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IMPACT OF COVID-19 ON AEROSOL OPTICAL DEPTH AND PARTICULATE MATTER OVER IRAQ

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Abstract

Aerosol Optical Depth (AOD) is a measure of aerosols that are small solid and liquid particles suspended in the atmosphere. Dust from wind, sea salts, volcanic ash, smoke from forest fires, and pollution from factories are all examples of aerosols. Depending on its size, type, and location, the aerosol can either cool or heat the surface. The high concentrations of droplets when inhaled lead to infection of the upper respiratory system, damage to people's health, and this is related to the spread of the Coronavirus. Optical depth data for aerosols AOD (496, 550, 675, 865, 1248) nm and Particulate matter (PM_1, PM_{10}. $PM_{2.5}$) of different concentrations were taken from the European Centre for Medium-Range Weather Forecasts (ECMWF) for 2019 and 2020. The impact of COVID-19 on human health was studied by changing of Aerosols index and Particulate matter, and the relationship between them by comparing 2019, and 2020, while the results concluded that aerosols are less valuable in 2020 compared to last year, and the reason is due to the low percentage of pollutants. Such as carbon monoxide and nitrogen oxide, which are considered dangerous pollutants and affect human health, and it was observed in this study that the northern regions are almost devoid of aerosols and particles, as they are present at low rates for the year 2020 compared to in 2019, the central and southern regions recorded the largest An increase in cases, due to the variation in the proportions of aerosols and particles that help the spread of the Coronavirus (COVID-19).

Keywords: Aerosol optical depth, Covid-19, Human health, Iraq, Particulate matter.

1. Introduction

Coronavirus in 2020 makes a great impact on human society in various sectors of life and has led to the closure of many companies and factories and social distancing, which reduced the movement of transport. As a result of all this, the number of pollutants that pollute the environment in general and air pollution, in particular, has decreased in many countries around the world that have implemented lockdown, social distancing, and curfew, a significant reduction in air pollutants such as air pollutants and Aerosol [1]. The term an aerosol refers to a mixture of gases and particles suspended in the atmosphere that are produced from different sources such as burning wood, fuel, dust, sea salts, and gas interactions with solar radiation and cause different effects on the climate [2, 3]. PM causes serious health problems for the human respiratory system due to its ability to carry viruses and their effect on the body's immunity [4]. Aerosol particles in the troposphere near the surface of the earth are in high concentrations because most of the aerosol particles are produced from sources close to the surface of the earth, and these particles can travel long distances, and rain can remove these particles from the atmosphere [5-7].

PM_{10} standard in the air according to EPA was (150 $\mu g/m^3$) in Iraq most monthly averages are higher than this value [8-10]. The health problems resulting from pollution with particles and aerosols are related to the period of exposure to these pollutants that cause an increase in the death rate as a result of respiratory diseases, as it is characterized by its ability to deposit inside the upper conductive airways in the lungs $PM_{2.5}$ have the ability to deposition in the lower part of the respiratory system, especially in the passages small antennae and pulmonary alveoli. As for particles smaller than $PM_{0.1}$, they can deposit in the upper and lower respiratory tract [11]. Many studies have been conducted to show the effect of the Coronavirus on air pollution and climate changes, such as Bashir et al. 2020, studied the statistical relationship to analyse the correlation between $PM_{2.5}$, PM_{10}, SO_2, NO_2, Pb, VOC, CO with Coronavirus and has found a strong relationship between $PM_{2.5}$ PM_{10} with Coronavirus, and also they found when the duration of exposure to these pollutants is shorter that make greater chance of overcoming the Coronavirus disease [12].

Zhu et al. [13] studied the relationship between air pollutants ($PM_{2.5}$, PM_{10}, SO_2, CO, NO_2, and O_3) and Coronavirus in 120 cities in China for the period from 23 January 2020 to 29 February 2020, where he found a significant statistical relationship between them and found that short-term exposure to high concentrations of pollutants such as $PM_{2.5}$, PM_{10} increases the risk of infection with a virus Corona. Fattorini et al. [14] studied the relationship between air pollutants ($PM_{2.5}$, PM_{10}, NO_2, O_3) in 71 provinces in Italy and found that chronic exposure to air pollution is strongly associated with cases of the spread of the Coronavirus and the high rate of infection with respiratory and cardiac effects. Bibek et al. [15] studied the relationship between air pollutants ($PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, O_3) and Covid-19, were used Spearman correlation and the Kandel test to clarify the link between them in 25 cities in India. It was found that PM_{10} and $PM_{2.5}$ particles have a strong relationship with the spread of Covid-19 and the increase in deaths. It was found that $PM_{2.5}$ is more effective than PM_{10}.

