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Article

Comparison Analysis of Wind Patterns and Its Correlations to Temperature, Humidity and Rainfall in Coastal and Non-Coastal Areas

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Abstract. Geographical location and topography determine the characteristics of atmospheric parameters in a location. This study aims to determine the comparison between wind patterns that occur in coastal and non-coastal areas, then the correlation between wind patterns and parameters of temperature, humidity and rainfall that occur at the Tanjung Priok Maritime Station and the Curug Meteorological Station. The chosen research method is descriptive analysis. This result is analysis of hourly wind data at the Tanjung Priok Maritime Station is dominated by local winds or sea breezes while the Curug Station is dominated by monsoon winds. The dominant wind direction in the months of the transitional season has a smaller percentage than in other months. Furthermore, the rainfall is dominated by rainfall from the west in the seasonal pattern as well as the humidity parameters at the two research stations.Temperatures in coastal areas as a whole are higher than non-coastal temperatures with a difference of up to 3 degrees Celsius. Last, in the temperature trend there is a random distribution pattern at the Curug meteorological station and there is no trend at the Tanjung Priok Maritime Station. The largest temperature is the same in 2019 and the average temperature is 0.3/year.

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1. Introduction

Indonesia is a country located on the equator where this area is an air movement trajectory. This air movement can cause differences in air pressure that occur or are commonly called monsoon winds [1-2].The occurrence of wind due to differences in air pressure due to high air temperatures. Wind itself is a vector quantity that has direction and speed. Wind speed is influenced by the location of the region, the higher the area, the higher the wind speed [3-4].

The movement of wind currents can rarely take place flat or smooth, but is generally disrupted by turbulence of various shapes and sizes that develop and interfere with each other's direction and movement. Close to the earth's surface, this turbulence is primarily a result of friction between the moving air and the generally uneven surface of the earth which in the air can cause eddy events and be accompanied by calm and loud gusts [5-6]. Wind direction is the direction from where the wind blows or where the wind currents come from and is expressed in degrees which are determined by clockwise rotation and starts from the north point of the earth in other words according to the compass point [7-8]. Generally, wind currents are named with the direction from which they blow, for example, a wind that blows from the north is a northerly wind [9-10].

Wind speed is the speed of wind currents and is expressed in knots or kilometers per hour or in meters per second [11-12]. Because wind speed generally varies, in determining wind speed, the average speed is taken for a period of ten minutes rounded up to the nearest knots unit price. The condition is determined as a calm wind if the speed is less than one knot. The most influential wind circulations in the Indonesian region include periodic winds [13-14]. Periodic winds are winds that blow over the earth's surface which at certain times reverse direction. Then the monsoon or monsoon winds, with a period of time turning around half a year or six months, where during the summer it flows into the continent and during the winter it flows out of the continent towards the ocean. This is due to the apparent longitudinal movement of the sun in the tropics, causing a difference in pressure between the continents and the oceans [15-16].

The coastal area is dominated by fishermen [17-18]. The area is dominated by sea breezes where the wind blows from the sea towards the land, these winds generally occur during the day from 09.00 (nine in the morning) to 16.00 (four in the afternoon). As for the morning at 9.00 pm 12.00 and afternoon at 15.00 as a determinant of time criteria [19-20].The sea breeze can be used by fishermen to return home from fishing at sea. On the other hand, when the onshore wind blows at night, fishermen can use it to go fishing.

This study aims to determine the comparison between wind patterns that occur in coastal and non-coastal areas, then the correlation between wind patterns and parameters of temperature, humidity and rainfall that occur at the Tanjung Priok Maritime Station and the Curug Meteorological Station. The results of this study are expected to provide information to the public, especially for people who work as fishermen on the coast of North Jakarta.

2. Experimental Section

2.1. Materials

The chosen research method is descriptive analysis. The analytical descriptive method is a method that functions to describe or give an overview of the object under study through data or samples that have been collected as they are without conducting analysis and making general conclusions.

