CARBON MONOXIDE EMISSIONS MONITORING DURING COVID-19 PANDEMIC IN JAKARTA

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ABSTRACT: Jakarta has been known as the capital city, has been dealing with air pollution since many years ago. The main contributor of air pollution in Jakarta is due to large population, and high numbers of transportation, of which still running on diesel fuels, emitting far higher levels of pollutants. Carbon monoxide pollution is associate with number of transportations run in the city. Mobility index provided by Facebook Data for Good has managed to identify people's movement during COVID-19 period (stay put and change in movement matrix's). Therefore, this study aims to analyze the dynamic of carbon monoxide emissions during the COVID-19 pandemic in Jakarta. The results showed the distribution of CO emission in Jakarta and its mobility index of each quarter showed a similar pattern. The quarter 2 of 2020) is presented the lowest CO emission distribution value compared to the other five quarters, ranging from 0.0309-0.0334 mol/m^2. The low value of CO emission distribution during that period was related to the low community mobility index (index of go) in the same period. While in the next quarter which is quarter 3 2020, the CO emission was relatively increased ranging from 0.031-0.037 mol/m^2, which associated with the rise of mobility index stay of go value. Therefore, in this study, there is a relationship between the distribution of CO emission with the mobility index provided by Facebook.

1. INTRODUCTION

Jakarta has been known as the capital city, yet it also the center of the economy, culture and politics of Indonesia. Unfortunately, Jakarta has been dealing with air pollution since many years ago. Based on IQAir (2021), Indonesia comes in with a poor quality of air statistically. The main contributor of air pollution in Jakarta is due to large population, high numbers of motorbikes, cars and trucks, many of which still using diesel fuels, caused higher levels of pollutants.

Carbon monoxide is one of the primary pollutants besides sulfur dioxide (SO_2), and particulate matter (PM). Carbon monoxide (CO) is a colorless, practically odorless, and tasteless gas or liquid. It results from incomplete oxidation of carbon in combustion, and it is also the main source of carbon monoxide pollution in urban areas like Jakarta. Burning fuel using kerosene, wood, charcoal, and gas can produce carbon monoxide (Dwiwibowo, 2020; Vasiliki, 2020). According to Wickramatillake and Hemantha (2000), the results of carbon monoxide levels in the busy streets were significantly higher than those of the less busy street.

In March 2020, Indonesia announced first case of COVID-19. From that time, the government did the mobility restrictions over the country, namely Large-Scale Social Restriction (LSRR) policy. The policy had successfully pressed the mobility of people to transport within and across the city. But then, when the COVID 19 cases were lower, the government would loosen the policy till the half of 2021 and vice versa. Carbon monoxide pollution is associate with number of transportations run in the city. Therefore, this study aims to analyze the dynamic of carbon monoxide emissions during the COVID-19 pandemic in Jakarta.

2. DATA AND METHODS

2.1 Study Area

Jakarta is located in Java Island, lies between 6º12‘ South latitude and 106º48‘ East longitude. Jakarta is one of the metropolitan city in Indonesia with over 10 million inhabitants. Jakarta covers land area of 662.33 km^2 and a sea area of 6977.5 km^2. Area of the Jakarta has no less than 110 islands scattered in the Kepulauan Seribu, and there are about 27 river/ waterway/canal which are used as a source of drinking water, fisheries, and urban businesses. Based on its geographic position, Province of DKI Jakarta has boundaries: to the north extends a 35 km cost line into which nine rivers and two canals discharge. The south and east is west Java Province and to the west is Banten Province on the north stretches a coast from West to East along the ± 35 km of the estuary of the 9 rivers and 2 channels, border on the Java Sea, while to the south and eastern is bordering with West Java Province, on the west is bounded by Province of Banten (Statistic Indonesia, 2021). The study area is showed in Figure 1.

