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Air Quality Impact during COVID-19 in Indonesia (Case Study of Rural and Urbanised Area)

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Abstract: In December 2019, unknown pneumonia found in Wuhan, China. This pneumonia has been called SARS-CoV-2, and this disease called COVID-19. This pneumonia has been spreading faster around the world. Indonesia is one of the biggest countries in Asia that's impacted. This pandemic forced all industrial activities to be closed; this condition affected environmental quality (i.e., air quality). This study aims to analyze the pandemic effect on air quality in the rural and urban areas in Indonesia, statistical analysis using a descriptive method used in this study. In the pandemic period from 1-18th May 2020, the concentration of PM2.5 on each place fluctuates. Based on statistical analysis with the least square method, this pandemic informed no correlation of PM2.5 with increased positive cases of COVID-19 from 1-18th May 2020 in Jambi, Jakarta, and Surabaya.

Keywords: *SARS-CoV-2, COVID-19, PM 2.5, air quality, urban and rural area.*

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Introduction

On 31st December 2019, unknown pneumonia has confirmed in Wuhan City, Hubei Province, China. The first cases were reported on 8th December 2019; a lot of confirmed patients worked or lived around the local Hunan Seafood Wholesale Traditional Market (Hui et al., 2020). This unknown pneumonia originally named Coronavirus Disease 2019 and also known as Novel Coronavirus 2019. This pneumonia also abbreviated as 2019-nCoV by the World Health Organization (WHO). This pathogen was later renamed as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the coronavirus research group. 83,707 confirmed cases and 4,634 of total death were reported in China (Anonymous, 2020). This pneumonia was detected in more than 213 countries worldwide (Finer et al., 2020).

SARS-CoV-2 is one of the members of the *coronavitridae* family and order *Nodovitrales*. This family consists of two subfamilies (*Coronavtrinae* and *Torovitrinae*), *Coronavtrinae* has been classified into four genera such as Alphacoronavirus, this type of coronavirus contains the human coronavirus (i.e. (HCoV)-229E and HCoV-NL93), Betacoronavirus including HCoV-OC43, Severe Acute Respiratory Syndrome human coronavirus (SARS-HCoV), HCoV-HKU1 and Middle Eastern respiratory syndrome coronavirus (MERS-CoV), Gamacoronavirus (Harapan et al., 2020). As of 27th May 2020, a total of 5,488,825 people has been reported confirmed for COVID-19 globally, and 349,095 were death due to COVID-19 (WHO, 2020).

Indonesia is one of the biggest countries in Asia, with more than 2.5 million people live. Based on the Ministry of Health, the Republic of Indonesia infected people on 1st May 2020, about 10,551 people, and growing up on 29th May 2020, about 25,733 people. The recent study informed the COVID-19 spreading in and its correlation with the weather in Jakarta as the center of Indonesia (Tosepu et al., 2020), but no studies in a rural area with high positive cases of COVID-19. Jambi is one of the small cities in another island in Indonesia, but this city has high positive cases of COVID-19 during May 2020, according to the Ministry of Health, Republic of Indonesia 97 cases of COVID-19 was reported in May 2020. This place has stopped transportation across Jambi, due to the air quality condition of this area should be better than before.

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In several cases, the COVID-19 pandemic was generated a better environment. In India, emissions of NOx, PM2.5, PM10, ozone, and SO_2 decreased since mid-May during the SARS-CoV-2 outbreak. Contradictory phenomena seen in Jambi, Indonesia, the air quality index of PM2.5 in Jambi increased about 164 (unhealthy) (available at https://www.iqair.com/indonesia/jambi) during social and physical distancing. During a month or so of the SARS-CoV-2 (COVID-19) disease pandemic, some environmental improvements occur naturally. For example, in terms of air quality, several locations worldwide, especially in industrial areas and densely populated areas, experienced significant improvements.

Another example is the concentration of suspended particulate matter (SPM) in Lake Vembanad, the longest freshwater lake in India. It decreased by an average of 15.9% (range: -10.3% to 36.4%, with a decrease value of ± eight ppm) compared to before the pandemic. PM2.5, PM10, and NO_2 concentrations in the region show that air quality has also increased dramatically since the first day of social restrictions (Kang, 2020). During the lockdown period and unfavorable events in early November 2019, PM10, PM2.5, CO, NO_2, ozone, and SO_2 decreased, and ozone increased by 41%, 52%, and 28%. (Masum & Pal, 2021). However, the reduction of emissions from the transportation sector and industry in large numbers still does not help reduce severe air pollution sustainably in a dense area, especially when meteorological conditions are unfavorable (Wang et al., 2020). The COVID-19 mortality rate did not show a significant relationship with temperature (Sobral et al., 2020; Xie & Zhu, 2020)

This paper described the correlation of increasing cases of COVID-19 during May with air quality impact in Jambi, Surabaya, and Jakarta. The limitation of this study is that pollutants are measured only at PM2.5; further analysis is needed regarding various parameters of air pollution that fell during the COVID-19 pandemic process.