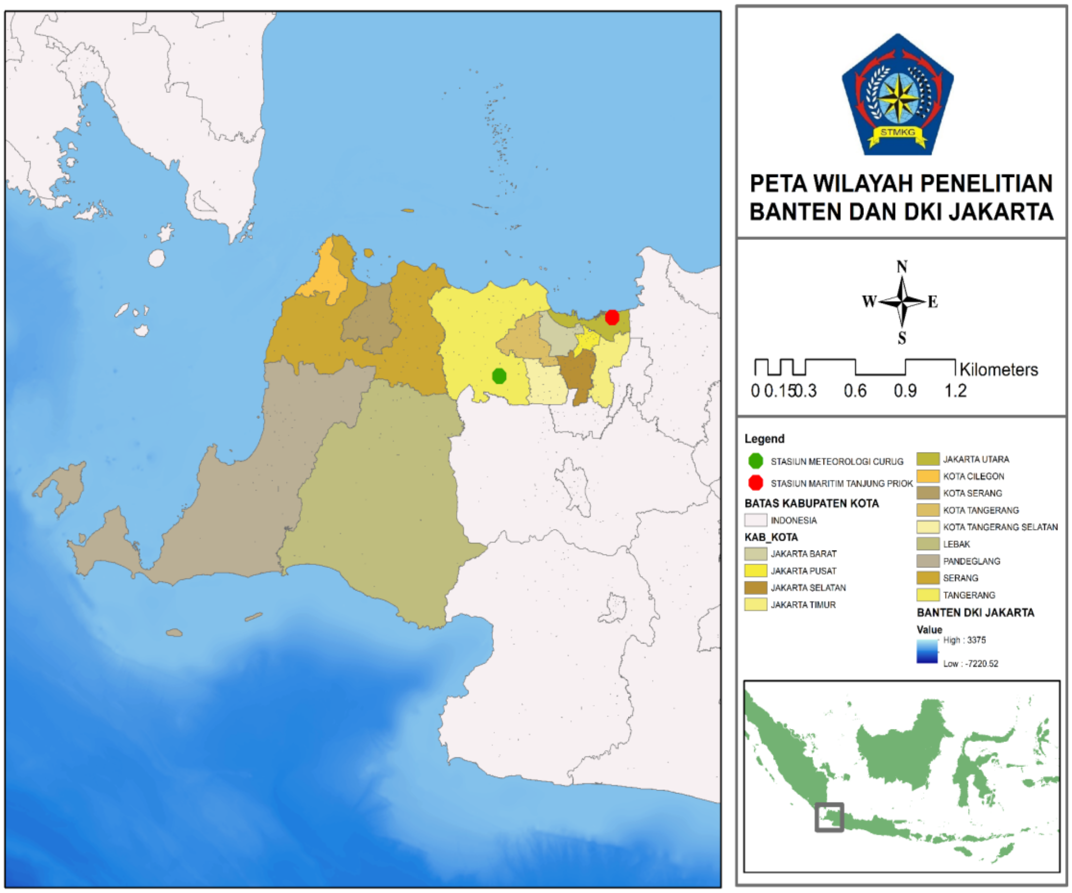


Figure 1. Map of the study area

2.2. Tips

The applications used in this method are the R application and the WRPLOT (Wind Rose Plots for Meteorological data) application which can show the direction and differences in the magnitude of wind speed between one class and another class as a support for the analysis included wind rose graphs of the wind speeds that occur.

Wind direction and speed data is processed by classifying the direction into 8 cardinal directions, namely 360° (North), 45° (Northeast), 90° (East), 135° (Southeast), 180° (South), 225° (Southwest), 270° (West), and 315° (Northwest) [16]. The wind data used in this discussion is surface wind observation data from an anemometer wind measuring device with a height of 10 meters, which is located around the Tanjung Priok Maritime Station and the Curug Meteorological Station. This data is hourly surface observation data which is routinely carried out for a period of 5 years from January 2016 to December 2020.

3. Results and Discussion

3.1. Windrose Analysis of Climate Data

3.1.1. Hourly Data Analysis

Based on Figure 1 below, it can be seen the *windrose diagram* at two stations per hour during the 2016-2020 period. Tanjung Priok Station (a) is dominated by winds from the northeast, southeast and west. The average speed is 0.5 – 6.0 m/s. The highest wind speed is 9.0 m/s from the northeast. This condition indicates that the hourly *windrose plot results of the* wind that blows at the Tanjung Priok maritime station are not only influenced by monsoonal wind patterns, but are also influenced by local or sea breeze patterns which are dominant at 03.00 - 09.00 UTC from the northeast. The dominant wind conditions on the coast can affect sea transportation and fishermen [21-22]. Can be seen and analyzed for chart mapping of wind rose units every hour at Tanjung Priuk Maritime Station with a period of five years, namely 2016 to 2020.

