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SHORT REPORT

COVID-19: SPACEBORNE NITROGEN DIOXIDE OVER TURKEY

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ABSTRACT

As a reason for a pandemic, the global novel COVID-19 virus has affected all of the World and caused lockdowns in many countries. Naturally, with decreased anthropogenic activities, the influence of the people over the environment has declined. Thus, improvement in air quality has been noticed. With the use of remote sensing data, in this short communication, we observed the Nitrogen Dioxide (NO_2) over Turkey in the first month from the first appearance of the virus. Then, we compare the results with the same period from last year. Results show a significant reduction in the NO_2 amount, especially in the most populated areas in Turkey.

Keywords: COVID-19, Remote sensing, Nitrogen dioxide, Air quality, Turkey

1. INTRODUCTION

Coronavirus diseases 2019 (COVID-19) is an infectious disease that was first identified in December 2019 in the capital of China's Hubei province, Wuhan. As the virus that causes COVID-19 is mainly transmitted through droplets generated when an infected person coughs, sneezes, or exhales [1], self-isolation has been recognized as one of the primary preventions to stop the spreading of the virus. This situation caused total lockdowns in the most affected parts in China, Italy, and partial lockdowns in many countries. However, until April 17 2020, more than 2.2 million people have been infected, and the virus has caused more than 150 thousand deaths worldwide.

The first case of Coronavirus in Turkey has been registered on March 10, 2020 [2]. Since then, the Government of Turkey has taken severe measures to stop the spreading of the virus. After March 15, all international flights have been suspended, shifted the education system to online classes leaving millions of students at home, restricted the vehicles from entering in 31 big provinces, resident under the age of 20, and above 65 have been directed not to leave their homes, encouraging home-office working, and more. Also, the Government of Turkey has applied a 48-hour home-leave restriction in 11 – 12 April in the 31 big provinces. According to the Ministry of Health of Turkey, until April 17 2020, Turkey has 78.546 confirmed Coronavirus cases, and 1.769 deaths (https://covid19.saglik.gov.tr/). This kind of situation has changed every-day life in the country, leaving a large part of the population of Turkey indoors. Naturally, these changes have a significant impact on the environment, as well. Air pollution is yearly causing thousands of deaths all over the World [3], and today it has been related to the high death tools in the United States [4] and Italy [5] in patients infected by the Coronavirus. As the primary source of Nitrogen Dioxide (NO_2), one of the most significant components of urban air pollution [6], is the burning of fossil fuels such as coal, oil, and gas, taking into consideration the previously stated, with the decrease of the traffic in Turkey, a reduction of the NO_2, and an increase of air quality is expected. To prove this, in this study we use satellite remote sensing data to monitor the NO_2 in the first month of the COVID-19 presence in Turkey, March 15 – April 15 2020, and we compare the results with data from the same period in 2019. For this purpose, we use the Sentinel-5 Precursor Tropospheric monitoring instrument (Sentinel-5P TROPOMI), launched in

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2017 by the European Space Agency (ESA). TROPOMI has a relatively high spatial resolution that is necessary for air quality applications [7]. Since the launch of Sentinel-5p, several studies have shown the success of the TROPOMI instrument. Thus, Kaplan et al. [8], used TROPOMI data for monitoring the NO_2 over Turkey, Theys et al. [9] investigated volcanic SO_2, and Borsdorff et al. [10] presented the first results of measuring CO with TROPOMI over China.

2. MATERIALS AND METHODS

In this paper, the NO_2 values over Turkey in the first month of the Coronavirus presence has been investigated. The total population of Turkey is 83 million, and the most populated city is Istanbul with approximately 15 million residents, followed by the capital, Ankara with 5.5 million, and Izmir, Konya, and Bursa as one of the most populated provinces.

Sentinel-5p TROPOMI is a space-borne spectrometer covering wavelength bands between the ultraviolet and the shortwave infrared, and it is the single payload of the Sentinel-5p spacecraft launched October 13, 2017, into the low earth orbit funded jointly by the Netherlands Space Office and the European Space Agency. The instrument is designed to obtain data for air quality and climate observations [11]. The instrument operates in a push-broom configuration (non-scanning), with a swath width of approximately 2600 km on the Earth's surface, which makes daily global coverage in combination with fine spatial resolution possible. Statistical analyses of the global comparison between TROPOMI and ground-based measurements show a small percentage difference [12]. The NO_2 data were downloaded from the Google Earth Engine platform, for two periods, first March 15 – April 15 2019, and second, March 15 – April 15 2020 (Figure 1).

