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Air quality status during 2020 Malaysia Movement Control Order (MCO) due to 2019 novel coronavirus (2019-nCoV) pandemic

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HIGHLIGHTS

• The PM2.5 concentrations dominated the Air Pollutant Index (API) in Malaysia.
• There were several reductions on PM2.5 concentrations during Malaysia Movement Control Order (MCO).
• Several red zone areas showed approximately 28.3% reduction of PM2.5 concentrations.
• The Northern Region of Peninsular Malaysia showed the highest average reduction of PM2.5 concentrations, with 23.7%.

GRAPHICAL ABSTRACT

ABSTRACT

An outbreak of respiratory illness which is proven to be infected by a 2019 novel coronavirus (2019-nCoV) officially named as Coronavirus Disease 2019 (COVID-19) was first detected in Wuhan, China and has spread rapidly in other parts of China as well as other countries around the world, including Malaysia. The first case in Malaysia was identified on 25 January 2020 and the number of cases continue to rise since March 2020. Therefore, 2020 Malaysia Movement Control Order (MCO) was implemented with the aim to isolate the source of the COVID-19 outbreak. As a result, there were fewer number of motor vehicles on the road and the operation of industries was suspended, ergo reducing emissions of hazardous air pollutants in the atmosphere. We had acquired the Air Pollutant Index (API) data from the Department of Environment Malaysia on hourly basis before and during the MCO with the aim to track the changes of fine particulate matter (PM2.5) at 68 air quality monitoring stations. It was found that the PM2.5 concentrations showed a high reduction of up to 58.4% during the MCO. Several red zone areas (~41 confirmed COVID-19 cases) had also reduced of up to 28.3% in the PM2.5 concentrations variation. The reduction did not solely depend on MCO, thus the researchers suggest a further study considering the influencing factors that need to be adhered to in the future.

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https://doi.org/10.1016/j.scitotenv.2020.139022
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1. Introduction

Coronavirus is one of the significant pathogens that affects human respiratory system. Coronavirus Disease 2019 (COVID-19) is caused by a novel CoV, namely severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which is formerly known as 2019 novel coronavirus (2019-nCoV) (H. Li et al., 2020). The outbreak of SARS-CoV-2 began at Wuhan, Hubei Province, People’s Republic of China in late December 2019 (Q. Li et al., 2020). Considering the global threat, the World Health Organization (WHO) has declared COVID-19 as a Public Health Emergency of International Concern (PHEIC) (Sohrabi et al., 2020). It is a pandemic that is spreading in other parts of Asia, such as Japan, Thailand, Singapore, Malaysia, and Australia as well as Europe and North America (Rothan and Byrareddy, 2020). Older people with the age of >80 years old has a high mortality susceptibility, with the case-fatality rate of 21.9% once infected with COVID-19 (Koh and Hoeing, 2020). In Malaysia, the earliest COVID-19 cases were detected on 25 January 2020 (Ministry of Health Malaysia, 2020). The number of cases have since then kept on increasing, especially in March 2020. This escalating COVID-19 outbreak in Malaysia has urged several measures to be taken, including putting surveillance system in place to detect cases immediately; carrying out rapid diagnosis; performing immediate case isolation and rigorous tracking; and quarantining close contacts of those who have been tested positive in COVID-19. Malaysian government has announced the implementation of Movement Control Order (MCO) with the aim to isolate the source of the COVID-19 outbreak. Statistically, the number of confirmed COVID-19 cases at the end of Phase I MCO is 2766 cases (31 March 2020) and for Phase II is 4987 cases (14 April 2020) (Ministry of Health Malaysia, 2020). During MCO, several activities, including operating business is not allowed, except for essential services (Malaysian National Security Council (NSC), 2020). Since people are working from home and several industries are suspended, the traffic density and industrial emissions have reduced. In Malaysia, the sources of air pollution are derived from motor vehicles, industrial emissions, and open burning (Latif et al., 2014; Abdullah et al., 2019). The air quality status is defined based on the Air Pollutant Index (API) of 6 criteria pollutants whereby the dominant pollutant in Malaysia is fine particulate matter (PM$_{2.5}$). Therefore, in this study, the researchers will evaluate the variation of PM$_{2.5}$ changes during and before MCO in Malaysia.