Andree [16] studied the relationship between exposure to particulate matter pollution in the air and infection with the Coronavirus in 355 municipalities in the Netherlands, and the results showed that air particles with a diameter of $PM_{2.5}$ are a very important indicator in the increase in the number of confirmed cases of Covid-19.

The current study aims to estimate the effects of aerosols on human health and the relationship with covid-19 cases number in different stations in Iraq.

2. Methodology

2.1. Data source and study stations

Data were taken from the European Centre for Medium-Range Weather Forecasts (ECMWF) [17], for mean total optical depth (AOD 496, 550, 675, 860, 1240) and Particulate matter, (PM 1, 10, 2.5) for 2019 and 2020 and twice. (00:00 AM - 12:00 PM). 00 m) over Iraq [5] and the central and southern regions of the country are characterized by high concentrations of the visual depth of aerosols, which are abundant in dust storms [18-20].

2.2. ArcGIS version 10.4.1

To find out how the Coronavirus spreads through aerosols and study the relationship between it and the optical depth of aerosols with different concentrations and molecular materials, and this requires studying spatial distributions by knowing the areas in which the spread of the Coronavirus (COVID-19) is frequent. Therefore, the total daily total of the optical depth of aerosols and particulate matter was taken at different concentrations for spatial analysis using geographic information systems (GIS) and the choice of the IDW method. As it started to draw analytical maps according to the geographical coordinates of all regions of Iraq [16].

3. Results and Discussion

3.1. The total daily mean of total AOD (496, 550, 675, 865, 1248) nm

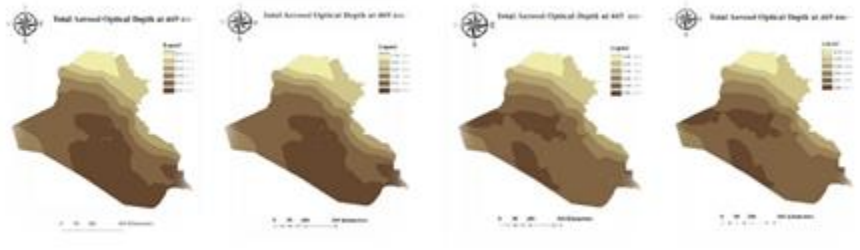
Figures 1 to 5 show the daily total optical depth of aerosols (496, 550, 675, 865, 1248) nm, and the results by analysing these concentrations for 2019 and 2020, The results showed a decrease in the northern regions of the country for all the optical depth concentrations of aerosols of all kinds, and this explains the small number of infections with the Coronavirus in these areas, as aerosols are a critical pathway for the transmission of Coronavirus COVID-19).

Coronavirus can live in the air for hours in fine particles, as most viruses are transmitted through aerosols while sneezing or coughing. For this reason, fewer infections were detected in Dohuk, Erbil, and Sulaymaniyah due to the lower concentrations of aerosols in these areas, but in the central and southern regions, we note that the number of infections is the largest in the cities of Baghdad, Najaf, and Basra. This indicates an increase in optical depth concentrations, as indicated by the spatial analysis.

On the other hand, when comparing aerosol concentrations with last year, we notice a significant decrease, and the reason for that is the decrease in the percentage of pollutants produced by factories and cars. To reduce the spread of the Coronavirus that causes respiratory syndrome in the Middle East, aerosol concentrations can be reduced by increasing ventilation, although recycling of the same air should be avoided unless the air is effectively filtered before reuse. When possible, open doors and windows to increase the flow of fresh air.

Respiratory infections can be transmitted through droplets of different sizes: when the droplet particles are >5-10 μm in diameter they are referred to as respiratory droplets, and when they are <5μm in diameter, they are referred to as droplet nuclei. According to current evidence, the COVID-19 virus is primarily

transmitted between people through respiratory droplets and contact routes. In an analysis of COVID-19 cases in Iraq, the airborne transmission was not reported, and was the *relationship* is positive between aerosols and the spread of Coronavirus.