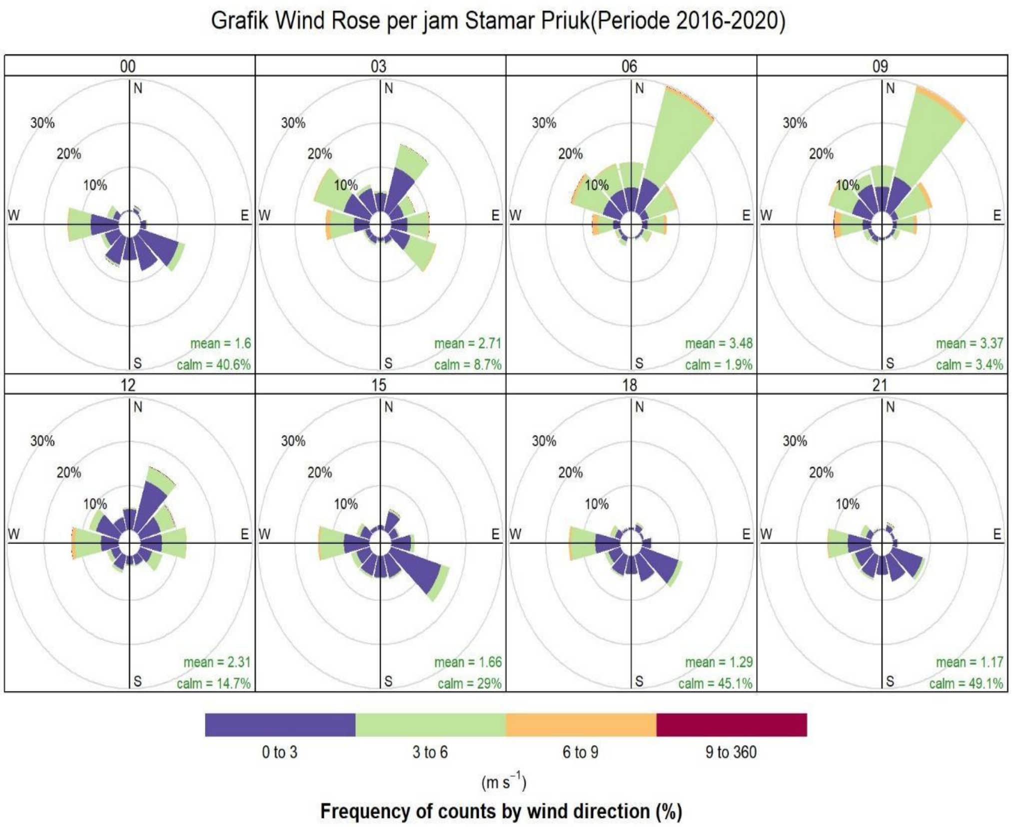


Figure 1. Hourly winds for Tanjung Priok maritime station

Furthermore, at Curug Station the wind is dominated from the southwest, west and northwest (Figure 2). The average speed is 3.0 – 6.0 m/s. The highest wind speed is 9.0 m/s from the west. This condition shows that the hourly windrose plot results of the wind that blows at Curug Station for the period 2016-2020 are not only influenced by local wind patterns coming from other directions, but are also influenced by monsoonal wind patterns from the west. This is indicated by the dominance of the wind coming from the southwest to the northwest. The dominant wind from the west or east can be called a monsoonal wind pattern [23-24]. Can be seen and analyzed for chart mapping of wind rose units every hour at Curug station with a period of five years, namely 2016 to 2020.

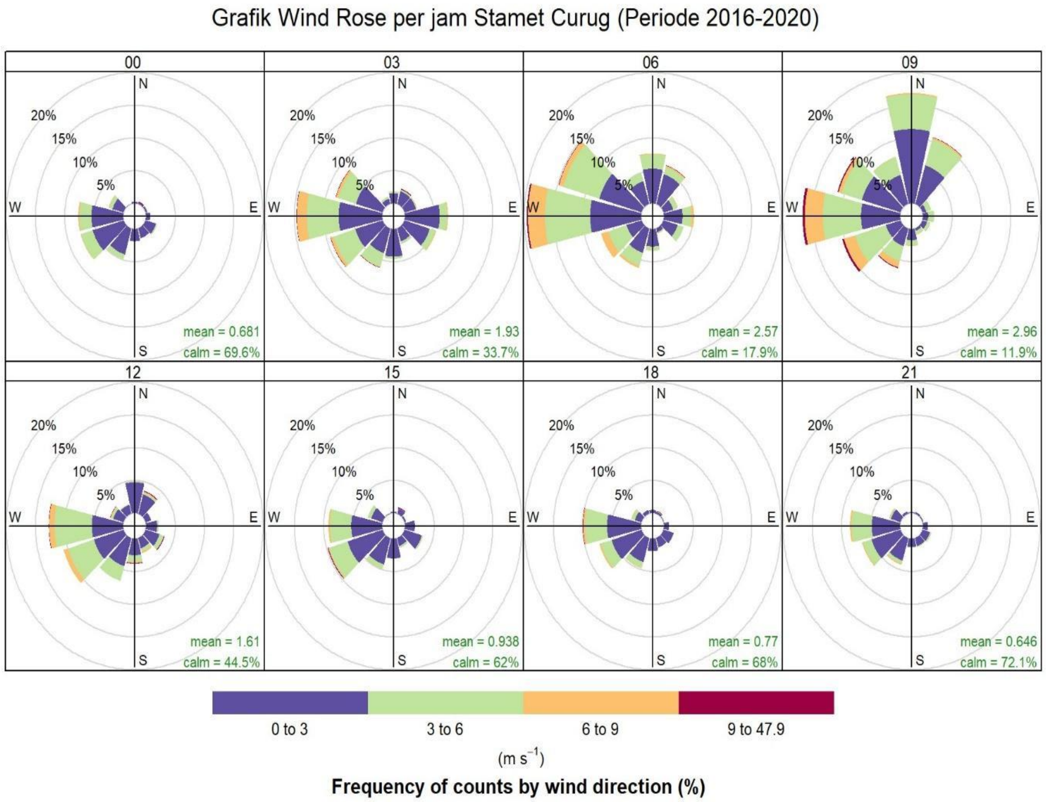


Figure 2. Hourly winds for Curug meteorological station

3.2. Seasonal Data Analysis

3.2.1 Seasonal Wind Data Analysis

Can be seen in Figure 3 showing the direction of the wind *rose* that occurs at the Tanjung Priok maritime station. The DJF period shows the dominant wind from the west with a percentage of 30% and a wind speed of 6-9 m/s. The MAM period shows the greatest wind direction from the northeast with a percentage of 11% and a wind speed of 3-9 m/s. The JJA period shows the dominant wind direction from the southeast with a percentage of 19% and a wind speed of 6-9 m/s.

During the SON period the greatest wind direction is from the northeast with a percentage of 20% and a wind speed of 9 m/s. This shows that the wind pattern during the DJF period is a westerly wind, while during the MAM, JJA and SON periods the prevailing wind is an easterly wind. The resulting east wind can have a positive impact on fishermen on the coast of North Jakarta where the east wind becomes a momentum for fishing [25-26]. Can be seen and analyzed for chart mapping of wind rose units every seasonal at Maritim Priuk Station with a period of five years, namely 2016 to 2020.

