

Air pollution during the strategy of COVID-19 lockdown in Iraq

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Abstract— The COVID- 19 pandemic appeared at the end of 2019, and no vaccine was found against this disease until a year after this spreadation. The imposition of the lockdown was one of the most important strategies that governments applied to reduce COVID- 19 cases, which may have caused a change in air pollution when institutions and movements stopped. Therefore, the current study aimed to investigate air pollution in Iraq before, during, and after the strategy, inferring the concentration of sulfur dioxide (SO₂) in the atmosphere. The informed cases of COVID-19 in Iraq were gained from the World Health Organization (WHO), the times of the COVID-19 lockdown in Iraq were stated, and the SO₂ emissions level in Iraq was obtained from the National Aeronautics and Space Administration (NASA). The emissions of SO₂ were higher in the months of 2019 than its emission in the next year, when the pandemic lockdown applied and restriction of traffic movement occurred. The lockdown appears to be showing a clear improvement in air quality over Iraq.

Index Terms— COVID-19, epidemiological curve, Iraq, NASA, lockdown, pandemic, sulfur dioxide, WHO.

I. INTRODUCTION

Since December 2019, there has been an epidemic of pneumonia of known aetiology related to coronavirus SARS-CoV-2 that causes Coronavirus disease 2019 (COVID-19).^[1] At the beginning of this epidemic on December 22 2019, WHO stated COVID-19 as the Public Health Emergency of International Concern (P.H.E.I.C.), and then as a "pandemic public health menace" on March 11, 2020.^[3] due to spread across the world. Up to December 25 2020, the growing number of COVID-19 cases in the world has exceeded 75 million cases and 1.6 million deaths.^[4] The spread of COVID-19 is extremely threatening public health. During the year of the pandemic spread and in the absence of a vaccine, governments around the world have applied city lockdown and/or quarantine measures to reduce the transmission of COVID-19 and control it. Some governments implemented a partial lockdown, which included stops working in some institutions or reducing hours mixing valuable people. In contrast, the total lockdown included the cessation of all institutions and transportation, except for hospitals and ambulances. People depended on their shopping from the

stores in their areas of residence. This strategy in applying city lockdown has affected the global economic growth,^[5] mental health,^[6] and education process.^[7] Because of this restriction movement and transportation, the dropping in the economic growth rate to -3%^[8] has been found. Moreover, the university laboratory missed the opportunity to monitor the ecosystem. On the other hand, the city lockdown strategy has been found in adding environmental health benefits; this halt led to a reduction in air pollution, which comes from the emissions of vehicles. City lockdown reduced the traffic emission compounds.^[9] Iraq is a country in Western Asia, bordered by six countries: Iraq-Iran, Jordan, Kuwait, Saudi Arabia, Syria, and Turkey. Due to the Iraqi strategy in applying the city lockdown during the COVID-19 pandemic. Jebril^[9] investigated the NO₂ level obtained from the National Aeronautics and Space Administration (NASA) in the atmosphere in Iraq before and after the lockdown pandemic, and she found that the emissions of NO₂ were reduced after the lockdown. A study by Hashim et al.^[10] to investigate the concentration of traffic emission compounds in the air of Iraq during the COVID-19 lockdown, that obtained from an online stage (<https://air.plumelabs.com/en/>) observing and analysing the air quality ([World Air Map, 2020](#)), found that the decreasing in these concentrations. In this study, we aimed to study the air pollution during the impact of COVID-19 lockdown in Iraq, mainly investigating the SO₂ level in the air. SO₂ is an environmental indicator that causes air pollutants from the burning process, such as burning fossil fuels (from industries and vehicles) and natural sources (from volcanoes). The increase in SO₂ in the air can affect health (harm the human respiratory system) and environments (harm trees and plants). The objectives were included to give the background information of the COVID-19 situation in Iraq and the times of the lockdown in Iraq until December 20 2020; firstly, to investigate the changes in SO₂ level in the air in Iraq under the COVID-19 pandemic.

II. METHODOLOGY

A. DATA

Three sources of data were included in this study. Firstly, the background information on COVID-19 in Iraq, the dates of COVID-19 lockdown in Iraq, and the track of SO₂ in the atmosphere over Iraq covers the period before and after the lockdown.

