Tropical Climate Influence the Cumulative Confirmed COVID-19 Cases in Indonesia

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Abstract

Objectives: This study aimed to find evidence on the effects of climatological parameters (temperature, rainfall, and humidity) on the cumulative cases of COVID-19 in Indonesia.

Methods: The daily climatological data and confirmed COVID-19 cases were recorded from March 1st to August 31st, 2020. The correlation analysis was performed with Pearson's Correlation Coefficient by using a Statistical Package for the Social Sciences.

Results: Indonesia has recorded more than 1,315 confirmed COVID-19 cases in almost all provinces during the dry season (March to August 2020). As of August 31st, 2020, the five highest cumulative COVID-19 cases were recorded from DKI Jakarta, Jawa Timur, Sulawesi Selatan, Jawa Barat, and Jawa Tengah Provinces. During the first six months of the pandemic, Indonesia had temperatures ranging 25.99-29.02°C, humidity of 76.43-87.35%, and rainfall of 2.91-18.81 mm^3 per month.

Conclusion: The temperature parameter showed a strong negative correlation with the cumulative confirmed COVID-19 cases. Meanwhile, the humidity and rainfall parameters presented a very strong negative correlation. This study's findings can help the Government to predict the progression of the COVID-19 pandemic over the coming months in Indonesia.

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`supportive file-appendix 1 (the list of climatological station).docx` available at https://authorea.com/users/538886/articles/599730-tropical-climate-influence-the-cumulative-confirmed-covid-19-cases-in-indonesia

Tropical Climate Influence the Cumulative Confirmed COVID-19 Cases in Indonesia

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Key Points:

- COVID-19 is a global pandemic that highly transmissible from human-to-human
- Numerous factors affect the pandemic including the temperature, humidity, rainfall
- This findings help to predict the progression of the COVID-19 pandemic in Indonesia

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Conclusion: The temperature parameter showed a strong negative correlation with the cumulative confirmed COVID-19 cases. Meanwhile, the humidity and rainfall parameters presented a very strong negative correlation. This study's findings can help the Government to predict the progression of the COVID-19 pandemic over the coming months in Indonesia.

Keywords: COVID-19; humidity; Indonesia; rainfall; temperature; tropical climate

1. Introduction

The World Health Organization (WHO) has declared a global pandemic for the outbreak of novel coronavirus disease on March 11th, 2020. As of November 4th, 2020, the SARS-CoV-2 virus has spread to 219 countries and affected over 46,840,783 individuals globally with 1,204,028 recorded deaths (www.worldometers.info). The overall geographic range of COVID-19 transmission is much broader than the epidemic of SARS which was caused by SARS-CoV infection in 2003. At the time of writing, Indonesia has recorded 418,375 confirmed cases with 14,146 deaths and 349,497 recovered cases (Indonesia Task Force for COVID-19 at www.covid19.go.id).

The Coronavirus Disease 2019 (COVID-19) is a pathogenic respiratory viral infection which is caused by Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2). SARS-CoV-2 is a single-stranded positive RNA virus, which is enveloped, non-segmented, and diameter size of 65-125 nm with spikes in a crown shape (Astuti and Ysrafil 2020). It is highly transmissible from human-to-human, typically transmitted via cough, sneeze, and direct contact with contaminated surfaces (Prather et al. 2020).

The coronavirus transmission can be directly or indirectly influenced by various factors such as environmental conditions (e.g. temperature, precipitation, humidity, and wind speed), population density, and medical facilities status (Dalziel et al. 2018). Research has reported that infectious disease transmission is directly correlated with the seasonal cycle (Martinez 2018; Puspa et al. 2014). This ever-present feature is commonly observed in respiratory viral diseases, e.g. influenza (Chattopadhyay et al. 2018) and other human coronaviruses (Killerby et al. 2018; Neher et al. 2020).