(a) (b) (c) (d)

Fig. 1. The Daily mean of Total Aerosol Optical Depth over Iraq. (a) 469nm at the time 00:00 am for the year 2019, (b) 469nm at the time 12:00 pm for the year 2019, (c) 469nm at the time 00:00 am for the year 2020, (d) 469nm at the time 12:00 pm for the year 2020.

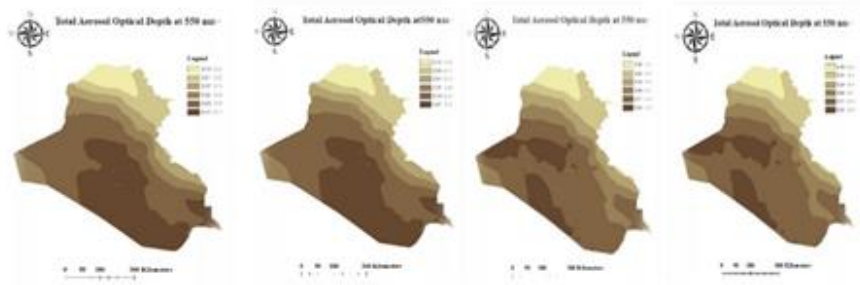


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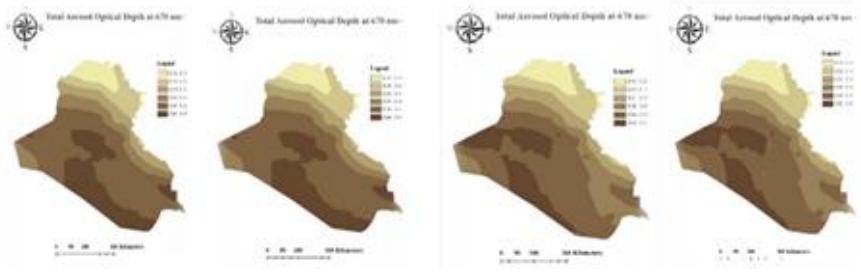
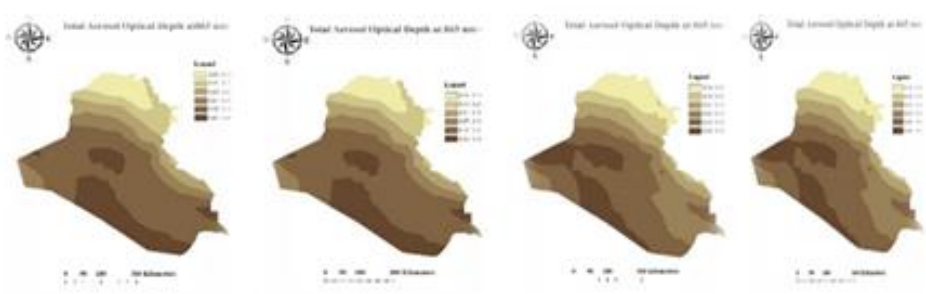
Fig. 2. The Daily mean of Total Aerosol Optical Depth over Iraq. (a) 550nm at the time 00:00 am for the year 2019, (b) 550nm at the time 12:00 pm for the year 2019, (c) 550nm at the time 00:00 am for the year 2020, (d) 550nm at the time 12:00 pm for the year 2020.



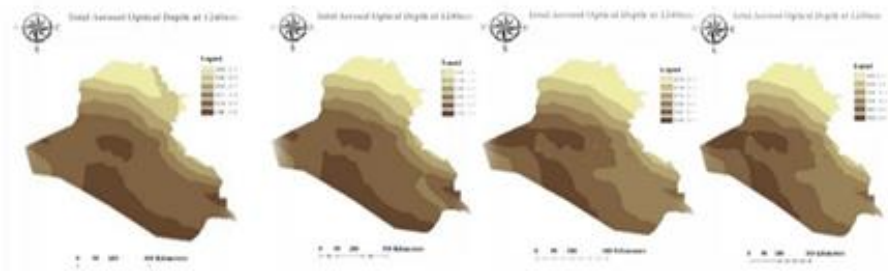
(a) (b) (c) (d)

Fig. 3. The Daily mean of Total Aerosol Optical Depth over Iraq. (a) 670nm at the time 00:00 am for the year 2019, (b) 670nm at the time 12:00 pm for the year 2019, (c) 670nm at the time 00:00 am for the year 2020, (d) 670nm at the time 12:00 pm for the year 2020.