B. ESTIMATION OF THE PANDEMIC IN IRAQ

The numbers of COVID-19 cases confirmed in Iraq were obtained from the dataset delivered by the WHO situation reports.^[11] The date of illness starts in Iraq was started from the situation report-36 of WHO, February 25, 2020, that has included the first cases of COVID-19.

C. DATES OF THE LOCKDOWN IN IRAQ

The dates of the lockdown in Iraq were obtained from Jebril^[12] and Hashim et al.^[10]

D. CHANGES IN SO₂ SCALES

NASA, Global Sulfur Dioxide Monitoring Home Page, 2020^[13] was used to track this concentration in Iraq. NASA used the S-5P/TROPOMI on the hurled atmosphere satellite to assemble the variations in Iraq's SO₂ releases before and during the pandemic.

III. RESULTS

A. EPIDEMIOLOGICAL CURVE OF THE PANDEMIC IN IRAQ

On February 25, 2020, there was the first case of pneumonia caused by SARS-CoV-2 in Najaf, Iraq. Subsequently, the cases were quickly spread to other parts of Iraq (WHO, situation report–36). According to the pandemic in Iraq in Figure 1, up to December 25 2020, the pandemic in Iraq decreases. From February 25, 2020, to March 25, 2020, the increase of confirmed cases per day was low. After that, the number of daily-confirmed cases gradually increased up to the end of the summer season. From the autumn season up to December 25 2020, there is a decline in cases.



Fig. 1. The pandemic in Iraq.

B. DATES OF THE COVID-19 LOCKDOWN IN IRAQ

The most powerful strategy in controlling the pandemic is to prevent and reduce the infection of vulnerable populations. Two days after the first COVID-19 case in Iraq, the government was applied the partial COVID-19 lockdown on February 28, 2020, when it had 7 cases. Table 1 summarises the start date of the partial/total lockdown and the number of COVID-19 cases when the government responded.

C. CHANGES IN SO₂ SCALES

Governments applied partial/total lockdown to avoid and governor the spread of the pandemic. Figures 2 and 3 show the tropospheric screen on the S-5P/TROPOMI of NASA's Aura satellite collected information on the SO₂ in the air through Iraq from January 02, 2020, to December 20, 2020. Figure 2 shows the impact of total lockdown in Iraq on April 02, 2020, the detection and recording of SO₂ emission before lockdown (months January and February), and during the starting dates

of lockdown (Month March) were higher in comparison to month April. On the other hand, Figure 3 shows the partial COVID-19 lockdown from April 30, 2020, to July 24, 2020,

Table 1. Dates of the lockdown and the number of confirmed COVID-19 cases in Iraq.

Start date	Reference	COVID-19 cases	Reference
January 02, 2020, before COVID-19 pandemic	Hashim <i>et al.</i> ^[10]	0.00	No WHO reported
February 04, 2020, before COVID-19 pandemic	Hashim <i>et al.</i> ^[10]	0.00	No WHO reported
February 28, 2020, during partial COVID-19 lockdown	Jebri ^[12]	7.00	^[14]
March 16, 2020, during partial COVID-19 lockdown	Hashim <i>et al.</i> ^[10]	124	^[15]
March 25, 2020, during total COVID-19 lockdown	Jebri ^[12]	316	^[16]
April 02, 2020, during total COVID-19 lockdown	Hashim <i>et al.</i> ^[10]	728	^[17]
April 30, 2020, during partial COVID-19 lockdown	Hashim <i>et al.</i> ^[10]	2003	^[18]
May 19, 2020, during partial COVID-19 lockdown	Hashim <i>et al.</i> ^[10]	3554	^[19]
June 05, 2020, during partial COVID-19 lockdown	Hashim <i>et al.</i> ^[10]	8840	^[20]
July 24, 2020, during partial COVID-19 lockdown	Hashim <i>et al.</i> ^[10]	34 502	^[21]
December 22, 2020, after COVID-19 lockdown	Current study	590000	^[22]

and up to the after COVID-19 lockdown (December 22, 2020), the observation and detection of SO₂ in the troposphere across Iraq were increased.