The current study indicates that climate significantly influences the cumulative confirmed COVID-19 cases at certain locations (Bukhari and Jameel 2020). In subtropical countries, some studies indicated that the outbreaks of SARS were strongly correlated with temperature variations (Tan et al. 2005). Epidemiological surveillance support the correlation of environmental conditions with the occurrence of the COVID-19 pandemic. Some independent studies have found that SARS-CoV-2 virus is sensitive to high humidity and temperature (Chin et al. 2020; Ma 2020; Sun et al. 2020; Wu et al. 2020; Xie and Zhu 2020; Yao et al. 2020). One in vitro study by Chin et al. (2020) found the stability of SARS-CoV-2 at 4°C and its sensitivity to heat.

Indonesia is the fourth most populous country in the world. Thus, Indonesia might suffer a longer period of the COVID-19 pandemic than other less-populous countries. Moreover, the occurrence of a second or third wave of the COVID-19 pandemic should be anticipated. Since numerous factors may affect the pandemic, the effect of climatological parameters on the COVID-19 transmission in Indonesia should be studied. This study aimed to find evidence on the effects of climatological parameters (i.e. temperature, rainfall, and humidity) on the cumulative confirmed COVID-19 cases in Indonesia from March to August 2020. This study's findings can help the Government to predict the progression of the COVID-19 pandemic over the coming months in Indonesia.

2. Methods

Data Collection

The daily data of confirmed COVID-19 cases from March 1st to August 31st, 2020 were collected from Indonesian government authorities that are available at www.covid19.go.id by Indonesia Task Force for COVID-19. The confirmed COVID-19 cases were recorded from 34 provinces in Indonesia. Meanwhile, the climatological parameters (temperature, rainfall, and humidity) were sourced from the Meteorological, Climatological, and Geophysical Agency of Indonesia (available at www.bmkg.org.id). The daily climatological data were

recorded from 163 different stations (App. 1). Both daily confirmed COVID-19 cases and climatological data were then calculated proportionally as monthly data from March to August 2020 (six months).

Data Analysis

The collected data were analyzed using a Microsoft Excel spreadsheet and presented in a graph. The monthly averages of climatological data (temperature, humidity, rainfall) were computed by using the monthly data from March to August 2020 in 33 provinces with 163 different stations in Indonesia. The data from Kalimantan Utara Province (as a new province declared in 2012) were excluded due to the lack of a climate station. The analysis results were visualized by using diagrams and distribution maps. The correlation comparison between each of the climatic parameters and cumulative cases of COVID-19 was performed with Pearson's Correlation Coefficient using a Statistical Package for the Social Sciences. The values of statistical significance were considered at 95% and 99% confidence intervals.

3. Results

Indonesia has recorded more than 1,315 confirmed COVID-19 cases in almost all provinces (30 out of 34) during the dry season (March to August 2020). The first COVID-19 case was recorded on March 2nd, 2020 (Indonesia Task Force for COVID-19). The cases were increasing rapidly in the next month which covered all provinces. As of August 31st, 2020, the five highest cumulative COVID-19 cases were recorded from DKI Jakarta, Jawa Timur, Sulawesi Selatan, Jawa Barat, and Jawa Tengah Province (Fig. 1).

