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# Understanding the Climate Behavior Through Data Interpretation: Java-Bali-Nusa Tenggara Case

*Amartya Natayu[1 2]*, Fatima Tasya Kamila[1 2], Ida Bagus Gede Genta Dananjaya[1 2], Rhainna Rheizkhira Reflin[1 2], Muhamad Rausyan Fikri[3]*

[1] Department of Mechanical Engineering, Faculty of Engineering and Technology, Sampoerna University, Jakarta, Indonesia.

[2] Department of Aerospace and Mechanical Engineering, College of Engineering, The University of Arizona, Tucson, AZ, USA

[3]Department of Information System, Faculty of Engineering and Technology, Sampoerna University, Jakarta, Indonesia.

*Corresponding email: amartya.natayu@my.sampoernauniversity.ac.id

## ABSTRACT

As an archipelago country in the equator, Indonesia has a tropical climate and often is subjected to monsoonal circulation. The geographical location affects Indonesia to have two seasons, which are the rainy season and drier season. Every season has its characteristic impacts against the mean temperature and rainfall rate. This research aims to analyze Indonesia's mean temperature and rainfall rate data concerning its tropical climate. The areas observed are limited to Java, Bali, and Nusa Tenggara Island from January 2019 to December 2020. The data gathered from the official Badan Meteorologi Klimatologi dan Geofisika (BMKG) website were processed using MATLAB, and Spearman's correlation was applied to analyze the rainfall and temperature data. From the observation, this study discovered that the mean temperature data is stable throughout the areas but reaches maximum during the transition between rainy and drier seasons and minimum during the middle of the rainy season. The data observation is often fluctuated, even though showing less rain during the drier season and more during rainy seasons. The fluctuation is affected by the geographical fact that Indonesia has a large water surface, which makes evaporation easily induced by warm tropical temperatures.

## ARTICLE INFO

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## 1. INTRODUCTION

Indonesia is one Southeast Asian country with a tropical climate as an archipelago that sits on the equator line (Cribb & Ford, 2009). The tropical condition is closely related to several climate aspects, particularly the mean temperature and rainfall rates. The mean temperature indicates the average heat in the air recorded during a specific period (American Meteorological Society [AMS], 2012a). The conclusion shows that the tropical areas are warm ties back to the sunlight spread phenomenon on the earth's surface. The spots near the equator line receive more intense sunlight than any other spots farther from the equator, implying the tropical area generally has warmer air temperatures (Stevens, 2010).

Meanwhile, rainfall rate is the intensity of rainfall measured during a specific period (AMS, 2012b). In tropical circumstances, the heavier rain intensity is expected due to the correlation with a warmer state. As the temperature increases, it is generally assumed that the rainfall intensity will also experience an increase (Sobel, 2012; Westra et al., 2014; Chen et al., 2013). This reason is why Indonesia has areas with a warmer temperature and higher rain intensity.

In the Indonesian region, the rainfall pattern is mainly influenced and based on the monsoonal circulation pattern of wet and dry months with the peak of rainfall within the December to February interval (Kementrian PPN/Bappenas 2010; Loo et al., 2015). Therefore, heavy rain usually happens from December to February, whereas little to no rain can occur from June to August.

However, the peak raining period is directly proportional to the mean air temperature. During rainy months (December-February), the air temperature will drop and surge in the drier months (March-May and October-December) (Prasetyo et al., 2021). The monsoonal pattern strongly occurs in Java, Bali, Nusa Tenggara, and several more areas in Sumatra and Papua (Hermawan, 2010). In the center of mobility, Java Island, the climate condition has changed over the years. The mean temperature on Java Island has increased in the past three decades (Prasetyo et al., 2021). The increasing trend is assumed to be the consequence of climate change in Indonesia, particularly in Java's big cities such as Jakarta, Bandung, Semarang, and Surabaya.

Not only in Java, but Bali also experiences a change in its monthly average temperature. A previous investigation during the 2004-2008 period captures a tendency of increasing mean temperature during dry months and decreasing during wet months (Setiawan, 2012). Aside from the temperature, it is also possible that the rainfall rates during wet months tend to be more intense as the opposite of less intense rainfall that usually occur during dry months (ICCSR, 2010). This temperature and rainfall increasing behavior is due to the alteration in the climate condition in recent years and is also predicted to keep happening in the future years (ICCSR, 2010; Case et al., 2007).

The purpose of this study is mainly focused on providing information on the rainfall rate and average temperature state in the Java-Bali-Nusa Tenggara area over the past two years. Furthermore, it aims to implement the result analysis and figure the pattern of each variable in different months and year periods. Specifically, the analysis later will be used to identify the maximum and minimum values, also the phenomena in the output of the rainfall rate and mean temperature data. Along with researching Indonesian climate

circumstances, this study involved the usage of data processing software MATLAB R2020a.

The investigation of rainfall rates and mean temperature data starts with data gathering from the BMKG official website. Subsequently, the data is imported and processed in MATLAB. Most of the procedures include running numerous processing codes to plot the data and gain the desired and organized output. Finally, the analysis of the data aspects such as maximum-minimum value, the plot patterns, and the correlation between the two variables is composed based on the resulting plot.

## 2. RESEARCH METHODOLOGY

### 2.1. Materials

In this project, three components used are: MATLAB R2020a application, Microsoft Excel, and rainfall data from Pusat Database – BMKG. The data used are the mean temperature and rainfall rate data of each province in Java, Bali, and Nusa Tenggara Island from January 2019 to December 2020.

### 2.2. Methodology

**Figure 1** shows the methods used in this project. The processes of mean temperature and rainfall rate data are done separately but within the same script and saved under the same workspace.

First, the data is gathered from the official Badan Meteorologi Klimatologi dan Geofisika (BMKG) website in Microsoft Excel files. The data of mean temperature and rainfall rate are within the same file. Next, the data is converted into numeric matrices in MATLAB using the import tool, and the cells that are difficult to import are replaced with "NaN." According to the province, the data of each month is averaged using the mean function in MATLAB. The average data per month is compiled into one array for each province and saved as MATLAB Workspace files (.mat).

In the final script, the workspaces are loaded, and the arrays are called. The data is averaged per island by combining the arrays of every province within the same island and calling the average function. Then, each array of mean temperature and rainfall rate data is plotted using the plot function accordingly. The plots are based on mean temperature Java Island, mean temperature Bali Island, mean temperature Nusa Tenggara Island, a summary of mean temperature, rainfall rate Java Island, rainfall rate Bali Island, rainfall rate Nusa Tenggara Island, and summary of rainfall rate. The values are assigned on the y-axis, and the months are assigned on the x-axis. The script also defines the properties of the plot, such as labels, label tick, docked figure view, titles, figure name, grids, and legends. The plots are analyzed visually to measure the characteristics of the trendline.

