

Analysis of Lightning Events Due to Rainfall and Wind Speed in Pekanbaru City

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ABSTRACT

Quantitative research has been conducted on the effect of rainfall and wind speed on lightning events in Pekanbaru City from August to October 2018. Observation data were obtained from Meteorological Station Class I Sultan Syarif Kasim II Pekanbaru, Riau Province, Indonesia. Observations are made by recording lightning events automatically using a lightning detector which will be analyzed using the Lightning Analysis program version 7.2 and the Google Earth Pro program. The results showed that high rainfall caused frequent thunderstorms, and relatively high wind speeds from late September to October caused the number of lightning strikes to increase due to the ionization process that produces an electric charge.

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1. INTRODUCTION

The power of lightning is extraordinary and its characteristics can cause enormous detrimental effects. Lightning is a natural event in the form of discharge between one cloud and another, between charge centers in the same cloud, or between clouds and the earth [1-3]. The occurrence of lightning is the result of the process of electrical loading of cloud particles and electrical separation in the cloud [4]. The greater the charge in the cloud, the greater the electric field that will occur and when the field strength exceeds the strength of the air-to-ground penetrating field, an electric charge will occur [5, 6]. The sudden release of electric charge is characterized by flashes and thunder and the sound of thunder will only be heard a few seconds after the appearance of lightning, this is because when lightning strikes the released energy heats the air it passes through so that the air expands and produce a thunder sound. The average lightning energy generated from one lightning strike reaches about 55 kWh [7-9].

Rain is a process of condensation of water vapor in the atmosphere into droplets of water that are heavy enough to fall and usually reach the surface. Rain usually occurs due to the cooling of the air temperature or the addition of water vapor to the air [10, 11]. Rainfall usually cannot be separated from the influence of air humidity which spurs the number of water droplets in the air. Rainfall is one of the most important climatic elements for life on earth [12]. The importance of spatial information on rainfall in a place can provide an overview of which areas experience a lack of rainfall and which areas experience excess rainfall so that water resources management strategies can be determined [13-15]. From this information, it can be said that rainfall data is important climatological data. High lightning events are followed by high rainfall due to the growth of rain-forming convective clouds. Therefore, falling rainfall can produce heavy rains. However, lightning remains dominant because lightning does not always produce rain, and rain produces lightning [16, 17].

Wind speed is caused by the movement of wind from high pressure to low pressure, usually due to changes in temperature [18]. In the tropics, wind speeds are usually lower than in the subtropics.

However, electric discharges often occur in the tropics, especially during the rainy season [19, 20]. So in this study, the causes of lightning events in the tropics, especially in Pekanbaru City, Indonesia, need to be analyzed by paying attention to natural factors in the form of changes in rainfall and wind speed detected by the weather analysis program from the provincial meteorological station.

2. RESEARCH METHODS

This research was conducted using the application of physical methods that will quantitatively predict the occurrence of lightning. The application programs used are LD/2000 v.5, Lightning Analysis version 7.2, and Google Earth Pro. The three programs function to determine the value of the factors causing the occurrence of lightning as an indication of the occurrence of lightning. Analysis and calculations based on meteorological observation data conducted at Meteorological Station Class I Airport Sultan Syarif Kasim II Pekanbaru. Where lightning events will be analyzed in August, September, and October 2018. The factors that cause lightning are taken from the influence of rainfall and wind speed. The process of recording lightning incident data can be seen as shown in Figure 1.