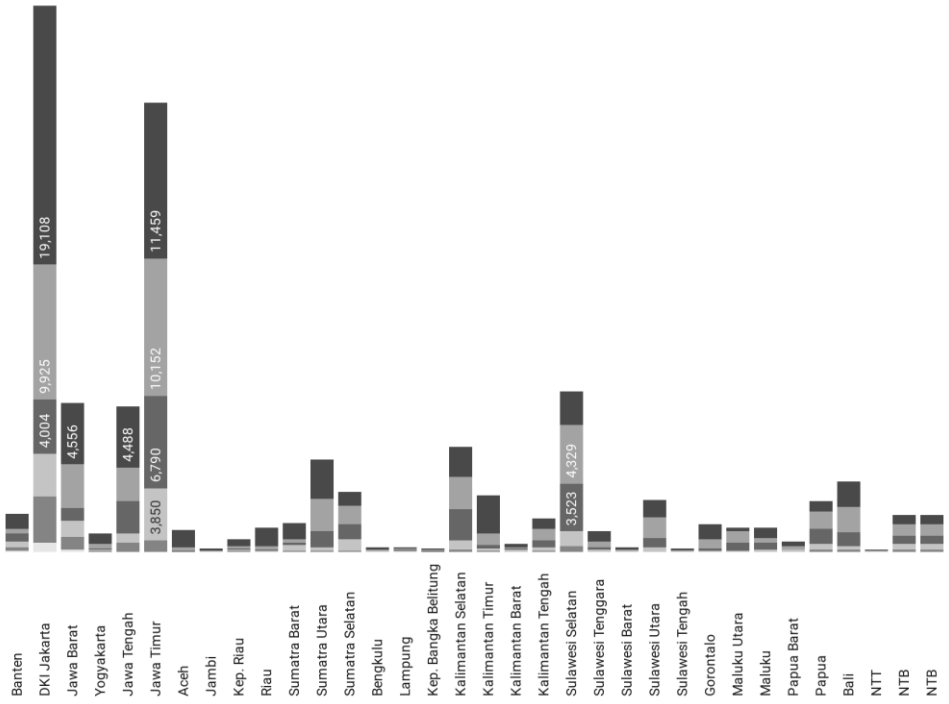

Fig. 1. The cumulative count of confirmed COVID-19 cases in Indonesia from March to August 2020 (source: Indonesian Task Force for COVID-19 at www.covid19.go.id).

COVID-19 is a respiratory illness which is caused by SARS-CoV-2 infection. The transmission of this influenza-like virus is thought to be affected by the climatological parameters. In this study, we monitored the range of different climatological data during the early pandemic in Indonesia (March to August 2020). The visualization showed the monthly average temperature across Indonesia ranged from 25.99 to 29.02^{o}C. The highest average temperature was recorded in DKI Jakarta in May at 29.48^{o}C. Meanwhile, the lowest average temperature was recorded in Jambi in July at 25.45^{o}C (Fig. 2a). During the first six months of the pandemic in Indonesia, the environmental humidity ranged from 76.43 to 87.35%. This condition might be related to the humidity range of Indonesia as a tropical country. The highest average humidity was recorded from Kepulauan Bangka Belitung in April at 88.80%. Meanwhile, the lowest average humidity was recorded from Nusa Tenggara Timur in July at 73.39% (Fig. 2b). Besides the temperature and humidity data, the rainfall data were also monitored from March to August 2020. The rainfall data were differently distributed across Indonesia which ranged from 2.91 to 18.81 mm^{3} per month. The highest rainfall recorded was obtained from Papua during March 2020 at 26.27 mm^{3} per month. The lowest average rainfall data were recorded from Nusa Tenggara Timur during August 2020 (Fig. 2c).