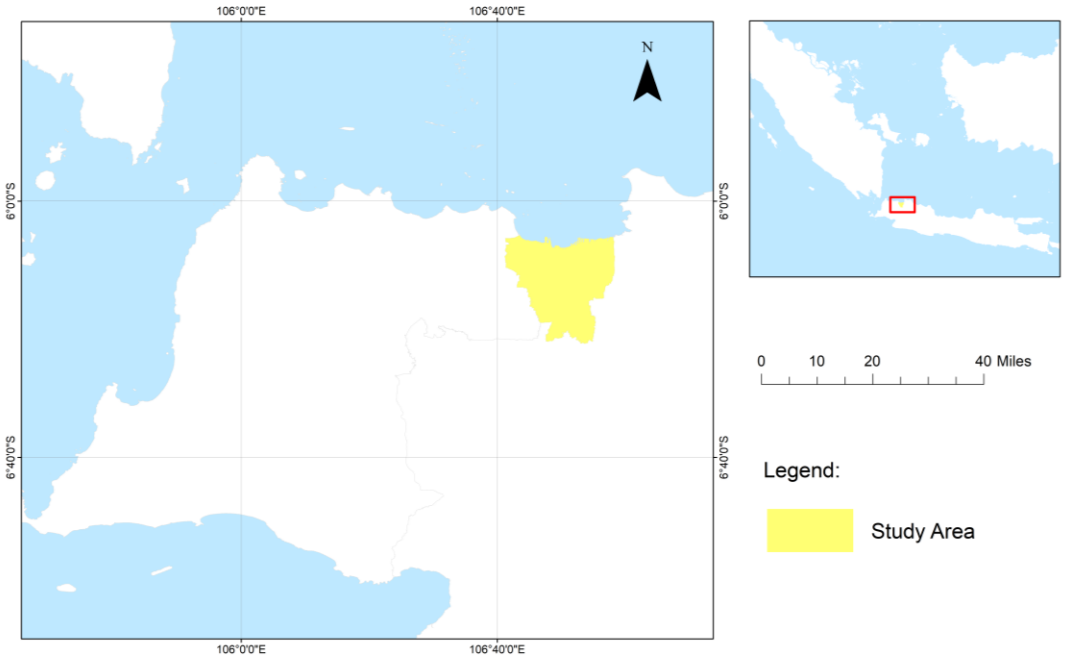

Figure 1. Study Area.

2.2 Data

In this research, we used two types of data, namely Sentinel-5 Precursor (S5P) satellite data to retrieved carbon monoxide information and Facebook mobility data. In 2017, the Copernicus Sentinel-5 Precursor (S5P) satellite with the TROPospheric Monitoring Instrument TROPOMI) on board was launched into a sun-synchronous orbit at 824 km altitude. TROPOMI comprises a hyperspectral spectrometer measuring radiation in the ultraviolet (270 nm - 320 nm), visible (310 nm - 500 nm) and infrared (675 nm - 775 nm, 2305 nm - 2385 nm) spectral regions (Veefkind et al., 2012). Its main mission is to monitor air quality with several air quality parameters, one of which is carbon monoxide (CO) (Rushayati, 2020).

While, In April 2020, Facebook offered Data for Good to support researchers, international agencies, non- profits, and other public sector institutions in the fight against COVID-19. Facebook’s Movement Range Maps, Co-Location Maps, and other Data for Good products incorporate mobility data that, to date, have been used for physical distancing monitoring, identifying high risk areas for disease spread, and other issues. Generally, there are two metrics, Change in Movement and Stay Put, that provide information towards movement trends (Spyratos et al., 2019). Change in Movement looks at how much people are moving around and compares it with a baseline period, while Stay Put looks at the fraction of the population that appear to stay within a small area during an entire day (Cuebiq, 2021).

2.3 Method

Sentinel-5 Precursor (S5P) satellite data was processed by using Google Earth Engine (GEE) Cloud Computing. Google Earth Engine (GEE) is a cloud-based platform which can access both multi-temporal remote sensing big data and high-performance computing resources for processing these datasets. Moreover, The Sentinel-5P carbon dioxide (CO) was then selected only band CO_colums_number_density. A quarter period composite of 2020 and 2021 was further processed. Clipping the study area was done to obtain the desired focus area, which is in Jakarta. The flow diagram is showed in Figure 2.

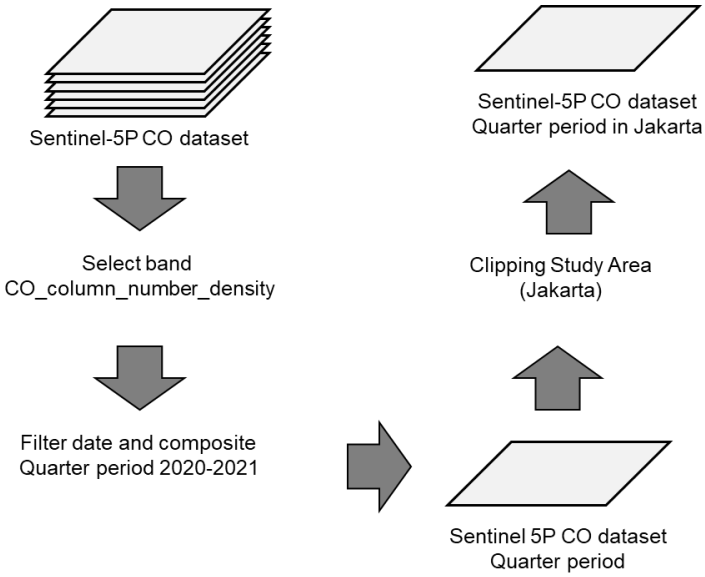

Figure 2. The flow diagram.