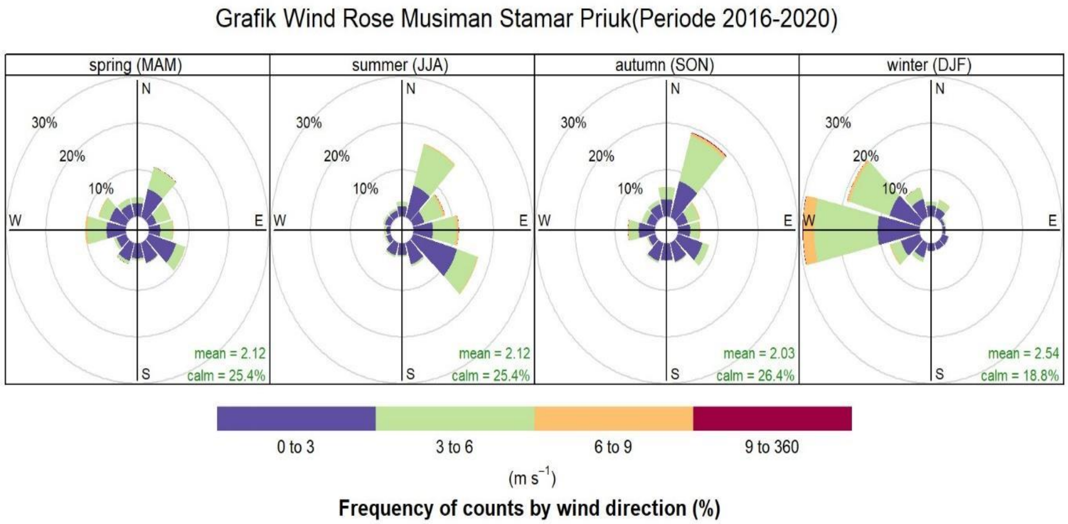


Figure 3. Seasonal winds at Tanjung Priok maritime station

Figure 4 shows the direction of the wind *rose* that occurs at the Curug meteorological station. The DJF, MAM, JJA and SON periods show the dominant wind blowing from the west, but there are several other wind directions that influence it. The biggest wind direction occurs during the DJF period with a percentage of 22% and a wind speed of 9 m/s. Based on the wind vector, from May to October and December the Java Sea blows east winds, while January to March blows westerly winds. The dominant wind direction blows from the west indicating that the wind direction that occurs at the Curug meteorological station has a good pattern for smooth flight. If the wind pattern blows from the east (*cross wind*) at a high speed, this incident can hinder the smooth *take-off* and *landing.* Can be seen and analyzed for chart mapping of wind rose units every seasonal at Curug Station with a period of five years, namely 2016 to 2020.

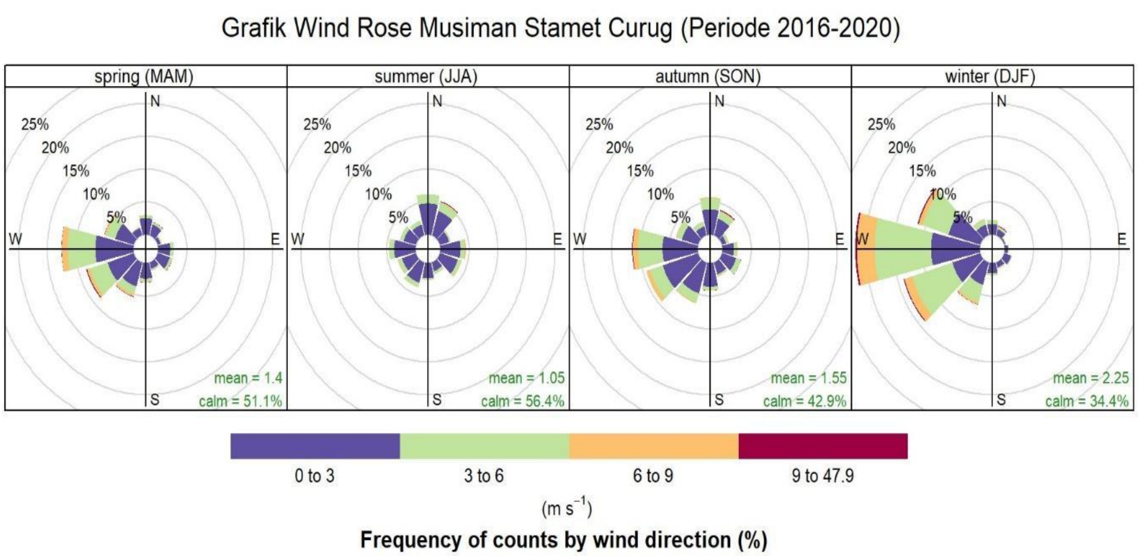


Figure 4. Seasonal winds at Curug meteorological station

3.2.2 Analysis of Seasonal Rain Data

Based on Figure 5 and 6 below, it can be seen the *windrose diagram* of the seasonal average rainfall at the Tanjung Priok Maritime Station and Curug Station during the 2016-2020 period. The average rainfall at the two stations ranges from 0.5-20 mm/day. The highest rainfall ranges from 100-200 mm/day. The results of the two stations show that the dominant rainfall occurs in the DJF season. The dominant rainfall comes from the west. The DJF period of monsoon winds blowing from West to East coincides with the rainy season in most parts of Indonesia and vice versa during the JJA season [27-28].The JJA period generally blows an easterly monsoon where the wind blows from east to west. The east monsoon is accompanied by little rain, so it is identified with the dry season. Can be seen and analyzed for chart mapping of rainfall units every seasonal at Maritim Priuk Station with a period of five years, namely 2016 to 2020.