(a) (b) (c) (d)

Fig. 4. The Daily mean of Total Aerosol Optical Depth over Iraq. (a) 865nm at the time 00:00 am for the year 2019, (b) 865nm at the time 12:00 pm for the year 2019, (c) 865nm at the time 00:00 am for the year 2020, (d) 865nm at the time 12:00 pm for the year 2020.



(a) (b) (c) (d)

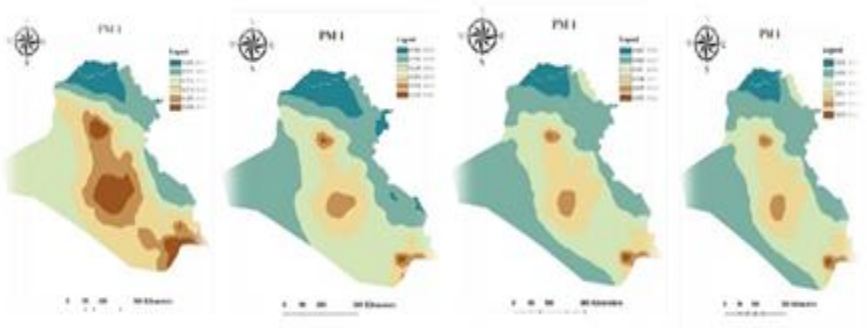
Fig. 5. The Daily mean of Total Aerosol Optical Depth over Iraq. (a) 1240nm at the time 00:00 am for the year 2019, (b) 1240nm at the time 12:00 pm for the year 2019, (c) 1240nm at the time 00:00 am for the year 2020, (d) 1240 nm at the time 12:00 pm for the year 2020.

3.2. The total daily mean of particulate matter (PM1, 10, 2.5)

Figures 6 to 8 show the daily particulate matter (PM1, 10, 2.5) and the results by analysing these concentrations for 2019 and 2020, the results showed a decrease in the concentration of particulate matter in the northern regions of the country. We notice that the droplets that are smaller than 5 microns remain suspended in the air for several hours because the effect of air clouds relative to gravity is large.

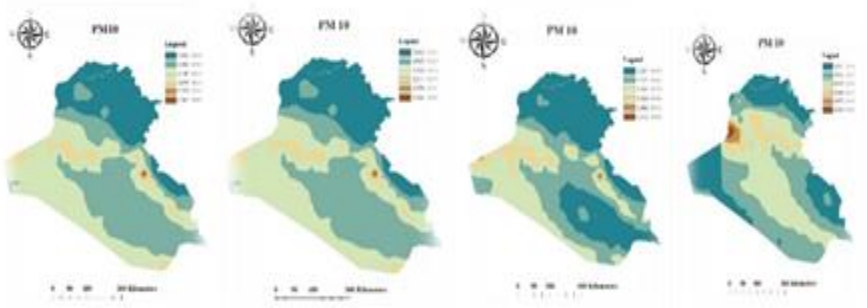
Also, the water content of virus-carrying droplets evaporates as they are carried through the air, which reduces their volume. Even if most of the liquid evaporates from droplets loaded with viruses, the droplet does not go away; it gets smaller, and the smaller the droplet, the longer it stays in the air. Because the drops are smaller in diameter and more effective in penetrating deep into the pulmonary system.

In the central and southern regions, particle concentrations were lower than they were in the past year. As for injuries, Baghdad is considered the most affected region of Iraq, due to a large number of housings, which makes the virus transmission faster through flying droplets while talking, sneezing, or coughing, and to reduce infection, it is necessary to stand at a distance of 6 feet from each other [21].