2. Methods

In Malaysia, the air quality is managed by the Department of Environment under the Ministry of Environment and Water. The researchers acquired the Air Pollutant Index (API) data from the website of Air Pollutant Index of Malaysia (available at http://apims.doe.gov.my/public_v2/home.html) on hourly basis from 14 March 2020 to 14 April 2020 to determine the relative changes (%) of air quality. These data covered the air quality status before MCO (14–17 March 2020) ($n=6445$), during Phase I MCO (18–31 March 2020) ($n=22,848$) and Phase II MCO (1–14 April 2020) ($n=22,835$). Overall, there are 0.19% of missing data and the total data used in this study is 55,128. The missing data were omitted in this study. The API for each hour was then converted to PM$_{2.5}$ concentrations ($\mu$g/m$^3$) (available at http://apims.doe.gov.my/public_v2/aboutapi.html). The computation of API and PM$_{2.5}$ concentrations is shown in Table 1.

All 68 air quality monitoring stations in Malaysia were selected in this study, as shown in Table 2. The stations are responsible of monitoring the air quality status in Malaysia comprehensively (available at http://apims.doe.gov.my/public_v2/aboutapi.html) to detect any significant changes in the environment quality that may be harmful to human health and the environment (Department of Environment Malaysia, 2020).

### Table 1

| API       | Breakpoint of concentration | Equation for API |
|-----------|-----------------------------|------------------|
| X = PM$_{2.5}$ (24 h average, unit: $\mu$g/m$^3$) |                          |                  |
| 0–50      | 0 ≤ X ≤ 12.0                | API = 4.1667 + X  |
| 51–100    | 12.1 ≤ X ≤ 75.5             | API = 0.7741 + (X−12.1) + 51  |
| 101–200   | 75.6 ≤ X ≤ 150.4            | API = 1.3218 + (X−75.5) + 101  |
| 201–300   | 150.5 ≤ X ≤ 250.4           | API = 0.9909 + (X−150.5) + 201  |
| 301–400   | 250.4 ≤ X ≤ 350.4           | API = 0.9909 + (X−250.5) + 301  |
| 401–500   | 350.5 ≤ X ≤ 500.0           | API = 0.6604 + (X−350.5) + 401  |

$*$ is multiply.

3. Results and discussion

The MCO has been found to reduce PM$_{2.5}$ Concentrations. Before the implementation of MCO and during the MCO (18 March–14 April 2020), the daily PM$_{2.5}$ concentrations were in the range of 5.3–425.9$\mu$g/m$^3$ and 3.9–692.5$\mu$g/m$^3$, respectively. The New Malaysia Ambient Air Quality Standard (NMAAQS) has set the standard limit of PM$_{2.5}$ to 35$\mu$g/m$^3$ for a 24-hour average (Department of Environment Malaysia, 2020) and the World Health Organization (WHO) (2017) has set a more stringent limit of PM$_{2.5}$ to 25$\mu$g/m$^3$. Before MCO, one of the air quality monitoring stations that exceeded the limit was Politeknik Kota Kinabalu (555) (42.5$\mu$g/m$^3$), while during MCO, the PM$_{2.5}$ concentrations at Rompin (S38) exceeded the limit of NMAAQS with 69.2$\mu$g/m$^3$. Table 3 shows the variation of daily PM$_{2.5}$ concentrations before and during MCO. The reduction of PM$_{2.5}$ concentrations occurred at 34 stations, which attributed for 50% of overall stations. The highest reduction was at Politeknik Kota Kinabalu (555), with 58.5% (Before = 41.2$\mu$g/m$^3$; During MOC = 17.1$\mu$g/m$^3$), while the lowest reduction was at Miri (558), with 0.6% (reduce at 0.1$\mu$g/m$^3$). Table 4 shows the variation of daily PM$_{2.5}$ concentrations before and during MCO I. The reduction of PM$_{2.5}$ concentrations occurred at 29 stations, which attributed for 42.6% of overall stations. The highest reduction was at Politeknik Kota Kinabalu (555), with 53.6% (Before = 41.2$\mu$g/m$^3$; MCO I = 19.1$\mu$g/m$^3$), while the lowest reduction was at Mindin (S8), with 0.8% (Before = 19.6$\mu$g/m$^3$; During MCO I = 19.7$\mu$g/m$^3$). Table 5 shows the variation of daily PM$_{2.5}$ concentrations during MCO I and MCO II. Interestingly, the reduction of PM$_{2.5}$ concentrations occurred at 52 stations, which attributed for 76.5% of overall stations. The highest reduction was at Seberang Perai (S7), with 35.1% (MCO I = 21.1$\mu$g/m$^3$; MCO II = 13.7$\mu$g/m$^3$), while the lowest reduction was at Mindin (S8), with 0.3% (reduce at 0.1$\mu$g/m$^3$). Fig. 1 shows the reduction average of PM$_{2.5}$ based on different regions in Peninsular Malaysia (North, Central, South, East) and the East Malaysia of Sabah and Sarawak. High reductions were found in Peninsular Malaysia at the North (23.7%), Central (16.2%), South (15%), and East (11.3%) regions as well as the East Asia of Sabah (23.1%) and Sarawak (13.6%) at a different timeline before MCO, during MCO I and MCO II. The ranges of reduction were 6.5–23.7%, 8.8–16.2%, 11.0–13.3%, 7.7–11.3%, 15.8–23.1%, 9.5–13.6% for North, Central, South, and East of Peninsular Malaysia, followed by the East Malaysia of Sabah and Sarawak, respectively.