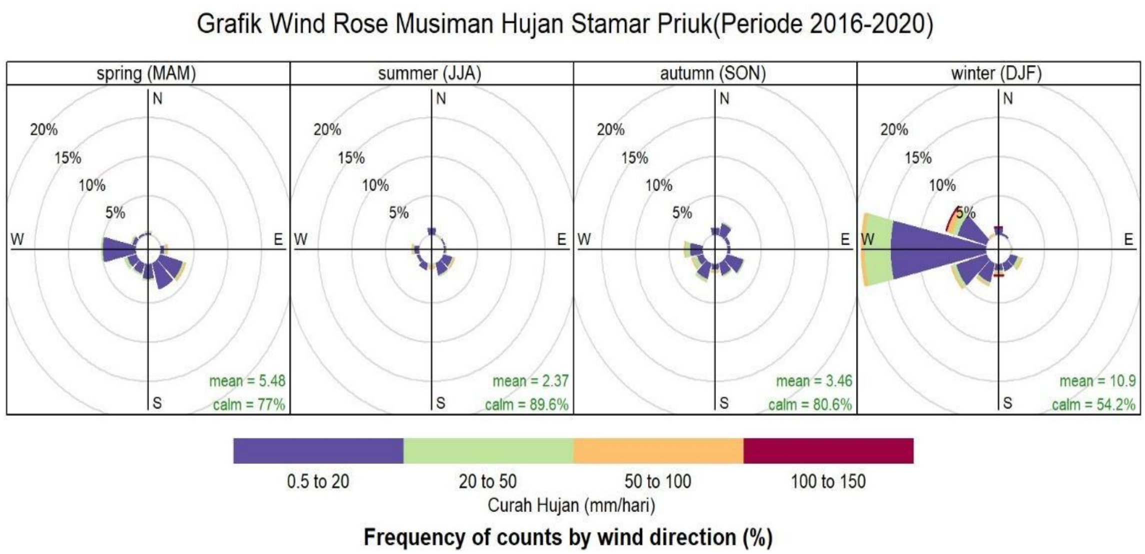


Figure 5. Seasonal rain at Tanjung Priok maritime station

Can be seen and analyzed for chart mapping of rainfall units every seasonal at Curug station with a period of five years, namely 2016 to 2020.

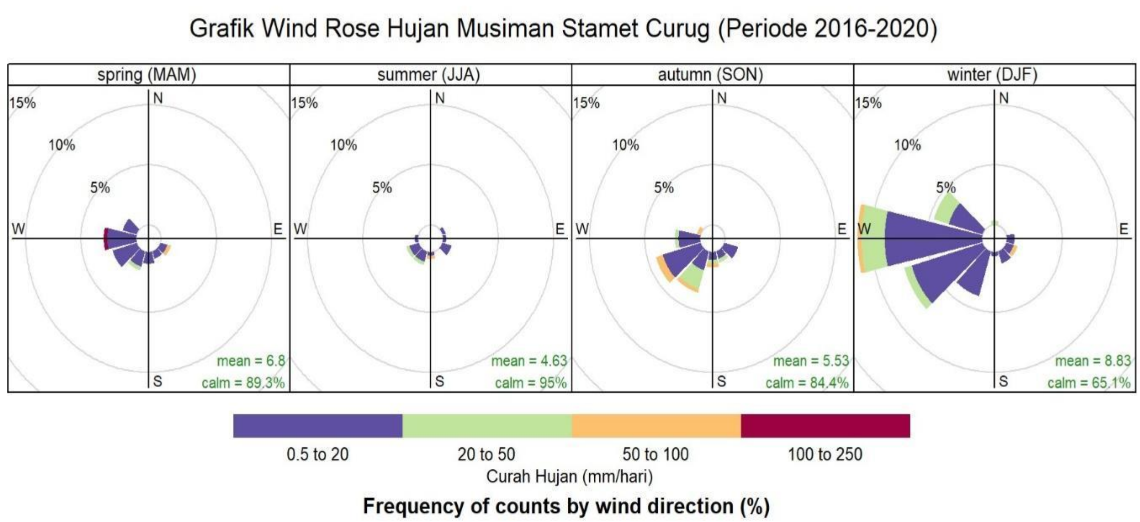


Figure 6. Seasonal rain at Curug meteorological station

3.2.3 Seasonal Humidity Data Analysis

Can be seen in Figure 7 is the humidity *windrose* that occurred at the Curug meteorological station during the DJF, MAM, JJA and SON periods showing the dominant direction of humidity from the west. The highest humidity occurs during the DJF period with a humidity percentage of 20% with humidity ranging from 90 to 100%. Can be seen and analyzed for chart mapping of humidity units every seasonal at Curug Station with a period of five years, namely 2016 to 2020.

