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The Impact of Movement Control Order (MCO) during COVID-19 Pandemic on Air and Water Quality in Malaysia: A Mini Review

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Air and water are essential aspects of life on earth, and any changes in the quality have a significant impact on human beings. Although the current COVID-19 pandemic has some adverse effects on the environment, there are also some benefits from this pandemic. One of the significant positive effects of this pandemic is the Movement Control Order (MCO) that the environment had rejuvenated during this period. Many reports worldwide, including Malaysia, had reported that the air and water quality had shown some improvement. This paper reviews the impact of MCO on air and water quality in Malaysia. The MCO effects on air and water pollution were reviewed, highlighting the latest research carried out in these areas. The reviewed studies showed a positive effect on air and water quality in Malaysia, where it was improved to a great extent. For instance, there is a reduction in carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate matter (PM) during the MCO period. As for the water quality studies, all the reviewed studies showed a remarkable improvement in the Water Quality Index (WQI), compared to before MCO. The review also shows that there are few studies on the effect of water quality during the pandemic, compared to air quality, probably because Malaysia is still under the MCO period.

1. Introduction

A pandemic has gripped the world over 2020 and 2021, and it was identified as a new Coronavirus Disease 2019 (COVID-19) (World Health Organization, 2020). Nearly 3 x 10^9 people are affected by MCO or lockdown globally (World Health Organization, 2020). One of the biggest questions during this pandemic is 'does the COVID-19 pandemic contribute positively to the environment ?'. Many have reported that the pandemic has positively affected the environment during the MCO (Zambrano-Monserrate et al., 2020). One of the significant improvements observed is that the pollution has reduced tremendously with enhanced air quality and cleaner water. During the MCO, the reduced movement of billions of people in public places such as roads (including the pavement), public squares, riverfront parks, and beaches has positively impacted the environment (Fuzeki et al., 2020). The reduced levels of physical activity in the general population in these places have a positive impact, such as reduced air pollution from vehicles on public roads, reduced amount of solid waste in rivers and beaches such as papers, plastics, and empty tins. The increased use of COVID-19 preventive equipment such as face masks, hand gloves, and others had created another unpleasant impact (Nghiem et al., 2020). The used preventive equipment had a vast amount of new waste, and its haphazard disposal has negative impacts on the environment. The positive aspect is related to reduced human activity in the environment, and the negative aspect is related consequences of reduced human activities.
The earliest COVID-19 cases detected in Malaysia is on January 25, 2020 (Elengoe, 2020). Since then, the number of cases is increasing, even though there was some reduction from July to September 2020. The situation becomes out of control again from April to July 2021 even though the Malaysian government had taken several control measures (Shah et al., 2020). With infections rising rapidly worldwide and no vaccine yet formulated during the first wave period, most nations had called for immediate and widespread lockdowns or

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MCO to curb the virus' spread (Elengoe, 2020), and the battle is still ongoing till July 2021. The Malaysian government similarly had enforced the MCO to control the COVID-19 outbreak from contagious. The five enforcement levels of MCO are Movement Control Order (MCO) (March 18, 2020 – May 3, 2020), Conditional Movement Control Order (CMCO) (May 4, 2020 – June 9, 2020), Recovery Movement Control Order (RMCO) (June 10, 2020 – December 31, 2020) and Enhanced Movement Control Order (EMCO) (January 1, 2021 – July 1, 2021). Each state switch between MCO, CMCO, RMCO, EMCO, and semi-EMCO depending on the COVID-19 condition in each state.