The scripts are divided into two types; one to calculate the average data per month of each province and store them as MATLAB workspaces and one to run the data as plots. The first script type is labeled as the name of the according province and is described in **Table 1**.

**Table 1. Algorithm of Data Average Calculation**

**PROGRAM:** the Calculation of Monthly Average Data per Provinces
**BEGIN**
    **LOAD** Excel files as numeric matrices;
    **COMPUTE** average mean temperature
    **DEFINE** average mean temperature array
    **COMPUTE** average rainfall rate
    **DEFINE** average rainfall rate array
    **SAVE** workspace
**END**

The second script type is labeled "final" and is described in **Table 2**.

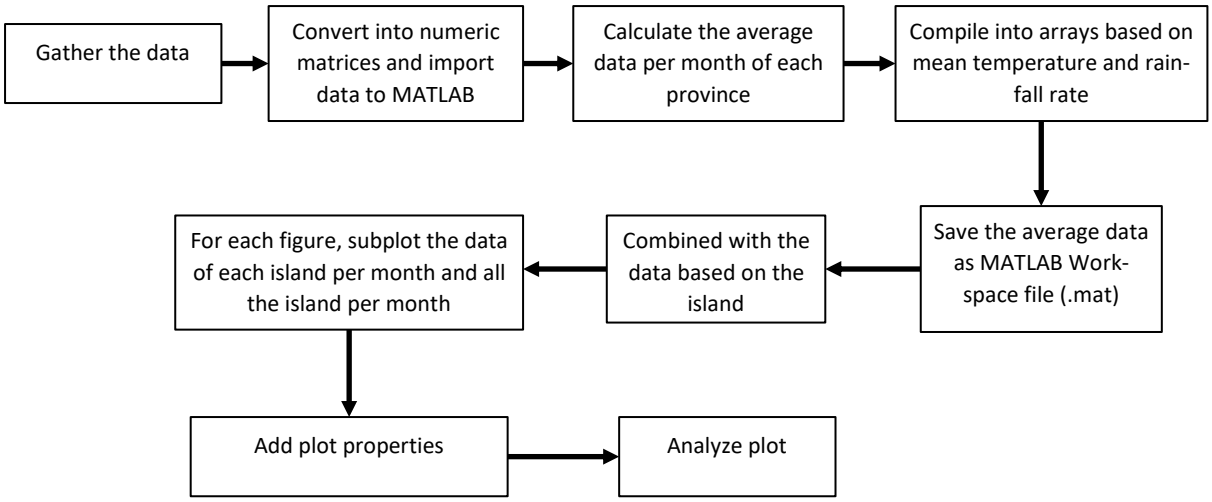


**Figure 1. Flow of processes conducted in this research**

**Table 2. Algorithm of Data Final**

**PROGRAM** to Run the Data as Plots;
**BEGIN**
  **LOAD** average data workspaces;
  **DEFINE** arrays of each data type for plotting;
  **DEFINE** plots properties;
  **RUN** plots;
**END**

The average data workspaces are the workspaces saved from the first type of script. All the workspaces are loaded in one final script. The variables in the workspaces are redefined as arrays with the month on the x-axis and the values on the y-axis. The arrays are then plotted with the according properties.

The values of each variables data are classified according to respective parameters. As for the mean temperature data, the parameters used is "Standar Kenyamanan Termal di Indonesia" by SNI-14-1993-3 (Rianty, 2007), which is shown in **Table 3**.

For the rainfall rate data, the parameter used is "Rainfall Rate Intensity" by BMKG ("Probalistik Curah Hujan"), which is shown in **Table 4**.

The correlation of mean temperature and rainfall rate is analyzed using Spearman's correlation. Spearman's correlation is used because of the non-parametric data that do not have a normal distribution.

**Table 3. Temperature Classification**

| Effective Temperature | Classification |
|---|---|
| < 20.5 ˚C | Cold |
| 20.5 ˚C – 22.8 ˚C | Cool |
| 22.8 ˚C – 25.8 ˚C | Optimal |
| 25.8 ˚C – 27.2 ˚C | Warm |
| > 27.2 ˚C | Hot |

**Table 4. Rainfall Rate Classification**

| Rainfall Rate | Classification |
|---|---|
| 0 mm | Cloudy/No rain |
| 0.5 mm – 20 mm | Light rain |
| 20 mm – 50 mm | Mild rain |
| 50 mm – 100 mm | Heavy rain |
| 100 mm – 150 mm | Very heavy rain |
| > 150 mm | Extreme rain |

The calculation is done using Python code. Spearman's correlation formula is described in Equation 1**.**

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)}. \quad (1)$$

Where $\rho$ is Spearman's rank correlation coefficient, $d_i$ is difference between two ranks of each observation, $n$ is the number of observations. The value ranges from [-1,1].

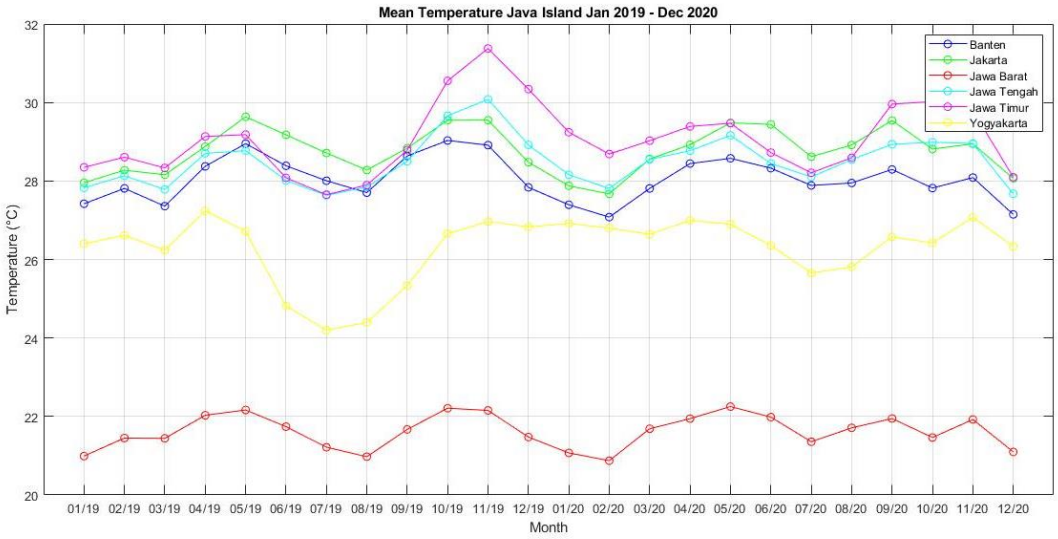


**Figure 2. Mean temperature Java Island**

A positive value shows a direct relationship between the variables, and a negative value shows opposite relation between the variables. The closer the Spearman's correlation value to -1 or +1 indicates a stronger monotonic relationship. When the value is 0, it indicates no monotonic relationship between the variables (Schober et al., 2018). According to Evans (1996), the correlation strength can be classified as the following using the absolute value of correlation:

