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RESEARCH ARTICLE

Determining the environmental and atmospheric effects of coronavirus disease 2019 (COVID-19) quarantining by studying the total aerosol optical depth, black carbon, organic matter, and sulfate in Blida City of Algeria

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ABSTRACT

Background: To study, estimate and discuss the variations of the aerosol optical depth (AOD), black carbon, sulfate and organic matter, in the atmosphere in Blida City of Algeria, which was greatly affected by COVID-19 pandemic.

Methods: We analyzed the effects of changes in the total AOD, black carbon, sulfate, and organic matter in the atmosphere (λ = 550 nm) in the same period of 2019 and 2020, following the COVID-19 epidemic in Blida City, which was the most-affected city in Algeria.

Results: The quarantine that was enacted to limit the spread of COVID-19 resulted in side effects that were identifiable in the total AOD and in some of its atmospheric components. Comparing these variables in 2019 and 2020 (in the months during the quarantine) revealed that in April, the BCAOD values were much lower in 2020 than in 19.

Conclusion: Based on the effects of the emerging COVID-19, the research listed the changes received from the AOD, and is considered as a comparative study and represents a significant side effect of the quarantine that was mainly designed to limit COVID-19.

1. Introduction

This study focuses on the effects of quarantining on air pollution, to combat coronavirus disease 2019 (COVID-19), considering regional factors such as industry and location. A questionnaire study was also conducted across regions of the Mediterranean basin. Anthropogenic global warming is a global challenge that is harmful to the general public. Since the development of the wheel, agricultural and industrial technology has evolved to such an extent that it can be argued that humanity is addicted to this technology, which has both disadvantages and advantages. The excessive use of technology has resulted in many negative effects, of which pollution is a major example. Pollution has changed our natural systems, and makes a change in the life and the equilibrium of people’s lives. Environmental pollution goes against fundamental human rights, and should be viewed as a serious global challenge for future generations.

The study focused on the COVID-19 noted that previous studies conducted in Jeddah, considered air pollution to be a dangerous factor capable of increasing infections of the respiratory system, thus increasing the impact of infections on the human body. The authors of this study therefore investigated the relationship between ambient air pollutants and infections caused by COVID-19. A further study applied the societal multi-standard air quality model to the period from January 1 to February 12, 2020, to study the particular matter in the size of 2.5 micrometers (PM2.5) changes. The study’s authors discussed the importance of reducing emissions, the effects on the areas affected by the virus, and the impacts of the quarantine on all industrial regions. They concluded that the estimated case for reducing emissions (case 3) reduced PM2.5 concentrations by up to 20%. This study also revealed that the benefits of emission reductions were negatively affected by meteorology, even though the quarantines were not conducted to reduce air pollution. The COVID-19 progresses in Wuhan City of China has also been studied, more deaths related to pulmonary infections in the respiratory system were recorded, and this effect was enhanced by emissions from factories. The authors therefore suggested reducing the pollution rate by 30%, because pollution was considered to be a major factor for the observed increase in mortality. The COVID-19 outbreaks occurred in almost all countries across the world by now, and the infections have spread rapidly. Some researchers made studies to find the link between the spread and meteorology, and considered the latter to be a key factor due to its impact on infectious diseases, such as severe acute...
respiratory syndrome (SARS) and influenza. Correlations between the number of deaths caused by COVID-19 and the weather parameters from January 20 to February 29, 2020, in Wuhan City of China have also been studied. The authors used a generalized model to determine the effects of temperature and humidity on the number of daily deaths, and found that changes in temperature and humidity were important factors regarding the COVID-19 mortality rate. A research report on Lombardy and Emilia-Romagna, the two Italian regions that were severely affected by COVID-19, revealed that they were among the most contaminated areas in Europe. Researchers analyzed the expected link between pollution and the development of acute respiratory distress syndrome, which leads to death. A previously conducted report in September 2018 in Wadi Bani Azza, which is located in Blida City examined transit routes to the municipalities of Blida and Ouled Daïh, as well as Bani Murad, and revealed that pollution was so serious that it represented a threat to public health. In particular, it was discovered that pollution contributed to the spread of the cholera epidemic that appeared in the state and affected several neighboring states.

2. Materials and methods

2.1. Study area

Blida is a city in the north of Algeria, which is located at 36.47°N, 2.83°E. It is considered to be in one of the most humid regions in Algeria and experiences moderate temperatures. It lies near various plains, and multiple fruits and vegetables are grown there. The mean maximum temperatures for January, February, March, and April are 15°C, 16°C, 17°C and 20°C, respectively; the mean minimum temperatures are 9°C, 9°C, 11°C and 12°C, respectively.