In this paper, the two main fields of the environment were reviewed in relation to the effect of the COVID-19 pandemic on the environment. The first is the effect on the air quality, where any disruption to its quality will affect human health and cause many respiratory and skin diseases. It is a well-known fact that the number one cause of air pollution is the combustion from vehicles, especially in urban areas. The pollutants in the air such as carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and particulate matter (PM) will affect human health (Mohd Nadzir et al., 2020). One crucial observation is that these pollutants have decreased during the MCO due to the decreased number of vehicles on the road, as many people were forced to work from home and the social activities were reduced immensely. This phenomenon was supported by Kanniah et al. (2020), where their studies show that there was a substantial reduction in the air pollutants in urban areas and the industries due to MCO. Figure 1 illustrates some positive impacts of the pandemic during MCO in Malaysia. MCO's most notable positive effects are that it reduced fossil fuel consumption in the country, and eventually, the greenhouse gases were lowered. When the number of vehicles is decreased on the road, fossil fuel combustion is reduced due to many residing at home or working from home. Another meaningful positive impact of this pandemic is eased pressure in the tourist destination, whereby there is a limited international flight coming to Malaysia and eventually reducing the pollutions.

The second is the effect to the water quality, where the quality of river water, which is severely polluted due to urbanization and modernization, had become one of the main factors for a severe water resources problem in Malaysia which had impacted the sustainability of water resources, mostly those flowing through large urban areas. One environmental aspect that improved during the declined human and industrial activities (MCO) is the blessing in disguise that the rivers are cleaner and more transparent than before MCO implementations (Radhi, 2020). As a result, river water quality has significantly improved, and its appearance is visually noticeable.

This review emphasizes the impact of the pandemic on air and water quality in Malaysia during the MCO. Some of the most recent studies were presented in this paper. This paper provides awareness of how COVID-19 during MCO has positively affected Malaysia's environment, particularly air and water quality.

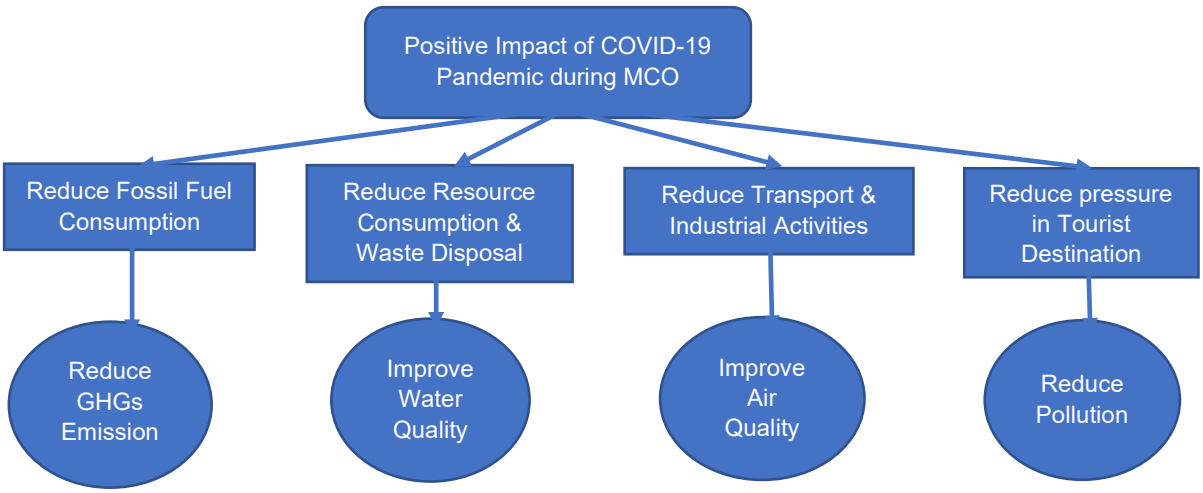

Figure 1: The advantages of COVID-19 pandemic during MCO in Malaysia

2. Air quality

As mentioned before, the primary sources of air pollution in urban areas are combustion from vehicles such as petrol, fuel oil, and natural gas. Other industrial areas such as power generation plants, wastewater treatment plants and unsustainable farming also contribute to air pollution (Latif et al., 2012). The four primary emissions of air pollutants that need to be monitored are carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and particulate matter (PM). These are the primary pollutants that affect human health, in addition to some