- 0.00 - 0.19 "very weak"
- 0.20 - 0.39 "weak"
- 0.40 - 0.59 "moderate"
- 0.60 - 0.79 "strong"
- 0.80 - 1.0 "very strong"

## 3. RESULTS AND DISCUSSION

### 3.1. Mean Temperature Analysis in Java Island

**Figure 2** shows the plot of the mean temperature in Java Island from January 2019 until December 2020. Based on the plot, the highest mean temperature is in November 2019 in the province of Jawa Timur, with a value of 31.38◦C. The lowest temperature is in February 2020 in the province of Jawa Barat, with a value of 20.87◦C. The temperatures in each province are quite stable throughout the years with the exception of a drop in temperature in the province of DI Yogyakarta in July 2019 and a rise in temperature in the province of Jawa Timur in November 2019.

**Table 5** indicates the change in monthly mean temperature in Java Island from 2019 to 2020. With a positive average difference of approximately 0.46°C per month, the table exposes a tendency of increasing mean temperature within a year.

### 3.2. Mean Temperature Analysis in Bali Island

**Figure 3** shows the plot of mean temperature in Bali Province/Island from January 2019 until December 2020. Based on the plot, the highest mean temperature is in December 2019 with a value of 29.26◦C. The lowest temperature is in August 2019 with a value of 25.45◦C. The temperatures in each province experience changes but are still quite stable throughout the years. There is a drop in temperature around August 2019 and August 2020 and a rise in temperature around December 2019 and November 2019.

**Table 5. Difference of Average Mean Temperature in Java Island from 2019 to 2020**

| Month | 2019 | | 2020 | | Difference |
|---|---|---|---|---|---|
| | Monthly Average (°C) | Description | Monthly Average (°C) | Description | |
| **January** | 26.49 | Warm | 26.78 | Warm | 0.29 |
| **February** | 26.81 | Warm | 26.49 | Warm | -0.33 |
| **March** | 26.55 | Warm | 27.05 | Warm | 0.49 |
| **April** | 27.39 | Hot | 27.41 | Hot | 0.02 |
| **May** | 27.57 | Hot | 27.64 | Hot | 0.07 |
| **June** | 26.70 | Warm | 27.21 | Hot | 0.51 |
| **July** | 26.24 | Warm | 26.64 | Warm | 0.40 |
| **August** | 26.18 | Warm | 26.92 | Warm | 0.74 |
| **September** | 26.96 | Warm | 27.54 | Hot | 0.58 |
| **October** | 27.94 | Hot | 27.25 | Hot | -0.69 |
| **November** | 28.17 | Hot | 27.46 | Hot | -0.71 |
| **December** | 27.31 | Hot | 26.40 | Warm | -0.91 |
| **Average Difference** | | | | | 0.46 |

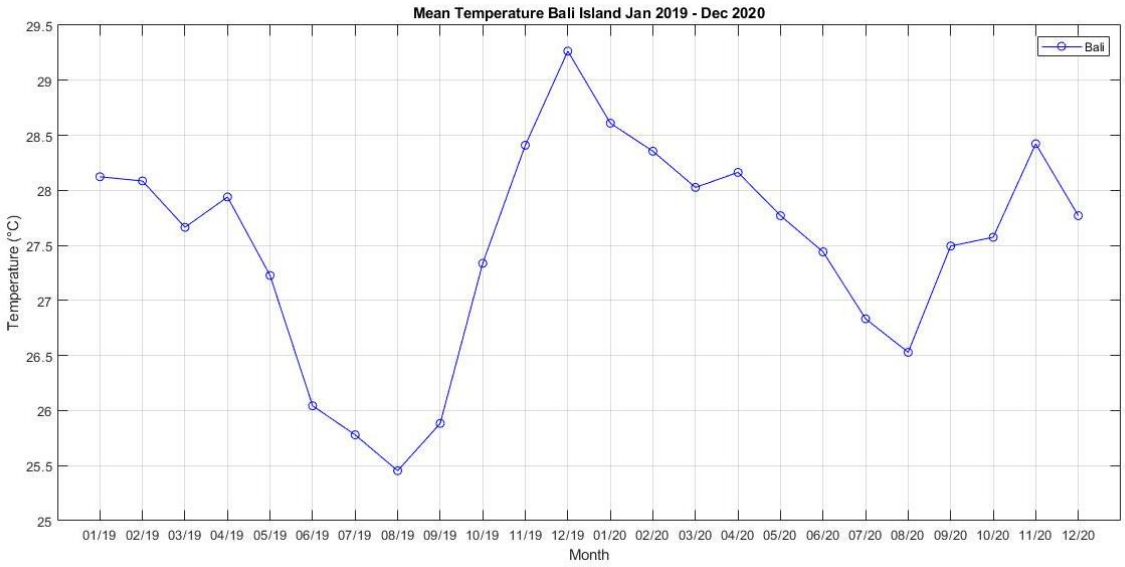


**Figure 3. Mean temperature Bali Island**

**Table 6** indicates the change in monthly mean temperature in Bali Island from 2019 to 2020. With a positive average difference of approximately 0.48°C per month, the table exposes a tendency of increasing mean temperature within a year.

### 3.3. Mean Temperature Analysis in Nusa Tenggara Island

**Figure 4** shows the plot of the mean temperature in Nusa Tenggara Island from January 2019 until December 2020. Based on the plot, the highest mean temperature is in November 2020 in the province of Nusa Tenggara Timur, with a value of 30.80°C. The lowest temperature is in July 2019 in the province of Nusa Tenggara Barat, with a value of 25.11°C.