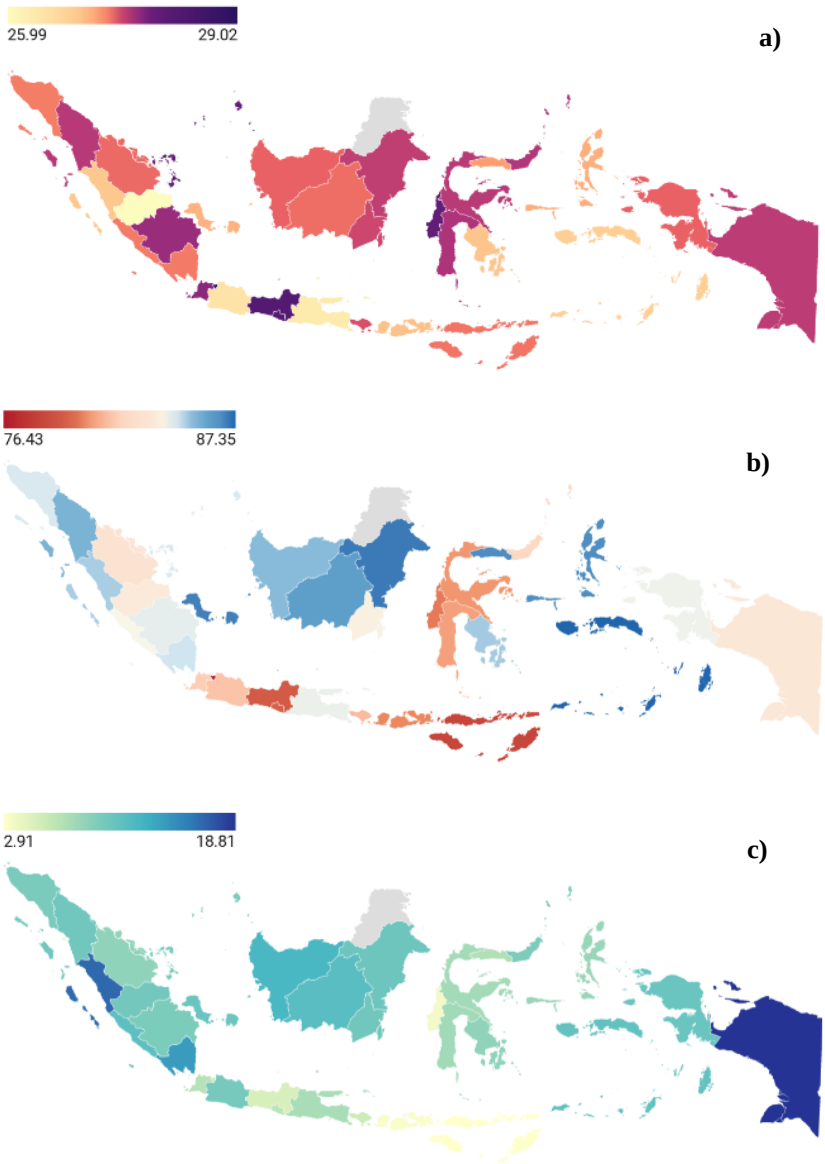

Fig. 2. The distribution and range of average temperature (a), humidity (b), and rainfall (c) in Indonesia from March to August 2020.

The correlations between the cumulative confirmed COVID-19 cases and climatological parameters (temperature, humidity, rainfall) are shown in Table 1 and Fig. 3. The correlation analysis was performed with Pearson's Correlation Coefficient using a Statistical Package for the Social Sciences. The values of statistical significance were considered at 95% and 99% confidence intervals.

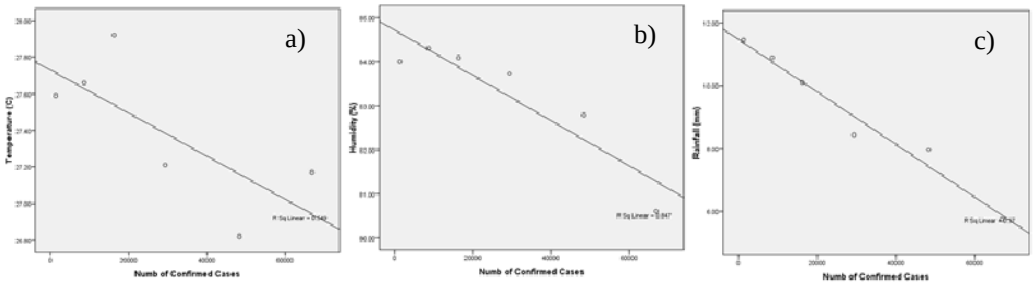

Fig. 3. Correlations between the cumulative confirmed COVID-19 cases and climatological parameters a) temperature; b) humidity; c) rainfall in Indonesia from March to August 2020.

Table 1. Correlations between the cumulative confirmed COVID-19 cases and climatological parameters in Indonesia from March to August 2020.