other pollutants. There are many studies on the effect of air pollution on human health in terms of toxicity effects (Sun et al., 2019). A study conducted from March 1 to April 28, 2020, showed that the Air Pollutant Index (API) increased to 26 %, and the PM 2.5 concentrations decreased to 58.4 % during the MCO compared to before MCO (Ujang, 2021). Several other researchers have reported their studies on the impact of the pandemic on air quality during the MCO period (Table 1). Othman and Latif (2021) examined the air pollution impacts from the COVID-19 pandemic in nine major cities in Malaysia (Ipoh, Alor Setar, Kota Kinabalu, Kuching, Kota Bharu, Kuantan, Johor Bahru, Seremban and Kuala Lumpur). They compiled and compared air pollutants such as PM 10, PM 2.5, SO_2, O_3 and CO. The results showed a reduction in PM 10 during the MCO in all cities except for Alor Setar. SO_2 showed increasing concentrations from the beginning of 2020 until the early part of the MCO and then decreasing concentrations after the first few days of the MCO in Kota Kinabalu. All cities showed decreasing concentrations of NO_2 during the MCO, except for Alor Setar, which had peak concentrations during the MCO. The mean concentrations of O_3 before the MCO in the studied cities were in the sequence Alor Setar > Ipoh > Seremban > Kuantan > Kuala Lumpur > Johor Bahru > Kota Bharu > Kota Kinabalu > Kuching. At the same time, the sequence during the MCO was Alor Setar > Seremban > Ipoh > Kuala Lumpur > Kuantan > Johor Bahru > Kota Kinabalu > Kota Bharu > Kuching. The average mean concentration of CO in all cities before the MCO period was 0.53 ppm which is about 0.94 times higher than the mean concentration during the MCO period.

In another study, Latif et al. (2021) reported a reduction in PM 10, PM 2.5, NO_2 and CO in the Klang Valley during the MCO period using a continuous air quality monitoring system (CAQMS). The results revealed a decrease in the NO_2 concentration up to 72 %, and other gases such as SO_2 and O_3 showed some variations. Abdullah et al. (2020) also reported the air quality status during the MCO and showed a decline in PM 2.5 up to 58.4 %. According to their study, several other red zone areas, highly affected by COVID-19, had also reduced up to 28.3 % in the PM 2.5 concentration. Kanniah et al. (2020) examined the COVID-19's impact on the atmospheric environment in the Southeast Asia region and showed a decrease in PM 10, PM 2.5, NO_2, SO_2, and CO concentrations by 26 - 31 %, 23 - 32 %, 63 - 64 %, 9 - 20 %, and 25 - 31 %, compared to the same periods in 2018 and 2019. Nadzir et al. (2020) reported that traffic and industry are essential factors contributing to air pollution, and the lockdown measures had yielded appreciable effects. Their investigation using an air sensor network called AiRBOXSense noted a significant drop in the air pollutants in Klang Valley (20 to 60 %). For instance, they observed a drop in CO in Kota Damansara; the PM 2.5 and PM 10 increased up to 60 % and 9.7 % during MCO days.

Table 1: Studies on air quality during COVID-19 pandemic in Malaysia

Study	Key Results	Reference
Air pollutants such as PM, SO_2, NO_2, O_3, CO	NO_2 showed a reduction up to 62 % (Kota Kinabalu). PM 10, PM 2.5, SO_2, O_3 and CO reduction were Kota Kinabalu (17 %), Kuantan (9.5 %), Alor Setar (38 %), Kota Bharu (15 %), and Ipoh (27 %).	Othman and Latif (2021)
Continuous air quality monitoring system (CAQMS	Reduction in PM 10, PM 2.5, NO_2 and CO concentrations. Highest reduction was NO2 (72 %). SO_2 and O_3 were also reduced.	Latif et al. (2021)
API, PM	Reduction in PM 2.5 up to 58.4 %. Red zone areas also reduced (28.3 %).	Abdullah et al. (2020)
Aerosol optical depth (AOD)	Reduction in PM 10, PM 2.5, NO_2, SO_2, and CO by 26 - 31 %, 23 - 32 %, 63 - 64 %, 9 - 20 %, and 25 - 31 %.	Kanniah et al. (2020)
Air sensor network AiRBOXSense	Pollutants dropped by 20 to 60 %. Reduction in CO to 48.7 % (Kota Damansara).	Mohd Nadzir et al. (2020)