**Table 6. Difference of Average Mean Temperature in Bali Island from 2019 to 2020**

| Months | 2019 | | 2020 | | Difference |
|---|---|---|---|---|---|
| | Monthly Average (°C) | Description | Monthly Average (°C) | Description | |
| **January** | 28.12 | Hot | 28.61 | Hot | 0.49 |
| **February** | 28.09 | Hot | 28.36 | Hot | 0.27 |
| **March** | 27.66 | Hot | 28.03 | Hot | 0.36 |
| **April** | 27.94 | Hot | 28.16 | Hot | 0.22 |
| **May** | 27.23 | Hot | 27.77 | Hot | 0.54 |
| **June** | 26.04 | Warm | 27.44 | Hot | 1.40 |
| **July** | 25.78 | Optimal | 26.83 | Warm | 1.05 |
| **August** | 25.45 | Optimal | 26.53 | Warm | 1.08 |
| **September** | 25.88 | Warm | 27.49 | Hot | 1.61 |
| **October** | 27.34 | Hot | 27.57 | Hot | 0.24 |
| **November** | 28.41 | Hot | 28.42 | Hot | 0.01 |
| **December** | 29.26 | Hot | 27.77 | Hot | -1.49 |
| **Average Difference** | | | | | **0.48** |

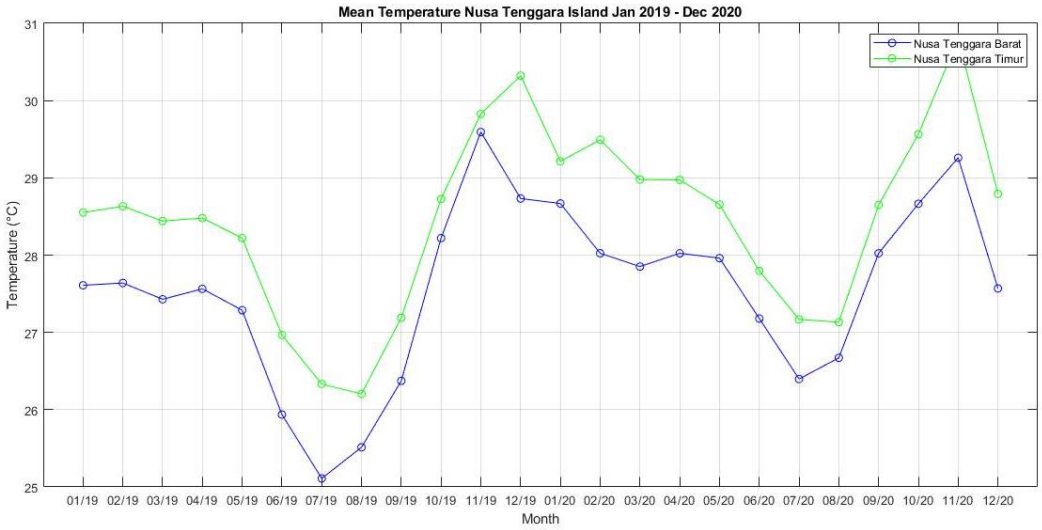


**Figure 4. Mean temperature Nusa Tenggara Island**

The temperatures in each province are quite stable throughout the years with the exceptions of a drop in temperature in the province of Nusa Tenggara Barat and Nusa Tenggara Timur in July 2019 and July 2020, a rise in temperature in the province of Nusa Tenggara Barat, and Nusa Tenggara Timur in November 2020 and rise of temperature in the province of Nusa Tenggara Barat and Nusa Tenggara Timur each in November 2019 and December 2019 respectively.

**Table 7** indicates the change in monthly mean temperature in Nusa Tenggara Island from 2019 to 2020. With a positive average difference of approximately 0.61°C per month, the table exposes a tendency of increasing mean temperature within a year.

**Table 7. Difference of Average Mean Temperature in Nusa Tenggara Island from 2019 to 2020**

| Month | 2019 | | 2020 | | Difference |
|---|---|---|---|---|---|
| | Monthly Average (°C) | Description | Monthly Average (°C) | Description | |
| **January** | 28.08 | Hot | 28.941 | Hot | 0.86 |
| **February** | 28.14 | Hot | 28.758 | Hot | 0.62 |
| **March** | 27.94 | Hot | 28.415 | Hot | 0.48 |
| **April** | 28.02 | Hot | 28.498 | Hot | 0.48 |
| **May** | 27.75 | Hot | 28.308 | Hot | 0.55 |
| **June** | 26.45 | Warm | 27.488 | Hot | 1.04 |
| **July** | 25.72 | Optimal | 26.783 | Warm | 1.06 |
| **August** | 25.86 | Warm | 26.902 | Warm | 1.04 |
| **September** | 26.78 | Warm | 28.337 | Hot | 1.56 |
| **October** | 28.47 | Hot | 29.114 | Hot | 0.64 |
| **November** | 29.71 | Hot | 30.032 | Hot | 0.32 |
| **December** | 29.53 | Hot | 28.181 | Hot | -1.35 |
| **Average Difference** | | | | | 0.61 |