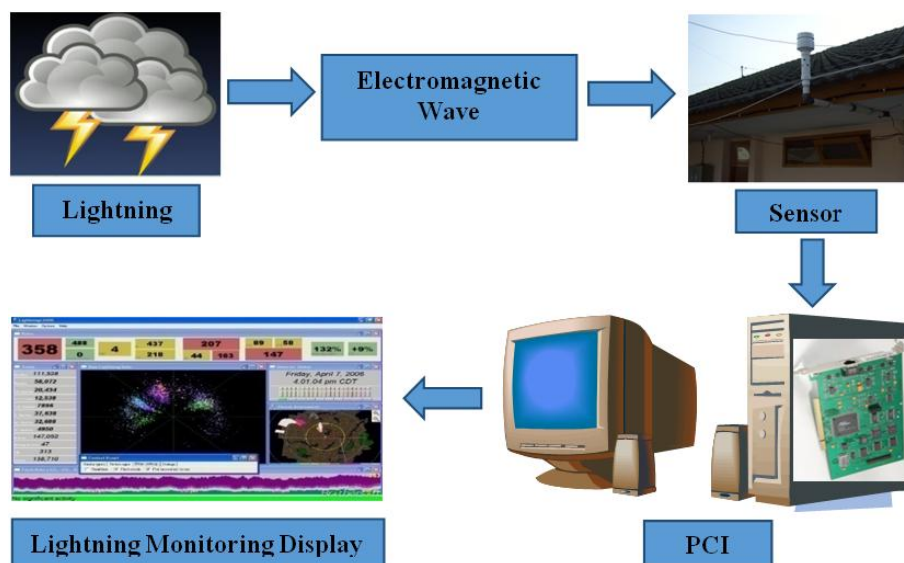


Figure 1. Diagram of the lightning incident data recording process.

A lightning detector is a device that detects lightning as a result of a lightning discharge event. Each lightning discharge generates several electrical pulses (strikes) which will be detected by sensors on the lightning detection equipment system. The working principle of a lightning detector is that when lightning occurs, lightning will emit electromagnetic waves. These electromagnetic waves are then picked up by the lightning detection sensor based on their frequency, which is then decoded by the PCI card storm tracker. With the LD/2000 display program, the results can be viewed in various lightning parameters. Lightning detection sensors are sensors that capture long-frequency waves/radio generated by lightning strikes. Lightning detection program 2000 v.5 is a database obtained from the results of the lightning detection sensor display, then stored automatically and in real-time on the computer display. Lightning Analysis v.7.2 program data processing is used to find the value of lightning events and data on factors that cause lightning such as rainfall and wind speed. The Google Earth Pro program is used to obtain the accuracy of the number of lightning strike points in the Pekanbaru City area.

The simulation procedure stage begins with identifying lightning and the factors that influence the occurrence of lightning. The lightning detector circuit consists of sensors, sensor housings, sensor cables, PCI, LD/2000 software, storm tracker lightning detectors, monitors, and computer displays. Fast data collection and data factors in order to get accurate results and there are no errors in the data processing. The data collected is data on lightning strike time, rainfall, wind speed, and the number of lightning strikes. The use of the LD/2000 v.5 program to display the results of lightning detection in real-time and run the archive of data processing results from the lightning detection sensor. Lightning Analysis Program v.7.2 to process lightning analysis data using data from the LD/2000 v.5 software

recording process. Google Earth Pro program as Microsoft for the Pekanbaru City area sheet and displaying the point of occurrence of lightning. Furthermore, processing the data obtained, until the final result will show the value or influence of factors on lightning events.

3. RESULTS AND DISCUSSIONS

The analysis is presented in the form of a line graph, which displays the amount of lightning, rainfall, and wind speed in the Pekanbaru City area for 92 days from August 1 to October 31, 2018.

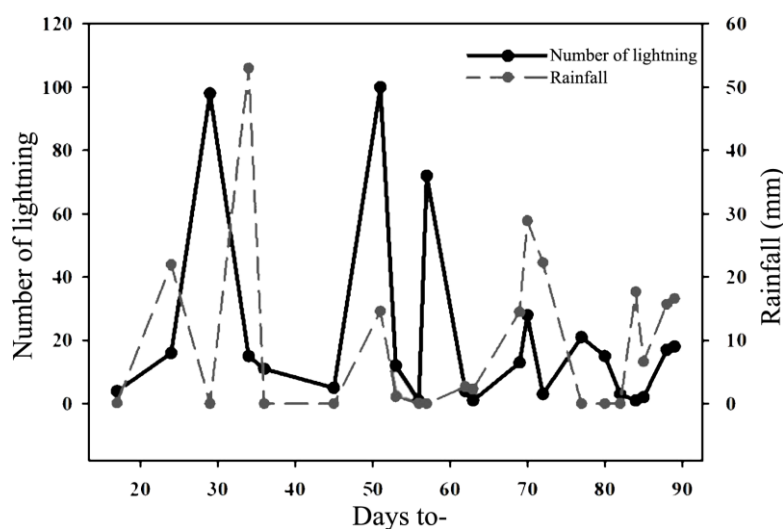


Figure 2. Total lightning and rainfall values.