Climatological Parameters	Pearson's Correlation Coefficient
Average Temperature (^{o}C)	-0.741
Average Humidity (%)	-0.921**
Average Rainfall (mm)	-0.985**

Note: **significant at a 99% confidence interval

This present study showed that the increase in average temperature, humidity, and rainfall was negatively correlated with the increased cumulative of confirmed COVID-19 cases. The classification of the correlation levels was as follows: at 0.00-0.19 as 'very weak', 0.20-0.39 as 'weak', 0.40-0.59 as 'moderate', 0.60-0.79 as 'strong', and 0.80-1.00 as 'very strong' (Evan 1996). Therefore, the temperature parameter presented a strong negative correlation with the cumulative confirmed COVID-19 cases. Meanwhile, the humidity and rainfall parameters presented a very strong negative correlation.

4. Discussion

The analysis results of the cumulative count of confirmed COVID-19 cases in Indonesia showed that DKI Jakarta, Jawa Timur, Sulawesi Selatan, Jawa Barat, and Jawa Tengah were the five most affected provinces from March to August 2020 (Fig. 1). In 2019, those provinces were recorded as the twelve most-densely populated provinces (Statistics of Indonesia 2020). Since SARS-CoV-2 is highly transmissible from human-to-human (Prather et al. 2020), it is assumed that COVID-19 transmitted rapidly in population-dense areas. During the last five years, DKI Jakarta is the densest province, with a population density of 16,704 people/km^2 in 2020 (Statistics of Indonesia 2020). The population density was reported to affect the infection and mortality rate of COVID-19 cases in metropolitan areas (Tosepu et al. 2020). Also, a broader study in India conducted by Bhadra et al. (2020) found the same result. Besides the population density, community mobility might also affect the infection rate of COVID-19 cases (Tosepu et al. 2020; Zu et al. 2020).

Many studies have been conducted globally to predict the effect of climatological parameters on disease transmission. Climatological factors have shown a constant correlation with the pathogen, host, and environmental factors of the emergence and re-emergence of

infectious diseases (Cohen 2020; Tosepu et al. 2020). Tropical countries, including Indonesia, welcome the dry monsoon which usually takes place from May to October. This condition can be potentially utilized as an environmental-based evidence to fight the COVID-19 pandemic. Here, we explored the correlation between climatological data (temperature, rainfall, and humidity) and the cumulative count of confirmed COVID-19 cases in Indonesia.

The temperature is an important factor that present a different impact on the living environment and public health. Studies have reported that the transmission of SARS-CoV and influenza is sensitive to rising ambient temperatures (Jaakkola et al. 2014). The range of monthly average temperature across Indonesia ranged from 25.99 to 29.02^{o}C from March to August 2020 (Fig. 2a). As a tropical country, Indonesia has a narrow range of daily temperature changes. Located in the equatorial area, Indonesia's climatic condition is strongly influenced by monsoon winds which create hot and humid conditions. Daily environmental temperature ranges 22-33°C. Meanwhile, the humidity is fluctuating from 60% to 95% (Feriadi and Wong 2004).

This present study showed that the increase in average temperature strongly negatively correlates with the cumulative count of confirmed COVID-19 cases but not significantly (Fig. 3a, Table 1). It indicates that the cumulative confirmed COVID-19 cases increased with decreasing temperature in Indonesia. This finding supports the previous studies which found as the increased temperature rises, the cumulative count of COVID-19 cases decreases (Bannister-Tyrrell et al. 2020; Iqbal et al. 2020; Ujiie et al. 2020; Wang et al. 2020; Wu et al. 2020). In contrast, other studies found a positive association between cumulative COVID-19 cases and temperature in subtropical countries (Wang et al. 2020; Xie and Zhu 2020). Low temperatures is suggested significantly associated with the viability and transmission rate of coronaviruses (Wang et al. 2020). It was supported by an in vitro study by Chin et al. (2020) that found the stability of SARS-CoV-2 at 4°C and its sensitivity to heat.