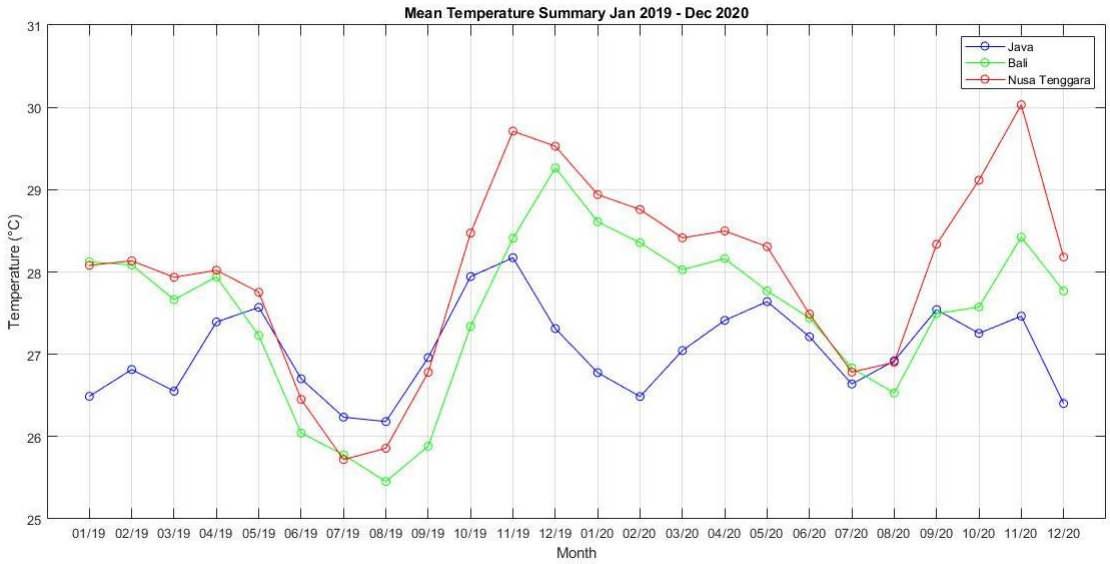


**Figure 5. Mean temperature summary**

### 3.4. Mean Temperature Analysis in Java, Bali, and Nusa Tenggara Island

**Figure 5** shows the plot of mean temperature in Java, Bali, and Nusa Tenggara Island from January 2019 until December 2020. Based on the plot, the temperatures in these islands experience changes around the same time. There is a drop in temperature around July 2019 and July 2020 and a rise of temperature around November 2019 and November 2020. Regardless, the temperatures are quite stable and range from the lowest average point of 25.45◦C in Bali Island in August 2019 to the highest average point of 30.03◦C in Nusa Tenggara Island November 2020.

**Table 8. Difference of Average Rainfall Rate in Java Island from 2019 to 2020**

| Month | 2019 | | 2020 | | Difference |
|---|---|---|---|---|---|
| | Monthly Average (mm) | Description | Monthly Average (mm) | Description | |
| **January** | 11.98 | Light rain | 12.82 | Light rain | 0.84 |
| **February** | 10.21 | Light rain | 20.82 | Mild rain | 10.61 |
| **March** | 9.84 | Light rain | 12.20 | Light rain | 2.36 |
| **April** | 8.07 | Light rain | 9.70 | Light rain | 1.63 |
| **May** | 2.35 | Light rain | 7.72 | Light rain | 5.37 |
| **June** | 0.72 | Light rain | 2.11 | Light rain | 1.39 |
| **July** | 49.60 | Mild rain | 2.01 | Light rain | -47.59 |
| **August** | 0.14 | Cloudy / No rain | 2.45 | Light rain | 2.31 |
| **September** | 0.39 | Cloudy / No rain | 1.86 | Light rain | 1.47 |
| **October** | 1.14 | Light rain | 6.29 | Light rain | 5.15 |
| **November** | 2.50 | Light rain | 5.08 | Light rain | 2.58 |
| **December** | 8.25 | Light rain | 11.73 | Light rain | 3.48 |
| **Average Difference** | | | | | -10.39 |

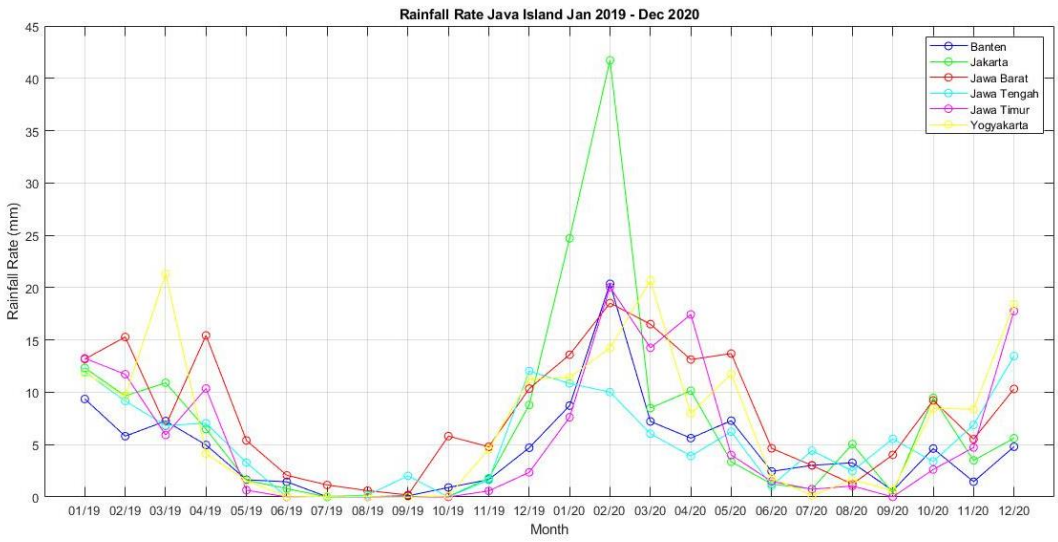


**Figure 6. Rainfall rate Java Island**

The mean temperature data shown in **Figure 5** shows that the temperature in Java, Bali, and Nusa Tenggara is averagely warm which fits with the tropical climate of Indonesia. Of the three islands, Java has the most stable temperature. The figure shows that temperature reaches its peak in drier months (November 2021). The peak temperature is less in 2019 than in 2020, except in the Nusa Tenggara Island.

### 3.5. Rainfall Rate Analysis in Java Island

**Figure 6** shows the plot of the rainfall rate in Java Island from January 2019 until December 2020. Based on the plot, the highest rate is in February 2020 in the province of DKI Jakarta with a value of 41.73 mm. The lowest rate is 0 mm which means that in the according province, it does not rain for a month.

**Table 9. Difference of Average Rainfall Rate in Bali Island from 2019 to 2020**

| Months | 2019 | | 2020 | | Difference |
|---|---|---|---|---|---|
| | Monthly Average (mm) | Description | Monthly Average (mm) | Description | |
| **January** | 11.07 | Light rain | 5.28 | Light rain | -5.79 |
| **February** | 5.33 | Light rain | 7.37 | Light rain | 2.04 |
| **March** | 8.79 | Light rain | 9.15 | Light rain | 0.36 |
| **April** | 1.70 | Light rain | 2.44 | Light rain | 0.74 |
| **May** | 0.90 | Light rain | 4.20 | Light rain | 3.31 |
| **June** | 0.01 | Cloudy / No rain | 1.89 | Light rain | 1.88 |
| **July** | 0.10 | Cloudy / No rain | 0.24 | Light rain | 0.14 |
| **August** | 0.96 | Light rain | 0.01 | Cloudy / No rain | -0.95 |
| **September** | 0.87 | Light rain | 0.05 | Light rain | -0.82 |
| **October** | 0.04 | Cloudy / No rain | 2.16 | Light rain | 2.12 |
| **November** | 0.12 | Cloudy / No rain | 3.15 | Light rain | 3.02 |
| **December** | 2.75 | Light rain | 10.87 | Light rain | 8.13 |
| **Average Difference** | | | | | 1.18 |