Methodology

This study was collected data from the website of the world air quality index (available at waqi.info) in real-time from 1st May to 18th May 2020 to determine the relative changes of air quality in Jambi, Indonesia. This study described the impact of the COVID-19 outbreak in May 2020 using a quantitative descriptive method. This study aims to analyze the correlation between positive cases of COVID-19 in Jambi, Jakarta, and Surabaya with a concentration of PM2.5 from 1-18th May 2020. Least square statistical analysis used in this study, this analysis aims to find the correlation of increasing PM2.5 concentration with positive cases of COVID-19. This statistical analysis used du to fit the aims of the study to find the correlation between positive cases of COVID-19 and PM2.5 concentration.

Findings / Results

COVID-19 Cases in Jambi, Jakarta and Surabaya

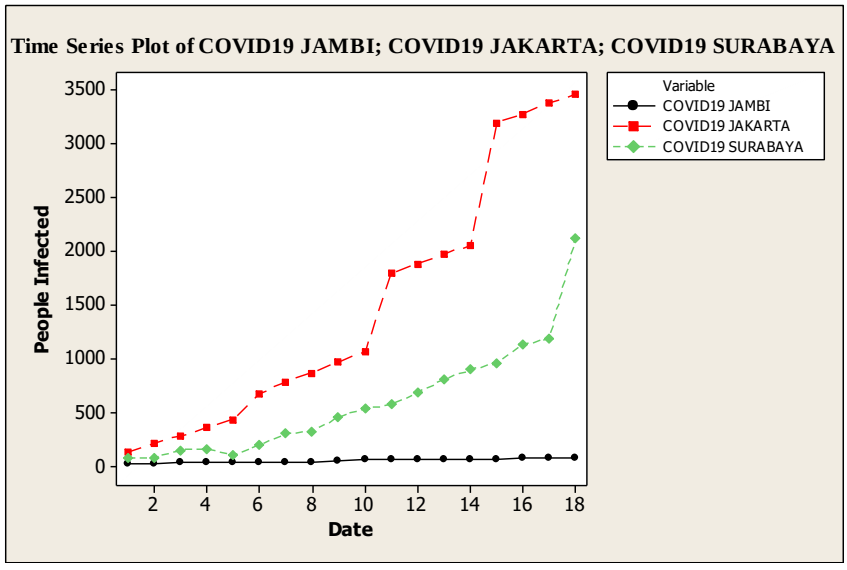


Figure 1. Time series of COVID-19 in Jambi and Jakarta

This figure showed that the infection of SARS-CoV-2 in urban areas (Jakarta and Surabaya) and rural areas (Jambi) has a different result. The data of COVID-19 Jambi is stable and does not show significantly increased. Besides, the SARS-CoV-2 infection in Jakarta and Surabaya showed significantly increased. This phenomenon caused by Jakarta is an epicenter of Indonesia, and Surabaya is near Jakarta. Due to this fact, the infected people in this area are higher than Jambi. Although these areas (Jakarta and Surabaya) were applied lockdown, the rate of increase of people who are infected continues to increase. Health protocols and locking out and entering areas in Jambi Province were among the

factors that caused the development of COVID-19 in this region to be relatively small. Also, lack of access to flights from abroad contributed to the low transmission in this region. The difference is seen in the Jakarta area as a center for international flights, the level of positive cases in the Jakarta area is very high due to the access of international flights that remain open.