During the first six months of the pandemic in Indonesia, the humidity ranged from 76.43 to 87.35%. The average humidity very strongly negatively and significantly correlated with the increase of the cumulative number of confirmed COVID-19 cases (Fig. 3b, Table 1). It indicates that the cumulative confirmed COVID-19 cases increased with decreasing humidity in Indonesia. Previous studies presented evidence of a negative association of relative humidity with the transmission rate of COVID-19 cases both in tropical (Pani et al. 2020; Suhaimi et al. 2020) and subtropical countries (Ma 2020; Yao et al. 2020). Wu et al. (2020) found daily COVID-19 cases decreased by 0.85% for every 1% increase of humidity.

The transmission of many viruses is increased due to humidity decrease, e.g. influenza (Puspa et al. 2014) and SARS-CoV-2 viruses (Ahlawat et al. 2020). A recent study explained that viruses survived well at humidity below 33% (Lin & Marr 2020). Also, Bu et al. (2020) suggested that COVID-19 is highly transmitted at 50-80% of humidity. In low environmental humidity, the droplets evaporate at a more rapid rate which will form smaller size particles (Feng et al. 2020; Prather et al. 2020). This condition provides more chances for other people to breathe in the infectious viral droplets or particles (Ahlawat et al. 2020; Somsen et al. 2020).

Rainfall availability can present a strong pressure on the dynamics of infectious diseases (Puspa et al. 2014). The rainfall data were differently distributed across Indonesia which ranged from 2.91 to 18.81 mm^3/month from March to August 2020. The average rainfall data very strongly negatively and significantly correlated with the increase of the cumulative confirmed COVID-19 cases (Fig. 3c, Table 1). It indicates a lower transmission rate of COVID-19 cases was observed during higher precipitation. Bu et al. (2020) suggested the favorable range of precipitation for virus survival is 30 mm^3/month or less. Our findings supported other studies that found a low influence of precipitation on COVID-19 spread both in tropical and subtropical countries (Ma 2020; Mendez-Arriaga 2020; Wang et al. 2020). Also, cold environments are suggested to be associated with pneumonia fatalities (Zhang et al. 2020) and seasonal influenza (Gomez-Barroso et al. 2017; Puspa et al. 2014).

Although the correlation between rainfall availability and the COVID-19 transmission is not well-known, high precipitation is suggested to contribute to the viability and transmission rate of coronaviruses (Ma 2020; Wang et al. 2020). Increasing precipitation will decrease the evaporation of infectious droplets which increases the opportunity to spread viruses (Lu et al. 2020). Innate immune systems are compromised in cold environments. Cold environmental temperature can reduce the blood supply which reduces the distribution of immune cell's availability to the nasal mucosa. Also, cold environments reduce the ability of respiratory cilia cells to secrete mucus and remove viruses, thus increasing the exposure of infectious virus to host (Sun et al. 2020).

Our findings and understanding of the climatic effect on the COVID-19 transmission in tropical countries including Indonesia can contribute to the decision-making process to fight and control the current pandemic. However, several limitations must be considered. In this present study, the daily confirmed cases might not exactly interpret the infection of transmission dates. Second, the low detection coverage might effected the cumulative count of confirmed COVID-19 cases, especially in low-resource areas.

5. Conclusions

Our study presented evidence that climatological parameters (average temperature, humidity, and rainfall) influence the COVID-19 transmission in Indonesia as one of the tropical countries. The temperature parameter showed a strong negative correlation with the cumulative confirmed COVID-19 cases. Meanwhile, the humidity and rainfall parameters presented a very strong negative correlation. Although the climate is likely affecting virus transmission, there is no doubt that the population density and social behavior are important factors of virus transmission. Therefore, the authors recommend the community to be disciplined in using masks, frequent hand washing, and practicing a physical distancing.

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Data Availability Statement

The datasets for this research are included in this paper (and its supplementary information files). The daily data of confirmed COVID-19 cases are available at www.covid19.go.id by Indonesia Task Force for COVID-19. The climatological parameters (temperature, rainfall, and humidity) were sourced from the Meteorological, Climatological, and Geophysical Agency of Indonesia (available at www.bmkg.org.id).

Conflicts of Interest

The authors report there were no conflicts of interest in this present study.

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