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COVID-19 LOCKDOWN EFFECTS ON THE AIR QUALITY: A CASE STUDY OF ISTANBUL

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Introduction

COVID-19, which was first observed in Wuhan, China in December 2019, is a novel coronavirus disease and has caused millions of people's death worldwide (WHO, 2021). This disease spreads with the human-to-human transmission; therefore, most of the countries have declared strict rules and lockdown. In the lockdown period, a huge amount of the industrial activities and transportation which affects the air quality conditions were propped up temporarily.

To investigate lockdown effects on air quality, there are several studies from different countries such as India (Kolluru et al., 2021), USA (Perera et al., 2021), Pakistan (Mehmood et al., 2021), and Spain (Tobías et al., 2020). In Turkey, few studies investigated the air quality during the COVID-19 pandemic. Dursun et al. (2021) evaluated the air quality of major cities in Turkey between January 2020 and April 2020 to show pre- and post-pandemic effects. Aydın et al. (2021) investigated the air quality based on ozone and particulate matter with diameter less than 2.5 ($PM_{2.5}$) parameters over the country as before and during the lockdown. Celik and Gul (2021) showed time series analysis of multiple air quality parameters for March-May 2019 and March-May 2020 using 19 air monitoring stations' observations. Ghasempour et al. (2021) analyzed the spatio-temporal density of TROPOMI-based nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) products, and MODIS-derived Aerosol Optical Depth (AOD) during the first wave of the COVID-19 over Turkey. Their results revealed a significant decrease in NO_2 and AOD, while SO_2 unchanged and had slightly higher concentrations in some regions during the first wave lockdown year of 2020 compared to 2019.

The aim of the study is to show the geospatial distribution of air quality conditions considering the station-based particulate matter with a diameter less than 10 (PM_{10}) and NO_2 parameters before, during the restrictions and lockdown, and after the COVID-19 lockdown for the first wave. For that purpose, four terms were determined for Istanbul megacity, and PM_{10} and NO_2 distribution maps of them were created using air monitoring stations' observations and the Inverse distance weighted (IDW) interpolation method.

Materials and Methods

According to COVID-19 restrictions and lockdown period, four terms were determined as in Table 1. First term states the before COVID-19 period in Turkey, and the second term refers to the period that first cases were observed in Turkey. In the third term, lockdown and restrictions were declared in the megacities, especially in Istanbul, and the fourth term is the "New Normal" period after the first wave of the COVID-19.

Table 1 Terms according to COVID-19 period

Term	Date interval
1st term	January 20, 2020 - March 11, 2020
2nd term	March 12, 2020 - April 9, 2020
3rd term	April 10, 2020 - June 1, 2020
4th term	June 2, 2020 - July 23, 2020

PM_{10} and NO_2 parameters were selected for the analysis of the first wave lockdown effect on Istanbul's air quality. Thus, 30 air quality monitoring stations, which measured both of the selected parameters, were used with the IDW interpolation method to map the spatial distribution. Used air quality monitoring stations are shown in Fig. 1. Daily average data were provided from the database of the Republic of Turkey Ministry of Environment and Urbanization (Url-1).

Figure 1 Used air quality monitoring stations in Istanbul

IDW method estimates the value of the unknown location as the distance-weighted average of a given number of neighboring points and the weight assigned to each neighbor point inversely proportional to the distance of neighboring points (Valley et al., 2005). The formulation is given in Eq. (1) and (2).

$$z(s_0) = \sum_{i=1}^{n} \lambda_i z(s_i) \quad (1)$$

$$\lambda_i = \frac{{d_i}^{-\propto}}{\sum_{i=1}^{n} {d_i}^{-\propto}} \quad (2)$$

where $z(s_0)$ is the unknown value at the s_0 location, $z(s_i)$ is the observation value at the s_i location, and λ_i is the weight of each observation point which is calculated via Eq. (2). d_i means the distance from each observation points to the unknown area and α is the power which is the control parameter of distance. As the distance increases, the weight is reduced by α factor (Burrough and McDonnell, 1998).

Results and Discussion

Daily average of PM_{10} and NO_2 parameters were collected according to the determined time interval and the average of the terms were taken for each air monitoring station. Using the IDW interpolation method, PM_{10} and NO_2 distribution maps were generated for each term considering limit values of the parameters. The daily limit value of PM_{10} is 50 $\mu g/m^3$ and the annual limit value of NO_2 is 40 $\mu g/m^3$ (WHO, 2005). More than limit values were shown as red color in the generated maps which are given in Fig. 2 and Fig. 3. According to the results, the red-colored class in PM_{10} maps decreased with the start of the restrictions, especially in the 3rd term, which is the lockdown term and has started to increase with the finish of the lockdown. Similarly, the red-colored class in NO_2 maps showed the same behavior with the PM_{10}. The maximum value of the PM_{10} was 78,32 $\mu g/m^3$ in the first term, 74,90 $\mu g/m^3$ in the lockdown, and raised to the 119,63 $\mu g/m^3$ in the new normal term. Like PM_{10}, the maximum value of the NO_2 was 109,78 in the first term, 81,30 $\mu g/m^3$ in the lockdown, and raised to 111,73 $\mu g/m^3$ in the new normal term. These preliminary results are based on the observed station datasets regardless of any other meteorological data, land use land cover (LULC), and so on, which has impact on atmospheric pollutants. For a robust analysis of the air quality, further research is required that considers more variables together that affect the air quality.

