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Analysis of Lightning activities level in North Sumatera

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ABSTRACT

The purpose of this research is to get an overview of the level of threat and vulnerability due to lightning strikes in North Sumatra Province and present it in the form of a thematic map. In this case, we use the real time lightning strike data during June 2020 in regencies / cities in North Sumatra from the Deli Serdang Geophysical Station Lightning Detector tool, then the data is processed and mapped in the Arcgis 10 program using the Gridding method. The result indicate that the mechanism of lightning is related to physical theory including the presence of electrostatic forces, collisions between particles in charge separation, changes in the form of substances at a certain height in the Cumulonimbus cloud, potential differences that cause lightning strikes and charge induction from charged clouds.

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1. INTRODUCTION

Indonesia is an archipelago country that has a tropical climate. Indonesia's sea area is very large, reaching 2/3 parts of the total area. The vast area of the ocean causes evaporation of sea water which causes the growth of convective clouds, one of which is the Cumulonimbus cloud [1]. This condition causes the potential for lightning events to be very high compared to sub-tropical areas [2]. According to [3], Lightning strikes can be in the form of direct strikes such as causing damage to buildings or indirect strikes in the form of radiation, conduction or induction of electromagnetic waves (lightning electromagnetic pulse). Indirect strikes are no less damaging because the electromagnetic waves that spread can damage electronic equipment such as household appliances, industrial equipment, banking and other important installations that can even reach a distance of 2 km from the lightning source [4], [5]. The purpose of this research is to get an overview of the level of threat and vulnerability due to lightning strikes in North Sumatra Province and present it in the form of a thematic map. The results of this study are expected to be used as a reference in infrastructure development in North Sumatra Province, especially for the construction of infrastructure protection systems that are vulnerable to lightning strikes such as electricity networks, BTS towers, TV / radio broadcasting towers or buildings with complex electronic networks in them to minimize losses due to the danger of lightning strikes. For policy makers, it can be used as material for consideration in preparing city spatial plans. In addition, you can find out areas that have a high level of lightning strike intensity.

2. RESEARCH METHOD

North Sumatra Province is a province located on the island of North Sumatra with coordinates 1 ° - 4 ° N and 98 ° - 100 ° East. The geographical condition of North Sumatra is quite strategic because it is located around the equatorial line, traversed by the Bukit Barisan mountains and is flanked by the Malacca Strait and the Indian Ocean. This causes the climatic conditions of North Sumatra's rainfall to have climatic characteristics that are influenced by global climate such as the Indian Ocean Dipole (IOD) phenomenon.[6], [7], Inter Tropical Convergenze Zone (ITCZ), Madden Julian Oscillation (MJO), and El Niño Southern Oscillation (ENSO). In addition, regional-scale climatic factors such as monsoons, tropical disturbances, and convergence areas also influence climatic conditions in these areas. On a local scale, cloud growth and rain are influenced by these natural conditions and are also influenced by the apparent movement of the sun. Topographic factors and regional weather systems play an important role in the amount and spatial pattern of rainfall in an area [8]. The initial process of understanding the influence of weather and climate patterns qualitatively and quantitatively is carried out by examining the interactions of land, oceans and regional topography at a local scale [9]. The spatial pattern of rainfall has a strong correlation with the topography of an area [10]. In addition, geographic physical conditions can be used to indicate the spatial distribution of rainfall [11]. The existence of an uneven topography, for example due to mountains, also seems to have an effect on the rainfall that occurs. This is according to research [12] who conducted research using the Weather Research and Forecasting (WRF) model in the Province of Alberta, Canada, stated that the presence of Rocky Mountains had an effect on the high maximum rainfall. As mountain elevation decreases, the WRF results provide a 50% reduction in maximum rainfall over the mountain and foothills, with deposition in flooded basins reduced by 15-45%. Furthermore, there is a local topographic effect that makes the variability of rainfall even greater [13].