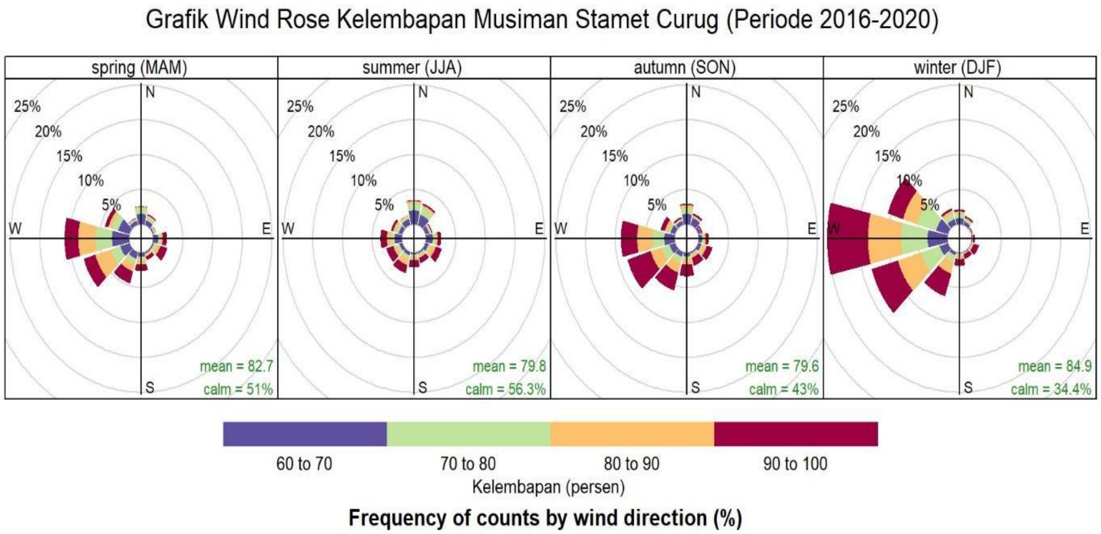


Figure 7. Seasonal humidity of Tanjung Priok maritime station

Figure 8 is a humidity *windrose* that occurred at the Tanjung Priok maritime station during the DJF, MAM, JJA and SON periods. The direction of the greatest humidity occurs in the DJF period with a percentage of 27% with humidity ranging from 90 to 100%. The average humidity that occurs at the Tanjung Priok maritime station is between 80 to. This causes that the direction of humidity is correlated with the direction of rainfall that occurs. Air humidity and high wind speeds can increase rainfall [29-30].Can be seen and analyzed for chart mapping of humidity units every seasonal at Maritim Priuk Station with a period of five years, namely 2016 to 2020.

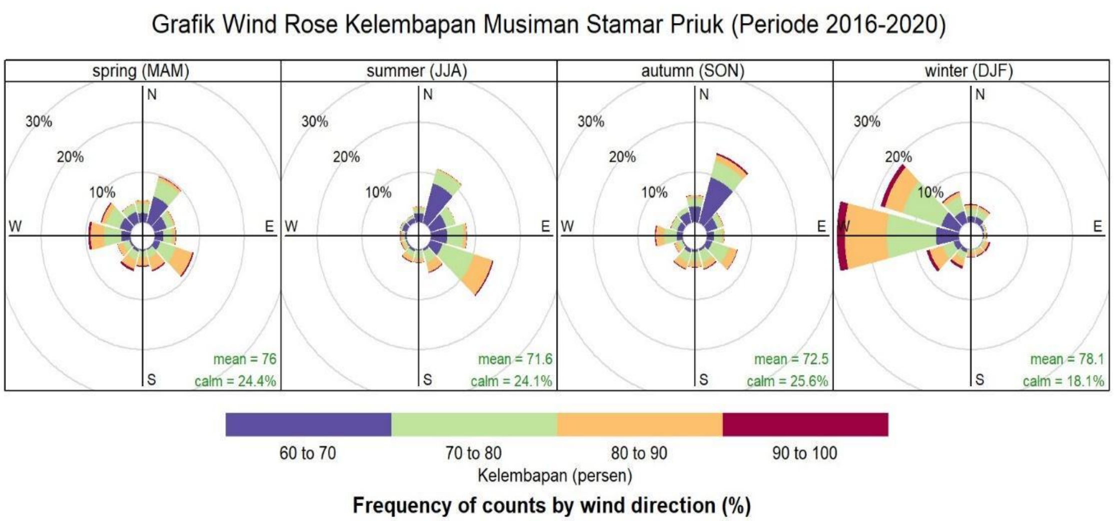


Figure 8. Seasonal humidity of Curug meteorological station

3.3. Graphical Analysis of Climate Data

3.3.1. Time Series Composite Analysis of Curug Meteorological Station Temperature

It can be seen and analyzed graphical images of temperature data time series at the Curug meteorological station. The hourly temperature is relatively the same as the highest value is 31 Celsius and the lowest is 23 Celsius. Then for the monthly analysis, the highest temperature in May is 27.3 Celsius and the lowest is 26.2 in February. Furthermore, for weekly analysis, the day with the highest temperature is Saturday at 26.9 Celsius and the day with the lowest temperature is Wednesday at 26.5 Celsius.

