 2020, some restrictions were removal and flexible and alternating work began in the workplaces. When the image of June 10, 2020 is examined, only partial redness can be seen in the city centers. Looking at the date of October 10, 2020, it is seen that redness is dominant throughout Turkey. The main reason for this is that the restrictions have been gradually removal since June and depending on this situation, there have been dynamism in industrial activities, transportation, and tourism sectors. This has led to an increase in nitrogen and derivatives in the atmosphere.

4. CONCLUSION

Using TROPOMI satellite data, the amount of NO2 emission in the atmosphere before and after Covid-19 was monitored. When the results of the study are examined, the restrictions and prohibitions made to control the epidemic had a great impact on industrial production, transportation, and social life. However, it has had a positive impact on environmental air quality. It has been determined that NO2 emissions, which is one of the pollutants in the air, decrease and lighten. This study revealed the potential benefits on air quality and human health, along with the impact of the pandemic on industrial and transportation activities.

Author contributions

The authors contributed equally to the study.

Conflicts of interest

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

REFERENCES

Apaydın C & Abdikan S (2021). Determination of Hazelnut Gardens by Pixel Based Classification Methods Using Sentınel-2 Data. *Journal of Geomatics*, 6(2), 107-114.

Arbex M A, Santos U D P, Martins L C, Saldiva P H N, Pereira L A A & Braga A L F (2012). Air pollution and the respiratory system. *Jornal brasileiro de pneumologia*, 38, 643-655.

Aykac N, Bostan P P, Olcay S S & Öztürk B (2021). Five-Year Analysis of Air Pollution in Istanbul Including Also the Impact of the COVID-19 Pandemic. *Journal of İzmir Chest Hospital,* 35(3), 113-124.

Bacak T N, Dursun Ş, & Toros H (2020). The Effect of COVID-19 outbreak on Air Quality of Istanbul city centre. *Journal of Research in Atmospheric Science*, 2(1), 7-11.

Bauer N, Bosetti V, Hamdi-Cherif M, Kitous A, McCollum D, Mejean A, & Van Vuuren D, (2015). CO2 emission mitigation and fossil fuel markets: Dynamic and international aspects of climate policies. *Technological Forecasting and Social Change*, 90, 243-256. doi:10.1016/j.techfore.2013.09.009

Bherwani H, Gupta A, Anjum S, Anshul A & Kumar R (2020). Exploring dependence of COVID-19 on environmental factors and spread prediction in India. npj *Climate and Atmospheric Science*, 3(1), 1-13.

Clay K, Lewis J & Severnini E (2018). Pollution, infectious disease, and mortality: evidence from the 1918 Spanish influenza pandemic. *The Journal of Economic History,* 78(4), 1179-1209.

ESA (2021). The European Space Agency Signature https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-5p/products-algorithms. [Accessed Date: 09.06.2021].

Gautam S (2020). COVID-19: Air pollution remains low as people stay at home. *Air Quality, Atmosphere & Health*, 13, 853-857.

Knopp L, Wieland M, Rättich M & Martinis S (2020). A deep learning approach for burned area segmentation with Sentinel-2 data. *Remote Sensing*, 12(15), 2422.

Kong L, Tang X, Zhu J, Wang Z, Fu J S, Wang X & Carmichael G R (2020). Evaluation and uncertainty investigation of the NO2, CO and NH 3 modeling over China under the framework of MICS-Asia *III. Atmospheric Chemistry and Physics,* 20(1), 181-202.

Lai C C, Shih T P, Ko W C, Tang H J & Hsueh P R (2020). Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. *International journal of antimicrobial agents,* 55(3), 105924.

Orhan O (2021). Monitoring of land subsidence due to excessive groundwater extraction using small baseline subset technique in Konya, Turkey. *Environmental Monitoring and Assessment*, 193(4), 1-17.

Pant P & Harrison R M (2013). Estimation of the contribution of road traffic emissions to particulate matter concentrations from field measurements: A review. *Atmospheric environment*, 77, 78-97.

Toming K, Kutser T, Laas A, Sepp M, Paavel B & Nõges T (2016). First experiences in mapping lake water quality parameters with Sentinel-2 MSI imagery. *Remote Sensing*, 8(8), 640.

WHO (2021). World Health Organization https://covid19.who.int/region/euro/country/tr. [Accessed Date: 02.08.2021].

WHO (2020). World Health Organization Coronavirus disease (covid-19) dashboard, global situation. http://who.covid19.int/ [Accessed Date: 2020].

Xu B, Luo L & Lin B (2016). A dynamic analysis of air pollution emissions in China: Evidence from nonparametric additive regression models. *Ecological indicators,* 63, 346-358.

Zhang Y L & Cao F (2015). Is it time to tackle PM2. 5 air pollutions in China from biomass-burning emissions. *Environmental Pollution*, 202, 217-219. doi:10.1016/j.envpol.2015.02.00