In this study, we use the real time lightning strike data during June 2020 in regencies / cities in North Sumatra from the Deli Serdang Geophysical Station Lightning Detector tool, then the data is processed and mapped in the Arcgis 10 program using the Gridding method or the method used to determine the density of a certain events using an imaginary area as a 'container' for analysis. The results of the data processing will be used to obtain a lightning strike density map. In processing using Arcgis 10 by applying the Gridding method, results will be obtained in the form of a map of areas prone to lightning strikes in regencies / cities in North Sumatra, so that the risk of casualties can be reduced as little as possible and damage due to lightning strikes in the area, for example by using a lightning protection system.

3. RESULTS AND DISCUSSION

There are two outputs obtained from the results of the lightning data analysis, namely the Number of Lightning Strikes Graph and the Lightning Strike Density Map. Each of these outputs is displayed in a period of one month. Based on lightning data from the Deli Serdang Geophysical Station Lightning Detector equipment, there were 449,649 lightning incidents that occurred in the North Sumatra region.

Table 1. Recorded Lightning Data During June 2020

Date	Number of Lightning Strikes	Date	Number of Lightning Strikes
1	10.675	16	11.893
2	31.863	17	2.830
3	29.969	18	4.339
4	18.200	19	2.739
5	9.764	20	13.650
6	3.376	21	14.797
7	2.777	22	12.722
8	1.523	23	4.118

9	15.375	24	34.745
10	37.709	25	22.199
11	16.048	26	6.169
12	12.532	27	16.078
13	18.208	28	16.290
14	25.125	29	3.869
15	21.279	30	28.788
		Total	254.423

The highest total number of lightning strikes occurred on June 10, 2020 with a total of 37,709 strikes. Meanwhile, the minimum total number of lightning strikes occurred on June 8, 2020 with a total of 1,523 strikes. The number of lightning strikes per day and a map of lightning density in June 2020 in North Sumatra are shown in Table 1 and Figure 1.