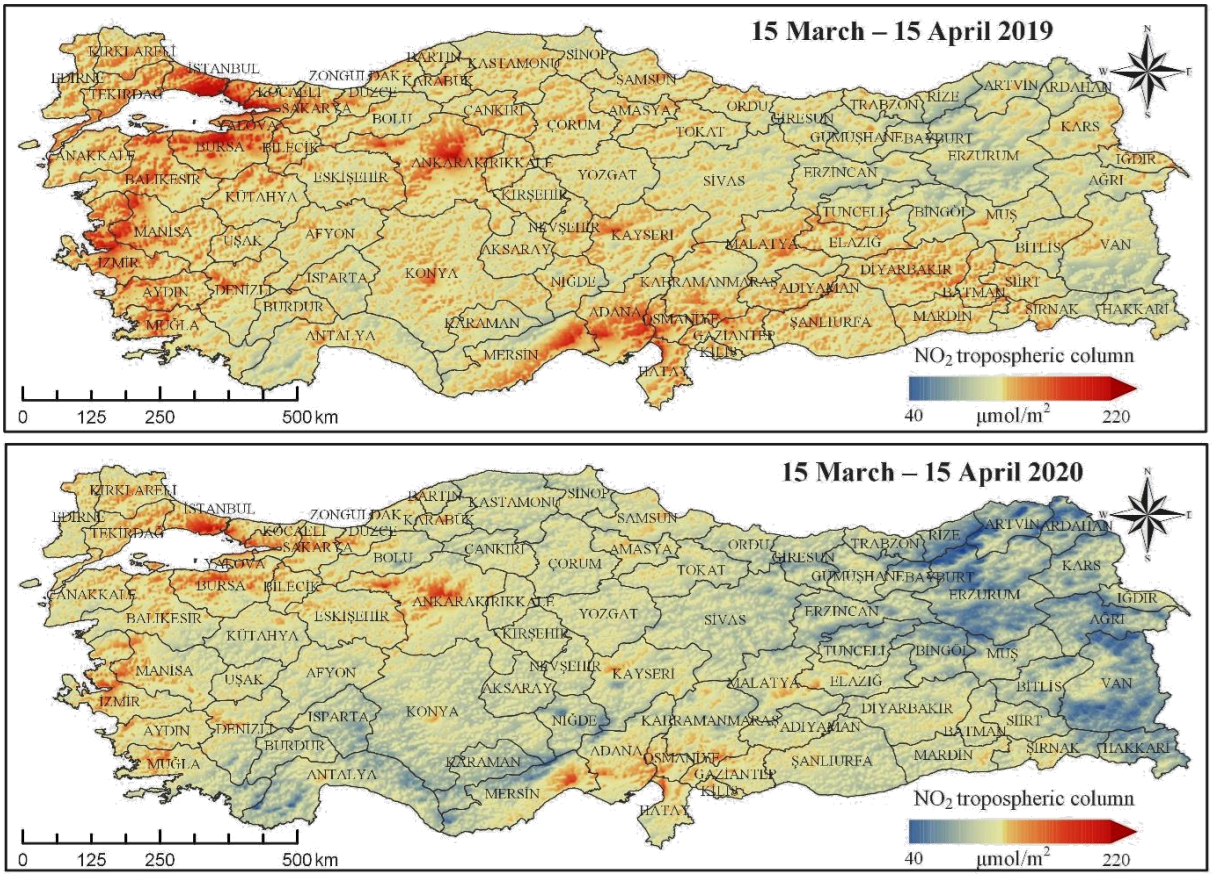

Figure 1. NO_2 over Turkey; March 15 – April 15 2019 and 2020

The mean values in 2019 vary from 50 to 220 µmol/m^2, while in the investigated period in 2020 range from 40 to 135 µmol/m^2. However, to be able to make a visual comparison, the data were presented under the same legend. The maximum values of the NO_2 were statistically calculated for all 81 provinces in Turkey. Also, for better visualization, the differences of the NO_2 values between the investigated periods have been calculated and mapped.

3. RESULTS AND DISCUSSION

The differences between the mean data from 2019 and 2020 are shown in Figure 2. As expected, there is a drastic decrease in the NO_2 values in several parts of Turkey. The maximum mean NO_2 difference between the two periods is 95 µmol/m^2, showing approximately 57% decrees in some parts of the study area. These changes are noticed in the most populated regions of Turkey, starting with Istanbul. The results can be supported with previous findings [8,13], where 50% of the NO_2 over Turkey were correlated with population statistics.