Air Quality Index in Jambi, Jakarta, and Surabaya

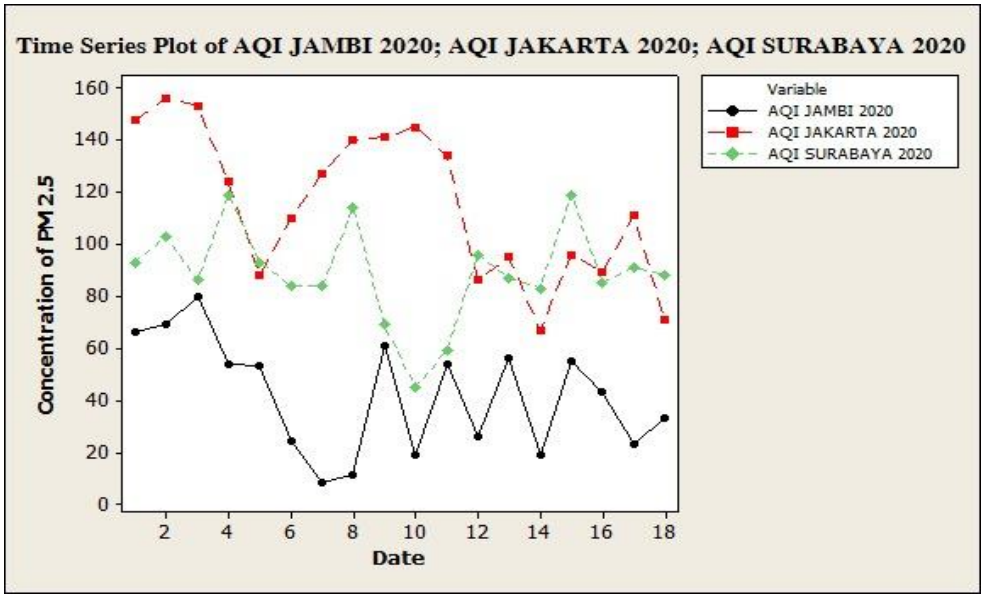
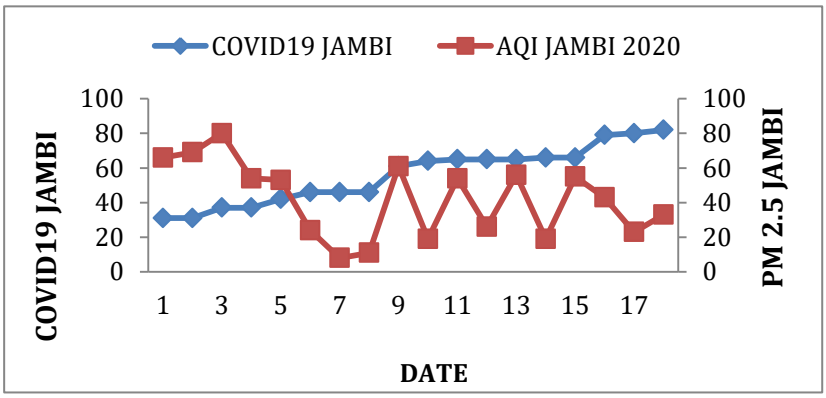


Figure 2. Time series of AQI of Jambi, Jakarta, and Surabaya

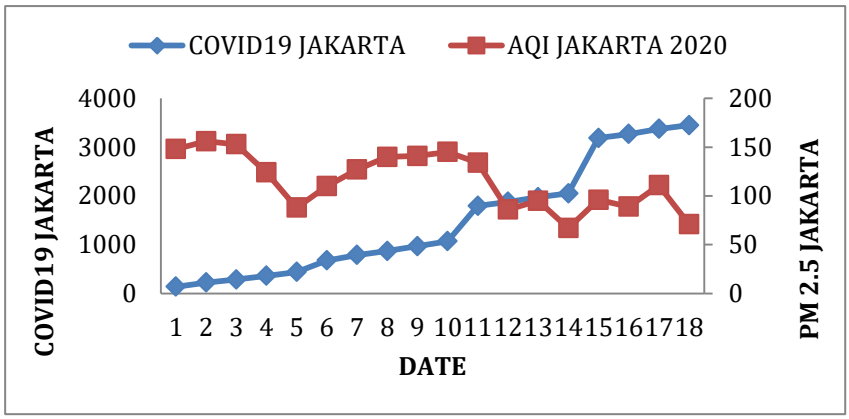
Air quality in three regions of Indonesia (Jambi, Surabaya, and Jakarta) experienced fluctuations during the period 1-18st May 2020. Based on data obtained from waqi.info PM2.5, quality improvements occurred in the Jakarta area since the first day (May 1, 2020), but after the fourth day, there was an increase in PM2.5 content, this was due to the mobility of vehicles that remained in operation during the pandemic. It is known that the Jakarta area can still be active outdoors but with strict health protocols (must use a mask and keep a distance). The condition of people who are afraid to use public transportation and choose to use private vehicles is one of the causes of the high again PM2.5 concentration, besides that, forest fires, garbage, and wood that occurred in various areas around Jakarta contributed to the increase in PM2.5 concentration.