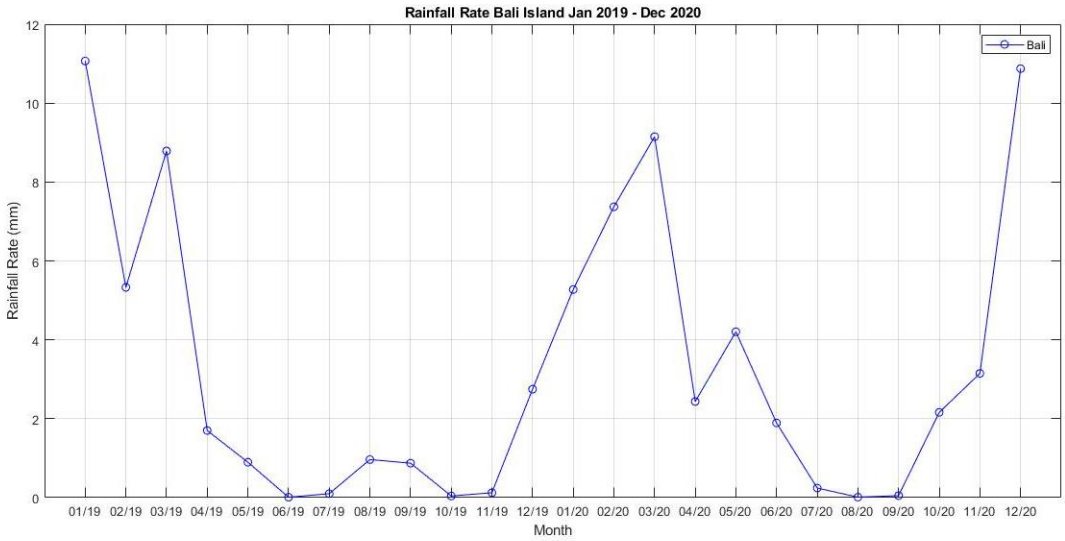


**Figure 7. Rainfall rate Bali Island**

The provinces that have 0 mm rainfall rate are Jawa Tengah and Jawa Timur in June 2016, DKI Jakarta in July 2019, DKI Jakarta and Jawa Timur in August 2019, DKI Jakarta, DI Yogyakarta, and Jawa Timur in September 2019, Jawa Timur and Jawa Barat in October 2019, and Jawa Timur in September 2020. The province that rains the least is Jawa Timur. Rainfall rates dropped around May 2019 until October 2019 and around May 2020 until September 2020. The rates increase significantly around January 2020 and peak in February 2020.

**Table 8** shows the change in monthly average rainfall rates in Java Island from 2019 to 2020. The table also exhibits a trend of decreasing rainfall rates shown by the negative average difference of -10.39 mm. There is a significant large decrease from July 2019 to July 2020.

**Table 9. Difference of Average Rainfall Rate in Nusa Tenggara Island from 2019 to 2020**

| Month | 2019 | | 2020 | | Difference |
|---|---|---|---|---|---|
| | Monthly Average (mm) | Description | Monthly Average (mm) | Description | |
| **January** | 7.20 | Light rain | 5.07 | Light rain | -2.13 |
| **February** | 5.41 | Light rain | 8.12 | Light rain | 2.71 |
| **March** | 6.65 | Light rain | 5.39 | Light rain | -1.26 |
| **April** | 3.60 | Light rain | 1.64 | Light rain | -1.96 |
| **May** | 0.25 | Cloudy / No rain | 1.18 | Light rain | 0.93 |
| **June** | 0.00 | Cloudy / No rain | 0.08 | Cloudy / No rain | 0.08 |
| **July** | 0.00 | Cloudy / No rain | 0.06 | Cloudy / No rain | 0.06 |
| **August** | 0.00 | Cloudy / No rain | 0.00 | Cloudy / No rain | 0.00 |
| **September** | 0.04 | Cloudy / No rain | 0.00 | Cloudy / No rain | -0.04 |
| **October** | 0.00 | Cloudy / No rain | 1.86 | Cloudy / No rain | 1.86 |
| **November** | 1.21 | Light rain | 1.82 | Light rain | 0.62 |
| **December** | 5.90 | Light rain | 12.54 | Light rain | 6.64 |
| **Average Difference** | | | | | 7.51 |

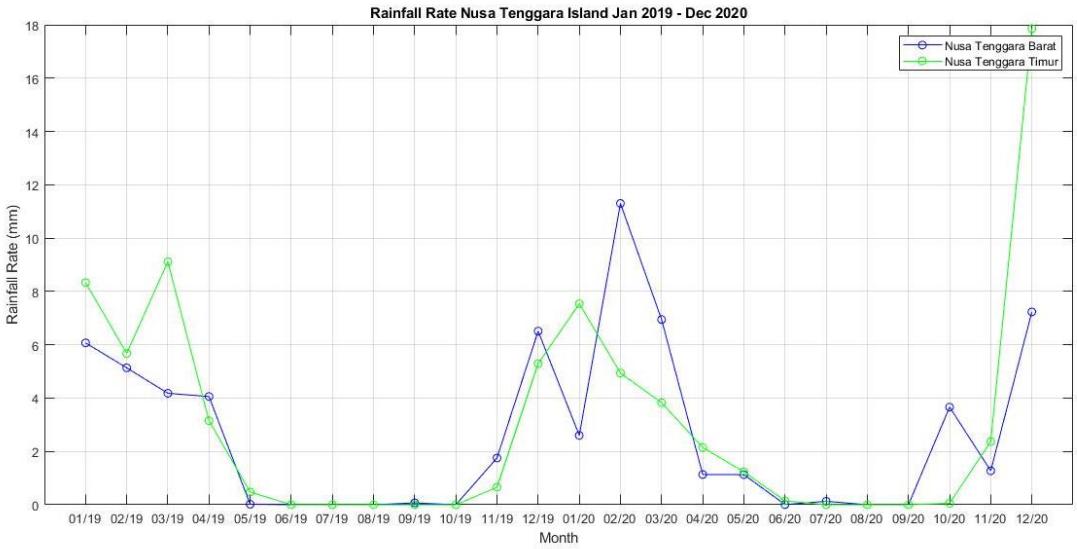


**Figure 8. Rainfall rate Nusa Tenggara Island**

### 3.6. Rainfall Rate Analysis in Bali Island

**Figure 7** shows the plot of the rainfall rate in Bali Province/Island from January 2019 until December 2020. Based on the plot, the highest rate is in January 2019 with a value of 11.07 mm. The lowest rate is in June 2019 with a value of 0.01 mm.