The MCO in Malaysia included several prohibitions of mass movement and gathering; Malaysians travelling abroad; tourists and visitors’ entry; and educational institutions, government and private agencies (except for essential services) closure (Malaysian National Security Council (NSC), 2020). These restrictions indirectly reduce the air pollution in Malaysia, although a detailed study needs to be conducted by considering other influencing factors, including local meteorology and anthropogenic emissions. Based on the results, the MCO had successfully reduced pollutants emission, particularly PM$_{2.5}$ concentrations, as there were less motor vehicles and industry activities during the MCO. There were several red zone areas with >41 cases of confirmed COVID-19 (Crisis Preparedness and Response Centre, 2020). Some red zone areas were then enforced under the Enhanced Movement Control
**Table 2**

Air quality monitoring stations in Malaysia.

| Station | Region | State | Location |
|---------|--------|-------|----------|
| S1      | North  | Perlis| Kangar   |
| S2      | North  | Kedah| Langkawi |
| S3      | North  | Kedah| Alor Setar |
| S4      | North  | Kedah| Sungai Petani |
| S5      | North  | Kedah| Kulim Hi-Tech |
| S6      | Pulau Pinang | Seberang Jaya |
| S7      | Pulau Pinang | Seberang Perai |
| S8      | Pulau Pinang | Minden |
| S9      | Pulau Pinang | Balik Pulau |
| S10     | Perak   |      | Taiping |
| S11     | Perak   |      | Tasek Ipoh |
| S12     | Perak   |      | Pegoh Ipoh |
| S13     | Perak   |      | Seri Manjung |
| S14     | Perak   |      | Tanjung Malim |
| S15     | Central| Kuala Lumpur | Batu Muda |
| S16     | Kuala Lumpur | Cheras |
| S17     | Kuala Lumpur | Putrajaya |
| S18     | Selangor|      | Kuala Selangor |
| S19     | Selangor|      | Petaling Jaya |
| S20     | Selangor|      | Shah Alam |
| S21     | Selangor|      | Klang |
| S22     | Selangor|      | Bangi |
| S23     | Selangor|      | Sungai Petani |
| S24     | Selangor|      | Tawau |
| S25     | Selangor|      | Kota Bharu |
| S26     | Selangor|      | Sandakan |
| S27     | Sabah   |      | Kota Kinabalu |
| S28     | Sabah   |      | Tawau |
| S29     | Sabah   |      | Kota Kinabalu |
| S30     | Sarawak|      | Keningau |
| S31     | Sarawak|      | Kuching |
| S32     | Sarawak|      | ILP Serian |

**Table 3**

Variation of daily PM$_{2.5}$ concentrations before MCO and during MCO.