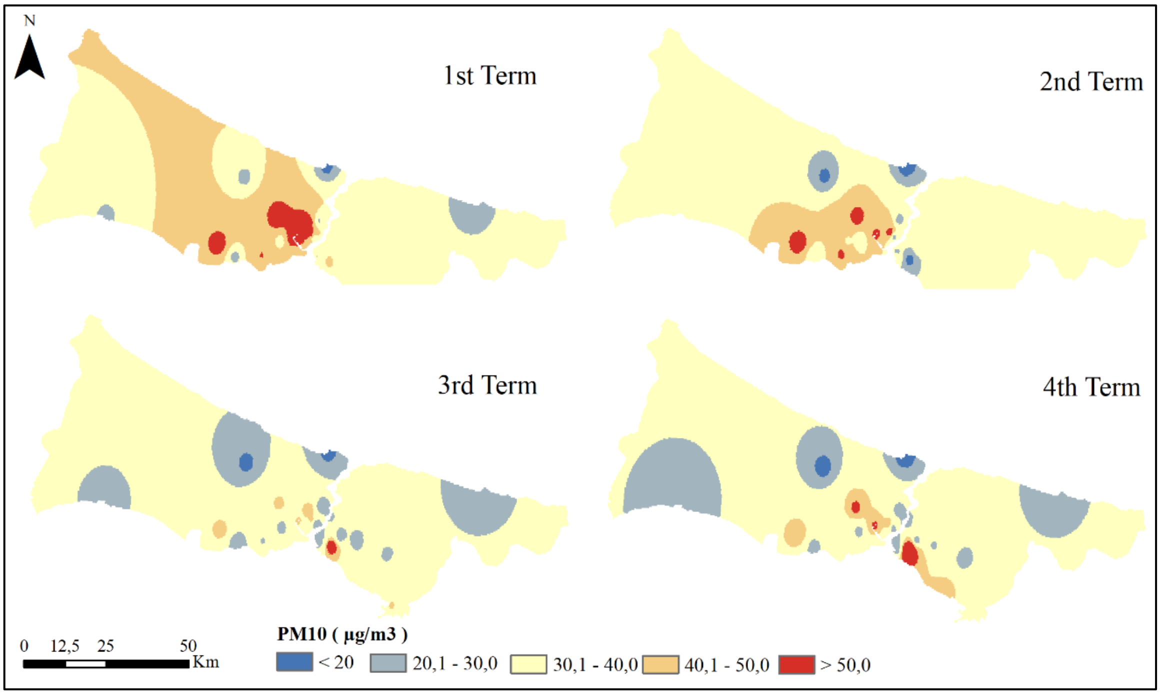

Figure 2 Daily average of PM_{10} distribution for four terms

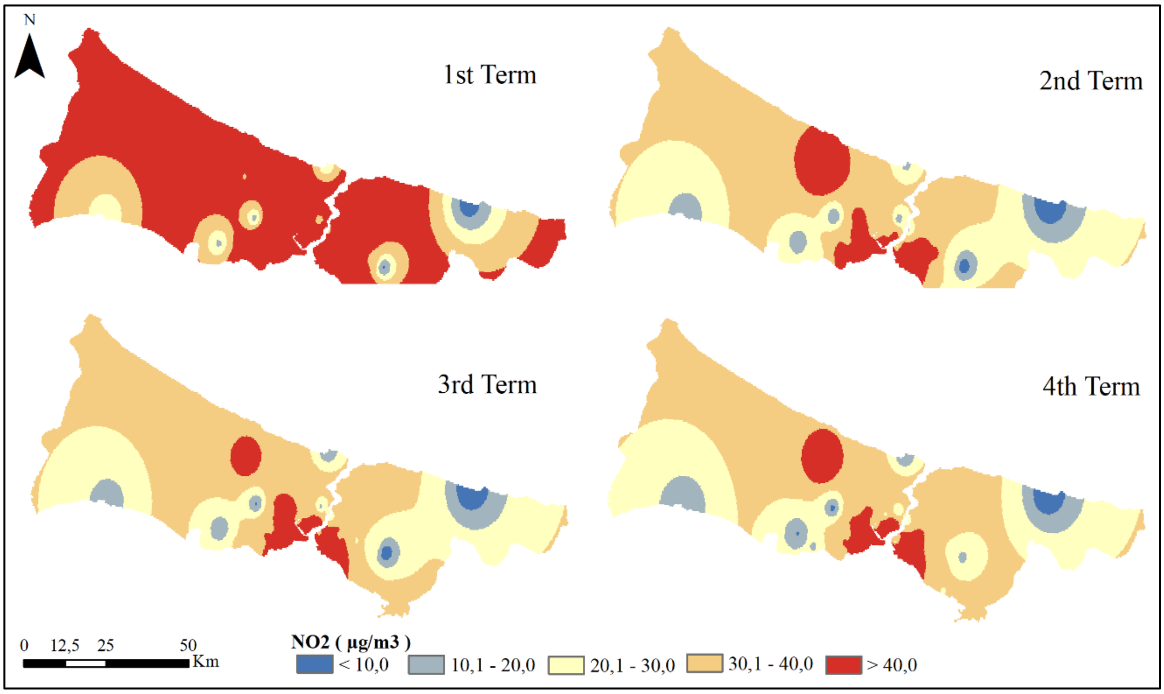

Figure 3 Daily average of NO_2 distribution for four terms

Conclusion

Air pollution caused by traffic and industrial applications is highly affected human life and the lockdown for the COVID-19 pandemic interrupted these types of activities for a while. This study presents the effects of the first wave lockdown on the air quality parameters (PM_{10} and NO_2) with the geospatial analysis for the selected periods. Obtained results clearly show that the air quality conditions got better in the lockdown based on the observed pollutants.

Keywords: *Air Quality, COVID-19, Lockdown, Istanbul*

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