The rainfall rate dropped around April 2019 until June 2019 had a slight rise and dropped again in October 2019. It also dropped around July 2020 until October 2020. The rate increased significantly around January 2019, March 2020, and December 2020.

**Table 9** shows the change in monthly average rainfall rates in Bali Island from 2019 to 2020. The table also exhibits a trend of increasing rainfall rates shown by the positive average difference of 1.18 mm. There is a significant large decrease from July 2019 to July 2020.

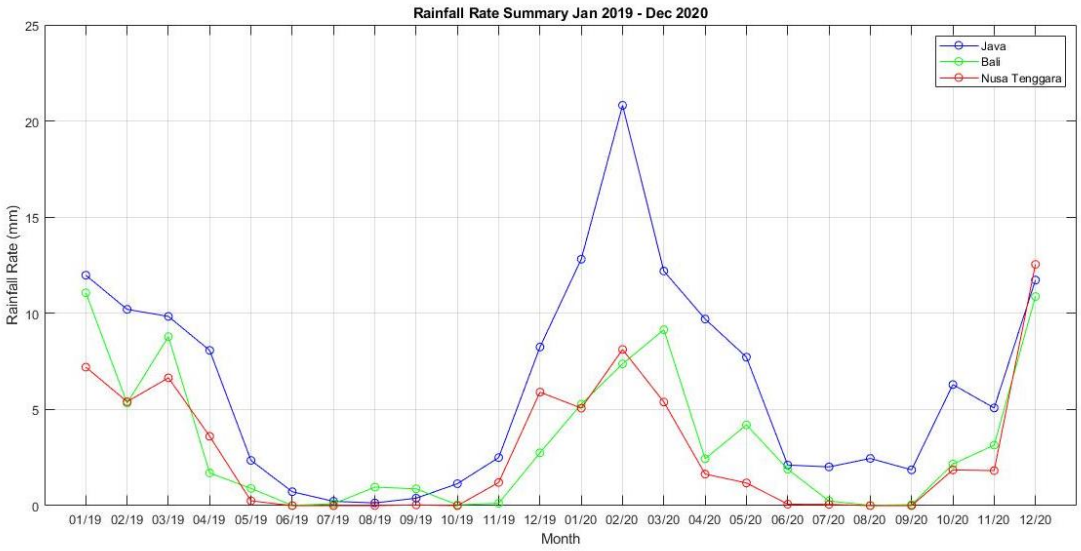


**Figure 9. Rainfall Rate Summary**

### 3.7. Rainfall Rate Analysis in Nusa Tenggara Island

**Figure 9** shows the plot of the rainfall rate in Nusa Tenggara Island from January 2019 until December 2020. Based on the plot, the highest rate is in December 2020 in the province of Nusa Tenggara Timur value of 17.86 mm. The lowest rate is 0 mm, which means that it does not rain for a month in the according province. The provinces that have 0 mm rainfall rate are Nusa Tenggara Barat and Nusa Tenggara Timur in June 2019, July 2019, August 2019, October 2019, August 2020, September 2020, Nusa Tenggara Timur in September 2019 and July 2020. Rainfall rates in Java Island dropped around May 2019 and significantly dropped around April 2020 until September 2020. The rates increased significantly around February 2020 for Nusa Tenggara Barat and around December 2020 for Nusa Tenggara Timur.

**Table 8** shows the change in monthly average rainfall rates in Nusa Tenggara Island from 2019 to 2020. The table also exhibits a trend of increasing rainfall rates shown by the positive average difference of 7.51 mm.

### 3.8. Rainfall Rate Analysis in Java, Bali, and Nusa Tenggara Island

**Figure 9** shows the plot of rainfall rates in Java, Bali, and Nusa Tenggara Island from January 2019 until December 2020. Based on the plot, the rate in these islands experience changes around the same time. The rate dropped around May 2019 and April 2020 and increased around November 2019 and October 2020. The lowest average point is 0 mm in Nusa Tenggara Island during June 2019, July 2019, August 2019, October 2019, September 2020, and October 2020. The highest average point is 20.82 mm in Java Island in February 2020.

The rainfall rate data in **Figure 9** shows that the rainfall rate in Java, Bali, and Nusa Tenggara is averagely high in certain months. The figure illustrates the rain intensity, that is less rain during the drier months in comparison to the significant rainfalls during the rainy months. The data matches with the fact that Indonesia is a country with a tropical climate whose rainfall rate is closely connected with the monsoonal circulation. The rainfall rate data in 2019 and 2020 shows similarity, reaching peak and base around the same time.