| Location | Before MCO | During MCO | Variation |
|----------|------------|------------|-----------|
|          | µg/m$^3$  | µg/m$^3$  | %         |
| Karnag   | 11.3       | 12.6       | +11.8     |
| Langkawi | 11.7       | 12.4       | +6.7      |
| Alor Setar| 15.4     | 16.8       | +8.7      |
| Sungai Petani | 20.8 | 18.2       | −12.5     |
| Kulim Hi-Tech | 20.0   | 15.7       | −21.5     |
| Seberang Jaya | 21.6   | 21.0       | −2.9      |
| Seberang Perai | 19.2     | 17.4       | −9.4      |
| Minden   | 19.7       | 16.2       | −17.7     |
| Balik Pulau | 19.3     | 20.3       | +5.2      |
| Taiping  | 20.3       | 16.4       | −39.2     |
| Tasek Ipoh | 20.9     | 17.7       | −15.2     |
| Pegoh Ipoh | 18.3     | 18.7       | +2.5      |
| Seri Manjung | 21.2     | 17.7       | −16.3     |
| Tanjung Malim | 11.5     | 9.3        | −23.1     |
| Batu Muda| 16.9       | 18.8       | +11.4     |
| Cheras   | 14.4       | 15.7       | +9.4      |
| Putrajaya| 15.0       | 17.6       | +26.9     |
| Kuala Selangor | 18.8   | 15.5       | −17.5     |
| Petaling Jaya | 22.1     | 16.7       | −24.3     |
| Shah Alam | 18.5       | 17.3       | −6.8      |
| Klang    | 19.5       | 22.0       | +13.0     |
| Bangi    | 12.6       | 15.0       | +24.7     |
| Nilai    | 14.1       | 15.8       | +11.8     |
| Seremban | 10.1       | 12.0       | +18.9     |
| Port Dickson | 11.2    | 13.8       | +23.0     |
| Alor Gajah| 8.9        | 10.9       | +22.8     |
| Bukit Rambai| 12.4       | 13.0       | +5.6      |
| Bandaraya Melaka | 11.0     | 13.0       | +20.6     |
| Semagat  | 14.0       | 18.9       | +34.8     |
| Batu Pahat| 9.4        | 11.7       | +23.9     |
| Kluang   | 9.1        | 9.6        | +5.0      |
| Larkin   | 13.6       | 13.9       | +2.3      |
| Pasir Gudang| 9.3       | 10.9       | +17.1     |
| Pengerang| 8.0        | 14.5       | +82.1     |
| Kota Tinggi| 8.1       | 7.2        | −9.0      |
| Tangkak  | 12.6       | 13.7       | +1.1      |
| Rompin   | 8.6        | 10.2       | +23.4     |
| Tenerloh | 12.4       | 14.1       | +13.6     |
| Jerantut | 12.5       | 12.9       | +2.7      |
| Indra Mahkota Kuantan | 8.5  | 8.8        | +2.9      |
| Balok Baru Kuantan | 10.3  | 9.6        | −7.0      |
| Keningau | 12.5       | 11.9       | −4.7      |
| Paka     | 8.7        | 9.2        | +5.8      |
| Kuala Terengganu | 13.3 | 17.0       | +32.8     |
| Besut         | 11.0       | 13.3       | +21.0     |
| Tanah Merah| 23.8       | 22.9       | −4.3      |
| Kota Bharu | 12.0       | 18.8       | +57.0     |
| Tawau    | 8.7        | 7.2        | +16.7     |
| Sandakan | 12.2       | 10.0       | −22.3     |
| Kota Kinabalu | 13.7      | 11.7       | −14.3     |
| Kimanis  | 22.5       | 13.7       | −39.0     |
| Keningau | 12.5       | 11.9       | −4.7      |
| Labuan   | 14.9       | 14.8       | −0.8      |
| Politeknik Kota Kinabalu | 11.3 | 9.4        | −16.6     |
| Limbang  | 20.5       | 18.5       | −9.9      |
| ILP Miri | 12.0       | 12.0       | −0.6      |
| Samalaju | 13.0       | 12.0       | −0.1      |
| Bintulu  | 13.9       | 13.5       | −3.0      |
| Mukah   | 7.7        | 7.3        | −4.2      |
| Kapit    | 7.4        | 6.8        | −16.4     |
| Sibu     | 11.3       | 9.5        | −18.5     |
| Sarikie  | 9.0        | 7.1        | −21.3     |
| Sari Aman| 8.1        | 7.8        | −13.8     |
| Samarahan| 8.1        | 8.6        | −6.5      |
| Kuching  | 8.9        | 9.8        | +10.4     |
| Johor Setia Klang | 41.9  | 29.1      | −30.6     |
| IPD Serian | 15.5     | 17.0       | +15.5     |