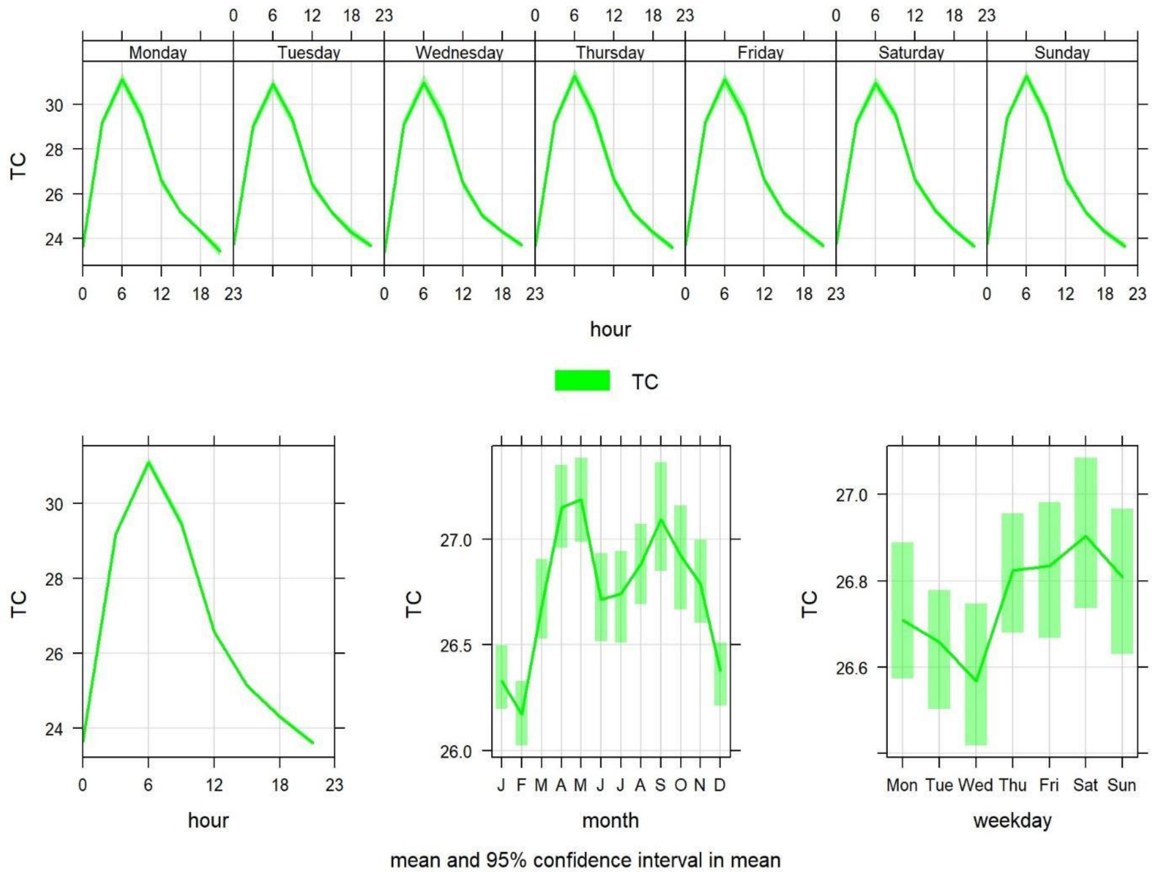


Figure 9. Graph of time series temperature data for the Curug meteorological station

The highest temperature at 6 UTC is due to low cloud cover [31-32].There was a significant increase in temperature from February to May because the land temperature in the dry season was higher than in the rainy season. Then for daily temperatures which are relatively high on Saturdays and Sundays because those days are holidays so that the population density increases.

3.3.2 Time Series Composite Analysis of Tanjung Priok Maritime Station Temperature

It can be seen and analyzed graphical images of temperature data time series at the Curug Meteorological Station. The hourly temperature is relatively the same as the highest value is 33 Celsius and the lowest is 27 Celsius. Then for the monthly analysis, the highest temperature in May is 30.5 Celsius and the lowest is 28 Celsius in February. Furthermore, for weekly analysis, the day with the highest temperature is Saturday at 29 Celsius and the day with the lowest temperature is Wednesday at 28.85 Celsius.