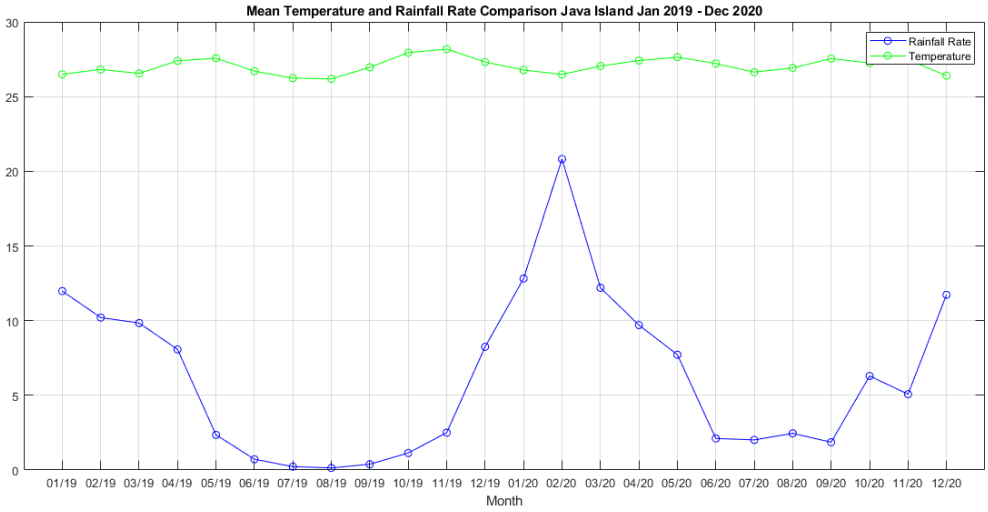


**Figure 10. Mean temperature and rainfall rate comparison Java Island**

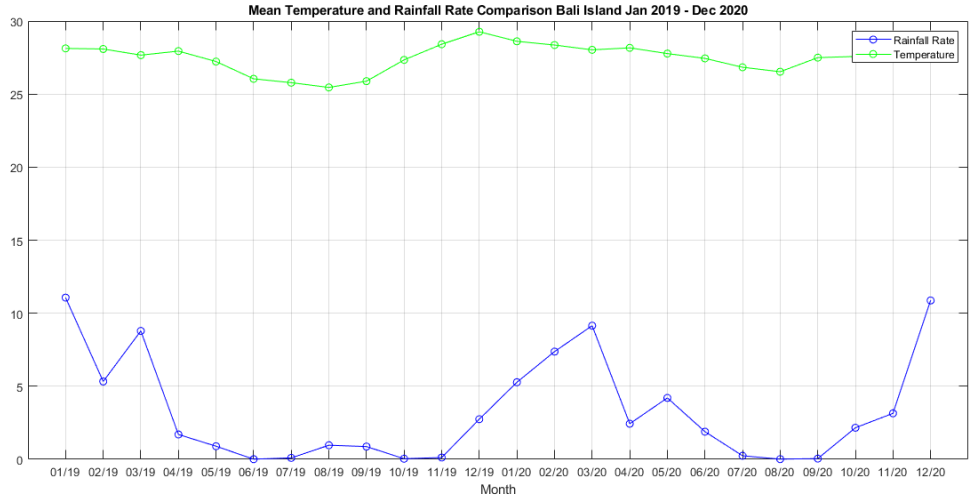


**Figure 11. Mean temperature and rainfall rate comparison Bali Island**

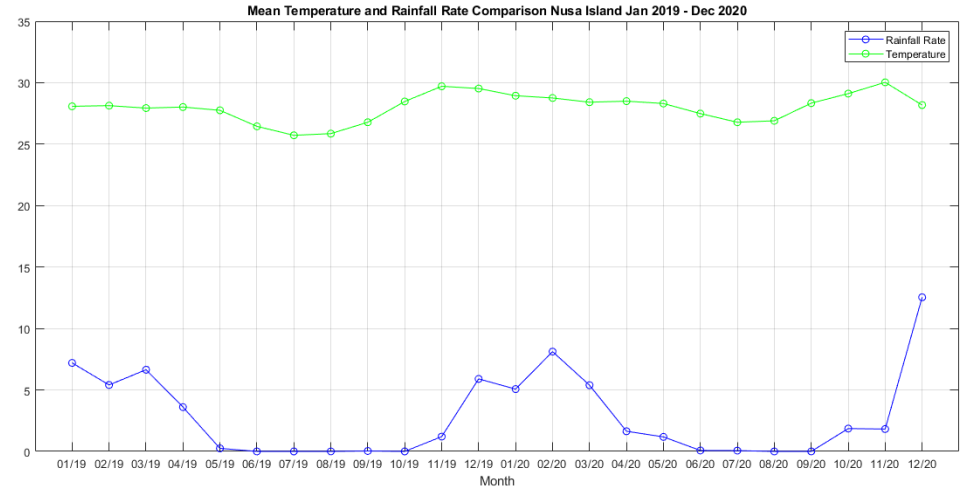


**Figure 12. Mean temperature and rainfall rate comparison Nusa Tenggara Island**

### 3.9. Correlation of Mean Temperature and Rainfall Rate

**Figures 10** to **12** show the comparison between the mean temperature and rainfall rates data in Java, Bali, and Nusa Tenggara Island. The Spearman's correlation coefficient value of each island is shown in **Table 10**.

**Table 10. Spearman's Correlation Coefficient**

| Islands | Spearman's Coefficient | Correlation |
|---|---|---|
| Java | - 0.323 | weak |
| Bali | 0.611 | strong |
| Nusa Tenggara | 0.445 | moderate |

Each island displays different correlation. Thus, the correlation between the mean temperature and rainfall rates data in Java, Bali, and Nusa Tenggara Island cannot be generalized.

### 3.10. Application of Mean Temperature and Rainfall Rate Analysis

The analysis of mean temperature can be applied for examining climate change and global warming phenomena. Both of these topics are essential as they are considered current issues. Climate change and global warming are identified through the occurrence of the ever-increasing temperature (Matawal, 2013), which; some of the consequences are the increase in sea level, weather disasters, and heatwaves (Grossman, 2018; Hayes et al., 2018). As it affects the sea level, the temperature can be defined through the correlation between the evaporation and the increase of rainfall rate. Based on this project, the mean temperature increases by an average of 0.52 from 2019 to 2020. Based on a study by Subarna (2017), this increasing temperature trend could signify a long-term temperature increase that is approximated to reach 28.5°C in 2050 and 29.23°C in 2100.

The analysis of rainfall rate can be applied for predicting and evaluating the cause of flooding and drought in a particular area. Research by Nugroho (2002) used this analysis to evaluate flooding in DKI Jakarta. Based on his research, DKI Jakarta is highly prone to flooding, and the main reason for the flooding is the high rainfall rate. Similarly, this present study found that from 2019 until 2020, DKI Jakarta holds the highest peak in rainfall rate between all provinces in Java, Bali, and Nusa Tenggara. The information shows a high correlation to Jakarta's frequent flooding. The influence of the rainfall rate to flooding is amplified for the coastline area (Sudirman, 2017; Simarmata and Surtiari, 2020). The increase in rainfall rate in DKI Jakarta might also be a sign of climate change as, according to Vuurst and Escobar (2020), Jakarta is one of the densest populated cities globally, and it is highly threatened by climate change.

The project's result is usable for future projects and educational purposes. Further research can be administered in relating the data from this research with data from a more current time and circumstance to improve the comprehension of the tropical climate of Indonesia.

## 4. CONCLUSION

As a tropical country, the results of the temperature analysis are proven to be relatively warm and stable. Based on the investigation, the temperature is higher around the dry season and lower around the rainy season. Indonesia also possesses many marine areas and hence is impacted by monsoonal circulation. It causes the rainfall intensity of several provinces to vary, but the rises and falls are similar to one another. The rainfall rate is lower during the dry season and higher during the rainy season. The data is also observed to

be fluctuating, which is affected by the geographical fact that Indonesia has a large water surface, and this makes evaporation to be easily induced by warm tropical temperatures.

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