Order (EMCO). The red zone areas included Kluang (S32) (28.3% reduction of PM$_{2.5}$ concentrations, MCO I and MCO II), Jerantut (S40) (14.5%, MCO I and MCO II), Kota Bharu (S48) (0.3%, MCO I and MCO II), Petaling Jaya (S19) (24.3%, before and during MCO), Klang (S21) (11.5%, MCO I and MCO II), Cheras (S16) (4.9%, MCO I and MCO II), Seremban (S25) (11.6%, MCO I and MCO II), Bandaraya Melaka (S29) (9.6%, MCO I and MCO II), Tawau (S49) (25.1%, before and during MCO), Kuching (S67) (0.3%, before and during MCO), and Samarahan (S66) (11.2%, before and during MCO). The researchers observed that the decreasing of
| Location | Before MCO | MCO I | Variation |
|----------|------------|-------|-----------|
|           | µg/m³ | %     |           |
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| Table 4  | Variation of daily PM<sub>2.5</sub> concentrations during MCO I and MCO II. |
| Location | Before MCO | MCO I | Variation |
|----------|------------|-------|-----------|
|           | µg/m³ | %     |           |
| Kangar   | 11.3    | 13.2  | 1.9      | +17.2 |
| Langkawi | 11.7    | 12.9  | 1.2      | +10.7 |
| Alor Setar| 15.4    | 20.2  | 4.7      | +30.7 |
| Sungai Petani | 20.8    | 21.1  | 0.3     | +1.4 |
| Kulim Hi-Tech | 20.0    | 18.6  | −1.4    | −7.0 |
| Seberang Jaya | 21.5    | 25.4  | 3.9     | +17.6 |
| Seberang Perai | 19.2    | 21.1  | 1.9     | +9.9 |
| Minden   | 19.7    | 19.6  | 0.1     | −0.5 |
| Balik Pulau | 19.3    | 23.6  | 4.2     | +22.0 |
| Taiping  | 20.3    | 19.1  | −1.2    | −6.0 |
| Tasek Ipoh | 20.9    | 20.1  | −0.8    | −3.9 |
| Pegah Ipoh | 18.3    | 18.2  | 0.1     | +5.3 |
| Seri Kembangan | 21.2   | 18.8  | −2.4    | −11.3 |
| Tanjung Malim | 11.5    | 10.3  | −1.2    | −10.2 |
| Batu Muda | 16.9    | 19.1  | 2.2     | +11.2 |
| Cheras   | 14.4    | 16.1  | 1.7     | +12.1 |
| Putrajaya | 15.0    | 18.0  | 3.0     | +19.4 |
| Kuala Selangor | 18.8    | 17.6  | −1.2    | −6.2 |
| Petaling Jaya | 22.1    | 17.2  | −4.9    | −22.0 |
| Shah Alam | 18.5    | 17.7  | −0.8    | −4.3 |
| Klang    | 19.5    | 23.4  | 3.9     | +19.9 |
| Banting  | 12.6    | 15.9  | 3.3     | +25.9 |
| Nilai    | 14.1    | 16.3  | 2.1     | +15.2 |
| Seremban | 10.1    | 12.8  | 2.7     | +26.2 |
| Port Dickson | 11.2    | 15.0  | 3.8     | +33.4 |
| Alor Gajah | 8.9    | 11.3  | 2.4     | +27.4 |
| Bukit Rambai | 12.4    | 13.1  | 0.7     | +5.5 |
| Bandaraya Melaka | 11.0    | 13.9  | 2.9    | +26.7 |
| Segamat  | 14.0    | 17.3  | 3.3     | +23.2 |
| Batu Pahat | 9.4    | 11.5  | 2.1     | +22.2 |
| Kluang   | 9.1     | 11.1  | 2.0     | +22.3 |
| Larkin   | 13.6    | 14.4  | 0.8     | +6.0 |
| Pasir Gudang | 9.3    | 10.5  | 1.5     | +16.3 |
| Pengerang | 8.0    | 17.1  | 9.1     | +115.0 |
| Kota Tinggi | 8.1    | 6.9   | −1.2    | −15.0 |
| Tangkak  | 12.6    | 14.9  | 2.3     | +18.2 |
| Rompin   | 8.6     | 17.3  | 8.7     | +115.8 |
| Temerloh | 12.4    | 14.6  | 2.2     | +17.6 |
| Jerantut | 12.5    | 13.9  | 1.3     | +10.7 |
| Indera Mahkota Kuantan | 8.5    | 8.9   | 0.4     | +4.4 |
| Balok Baru Kuantan | 10.3   | 9.9   | −0.4    | −4.0 |
| Kemaman  | 4.8     | 12.8  | 8.0     | +63.9 |
| Paka     | 8.7     | 8.4   | −0.3    | −3.7 |
| Kuala Terengganu | 13.3  | 18.8  | 5.5     | +41.7 |
| Besut    | 11.0    | 12.5  | 1.5     | +13.6 |
| Tanah Merah | 23.8    | 24.0  | 0.2     | +0.8 |
| Kota Bharu | 12.0    | 18.8  | 6.8     | +57.0 |
| Tawau    | 8.7     | 6.5   | −2.2    | −25.1 |
| Sandakan | 12.2    | 9.0   | −3.3    | −26.6 |
| Kota Kinabalu | 13.7    | 13.1  | −0.6    | −4.6 |
| Kinabalu | 22.5    | 16.1  | −6.4    | −28.4 |
| Keningau | 12.5    | 12.6  | 0.1     | +0.4 |
| Labuan   | 14.9    | 16.6  | 1.7     | +11.4 |
| Limbang  | 11.3    | 9.2   | −2.1    | −18.5 |
| ILP Serian | 20.5    | 21.2  | 0.7     | +3.4 |
| Miri     | 12.0    | 12.7  | 0.7     | +5.5 |
| Samaralau | 13.0    | 12.1  | −0.9    | −7.3 |
| Bintulu  | 13.9    | 13.7  | −0.2    | −1.1 |
| Mukah    | 7.7     | 7.4   | −0.3    | −4.4 |
| Kapit    | 7.4     | 6.3   | −1.1    | −14.5 |
| Sibu     | 11.3    | 10.6  | −0.7    | −6.0 |
| Sarawak  | 9.0     | 7.0   | −2.0    | −22.1 |
| Sri Aman | 8.1     | 7.3   | −0.8    | −9.5 |
| Samarahan | 8.1    | 7.2   | −0.9    | −11.2 |
| Kuching  | 8.9     | 8.8   | −0.1    | −0.9 |
| Johan Setia Klang | 41.9  | 32.0  | −9.9    | −23.6 |
| IPD Serian | 5.4    | 6.9   | 1.5     | +27.3 |
| Politeknik Kota Kinabalu | 41.2   | 19.1  | −22.1   | −53.6 |