PM2.5 concentrations in the Surabaya and Jambi regions were recorded to have fluctuated during 18 days of monitoring. The absence of a decrease in PM 2.5 concentration informs that industrial activities and human activities did not decrease significantly during 18 days of monitoring. Based on the data, it can be seen that the highest PM2.5 concentration during the pandemic occurred in Jakarta, then followed by Surabaya and Jambi. The high mobility and population in Jakarta as the center of the nation's capital cause the concentration of PM2.5 in this region to be higher than the other two regions (Jambi and Surabaya).

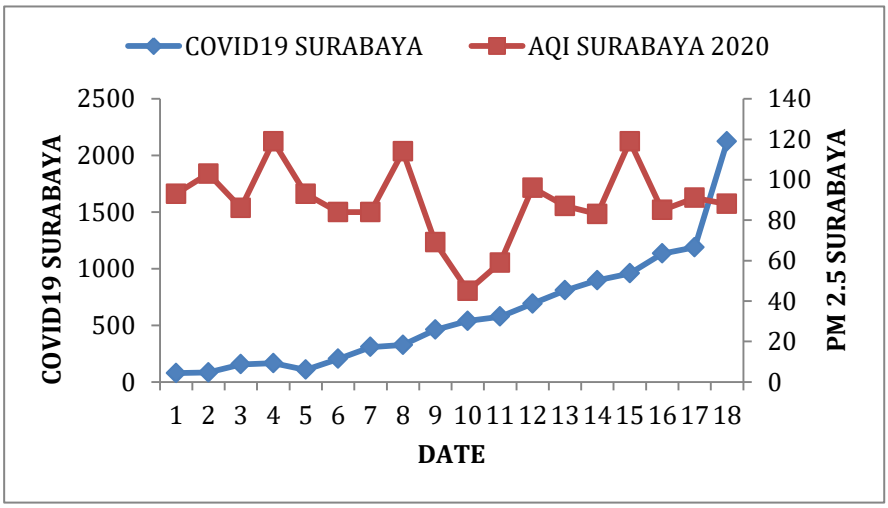
Correlation of AQI and Positive cases in Jambi, Jakarta, and Surabaya



(a)



(b)



(c)

Figure 3. Correlation of AQI and Positive case in Jambi (a), Jakarta (b) and Surabaya (c)

Figure 3 showed that there was no decrease in PM2.5 concentrations, along with an increase in positive cases in Jambi. For the Jakarta and Surabaya regions, there was a decrease in the relative concentration of PM2.5 to the addition of positive cases of COVID-19. This is due to the condition of the people who prefer to quarantine at home during the increasing COVID-19 cases. The absence of a significant increase in COVID-19 cases has also contributed to the absence of a decrease in PM2.5 concentration. This is due to the condition of the people in Jambi who continue to carry out their usual activities.

Statistical Analysis

Table 1. Estimation of model parameters using the least-squares method

Parameters	Coefficient	Deviation standard	t-value	P-value
COVID-19 in Jambi	-0.4842	0.317	-1.61	0.000
COVID-19 19 in Jakarta	-0,2918	0.2282	-1.28	0.000
COVID-19 19 in Surabaya	-0,1400	0.1211	-1.49	0.000

The observations made in this study inform that the spread of COVID-19 in the Jakarta and Surabaya regions increased significantly every day in period 1 to 29th May 2020. The contrary was found in the Jambi area, where the increase in cases per day was not so significant. Jambi is one of Indonesia's regions far from the capital city of Jakarta as the COVID-19 epicenter. The city of Surabaya is an area that is close to Jakarta, causing the spread to this region to be very significant. Although COVID-19 caused many deaths quickly, improvements in environmental quality have been reported during the pandemic. This study's results inform that AQI for the Jakarta, Surabaya, and Jambi areas has

decreased PM 2.5 due to the non-operation of industrial and transportation activities. This study also tried to inform the correlation between the spread of COVID-19 and AQI in each region. The results of the study inform us that there is a decrease in the number of PM2.5 in the regions of Jakarta and Surabaya. However, the different reality is found in Jambi, PM2.5 concentrations in the Jambi region are still volatile; this is due to the still-operating vehicles and industries in the Jambi region. A decrease in pollutant concentrations, such as PM2.5, is also reported in various countries. The results of the statistical analysis show that the results of the F test value are 2.58. Based on table 1 above, it can be seen that the estimated value of t for each parameter has been significant with a value of $p < 0.05$. In this case, it can be shown that COVID-19 has a negative and significant effect on air quality. Subsequent analysis showed that the movement of COVID-19 greatly affected air quality. By looking at the analysis results obtained, the adjusted R results in this analysis are 85%. This result shows that 85% of air quality can be explained by the independent variable, COVID-19, while the remaining 15% is explained by other factors not examined in this study.