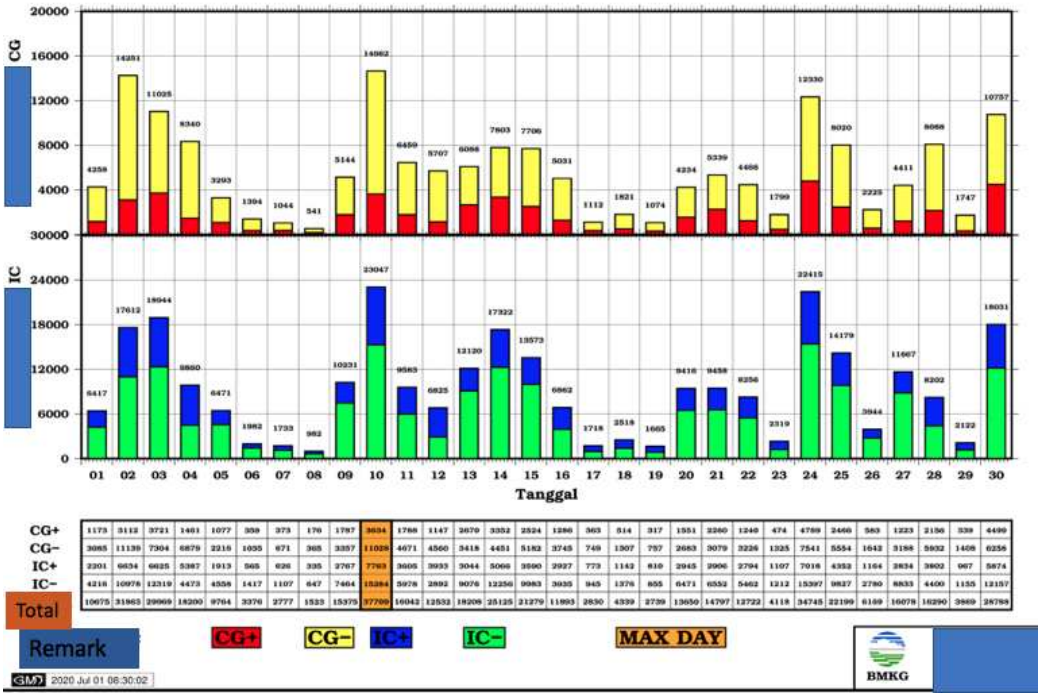

Figure 1. Lightning Strike Graph for June 2020

By using GIS 10 software, the distribution of lightning strikes per square kilometer (km2) was carried out in the North Sumatra region that occurred during June 2020. The lightning strike contour map and the lightning strike density map in June 2020 are shown in Figure 2.

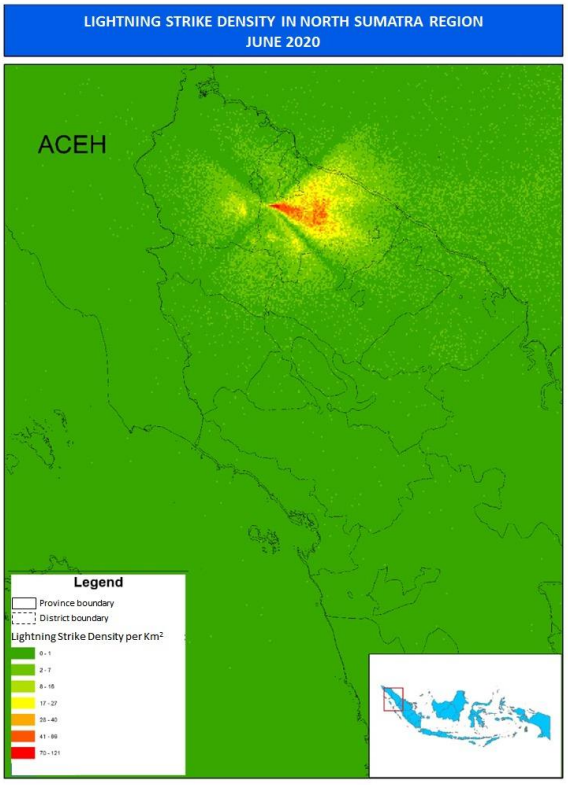

Figure 2. Lightning Strike Density Map for June 2020

On the lightning density map shown in Figure 2, it can be seen that areas that have a fairly large level of lightning strike vulnerability are in most parts of Deli Serdang district with strike intensities of 32 - 121 strikes / km2 which are shown in red contour. In addition, some areas of Langkat and Serdang Bedagai with strike intensity between 14 - 31 strokes / km2. The area is close to the ocean, so the intensity of the lightning strikes can be greater because lightning tends to strike land more than the ocean. This happens because the land absorbs heat energy faster from the oceans so that the air temperature on land is warmer than in the sea. So that the so-called sea breeze appears which brings the evaporation from the sea to the land. Lands are more easily induced by lightning charges than oceans.

4. CONCLUSION

Based on the result that has been carried out, from this study it can be concluded that the mechanism of lightning is related to physical theory including the presence of electrostatic forces, collisions between particles in charge separation, changes in the form of substances at a certain height in the Cumulonimbus cloud, potential differences that cause lightning strikes and charge induction from charged clouds. Areas prone to lightning strikes according to the lightning strike density map in the North Sumatra region based on the recorded data from the Lightning Detector cover the Deli Serdang Regency area with a strike intensity of 32-121 strikes / km2, some Serdang Bedagai Regency and some Langkat Regency with a strike intensity of 14 -31 strikes / km2. The highest total number of lightning strikes occurred on June 10, 2020 with a total of 37,709 strikes. Meanwhile, the minimum total number of lightning strikes occurred on June 8, 2020 with a total of 1,523 strikes.

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