The above review of the effect on air quality during the pandemic shows that the pandemic has helped reduce pollution. It also shows that the “new normal” lifestyle during the pandemic positively affects air quality. The researchers fail to identify the source of air pollution in each city they investigated and lack chemical composition and other air pollution data. For example, there is no detailed information about the number of vehicle data and the industries operated during the MCO period. There is also no data on some crucial compounds, such as volatile organic compounds (VOC).

3. Water quality

Before COVID-19, water pollution is one of the biggest challenges for many countries, especially developing countries. During the MCO period, most water industrial pollution sources such as wastewater treatment plants did not operate, substantially reducing pollutants such as heavy metals, crude oil, chemicals etc. This industrial pollution has reduced the impact on the environment, especially on the rivers, which received less pollutant loading during this period. Many factories and industries using water as a source of process water were forced

to shut down due to the MCO, and their operations were temporarily closed. This economic slowdown scenario had demonstrated a notable change in numerous river water quality worldwide. These lockdowns also helped reduce various nonpoint sources of pollution such as farming, recreational, domestic etc. The point source pollution from the industrial sites has reduced significantly, and the rivers received less input as the lockdowns continue. As a result, signs of recovery in the urban surface water quality starts to show recovery. The worst-case economic situation also had rippled other primary nonpoint sources such as agriculture and mining, contributing to the depositions into rivers. It is vital to remember that the reduced nonpoint source water quality may take a more extended period to measure than the effects of reduced point source inputs, where the surface water quality can be seen affected within few months. It is important to get information on how this pandemic affects water quality quickly (Hallema et al., 2020).

Poor river water quality will severely affect the water supply to the communities. The polluted rivers have caused pollutions, floods and water scarcity to the community. During MCO, enormous changes have happened to the polluted rivers all over the country. A study by Wan Ahmad and Ali (2020) confirmed that the water quality has enhanced during the MCO period. According to their study using monitoring stations, there was an improvement of 28 % in water quality during MCO. For example, the rivers that showed the improvement are Sungai Batang Sadong, Sungai Kelantan, Sungai Kuantan, and Sungai Besut (Wan Ahmad and Ali, 2020). Table 2 illustrates the studies on water quality during pandemic COVID-19 in Malaysia. Najah et al. (2021) explored the WQI study in Putrajaya Lake and showed a significant increase in the WQI from 24 % to 94 % during the MCO period.

Table 2: Studies on water quality during COVID-19 pandemic in Malaysia

Study	Key Results	Reference
Rivers of Klang, Penang, Putrajaya Lake for Water quality index (WQI)	Increase in Putrajaya Lake WQI from 24 % to 94 % (Class 1 river).	Najah et al. (2021)
Water quality index (WQI)	Rivers were clearer during MCO: Sg. Btg Sadong, Sg. Kuantan, Sg. Pahang, Sg. Johor, Sg. Besut, Sg. Kim Kim, Sg. Gombak, Sg. Klang, Sg. Melaka, Sg. Gisir etc.	Goi (2020)
Water quality index (WQI)	Improvement in WQI in 29 water monitoring statons (28 % WQI improved). Rivers showing improved water quality are Sg. Batang Sadong, Sg. Besut, Sg. Kelantan, Sg. Linggi, Sg. Johor, Sg. Muar etc.	Wan Ahmad and Ali (2020)
Sungai Melaka visibility	The visibility is ‘greener’ and cleaner. The water can be visible at several locations and drastic reduction in rubbish in the river.	The Star (2020)
Sungai Pinang visibility	Water has been noticeably clearer and cleaner.	New Strait Times (2020)