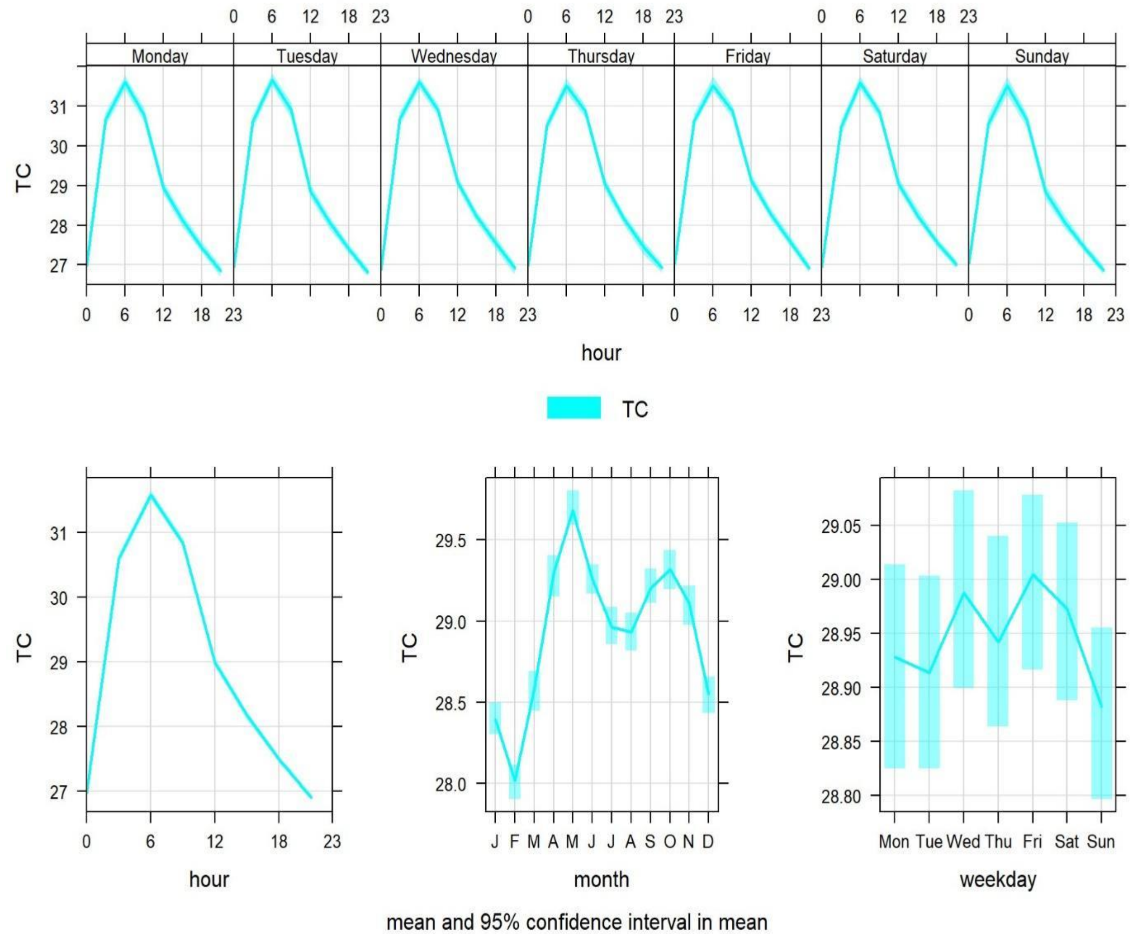
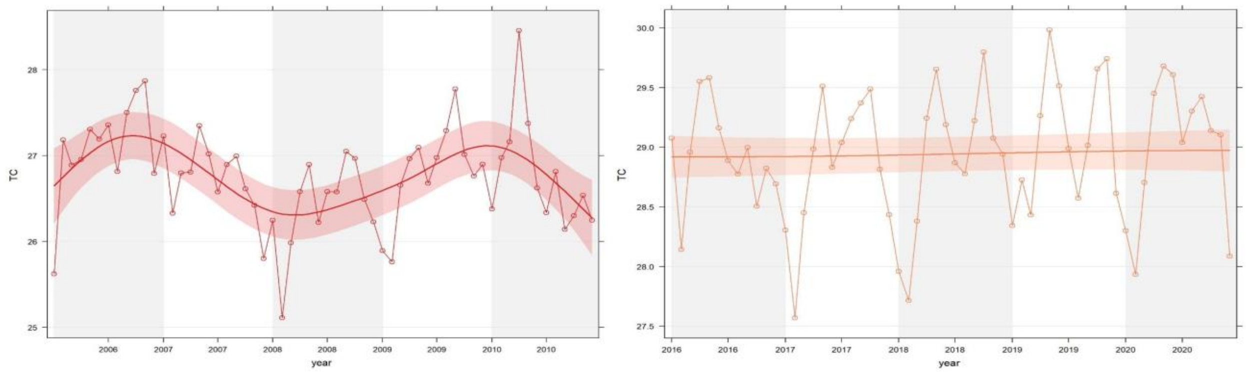


Figure 10. Graph of time series temperature data for Tanjung Priok maritime station

It can be noted that the overall average temperature for coastal areas is higher than for non-coastal areas with a difference of almost 3 Celsius, meaning that coastal areas with low elevations have smaller values compared to high elevation areas [33-34]. Relatively high temperatures in coastal areas have a range of values that are relatively low or do not fluctuate.

3.3.3 Analysis of Temperature Trends

It can be seen and analyzed in Figure 11 that the temperature trend graph at Tanjung Priok Maritime Station has no trend because there are no waveforms and there are only straight lines. The highest temperature occurred in May 2019 with a value of 29.9 while the lowest temperature occurred in February 2017 with a value of 27.6. The average temperature at the Curug Meteorological Station has increased by 0.3/year.



(a) **(b)**

Figure 11. Temperature trends at (a) the Tanjung Priok maritime station and (b) the Curug meteorological station

It can be seen and analyzed in Figure 12 that the temperature trend graph at the Curug meteorological station experiences a random distribution pattern with an up and down trend and has several peaks. The highest temperature occurred in April 2019 with a value of 28.4 while the lowest temperature occurred in February 2018 with a value of 25.2. The average temperature at the Curug Meteorological Station has increased by 0.3/year

4. Conclusion

Analysis of hourly wind data at the Tanjung Priok Maritime Station is dominated by local winds or sea breezes while the Curug Station is dominated by monsoon winds. The dominant wind direction in the months of the transitional season has a smaller percentage than in other months. Furthermore, the rainfall is dominated by rainfall from the west in the seasonal pattern as well as the humidity parameters at the two research stations.Temperatures in coastal areas as a whole are higher than non-coastal temperatures with a difference of up to 3 degrees Celsius. Last, in the temperature trend there is a random distribution pattern at the Curug meteorological station and there is no trend at the Tanjung Priok Maritime Station. the largest temperature is the same in 2019 and the average temperature is 0.3/year.

5. Acknowledgement

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