2.2. Data collection

COVID-19 was first recorded in Algeria on February 25, 2020, following a positive result related to SARS conducted on an Italian citizen who was in Algeria. Following this, further cases of COVID-19 were recorded.

As of April 19, 2020, there were 2,629 confirmed cases of COVID-19 and 375 related deaths in Algeria. Global warming is a dangerous issue that is strongly linked with air pollution, which affects human respiratory systems and makes them more vulnerable to epidemics. The variable aerosol optical depth (AOD) is sensitive to multiple pollutants in the atmosphere, including black carbon, sulfur, and organic materials. It is therefore an appropriate variable to study the transmission of viruses owing to pollution. It considers a range of pollutants of different particle sizes, some of which may help to transmit viruses, such as the wind. Weather conditions are one of the most important factors regarding the transmission of pollution, which in turn can influence COVID-19 infections. Weather conditions affect the temperature and humidity of the air, and changes in temperature and humidity are important factors regarding the COVID-19 mortality rate. Contamination from pollutants can also accelerate the duration of the virus’s interaction with the human body, which can reduce immunity and make people more susceptible to hosting the virus. For this reason, this study investigated the linkage between the AOD and COVID-19 infection rates. Besides, this study contributed to the examination of the effect of quarantining on reducing the severity of air pollution, as quarantining reduced emissions from factories and the movement of cars, which contribute to sulfur dioxide and carbon dioxide emissions. Therefore, the total AOD and its components (black carbon, organic matter, and sulfate) were studied from January to April in 2019 and 2020; the latter period coincided with the most pronounced quarantining efforts to combat COVID-19. Sulfur and its compounds are important regarding air pollution, and many studies have examined the potential of recovering and reusing sulfur-containing pollutants. The removal of sulfur from fuel usually produces sulfur in the form of hydrogen sulfide. Sulfur dioxide resulting from the alloying of non-ferrous metals, or burning fuels, can be more economically recovered in the form of sulfuric acid. It can also be recovered as liquid sulfur dioxide, sulfur, or sulfur salts. For a long time in Blida City, sulfuric acid was made from gases in smelters close to the market.

2.2.1. Database details

The U.S. National Aeronautics and Space Administration (NASA) provide a petabyte worth of global earth science data collected from satellites. Some of those data can be used to analyze the climate, atmosphere, and types of pollutants present in atmospheric layers; NASA’s satellite data can thereby be used to monitor the environment and the earth. The program My NASA Data allows data analysis by researchers around the world. It is an online tool that allows researchers to easily locate areas that they wish to analyze and enables the examination of relevant scientific data, paired with coordinates.

2.2.2. What are the immediate health effects of the exposure to sulfur dioxide?

Sulfur dioxide inhalation irritates the nose, eyes, throat, and lungs, the main symptoms of which are a sore throat, runny nose, red eyes, and coughing. If inhaled at high concentrations, it causes pulmonary suffocation and breathing difficulties. Contact with sulfur dioxide in a vapor form causes irritation and burns. Besides, liquid sulfur dioxide can cause eye wounds and skin ulcers. People with asthma who are allergic to sulfur compounds may develop asthma attacks if they eat foods preserved with sulfur dioxide or other sulfur compounds.

Pollution from vehicles comprises a major component of exhaust emissions, in addition to non-exhaust emissions from road traffic and emissions from solid biomass combustion. For black carbon, however, local sources are equally or more important. It has been found that the majority of premature deaths result from domestic emissions.

Owing to these effects, sulfur and carbon are considered to be important pollutants for increasing and accelerating the spread of the COVID-19 epidemic in the human. Thus, the optical properties were studied to measure the atmospheric concentrations of these compounds.

3. Results and discussion

3.1. Ambient temperature

Fig. 1 shows the variations in the ambient temperature across the region of Blida City in 2019 and 2020 (from January 1 to March 31). The curve in Fig. 1 shows the number of COVID-19 cases on each day in Blida City; it was added because the temperature is an important factor for this part of the study.

The ever-increasing cases and the daily average levels of up to 120 cases could be related to the atmospheric temperature; temperature increased throughout the study period, as did the number of deaths.

3.2. Atmospheric pressure

Global warming is a sensitive element for this study, so the temperature trend is plotted alongside the atmospheric pressure trend in Fig. 2. Atmospheric pressure is a factor that is sensitive to temperature, and increases in air pressure can affect respiratory system diseases. These data can also help explain changes in the AOD. Fig. 2 shows the evolution of pressure from January 1 to March 31 for 2019 and 2020.