Discussion

Lockdowns in Spain due to the SARS-CoV-2 virus have been carried out since 14th May 2020, where all public transportation, restaurants, shops, administrative centers, and other economic activities are closed to reduce social contact. As a consequence, the level of urban air pollution is reduced very dramatically. Some parameters of urban air pollution such as PM10, BC, NO2, and SO2, experienced a significant decrease of 27.8%, 45.4%, 47.0%, and 19.4%. Meanwhile, on the road conditions, the SO2 parameter increased 1.8% from the previous condition, and PM10 NO_2 decreased respectively 31.0% and 51.4%. From these results, it can be seen that the most significant change in pollution levels is seen in NO_2 and PM10 concentrations due to the cessation of activities involving the combustion process. The low SO_2 level decrease may be due to the low initial SO_2 level in Barcelona City, and the observed value is at the limit detection of the SO_2 measurement instrument. Impressive results can also be seen at the O_3 level. Traffic and urban areas experienced an increase of O_3 during a lockdown of 28.5% and 57.7%. A recent study also reported a decrease in PM during the pandemic in Barcelona, Spain, by 27.8% compared to the reasonable (before pandemic) period (Tobias, 2020). The condition can occur due to several causes, namely decreasing NOx in the form of VOCs, decreasing NO concentrations in ambient air so that O_3 used in the NO_2 formation reaction is very small, and increased insulation and temperature February to April. The regional lockdown policy was able to reduce air emissions and improve air quality in a short time. However, research related to the long-term effects of lockdown on air quality needs to be done to ensure changes in air quality in an area due to a massive policy carried out during this pandemic (Tobias, 2020).

Restrictions on activities throughout China impact NO_2 reduction of 30% and CO_2 reduction by 25%. This figure is very significant compared to other countries, which only reached a 6% decline. Then what is the other real impact? Previously it should be understood that in 2016 China had lost 1.6 million people due to air pollution. WHO has also revealed that as many as 4.6 million people worldwide die each year from poor air quality. Lung disease, asthma, bronchitis, or other respiratory allergies are contributors to many deaths. The air level has also decreased, and clean air is increasing, and then slowly, the environment is recovering. If correlated with the calculation approach, the possibility can be predicted as much as 6%, or the equivalent of 100,000 Chinese residents will be saved from the adverse effects of air pollution that had previously occurred. Although this scheme of reducing mortality to pollution reduction has not yet been fully agreed upon, the activity limitation policy can be a reliable measure in determining future environmental control policies (Dutheil et al., 2020).

In China, social distancing regulations have reduced activity in power generation, industry, and vehicle traffic. These conditions caused a decrease in NO_2 of 22.8 $\mu g/m^3$ in Wuhan and 12.9 $\mu g/m^3$ in China. This event also resulted in a PM2.5 reduction of 1.4 $\mu g/m^3$ and 18.9 $\mu g/m^3$ in a row or equivalent to a 20-30% decrease compared to pollution in 2017-2019 (Zambrano-Monserrate et al., 2020). Efforts to reduce the rate of infection can reduce 30% of environmental pollution. The determination of pollution reduction is based on the presence of NO_2 pollutants in the air because NO_2 is reactive and is commonly found in motor vehicle emissions. Lockdown causes a decrease in sectoral mobility of 90% of regular activity. These sectors include transportation, shopping, recreation, offices, and parks or green open space. However, there was also an increase in the Mobility Index of 15-20% in the residential sector. Although this condition harms the economy, especially the decline in energy and oil demand, the good news is that the environment can do it independently.

Conclusion

The COVID-19 pandemic that occurred in Indonesia has caused significant deaths in a short time. Various prevention efforts have been made, including lockdown. This effort has led to improved environmental recovery (precisely air quality). PM2.5 concentrations decreased significantly during the pandemic process in the Jakarta and Surabaya regions as the epicenter of the COVID-19 spread. However, PM2.5 concentrations are still fluctuating in the city of Jambi. This condition is due to the great distance from the COVID-19 deployment center, and the Jambi region is not lockdown so that industry and transportation continue to operate. Even though there is a correlation between the COVID-19 pandemic and air quality, case studies in the Jakarta, Surabaya, and Jambi regions inform that there is no

positive correlation between air quality (PM2.5) on the distribution of COVID-19. Further analysis is needed to influence air quality and the spread of COVID-19 in a longer vulnerable time.

Recommendation

More prolonged data analysis is needed to determine changes in pollutant conditions in urban and rural areas. Besides, other parameter data such as NOx, ozone, PM10 are needed to determine the extent of the influence of the COVID-19 pandemic on air quality in Indonesia.

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