Goi (2020) studied several rivers in Malaysia and found that many are cleaner and clearer than before. For example, in their study, they found that Sg. Melaka, which is in the centre of the town and renowned for its water pollution, becomes the town's talk for its cleaner water during the MCO period. The Star (2020) also reported that the Sg. Melaka is 'greener' during the MCO period. The same goes for the Sg. Kim Kim, infamous for having chemical waste pollution from factories in Johor Bahru and become the country's talk a few years ago. The river is clearer when the factories ceased operation during the MCO. Goi (2020) also described that the activities that affected the water quality of Indah Water Konsortium (IWK) operated during the MCO. According to his study, Sg. Klang recorded Class III WQI (90 %) during MCO, compared to 46 % before MCO, and a total of 43 % less solid waste was removed. Figure 2 illustrates the comparison between before and after MCO of Sg. Gisir, Klang. It is clearly showing that the river is clearer during the MCO period. Other rivers that are in these similar conditions are Sg. Way Sg. Gombak, and Sg. Kemuning (New Straits Times, 2020).

Rivers in Malaysia encountered enormous threats from various pollutant sources due to the different types of industries. Some water pollution discharge sources are effluent from sewerage treatment plants, commercial and residential centres, industries and workshops, the food industry, wet markets, restaurants, and squats. The river flows through a densely populated and received flow from various point and nonpoint sources, makes it challenging to track these pollutants' loading in the river. In addition to sewage discharges, other pollution sources require attention. For example, many licensed hawkers and petty traders, plus unlicensed traders, account for unnecessary health threats due to the lack of sanitation and hygiene (Tan 'G'-Ling and Aminuddin, 2019). These hawkers who are not located within buildings and discharge sullage direct to storm drains. The pollution load in storm drains also derived from the large numbers of shophouse-based restaurants and coffee shops that prepare food and wash dishes in the back lanes.

Figure 2: Sungai Gisir a) before MCO in March 2020 and b) during MCO

Other pollution sources that are difficult to quantify are small-scale illegal factories and the direct discharge of wasters to the river from indiscriminate dumping. In addition, the squatter colonies along the river often missed the pollution load in the river and whilst the inhabitants of such colonies may throw refuse on the riverbanks and construct overhung latrines. Some reports showed that the older housing areas are discharging household sullage, particularly from kitchens and washrooms direct to the storm drains (Lembaga Urus Air Selangor, 2015). This practice is also prevalent for those houses provided with individual property septic tanks that usually only receive toilet wastes. Hence, although a large population in Malaysia are provided with piped water and connected to some form of sewerage system and sewage treatment, a considerable proportion of the wastewater continues to be discharged untreated to the drainage system.

4. Conclusions

The MCO in Malaysia has changed the entire socio-economy and environmental activities. During the MCO, human activities have decreased and helped the environment to thrive. The restriction on social activities and movement during this pandemic has appeared as a boon for nature and the environment. As a result, the air and water quality has improved during the MCO period. One of the beneficiaries is waterways, where rivers, estuaries and seas have become clearer and cleaner. When the MCO was lifted and people started to socialize, economic sectors were opened, the social activities increased, the pollution resurfaced, and the environment was affected again. The river water quality deteriorates in total suspended solids (TSS) when the MCO was lifted and replaced with the CMCO. The pandemic only temporarily halted the effect on the environment, and the effects continue to resurface, giving to the contention that it is good to see the pandemic continue. There is a lesson to be learned from the pandemic, that when disaster transpires, only then do people think about the environment, and very little was done before the pandemic to preserve the environment. Although the air and water quality improved in the MCO moment, people should protect these two fields of the environment safe from pollution. The environment will be flourished if the people have an awareness of the importance of protecting the environment and should have a balance between economic development and at the same time protect the environment.

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