3.3. AOD of black carbon (BCAOD)

Fig. 3 shows a comparison of BCAOD as a function of the total AOD for all components. From January 1 to 31 of 2019, the total AOD values of the scattering concentrated in (250–1 250) × 10⁻⁴, varying from
20 × 10⁻⁴ to 75 × 10⁻⁴. The rest will be far apart from each other significantly from January 1 to 31, 2019. For the same time bucket of 2020, we can see that BCAOD is concentrated under 50 × 10⁻⁴ with a difference of 25 × 10⁻⁴ from BCAOD.

From February 1 to 28 of 2019, the total AOD values of the scattering approximately concentrated in (500–1 500) × 10⁻⁴, while whose BCAOD values sandwiched between 25 × 10⁻⁴ and 75 × 10⁻⁴.

There is a noticeably large-scale scattering of the BCAOD values on March 1 to 31 of 2020. Conversely, when it came to the same bucket of 2019, the BCAOD values becomes remarkably compact between 25 × 10⁻⁴ and 100 × 10⁻⁴ with total AOD values between 500 × 10⁻⁴ and 1 300 × 10⁻⁴.

From April 1 to 31 of 2019, BCAOD values increased with that of total AOD which varied from 1 500 × 10⁻⁴ to 3 000 × 10⁻⁴. Regarding the same period of 2020, the BCAOD values scattered in the remarkable form and the approximated in the interval line by 50 × 10⁻⁴ of BCAOD. Conclude that scattering of BCAOD with difference between 2019 and 2020 by 25 × 10⁻⁴.

3.4. AOD of sulfate (SUAOD)

The current global economic and industrial development depends on the proliferation of factories producing various goods, and on the expansion of transportation infrastructure and vehicles, regardless of associated negative environmental impacts. These processes generate gases that have led to increases in the concentrations of air pollutants and harmful gases in the atmosphere. This is directly reflected in human health, and in the heightened risks of various diseases. This section focuses on SUAOD (Fig. 4) by examining it as a function of the total AOD. Fig. 4 shows the variation of SUAOD values from 2019 and 2020. We can see that evolution of the SUAOD from January 1 to 31 of 2019 started up from 250 × 10⁻⁴ and the total AOD values scattered approximately between 250 × 10⁻⁴ and 1 250 × 10⁻⁴, with the variation of SUAOD values between 100 × 10⁻⁴ and 750 × 10⁻⁴. About the same period of 2020, the SUAOD values were confined between 100 × 10⁻⁴ and 450 × 10⁻⁴, which were lower than those values of 2019. It can be concluded that compared to 2020, the trend of increase was more obvious in 2019 (It is estimated that stringent quarantine practices took effect in April 2020 in Blida City).
Fig. 3. AOD of black carbon (BCAOD, $\lambda = 550$nm) from January 1 to April 30 for 2019 and 2020 in Blida City of Algeria
Fig. 4. AOD of sulfate (SUOD, $\lambda = 550$nm) from January 1 to April 30 for 2019 and 2020 in Blida City of Algeria
Fig. 5. AOD of organic matter (OMAOD, $\lambda = 550$nm) from January 1 to April 30 for 2019 and 2020 in Blida City of Algeria
3.5. AOD of organic matter (OMAOD)

Fig. 5 shows the variations in OMAOD as a function of the total AOD between 2019 and 2020. We noticed that the OMAOD values in 2019 gradually increased, on the contrary, while those dots of 2020 were more dispersive showing an increasing trend as well.

4. Conclusion

Inhaling low concentrations of sulfur dioxide can exacerbate chronic lung diseases such as asthma and emphysema. Some asthma patients develop pulmonary spasms as a result of inhaling sulfur dioxide or eating foods preserved with sulfates. Algeria is the most-affected country by COVID-19 of Africa as of April 6, 2020. 16 Therefore, this study examined how the development of COVID-19 related to several types of pollutants in the atmosphere, and made some observations about the symptoms and causes of the observed increases in COVID-19 cases and mortality ratios according to the epidemic region. In conclusion, this study analyzed the effects of changes in the total AOD, black carbon, sulfur, and organic matter in the atmosphere between 2019 and 2020, following the period of the COVID-19 epidemic in Blida City, which was the most affected city in Algeria. The quarantine that was enacted to limit the spread of COVID-19 resulted in side effects that were identifiable in the total AOD and in some of its atmospheric components. Comparing these variables in 2019 and 2020 (in the months during the quarantine) revealed that in April, the BCAOD values were much lower in 2020 than in 2019. This represents a significant side effect of the quarantine that was mainly designed to limit COVID-19.

CRediT author statement

Foued Chabane: Conceptualization, Writing—original draft, Writing—review & editing, Data curation, Formal analysis. Ali Arif: Conceptualization, Writing—original draft, Writing—review & editing, Data curation, Formal analysis.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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