It was necessary to investigate SO₂ releases in Iraq before the year pandemic appeared. The difference in SO₂ emissions occurred in 2019 before the pandemic, as shown in Figures 4 and 5. Months January 02, February 04 and March 16, and July 24, 2019, showed similar SO₂ emissions to these months in the year 2020. While months February 28, March 25, and May 19 2019, showed fewer emissions than 2020. However, in the months April 02, April 30, June 05, July 24, and December 20, 2019, that the months had total lockdown in 2020 showed higher emissions of SO₂ compared to its emission in the next year, where the pandemic lockdown applied and restriction of traffic movement occurred.

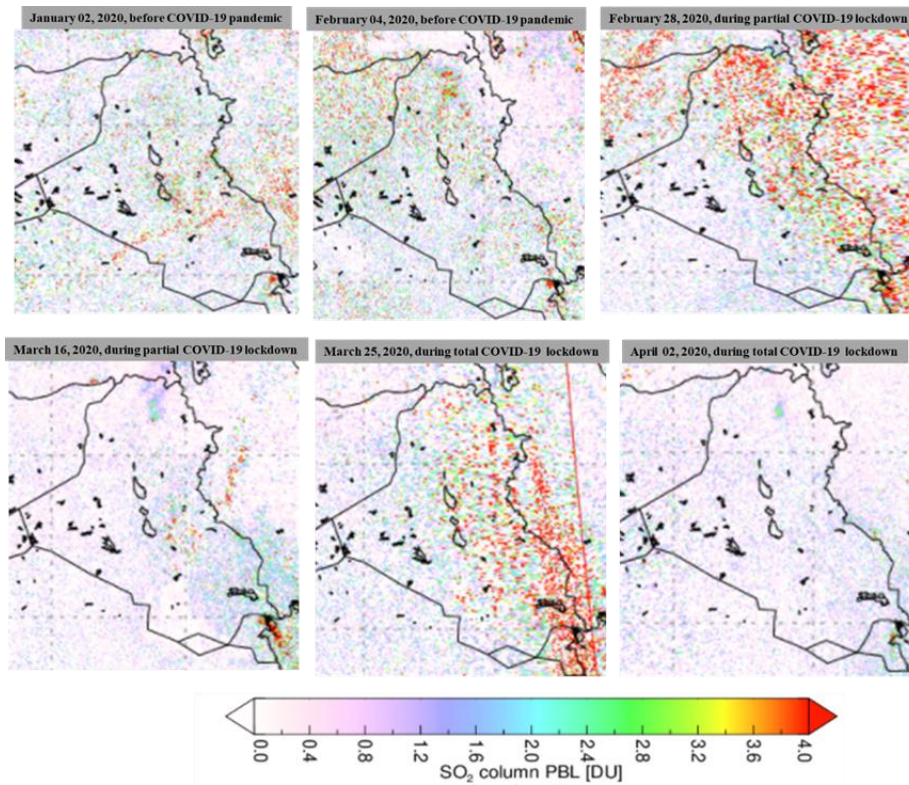


Fig. 2. SO₂ scales in the air of Iraq before and during the lockdown, up to April 02, 2020.