3. RESULTS AND DISCUSSION

The distribution of CO emission in Jakarta is showed in Figure 3 for 4 quarters in 2020 and 2 quarters in 2021. Figure 4 shows the comparison between the average value of CO emission and its mobility index (stay put=index of stay; change in movement=index of go) of each quarter. The results showed similar pattern between the CO emission and index of go. Figure 3b (Q2 2020) is presented the lowest CO emission distribution value compared to the other five quarters, ranging from 0.0309-0.0334 mol/m^2. The low value of CO emission distribution during that period was related to the low community mobility index (index of go) in the same period (Figure 4). The outbreak of the COVID-19 in Indonesia since March 2020 has made the national government decide to conduct Large-Scale Social Restriction (LSRR) policy from March 20th, 2020, to May 31st, 2020, before entering the new normal era in June 2020. This condition has forced people to do self-isolation at home, close all non-essential public facilities, impose social distancing for the community, and postpone inter-regional mobilization. The low level of mobilization due to this situation affects the low level of human activity in urban areas, including Jakarta. While in the next quarter which is quarter 3 2020, the CO emission was relatively increased ranging from 0.031-0.037 mol/m^2. It is due to the implementation of The New Normal suggested by the government on early of June 2020. The results also associated with the rise of mobility index stay of go value.

Transportation is the main sector that produces CO emissions (Georgatzi et al, 2020). In some cities in developing countries that have not implemented environmentally friendly and accessible public transportation system, the impact of CO emission on human health is very significant. Based on Levy's research (2015), motorcycles contribute 70% of pollution in urban areas and increase CO levels in blood cells. According to Zaini et al. (2020), high levels of CO emission in the air can also cause reduced lung function on human. Indonesia is one of the cities with quite a high number of motorcycle users in the Southeast Asia Region. According to BPS data, the number of motorcycles in Jakarta reached 16,141,380 units in 2020 or around 79.82 percent of all motorized vehicles in Jakarta. The high use of motorbikes is inseparable from the conditions of severe traffic jams in the city of Jakarta.

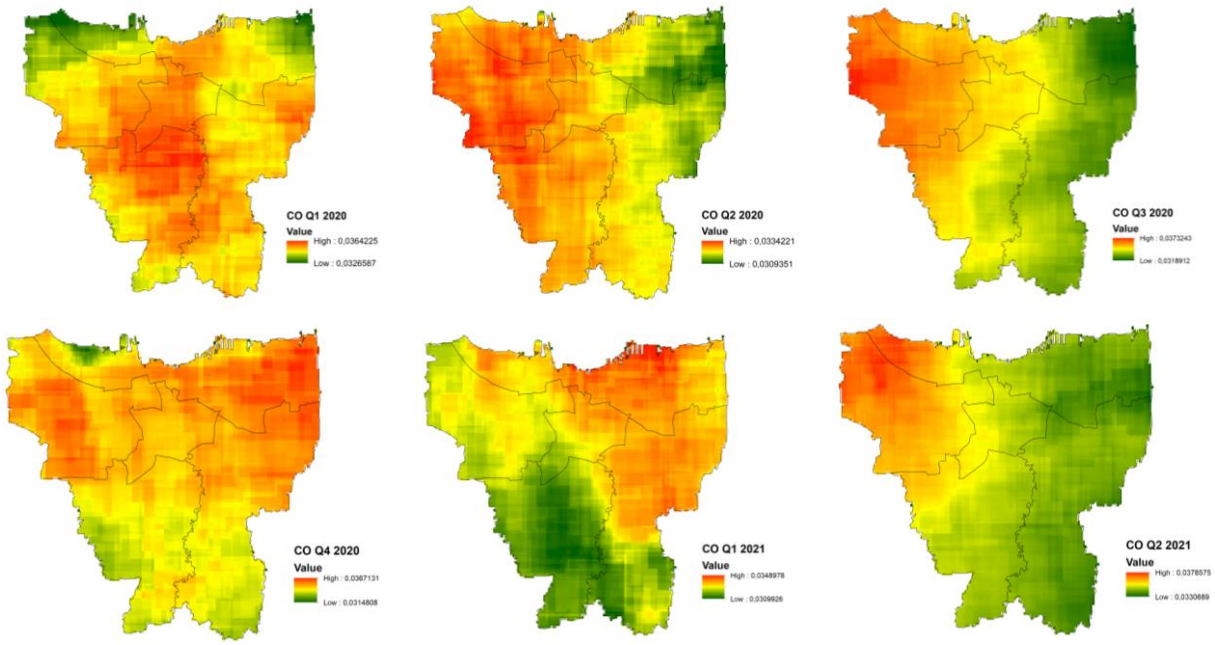

Figure 3. The distribution of CO emission in Jakarta from Q1 2020 to Q2 2021.