High rainfall occurs due to the growth of convective clouds that produce heavy rain for a long duration [16]. The highest rainfall occurred on the 33rd day, namely 53.0 mm with 15 lightning strikes. While the lowest rainfall on day 29 experienced a three-fold increase in the number of lightning strikes with 98 lightning strikes. Figure 2 shows the state of unbalanced rainfall and lightning because high lightning events are not always accompanied by high rainfall. But usually, the increase in rainfall has a tendency with the number of bolts of lightning that often occur, but the number of lightning can be said to not increase. Due to the occurrence of lightning almost every increase in the amount of rainfall [16]. At a height of 53 mm, 29 mm, and 22 mm of rainfall, the number of lightning that occurred was 15, 28, and 3 times, respectively. Does not follow the calculated rainfall amount for lightning events. From the graph of the influence of rainfall on the occurrence of lightning, rainfall cannot be used as a fundamental function to determine the magnitude of lightning. This means that the occurrence of lightning is not always caused by rainfall in the Pekanbaru City area.

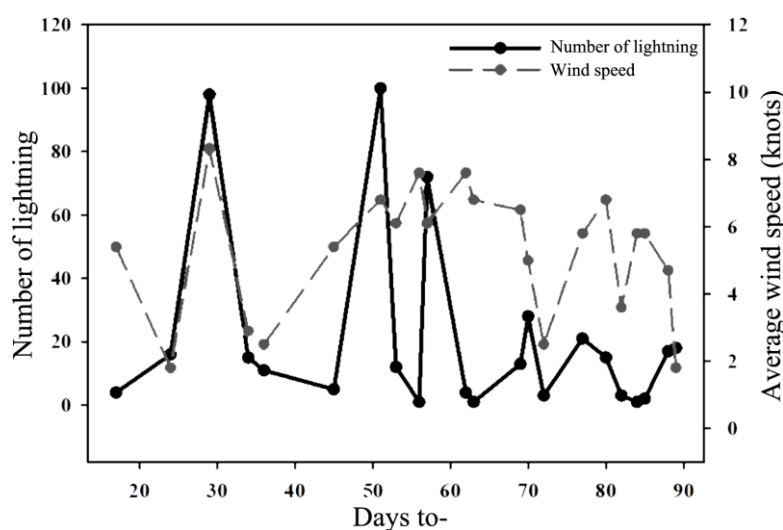


Figure 3. Total value of lightning and wind speed.

Analysis of lightning events due to rainfall and wind speed in ... (Defrianto)

Wind speed is a fundamental atmospheric quantity [19]. The wind speed can be seen in Figure 3, there is an increase in the number of wind speeds fluctuating between 1 knot to 11 knots. Where the value of the wind speed of 1 knot is equal to 1.852 kilometers/hour. The highest wind speed occurred on day 29, namely 8.3 knots with 98 lightning strikes. In addition, the lowest wind speed occurred on the 24th and 89th days, namely 1.8 knots with 16 and 18 lightning. Figure 3 illustrates that the increase in wind speed is followed by the number of lightning events. It is understood that the amount of lightning increases with increasing wind speed due to easier cloud ionization at certain heights. This means that wind speed brings high ionization properties and causes lightning to occur more often. The wind speed values reached 8.3 knots, 6.8 knots, and 6.1 knots with a number of lightning incidents as many as 98 times, 100 times, and 72 times which were counted a lot. This means that lightning events due to high wind speeds have the potential for lightning events to occur. It is true that wind speed affects the occurrence of lightning in the Pekanbaru City area.

4. CONCLUSION

Two variations that cause differences in lightning in the Pekanbaru City area have natural factors. On natural factors due to rainfall where the calculation time has just entered the rainy season in the territory of Indonesia. The rainfall value is still fluctuating with the number of lightning events that do not follow the rainfall value. So that rainfall is not too influential or does not cause lightning events at the time of measurement in the Pekanbaru City area. On the influence of wind speed with wind speed values, the measurement time ranges from 1 knot to 11 knots. Where the value is about 1 knot to 11 knots equal to 1,852 kilometers/hour to 20,372 kilometers/hour. The high value of the wind speed is followed by the number of lightning events measured in the measurement. So that the wind speed can be expressed as a factor due to the occurrence of lightning events in the Pekanbaru City area within 92 days of measurement data.

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