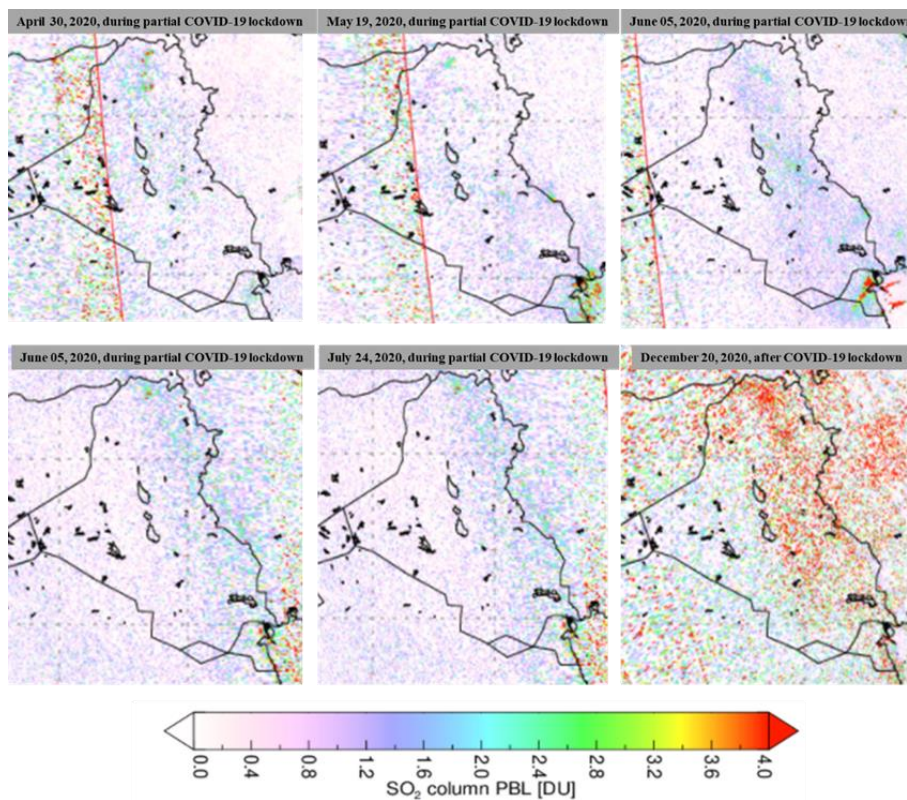


Fig. 3. SO₂ scales in the air of Iraq during and after the lockdown.

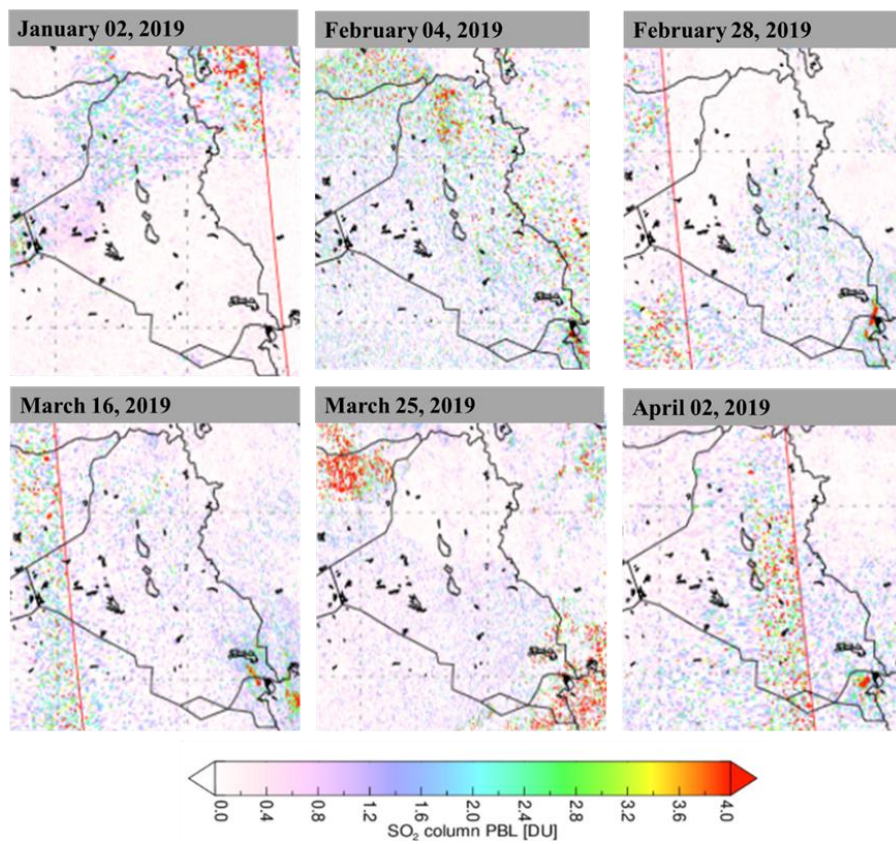


Fig. 4. SO₂ emissions in Iraq in the year 2019, before the pandemic.