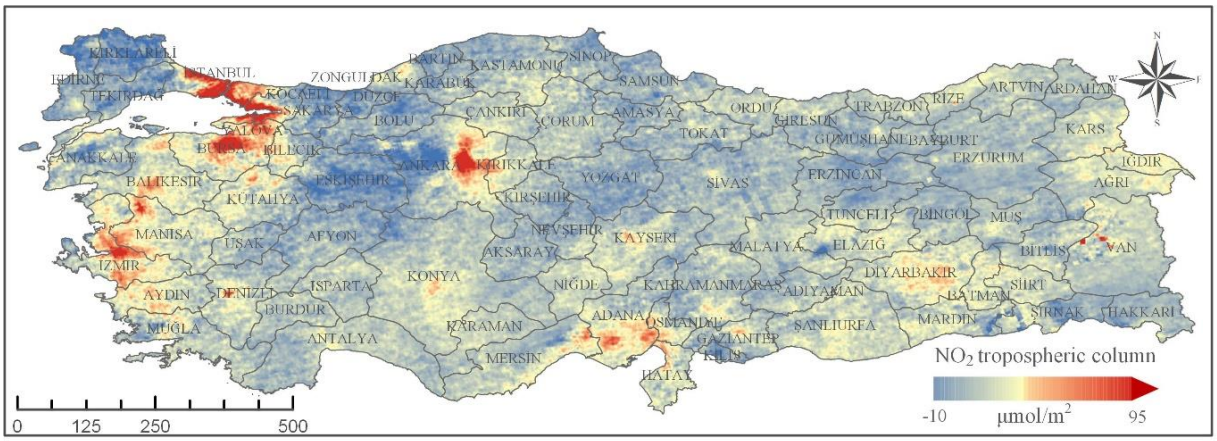

Figure 2. NO_2 difference between the investigated periods

The detailed investigation about all of the 81 provinces in Turkey, also shows a significant decrease in the maximum NO_2 amount. The differences for all 81 provinces are presented in Figure 3, sorted by provinces number, left to right. However, only the most significant have been labelled. As expected, in the most populated and industrially relevant provinces, the decrease of the maximum value of NO_2 was noticed.

The presented results are a preliminary result of the environmental changes in Turkey in the first month during the Coronavirus pandemic situation. As the situation is unpredictable at the moment, this kind of environmental changes can increase even more. Similar results on the air quality have been reported in China and Italy by the European Space Agency. More studies should be made on related topics, concerning environmental problems, as at the moment, the impact of the people is reduced to a minimum. For future studies, we recommend investigating the air quality over the 48-hour lockdowns in Turkey.

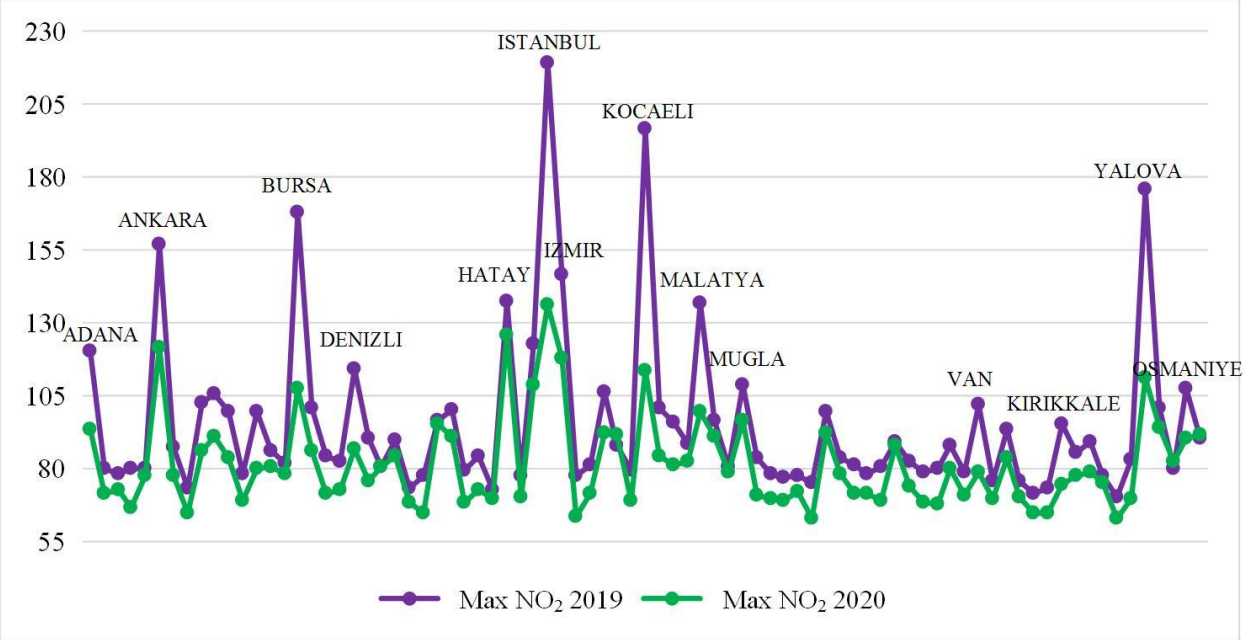

Figure 3. NO_2 maximum difference in the 81 Turkeys provinces

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