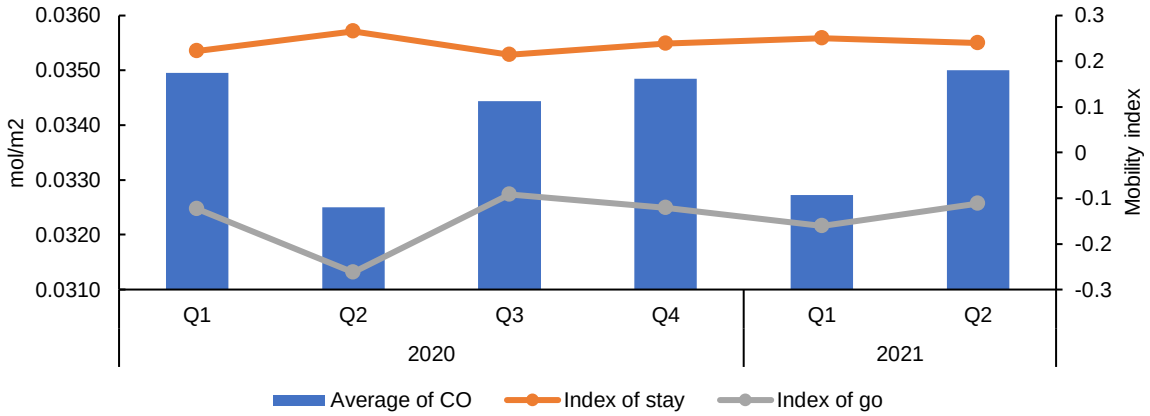

Figure 4. Comparison between CO emission value and Mobility index.

Community mobilization is a social phenomenon that cannot be avoided. In 2020, the population of Jakarta reach more over 10 million people (Statistics Indonesia, 2020) which has increased by almost 10% in 10 years. The high population in a city is directly proportional to the level of mobilization. Community mobilization by using transportation that is not environmentally friendly is a key factor in increasing pollutants including CO. According to Dixon et al. (2019), community mobilization can be sustainable if it maintains three key factors such as performance and resilience (efficiency in transportation modes to minimize congestion, pollutant emissions, and time use); vision and leadership (the participation of regional leaders to create a strong, high-quality, and minimal accident transportation system); as well as service and inclusion (a transportation system that can be accessed by the entire community). Based on this, the phenomenon of high CO in urban areas cannot be separated from the social components such as community habits and government policies.

Currently, Indonesia has entered the new normal era by observing health protocols and social restrictions on a regular basis. Community mobilization is currently taking place normally. The Jakarta provincial government has carried out several scenarios to carry out scenarios to reduce traffic density. The construction of the mass rapid transit (MRT), bus rapid transit (BRT), and light rail transit (LRT) systems is one of the commitments in improving the public transportation system. The existence of odd-even and three-in-one schemes is also a strategy carried out by the government to reduce traffic congestion. Urban dwellers who care about the high transportation emissions in

Indonesia have formed several B2W (Bike to Work) communities spread across several cities, including Indonesia. Solving the transportation problems in a city is not an easy task. However, the strong commitment of the government and the community in reducing transportation emissions is a major factor in improving the quality of the environment in urban areas.

4. CONCLUSION

The distribution of CO emission in Jakarta and its mobility index (stay put=index of stay; change in movement=index of go) of each quarter showed a similar pattern. The quarter 2 of 2020) is presented the lowest CO emission distribution value compared to the other five quarters, ranging from 0.0309-0.0334 mol/m^2. The low value of CO emission distribution during that period was related to the low community mobility index (index of go) in the same period. The outbreak of the COVID-19 in Indonesia since March 2020 has made the national government decide to conduct Large-Scale Social Restriction (LSRR) policy. While in the next quarter which is quarter 3 2020, the CO emission was relatively increased ranging from 0.031-0.037 mol/m^2. The results also associated with the rise of mobility index stay of go value. It is due to the implementation of The New Normal suggested by the government on early of June 2020. Therefore, in this study, there is a relationship between the distribution of CO emission with the mobility index provided by Facebook.

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