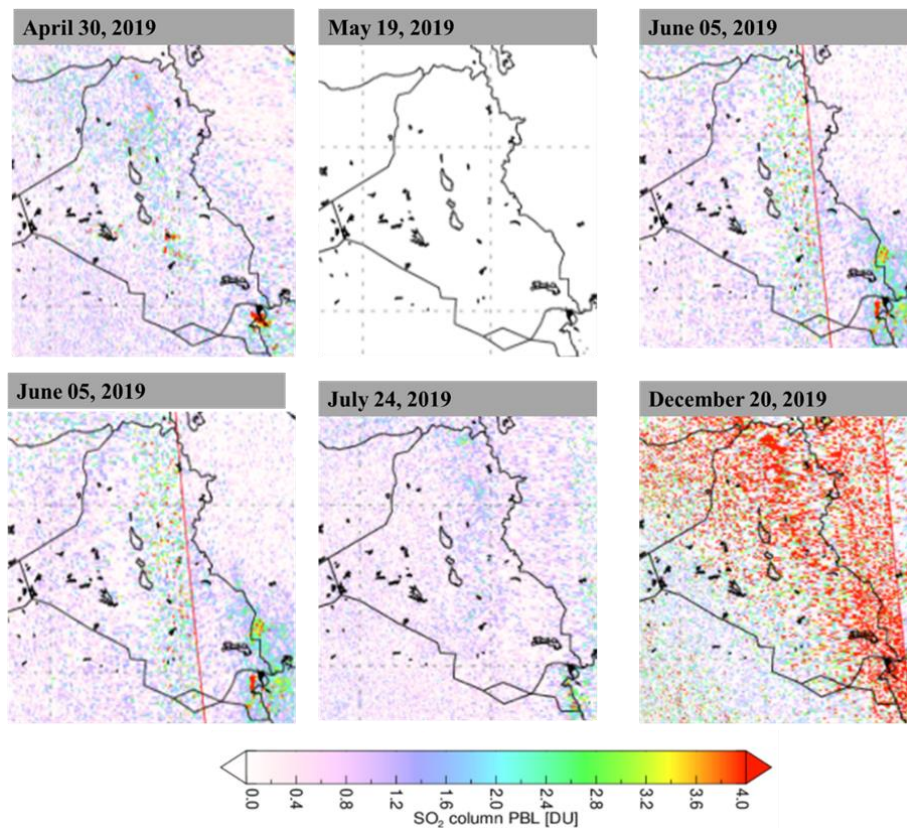


Fig. 5. SO₂ scales in Iraq in the year 2019, before the pandemic.

IV. DISCUSSION

The current investigation of air pollution in this study was carried out using the data from S-5P/TROPOMI of NASA, which differs from other studies that included the impact of lockdown on air pollution in Iraq.^[9, 10] Iraq had already brought the epidemic under control through a strict isolation strategy in the early stage (between 25, 2020 to March 25, 2020).^[23] In June, due to partial COVID-19 lockdown and freeing up imported cases, the epidemic rebounded again, and it is starting to get a little out of control. However, with the beginning of the summer season (22 June), the number of daily-confirmed cases gradually increased as we predict this increase with the summer season.^[24] In addition, this shows how the cases decreased from the autumn season up to 25 December 2020. On the other hand, the herd immunity against COVID-19 in Iraq occurred, which led to the declination in the cases.^[12] Regarding the results of SO₂ scales in Iraq before, during, and after the lockdown, the changes in the emissions were reasonably simple, meaning that the reduction in the emission for all cities in Iraq during the COVID-19 lockdown. These results were dissimilar to the study of Kumari and Toshniwal^[23], where the emission remained unchanged for some cities. This dissimilation is due to the major emission sources of SO₂ in Iraq being from the vehicle that has been stoppable during the lockdown. Secondly, the stable weather through the seasons in Iraq did not affect SO₂ emissions. Thirdly, the little variance in the local meteorological conditions in Iraq, such as temperature, humidity, rainfall, wind speed, solar radiation, etc., could little affect the SO₂ emissions. Due to these above reasons, the SO₂ emissions changed or decreased for all cities in Iraq during the lockdown. Moreover, the evident reduction in SO₂ emissions in the year pandemic was compared to before the pandemic (2019) in Iraq. The SO₂ emissions in 2019 have shown a similar scenario to that shown in 2020. Emissions increased in some months compared to the year 2020 when the pandemic lockdown applied, while remained unchanged for some months, similar to the month in 2020 when the pandemic lockdown unapplied.

CONCLUSION

In this study, SO₂ emission reduction impacts are due to reduced human activities, particularly on transport during the COVID-19 lockdown in Iraq has been investigated. The lockdown appears to be showing a clear improvement in air quality over Iraq.

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