In Malaysia, Jerantut (S40) is considered as the background station (rural). Unfortunately, it did not show the lowest PM<sub>2.5</sub> concentrations as expected whereby the PM<sub>2.5</sub> concentrations before MCO was 12.5 µg/m³ and during MCO was 12.9 µg/m³ with an additional of PM<sub>2.5</sub> concentrations mostly occurred after the MCO I. The movements and activities of residents living in the red zone area may have been restricted; however, pollutant emissions, especially from mobile sources had indirectly reduced in such areas.
The variation of PM$_{2.5}$ concentrations was further increased with the increment of 10.7% when the researchers compared the PM$_{2.5}$ concentrations before MCO (12.5 µg/m$^3$) and during MCO I (13.9 µg/m$^3$). It showed a decreasing variation (14.5%) between MCO I and MCO II, with 13.9 µg/m$^3$ and 11.9 µg/m$^3$, respectively. The researchers observed that this station did not show the lowest PM$_{2.5}$ concentrations as a representative background station, thus a further study needs to be conducted by considering the other factors, including meteorological and the anthropogenic sources to justify the variation of PM$_{2.5}$ at this station as compared with other stations. Previously, Latif et al., (2014) clarified that there is an emergence of development around 10 km radius from the station. This could affect the condition of the station as a background station. A background station must be located at a remote area which has minimal influence of anthropogenic sources.

### 4. Conclusion

In this study, the researchers concluded that the MCO has significant effects in reducing the PM$_{2.5}$ concentrations in Malaysia. It should be noted that other factors, such as weather conditions, traffic density, industrial activities, and biomass burning should be considered for further investigations. The MCO has been continued in Phase III, which started on 15 April 2020, and the PM$_{2.5}$ concentrations are expected to continue to stay low, as several areas have been placed under enhanced MCO.

### CRediT authorship contribution statement

**Samsuri Abdullah**: Methodology, Writing - original draft, Writing - review & editing. **Amalina Abu Mansor**: Investigation, Formal analysis. **Nur Nazmi Liyana Mohd Napi**: Investigation, Formal analysis. **Wan Nuridiyana Wan Mansor**: Methodology. **Ali Najah Ahmed**: Methodology. **Marzuki Ismail**: Methodology. **Zamzam Tuah Ahmad Ramly**: Investigation, Formal analysis.

### Declaration of competing interest

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.

### Acknowledgements

This research was funded by the Fundamental Research Grant Scheme for Research Acculturation of Early Career Researchers by the Malaysian Ministry of Education (FRGS-RACER) and Research and Management Centre, Universiti Malaysia Terengganu. We greatly appreciate the front line doctors, nurses, police, soldiers, etc. especially the Director-General of Health Malaysia, Dato Dr. Noor Hisham Abdullah, for their hard work during this critical time. Those who are directly impacted with COVID-19, we wish you brighter days ahead.

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