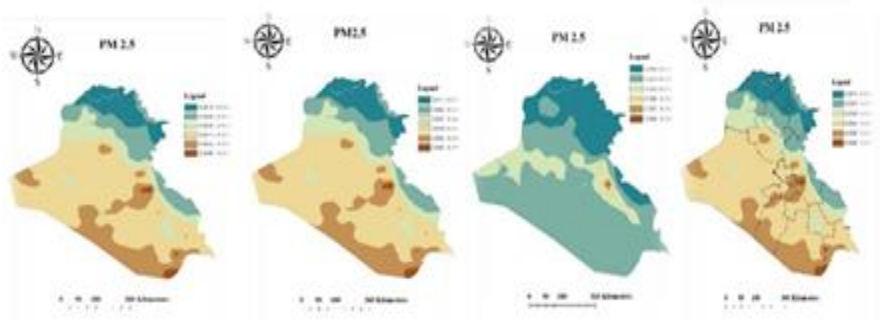
(a) (b) (c) (d)

Fig. 6. The Daily mean of Particulate Matter (PM_1) d < 10 um kg m^{-3}. (a) PM_1 at the time 00:00 am for the year 2019. (b) PM_1 at the time 12:00 pm for the year 2019, (c) PM_1 at the time 00:00 am for the year 2020, (d) PM_1 at the time 12:00 pm for the year 2020.



(a) (b) (c) (d)

Fig. 7. The Daily mean of Particulate Matter (PM_{10}) d < 10 um kg m^{-3}. (a) PM_{10} at the time 00:00 am for the year 2019, (b) PM_{10} at the time 12:00 pm for the year 2019, (c) PM_{10} at the time 00:00 am for the year 2020, (d) PM_{10} at the time 12:00 pm for the year 2020.



(a) (b) (c) (d)

Fig. 8. The Daily mean of Particulate Matter ($PM_{2.5}$) d < 10 um kg m^{-3}. (a) $PM_{2.5}$ at the time 00:00 am for the year 2019, (b) $PM_{2.5}$ at the time 12:00 pm for the year 2019, (c) $PM_{2.5}$ at the time 00:00 am for the year 2020, (d) $PM_{2.5}$ at the time 12:00 pm for the year 2020.

3.3. The highest prevalence rates of coronavirus

Figure 9 shows the highest spread of Coronavirus (Covid-19) was in the Baghdad station, where we note that the number of infections reached 3263, while the number of deaths reached 62 cases per day to recover. As for the cases of recovery, there were 5 cases, the least of which was the Anbar station, which recorded 20 cases per day, while the number of deaths reached one case per day, and these cases coincide with the climatic conditions in the region, as shown in Table 1.

Table 1. The highest prevalence rates of Coronavirus in Iraqi stations.

Stations	Injuries	Deaths	Healing
Mosul	50	2	14
Baghdad	3263	150	24760
Basra	774	57	633
Anbar	20	1	5

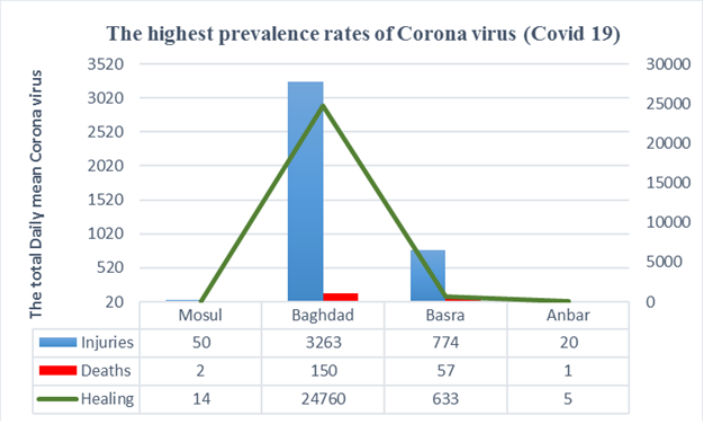


Fig. 9. The total Daily mean of Coronavirus in Iraqi stations.

4. Conclusions

This paper presents a new idea about studying the impact of COVID-19 on human health by changing the index of aerosols and particulate matter, and the relationship between them by comparing 2019 and 2020, and an extensive discussion of the results and presentation of the figures. We got the conclusions:

- The northern and western stations recorded the lowest rate of infection with the Coronavirus.
- A decrease in the optical depth and particle concentrations is due to a decrease in the percentage of air pollutants.
- The results showed that the Baghdad station was the highest in infection, due to the presence of a high.
- Percentage of the population, and thus the infection was more.
- The relationship is positive between aerosols and the spread of Coronavirus.

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